2006

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

MINUTES

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

2005-2006 Membership

(Revised 29 September 2006)

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:

John L. W. Garrou, Co-Chair
P. O. Box 5958
Winston-Salem, NC 27113
(336) 714-8050
E-mail: jgarrou@slickenterprises.com

Senator Charlie Albertson
136 Henry Dunn Picket Road
Beulaville, NC 28518
(910) 298-4923
E-mail: Charliea@ncleg.net

Senator Janet Cowell
230 Grand Avenue
Raleigh, NC 27606
(919) 858-5337
E-mail: Janetc@ncleg.net

Senator Robert M. Pittenger
4521 Sharon Road, Suite 120
Charlotte, NC 28211
(704) 365-0065
E-mail: Robertp@ncleg.net

Speaker of the House of Representatives Appointments:

Representative Joe Hackney, Co-Chair
P. O. Box 1329
Chapel Hill, NC 27514
(919) 929-0323
E-mail: Joeh@ncleg.net

Representative Becky Carney
P.O. Box 32873
Charlotte, NC 28232
(704) 332-1893
E-mail: Beckyc@ncleg.net

Representative Pricey Harrison
P.O. Box 9339
Greensboro, NC 27429
(336) 292-1953
E-mail: Priceyh@ncleg.net

Representative Wilma Sherrill
P.O. Box 18561
Asheville, NC 28814
(818) 254-0991
E-mail: Wilmas@ncleg.net

Walter Clark
310 Pogue Street
Raleigh, NC 27607
(919) 515-1895
E-mail: walter_clark@ncsu.edu

Representative Alice Underhill
3910 Country Club Road
New Bern, NC 28562
(252) 633-2270
E-mail: Aliceu@ncleg.net

Dr. Dolores "Dee" Eggers
Department of Environmental Studies
CPO#2330
University of North Carolina Asheville
Asheville, NC 28804-8511
(828) 251-6654
E-mail: eggers@unca.edu

Representative W. A. "Winkie" Wilkins
210 Fair Oaks Drive
Roxboro, NC 27574
(336) 599-7336
E-mail: Winkiew@ncleg.net

Dr. Edward W. Erickson
Professor of Economics
Box 8110, North Carolina State University
Raleigh, NC 27695-8110
(919) 513-2876
E-mail: ed_erickson@ncsu.edu

Thomas F. Cecich
113 Kenneth Ridge Court
Apex, NC 27523
(919) 303-6802
E-mail: tom@tfc-assoc.com

Tim Toben
8300 Pickards Meadow Road
Chapel Hill, NC 27516-4861
(919) 280-1103
E-mail: tobent@bellsouth.net

Robert J. Glaser
1029 Wade Ave.
Raleigh, NC 27605-2167
(919) 828-4421
E-mail: rglaser@ncada.com

Ivan Urlaub
P. O. Box 6465
Raleigh, NC 27628
(919) 832-7601
E-mail: ncseapolicy@mindspring.com

Susan Tompkins
815 Hungerford Place
Charlotte, NC 28207
(704) 375-3276
E-mail: stompkins@bellsouth.net

Ex Officio Members:

The President of Duke Power or the President's designee

Dr. George T. Everett
Director of Environmental and Legislative Affairs
Duke Power
225 Hillsborough Place, Suite 480
Raleigh, NC 27603
(919) 235-0955
E-mail: gteverett@duke-energy.com

The President of Progress Energy or the President's Designee	Ms. Vicky K. Will Director - Environmental Services Progress Energy 410 South Wilmington Street, Suite 4A Raleigh, NC 27601 (919)-546-4803 E-mail: Vicky.Will@pgnmail.com
The President of the North Carolina Citizens for Business and Industry or the President's designee	S. Lewis "Lew" Ebert President and CEO North Carolina Citizens for Business and Industry (NCCBI) 225 Hillsborough Street, Suite 460 Raleigh, NC 27603 (919) 836-1410 E-mail: lebert@nccbi.org
The President of the Manufacturers and Chemical Industry Council of North Carolina or the President's designee	A. Preston Howard, Jr. President Manufacturers and Chemical Industry of North Carolina (MCIC) 620 N. West Street, Suite 101 Raleigh, NC 27603 (919) 834-9459 E-mail: preston.howard@mcicnc.org
The President of the North Carolina Farm Bureau Federation or the President's designee	Mitchell A. "Mitch" Peele Director of Public Policy North Carolina Farm Bureau Federation P.O. Box 27766 Raleigh, NC 27611 (919) 788-1004 E-mail: mpeele@ncfb.net
The President of the North Carolina Forestry Association or the President's designee	Robert W. Slocum, Jr. Executive Vice President North Carolina Forestry Association 1600 Glenwood Avenue, Suite I Raleigh, NC 27608 (919) 834-3943 E-mail: rwslocum@ncforestry.org

The Southeast Regional Director of Environmental Defense or the Regional Director's designee	Michael Shore Manager, Southeast Climate & Air Program Environmental Defense 186 Pearson St. Asheville, NC 28801 (828)-254-7359 E-mail: mshore@environmentaldefense.org
The Executive Director of the Southern Alliance for Clean Energy or the Executive Director's designee	Stephen A. Smith, DVM Executive Director Southern Alliance for Clean Energy 29 North Market Street, Suite 604 Asheville, NC 28801 (865)567-7429 E-mail: sasmith@cleanenergy.org
The Executive Director of the North Carolina Coastal Federation or the Executive Director's designee	James H. Stephenson Program Analyst North Carolina Coastal Federation 3609 Highway 24 (Ocean) Newport, NC 28570 (252) 393-8185 E-mail: jims@nccoast.org
The Executive Director of the North Carolina Conservation Council or the Executive Director's designee	Michael Nelson Director of Governmental Relations Conservation Council of North Carolina 112 S. Blount Street Raleigh, NC 27601 (919) 839-0020 E-mail: mike@conservationcouncilnc.org
The Dean of the Nicholas School of the Environment and Earth Sciences, Duke University, or the Dean's designee	Timothy Profeta Director, Nicholas Institute for Environmental Policy Solutions P.O. Box 90328, Duke University Durham, NC 27708 (919)613-8709 E-mail: tim.profeta@duke.edu

The Dean of the College of Agriculture and Life Sciences at North Carolina State University or the Dean's designee	Dr. Daniel J. Phaneuf Associate Professor of Agriculture and Resource Economics Box 8109 North Carolina State University Raleigh, NC 27695 (919) 515-4672 E-mail: dan_phaneuf@ncsu.edu
The Dean of the School of Agriculture and Environmental Sciences at North Carolina Agricultural and Technical State University or the Dean's designee	Dr. Godfrey A. Uzochukwu Professor of Earth and Environmental Sciences North Carolina Agricultural and Technical State University 261 Carver Hall Greensboro, NC 27411 (336) 334-7030 E-mail: uzo@ncat.edu
The Director of the Carolina Environmental Program at the University of North Carolina at Chapel Hill or the Director's designee	Dr. Douglas Crawford-Brown Director, Carolina Environmental Program Professor of Environmental Science and Public Policy University of North Carolina at Chapel Hill Chapel Hill, NC 27599-1105 (919) 966-6026 E-mail: douglas_crawford-brown@unc.edu
The Distinguished Research Professor (with expertise in sea level change), Department of Geology at East Carolina University	Dr. Stanley R. Riggs Distinguished Research Professor Department of Geology, College of Arts and Sciences East Carolina University Room 101, Graham Building Greenville, NC 27858 (252) 328-6015 E-mail: riggss@mail.ecu.edu

The North Carolina State Climatologist

Dr. Ryan Boyles
Director and State Climatologist
Research III Building, Centennial Campus
Box 7236, North Carolina State University
Raleigh, NC 27695-7236
Telephone: 919-513-2816
Email : ryan_boyles@ncsu.edu

STAFF

George F. Givens, Commission Counsel
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Georgeg@ncleg.net

Jeff Hudson, Commission Counsel
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Jeffreyh@ncleg.net

Susan Iddings, Commission Counsel
Bill Drafting Division
North Carolina General Assembly
401 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-6660
Fax: (919) 715-5459
E-mail: SusanI@ncleg.net

Jennifer McGinnis, Commission Counsel
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Jenniferm@ncleg.net

Mary Watson, Senate Commission Clerk
1129 Legislative Building
16 West Jones Street
Raleigh, North Carolina 27601
Phone: (919) 715-3050
Fax: (919) 754-3255
Email: Forresterla@ncleg.net

Thelma Utley, House Commission Clerk
1323 Legislative Building
16 West Jones Street
Raleigh, North Carolina 27601
Phone: (919) 733-5775
Fax: (919) 754-3191
E-mail: Lucasmla@ncleg.net

Jennifer Mundt, Commission Analyst
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Jennifermu@ncleg.net

(THIS IS ONLY A DRAFT)
Minutes

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

Friday 3 February 2006
10:00 a.m.
Room 643, Legislative Office Building

The Legislative Commission on Global Climate Change convened its first meeting on Friday 3 February 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building with Representative Joe Hackney, Co-Chair, presiding. Other members present were Mr. John Garrou, Co-Chair, Senators Albertson, Cowell, Pittenger, Representatives Carney, Harrison, Sherrill, Underhill and Wilkins. Other members present were Mr. Walter Clark, Dr. Dolores Eggers, Dr. Edward W. Erickson, Mr. Tim Toben, Mr. Ivan Urlaub, Mr. Thomas Cecich, Mr. Robert J. Glaser, Ms. Susan Tompkins, Ms. Caroline Choi, Dr. Douglas Crawford-Brown, Mr. Barry Eveland, George Everett, Ph.D., Mr. Preston Howard, Mr. Michael Nelson, Mr. Mitchell Peele, Dr. Daniel Phaneuf, Mr. Tim Profeta, Dr. Sethu Raman, Dr. Stanley Riggs, Mr. Michael Shore, Mr. Robert Slocum, Stephen Smith, D.V.M., and Dr. Godfrey Uzochuckwu. Absent was Mr. James Stephenson.

A copy of the meeting notice for this meeting, a copy of the agenda and the visitor's registration are attached to these minutes as **Exhibits A, B and C.**

Representative Hackney opened the meeting by introducing Commission staff and Sergeant-at-Arms Staff. Commission staff includes George Givens, Commission Counsel, Jeff Hudson, Commission Council, Jennifer McGinnis, Commission Counsel, Susan Iddings, Commission Counsel, Tim Dodge, Commission Analyst, Thelma Utley, Commission Clerk and Mary Watson, Commission Clerk.

Representative Hackney said that the purpose of a legislative Commission is generally to educate and to make recommendations and he hoped that this would be an educational experience for everyone and an opportunity to make recommendations.

Representative Hackney cautioned members against concluding that we cannot do anything about global warming if we should conclude that we do need to do something. Representative Hackney said that federal officials have followed the lead of many of the states. He hoped that we would educate ourselves on what effect, if any, global warming will have on North Carolina in coming years. We are a big tourism state, forestry state, and agriculture state. We need to examine these issues carefully so we can prepare for things to come, if we need to.

Representative Hackney introduced Mr. John Garrou, Co-Chair of the Commission and asked Mr. Garrou to come forward for comments. Mr. Garrou said that he was pleased and honored to be a part of this Commission and looked forward to working with everyone. Mr. Garrou said that he had no particular expertise or qualifications to serve on this Commission other than as a managing partner in a group of

attorneys and trying to get them to reach a consensus. Mr. Garrou said that he has no preconceived ideas about what North Carolina should do about global warming. He said he feels very strongly as an interested citizen that this is an issue we should address, and that we have a duty to our State and our grandchildren. Mr. Garrou said that with goodwill and open minds, we could reach some conclusions and make some recommendations about an issue that potentially is the most important issue facing our state, our nation, and our planet.

At the request of Representative Hackney, Commission members introduced themselves and said how they were appointed to the Commission. Mr. Jim Stephenson, Program Analyst at NC Coastal Federation, was absent from the meeting because of illness.

Representative Hackney called on Mr. George F. Givens, Commission Counsel, to introduce staff counsel and explain the agenda. Mr. Givens made note of the Commission Membership List and reviewed authorizing legislation that created this Commission. Both of these documents are included in the minutes as **Exhibit D**.

Mr. Givens said that the major responsibility of this Commission is 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 General Assembly.

Mr. Givens said that the Commission's duties are to work cooperatively with other state and national governments to organize a forum on global climate change.

Mr. Givens said that this Commission is supposed to report to the General Assembly and the Environmental Review Commission on or before 1 November 2006; however, the Commission members were not appointed until recently. The reporting date will need to be changed.

Mr. Givens asked visitors to sign the visitor's registration sheets and asked members to sign and send forward their reimbursement forms.

Mr. Givens noted that House Bill 1600, a bill introduced by Representatives Harrison and Underhill to direct state agencies to evaluate and report annually on their activities and research related to greenhouse gas emissions and climate change, is included in these minutes as **Exhibit E**.

Mr. Givens said that the legislation that created this Commission was originally intended to be part of the general studies bill and House Bill 1600 would have been incorporated into that legislation by reference. As it happened, the general studies bill failed and this authorizing legislation (S.L. 2005-442) passed at the last minute.

Dr. William H. Schlesinger, Dean, Nicholas School of Environmental & 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. A copy of Dr. Schlesinger's slides and comments are included in these minutes as **Exhibit F**.

Dr. Schlesinger said that global climate change was a huge important issue for the state and for the world and was certainly deserving of deliberation.

Dr. Schlesinger introduced himself as Dean of the Nicholas School of the Environment at Duke University, which is the country's first graduate school of professional environment in the nation. The School has about 50 faculty and 400 students that deal with issues such as climate change and land use. Dr. Schlesinger said they are seeing more and more statements on climate change everyday. This issue is well before the public as shown in the February 2006 issue of **North Carolina Wildlife's** article on potential effects of climate change on the wildlife of this state by John Manuel. He urged all Commission members to take a look at that article.

Dr. Schlesinger referenced his handout and the American Geophysical Union (AGU), the largest collection of scientists that study the conditions of planet earth. The AGU came out with a statement acknowledging that the climate of earth shows variations and variability through the past, and that things are happening now that can only be explained by recognizing a human influence on the planet's climate. Dr. Schlesinger said that half of his presentation would cover carbon dioxide and our atmosphere and its effect on climate and half considering 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 said that best records obtained on measures of carbon dioxide in earth's past have been from taking cores of ice from Antarctica and from Greenland that can be cored to great depth, brought back frozen to the laboratory, sectioned into what amounts to the size of hockey puck sized cookies, and melted in controlled laboratory conditions. When the ice was laid down, there were bubbles of air trapped in it and, when melted under controlled conditions in the laboratory, those bubbles can be extracted. You can melt those bubbles out and measure the concentration of gases in them. Hence, comes a record of carbon dioxide in earth's atmosphere, parts per million by volume. From 900 A.D. to about 1950, carbon dioxide concentration varies from about 275 to 285 parts per million. Some of that variation is sampling air and analytical air.

Dr. Schlesinger said that in 1850, things began to change rapidly with the timing of the Industrial Revolution, the widespread use of the steam engine with coal, the discovery of oil in Titusville, PA, and the proliferation of modern conveniences that liquid petroleum, natural gas and the widespread use of coal to generate electricity have brought to modern life. All of those fuels contained carbon and, when you burn them, it is an oxidized process that puts carbon dioxide in the atmosphere (CO_2). Today's value (in this room) would have a concentration of around 380 parts per million. Dr. Schlesinger said that essentially all scientists agree with the accuracy of these measurements, the procedures for doing so. Our carbon dioxide is rising and has risen from historically lower values.

Dr. Everett asked Dr. Schlesinger if he had a similar graph that shows sea level in the same time period.

Dr. Schlesinger said that there are such graphs available but he did not have them with him today.

Dr. Schlesinger said that gases such as carbon dioxide, water vapor, methane, nitrous oxide, various gases that have more than two atoms comprising them, have what we call a radiating force in the atmosphere. They absorb heat radiation trying to

leave earth's atmosphere. The way the greenhouse effect got to be the analogy for this is very much the way your car left in a suburban parking lot on a summer day warms up on the inside. Sunlight shines through the glass of your windshield with complete transparency, warms the inside of your car or a greenhouse, and the glass on your car or greenhouse acts exactly in analogy to gases in earth's atmosphere. It impedes the transmission of heat radiation back out to the atmosphere. The same thing is essentially true with earth's atmosphere. The sun's radiation, which is short wave or visible radiation, passes through the atmosphere transparently on a non cloudy day, warms the surface of the ground and the sea, those warm surfaces give off infrared or heat radiation and carbon dioxide water vapor and other gases tend to impede the transmission of that back to outer space, so the atmosphere warms.

Dr. Schlesinger said that we should be thankful that there is a natural greenhouse effect on planet earth. If it wasn't for natural levels of carbon dioxide water vapor and some other gases in the atmosphere, our planet, at its distance from the sun, shows every sign of being below freezing and the oceans would be frozen from top to bottom and we would not be here talking about this problem today.

What we are really thinking about the effect is not of the natural greenhouse effect that we all need to be thankful for but for what will happen as concentrations of some of these gases increase in the atmosphere. The prime culprit is carbon dioxide because it is so directly linked to fossil fuel combustion and we have such good records that it has risen quite a bit already.

Dr. Schlesinger showed a slide of a longer core taken from Antarctica. There are scientific aspects of this graph which scientists have a real curiosity about. Why the trough always seems to be a 200 parts per million (ppm), carbon dioxide and why, until humans came on the scene with the Industrial Revolution, the peak of carbon dioxide has always seemed to be 275-285 ppm. We are up to 380 ppm today. We have essentially taken the earth from a realm that includes all of civilized human society on the planet in which the carbon dioxide concentration was bounded between 200-280 ppm and raised it in about 150 years to a realm of around 380 ppm. One of the basic paradigms of the past is an index of the present and the future and so the correlations of the past very much lead us to feel that there will be a warming of earth's temperature in parallel with that rise of carbon dioxide.

Dr. Schlesinger showed a slide on Greenland and the slight variability of carbon dioxide concentration through time and rapid rise at the beginning of the Industrial Revolution. This data was gathered from a variety of sources by Michael Mann who is now at Penn State University. The blue data are reconstructions of the temperature of planet earth, back to 1000 A.D., based on the isotopic record contained in tree rings, coral reefs. All kinds of proxy sources show us today, by looking at that ring of wood in an oak tree, the ratio in the cellulous will reflect the temperature of the year in which that ring was laid down. So, we assume that kind of relationship can be used to reconstruct the temperature of the past, way before anybody thought of setting up weather stations and recording it. The red line on the graph is the history of instrumented data recorded from when we began to have enough weather stations that persist in the same place. The line across the center of the graph is the zero point. The whole period before the Industrial Revolution showed stable environmental conditions. The entire variation of earth's temperature over that period was within plus or minus a quarter of a degree centigrade and then

began to rise very rapidly. The correlation to that of the carbon dioxide in the Greenland icepack carries that to a new temperature regime. This graph has been challenged by a number of folks who have looked at parts of it in isolation of the overall importance. For instance, a number of groups have asked why there was a big down slope in earth's temperature during that period. Dr. Schlesinger said we need not lose sight of the whole picture of what these data show which is relatively constant conditions for most of our history, followed by rapid rise at a rate and to a realm that we have never really before experienced. We can be thankful that most of human evolution and most of the history of industrialized society was actually during a relatively climate stable and favorable condition that now seems to be changing rapidly.

Dr. Schlesinger showed a graph representing over 100 years of carbon dioxide rising with mean global temperature. He said that you can focus on the variation, but he focuses on the correlation between those two, which alarms him as to where it is and to where we are headed in terms of the planet's temperature. These are data that North Carolina should be proud that we house in the National Climate Data Center in Asheville, which Tom Carl has headed up for many years. This is a gathering of all of the data from the U. S. Weather Bureau and other stations around the world that can be gathered together. So we can look at the last 100 years or so, and see land and ocean stations showing data showing average of all values and data showing colder than average and warmer than average years. Almost all of the cold years are in the late 1800's or early 1900's and almost all of the warm years are recent; 2005 was just analyzed as the warmest year on record. The trends show it getting higher each year.

Dr. Schlesinger said there was a widespread consensus that the planet is in fact getting warmer. He sees a correlation to that of rising carbon dioxide; others may argue whether this is a natural trend and we simply will expect these kinds of natural fluctuations to bring it back to some level. But, there are all kinds of reasons to look at the increasing concentration of a gas that we know very well the physics of in the atmosphere, and one gas that we know has a radiated property in our atmosphere.

Dr. Schlesinger showed a slide of a satellite picture of earth measuring temperature over a 20 year period. This data revealed areas that showed some degree of cooling, areas showing very little change, and areas of increasing warmth. In the Northern Hemisphere, in Alaska, Canada, and in North Europe and Siberia, there was strong warming of about 2 degrees centigrade over that instrumented satellite data. There have been arguments in literature about whether this is well calibrated and whether or not the satellites have had to be replaced and is the new one calibrated like the old one. Most of those arguments are now resolved and those who had questions are now convinced that this does show a warming and that the warming is real. Dr. Schlesinger showed data measuring sea ice in the Arctic as an example of this; nature's way of telling us what is going on. Every record showed a downtrend from close to 13 million square kilometers in 1970 down to about 11 ½ million square kilometers more recently to the present. Senator Pittenger asked Dr. Schlesinger if the Arctic phenomenon is also present in the Antarctic. Dr. Schlesinger said that the Antarctic has much less sea ice because there is a continent under there. And the icepack in Antarctica seems to be in a rough study state. The ice is melting on the Antarctic Peninsula, but apparently a small amount is accumulating on the center by the South Pole. Senator Pittenger said that a study he

read from NASA indicated that it was growing in terms of ice. Dr. Schlesinger said that they were probably looking at the grounded ice on the continent itself. The overall change that was reported in a paper by some NASA folks in science last year shows a rough balance; an accumulation on the continent, a loss on the Antarctic Peninsula, that about balances it. The warming is very much concentrated in the Arctic and less has been seen in the Antarctic. These results are consistent with projections based on ice cover taken in Antarctica and Greenland, which indicate the concentration of carbon dioxide and gases present in 900-1000 A.D. up to almost the present. Senator Pittenger followed up by asking Dr. Schlesinger if there are variables that could affect the outcome of the models such as water vapor. Dr. Schlesinger said that this is a difficult science, but that the models have gotten very sophisticated and can now predict much better. These results represent the consensus of earth scientists.

Dr. Schlesinger said that he would speak to effects showing a consensus of scientific opinion and where there is no consensus there is uncertainty. He said that scientific meetings are a great place for airing differences. One of these is a prediction from US Forest Service Workers of the likely dominance of tree species that would occur over the Eastern United States, late in this century, with the projected changes in temperature that the climate models show. Dr. Schlesinger showed graphs supporting this prediction. He said that if you let forests develop, you would expect an oak hickory forest to dominate over time. In the Coastal Plain, the pine trees dominate. The graph showed what would happen late in this century with the typical prediction of climate by a climate model. Sugar maple disappears from the Northeast and Midwest, the Eastern U.S. becomes widely dominated by oak hickory forests, and the various species of pines becomes the predicted dominant productive species in Arkansas and Missouri. Dr. Schlesinger said that climate change, played down on the landscape of natural vegetation, has every expectation of causing large changes in the distribution of trees as we know them. Livelihoods dependent on certain trees growing well and being productive have every reason to be of dominant concern. Dr. Everett asked Dr. Schlesinger if the trees in the Northeast would then move further north and why the pine trees disappeared on the East Coast. Dr. Schlesinger said the dominant species in a natural forest would no longer be the species of pines that we think of today. Dr. Everett asked if the pine trees were the dominant species today. Dr. Schlesinger said pines trees were dominant species in the coastal plain of North Carolina before human planting of plantations, they were just not as well managed. Dr. Everett asked if those forests would convert to oak hickory if they are left. Dr. Schlesinger said that the disappearance of pine trees is due to frequent fires or they are out competed out by a species of oak and hickory.

Rep. Wilkins asked Dr. Schlesinger what degree of climate change is predicted. Dr. Schlesinger said that the increase in global surface air temperature is predicted to be between five to nine degrees Fahrenheit by 2060.

Dr. Schlesinger displayed a graph showing the prediction of future rainfall. He said there is nowhere near the consensus, scientifically, on future rainfall patterns that there is on future temperature patterns. Climate scientists are very much in agreement about warming and how much warming and where, but there is much less agreement on changes in rainfall. Nevertheless, there are some emerging views and one of those views is that there will be some substantial areas in North America and around the world that are predicted to get lower rainfall (10 to 20

percent) in future climates. There are also areas in California that are predicted to get higher rainfall. That is largely driven by an anticipated, more frequent El Nino cycle. The alarming one is the prediction of 10-20 percent rainfall decline in the grain growing regions of the Great Plains. For our concern today, the State of North Carolina falls in a prediction that the average annual rainfall would be up to 20 percent lower. The shortfall of rainfall that we saw last summer, as various kinds of water restrictions were imposed, is predicted as the average condition in the future. It is not 20 percent seasonally because we expect a greater frequency of hurricanes. So, you might expect more rain in the fall, but our overall annual rain is predicted to be of that degree lower in the future, meaning that spring and summer show higher than 20 percent anticipated declines. Senator Pittenger asked Dr. Schlesinger how the predictions are arrived at. Dr. Schlesinger said that the predictions are arrived from general circulation models of the climate. The planet is modeled with an atmosphere surrounding it with several stacked layers, very much like an onion. Sunlight shines down through those layers and warms the surface of the earth or the sea that re-radiates heat radiation into the little parcel of air right above it. The whole atmosphere has layers that are divided into boxes. That box either re-radiates into the atmosphere or can move by the work of the wind, or it can get warmer in place. Depending on those conditions, it can evaporate water off the ocean surface or land surface. If it gets cold at night, it can rain that back out on the surface. Senator Pittenger asked if the computer model had variables in them that could affect the outcome of those models such as clouds and water vapor. Dr. Schlesinger said this is a very difficult science and that very few places around the world are able to participate in these models effectively. As the models have evolved through time, they have gotten better and better. Dr. Schlesinger showed a satellite measure of the planet's temperature and a climate model's prediction of where the temperature of the planet will warm. There is a real correspondence between the two that shows the maturity of the science.

Dr. Schlesinger spoke to the area of diseases spread globally according to climate. When we talk about a warming of the planet, there is very much the possibility that either the disease or the mosquito that carries the disease that cannot survive in the temperate zone today. Some of the best work has been done with malaria by a group out of the UK. By 2050, malaria will be present with the predicted climate changes. The place to notice is along the Gulf Coast and extending up the East Coast of the U.S. We have not had to worry about malaria as an emergency room condition; however, malaria will be a consideration as something that may come into the door 50 years from now. Some of the difficulty of this globally is the areas that are currently suitable that are becoming unsuitable. So, there are winners and losers on this on the global map. In CA, the Central Valley is predicted to become unsuitable, largely because of the dry climate predicted. The rest of the Eastern US and our State needs to be concerned about this.

Mr. Cecich said he had participated in the U. S. Global Change Program in 2000 and had edited the health section of that report from this program. Malaria was discounted as an impact on the United States. There are health concerns from mosquitoes, but malaria hasn't been an issue. He said he wanted to be careful that we were not misleading folks into thinking that we would have a malaria outbreak in North Carolina. Dr. Schlesinger if he was correct in saying that malaria was a grave concern for some parts of the United States. Dr. Schlesinger said this conclusion is based on modeling for a world without a public health infrastructure. Malaria is a

coastal plain disease. According to one study done, it poses a future risk for the Gulf Coast and the lower East Coast of the United States.

Dr. Schlesinger said that a paper by Emmanuel at MIT who noticed a striking correlation between sea surface temperature as measured by submarines and merchant ships over the last few decades and hurricane severity which is an index they calculated taking in account the most intense winds that the hurricane showed and how many days it lasted. A large number of climatologists have some resonance that this seems to be an important thing to expect. There is every reason to think that hurricanes feed on warm surface oceans, and as they surface of the world's oceans gets warmer, that will be a feeding ground for water vapor in hurricanes.

Dr. Schlesinger said that he did not want to be quoted as saying that Hurricane Katrina was due to global warming but an increasing intensity and frequency in hurricanes is some that very much should be on the table for discussion.

Dr. Schlesinger showed a graph on sea level rise for Baltimore that showed sea level above standard points back to 1900. Sea level has been rising, with the rate of rise recently increasing by a factor of four in Baltimore. They are subjected to high sea level rise compared to the global value by virtue of rebounding from some glacial conditions 18,000 years ago. The overall trend is one of rise during the time that we have seen rising carbon dioxide. Dr. Schlesinger said that Dr. Riggs would have some longer record of data to show on this.

Dr. Schlesinger said that Ben Poulter, a graduate student in the Nicholas School at Duke, took the rather simple approach of looking at eastern North Carolina and a topographic map of NC, and said what would happen if sea level rose a third of a meter (about a foot) or one meter (close to three feet) by the end of the century (see graph on page 6 of Exhibit F). The median predication by the IPCC is about 18 inches. The graph shows what will be flooded with the smaller rise of sea level and what will be flooded with the larger rise in sea level. A copy of this graph is reprinted in the Environmental Defense booklet. Dr. Schlesinger said that if you are interested in tourism, or if your family has a history and heritage of enjoying a beach front property in North Carolina or the Outer Banks, be somewhat concerned about this. It might be underwater. If it is not underwater on the average basis, it could very well be under water on the over washed conditions of hurricanes, which may themselves be more intense and more frequent. So, the topographic maps are pretty good maps these days and sea levels rising show how much land could be under water some day.

Dr. Schlesinger concluded by saying that it is striking that we have a prediction in the northern hemisphere with the greatest warming far north. He said that the greatest warming in North Carolina appears to be during the winter with not much change in the tropics.

Representative Hackney suggested to Commission members that they e-mail names of future presenters they wished to hear make presentations to the Commission and the Co-Chairs would consider them.

Senator Albertson asked Dr. Schlesinger when the ice core samples were taken. Dr. Schlesinger said that this program started in the 1970's. Senator Albertson asked if the information derived from these samples was agreed upon as valid and reliable information. Dr. Schlesinger said that very few people doubt the samples until you get to the top of the core, which has the ice deposited most recently in time. Senator Albertson asked Dr. Schlesinger if there was one piece of evidence he has analyzed that would convince him that global warming is indeed taking place. Senator Albertson asked about the graph showing the large rising increase in measurements. Dr. Schlesinger said that the rate of increase of carbon dioxide in the atmosphere is itself increasing as the world economies use fossil fuels. So, the rate of carbon dioxide is rising and the rate of temperature rise is not only predicted to increase but you can begin to see evidence that it is also increasing.

Senator Albertson asked Dr. Schlesinger if there is agreement in the scientific community that global warming is indeed taking place. Dr. Schlesinger said that there is consensus in the scientific community. A statement from the American Geophysical Union, the nation's premier society of more than 10,000 earth scientists, says that the temperature of the planet is warming and humans are responsible for warming above and beyond any natural variability one may expect. However, there will never be 100 percent consensus in the academic world on any issue. There are probably 10 scientists of note compared to 10,000 that might hold a contrary view.

Senator Pittenger asked Dr. Schlesinger what percentage of the natural greenhouse effect is carbon dioxide. Dr. Schlesinger said that the percentage of carbon dioxide is about one-third of the total; the remaining two-thirds from water vapor. Senator Pittenger said that he had read that only four percent of greenhouse gases are carbon dioxide related. Dr. Schlesinger said that of the gases that are increasing in the atmosphere today, somewhere between 50 and 60 percent is due to carbon dioxide.

Senator Pittenger asked Dr. Schlesinger if he was familiar with the Kyoto protocol that stated there were 17,000 scientists who opposed that agreement and did not subscribe to the same theory that global warming was anthropogenic. Dr. Schlesinger said that he was familiar with that statement and had been asked to sign that statement. He said that one should look closely at how these signatures were obtained. Senator Pittenger said that there are, however, those scientists who do not agree that global warming is taking place. Dr. Schlesinger said that number is probably 10 in 10,000 who do not agree.

Mr. Cecich asked Dr. Schlesinger if he could comment on the latest data regarding the rate of generation of carbon dioxide concentrations, as more fossil fuels are being used, and also comment on the length of time that carbon dioxide stays in the atmosphere.

Dr. Schlesinger said that the average residence time for carbon dioxide in the atmosphere is about five years. The largest sink, whereby carbon dioxide is removed from the atmosphere is the ocean. Carbon dioxide is dissolved in the ocean water. The prediction on how long it would take to get rid of the anthropogenic carbon dioxide in the atmosphere and in the ocean is100 to 200 years.

Senator Pittenger asked Dr. Schlesinger if there was an increase in the temperatures over the last 100 years, how the cooling periods would be accounted for. Dr. Schlesinger said that the cooling periods could be due to particulates or natural variability. The magnitude of the overall trend from 1800 to today is the period of cooling is relatively small on a trend that shows a rapid temperature increase.

Mr. Clark asked Dr. Schlesinger if there are any studies that show a relationship between deforestation, hence a lack of carbon sequestration opportunities, during the rapid increase in carbon dioxide levels in the atmosphere, beginning with the Industrial Revolution.

Dr. Schlesinger said that beginning in the late l800s when the westward expansion caused a lot of forests to be cut down in North America, there is some indication in the isotope record of carbon dioxide that some of the expansion in carbon dioxide concentrations were due to deforestation. After World War II, a lot of land was abandoned, forests grew back, and a source of fossil fuels began to dominate our economy. The source is now 80 percent fossil fuel and 20 percent from the forest.

Mr. Slocum commented on Dr. Schlesinger's data with regard to projections regarding the change in forest cover. Mr. Slocum said that review of materials show that softwood range expands, with rising temperatures, it does not contract. In fact, a warmer and potentially dryer climate in parts of North Carolina would tend to favor pines as opposed to hardwoods. Mr. Slocum said that he had not found anyone at NCSU and those looking at climate models that believe that the southern pine forests are going to contract and disappear from the United States and North Carolina.

Dr. Schlesinger said that this surprised him also and that is why he had been very careful to use the words dominant tree species and productivity. He said that it is not that they really expect it would become impossible to grow a loblolly pine in North Carolina, but whether it will be the highest productive species on managed land in those future climates. It does coincide with some of the conclusions of the U. S. National Assessment of Climate Change of differential productivity in these regions.

Mr. Slocum said that he understands that some of the work done at Duke reports that increasing carbon dioxide is improving the productivity of the world's forests, not decreasing it.

Dr. Schlesinger said that data is only based on increasing temperature. If one adds changes in precipitation, one may get a different result.

Dr. Schlesinger said that the work in Duke Forest, when grown in the atmosphere of somewhat higher carbon dioxide, one sees an increase in the productivity of a lot of species. The species that did the best was poison ivy.

Mr. Slocum said that loblolly pine is grown in east Texas and Louisiana, which is considerably warmer on average than the climate in North Carolina. He believes that productivity will improve and continue the dominance of southern pine as an intermediate species, which is what it is now in terms of overall forest evolution.

Dr. Smith asked Dr. Schlesinger if most of the sea level rise and associated land loss observed to date is largely due to thermal expansion of the ocean.

Dr. Schlesinger said that about half of the sea level rise observed to date is largely due to thermal expansion of the ocean. Dr. Smith asked Dr. Schlesinger to speak to the degradation of land ice in Greenland and Antarctica and some evidence that those land glaciers are moving more rapidly towards the sea. Dr. Schlesinger said that if all of the ice melted in the sea, it would have no effect on sea level. When ice melts that has land under it or when ice melts that is over the ocean but sitting on the bottom, these contribute to sea level rise.

Dr. Raman said that there are several stations that record the climate change in North Carolina. Based on a study for over 100 years, the NC coastal area has warmed about 4 degrees Fahrenheit, the Piedmont area about two degrees Fahrenheit and the mountains of NC have neither warmed nor cooled. The precipitation has generally increased except in the over the past 100 years. In the coastal region, there has been a decrease in precipitation in 100 years, but in the past 50 years, there has been an increase. He said he would be glad to provide more information on this at a future meeting.

Dr. Uzochuckwu asked Dr. Schlesinger why the satellite measurements of precipitation did not show a significant change of precipitation in Africa. Dr. Schlesinger said that the lack of fieldwork and field stations in Africa and South America hamper their ability to get the data they need in those areas.

Dr. Everett asked Dr. Schlesinger to comment on where sea level was during the last ice age. Dr. Schlesinger said that it was about 120 meters below today. Dr. Everett asked if sea level was much further west than what the graph of the Nature Conservancy showed even before man was living on the earth. Dr. Schlesinger said that was during the time when the earth was warmer. Dr. Everett asked how long the earth has been warming. Dr. Riggs said that the glacial maximum was 18,000 to 20,000 years ago and there has been a whole series of ups and downs since then.

Representative Wilkins referred to the slide on the northern hemisphere and asked what caused the dip in 1575. Dr. Schlesinger speculated as to whether there was a volcanic eruption, sun fluctuations or other events of nature that may have caused the variation. Mr. Howard asked Dr. Schlesinger to give some idea of what the percentage of carbon dioxide that exists around the globe is due to natural conditions and what percentage exists due to mans activity. Dr. Schlesinger said that the amount of carbon dioxide in the atmosphere today compared to 1850 is about 30 percent higher, and it is all due to human activity. Some of it is from fossil fuel combustion, some of it from forest destruction. Today, deforestation is largely continuing in the tropics. Some carbon dioxide is dissolving in the ocean and some of it is thought to be taken up by tempered forests.

Mr. William G. Ross, Jr., Secretary of Environment and Natural Resources (DENR), gave a report on the ongoing efforts by DENR to control emissions of carbon dioxide and other greenhouse gases.

Secretary Ross said that we had started implementing the North Carolina Clean Smokestacks Act (CSA) When Governor Easley signed that bill into law in 2002, North Carolina took a great step forward toward a cleaner environment, healthier

lives and a stronger economy. This great step forward was propelled by a great consensus.

Secretary Ross said that the Clean Smokestack Act established a plan and deadlines for significant reduction of sulfur dioxides, nitrogen oxides, and mercury.

Secretary Ross said that he was happy to report that Duke Energy and Progress Energy were doing a great job in carrying out the installation of control equipment that is needed to meet those reductions on schedule.

Secretary Ross said, the Clean Smokestacks Act also directed the Division of Air Quality in DENR to conduct a study on carbon dioxide emissions. That study has looked at the science of climate change and at options for reducing greenhouse gas emissions. Secretary Ross said that the CSA also directed the Division, in September of each year through 2005, to report its finding and recommendations to the legislature and to the public at large.

Secretary Ross introduced Brock Nicholson, Deputy Director of the Division of Air Quality (DAQ) DENR, to give an update on this report, its findings, its recommendations and what has been done under the carbon dioxide study that has already been undertaken. Secretary Ross also introduced Mr. Keith Overcash, Chief of DAQ, DENR.

Secretary Ross said that when the September 2005 report was completed, he asked DAQ to extend the technical efforts that were used to help produce the report to conduct a facilitated dialogue with a diverse group of parties who were interested in the subject of climate change. That group is called the Climate Action Plan Advisory Group (CAPAG). Secretary Ross said that the purpose of all of this effort by DAQ, by DENR and by partners is to support, inform, assist, and complement the work that our State, led by the Global Climate Change Commission (GCCC), is doing on the subject of climate change. Secretary Ross said that DAQ/DENR would be reporting the results of their ongoing work to the GCCC on a regular basis and would welcome suggestions and comments. Secretary Ross said that what had been learned so far makes them think that there will likely be many options for our State that would help reduce greenhouse gas emissions, help the State prepare for and respond to climate change, and provide important economic opportunities.

Secretary Ross said that his opinion of climate change is that it is center stage for a great challenge and a great opportunity that our State, our nation, our planet faces. It addresses how we sustain the earth, the planet, so that it sustains us. How do we sustain the earth so that it continues to provide for us the conditions for everyone to have a secure, healthy, decent life? Secretary Ross said that he is hopeful that the ideas of those responding to climate change will generate economic opportunity. Secretary Ross gave two examples of this opportunity—one from NC and one from PA. If you look at the outcome of the base realignment and closure commission process of North Carolina, you will see a very positive outcome for our State in many ways. The heart of that outcome was a great partnership between NC and the military focused on sustainability of environmental, social, economic and military on an ongoing basis. Secretary Ross said that Pennsylvania brought in a Spanish wind energy company that was going to create over 1,000 jobs in a five-year period. 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.

The Commission took a lunch break.

After the lunch break, Representative Hackney noted that a packet of information was distributed to each member that was received from the British Consulate in Atlanta.

Mr. Brock Nicholson, Deputy Director, DAQ, DENR, 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. A copy of Mr. Nicholson's slide presentation and the final report on Carbon Dioxide Emissions Reduction Strategies for North Carolina, pursuant to North Carolina's Clean Smokestacks Act, are in included in the minutes as **Exhibit G**.

Mr. Nicholson said that he would be focusing on recommendations from the report. Section 13 of the Clean Smokestacks Act required DAQ, DENR, to look at the issues of carbon dioxide control from power plants and other stationary sources as well as the mercury issue. The first report in September 2003 was focused on the science issue of carbon dioxide controls. Mr. Nicholson acknowledged Mr. Jim Southerland, staff member of DAQ, who did the vast majority of work on this report, and Mr. Tom Peterson, a consultant who helped to provide the technical baseline for the report.

Mr. Nicholson said that DAQ thought it would be more appropriate to look more broadly at potential for all sources in all sectors for consideration because there are many other sources than the utilities. They also talked about pollutants other than carbon dioxide. Mr. Nicholson said the recommendations are up for consideration for further refinement and fall into three groups. The first group includes the actions that are currently underway and consist of eight listed plans of action. The second is a group of regulations that one might arguably say might not require legislation. The third group is one that will require some other direction by entities such as this Commission and the legislature. These recommendations will be on the table for refinement by the advisory group process.

Mr. Nicholson said that the first recommendation will be a consensus based process of developing and facilitating a North Carolina climate action plan effort, involving technical working groups, government consultants, and the whole spectrum of stakeholders that have an interest in this subject. The next recommendation is for DAQ to initiate activities to assist in the development of a Southeastern States Regional Climate Action Plan involving other states. A meeting has been held with the Air Directors in Georgia, South Carolina and Tennessee to begin discussions on this. Another recommendation is that a required baseline, point source inventory reporting requirement for greenhouse gases CHg for facilities holding an air permit with the Division, will be instituted within three years. A lot of these emissions are already being reported under another program. Mr. Nicholson said it was important to continue to review rules and evaluate means to stimulate improvement and efficiencies at existing and future proposals for coal-fired units to the extent that they are complimentary. Current utilities operate at some of the highest efficiencies in the country, but it is also good to look for other opportunities in that area. Efficiency

equates to less carbon emitted. Mr. Nicolson said that it was important to look at our State Implementation Plan (SIP) and assure that when we make selections for strategies, that we do those that are most mutually complementary to reducing greenhouse gases. The next recommendation is defining carbon dioxide for other greenhouse gases. Another recommendation is to look at opportunities to see if there are opportunities for a fee system that could help support a registry or inventory effort. The eighth recommendation is a commitment to work with this Commission in any way appropriate to help understand the technical aspects of these issues and develop information this Commission would like to have in terms of benefits from various measures, especially as compared to a goal to be reached.

Mr. Nicholson added that DAQ recommends that North Carolina state government increase its leadership role and intensify efforts currently outlined in the State Energy Plan (SEP). There is a lot of information in the SAP in terms of energy efficiency and looking at alternative fuels. They also recommend that clean coal technologies and non combustion energy electricity sources such as gas fired coal systems, wind, solar, hydro or other emerging low emission technologies are strongly considered when new power plant capacity is initiated. Each five years, starting in 2010, we need to report on the state of the science and practical application of energy efficient power generation technology, such as IGCC and technology to remove and sequester carbon dioxide from coal-fired power plants. In addition, a CHg greenhouse gas point source inventory, a registry of greenhouse gas reductions that require state and private participation in a carbon market, should be instituted with guidance and resources for third party verification. The General Assembly and all agencies of the state should intensify actions to establish the State as a major greenhouse gas technology and information center to include educational, consulting resources, manufacturing expertise, and selling of equipment on or for the world market. There is a grand opportunity here to develop ourselves with the universities we have in our area. DAQ believes the General Assembly and Executive Branch should use their formal and informal powers with national and international bodies to make a statement of support to assure strong and sustainable reductions of greenhouse gases. While we think our efforts in this state alone are really important, we need to encourage our friends and neighbors to be doing similar things.

Mr. Tim Profeta asked Mr. Nicholson to talk about the timeframe on the decision-making for the clean air plans for the criteria pollutants for NOx and SOx and the incentives for those criteria. Mr. Nicholson said that, with the new standards coming on, there are plans in place for both ozone and fine particulate matter starting in 2009-10. The EPA has new proposed standards that would require plans regarding the 2012-14 fine particulate matter to be developed.

Mr. Profeta also asked Mr. Nicholson if NC should be looking at the same incentives as Pennsylvania on the technology of greenhouse gases. Mr. Nicholson said they would be interested in the incentives PA created and the view of the Commission regarding those incentives. There are opportunities there to be explored.

Dr. Everett asked Mr. Nicholson if they had looked at nuclear power generation. Mr. Nicholson said that nuclear generation was not listed as an option but could be an option for reducing carbon dioxide.

Mr. Nicholson continued by saying that long term recommendations encourage strong considerations in the SEP and where we need to give incentives for getting those things done. They also recommend that the General Assembly establish a leadership center within the university system and fund agriculture and forestry and programs in other areas throughout state government or the private sector to undertake and continue programs to maximize permanent or long term carbon dioxide capturing sequestration or elimination of emissions and to utilize the state's vast bio fuel potential with partial cost recovery from sale of carbon credits on the international market. The Division also recommends that efforts be undertaken to assist new systems and technologies being implemented to treat animal waste as an energy resource and to provide the economic and technical assistance to get these programs and Smithfield Agreements in place. Mr. Nicholson added that there are vast opportunities to use the bio resources we have in this state.

Mr. Nicholson added that the Division also recommends the development of a renewable portfolio standard and environmental portfolio standard and the implementation of those at the earliest possible time. The main difference is under an environmental portfolio standard, you open it up to energy efficiency credits or considerations as opposed to not having those. Mr. Nicholson also said that they recommend that a public benefits fund be established to assist in the adoption and implementation of an energy reduction project that will also reduce emission of greenhouse gases from various private and public operations. Mr. Nicholson said that they recommend that the North Carolina governmental agencies continue to work with county, municipal, and other state and national and international and private organizations to insure that North Carolina is able to develop a more energy efficient and less emitting transportation sector. Another recommendation is for a planning group or commission to be established to evaluate needed steps and develop long range energy disaster recovery plan adaptation.

Mr. Nicholson said that the next steps are to establish the Climate Action Plan membership in groups, implementation of inventory details, and work with this Commission to develop the climate action plan advisory group (CAPAG), report to this Commission, the General Assembly and the Governor and implement these recommendations.

Dr. Smith asked Mr. Nicholson if black carbon from diesel fuel was an agent contributing to climate change and what the co-benefits would be from looking at other greenhouse gases. Mr. Nicholson said they do have options to look at black carbon.

Mr. Shore asked Mr. Nicholson if he had thought through how his work would feed back into the Commission, how the timing would be, and how he would suggest this Commission might use the information he provides. Mr. Nicholson said DENR basically plans to work with the Commission and thinks it is a logical component of what the Commission is doing. DENR proposes interacting on an ongoing basis, reporting to the Commission their findings, and offering opportunity for comments, suggestions, and advice. Representative Hackney said that he and Mr. Garrou had discussed this, met with Secretary Ross and Mr. Nicholson, and the tentative plan was to have an agenda item from DENR at each meeting, especially if there is anything new to report. Mr. Slocum asked Mr. Nicholson when the CAPAG group is going to be established. Mr. Nicholson said that the first meeting would be held on

the 16 February 2006. They are getting all of the members lined up for the kickoff. Mr. Slocum asked Mr. Nicholson if the membership had been determined. Mr. Nicholson said that the membership had not yet been fully determined. Mr. Slocum said that he was glad to hear that DENR was looking at removal and sequestration as well as emissions and hoped the CAPAG would follow their lead and look at the broad issue and not just focus on the emissions side. Dr. Eggers asked Mr. Nicholson where energy conservation and the use of alternative fuels fit into the picture. Mr. Nicholson said that the executive summary has more information on conservation efforts. He said they were totally open for all suggestions to put on the table. Representative Hackney urged all members of the Commission to read Mr. Nicholson's report. Mr. Profeta asked Mr. Nicholson if the Commission could offer suggestions to include in DENR's process. Mr. Nicholson said that they were open to all suggestions from Commission members.

Mr. Profeta asked Mr. Nicholson if the Commission could offer advice and suggestions to DAQ, DENR. Mr. Nicholson said that they were certainly open to any advice and suggestions the Commission had to offer. Dr. Everett asked Mr. Nicholson about the statistic on page 12 of the report that ranks NC as 14 in total carbon dioxide emissions and somewhere around tenth in the nation. Mr. Profeta said that we are doing really well as a nation but we have a long way to go. Mr. Nicholson said our utilities do very well as producing power as efficiently as we can; however, we can continue to look at opportunities.

Mr. Urlaub asked Mr. Nicholson to explain why it is important to establish a baseline for greenhouse gas emissions inventory. Mr. Nicholson said that knowledge of where we are is important to understand what benefit we will get from various options and to develop a tracking system whereby credits of reductions for carbon are traded. Mr. Urlaub asked Mr. Nicholson if a market value for carbon emissions would be established in the United States that this Commission would need to address. Mr. Nicholson said that he could not predict for sure, but he thought it is one option which creates an incentive for reductions.

Mr. Nicholson gave a report on specific activities and plans of the Division of Air Quality, DENR, to develop and implement standards and plans to control emissions of carbon dioxide and other greenhouse gases. A copy of his presentation is listed as **Exhibit H**. Representative Hackney said that he and Mr. Garrou thought it was important for this Commission to know what DENR is doing and they look forward to working with them.

Mr. Nicholson said that the CAPAG complements and supports the efforts of the Legislative Commission, provides technical support and knowledge on greenhouse reductions to include cost and benefits, focusing on those actions that can be taken to reduce or sequester more of the controlled approaches. He emphasized that the benefits they want to address are those that are of benefit to industry sectors in the state economy and this includes options that create jobs to the extent we can quantify those through various models and analyses. Mr. Nicholson said that the idea of ongoing reporting to the Commission is very valuable to them.

Mr. Nicholson said the purpose and goals are to develop a proposed climate action plan or recommendations for that plan. Policy options, including cost and benefit analysis, utilizing Duke University as well as a consulting team, will be a consensus

process of stakeholders. This is a facilitated, invited stakeholder process to come up with recommendations; and, if there is no consensus, it may not be worthy of consensus. Consensus does not mean full unanimous agreement, necessarily. Some of the areas they want to look at are agriculture, whether it is better sequestration of carbon in the soils through farming practices and the nature of those practices to growing certain crops for alternative fuels, tweaking of forest management practices to make more money while sequestering more carbon, energy use whether it is commercial, industrial or residential, which is a huge area for conserving emissions of carbon. That could take on more efficient electric motors and encourage industry to replace existing motors with more efficient motors to building codes that would allow for building construction to take advantage of these opportunities. Transportation and land use are big users of fuel in this country and there are ways to conserve travel. The opportunities for resources, such as bio waste, are an alternative form of energy.

Mr. Nicholson said that this is a consensus based process to come up with these options or policies. Some of the decision criteria for selection would obviously be the question of whether we have good greenhouse gas reduction potential and is it cost effective. Are there co-benefits to the economy and does it make sense. Direct savings in terms of fuel use and other feasibility issues will play into the dialogue and discussion. Economic analysis is critical because this is what will sell the programs.

Mr. Nicholson said there was a ten step, fact based process. Consultants and contractors will be present to provide those facts for each option under consideration. This is an open table for all stakeholders. There will be non stakeholder members participating in workgroups and all can observe the process and contribute their resources to the effort.

Mr. Nicholson said that there will be voting, if necessary, to come up with a recommendation. They are looking at about six formal meetings of this stakeholder group through 2007, culminating in a report with recommendations to this Commission and the legislature.

Representative Hackney told Mr. Nicholson that this Commission would look forward to hearing from him regularly about the CAPAG activities.

Dr. Uzochuckwu asked Mr. Nicholson if he had models from other states they were looking at in terms of the process. Mr. Nicholson said that similar processes had been carried out in Connecticut and are currently being considered in Arizona and New Mexico. Over time, a good model will evolve and we will benefit from that experience.

Dr. Uzochuckwu asked if other states have global warming commissions. Representative Hackney said that this information would be provided in the next presentation.

Mr. Givens asked Mr. Nicholson what he thought the potential was for future regional cooperation with the USEPA Southeast Region. Mr. Nicholson said that they are working with the other southeastern states and have had their first meeting by phone with Georgia, South Carolina, and Tennessee; however, there are no formal agreements at this time.

Dr. Smith asked Mr. Nicholson if he anticipated a member of the North Carolina Utilities Commission to be appointed to CAPAG. Mr. Nicholson said they do not presently have a member from the Utilities Commission but would certainly consider this excellent suggestion.

Ms. Judith Greenwald, Director of Innovative Solutions, Pew Center on Global Climate Change, Alexandria, VA, gave a report on actions taken by other states and local governmental units in the United States to address global climate change. A copy of Ms. Greenwald's presentation slides, a brochure on The Basics of Global Climate Change, and a handout entitled Learning from State Action on Climate Change are listed as **Exhibit I**.

Ms. Greenwald gave an overview of what other states are doing to address global climate change. Ms. Greenwald said that the Pew Center was founded in May 1998 and is an independent, nonprofit, and nonpartisan organization. They are a one-stop shop on climate change and are essentially three organizations in one. They do research, education and outreach, and work with businesses. Their work is focused on both domestic and international issues. Ms. Greenwald said their education and outreach is focused on opinion leaders and their business work is focused on 41 Fortune 500 companies who are members of their Business and Environmental Leadership Council. They work with companies in three ways, they review their research, collaborate on education and outreach, and they study the companies and draw lessons from their experience and bring those lessons to other companies who may want to take action. Ms. Greenwald said they are independent of these companies and receive no monies from them.

Ms. Greenwald showed a slide listing the members of the Environmental Leadership Council and said that most of these companies are large greenhouse gas emitters. She said the companies tend to be active on pollution on one of three fronts: reducing their own greenhouse gas emissions, developing products or services that will reduce greenhouse gases ultimately, and they will be working with policy makers to design solutions that are both environmentally effective and business friendly.

Ms. Greenwald said that state level emissions are significant. If you put the southeastern states together as a group, emissions come out somewhere between that of India and Germany. If you just look at North Carolina alone, it has emissions similar to the Netherlands or Venezuela. The United States is a big emitter, but it is comparable to many countries that are engaged in this issue globally.

Ms. Greenwald said the motivations for greenhouse gas reductions are all over the place. A lot of people are reducing greenhouse gases because they care about climate impacts but they also do it because of a side benefit or other things they are trying to pursue, i.e. economic development, energy price volatility, energy independence, air quality concerns, traffic congestion, and all other things. Ms. Greenwald said that North Carolina has been particularly active in dealing with hog waste issues that can have significant greenhouse gas co-benefits.

Ms. Greenwald said that if you look around the country at what states are doing and at both policies that are being directly done for purposes of reducing greenhouses gas emissions and those achieving initial reductions indirectly, just about every state

is doing something. This action is occurring both on the legislative side as well as the executive branch. Most states are involved in some sort of regional initiative on either climate change or clean energy. Twenty eight states have climate action plans and a number of states have greenhouse gas reporting. There is a lot going on in the electricity sector which is the biggest contributor to greenhouse gas emissions and states have a lot of relevant authorities to bring to bear on that issue. Transportation is the second biggest sector in contributing to greenhouse gas emissions. There is also quite a bit going on in agriculture and forestry; however, they do not have that many greenhouse gas emissions, although there are some emissions from the agriculture sector. But the biggest role for agriculture and forestry is a potential sink for the emissions from other sectors. What trees, soils, and plants can do is absorb carbon dioxide from the atmosphere and turn it into carbon. This is a way of offsetting emissions from other sectors. Agriculture and forestry have the potential to be the producers of biofuels and biofuels can displace fossil fuels and fossil fuels are the major cause of climate change. The reason why biofuels work on a life cycle basis is that the carbon dioxide that you absorb from the atmosphere during the time when the trees and plants are growing is then released when you burn that energy, but then you plant it again. On a lifecycle basis, you have zero emissions.

Ms. Greenwald said that the regional greenhouse gas initiative in the northeast, announced in December 2005, is a regional cap and trade program that will initially cover power plants and carbon dioxide emissions. Ms. Greenwald explained that a cap and trade program means that you put an overall cap on a group of sources of emissions. In this case, it is about power plants which have a cap. But any individual source can emit as much as it wants as long as the whole region stays under the cap and holds an emission allowance. The state has to figure out some way of distributing these emission allowances which are certificates that allow you to emit one ton of carbon dioxide. As long as you hold ten tons of emission certificates, you can emit ten tons of emissions. If there is a power plant that has a particularly difficult time reducing their emissions, they can buy allowances from someone else, by reducing extra and selling some of their allowances. It is an especially efficient and effective way to achieve a particular environmental goal.

Ms. Greenwald said that there is a lot of experience in this country with the sulfur dioxide program, which is a cap and trade program. That is how dramatic reductions in the emissions that cause acid rain have been achieved. The European Union is now engaging in their cap and trade program to meet their Kyoto targets and is the first mandatory greenhouse gas cap and trade program in the world. The Northeast Regional Greenhouse Gas Initiative is the second mandatory cap and trade program in the world and the first in the U.S.

Ms. Greenwald said the beginnings of this initiative are interesting from Europe's perspective. Governor Pataki had a process looking into what NY could do on the issue of climate change. They did a lot of analysis which indicated that if they could involve more states and more sources, they could do more for the environment for less money, working with other states. Governor Pataki invited his fellow governors throughout the northeast to participate in this process which took about two years to development an agreement which seven of them signed onto in December. Just a few days prior to the agreement, it looked like there were going to be nine states, but at the last moment, Massachusetts and Rhode Island decided not to participate.

Massachusetts has decided to go its own way and has its own carbon dioxide power plant initiative. Others speculate that these initiatives will merge and they, along with Rhode Island, will come into the northeast initiatives. The goals for this program are to stabilize power plant emissions at current levels, starting in 2009, they are going to hold that to 2015, and then start reducing in a second phase and get to ten percent reduction by 2019.

Ms. Greenwald said that California is doing quite a bit to reduce greenhouse gas emissions. Governor Schwarzenegger in June 2005 announced targets and timetables for the state to achieve 2000 levels by 2010, 1990 levels by 2020 and have a long term target of 80 percent below current emissions by 2050. The Governor's Climate Action Team, which is a group of folks from state government, has worked on a draft report that is out for public comment. This is their first cut at what California is already doing that will help it meet its targets and what more needs to be done to bridge the gap as to where they are headed and to where the Governor's targets have demanded that they go. California has an aggressive renewable portfolio standard that will help them meet their targets with vehicle greenhouse standards requiring cars and light trucks to meet certain greenhouse gas standards, achieving a 22 percent reduction by 2012 and a 30 percent reduction by 2016. The auto industry has sued the State of California over these standards, so it is not clear what their fate is. If they are upheld, this will be a fairly significant reduction and makes a big difference in California's ability to meet these targets. CA has an unusually large fraction of its emissions coming from its motor vehicles. Every agency in CA is in on this game; all different agencies are participating in different ways.

Ms. Greenwald said that the California Energy Commission and Public Utilities Commission have a policy statement that standards should be set requiring coal-fired power plants to capture and sequester their carbon dioxide emissions. Carbon capture and sequestration, or CCS, is an important potential solution to continuing to use the coal that we have such an abundant resource of in this country, in a carbon constrained future. There is a lot of interest in this technology which has tremendous potential. It looks like it can be done but there are still issues with integrating the various components of this technology, demonstrating that it can be done at the scale needed, and demonstrating that once you capture the carbon and inject it into underground, geological formations determine that it actually stays there. There is a lot of work to be done but a lot of interest in this technology. The CA Public Utility Commission already requires is utilities to use a carbon adder in their analyses which means they have to assume that in the future, carbon dioxide is going to have some price. They have to take this into account when they make their investment decisions. There are a number of other states that require this as well. Ms. Greenwald said that the CPUC also just announced they are going to start a proceeding looking at a load cap or cap on their utilities overall emissions both from a power in its generators as well as the power that it brings into the state. There is quite a bit going on at the various California agencies that bears looking at.

Ms. Greenwald said that Pennsylvania has an alternative energy portfolio standard (AEPS), which is their variant of a renewable portfolio standard (RPS). A renewable portfolio standard means a certain fraction or a certain amount of generation has to come from renewables. There is a variation among states on how renewables are defined. PA is the only state that includes coal in its renewable portfolio standard

and that is why they are calling it an AEPS and not a RPS. It will require a significant amount of renewables as well. They have a tiered standard. Tier one standard will require an eight percent of generation to come from renewables by 2020, including solar, wind, low impact hydro, coal mine methane and fuel cells, and Tier Two, which will be ten percent by 2020 and has waste coal, large hydro, municipal solid waste, and integrated gasification combined cycle. They have a program called Energy Deployment for a Growing Economy (EDGE). This is an initiative that was recently announced by their Governor to promote these advanced clean coal technologies. They are using a number of different tools to advance these technologies, including procurement authority to buy output of some of these projects that helps them get financing, using state monies to provide financing and using some of their regulatory powers to help some of these projects pass through their PUC. They have asked the USEPA to provide some regulatory relief for some smaller plants if they do innovative projects. It is not clear if EPA has the authority to grant this relief, but they are trying a multiplicity of approaches to try to get these projects moving. They also have an Energy Harvest Grant Program which includes smaller projects on renewables. They have an Energy Development Authority which provides all kinds of innovative financing, including grants, bonds, loans, etc., and they have an Alternative Fuels Incentive Grant Program that focuses on developing alternative fuels infrastructure.

Ms. Greenwald said there was also a lot of action in the southwest. In Arizona, Governor Napolitano had an executive order that established an advisory committee to develop a plan and greenhouse gas emission targets for the state. They already have a RPS that would help them meet any targets with recommendation due in a few months. In New Mexico, Governor Richardson actually has set a target similar to what Governor Schwarzenegger did. Their emission targets are to achieve 2000 levels by 2012, ten percent below 2000 by 2020, and presenting a report on impacts of what climate change would mean for the state. Their report is due to the Governor at the end of 2006. The key differences between these two processes are that in New Mexico, the Governor set the target and the group is assigned as to how to meet it. In Arizona, the group is trying to figure out what the target should be as well as how it should be met. In North Carolina, the question is open to whether or not there should be targets at all.

Ms. Greenwald said that electricity and transportation are the two biggest emitters in North Carolina as well as opportunities in other sectors. If you look at the U.S. as a whole, electricity is 32 percent of the emissions and in North Carolina it is 42 percent. If you look at transportation, emission is twenty-six percent nationally and 30 percent in North Carolina.

Ms. Greenwald said that are two ways to look at electricity. Generators with facilities located within the borders of the state of North Carolina, you have a pretty big coal fraction, sixty one percent in NC versus 50 percent in the nation as a whole. Nuclear faction is also larger in NC than the national average of 32 percent versus 20 percent. NC uses less natural gas than the US as a whole. What this means is that the overwhelming majority of the emissions that are from this sector come from coal. Natural gas emits much less carbon dioxide than coal. The other way to look at this is by consumption of power from outside the state. On that basis, coal is about half of the emissions from the power that is used to serve the citizens of NC. This is pretty much in line with the rest of the country. Nuclear power in NC is about 45 percent of the fuel mix to serve the citizens and 20 percent nationally.

Ms. Greenwald said that since coal is such a big part of this problem, solutions need to be made. The Northeast Regional Greenhouse Gas Initiative covers coal plants, natural gas plants. The Massachusetts Power Plant Initiative will also cover coal plants through a cap and offset program which is slightly different from a cap and trade program. The Western Governor's Association has a process to consider incentives for demonstrating the carbon capture and sequestration technology that people think is so important to the future of coal. There are also many efforts around the country to advance integrated gasification combined cycle (IGCC). IGCC has many benefits in terms of air and water quality. On carbon, IGCC gets so much attention because the way the technology is set up and makes it much easier to capture the carbon dioxide and store it. By itself, IGCC is no more efficient that the best conventional coal power plants. There are people who think it has the potential to be significantly more efficient because it is a newer technology; however, at the moment, it does not give a greenhouse gas benefit by itself. What it does is set up an easier way to capture and store the carbon.

Ms. Greenwald said that 22 states, plus the District of Columbia, have RPS's. The approach where you require a certain amount of electricity to come from renewables is becoming fairly popular around the country. Each state has an interesting story, especially Texas. Texas enacted its RPS in the late 1990's while it was doing electric restructuring. It was signed into law by then Governor George W. Bush. The Texas law was one of the first states to do renewable energy credit trading, which is similar to the cap and trade program, and has been copied by many other states. The economic development benefits in Texas have been enormous. West Texas has a tremendous wind resource and a lot of jobs have been created. The state has updated its target that is much more aggressive and includes a small solar component.

Ms. Greenwald said that a lot of states have worked together to track renewable energy credits across state lines to set up renewable energy credit trading. Twenty two states have public benefit funds, 14 of them with energy efficiency and renewables. The rest have renewables only, funded through a fee on electric power, and this money has been used to promote energy efficiency and renewables in a variety of ways.

Ms. Greenwald said that 10 states have formally adopted the CA greenhouse gas standards. If the standards are upheld and these ten states follow CA with these greenhouse gas standards, then over one third of newer vehicles sales will be subject to these emissions standards. There are more states considering this, pending the outcome of the lawsuit.

Ms. Greenwald said that 27 states have incentives and mandates for promoting ethanol. Ethanol is potentially very helpful on climate change. If you make ethanol from cellulose, which is the plant matter than comprises most plant stalks, you get 100 percent improvement in greenhouse gas emissions compared to fossil fuels. That is the goal and where everyone would like to be headed. However, at the moment, most of the ethanol in this country is made from corn. The benefit from ethanol made from corn is much smaller than the benefit from ethanol made from cellulose. Best estimate is a 30 percent benefit on a life cycle basis if you make it from corn, with a range of estimates and differing opinions on the subject.

Ms. Greenwald said that 28 states have Climate Action Plans (CAP). What these plans mean is that you have looked at emissions and what might be done to reduce these emissions. The impacts tend to vary by region such as impacts on sea level rise or storm intensity on the coast and water availability and drought concerns in the west, and specialized concerns such as in Vermont regarding Sugar Maples.

Ms. Greenwald said that many states are working on greenhouse gas reporting and registries. A few of these are mandatory but more of them are voluntary. Several states have moved into regional groups to work on these registries—one in the northeast under development and one in the Midwest who are working together on a registry. A number of individual states have greenhouse gas registries, already. A number of states are especially focusing in on carbon sequestration registries.

Ms. Greenwald said that in June 2005, the U. S. Conference of Mayors adopted the Kyoto targets with over 200 mayors agreeing to this. These targets have three components: smart growth, urban tree planting, and building codes. They also committed as a group to lobby other levels of government to get them to do their part to meet the Kyoto targets. They also endorsed that the federal government should develop a national cap and trade program.

Ms. Greenwald said that a group is working with cities around the world on climate protection plans, and over 600 cities worldwide are implementing plans to reduce greenhouse gas emissions. They have quite a bit of information around the world on cities adopting climate strategy, transportation, water management, building standards, renewable energy procurement, smart growth and energy efficiency similar to what is happening at the state level but with a flavor or what local government is better able to do. Atlanta has an interesting set of standards under its transportation department. Salt Lake City has been doing a number of interesting things with more efficient traffic lights, urban tree planting and other things. Ms. Greenwald suggested that NC might want to look at what other cities are doing when planning their work.

Ms. Greenwald said there is an interesting initiative in the upper Midwest called Powering the Plains that NC may want to look at carefully. Most of these initiatives are Governor to Governor with mostly state legislators being involved as well as private sector businesses. Their big focus is on rural economic development with regard to wind power and bio fuels. They also have a coal initiative and are trying to move ahead on a number of technological fronts as well as figuring out a plan for the region. The Northeast Regional Greenhouse Gas Initiative, cap and trade program, as well as the New England Governors and Easter Canadian Premiers have an initiative and have set targets and timetables and an action plan to meet these targets and timetables. There is a lot going on with states working together. Each of the west coast states is quite active on its own and is working cooperatively as well.

Ms. Greenwald said she was here today to help the Commission decide which policies they might want to pursue. Many recommendations in DENR's report have precedence in states around the country. North Carolina may want to look to these other states and find out their experience as you explore some of these initiatives. Ms. Greenwald said that The Pew Center would be happy to provide as much

information as needed on these specific initiatives and would connect NC to officials in other states who can fill you in on their initiatives.

Ms. Greenwald said that some of the DENR recommendations are to promote cleaner coal and renewable energy capacity, mandatory greenhouse gas reporting, energy efficiency becoming a center of low carbon technology development. There is also The Third Frontier Initiative in Ohio is working on developing their capacity to work on low carbon and other technologies of the future. There is a particular emphasis on fuel cells. DENR wants to work with other states in the southeast and there are a lot of models for regional cooperation around the country. There is quite a bit going on in agriculture. A number of states have public benefit funds; a lot of states have RPS's, and a lot going on in transportation emission reductions. There is a wealth of experience for NC to draw on as you look through these options.

Ms. Greenwald concluded by saying that states are actually leading on climate change with most of the efforts having extensive stakeholder involvement, including the private sector, which has been quite important in their success. There are multiple drivers and multiple benefits of these initiatives, not just about climate change, and they are achieving real emission reductions. States are providing lessons for potential federal action, which is a big interest to The Pew Center. Even with federal action, states will have a role to play because of the relevant authorities. Whether it is a federal program implemented through the states or complimentary programs that the states can do that the feds do not have a particularly good grip on, there is a role for the states over time. The Pew Center is seeing a trend toward regional action which is a positive step toward better efficiency and effectiveness. There is some interest in NC in working regionally, and NC is well positioned to be a leader in this region and could benefit from cooperation with the other states and the other states could benefit from cooperation with NC. There are tremendous resources here with universities, research, and the desire to move ahead.

Ms. Greenwald gave the website for the Pew Center, and said it offered a lot of information on the issues this Commission would be dealing with regarding the science, the impacts, technologies, and what is going on in the rest of the world with climate change.

Dr. Eggers asked Ms. Greenwald if the Pew Center had looked at carbon reduction goals, and which states have penalized components. Ms. Greenwald said that the Pew Center is stronger at the federal level but tends to prefer an approach with more specific goals for the private sector. They believe that this is a big problem that will be solved with a number of little pieces. Mr. Toben asked Ms. Greenwald if it would useful to look at North Carolina specifically and where our opportunities are for some of these alternative energy and transportation opportunities.

Mr. Toben also asked Ms. Greenwald if there was an opportunity for a carbon tax instead of the CAP and trade system. Ms. Greenwald said that they are in contact with Commission staff as to how the Pew Center can help North Carolina. A case study was done with the North Carolina hog waste agreement after a major hurricane flooding. It is a good example of companies implementing technologies. There is a lot of North Carolina specific opportunity that DENR is exploring. Ms. Greenwald said with regard to Mr. Toben's question on CAP and trade versus taxes, this is both economic and political. Analytically, there are many reasons for a tax. Economists

say that, depending on how you design your cap and trade program, you can get very similar outcomes on a tax versus a cap and trade program. What cap and trade does is it gives you the opportunity to award good behavior and punish bad behavior. Ms. Greenwald said that in a cap and trade program, you don't just have one step where you set the tax and let things happen. You also have a step on how you are going to distribute the allowances. In that process, which can be quite messy and politically difficult, you actually make decisions on who is going to get those allowances and who is not. Ms. Greenwald said that one of the things that can be done is an initial distribution, which helps transition high emitters into being low emitters, but over time you can make it a more level playing field. The distinction between a cap and trade program and a tax program is, under the cap and trade program, you can make some choices about what you are going to do with the emitters. That can include revenue choices.

Mr. Urlaub asked Ms. Greenwald how North Carolina could take a more integrated look. He asked the Pew Center to direct us to resources that can help us bring the transportation and electric sectors together, with energy efficiency measures, alternative fuels, and energy renewables, along with nuclear power. Ms. Greenwald said that the short answer is yes. NC DENR is going to be doing some modeling analysis and they should be able to get a lot of information from this process.

Mr. Profeta said that the Nicholas Institute School of Environmental Earth Sciences at Duke University and Duke Energy are working together on a climate change policy project that focuses on assessing carbon taxes (versus cap and trade) how to optimize both policy options, and which option better transitions our economy in terms of greenhouse gases.

Senator Cowell asked Ms. Greenwald if the Pew Center has a position on nuclear energy as part of the mix of energy resources that could be used to reduce greenhouse gases. Ms. Greenwald told Senator Cowell she would send her a paper she had written on nuclear energy as a source for greenhouse gases reduction. Ms. Greenwald said that the Pew Center's view on nuclear power is that it is potentially part of the solution to climate change, but it has troubles of its own. Because of climate change, it is worth making a significant public investment to try to solve those problems. They are in favor or various initiatives that would lead to improvement in nuclear power, particularly with waste and cost issues.

Mr. Peele said that it is important for us to look at what we are already doing in North Carolina. There are a number of projects already in place that Commission members may be interested in hearing from such as Advanced Energy, North Carolina GreenPower, the State Energy Policy Council, and the North Carolina Biomass Council. Representative Harrison asked Ms. Greenwald about her comments on ethanol gas. Was this science capable of producing a 30 percent reduction rate? Ms. Greenwald said that the 30 percent was not universal, but it was their best estimate.

Representative Hackney noted that reading material had been passed out to Commission members provided by Mr. Shore on Economic Opportunity in Addressing Global Warming and Understanding Global Warming for North Carolina. These reports are listed as **Exhibit J**.

Senator Pittenger said that he had distributed to members of the Commission a copy of a book, The Skeptical Environmentalist by Bjorn Lomborg; and if others were interested, he would be glad to provide them with a copy of the book.

Representative Hackney called on Mr. Jim Havens to bring the Commission up to date on what he was doing regarding greenhouse gas emissions. Mr. Havens said that he worked on the subject of greenhouse gas emissions since 1995 with EPA and DOE under a five-year pilot program on climate life, and submitted many recommendations to them for how to establish so-called climate leaders. North Carolina leads the nation for having a number of industries that report their greenhouse gas emissions to the DOE. Since the monies ran out for the pilot program, the same program has been reincorporated into global warming initiatives and continues to date. North Carolina has been recognized as leading the nation in textile companies that are reporting greenhouse gas emissions. He offered to give a more in depth report at a future meeting.

Representative Hackney said that the Commission would meet monthly. The Commission would not be meeting when the legislature is in session, but would resume its meetings in the next interim. Meeting dates would be selected three to four weeks in advance.

Representative Hackney asked members to comment on future speakers, topics, and their ideas for direction of the Commission.

Senator Pittenger said that all of the presenters today were strong advocates of the anthropogenic base causes of global climate changes. He had read material from those scientists who do not share that perspective and would encourage some of these folks be invited to speak to the Commission in order to broaden our perspective. Senator Pittenger suggested inviting Dr. Richard Lindzen, professor of Meteorology at MIT and member of the National Academy of Sciences, Dr. Fred Singer, Atmospheric Physicist from George Mason University and Dr. Bjorn Lomborg from the University of Denmark, to address the Commission.

Representative Harrison asked Dr. Riggs to comment on what is being done at East Carolina University with regard to greenhouse gas emissions. Dr. Riggs said that he and 40 other scientists are working on a program funded by the US Geological Survey dealing with sea level and climate curves for the last 10,000 years, the last 1,000 years, and up to the present. A coastal geologist looks backward and can put together the evolutionary development of the state. They know where they are based on where we are headed, with respect to the changes that are going on. He reminded members that our coastal system does not have a very high elevation, and the changes taking place are traumatic. He said we have a very good understanding of what those changes are and the cost of those changes for North Carolina if we do nothing. He said that it is important to calculate the cost of doing nothing. He reminded everyone of the hurricanes that went into the gulf this past year. They could have come up our coast and would have done the same thing to North Carolina that they did to the Gulf coast states. He said he would like to put before the Commission the information that they have at this time. Representative Hackney said that we would look at that in the future. Dr. Crawford-Brown said that he had worked with both Dr. Fred Singer and Dr. Bjorn Lomborg from Denmark, whose positions are not that different from the rest of the scientific community. They both

claim that there is a lot of uncertainty surrounding this issue. Where they disagree with most of the scientific community is whether that uncertainty is so profound that we ought to be willing to invest in resources to reduce carbon dioxide emissions. Dr. Crawford-Brown said that there is scientific uncertainty at the moment. We need to understand that the emissions we are producing are coming out of legitimate human needs. Our task is to find out how we can satisfy those legitimate needs in ways that do not produce so much carbon dioxide. Every one of us got us into this situation, and every one of us is part of the solution.

Dr. Eggers said that if we err on the side of addressing global warming and we are wrong, we are probably okay. If we err on the side of not addressing global warming and, it happens, the consequences would be grave. The stakes are high in being wrong in that direction. Carbon standards are coming, and greenhouse gas emissions standards are coming. At www.businessweek.com/go/carbon where there is a list of companies that have saved billions of dollars by reducing their carbon emissions. Representative Hackney asked Dr. Eggers to send that link to our staff and we would e-mail the link out to members of the Commission. Dr. Eggers said the state needs access to data and systems models predicting carbon emissions in the future, under alternative energy scenarios. Southern Alliance for Clean Energy has some good information available. DAQ is also getting together some good information. We need to coordinate with other bodies to get a grip on what the future looks like under various scenarios. Senator Pittenger asked Dr. Crawford-Brown to respond to statements by Dr. Singer and Dr. Lindzen. Dr. Crawford-Brown said that the economy of the United States fluctuates. It is not to say that interventions by people in the market do not also cause changes to the global climate. We do not know if the climate fluctuations that are occurring right now are due to human influence or due to a natural variability. Mr. Toben said it would be good to invite members of the business community to speak to the Commission, such as folks from General Electric, DuPont, and BP, who have made a decision to move down a path that foresees a carbon constrained world and have actually made investments and see opportunities for growth and profitability.

Mr. Profeta quoted Senator Joe Lieberman as saying, "if we take action and we are right about global warming, we save the world. If we take action and we are wrong about global warming, we just get more energy efficient and less dependent on foreign oil." Mr. Profeta said that when he considers this topic of global warming, he thinks of two concepts. One is inevitability and one is opportunity. Unless you are one of the ten scientists who do not believe global warming is occurring due to human activity, there is an inevitability that we are going to have to address this problem. If you believe there is inevitable change, change begets opportunity.

Mr. Urlaub said if we do want more information on science, perhaps we should go to the nation's expert, the Director of National Center of Atmospheric Research. We are sitting on top of a lot of opportunities. We have industries in rural counties that are looking for opportunities to carry them into the economic future and need to become more sustainable to protect our state's economic future. Mr. Urlaub said he thinks business can help show us the way and would second the recommendations to bring business speakers to address this Commission.

Dr. Smith commended the leadership provided by the elected representatives to get this Commission going. He said, as a father of three, he believes we have a

responsibility to our children to take action on global warming. Dr. Smith said that we should pay close attention to the co-benefits that will flow from this rural economic development and increased efficiency fuel diversity. As the co-chair of the U. S. Climate Action Network, he believes we need to spend more time understanding the benefits of the emerging carbon trading network and take a hard look at this and how it could benefit NC. Mr. Shore said that he agrees with Senator Pittenger that we need to find out where we have consensus in the science and where we do not have consensus. We will find that there is a tremendous platform on which we can build a solution for NC. The responsibility for us as a state on the issue of climate change will ultimately be solved at the national and international levels. We can only go so far to make a difference; however, states are the foundation for experimenting with policies and this will have an effect at the national level. We need to see what the winning opportunities are, and how we can focus all 34 members of the Commission to deal with some narrow range of issues.

Mr. Cecich said there are many opportunities to move forward to address climate change. If we stopped generating carbon tomorrow and went back to 100 years ago, the carbon in the atmosphere would probably exist another 100 years. So, despite many positive steps that are occurring, we need to look at how to adapt to the impacts of climate change.

Mr. Nicholson said that DENR had prepared an updated comprehensive inventory for the state and projected it forward for a number of years. This will be presented at the first CAPAG meeting on 16 February 2006.

The next meeting date for this Commission is tentatively set for March 3, 2006.

The meeting was adjourned at 3:00 PM.

Representative Joe Hackney
Presiding Co-Chair

Mary R. Watson
Committee Assistant

LIST OF EXHIBITS

EXHIBIT A	Meeting Notice
EXHIBIT B	Meeting Agenda
EXHIBIT C	Visitor's Registration
EXHIBIT D	Commission Membership List and Session Laws
EXHIBIT E	House Bill 1600
EXHIBIT F	PowerPoint presentation and comments made by Dr. Schlesinger on the state of the science related to global climate change
EXHIBIT G	PowerPoint presentation by Brock Nicholson and the final report on Carbon Dioxide Emissions Reduction Strategies for North Carolina
EXHIBIT H	PowerPoint presentation by Brock Nicholson on specific activities and plans of the Division of Air Quality of the Department of Environment and Natural Resources to develop and implement standards and plans to control emissions of carbon dioxide and other greenhouse gases
EXHIBIT I	PowerPoint presentation by Judith Greenwald of the Pew Center, a brochure on The Basics of Global Climate Change, and a handout entitled Learning from State Action on Climate Change
EXHIBIT J	Reading material distributed to Commission members provided by Mr. Michael Shore on Economic Opportunity in Addressing Global Warming and Understanding Global Warming for North Carolina

General Assembly of North Carolina

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

State Legislative Building
Raleigh, North Carolina

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

TIMOTHY R. DODGE
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

12 January 2006

TO: Members of the Legislative Commission on Global Climate Change
Interested Parties

FROM: George F. Givens, Commission Counsel

RE: **Notice of Meeting**

COMMISSION MEETING:

The Legislative Commission on Global Climate Change will meet at 10:00 a.m. on Friday 3 February 2006 in Room 643 of the Legislative Office Building.

Potential agenda items for the 3 February meeting include:

1. 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 (S.L. 2002-4, Sec. 13).
2. Report on activities of the Department of Environment and Natural Resources to develop and implement standards and plans to control emissions of carbon dioxide and other greenhouse gases.
3. Discussion of the state of the science related to global climate change.
4. Report on actions taken by other governmental units to address global climate change.
5. Other matters related to the powers and duties of the Commission.

OTHER 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.

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — February 3, 2006
Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
June Small	NC Electric Membership Corp
Loree Eason	Progress Energy NC
Tony D'Amico	Wake County Parks, Recreation & Open Sp.
Hoke F. Kimball	Division of Air Quality
Lisa Campbell	URS Corporation
Natasia Gundlach	URS Corporation
Tom Mather	NC Div. of Air Quality
Tom Fearn	NC Env. Def NCSEA
Larry Shirley	State Energy Office
Alice Lord	NC Council of Churches
Joanne Kenney Frazer	NC [illegible]

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — February 3, 2006

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Chad Hinton	Civitas Institute
Shannon [illegible]	[illegible]
Denise Chou	Environmental Defense
Amy McCreath	
Tom Tillett	Office of Gov. Jim
ROGER SHEATS	Global Warming Initiatives, Inc.
JAMES HAYEN	Global Warming Initiatives 1017 MAIN Campus Dr. Raleigh 27606
Elizabeth Autz	NC-PIRG
Robin Smith	DENR
Patricia Gunther	NC DENR - DAQ
Keith Overcash	NC DAQ

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — February 3, 2006

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Nancy Thompson	UNC IC
[illegible]	NCAGA
[illegible]	[illegible]
[illegible]	[illegible]
ANDREW M BAILEY	BNA, INC
Ellen Beckmann	City of Durham
Anne Galamb	Triangle Tomorrow
GARY HUNT	DENR
JERI GRAY	League of Women Voters
Jennifer Goodson	office of the Governor
[illegible]	[illegible]

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — February 3, 2006

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Steve Neal	DENR
Wm. Schlesinger	Duke
DENNIS GRAY	ASU
Jim Southerland	NC DENR/DAQ
Judi Greenwald	Pew Center on Global Climate Change
Brock Nicholson	DENR - DAQ
Bill Ross	NC DENR -
GRAHAM LONG	SEN. PITTENGER'S OFFICE
Elizabeth Gill	NC Sierra Club
Kim Hibbard	NCLM
Anita Watkins	NCLM

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — February 3, 2006

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Robert Wilson	S.O.S.
Rodney Wilson	ALSCE
	NC Home Builders
PB Pine	
Angie Kaun	
Dana Peterson	
	NCSU
Kathy Hawkins	
John Mc[illegible]	
Amy Fullbright	

General Assembly of North Car.....

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

State Legislative Building
Raleigh, North Carolina

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

TIMOTHY R. DODGE
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

AGENDA

10:00 a.m. Friday 3 February 2006
Room 643 Legislative Office Building

1. Call to order
   Representative Joe Hackney, Presiding

2. Introductory remarks by Cochairs
   Representative Joe Hackney
   John. L. W. Garrou

3. Report to the Commission and explanation of agenda items
   Authorizing legislation and charge to the Commission
   Introduction of Commission staff
   George F. Givens, Commission Counsel

4. Introduction to, and discussion of, the state of the science related to global climate change
   William H. Schlesinger, Dean
   Nicholas School of Environmental & Earth Sciences, Duke University
   James B. Duke Professor of Biogeochemistry

5. Remarks regarding ongoing efforts by the Department of Environment and Natural Resources (DENR) to control emissions of carbon dioxide and other greenhouse gases
   William G. Ross, Jr.
   Secretary of Environment and Natural Resources

6. 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 (S.L. 2002-4, Sec. 13)
   Brock M. Nicholson, Deputy Director
   Division of Air Quality, DENR

LUNCH *– Estimated for 12:00 p.m. to 12:45 p.m.*

7. Report on specific activities and plans of the Division of Air Quality of the Department of Environment and Natural Resources to develop and implement standards and plans to control emissions of carbon dioxide and other greenhouse gases
   Brock M. Nicholson, Deputy Director
   Division of Air Quality, DENR

8. Report on actions taken by other state and local governmental units in the United States to address global climate change
   Judith M. Greenwald, Director of Innovative Solutions
   Pew Center on Global Climate Change

9. Introduction of, and introductory statements by, members of the Commission

10. Commission discussion and announcements

11. Adjourn

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

2005-2006 Membership

(Revised 3 February 2006)

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:

John L. W. Garrou, Co-Chair
P. O. Box 5958
Winston-Salem, NC 27113
(336) 714-8050
E-mail: jgarrou@slickenterprises.com

Senator Charlie Albertson
136 Henry Dunn Picket Road
Beulaville, NC 28518
(910) 298-4923
E-mail: Charliea@ncleg.net

Senator Janet Cowell
230 Grand Avenue
Raleigh, NC 27606
(919) 858-5337
E-mail: Janetc@ncleg.net

Senator Robert M. Pittenger
4521 Sharon Road, Suite 120
Charlotte, NC 28211
(704) 365-0065
E-mail: Robertp@ncleg.net

Walter Clark
Box 8605, North Carolina State University
Raleigh, NC 27695-8605
(919) 515-1895
E-mail: walter_clark@ncsu.edu

Speaker of the House of Representatives Appointments:

Representative Joe Hackney, Co-Chair
P. O. Box 1329
Chapel Hill, NC 27514
(919) 929-0323
E-mail: Joeh@ncleg.net

Representative Becky Carney
P.O. Box 32873
Charlotte, NC 28232
(704) 332-1893
E-mail: Beckyc@ncleg.net

Representative Pricey Harrison
P.O. Box 9339
Greensboro, NC 27429
(336) 292-1953
E-mail: Priceyh@ncleg.net

Representative Wilma Sherrill
P.O. Box 18561
Asheville, NC 28814
(818) 254-0991
E-mail: Wilmas@ncleg.net

Representative Alice Underhill
3910 Country Club Road
New Bern, NC 28562
(252) 633-2270
E-mail: Aliceu@ncleg.net

Dr. Dolores "Dee" Eggers
University of North Carolina-Asheville,
CPO#2330
Asheville, NC 28804-8511
(828) 251-6654
E-mail: eggers@unca.edu

Dr. Edward W. Erickson
Professor of Economics
Box 8110, North Carolina State University
Raleigh, NC 27695-8110
(919) 513-2876
E-mail: ed_erickson@ncsu.edu

Tim Toben
8300 Pickards Meadow Road
Chapel Hill, NC 27516-4861
(919) 280-1103
E-mail: tobent@bellsouth.net

Ivan Urlaub
P. O. Box 6465
Raleigh, NC 27628
(919) 832-7601
E-mail: ncseapolicy@mindspring.com

Representative W. A. "Winkie" Wilkins
210 Fair Oaks Drive
Roxboro, NC 27574
(336) 599-7336
E-mail: Winkiew@ncleg.net

Thomas F. Cecich
113 Kenneth Ridge Court
Apex, NC 27523
(919) 303-6802
E-mail: tom@tfc-assoc.com

Robert J. Glaser
1029 Wade Ave.
Raleigh, NC 27605-2167
(919) 828-4421
E-mail: rglaser@ncada.com

Susan Tompkins
815 Hungerford Place
Charlotte, NC 28207
(704) 375-3276
E-mail: stompkins@bellsouth.net

Ex Officio Members:

The President of Duke Power or the President's designee	George T. Everett, Ph.D. Director of Environmental and Legislative Affairs Duke Power 225 Hillsborough Place, Suite 480 Raleigh, NC 27603 (919) 235-0955 E-mail: gteverett@duke-energy.com
The President of Progress Energy or the President's designee	Caroline Choi Director of Environmental Services Progress Energy 410 South Wilmington Street PEB4A Raleigh, NC 27601 (919) 546-3775

	E-mail: caroline.choi@pgnmail.com
The President of the North Carolina Citizens for Business and Industry or the President's designee	Barry W. Eveland President and CEO North Carolina Citizens for Business and Industry (NCCBI) 225 Hillsborough Street, Suite 460 Raleigh, NC 27603 (919) 836-1410 E-mail: bsparks@nccbi.org
The President of the Manufacturers and Chemical Industry Council of North Carolina or the President's designee	A. Preston Howard, Jr. President Manufacturers and Chemical Industry of North Carolina (MCIC) 620 N. West Street, Suite 101 Raleigh, NC 27603 (919) 834-9459 E-mail: preston.howard@mcicnc.org
The President of the North Carolina Farm Bureau Federation or the President's designee	Mitchell A. "Mitch" Peele Director of Public Policy North Carolina Farm Bureau Federation P.O. Box 27766 Raleigh, NC 27611 (919) 788-1004 E-mail: mpeele@ncfb.net
The President of the North Carolina Forestry Association or the President's designee	Robert W. Slocum, Jr. Executive Vice President North Carolina Forestry Association 1600 Glenwood Avenue, Suite I Raleigh, NC 27608 (919) 834-3943 E-mail: rwslocum@ncforestry.org
The Southeast Regional Director of Environmental Defense or the Regional Director's designee	Michael Shore Manager, Southeast Climate & Air Program Environmental Defense 186 Pearson St. Asheville, NC 28801 (828)-254-7359 E.mail: mshore@environmentaldefense.org

The Executive Director of the Southern Alliance for Clean Energy or the Executive Director's designee	Stephen A. Smith, DVM Executive Director Southern Alliance for Clean Energy 29 North Market Street, Suite 604 Asheville, NC 28801 (865)567-7429 E-mail: sasmith@cleanenergy.org
The Executive Director of the North Carolina Coastal Federation or the Executive Director's designee	James H. Stephenson Program Analyst North Carolina Coastal Federation 3609 Highway 24 (Ocean) Newport, NC 28570 (252) 393-8185 E-mail: jims@nccoast.org
The Executive Director of the North Carolina Conservation Council or the Executive Director's designee	Michael Nelson Director of Governmental Relations Conservation Council of North Carolina 112 S. Blount Street Raleigh, NC 27601 (919) 839-0020 E-mail: mike@conservationcouncilnc.org
The Dean of the Nicholas School of the Environment and Earth Sciences, Duke University, or the Dean's designee	Timothy Profeta Director of the Nicholas Institute for Environmental Policy Solutions The Nicholas School of the Environment and Earth Sciences P.O. Box 90328, Duke University Durham, NC 27708 (919)613-8709 E-mail: tim.profeta@duke.edu
The Dean of the College of Agriculture and Life Sciences at North Carolina State University or the Dean's designee	Dr. Daniel J. Phaneuf Associate Professor of Agriculture and Resource Economics Box 8109 North Carolina State University Raleigh, NC 27695 (919) 515-4672 E-mail: dan_phaneuf@ncsu.edu

The Dean of the School of Agriculture and Environmental Sciences at North Carolina Agricultural and Technical State University or the Dean's designee	Dr. Godfrey A. Uzochukwu Professor of Earth and Environmental Sciences North Carolina Agricultural and Technical State University 261 Carver Hall Greensboro, NC 27411 (336) 334-7030 E-mail: uzo@ncat.edu
The Director of the Carolina Environmental Program at the University of North Carolina at Chapel Hill or the Director's designee	Dr. Douglas Crawford-Brown Director, Carolina Environmental Program Professor of Environmental Science and Public Policy University of North Carolina at Chapel Hill Chapel Hill, NC 27599-1105 (919) 966-9920 E-mail: douglas_crawford-brown@unc.edu
The Distinguished Research Professor (with expertise in sea level change), Department of Geology at East Carolina University	Dr. Stanley R. Riggs Distinguished Research Professor Department of Geology, College of Arts and Sciences East Carolina University Room 101, Graham Building Greenville, NC 27858 (252) 328-6015 E-mail: riggss@mail.ecu.edu
The North Carolina State Climatologist	Dr. Sethu Raman State Climatologist, Professor of Meteorology Department of Marine, Earth, and Atmospheric Sciences Room 242, Research III Building Box 7236, North Carolina State University Raleigh, NC 27695-7236 Email: sethu_raman@ncsu.edu

STAFF

George F. Givens, Commission Counsel
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Georgeg@ncleg.net

Jeff Hudson, Commission Counsel
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Jeffreyh@ncleg.net

Susan Iddings, Commission Counsel
Bill Drafting Division
North Carolina General Assembly
401 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-6660
Fax: (919) 715-5459
E-mail: SusanI@ncleg.net

Jennifer McGinnis, Commission Counsel
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Jenniferm@ncleg.net

Mary Watson, Senate Commission Clerk
1129 Legislative Building
16 West Jones Street
Raleigh, North Carolina 27601
Phone: (919) 715-3050
Fax: (919) 754-3255
Email: Forresterla@ncleg.net

Thelma Utley, House Commission Clerk
1323 Legislative Building
16 West Jones Street
Raleigh, North Carolina 27601
Phone: (919) 733-5775
Fax: (919) 754-3191
E-mail: Lucasmla@ncleg.net

Tim Dodge, Commission Analyst
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Timd@ncleg.net

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.
(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 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

GENERAL ASSEMBLY OF NORTH C

SESSION 2005

H 1

HOUSE BILL 1600

Short Title:	Climate Change/State Agency Reports/Funds.	(Public)
Sponsors:	Representatives Harrison, Fisher, Haire, Underhill (Primary Sponsors); B. Allen, Bordsen, Faison, Farmer-Butterfield, Insko, Jones, Luebke, and Weiss.	
Referred to:	Appropriations.	

May 5, 2005

A BILL TO BE ENTITLED

AN ACT TO DIRECT STATE AGENCIES TO EVALUATE AND REPORT ANNUALLY ON THEIR ACTIVITIES AND RESEARCH RELATED TO GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE; TO DIRECT THE STATE ENERGY OFFICE TO PREPARE AN ANNUAL ASSESSMENT OF THE STATE'S ACTIVITIES RELATED TO GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE; AND TO APPROPRIATE FUNDS TO IMPLEMENT THE PROVISIONS OF THIS ACT.

The General Assembly of North Carolina enacts:

SECTION 1. The following State agencies shall report to the State Energy Office of the Department of Administration no later than 1 October of each year on their activities and research related to greenhouse gas emissions and climate change:

(1) The Department of Administration.
(2) The Department of Agriculture and Consumer Services.
(3) The Department of Commerce.
(4) The Department of Crime Control and Public Safety.
(5) The Department of Environment and Natural Resources.
(6) The Department of Health and Human Services.
(7) The Department of Insurance.
(8) The Department of Revenue.
(9) The Department of Transportation.
(10) The Utilities Commission.

SECTION 2. The reports required in Section 1 of this act shall include all of the following information:

(1) A description of any studies or research related to greenhouse gas emissions and climate change conducted by the agency.

(2) A description of planning by the agency related to greenhouse gas emissions and climate change.
(3) A description of present and projected risks and vulnerabilities to the agency's areas of responsibility with regard to greenhouse gas emissions and climate change.
(4) A description of the agency's utilization of sources of information related to greenhouse gas emissions and climate change.
(5) A list of key personnel and offices in each agency related to greenhouse gas emissions and climate change.
(6) A list of recommendations to address present and projected risks and vulnerabilities to the agency's areas of responsibility with regard to greenhouse gas emissions and climate change.

SECTION 3. The State Energy Office shall publish at least quarterly a newsletter that provides information on relevant research and models of State action related to greenhouse gas emissions and climate change to the key personnel and offices in each agency listed in Section 1 of this act. The State Energy Office shall post the newsletter on the State Energy Office Web site and shall also distribute the newsletter electronically via the Internet.

SECTION 4. The State Energy Office shall review the reports it receives pursuant to Section 1 of this act and prepare an annual assessment on the adequacy and general preparedness of State agencies with regard to greenhouse gas emissions and climate change. The State Energy Office shall report to the Governor, the General Assembly, and the Environmental Review Commission no later than 1 January of each year on its assessment of the adequacy and general preparedness of State agencies with regard to greenhouse gas emissions and climate change. The State Energy Office shall also distribute its annual assessment in the following formats:

(1) Distribute printed copies of the report to the agencies listed in Section 1 of this act.
(2) Post the assessment on the State Energy Office Web site.
(3) Maintain printed copies of the assessment for inspection at the State Energy Office.
(4) Establish an interested parties electronic distribution list and distribute the assessment via the Internet.

SECTION 5. The State agencies listed in Section 1 of this act shall submit the first reports required by Section 1 of this act to the State Energy Office on or before 1 October 2006. The State Energy Office shall submit the first electronic newsletter required by Section 3 of this act on or before 1 January 2006. The State Energy Office shall submit the first report required by Section 4 of this act to the Governor, the General Assembly, and the Environmental Review Commission on or before 1 January 2007.

SECTION 6. There is appropriated from the General Fund to the State Energy Office of the Department of Administration the sum of two hundred thousand dollars ($200,000) for the 2005-2006 fiscal year and the sum of two hundred thousand dollars ($200,000) for the 2006-2007 fiscal year to implement the provisions of this act.

The State Energy Office may award funds of up to twenty thousand dollars ($20,000) to each agency required to report on their activities and research related to greenhouse gas emissions and climate change pursuant to Section 1 of this act.

SECTION 7. Sections 1 through 5 and Section 7 of this act are effective when the act becomes law. Section 6 of this act becomes effective 1 July 2005.

The Science of Global Climate Change

General Assembly of North Carolina
Legislative Commission on Global Climate Change
3 February 2006

William H. Schlesinger
Dean, The Nicholas School of the Environment and Earth Sciences
Duke University

Thank you for the opportunity to speak before you today. I am Dean of the Nicholas School of the Environment and Earth Sciences at Duke University—the nation's first school wholly focused on professional graduate education in environmental science and policy. We have 50 faculty and more than 400 students who, every day, study critical problems of the environment, including climate change.

It is, of course, the issue of climate change that brings me before you today. Despite a few nay-sayers, I have never before seen a scientific consensus that is stronger than that which accompanies predictions of future climate change. Last year, the American Geophysical Union (AGU), the nation's premier society of more than 10,000 earth scientists, issued a new statement on climate change, which says, "Human activities are increasingly altering the Earth's climate. These effects add to natural influences that have been present over Earth's history. 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."

After 10,000 years of relatively stable concentrations, the carbon dioxide content of Earth's atmosphere began to rise rapidly at the start of the Industrial Revolution, with concentrations increasing from around 270 ppm in 1850 to today's value of about 380 ppm. Along with other gases, carbon dioxide imparts a "greenhouse" warming to Earth's atmosphere. The natural greenhouse effect is enough to keep Earth's temperature above the freezing point of water—something we can all be thankful for. Rising concentrations can be expected to raise the temperature of the planet, especially at night and in polar regions. The temperature on Venus is 890 F, versus a predicted equilibrium temperature of 130 F, which would be found if Venus had no CO_2 in its atmosphere.

During the past 500,000 years, through several ice ages, the Earth has shown a strong correlation between its temperature and carbon dioxide concentrations, as measured in Antarctic ice cores. The cause-and-effect relationship is still under scientific scrutiny, but there seems to be no doubt that when CO_2 has risen, so has the Earth's temperature. The rise in Earth's carbon dioxide during the past 150 years is well correlated to a rise in its temperature, as seen in the records of tree rings, weather stations, measurements taken from satellites, and trends in Arctic ice.

Future increases in Earth's temperature—global warming—around 4 to 10 F for our state are destined to cause changes in the distribution of vegetation, drought, frequency and occurrence of tropical diseases, the intensity of hurricanes, and sea level rise. The latter is due to the thermal expansion of the ocean and a loss of "grounded" ice, from mountain and polar glaciers. We can expect an 18" rise in mean sea level by the end of this century, leading to inundation of much of our coastal areas, a reconfiguration of many beaches and barrier islands, and perhaps even the disappearance of the Outer Banks. If not under water under calm conditions, these areas will be subject to catastrophic overwash during hurricanes, which themselves are predicted to be more frequent and severe with global warming.

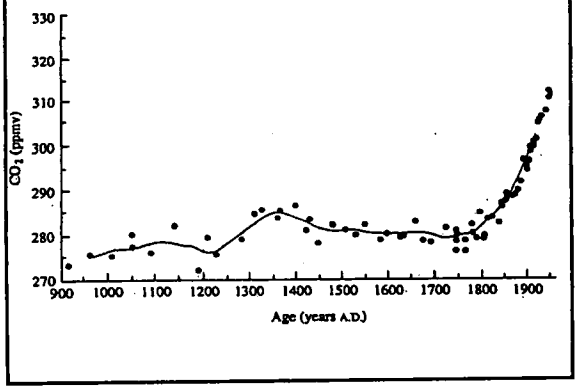
We can expect large changes in what grows in North Carolina—the crops that feed us and the forests that form such an important part of our economy. More than one model shows increases in the productivity of hardwood forests, at the expense of conifers. North Carolina will not be treeless, but if I were a corporate executive in the forest products industry, I would seriously question whether I was planting the right trees today for harvest tomorrow. The rising levels of carbon dioxide in our atmosphere that cause global warming are known to increase the growth of trees, but also the growth of poison ivy and the production of pollen—a problem for all of you that may suffer from summertime respiratory problems. In the high CO_2 experiment in Duke Forest, the growth of poison ivy increased more than three-fold and the active content of the skin allergen was higher in its leaf tissue.

We can expect other impacts on the health of North Carolina citizens. Looking globally, there is a strong correlation between climate and the occurrence of disease. A warmer North Carolina will certainly be more likely to harbor some diseases now confined to and associated with the tropics. The health community in this state can expect a greater epidemiology of diseases, along with a greater occurrence of direct heat-related deaths such as by stroke.

The Science of Global Climate Change
General Assembly of North Carolina
Legislative Commission on Global Climate Change
3 February 2006

William H. Schlesinger

NICHOLAS SCHOOL OF THE ENVIRONMENT AND EARTH SCIENCES
DUKE UNIVERSITY



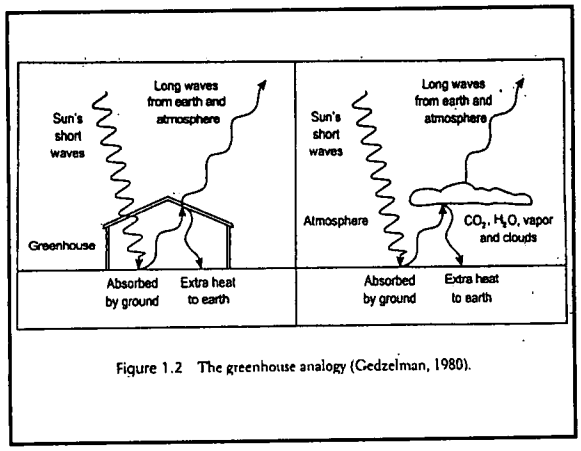
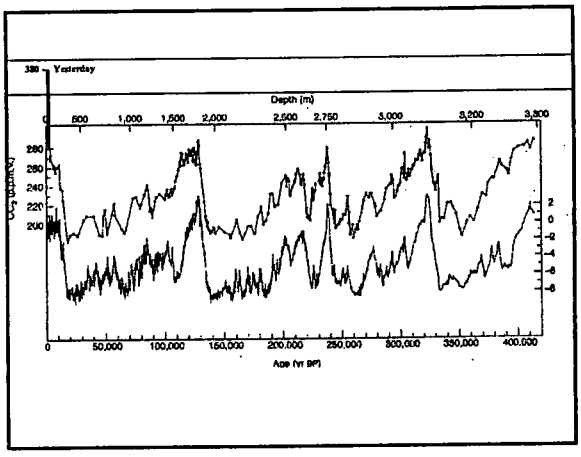
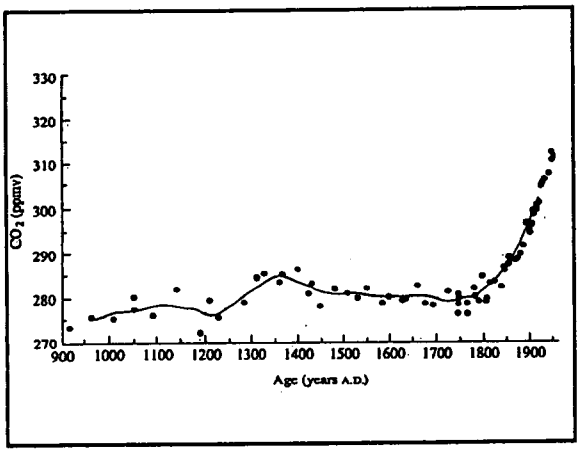
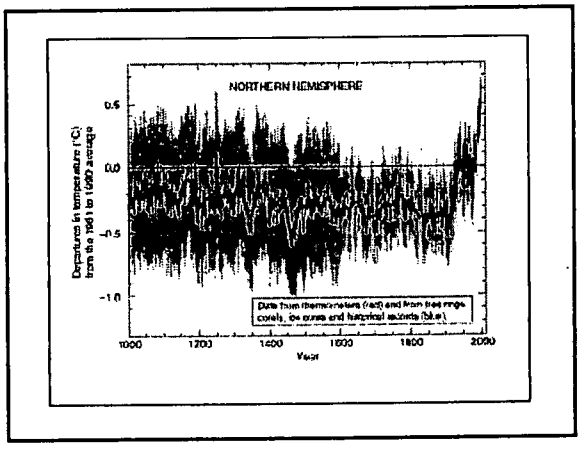
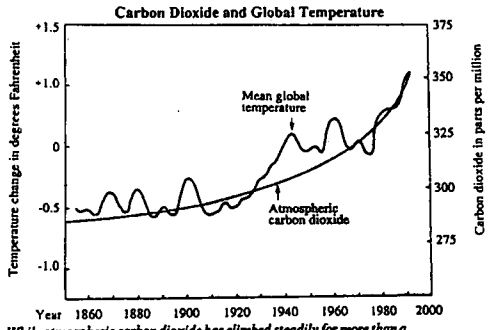


Figure 1.2 The greenhouse analogy (Gedzelman, 1980).

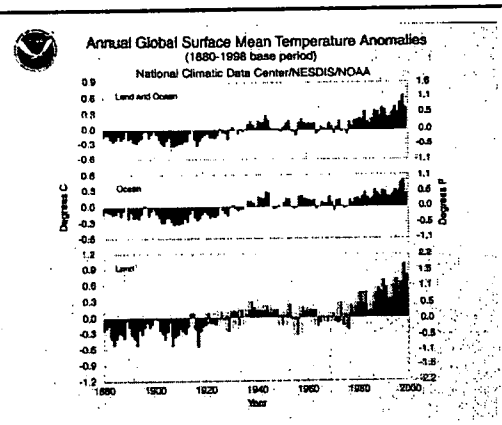

380
Yesterday
Depth (m)
0
500
1,000
1,500
2,000
2,500
2,750
3,000
3,200
3,300
280
260
240
220
200
2
0
-2
-4
-6
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
400,000
Age (yr BP)


330
320
310
300
290
280
270
CO_2 (ppmv)
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
Age (years A.D.)


NORTHERN HEMISPHERE
0.5
0.0
-0.5
-1.0
Departure in temperature (°C) from the 1961 to 1990 average
1000
1200
1400
1600
1800
2000
Year



While atmospheric carbon dioxide has climbed steadily for more than a century, the earth's temperature shows a more erratic upward trend.



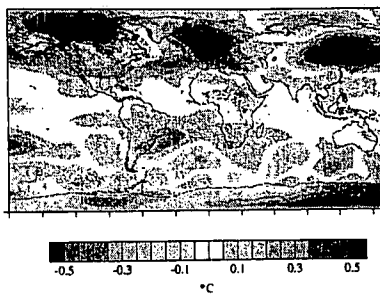
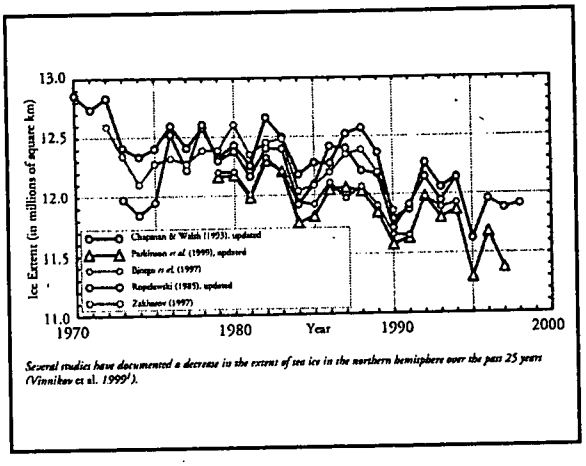
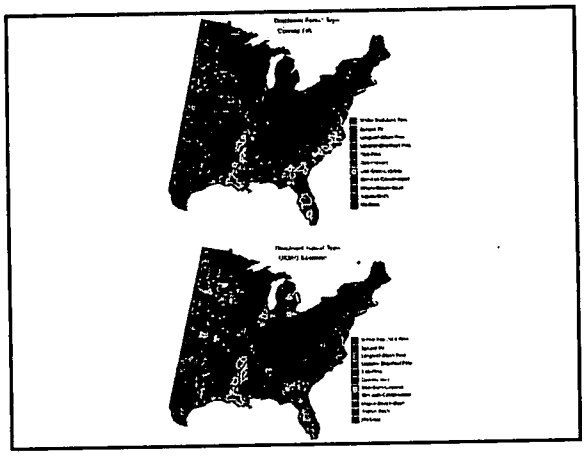
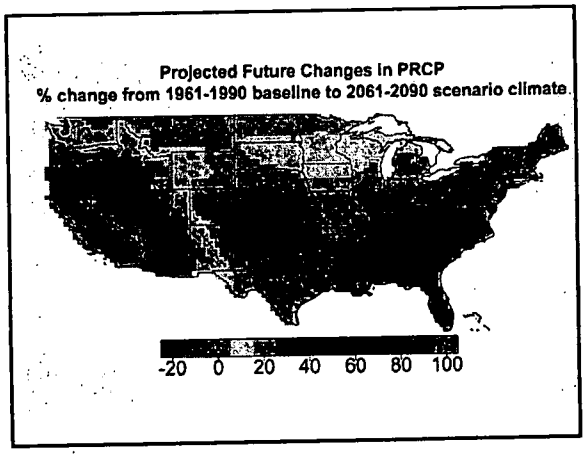


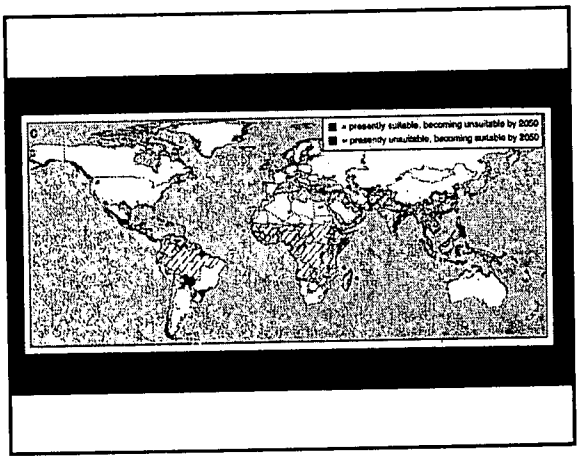
FIGURE 7.1 Global lower to mid-tropospheric temperature trends (°C/decade) from the MSU version D over the 20-year period 1979-98. These ordinary least square trends are computed from data from Christy et al. (2000).

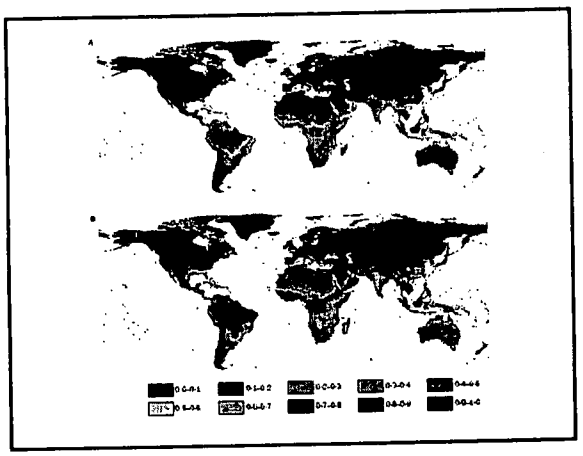


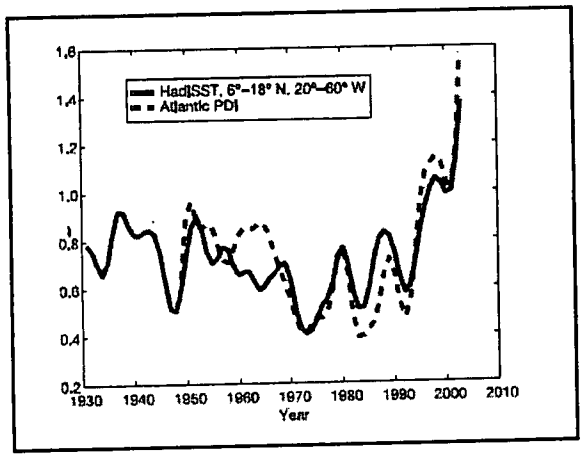
Several studies have documented a decrease in the extent of sea ice in the northern hemisphere over the past 25 years (Vinnikov et al. 1999[1]).






= presently suitable, becoming unsuitable by 2050
= presently unsuitable, becoming suitable by 2050




HadISST, 6°–18° N, 20°–60° W
Atlantic PDI
1.8
1.4
1.2
1.0
0.8
0.6
0.4
0.2
1930
1940
1950
1960
1970
1980
1990
2000
2010
Year

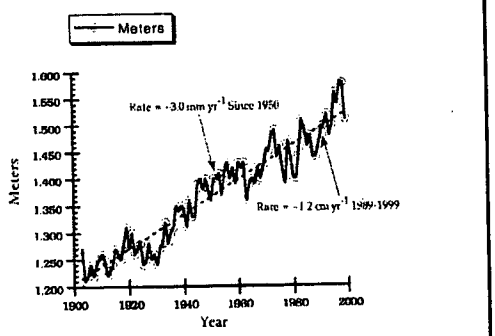
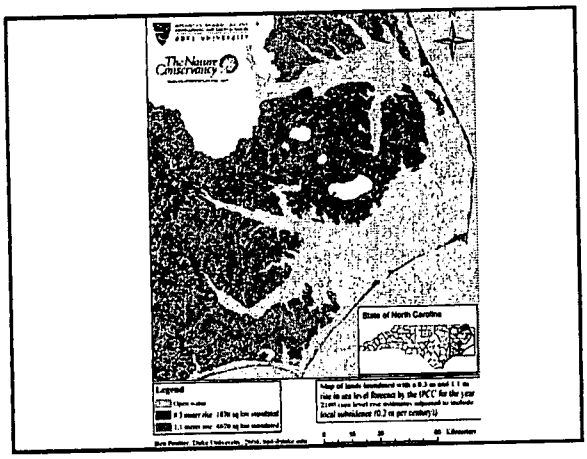


Fig. 1. Graphical here is the tide gauge record in Baltimore, Maryland, since 1900



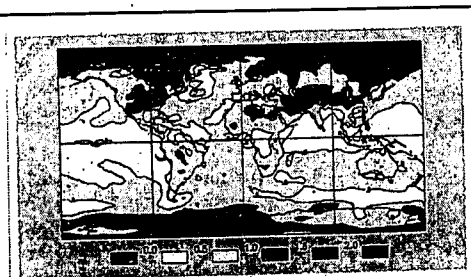
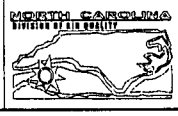


Figure 1 A warmer world. Shown here are projected changes in surface air temperature, relative to 1990–2000, for the decade 2020–30. The global change in mean temperature estimated by this model[13], the Canadian Centre for Climate Modelling and Analysis CGCM2, is 0.68 K. This result is similar to that obtained by other atmosphere–ocean global climate models, such as that used by Stott and Kettleborough[4]. It is also similar to the conclusions drawn by Knutti *et al.*[2] from a model of intermediate complexity. The change projected by CGCM2 falls well within the approximate 5–95% uncertainty ranges estimated by Stott and Kettleborough (0.3–1.3 K) and by Knutti *et al.* (0.8–1.1 K). The global change in mean temperature is expected to have an uneven distribution geographically, with generally greater warming over land and at high latitudes than elsewhere. So local effects of climate change may be greater than one might infer from global mean projections.

Legislative Commission on Global Climate Change

Clean Smokestacks Act Report on Control of CO2 - Recommendations

February 3, 2006



Brock M. Nicholson, P.E.
Deputy Director
Division of Air Quality

Background – CSA CO_2 Reports

- Sections 13 required reports by DAQ on Sept. 1, 2003, 2004 and 2005 on CO_2
- 2003 Report was "State of Science"
- 2004 Report was "Range of Options"
- 2005 Report was "Recommendations"

CO2 – Assumptions & *"Extrapolations"*

- *Acceptance of Global Warming Implied in CSA – Not an Issue to Decide*
- *CO_2 Specified in CSA, but Assumed to be Inclusive of all GHG (Basically, Adds Methane, N_2O, and Other but "Less Common" Gases)*
- *CSA Basically Directed Toward Coal-fired Power Plants, but Effort was Viewed in Context of all Sources of GHG, Stationary and Mobile*

DAQ Recommendations *for* CO_2

DAQ to do (Action Plans)	Administrative & Regulatory	Longer Term Studies/Plans
8 Listed Plans of Action that DAQ is committing to do.	7 Recommendations for the DAQ and other agencies to act upon under existing authorities and level of knowledge.	7 Long Term general Recommendations to be studied and further developed as part of the stakeholder developed Climate Action Plan.

DAQ To Do (Action Plans)

- Develop / facilitate a NC Climate Action Plan Effort
  - Facilitated Stakeholder Process
  - Technical working groups – government, consultants, etc.

DAQ To Do (Action Plans) cont.

- Coordinate Development of plan for Southeast Region
- Baseline Point Source GHG Reporting within 3 Years
- Explore Ways to Facilitate Higher Power Plant Efficiency
- Include Consideration of Measures in State Air Plan
- Adopt / Recommend Use of GHG Term "CO_2e" State-wide Instead of "CO_2"
- Explore Ways to Use CO_2 Emission Credits to Fund Program
- Assist Legislative Commission on Climate Change

Administrative & Regulatory Recommendations

A-1: NC should increase state government efforts to reduce its own CO_2e	A-2: Encourage use of clean coal technologies such as Integrated Gasification Combined Cycle (IGCC)
A-3: 5 years – Re-assess CO_2 removal and sequestration technology status	A-4: Initiate a NC GHG Registry w/verification
A-5: Establish major NC GHG tech centers for education, consulting and manufacturing	A-6: NC General Assembly and Executive Branch Influence National/World Climate Policy
A-7: NC education system incorporate GHG science	

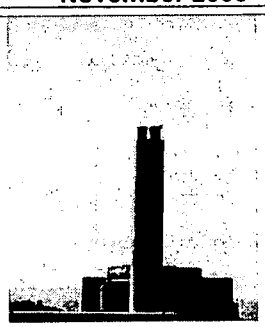
Longer Term CAP Study, Assessment & Actions

LT-1: Endorse, continue to expand and refine State Energy Plan	LT-2: Establish Leadership Center in University for Ag & Forestry Roles
LT-3: Maximize use of animal waste for energy	LT-4: Establish RPS and EPS Standards ASAP
LT-5: Establish Public Benefits Fund	LT-6: Transportation use Reductions and Efficiency Increases
LT-7: Plan or Commission for Long Range Global Warming Disaster Recovery	

Next Steps

- Establish CAP Membership and Groups
- Begin Implementation of EI Details
- Work with Global Climate Change Commission
- Develop Climate Action Plan – CAPAG Process
- Report to Commission, General Assembly, Governor and Implement

NC's First Operating Scrubber – Progress Energy – Asheville November 2005



Questions?

Contact

- *www.ncair.org*
- *Brock.Nicholson@ncmail.net*
  919-715-0587

Carbon Dioxide (CO_2) Emissions Reduction Strategies for North Carolina

(Pursuant to North Carolina's Clean Smokestacks Act of 2002)

September 2005: Final Report

North Carolina
Department of Environment and Natural Resources
Division of Air Quality

Understanding Global Warming for North Carolina

SOUND SCIENCE FOR MAKING INFORMED DECISIONS

AUTHORS
Amber Munger
Michael Shore

Although past emissions have dictated that temperatures will rise and that North Carolina will experience impacts as a result, current and future emissions will determine the severity of those impacts. We have a choice: The quality of our future depends on our actions in North Carolina and the nation.

e

ENVIRONMENTAL DEFENSE

finding the ways that work

Questions and comments can be directed to Michael Shore at
mshore@environmentaldefense.org.

The authors would like to acknowledge the scientists participating in the North Carolina Climate Education Partnership, whose review was critical to the development of this report.

Environmental Defense gratefully acknowledges Kristen Thornburg, Georgette Shepherd and Bonnie Greenfield, all of whom were instrumental to the report's production. Much gratitude also to the Tyler family for allowing us to share the story and photo of their lovely daughter Caroline.

Cover photos: Getty Images (mountains and sun), Corbis (child).

Our mission
Environmental Defense is dedicated to protecting the environmental rights of all people, including the right to clean air, clean water, healthy food and flourishing ecosystems. Since 1967, Environmental Defense has linked science, economics, law and innovative private-sector partnerships to create breakthrough solutions to the most serious environmental problems.

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Contents

Executive summary v

CHAPTER 1
Introduction 1

CHAPTER 2
Global warming science 2

CHAPTER 3
Global warming trends in North Carolina 7

CHAPTER 4
Impacts of global warming on North Carolina 10

CHAPTER 5
Opportunities for North Carolina to address global warming 14

CHAPTER 6
Dispelling the myths about global warming 17

CHAPTER 7
Recommendations 18

CHAPTER 8
Conclusion 20

Notes 21

What future will our children face?

Caroline Tyler was born in Charlotte on March 2, 2001. When she was one year old, she took her first trip to the Outer Banks, where her mom and dad helped her build sand castles and chase crabs. When Caroline turns 30, the beaches she visited with her family may very well have disappeared. That's because sea level is likely to rise by about six inches by 2030,[1] destroying much of the coast we know. By the time Caroline's grandchildren are grown, sea level in North Carolina is expected to have risen by 19 inches.

KRISTEN THORNBURG

Caroline Tyler, age 2

The differences Caroline sees will not be limited to North Carolina's coastline. When Caroline turns 30, warming trends could increase mosquito populations, exposing more North Carolinians to West Nile Virus and malaria.[2] The reductions the state has made in smog-forming pollutants may be partially offset by hotter summers, which encourage smog and contribute to respiratory illness such as asthma, which is an epidemic among our state's children. Today, it is estimated that 10–17% of North Carolina children have asthma.[3]

Already, North Carolina's climate is changing. According to the U.S. National Assessment, a government study of climate change, global temperatures have risen by nearly 1°F during the last century, and global temperatures are expected to rise more rapidly in the next 100 years than in the last 10,000 years.[4] Models predict that temperatures in the Southeast will rise by 1.8° to 3°F during the next 30 years and by 4.1° to10°F during the next 100 years.[5] North Carolina's environment, economy and public health will all be affected. From the loss of coastal property to increased health risks, climate change creates problems for North Carolina that we can no longer afford to ignore.

Now that we understand the science of global warming and the solutions, we have an opportunity to choose a better future for Caroline and all of our children.

Executive summary

A general, worldwide consensus exists among the scientific community that global temperatures have already risen and will continue to rise, and that the increase in global temperature is mainly due to human activities. North Carolina's environment, public health and economy are likely to experience significant adverse effects as a result of global warming. While scientists agree on the fundamentals of global warming, these facts are not yet reflected in policy. The choices we make today about energy use and emissions of global warming pollutants will directly affect our future and our children's future. Therefore, it is imperative that policymakers and the public understand what global warming will mean for North Carolina. Environmental Defense has written this report to help bridge the gap between the scientific and policy communities on global warming.

Low estimates suggest that annual temperatures in the Southeast will increase by 4.1°F over the next century, unless actions are taken to reduce emissions of heat-trapping gases, while high estimates suggest the temperature rise could be 10°F.[6] North Carolina is highly vulnerable to the impacts expected to accompany the rise in temperature. For example, the Intergovernmental Panel on Climate Change (IPCC) estimates that sea levels in the Atlantic Ocean are expected to rise by about 19 inches by 2100.[7] Such a rise in sea level would enable storms such as Hurricane Fran to reach further inland, exposing an even greater number of coastal North Carolinians to flooding and storm damage. Hurricanes are also expected to increase in intensity as a result of global warming which could increase the risk for mountain areas prone to flooding such as those still recovering from the recent Hurricanes Ivan and Frances.

Scientists examining the impacts of global warming have identified several categories of effects. Though the severity will greatly depend on future emissions of global warming pollutants, North Carolina can expect to experience the following effects:

- Rising seas will significantly impact North Carolina's coast.
- Warmer temperatures may worsen North Carolina's air quality.
- Increased temperatures are expected to lead to health problems.
- North Carolina's natural environment will be altered.
- Global warming will significantly affect North Carolina's economy.

Global warming presents a serious challenge for North Carolina, but we have choices about how to respond. While the consequences of a warming planet may be numerous, so too are the options for addressing global warming. Environmental Defense recommends that the State of North Carolina take the following first steps to begin addressing global warming:

RECOMMENDATION #1. North Carolina leaders should establish a goal to reduce global warming pollutants. A state goal will position North Carolina to take advantage of the economic opportunities that can result from addressing global warming, such as opportunities in the carbon marketplace, and it will help the state prepare for potential global warming impacts. A carbon reduction goal will help align North Carolina's environmental and economic interests, and similar to

the state's million-acre land conservation goal, it will help move North Carolina in the right direction.

RECOMMENDATION #2. The state should convene a stakeholder committee to develop an action plan to reduce global warming and position North Carolina to win in a lower carbon economy. A holistic, thoughtful and fair plan is needed to put North Carolina on course towards meeting its reduction targets and taking responsibility for its global warming pollution.

RECOMMENDATION #3. North Carolina Senators Dole and Burr should vote to pass the Climate Stewardship Act to cap global warming pollution nationally. North Carolina stands to suffer greatly from the effects of global warming. At the same time, North Carolina could reap economic benefits by taking action on global warming, including participation in a national carbon market. In order to both avoid the economic risks of global warming and to take advantage of the economic opportunities, North Carolina's national representatives should support—and even lead—the effort to cap global warming pollution as called for in the proposed Climate Stewardship Act.

CHAPTER 1

Introduction

Calls for the Earth's demise have come and gone throughout history . . . and we're still here. It is entirely possible of course that this decade will be our last, but I'm betting that it won't be, that the Earth will still be here in a hundred years and a thousand. In consequence, the stewardship and vision that we show today will help determine the type of world that our descendants inherit.

—Dr. Rob Jackson, Duke University

In August 2005, the General Assembly passed the North Carolina Global Warming Act. This legislation establishes a Global Warming Commission that will evaluate potential impacts on the state from rising temperatures, consider recommending a global warming pollutant reduction goal, and prepare the state's economy to capitalize on emerging economic markets associated with addressing global warming. With this law, North Carolina becomes the first state in the Southeast to join the growing number of states that are moving forward to meaningfully address global warming.

States are not acting alone. Nations across the globe are moving forward to curb heat-trapping pollution. Major corporations such as Duke Energy, DuPont, General Electric and many others are taking steps to prepare for global warming and calling on the United States to take action. Although slower to act, the federal government has also become engaged. The United States Senate formally recognized the need to cap global warming pollution with their June 2005 "Sense of the Senate" vote, stating that "Congress should enact a comprehensive and effective program of mandatory, market-based limits on emissions of greenhouse gases."

Environmental Defense has written *Understanding Global Warming for North Carolina* to raise awareness about the science of a warming planet and to offer solutions to meet this challenge. North Carolina is one of the states that is most vulnerable to the impacts of global warming, such as rapid sea-level rise, but our state can position itself to take advantage of opportunities that come with developing and commercializing new technologies needed for a lower carbon economy. We have a choice about the future we leave to our children, and future generations will judge us by the decisions that we make today. *Understanding Global Warming for North Carolina* provides North Carolina with the necessary information to choose a path that respects both our needs of today and the needs of future generations.

CHAPTER 2

Global warming science

"Regarding climate change, I have not seen this level of consensus on a scientific issue since medical scientists first spoke out on the carcinogenic effects of smoking cigarettes."

William Schlesinger, Dean, Nicholas School of the Environment, Duke University

Scientists worldwide agree that the earth is warming as a result of human activities such as the burning of fossil fuels.

Observed trends and scientific understanding

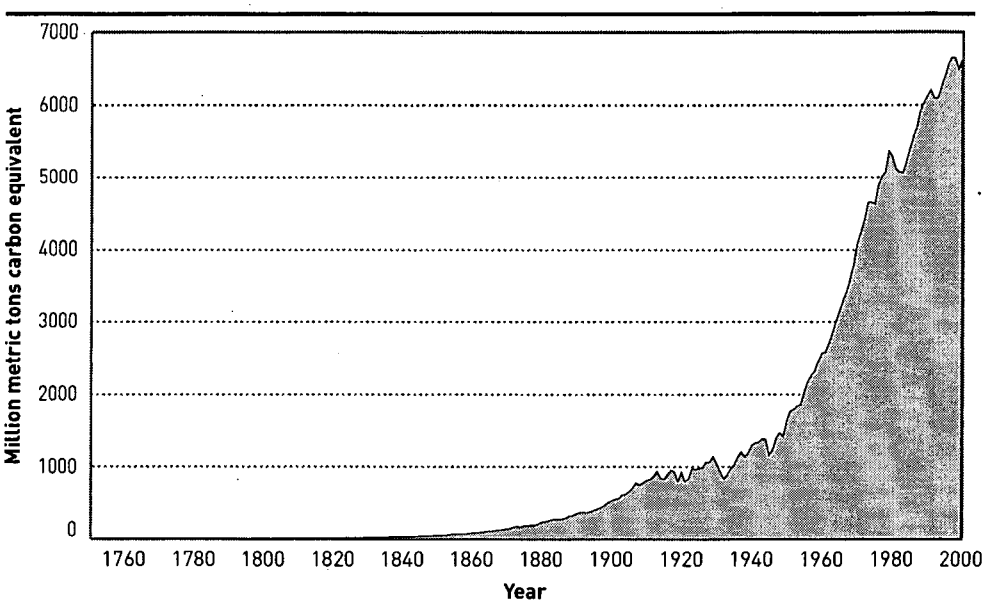
Several key trends support the notion that human-induced global warming is real and ongoing.

- **Global emissions of carbon dioxide (CO_2) from fossil fuel combustion have risen and continue to rise.** The combustion of fossil fuels such as coal and petroleum is responsible for the increased CO_2 and other global warming pollutants in the atmosphere. Since the Industrial Revolution, emissions of CO_2 from fossil fuels have continued to increase (Figure 1).
- **Global concentrations of CO_2 in the atmosphere have risen and continue to rise.** Global CO_2 concentrations in the atmosphere have been steadily rising since the beginning of the Industrial Revolution (Figure 2). According to the Intergovernmental Panel on Climate Change (IPCC), an international group of scientists studying global warming, the atmospheric concentration of carbon dioxide has

FIGURE 1

Global anthropogenic CO_2 emissions

Global emissions of CO_2 from fossil fuel combustion have risen and continue to rise.



Source: Carbon Dioxide Information Analysis Center

increased by 31% since 1750. The present CO_2 concentration is higher than at any time during the past 420,000 years and likely during the past 20 million years.[8]

- **Global temperatures have risen and continue to rise.** Global temperature is rising as a result of increasing CO_2 emissions (Figure 3). The vast majority of scientists agree that global average temperature has already risen and will continue to rise over the next 100 years. The increase in temperature in the 20th century is likely the largest of any century during the past 10,000 years.[9]
- **Scientists have predicted temperature rise due to increased CO_2 levels since the late 1800s.** As early as 1863, people knew that atmospheric CO_2 keeps the Earth warmer than it otherwise would be.[10] In fact, the term "greenhouse effect" was coined by the scientist Svante Arrhenius in 1896, who pointed out that the combustion of fossil fuels might increase the level of CO_2 in the atmosphere and warm the Earth several degrees.[11]

The international consensus on global warming

Climate scientists have known for years that global warming, or climate change, is real. Here is what the leading scientific organizations in the world have to say about it:

National Academy of Sciences: "Greenhouse gases are accumulating in the Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising. . . . Human-induced warming and associated sea-level rises are expected to continue through the 21st century. Secondary effects . . . include increases in rainfall rates and increased susceptibility of semi-arid regions to drought."[12]

Intergovernmental Panel on Climate Change: "The greater our emissions of greenhouse gases and the associated changes in climate, the more severe the adverse impacts of climate change will be."[13] There is new and stronger evidence that most of the warming over the last 50 years is attributable to human activities."[14]

U.S Climate Change Science Program and the Subcommittee on Global Change Research (Bush Administration Report): "Carbon dioxide is the largest single forcing agent of climate change, and methane is also a significant contributor. Atmospheric concentrations of CO_2 and CH_4 have been increasing for about two centuries as a result of human activities and are now higher than they have been for over 400,000 years. . . . Approximately three quarters of present-day anthropogenic CO_2 emissions are due to fossil fuel combustion . . ."[15]

U.S. National Synthesis Team: "It is very likely that the U.S. will get substantially warmer. Temperatures are expected to rise more rapidly in the next 100 years than in the last 10,000 years. It is also very likely that there will be more precipitation overall, with more of it coming in heavy downpours. In spite of this, some areas are likely to get drier as increased evaporation due to higher temperatures outpaces increased precipitation. Droughts and flash floods are likely to become more frequent and intense."[16]

U.S. Environmental Protection Agency: "There is new and stronger evidence that most of the warming over the last 50 years is attributable to human activities. Human activities have altered the chemical composition of the atmosphere through the buildup of greenhouse gases—primarily carbon dioxide, methane, and nitrous oxide."[17]

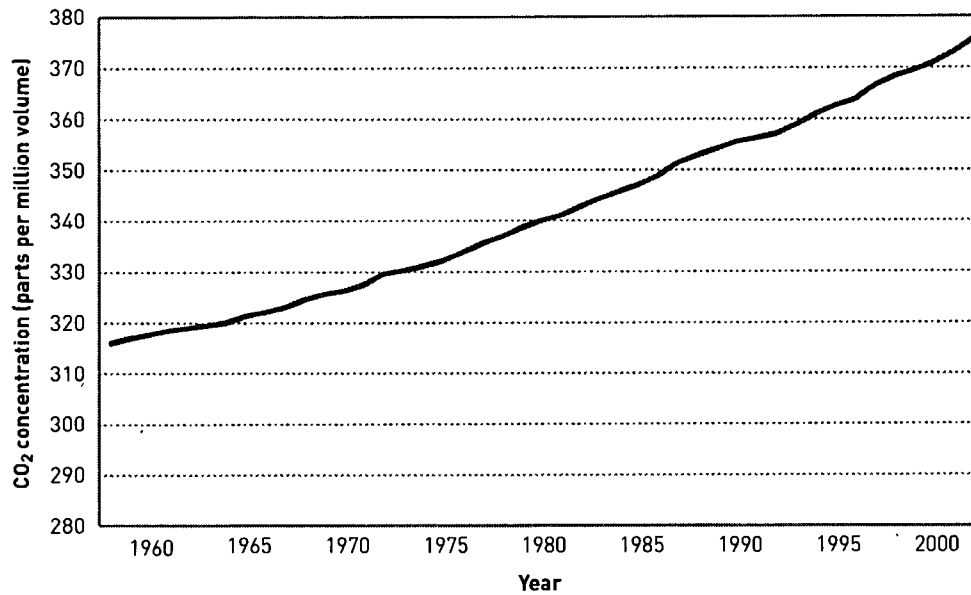
Global warming pollutants and global warming

Global warming pollutants trap heat in the atmosphere causing the earth to warm. Although the pollutants that contribute to global warming are emitted naturally in many cases, humans have also begun to release these pollutants at an unprecedented rate since the advent of the Industrial Revolution. As people release more global warm-

FIGURE 2

Global CO_2 concentrations

Global concentrations of CO_2 in the atmosphere have risen and continue to rise.

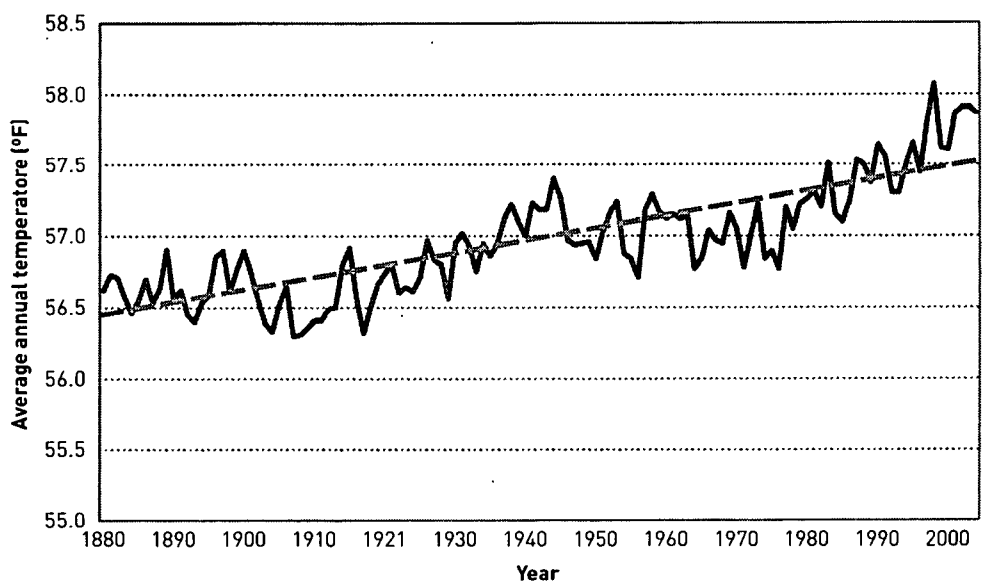


Source: Mauna Loa Laboratories

FIGURE 3

Global temperature trend

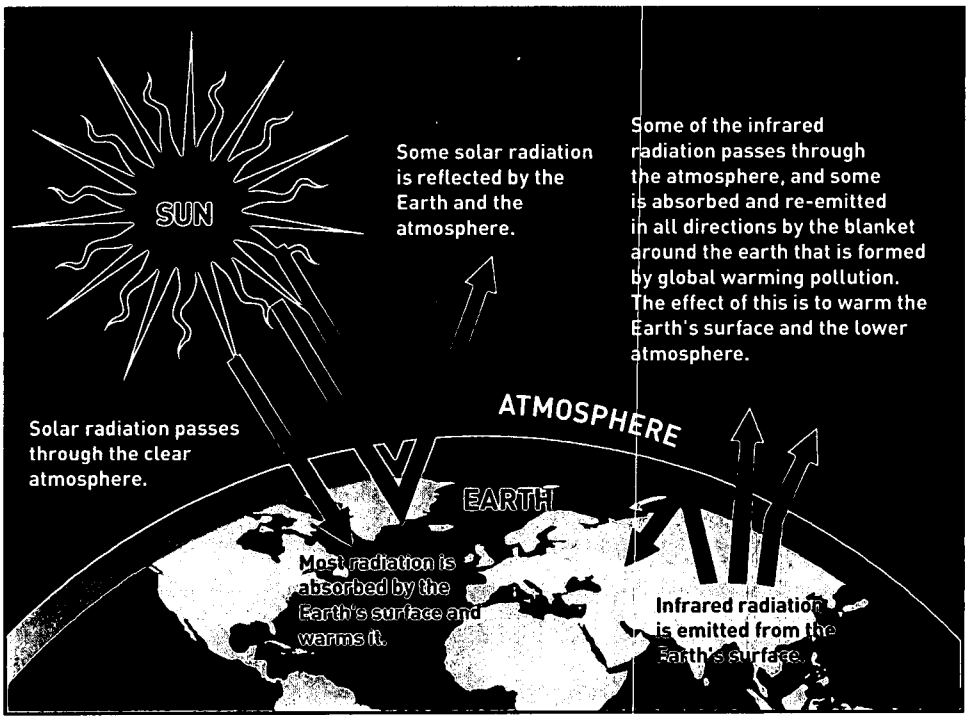
Global temperature is rising as a result of increasing CO_2 emissions.



Source: National Climatic Data Center

FIGURE 4

The effect of global warming pollution



Source: United States Environmental Protection Agency

ing pollutants through tailpipes and smokestacks, the heat-trapping blanket of pollution around the earth becomes thicker and the planet warms (Figure 4). A warming planet can lead to a variety of consequences (Figure 5), which are discussed in Chapter 4.

Variations in global warming models

Global warming science has advanced significantly over the last decade. There is global consensus among scientists on the major factors contributing to climate change, but some models for predicting the rate of warming assign faster rates for certain regions. For example, while the leading models agree that the southeastern United States will warm significantly by 2100, one model predicts that the region will experience a high degree of warming, a decrease in precipitation due to the higher temperatures and low soil moisture. On the other hand, another model for the region predicts warming at a slower rate with an increase in precipitation. Although these models vary on some of the specific details, they agree on the fundamentals of global warming science: The planet will continue to warm as a result of fossil fuel combustion. The models also predict that the higher the emissions, the greater the severity of the impacts.

Effects of past emissions vs. future emissions

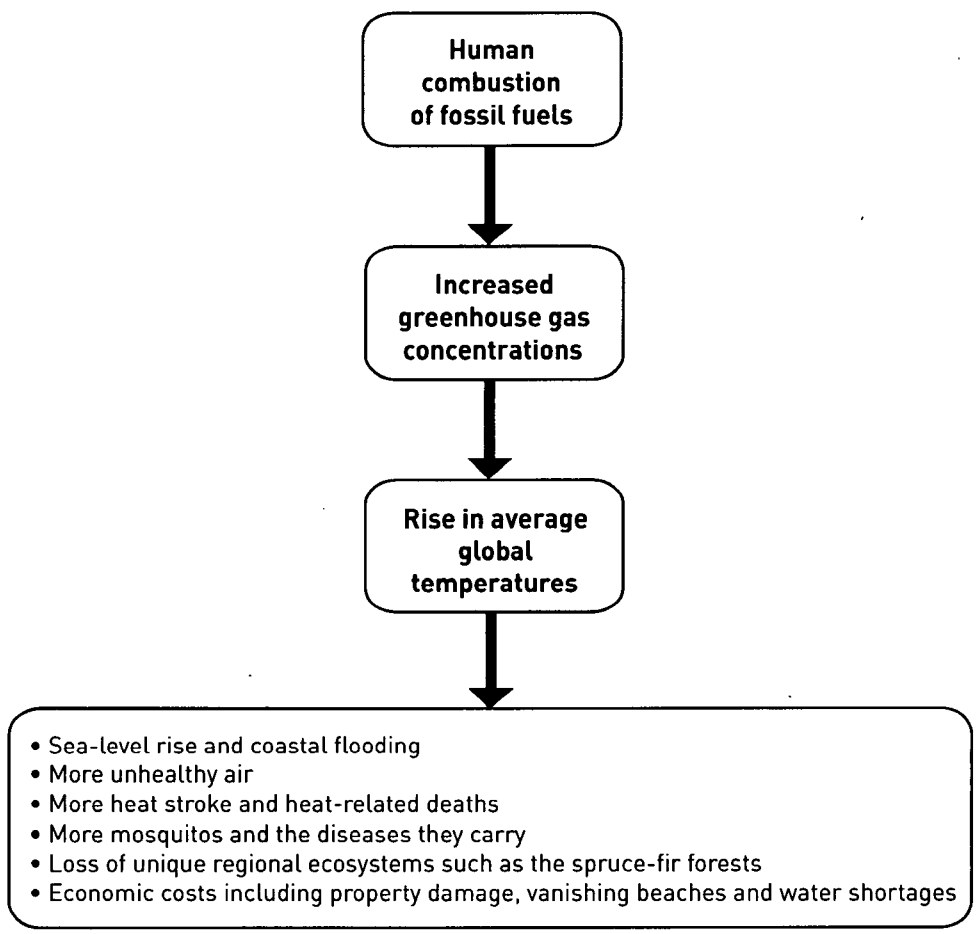
The terms "climate change," "global warming" and "global temperature rise" describe both the rise in temperature that will occur as a consequence of *past* emissions of

global warming pollutants, and the rise in temperature that will occur as a consequence of *future* emissions. Past emissions of global warming pollutants will remain in the atmosphere, trapping heat for decades to come. However, while past emissions dictate that temperatures will continue to rise and that North Carolina will experience impacts as a result, current and future emissions will dictate the severity of those impacts. We have a choice: The quality of our future depends on our actions in North Carolina and the nation.

FIGURE 5

Impacts of a warming planet

Fossil fuel combustion, used to generate electricity and power cars, releases carbon dioxide and other global warming pollutants into the atmosphere. The increased concentrations of global warming pollutants trap heat like a thick blanket that does not allow excess heat to escape. As a result, the earth's temperature is rising, which in turn causes many other problems around the world, and here in North Carolina.



CHAPTER 3

Global warming trends in North Carolina

As emissions of global warming pollutants throughout the world have increased, so too have North Carolina's.

Carbon dioxide

Since the Industrial Revolution, human activities have increased the amount of carbon dioxide (CO_2) in the atmosphere by more than 30%.[18] In North Carolina, CO_2 emissions have grown steadily along with increases in energy consumption, with emissions of CO_2 increasing by more than 30% since 1990 (Figure 6). North Carolina's residential energy consumption is expected to increase by about 50% by 2025.[19]

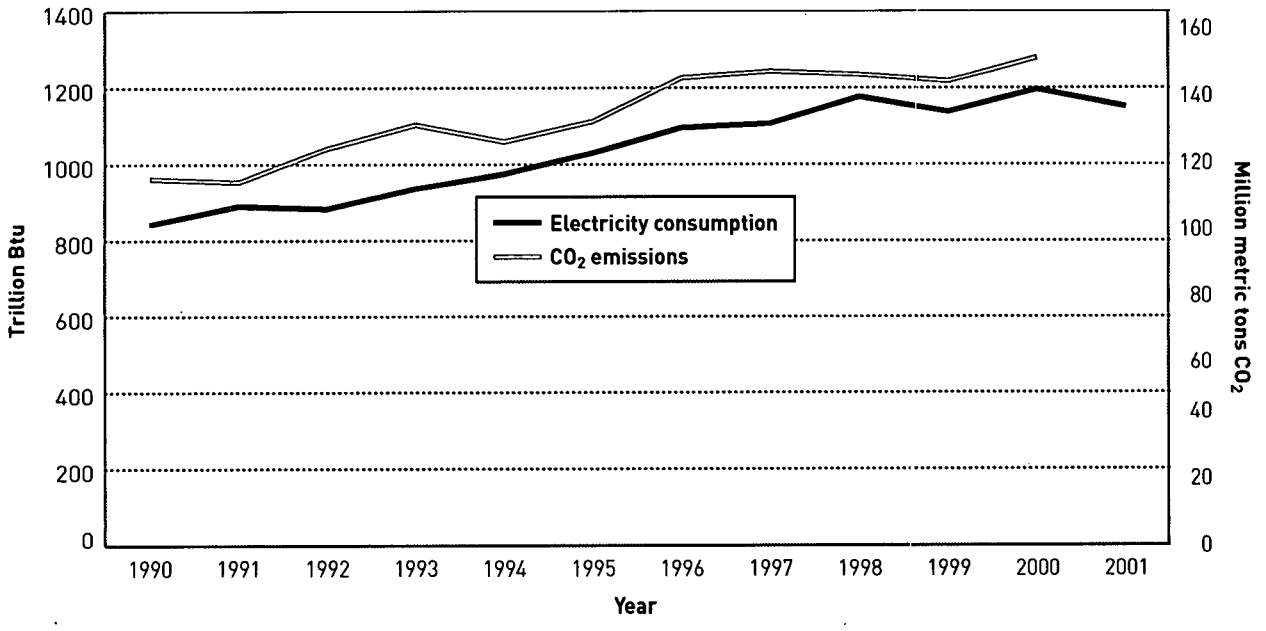
Although the state has outstanding opportunities to increase its use of renewable energy, more than 78% of the state's energy comes from fossil fuels, while about 5% comes from renewable sources.[20]

Electric utilities and the transportation sector are responsible for more than three quarters of the state's emissions (Figure 7).[21] Although the North Carolina Clean Smokestacks Act will reduce emissions of harmful pollutants from power plants, this law does not require reductions of CO_2 and other global warming pollutants. In fact, while power plant emissions of sulfur dioxide (SO_2) will decrease in North Carolina over the next decade, CO_2 emissions will continue to increase (Figure 8).

FIGURE 6

North Carolina electricity consumption and CO_2 emissions

North Carolina is consuming more energy than ever before and CO_2 emissions are increasing as a result.

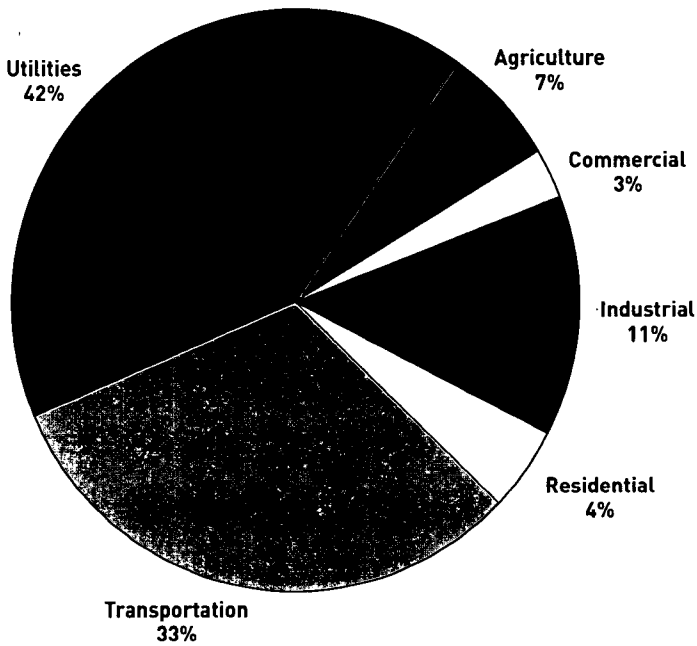


Source: United States Department of Energy (energy consumption), United States Environmental Protection Agency (CO_2 emissions)

FIGURE 7

Primary sources of global warming pollution in North Carolina, 2000 (million metric tons carbon equivalent)

Most global warming pollutants come from our tailpipes and our electricity use.

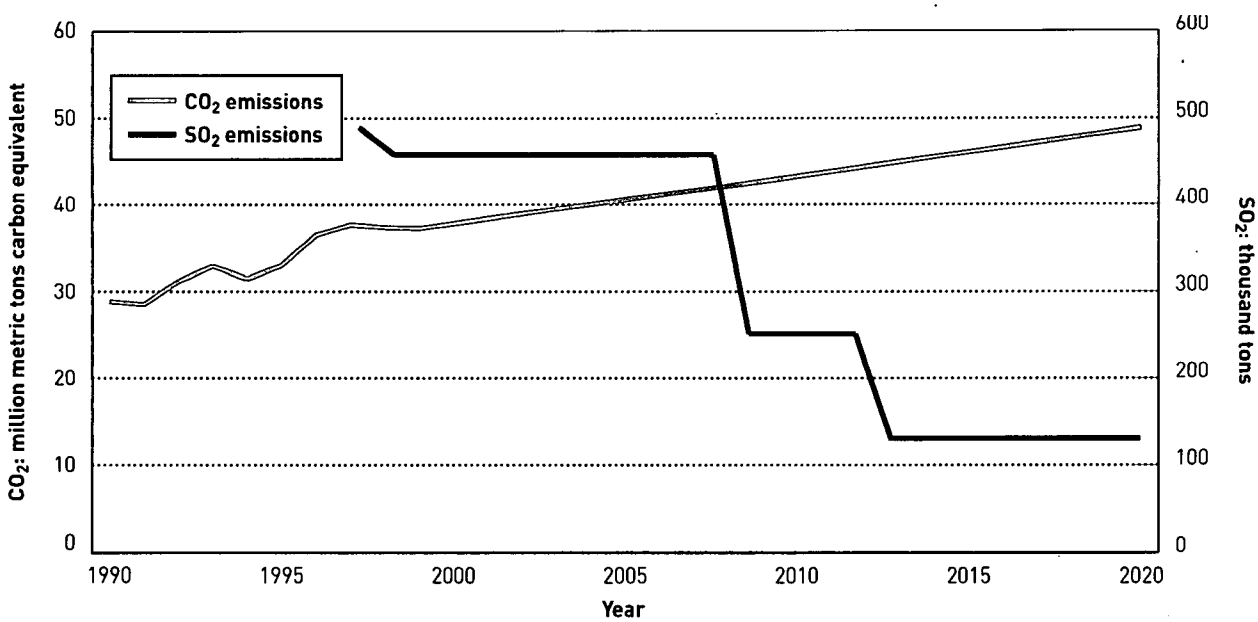


Source: United States Environmental Protection Agency

FIGURE 8

Projected CO_2 and SO_2 emissions

While other emissions from North Carolina's power plants will decrease in the coming decades, CO_2 emissions are predicted to increase. Just as North Carolina took measures to reduce SO_2, decoupling it from energy consumption, North Carolina can also reduce CO_2 emissions.**

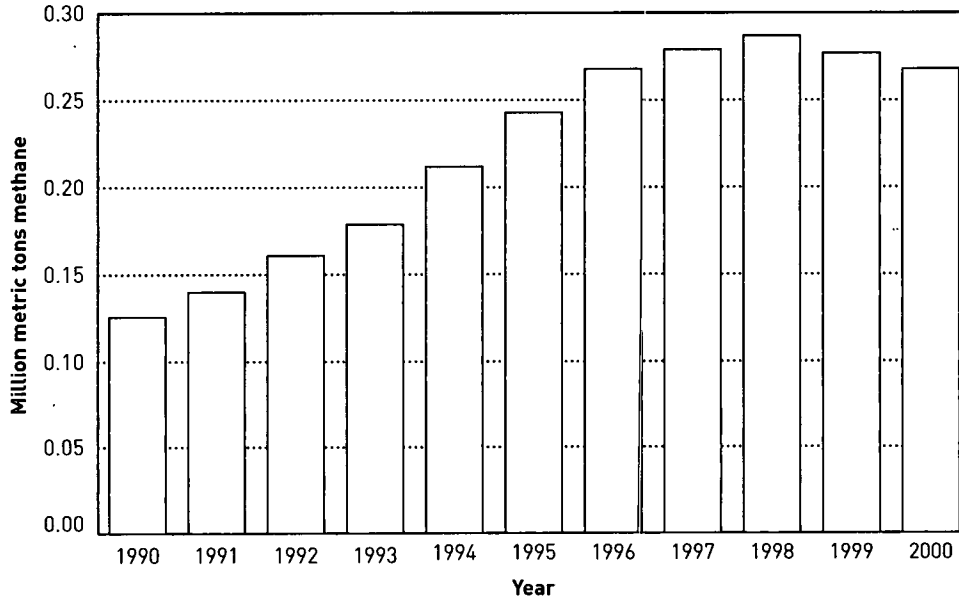


Source: United States Environmental Protection Agency (CO_2), North Carolina Clean Smokestacks Act (SO_2)

FIGURE 9

North Carolina methane emissions from 1990

North Carolina's methane emissions have increased since 1990 due largely to the increase in North Carolina's hog industry.



Source: United States Environmental Protection Agency GHG Tool NC default options

Methane

While methane emissions are far lower than CO_2 emissions, methane is estimated to be 21 times more effective than CO_2 at trapping heat in the atmosphere over a 100-year time horizon.[22] The primary source of methane emissions in North Carolina is the agricultural sector. Methane emissions from agriculture have increased nearly 60% since 1990 (see Figure 9).[23] Most of this growth has occurred due to manure-management in North Carolina's large hog and poultry industries. North Carolina's hog population, a major source of methane, has grown from 2.6 million in 1987 to over 10 million today, almost a 300% increase.[24]

Other pollutants

A 2003 report by NASA's Goddard Institute shows that black carbon (or soot) contributes more to globalw warming than was recently believed.[25] Black carbon is a product of incomplete combustion and is generated by tailpipes, industrial pollution, outdoor fires and household burning of coal and other fuels.[26] Another cause for concern is ground-level ozone, or smog, which is also a heat-trapping gas that contributes to global warming.

CHAPTER 4

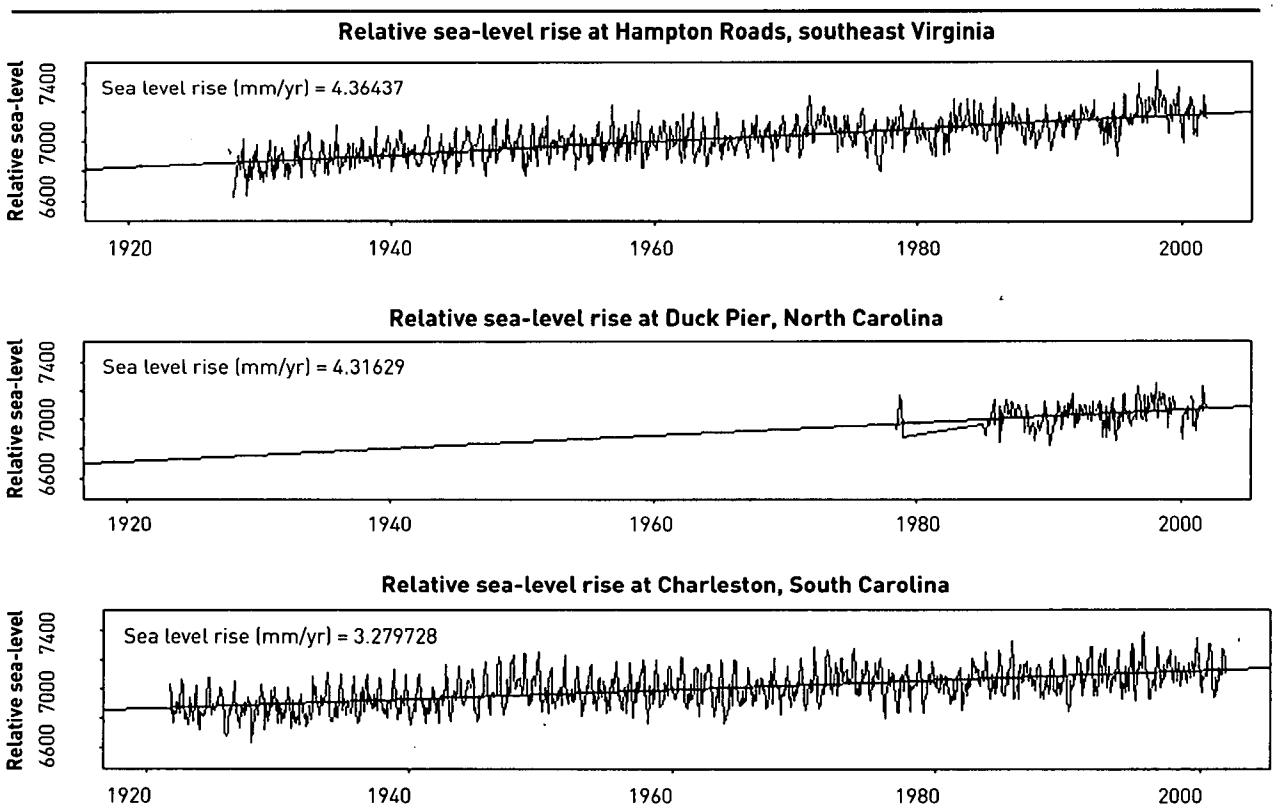
Impacts of global warming on North Carolina

North Carolina has kept pace with the global trend of increasing emissions of global warming pollutants, and North Carolina also stands to face the consequences of global warming. Low estimates suggest that annual temperatures in the Southeast will increase by 4.1°F over the next century, unless actions are taken to reduce emissions of global warming pollutants, while high estimates suggest the temperature rise could be 10°F.[27] According to William Schlesinger, the Dean of Duke University's Nicholas School of the Environment, a temperature rise of 4°F would make the climate of central North Carolina similar to that of central Florida. Scientists examining the impacts of global warming have identified several categories of effects: temperature increase, sea level rise, public health consequences, ecosystem responses, shifts in agricultural productivity and overall economic dislocation. North Carolina will experience each of these—though the severity will depend on the choices that we make about our global warming pollution today. With its miles of shoreline currently threatened by erosion, and its mountain region already under stress from acid rain, North Carolina will suffer irreparable consequences if global warming continues at its current rate.

FIGURE 10

Sea-level rise measurements on the Carolina and Virginia coasts

Sea-level off the Atlantic Coast has risen over the last 80 years.



Source: Permanent Service for Mean Sea Level. Graph by Ben Poulter, Duke University

- **Rising seas will significantly impact North Carolina's coast.** Warmer atmospheric temperatures cause sea levels to rise in two ways: 1) through warmer ocean waters expanding and 2) through the melting of snow, glaciers and polar ice caps. From 3,000 years ago to the beginning of the industrial revolution, sea levels around the globe remained nearly constant, rising only about 0.01–0.02 cm/yr.[28] Since the industrial revolution, sea levels along most of the U.S. coast have risen 10–12 inches.[29] Recorded levels of sea-level rise along the North Carolina Coast are shown in Figure 10. The IPCC estimates that global sea-level will rise by about 19 inches over the next century. Of additional concern to North Carolina is that many areas along the North Carolina coast are estimated to be sinking by about 7 inches per century, indicating that some areas of coastal North Carolina may experience an accelerated rate of inundation. For example, models predict that a sea-level rise of less than 14 inches would inundate about 770 square miles of the North Carolina coast, an area nearly the size of Great Smokey Mountains National Park. Rising seas inundate wetlands and other low-lying lands, erode beaches, intensify flooding and increase the salinity of rivers, bays and groundwater tables.[30] A higher sea-level will increase the vulnerability of coastal and low-lying areas to severe weather, allowing storms such as Hurricane Isabel to inflict even greater damage. The expected sea-level rise of at least 19 inches over the next century will cause extensive erosion along the state's 3,375-mile shoreline (Figure 11). Billions of dollars worth of buildings and real estate are currently threatened by erosion. The steady erosion of wetlands and barrier islands such as the Outer Banks makes the coastline even more susceptible to erosion and storm damage.

- **Increased temperatures are expected to lead to health problems.** Warmer temperatures will increase the number of very hot days, causing an upswing in heat-related deaths and illnesses such as heat stroke. The heat wave that gripped Europe in the summer of 2003, causing between 22,000 and 35,000 deaths, is a reminder of how vulnerable sensitive populations can be to increases in temperature.[31] The warmer weather is also expected to bring an increase in disease-carrying insects. Mosquitoes carry a number of life-threatening diseases including West Nile Virus and malaria.[32] Other health risks from climate change include illnesses from water supplies contaminated by increased flooding and the possible overflow of hog waste lagoons.[33]

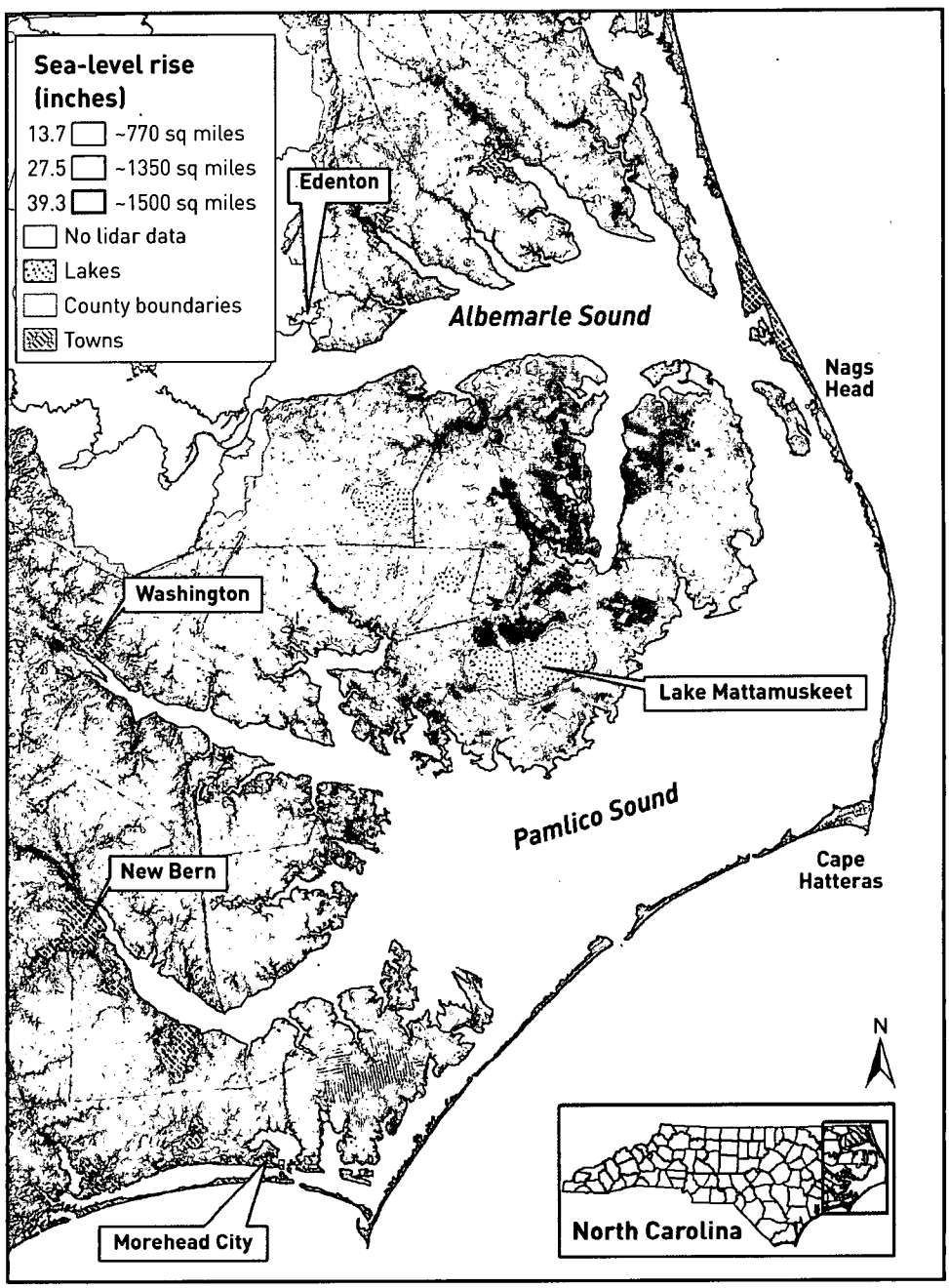
- **Warmer temperatures may worsen North Carolina's air quality.** Oxides of nitrogen released from power plants and automobiles react, in the presence of sunlight, with other chemicals in the air to form ground-level ozone or smog.

Positive vs. negative effects of global warming

A warmer climate may bring some benefits, such as longer growing seasons. A great deal of research has been conducted on this aspect of global warming. The research shows that the greater our emissions of global warming pollutants, the more severe the adverse impacts will be, and the more likely that the adverse effects will significantly outweigh any benefits.[34] Thus, the problems global warming will pose for North Carolina are the focus of this report.

FIGURE 11

Possible North Carolina coastline after continued sea-level rise



Source: Ben Poulter, Duke University, and Sam Pearsall, The Nature Conservancy, 2003

Some of the gains achieved by reducing this pollution in the Clean Smokestacks Act will be erased as warmer summers increase ground-level ozone formation and the number of unhealthy air days.[35] Models suggest that by 2030 maximum summer temperatures in the Southeast will increase in the neighborhood of 2.3° to 5°F. A 1999 study estimated that during the summer months of 1997 smog pollution triggered 1,900 hospital admissions for respiratory illness, 630 emergency room visits for asthma and 240,000 asthma attacks in North Carolina.[36] A 2002 California Air Resources Board study has

Undeniable global warming

In a *Science Magazine* article by Naomi Oreskes [*Science*, Vol 306, Issue 5702, 1686, 3 December 2004], entitled "Undeniable Global Warming," Oreskes had the following to say about the consensus position on global warming:

"The Institute for Scientific Information keeps a database on published scientific articles, which my research assistants and I used to answer [the] question [of the consensus on] global climate change. We read 928 abstracts published in scientific journals between 1993 and 2003 and listed in the database with the keywords 'global climate change.' Seventy-five percent of the papers either explicitly or implicitly accepted the consensus view. The remaining 25 percent dealt with other facets of the subject, taking no position on whether current climate change is caused by human activity. None of the papers disagreed with the consensus position. There have been arguments to the contrary, but they are not to be found in scientific literature, which is where scientific debates are properly adjudicated. There, the message is clear and unambiguous."

linked exposure to ozone pollution not only to increased asthma attacks but also to the development of asthma.[37]

- **North Carolina's natural environment will be altered.** Rising sea levels will flood the coastline, breaching barrier islands and inundating wetlands, which serve as critical habitats for a range of species. Extensive loss, alteration and displacement of habitat from sea-level rise will put even greater pressure on many threatened or endangered species such as the American alligator, Bachman's warbler, brown pelican, loggerhead sea turtle, piping plover, red-cockaded woodpecker, shortnose sturgeon and wood stork.[38] Of the 70 endangered or threatened species that live in the Southeast, more than 27% have habitats within three miles of mean sea level. Increases in air pollution due to warmer temperatures will place significant pressure on North Carolina's native spruce-fir mountain ecosystems, which are already threatened by acid rain and ground-level ozone.

- **Global warming will affect North Carolina's economy.** Sea-level rise could come at a significant cost to North Carolina. In Dare County alone, $5.5 billion worth of property is at risk,[39] as well as nearly $600 million in annual tourism revenue and 10,000 tourism-related jobs.[40] Eroding coastlines and vanishing beaches will put billions of dollars worth of coastal property at risk, likely affecting North Carolina's tourism industry. The North Carolina coast hosts approximately 11 million visitors annually. More than half of all visitors to the state spend time at the beach. Tourists spent $11.9 billion in 2001, and state and local tax receipts from visitors exceeded $1 billion.[41] It will cost an estimated $660 million to $3.6 billion for beach dredging and filling (also called "beach renourishment") to protect the coast from a 20-inch sea-level rise by 2100.[42] North Carolina is likely to face water shortages due to saltwater contaminating the water table. Additionally, traditional agriculture and forestry crops such as loblolly pine, soy beans and Christmas tree production in the mountains, all a significant boon to North Carolina's economy, are likely to be adversely affected by the warming trends that will accompany global warming.

CHAPTER 5

Opportunities for North Carolina to address global warming

North Carolina on the national stage

North Carolina has many opportunities to take action on global warming. At the national level, proactive global warming policies such as the McCain-Lieberman Climate Stewardship Act will not only significantly reduce the global warming pollution emitted from the United States, but will also help to create jobs and stimulate investment in indigenous energy sources. Analysis of the Climate Stewardship Act, conducted by the Tellus Institute, estimates that 15,000 jobs could be created in North Carolina by taking action on global warming.[43] Further, national caps on global warming pollution would create a strong national carbon marketplace from which many sectors of North Carolina's economy could benefit. Businesses that reduce their emissions of global warming pollutants would be able to sell the reductions on the market. For more information on the potential economic benefits of addressing global warming in North Carolina, please see the Climate Stewardship Task Force report, "Economic Opportunity in Addressing Global Warming: The silver lining for North Carolina in a lower carbon economy" at www.environmentaldefense.org/go/climatestewardship/.

North Carolina's in-state resources

In advance of federal legislation to cut global warming pollution, North Carolina can begin to reduce its contribution to the global warming problem by reducing its dependence on fossil fuels. Conservation, efficiency and the development of renewable energy not only reduces pollution but also reduces imports of fossil fuels from out-of-state through conservation and planning and by increasing energy production from renewable sources and alternative fuels. Important opportunities for the state are listed below:

- **Methane reductions and energy production from agricultural wastes.** North Carolina's agricultural sector is dominated by the poultry and swine industries. Industrial-scale animal farming operations, which have been criticized for causing a number of environmental problems, also emit huge quantities of methane pollution from animal waste. As noted earlier, methane is 21 times more effective at trapping heat than carbon dioxide. Fortunately the state's poultry and swine industries can use new technologies to dramatically reduce the amount of methane emitted. In addition, these industries have enormous potential to provide North Carolina with an alternative source of energy by converting the waste methane into energy. Researchers at North

Carbon sequestration made simple

Soil contains a lot of carbon. Soil retains more carbon if it is not disturbed by forestry or agricultural practices. Trees also store carbon, so more trees means more carbon locked into the wood of forests. Changes in farming, forestry and conservation practices can increase the carbon stored in soil and trees, reducing the amount of CO_2 in the atmosphere.

Reducing emissions of global warming pollutants: benefits for North Carolina

- **Taking action on global warming supports North Carolina's economy.** Since North Carolina has no indigenous fossil fuel reserves, we must import all of the fossil fuels used to generate electricity in the state, costing the state about $6 billion in energy imports. Increasing the role of indigenous renewable and alternative fuels in North Carolina's energy mix can put our energy dollars back into our economy.
- **Taking action on global warming increases North Carolina's energy stability.** Increasing our share of indigenous fuels puts us in a strong position to withstand fossil fuel price increases and reduces our dependency on fuels from other states and other nations.
- **Measures taken to reduce the effects of global warming address other pressing environmental and health issues.** Efforts to reduce pollutants that contribute to global warming result in reductions in other pollutants (such as sulfur dioxide, oxides of nitrogen and mercury) that contribute to asthma, mercury poisoning, acid rain and other problems.
- **North Carolinians want clean energy.** According to the N.C. State Energy Plan, research conducted by the National Renewable Energy Laboratory in 1999 demonstrated a customer preference and willingness to pay more, if necessary, for cleaner energy sources.

Carolina State University are examining the potential for energy recovery from animal waste and the best technologies for producing marketable fuels.[44] As the livestock industry installs new, emission-reducing technologies, they could secure financial and regulatory credits if the state prepares in advance of federal standards.

- **Carbon sequestration.** While the agriculture sector's contribution to global warming is relatively small, it has substantial opportunities to lessen global warming. Changes in farming techniques and forestry practices could result in an increase in stored carbon in farmland soil, known as biological carbon sequestration. The carbon dioxide stored in soil and forests could offset emissions from other sectors. According to the United States Department of Agriculture, American cropland has the potential to sequester more than 8% of total national emissions (about 154 million metric tons of carbon per year).[45] In addition, carbon sequestration could be a "new crop" and source of income for farmers, who could earn money by selling their shares of sequestered carbon to industry in the carbon marketplace. Biological sequestration, which provides great opportunity for North Carolina, should not be confused with geological sequestration, a developing technology for injecting carbon dioxide into deep reservoirs in the Earth. It is important to note that while carbon sequestration may be a beneficial supplement to reducing emissions, carbon sequestration cannot replace emission reductions.
- **Wind energy.** North Carolina has outstanding potential for wind power and the best wind resources in the Southeast. Technological advances have made

wind power more efficient than ever before, enabling far fewer turbines to produce greater amounts of power. The cost of wind-generated electricity has fallen from nearly 40 cents per kilowatt-hour in the early 1980s to 3–10 cents per kilowatt hour, depending on wind speed and project size. With an average annual growth rate of more than 30% over the past half-decade, wind is the fastest growing sector of the energy industry in the United States. In addition to reducing the state's contribution to global warming, wind power can support local economies, create jobs and increase a local government's tax base.

- **Solar energy.** Humans have relied on energy from the sun for centuries. Today a variety of technologies are available to put the energy of the sun to work. Designs that accommodate natural light can be used to light and cool commercial buildings and can be a cost-effective alternative to high daytime energy use. Solar thermal technologies use the energy of the sun to heat air, water and other fluids. Solar thermal technologies can be used to heat and cool buildings, heat domestic water supplies and swimming pools, and provide electricity. Photovoltaics use solar radiation to create a flow of electrons and generate electricity. A number of different photovoltaic systems are available, many of which can be used for multiple purposes. For example, a roof system using photovoltaics can produce electricity and capture solar thermal energy for water heating, space heating and other uses while also serving as the roof itself.[46]

- **Fuel cells.** In fuel cells, hydrogen combined with oxygen in the air creates a reaction that produces electricity. When the raw hydrogen is produced by a clean source of energy such as wind power, the only by-products are heat and water vapor. Fuel-cell technology is being aggressively researched, and fuel cells are currently used to power private and commercial automobiles, laptop computers and mobile phones. Looking ahead at this promising technology, the state of Florida has already earmarked $15 million to encourage investment in the technology in the state. The North Carolina State Energy Plan notes that "fuel cell manufacturing companies have located in the state, so it is especially important for the state to attract and assist these industries for economic development reasons."[47]

- **Conservation and efficiency.** Conserving energy is the most cost-effective way to reduce emissions, and it often saves businesses and households money. Energy efficiency means extracting as much energy as possible out of the electricity we do use, which makes good economic and environmental sense. Efficiency measures are estimated to have reduced national energy needs by 31% between 1975 and 1999.[48] By employing modern, efficient technologies in power plants, businesses and homes, we can power our economy while creating fewer emissions.

- **Smart growth and clean vehicles.** In North Carolina, the transportation sector emits more than 33% of global warming pollution (see Figure 7). A documented relationship exists between land-use patterns and the amount people drive.[49] A smart growth approach to development, which encourages land-use planning, mixed use development and transportation choices can reduce

dependence on driving and decrease global warming pollution from transportation. Additionally, cleaner cars are needed as North Carolina's population continues to grow. Putting cleaner cars and alternative technology vehicles such as hybrids on the road can help to reduce global warming pollutants as well as smog-forming pollutants and carcinogenic air toxics.

- **Reducing diesel pollution.** On and off-road diesel vehicles like buses, trucks, construction and farm equipment and other heavy-duty diesel engines emit very large quantities of black carbon (soot), a climate-forcing greenhouse gas, in addition to carbon dioxide and nitrogen oxides that form ozone. Pollution from diesel engines can be removed by retrofitting them with control devices, burning cleaner fuels like Ultra Low Sulfur Diesel or natural gas, reducing idling time, improving vehicle efficiency and strengthening inspection and maintenance programs.

CHAPTER 6

Dispelling the myths about global warming

Global warming poses a serious problem for North Carolina. Yet even though solutions are at hand, many policymakers hesitate to address this issue. The facts of global warming science are not yet reflected in policy, and North Carolina's decision-makers are having difficulty matching solutions to the problem. This is because discussions of how to address global warming have persistently been more politicized than informed. Objections to taking action on global warming are based on several myths. It is important that decision-makers be aware of those myths so as not to be hindered in their ability to make good decisions.[50]

MYTH #1. There's nothing we can do; global warming will happen anyway. While temperatures will continue to rise over the next 100 years as a result of our *past* emissions, it is our *future* emissions that will determine the *severity* of the impacts that will result from higher temperatures. We can arrest the growing global warming pollutant emission trend both in North Carolina and nationally, to keep problems associated with global warming from getting worse.

MYTH #2. North Carolina can't make a difference. Global warming is not just a national and global problem; it is a local one as well. Global warming must be addressed at all levels. While one state's actions alone will not stop global temperatures from increasing, the collective actions of individual states will make a difference. Most states are evaluating global warming challenges and opportunities, and many states have policies to reduce emissions of global warming pollutants.[51] In fact, even modest steps by North Carolina to understand and act on global warming would be a valuable contribution to the chorus of activity across the nation and would help build a stronger case for the federal government to develop a responsible plan of action.

MYTH #3. Action means sacrifice. Assuming a leadership role among states in addressing rising CO_2 emissions should begin with the development of simple, cost-effective policies. If North Carolina fails to seriously address the impacts of global warming, then the future economic and public health sacrifices will be significant. North Carolina has a range of options available to address global warming including options that would benefit many sectors of North Carolina's economy (see report *Economic Opportunity in Addressing Global Warming: The silver lining for North Carolina in a lower carbon economy*). Accepting leadership responsibility does not mean North Carolina must adopt inflexible, costly policies. Rather, North Carolina officials must discuss and understand global warming, debate policies and lay out a common sense approach to address emissions of global warming pollutants.

CHAPTER 7

Recommendations

Environmental Defense recommends three common sense and low-risk actions as first steps to understanding global warming, its impacts on North Carolina and the appropriate role for the state in addressing the problem.

RECOMMENDATION #1. North Carolina leaders should establish a goal to reduce global warming pollutants. A state goal will position North Carolina to take advantage of the economic opportunities that will result from addressing global warming such as opportunities in the carbon marketplace, and it will help the state prepare for potential global warming impacts. A carbon reduction goal will help align North Carolina's environmental and economic interests and similar to the state's million acre land conservation goal, will help move the North Carolina economy in the right direction. This goal should be consistent with long-term climate stabilization of atmospheric concentrations of carbon dioxide at or below 500 parts per million while protecting economic development. In setting the level of the goal, the state should consider global warming pollution reduction targets established under the United Nations Convention on Climate Change and adopted by other states. The benefits of a carbon reduction goal are as follows:

- **Preparing for the emerging carbon marketplace.** North Carolina businesses can potentially sell tens or even hundreds of millions of dollars of carbon equivalence credits into the carbon marketplace that national climate legislation will eventually generate. A state goal can help companies position themselves to take advantage of these economic opportunities.

- **Economic development.** As the state plans its economic development activities, a state carbon reduction goal can help promote expansion and recruitment of renewable energy and clean transportation technologies that cause less pollution and generate jobs right here in North Carolina. Homegrown renewable energy and cleaner technologies can help replace or reduce the non-native coal, oil and gas that currently produce the bulk of North Carolina's energy and that must be purchased from out-of-state sources.

- **Addressing potential global warming impacts.** The health, economic and environmental impacts of global warming on North Carolina may be enormous. A state goal will draw attention to regional warming trends and their associated effects and help business and government prepare for the future.

- **Business responsibility.** A state goal will provide the motivation and opportunity for companies to examine their options for cost-effectively reducing their emissions. Many companies in North Carolina are already considering the need to reduce carbon dioxide in their long-term planning. A reduction goal will promote that forward thinking across the broader business community.

- **State leadership.** Companies such as Duke Energy and General Electric are calling for the federal government to act on global warming. The best way to encourage the federal government to assume its responsibility is through state

leadership. By establishing a state goal, North Carolina will join the numerous states across the country that are already taking steps to reduce global warming pollution.

RECOMMENDATION #2. The state should convene a stakeholder committee to develop an action plan to reduce global warming pollution and position North Carolina to win in a lower carbon economy. A holistic, thoughtful and fair plan is needed to put North Carolina on course towards meeting its reduction targets and taking responsibility for its global warming pollution. Several states are using stakeholder processes to plan for a warming planet. A North Carolina stakeholder process could be charged with accomplishing four goals:

- **Global warming impacts.** Conduct or set in motion technical analysis on the public health, environmental and economic impacts of global warming to inform decision-makers and to enable North Carolina to prepare for the effects of sea-level rise and the other consequences of a warming planet.

- **Pollution reduction opportunities in the electricity and transportation sectors.** These two sectors together account for more than 75% of North Carolina's global warming pollution. An action plan should explore opportunities to reduce emissions from the energy sector through renewable energy and efficiency. It should also evaluate policies to reduce vehicle miles traveled and put cleaner cars on the road.

- **Economic development opportunities.** Identify opportunities and steps for key business sectors—electricity, manufacturing transportation, agriculture—to compete in a lower carbon economy. Conduct sector-by-sector economic analyses to enable businesses to position themselves to be winners in the emerging carbon trading marketplace.

- **Recommendations.** Provide specific recommendations on policies and programs to prepare North Carolina for the economic opportunities and environmental impacts of a warming planet.

RECOMMENDATION #3. North Carolina Senators Dole and Burr should vote to pass the Climate Stewardship Act to cap global warming pollution nationally. North Carolina stands to suffer greatly from the effects of global warming. At the same time, North Carolina could reap economic benefits by taking action on global warming, including participation in a national carbon market. In order to both avoid the economic risks of global warming and to take advantage of the economic opportunities, North Carolina's national representatives should support—and even lead—the effort to cap global warming pollution as called for in the proposed Climate Stewardship Act.

CHAPTER 8

Conclusion

Global warming presents a serious challenge for North Carolina. The scientific consensus is clear that past human activities will create major consequences for the state's environment and economy. But the science also tells us that the severity of global warming impacts will be directly related to decisions that we make about our global warming pollution today and in the future. We have opportunities and choices for responding to climate change, and decisions made by North Carolina today can determine a new direction for the state's environment and economy. With forward-thinking actions today, we can create a better world for ourselves and our children.

Notes

[1] Intergovernmental Panel on Climate Change, "Climate Change 2001; Impacts, adaptations and vulnerability."

[2] Physicians for Social Responsibility, "Death by Degrees; the health threats of climate change in North Carolina," March 2001.

[3] North Carolina Department of Health and Human Resources, Division of Public Health, "The Health of North Carolinians: A Profile," July 2003.

[4] National Assessment Synthesis Team, U.S. Global Change Research Program, "Climate Change Impacts on the United States; the potential consequences of climate variability and change," Cambridge University Press, April; 2001. www.usgcrp.gov/usgcrp/nacc/default.htm.

[5] Ibid.

[6] National Assessment Synthesis Team, U.S. Global Change Research Program, "Climate Change Impacts on the United States; the potential consequences of climate variability and change," Cambridge University Press, April; 2001. Southeast overview p.47. www.usgcrp.gov/usgcrp/nacc/default.htm.

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Economic Opportunity in Addressing Global Warming

THE SILVER LINING FOR NORTH CAROLINA IN A LOWER CARBON ECONOMY

AUTHOR

North Carolina Climate Stewardship Task Force

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ENVIRONMENTAL DEFENSE

finding the ways that work

The North Carolina Climate Stewardship Task Force was founded by Environmental Defense to explore North Carolina-based solutions to global warming. This report shares the results of the learning process of the Task Force. Environmental Defense acknowledges the hard work and contribution of the Task Force members.

NORTH CAROLINA CLIMATE STEWARDSHIP TASK FORCE

Simon Rich, Former Chairman and CEO of Louis Dreyfus Natural Gas
Robert M. Perkowitz, Paradigm Management, Inc., VivaTerra LLC
Katherine M. Shea, MD, MPH, FAAP; Adjunct Professor, Department of Maternal and Child Health, UNC School of Public Health, Chapel Hill, NC
Jeff Johnson, Executive in Residence, Nicholas School of the Environment and Earth Sciences, Duke University; Retired Senior VP, Louis Dreyfus Corporation
Timothy P. Toben, Founder and former CEO of Knowledgebase Marketing, Inc.
Thomas F. Darden, CEO, Cherokee Investment Partners, LLC
Alice Loyd, Coordinator, Climate Connection, NC Council of Churches
Deborah Leiner, MD, FAAP; North Carolina Pediatric Society Environmental Health Group, Piedmont Pediatrics and Moses Cone Health System, Greensboro, NC
William Bailey, Principal Consultant, DuET Energy Engineering (DuPont)

ENVIRONMENTAL DEFENSE STAFF TO TASK FORCE

Jane Preyer, M.P.A.
Michael Shore, MCE, MS
Kris Thornburg
Amber Munger

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Our mission
Environmental Defense is dedicated to protecting the environmental rights of all people, including the right to clean air, clean water, healthy food and flourishing ecosystems. Guided by science, we work to create practical solutions that win lasting political, economic and social support because they are nonpartisan, cost-effective and fair.

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Contents

Executive summary iv

Introduction 1

CHAPTER 1
Moving towards a lower carbon economy 2

CHAPTER 2
Economic opportunities for North Carolina 7

CHAPTER 3
Protecting public health and North Carolina's natural assets 13

CHAPTER 4
Recommendations 15

CHAPTER 5
Conclusion 18

APPENDIX A
North Carolina companies acting on global warming 19

APPENDIX B
Global warming pollution trends in North Carolina 21

Notes 24

Executive summary

While significant attention has been devoted to the threat of global warming,[1] little public attention has been given to the opportunities that come with addressing it. In the summer of 2004, Environmental Defense convened a bipartisan, multi-disciplinary, ad hoc committee—the North Carolina Climate Stewardship Task Force—to assess the impact of global warming on North Carolina. Representatives from the science, business, health care and faith communities collaborated to review specific threats and opportunities for the state and came to a seemingly startling conclusion: Addressing global warming presents a huge economic opportunity for North Carolina.

In fact, industry and government response to a more carbon constrained world may be one of the most important economic drivers of the 21st century. The emerging carbon emissions marketplace is expected to develop into one of the world's largest commodity markets. This, together with the development and implementation of energy efficiency, alternative energy production (including biomass, wind and solar) and commercialization of cleaner technologies in the transportation sector, will create tens of thousands of new jobs across many sectors. North Carolina is well positioned to gain substantial economic benefit by taking a leadership position in this emerging economy.

Another major economic benefit for North Carolina in addressing the impacts of global warming comes from cost avoidance. If unchecked, sea-level rise and other impacts of global warming could take a tremendous toll on mainstays of the state's economy such as the $60 billion agriculture and forestry sectors and $13 billion tourism industry, as well as inflicting damage to private property and increasing health care costs. If North Carolina acts in concert with other states, the federal government and the international community, the global warming challenge can be met and much of its potential costs to citizens, businesses and the state economy can be mitigated.

Based on the Task Force's assessment, the overall benefit for North Carolina's economy in addressing global warming is substantial—potentially billions of dollars annually. Therefore, the Task Force urges state leaders to set forth a vision of opportunity and prosperity as the world moves to a lower carbon economy and to implement an action plan to competitively position North Carolina's businesses and to protect the quality of life of all its citizens. North Carolina can provide a mix of market-based guidance, support, incentives and disincentives to lead all sectors of the economy to this new opportunity. To move North Carolina toward this vision, the Task Force offers the following recommendations:

RECOMMENDATION #1

Carbon marketplace leadership

Develop an action plan to position North Carolina to benefit economically from the lower carbon economy and establish a specific carbon reduction goal.

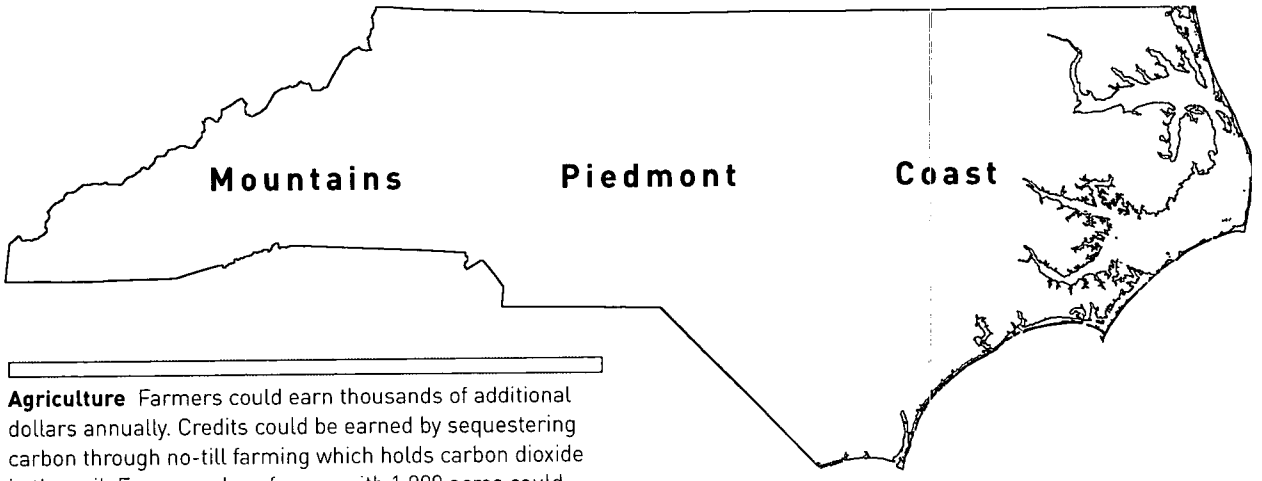
Carbon now has a price. It is a commodity that can be bought and sold, especially overseas where nations are embracing lower carbon economies. Reducing carbon pollution and exploiting the technologies and services associ-

ated with the reductions will be a new source of income. North Carolina energy producers, industry and agriculture can capitalize on carbon reduction strategies. State leaders should develop a statewide action plan that taps the expertise of North Carolina's academic institutions, innovative business community and civic leaders to assess the economic benefits and job creation opportunities in moving toward the new lower carbon economy. As a first step, a carbon reduction goal for North Carolina will draw statewide attention to global warming pollution and align future economic development with new market opportunities.

FIGURE ES1

Economic opportunities by North Carolina region associated with a lower carbon economy

Several business sectors across North Carolina have the potential to reap substantial economic benefits by addressing global warming and participating in the carbon market.



Agriculture Farmers could earn thousands of additional dollars annually. Credits could be earned by sequestering carbon through no-till farming which holds carbon dioxide in the soil. For example, a farmer with 1,000 acres could earn more than $13,000 annually by converting his farmland to no-till practices.

Biofuels industry Potential billion dollar economic opportunity for the state. By providing an alternative source of fuel for vehicles, farmers could earn hundreds of millions of dollars a year by growing crops used for biofuels. The industry has the potential to create about 22,000 jobs in the state.

Forested croplands Owners of marginal croplands could earn thousands of dollars annually. Credits could be earned for foresting marginal lands. For example, a landowner who forested 1,000 acres of marginal land could earn more than $58,000 in carbon reduction credits annually.

Fuel cell development The national fuel cell market, currently at about $40 million, is projected to grow to more than $10 billion by 2010. North Carolina already has 15 companies associated with the manufacture and development of fuel cells, employing about 240 people across the state.

Swine industry Methane capture could supply power to the grid and could potentially generate $50 million annually in carbon reduction credits.

Wind power industry Potential economic benefit of $1.6 billion in new investments. Wind power development could also create more than 4,500 new jobs in the state.

ADDITIONAL OPPORTUNITIES FOR NORTH CAROLINA

Coastal wetlands Carbon credits could be earned for retaining carbon intact in wetland soils. Developing and implementing water management plans for peat soils on public or private lands could help these lands to serve as carbon sinks.

Solar industry Photovoltaic jobs are projected to increase nationally from 20,000 to 62,000 by 2015 with $34 billion in investments expected nationwide by 2015. North Carolina is in a strong position to take advantage of the expected growth in this sector.

RECOMMENDATION #2

Energy independence

Pursue new technologies and conservation efforts in the electricity and transportation sectors.

Over the next decade, it is projected that North Carolina will spend more than $100 billion importing energy from sources outside the state. North Carolina should pursue increasing energy independence through in-state development of alternative sources of energy (biofuels and wind and solar power), as well as energy efficiency and conservation incentives, in both the electric utility and transportation sectors. Advancing these technologies in a lower carbon economy will keep energy dollars in the state and will benefit local businesses, agriculture, research institutions and consumers.

Detroit is remembered for the transition to automobiles, Silicon Valley for the transition to computer chips, Hollywood for being the epicenter of the entertainment business, and North Carolina's own hometown, Charlotte, for advances in the banking industry. If North Carolina leads the transition to the next generation energy economy, others will buy the technology, biofuels, equipment and expertise, enriching the state. Rather than importing energy and creating economic growth elsewhere, North Carolinians can benefit and prosper from the state's planning and participation in the lower carbon economy.

Introduction

The North Carolina Climate Stewardship Task Force, convened by Environmental Defense, is an ad hoc committee representing interests of the business, medical, academic, religious and environmental communities. Initially assembled in the summer of 2004 to address the economic, social and public health threats of global warming, the Task Force came to a startling conclusion: taking action to reduce global warming presents major opportunities for North Carolina's economy.

Industry and government response to a more carbon constrained world may be one of the most important economic drivers of the 21st century, moving the world towards a "lower carbon economy." If North Carolina plans for and embraces this new economy, the state could have exceptional opportunities to increase investment and create jobs. North Carolina's energy producers, research companies, agricultural sector and consumers can all benefit if the state chooses to chart a course towards solutions, rather than reacting to consequences.

In this report, the Task Force highlights the economic opportunities that come with a lower carbon economy and encourages North Carolina's leaders to find win-win solutions to the problem of global warming. Although the precise level of economic benefit stemming from a lower carbon economy is still unknown, it can be measured in the billions of dollars per year. To position itself to take advantage of economic opportunity in addressing global warming, North Carolina should begin the long-term process of answering the following questions:

- How can North Carolina position its key sectors (electric utility, transportation and agriculture) to benefit economically from and prepare for the worldwide movement to cap global warming pollutants?
- What goals should North Carolina set to address global warming, given the costs and benefits associated with participating in the emerging carbon market?
- Considering that North Carolina's electricity demand and vehicle travel is expected to increase by about 50% in the next 20 years, how can the state meet this need while generating jobs, investment and economic growth in the state instead of increasing its dependence on expensive, foreign, high carbon fuels?
- What specific analysis is needed for North Carolina to make informed decisions about the economic opportunities associated with state, national and international movement towards a lower carbon economy?

Over the years, North Carolina has proven to be forward thinking in building its economic base—often a step in front of other states. Such leadership is now needed to help North Carolina to find the silver lining in addressing global warming and to create new economic opportunity for this and future generations.

CHAPTER 1

Moving towards a lower carbon economy

The international response

On February 16, 2005, the Kyoto Protocol went into effect. The Kyoto Protocol is an agreement between 130 nations to reduce emissions of global warming pollutants to 5% below 1990 levels in 2008–2012.[2] The Protocol's "emissions trading" regime enables pollution emitters in industrialized countries to buy and sell emissions credits among themselves, effectively creating a market for global warming pollutant reductions. This market-based approach, born in the United States to reduce acid rain pollution, will improve the efficiency and cost-effectiveness of emission cuts. The European Union is leading the world in using the cap-and-trade approach to reduce global warming pollution.

In response to the broad scientific consensus that global warming is occurring in large part because of human activities, the U.S. Congress has begun a serious debate on global warming policy despite the country's withdrawal from the Kyoto Protocol. In June 2005, the U.S. Congress voted on the McCain-Lieberman Climate Stewardship and Innovation Act, a bill that would cap emissions of CO_2 nationally. While the vote fell short of passage, a later vote in favor of a non-binding "Sense of the Senate Resolution" earned 54 votes, putting the Senate on record for the first time in recognition of the need for a mandatory cap on America's global warming pollution. This signaled a clear shift in climate policy in the U.S. The Senate is moving beyond a discussion of *whether* America will deal with global warming, to *how*. Given the pressure of scientific consensus and world-wide action on global warming, many agree that the U.S. will eventually join the rest of the world in capping CO_2 and other global warming pollutants either as a national program, or in conjunction with the rest of the global community.

States are moving forward

Many U.S. states are moving toward adopting policies to reduce their emissions of global warming pollutants unilaterally or collectively as regions. So far, 22 states have already developed policies directly aimed at reducing emissions of global warming pollutants (See Figure 1). Businesses that recognize the opportunities in the emerging carbon emissions market will be greatly served by state governments that have prepared their economies for the carbon marketplace.

State policies to reduce emissions of global warming pollutants vary in nature and scope. Massachusetts, for example, has set caps on utility emissions aimed at dropping state emissions to the levels required in the Kyoto Protocol. Oregon has created a carbon offset program, so as utilities expand their operations and increase emissions, they fund pollution reductions in other sectors. In June 2005, Governor Schwarzenegger of California announced an ambitious state target to reduce global warming pollution back to 1990 levels. Other agricultural states such as Georgia have explored programs to create carbon sinks by sequestering carbon in the agriculture sector.

North Carolina has recently joined the ranks of states that are moving forward to address global warming. Its 2005 Global Warming Act establishes a 32-member Legislative Commission to evaluate potential impacts on the state from rising temperatures, consider recommending a global warming pollutant reduction goal, and prepare

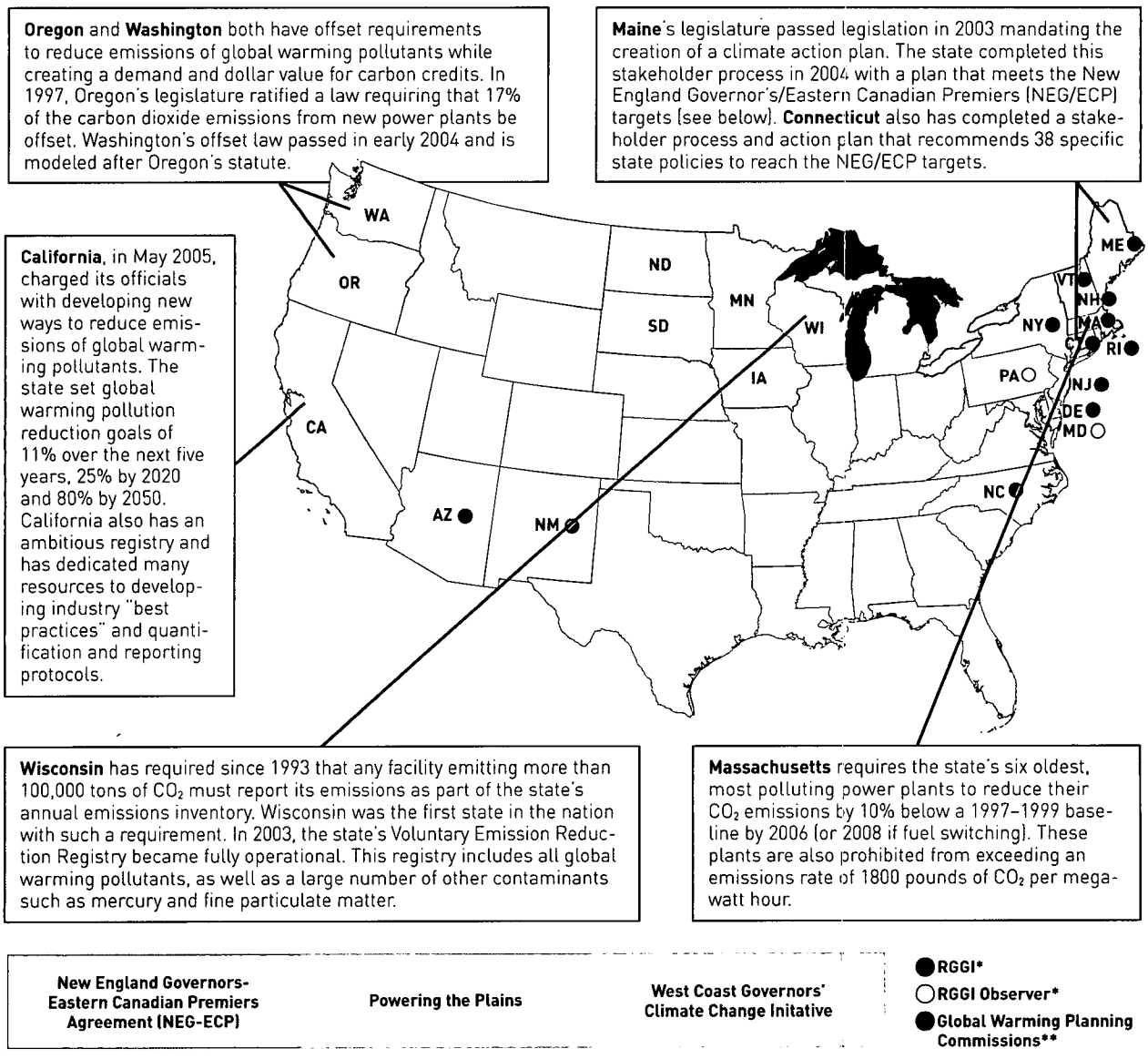
the state's economy to capitalize on emerging economic markets associated with addressing global warming.

Many other states have chosen to take indirect action on reducing global warming emissions. Texas boosted its investment in renewable energy through renewable portfolio standards that provide revenue for renewable energy development. California and eight other states have adopted clean car standards that go beyond federal standards at

FIGURE 1

States take action on global warming

Twenty-two states have enacted policies directly aimed at reducing emissions of global warming pollutants.



*Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by Northeastern and Mid-Atlantic states to reduce emissions of carbon dioxide by developing a regional strategy for controlling emissions.

**Many states already recognized on this map for taking action on global warming have developed state level global warming planning commissions. In addition to these states, Arizona, New Mexico and North Carolina have recently embarked upon or committed to planning processes for addressing global warming.

reducing pollution. These programs typically promote the use of alternative car technologies—such as hybrids—which are significantly more efficient than conventional automobiles and therefore reduce global warming pollution. States that have already begun to explore solutions to electricity and transportation pollution and opportunities in the carbon market are positioning their economies for competitive advantage.

Top businesses take action on global warming

Of *BusinessWeek*'s top 20 grossing global companies, eight have taken committed action on reducing global warming pollutants. Companies with progressive global warming policies are indicated in bold.

1. **General Electric U.S.**
2. Microsoft U.S.
3. Exxon Mobil U.S.
4. **Pfizer U.S.**
5. Wal-Mart Stores U.S.
6. Citigroup U.S.
7. **BP Britain**
   In 2001, BP achieved its 2010 target of reducing its emissions of global warming pollutants 10% below 1990 levels. BP's new target, set in 2002, is that by 2012, net emissions should show no increase on 2001 levels despite business growth.
8. American International Group U.S.
9. **Intel U.S.**
10. **Royal Dutch/Shell Group Neth./Britain**
11. **Bank of America U.S.**
    Recognizing the threats posed by global warming to the ultimate stability and sustainability of its business and to the world, Bank of America has committed to assessing its emissions of global warming pollutants, reducing energy consumption, working with others to find solutions, assessing the risk of global warming to its businesses, informing its associates, and reporting on its goals, actions and progress.
12. **Johnson & Johnson U.S.**
13. HSBC Holdings Britain
14. Vodafone Group Britain
15. Cisco Systems U.S.
16. International Business Machines U.S.
17. Procter & Gamble U.S.
18. Berkshire Hathaway U.S.
19. **Toyota Motor Japan**
20. Coca-Cola U.S.

Businesses take action

In light of the global and national momentum and because of the threats posed by global warming, many U.S. and North Carolina companies are already taking action to prepare for the global carbon market as well as for national policies to reduce global warming pollution that are likely forthcoming (see sidebar "Top businesses take action on global warming").

Based on a survey of company websites, businesses commit to action on global warming for some or all of the following reasons: They recognize the economic, health and environmental threat that excessive emissions of global warming pollutants pose; they recognize the financial benefits of energy efficiency and conservation that simultaneously serve to reduce their bottom line and their global warming pollution; and they recognize the value of emissions reduction credits that they may be able to offer in the emerging carbon market.

Of the top 20 grossing global companies, eight have taken significant action to reduce emissions of global warming pollutants. These companies include pharmaceuticals, petroleum products, computer technology, financial services, manufacturers and automotive companies. Furthermore, many global and national companies with a presence in North Carolina have recognized the value in taking action on global warming. For example, ABB, Alcoa, Cummins, Inc., DuPont, Intel, Interface, Inc., Novartis, Rohm and Haas, and Weyerhaeuser have all taken significant steps to reduce global warming pollution (see Appendix A).

The actions of major corporations have not gone unnoticed in the news media. In 2004, many major newsmagazines published lead articles on

global warming and many featured independent business action. Some notable highlights include:

• *BusinessWeek*

"Global Warming" (cover story) 08/16/2004

Business is far ahead of Congress and the White House. Some CEOs are already calling for once-unthinkable steps. "We accept that the science on global warming is overwhelming," says John W. Rowe, chairman and CEO of Exelon Corp. (EXC) "There should be mandatory carbon constraints."

• *The Economist*

"Welcome to Kyoto-land" (cover story) 10/09/2004

[British Petroleum (BP)] met its [greenhouse gas emissions reduction] targets eight years ahead of schedule through a combination of higher efficiency, new technology and better management of energy. Most impressive, Lord Browne [of BP] explains, is the price tag: "We've met it at no net economic cost-because the savings from reduced energy inputs and increased efficiency have outweighed all the expenditures involved." The costs of tackling climate change, he concludes, "are clearly lower than many feared. This is a manageable problem."

• *The Wall Street Journal*

"Companies Get Ready for Greenhouse Gas Limits" 10/26/2004

Some major corporations, anticipating that they may soon be facing government regulations on so-called greenhouse gas emissions at home as well as abroad, are already taking steps to reduce the financial risks of tighter controls and searching for ways to make money on them.... Pfizer, Inc., [the largest pharmaceutical company in the world], which operates 102 facilities world-wide, has identified more than 600 energy-saving projects, ranging from new solar and wind-powered projects to finding ways to prune costs of existing lighting, heating and cooling systems. "There's a competition for capital within the company," explains Al Forte, Pfizer's assistant director of environmental affairs. "These guys have other priorities at plant sites, mainly getting products out the door. Having a company-wide goal allows us to have a greater amount of visibility for a lot of these projects."

Regularly, major corporations with a presence in North Carolina reiterate their commitment to reducing global warming pollution and call for government policies to address climate change. Some of those statements include:

"Global climate change is one of the most pressing issues of our time. Few scientists disagree that the climate is changing, though there is much debate about its cause and effect. Nevertheless, there is general agreement that climate change is likely being influenced by human activity...reducing greenhouse gas emissions has become a worldwide political and social imperative. It is an imperative where American leadership is not just needed; American leadership is required... But it's clear to me now that we have to move to mandatory measures to get real results in a fair manner.... Let me underscore an important point on global climate change: We have great faith in American innovation. The mandate to become less carbon intensive will spur the kind of technological innovation that we saw in the last century. Innovation that propelled us to become the world's leading economy. Set the right goals, and Americans can and will lead the way."[3]

PAUL ANDERSON, DUKE ENERGY, CEO
APRIL 7, 2005

"Industry and the government have to take steps to develop a policy that is engaged on

greenhouse gases like carbon dioxide. There's a long road ahead to implement lasting solutions—but even small steps will get us headed in the right direction. We're taking these steps because while being a good corporate citizen was once a business imperative, today it has become a competitive advantage... There's no time to wait because tomorrow is now. We are living in a carbon-constrained world where the amount of CO_2 must be reduced."

JEFFREY IMMELT,
CHAIRMAN AND CEO OF GE
UNVEILING HIS COMPANY'S
"ECOMAGINATION" COMMITMENT
MAY 9, 2005

"DuPont has set business-driven internal goals for the current decade, anticipating both market pressures and opportunities as economies respond to the long-term climate challenge. These are aimed to position our businesses for the marketplace of 20 to 50 years from now—one which will demand less emissions and a markedly smaller 'environmental footprint' from human activity."[4]

DUPONT POSITION STATEMENT
DUPONT WEBPAGE, LAST UPDATED
DECEMBER 12, 2002

"We, at Bank of America, recognize that climate change and atmospheric pollution represent a risk to the ultimate stability and sustainability of our way of life. Bank of America is committed to addressing climate change issues even more so today, when we believe we can set real and achievable targets for greenhouse gas reductions in both our operations as well as investment opportunities."[5]

CANDACE SKARLATOS, BANK OF AMERICA
ENVIRONMENTAL INITIATIVES
2005

"We regard the Kyoto Protocol, and other national and international efforts, as important initial steps in lowering greenhouse gas emissions and stabilizing global temperatures. [Therefore,] ABB has initiated a global project with the World Energy Council (WEC) to reduce greenhouse gas emissions by one billion tons annually by 2005. Progress is publicly reported in a database on the WEC website. Today, the one billion ton target has been reached and the database contains more than 1,300 projects in 124 countries."[6]

ABB POSITION STATEMENT
2005

"Alcoa has concluded that available evidence indicates Greenhouse Gas (GHG) emissions from human activities affect climate. We recognize that the risk of significant climate change is an issue of vital importance requiring action [and have committed to] reducing our direct GHG emissions to 25% below the 1990 baseline on a worldwide basis by 2010, with the potential for significant additional reductions through major technology improvements."[7]

ALCOA POSITION STATEMENT
2005

CHAPTER 2

Economic opportunities for North Carolina

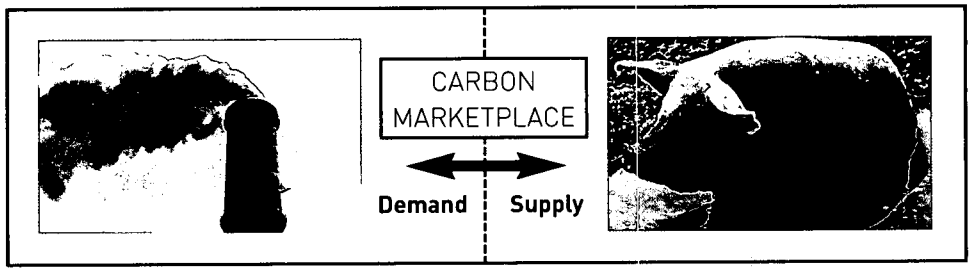
International limits on global warming pollution may be one of the most important economic drivers of the 21st century. The emerging carbon emissions marketplace is expected to develop into one of the world's largest commodity markets. This, coupled with the development and implementation of alternative energy production including biomass, wind and solar could create hundreds of thousands of jobs nationally in the industrial, agriculture, academic research, and other sectors. Other states are preparing their economies for global warming. Pennsylvania, which like North Carolina gets about 90% of its energy from coal and nuclear sources, anticipates huge benefits in renewable energy investments including an additional $10 billion in gross state output, $2.8 billion advantage in employee earnings and 85,000 new jobs.[8] North Carolina is well positioned to compete in the lower carbon economy. Just as Charlotte has become a national banking center, North Carolina can become a leader in the transition to a clean energy future.

The carbon marketplace: linking agriculture, forests and industry

International global warming pollution caps under the Kyoto Protocol create a carbon marketplace through which carbon credits can be bought and sold (see Figure 2). Despite the U.S. government's reluctance to join worldwide efforts to reduce global warming pollution, many states and businesses have begun to embrace the emerging carbon market. Aware of the overwhelming scientific evidence that the planet is warming because of human activities, they also recognize the economic opportunities that the carbon market presents both in terms of selling emission credits and commercializing technologies that will flourish in a lower carbon economy.

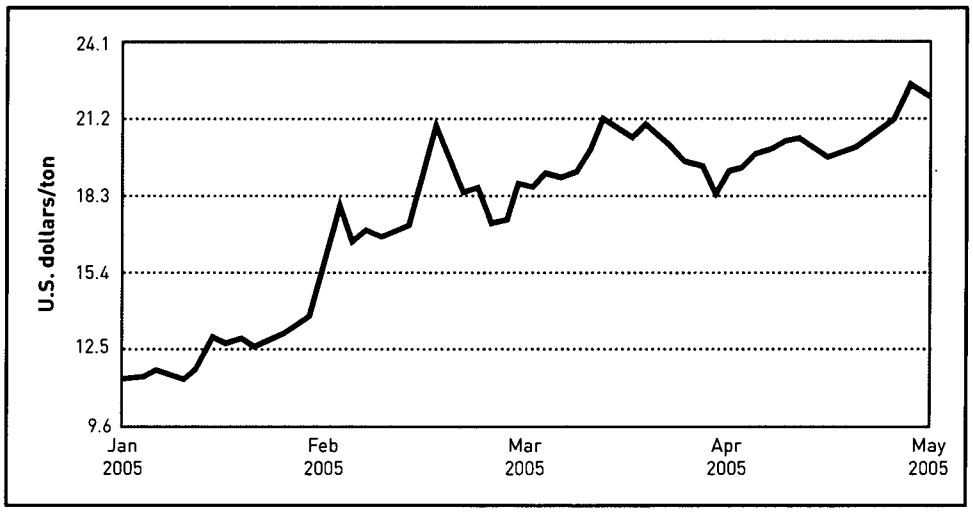
If companies reduce their emissions below the limits set by government caps, they can sell their surplus reductions to companies that face high on-site reduction costs. Businesses that emit more than their allotment under a cap must buy credits, thus creating demand for the carbon equivalency credits. Therefore, there is a financial incentive

FIGURE 2
What is the carbon marketplace?



A carbon marketplace is the buying and selling of carbon dioxide reductions and other global warming pollution credits. As nations cap global warming pollutants, companies that reduce emissions beyond requirements can sell their credits. In North Carolina, many sectors have the potential to supply carbon credits. For example, a power plant may find it more cost-effective to purchase credits than to make reductions. A hog farmer who installs new technologies that dramatically reduce his farm's global warming pollution can sell his pollution credits to the power plant, creating a new income stream for the farmer while saving money for the power plant.

FIGURE 3
Selling price of carbon in the EU's Emission Trading Scheme



Source: Point Carbon

for businesses to reduce emissions, while also creating a public and environmental benefit.

Although the Kyoto Protocol's emissions trading market will not materialize until 2008, the European Union has moved ahead with its own Emissions Trading Scheme (ETS). Under the ETS, most nations in the European Union have agreed to reduce emissions under a cap-and-trade program. As of July 2005, the value of credits in the ETS was about US $34 per ton.[9] Figure 3 shows the value of carbon credits from January through May of 2005.

Key sectors of North Carolina's economy could benefit significantly by selling credits in the carbon marketplace. For example, the swine industry can convert to cleaner technologies to manage hog waste and earn nearly $50 million in carbon equivalency credits for reducing methane emissions, in addition to at least that much revenue from selling methane generated from electricity.[10] Private landowners and forest companies who commit to growing trees that sequester carbon may also receive credits. For example, a landowner with 1,000 acres converted to forests could earn $58,000 per year by "growing carbon" instead of harvesting the trees.[11] And, corporations like DuPont can voluntarily reduce emissions of global warming

Million dollar hog waste?

Chile's leading pork producer, Agrosuper, signed a million dollar agreement with power companies in Canada and Japan in the summer of 2004 to help these companies lower their global warming pollutant emissions and comply with obligations under the Kyoto Protocol. Agrosuper is using technology that captures and eliminates methane from pig manure, preventing methane, a global warming pollutant that is 21 times more potent at trapping heat than carbon dioxide, from entering the atmosphere. As the Kyoto Protocol is implemented, it is likely that innovative deals like that of Agrosuper and energy companies may become more common as countries and businesses find the most cost-effective ways to reduce global warming pollution. North Carolina's hog industry and other sectors may reap similar benefits if they are prepared to compete in a carbon market.

pollutants and receive carbon equivalency credits for the early reductions.

North Carolina utilities can also benefit by entering the carbon market. Even prior to national caps, utilities can develop partnerships with other sectors of North Carolina's economy that may be suppliers of carbon credits. For example, electric utilities in Canada have already entered into partnership with the hog industry in Chile to secure contracts for emissions reductions (see "Million dollar hog waste," page 8).

Energy efficiency and renewables

North Carolina spends more than $10 billion for energy imports such as coal and oil each year (see Figure 4).[12] Electricity generation, primarily from coal, is responsible for 40% of North Carolina's global warming pollution.[13] The way coal is commonly burned, well over half the energy potential is lost as heat, and there is often tremendous inefficiency in how electricity is used in homes and businesses across North Carolina.

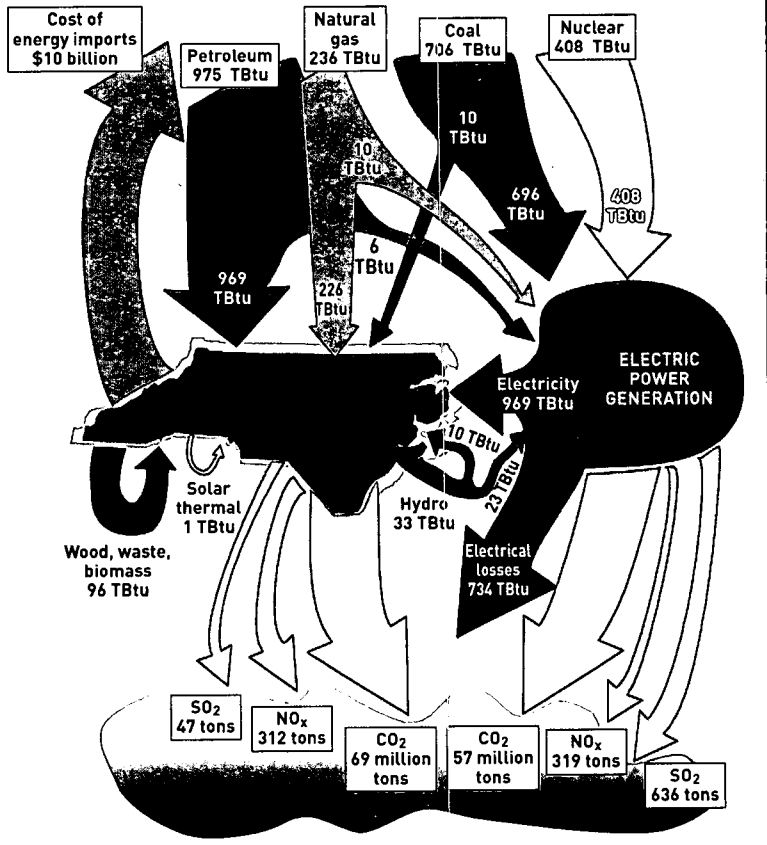
Businesses and institutions across the economy can benefit from conservation and efficiency practices, which are often the most cost-effective way to reduce carbon emissions. Additionally, conservation, efficiency and new renewable technologies can keep significant portions of the exported funds in the state economy, and they provide real business opportunities for

FIGURE 4

Energy flow of North Carolina's economy

North Carolina spends more than $10 billion each year to import fossil fuels. But conservation, efficiency, and the use of alternative, indigenous sources of energy could keep much of this money in the state economy. The top arrows of this diagram represent energy coming into North Carolina from out-of-state sources, as measured in Trillions of British Thermal Units (TBtu). The large green arrow shows that this energy costs North Carolina more than $10 billion annually. Some of it (mostly coal and nuclear) is shipped to large in-state power plants, represented by the large bubble on the right hand side of the diagram. The bubble also shows that at conventional power plants most of the potential energy is lost as heat. Petroleum (wide red arrow) is largely used to fuel the transportation sector; natural gas (narrow blue arrow) is mostly used for heating. Renewable energy sources such as solar thermal, biomass, and hydro come from in-state sources, as represented by the arrows that loop back to the state. The cloud at the bottom of the diagram represents estimates of air pollution—carbon dioxide (CO_2), sulfur dioxide (SO_2), and oxides of nitrogen (NO_x)—that are emitted by North Carolina's combustion of fossil fuels.

Source: North Carolina State Energy Plan



North Carolina. Between 2001 and 2003, the state invested $11 million in energy efficiency and renewable energy, which is estimated to save about $60 million in energy costs by 2010 and stimulate $191 million in private sector growth.[14] This is only the tip of the iceberg, as investment in renewable energy and energy efficiency could create more than 22,000 jobs in North Carolina by 2010 and nearly 39,000 jobs by 2020.[15] A 10% renewable energy portfolio standard is estimated to produce, through 2020, $72 million in new capital investments and millions of dollars in new property tax revenues for local communities.[16] Investments in renewable energy via the McCain-Lieberman Climate Stewardship and Innovation Act are estimated to result in the creation of more than 15,000 jobs in North Carolina.

This macroeconomic potential underscores on-the-ground business opportunities. From advanced windows to lighting to insulation to thermal heating, new and expanded businesses can grow to meet demand for energy efficient buildings. For example, U.S. GreenFiber, based in Charlotte, manufactures insulation using 80% recycled paper fiber and meets fire resistant standards using non-toxic borates instead of formaldehyde, asbestos or fiberglass. GreenFiber sells nationwide to contractors, manufactured home builders, modular homebuilders and retailers.[17] CREE, Inc., based in Durham, produces light emitting diodes (LEDs) that produce high intensity light using little energy. Last year the company earned $307 million.[18] Meanwhile, the manufacturing industry, a huge consumer of energy, has myriad opportunities to improve efficiency in their boilers, chillers, waste treatment systems and other processes, creating the need for new products.

Renewable energy such as wind, solar and biomass from landfills, animal operations and crop agriculture are abundant and largely untapped energy resources indigenous to North Carolina. North Carolina has the potential to gain more than 4,500 new jobs and $1.55 billion in new investments in wind energy manufacturing.[19] North Carolina's biomass resources could provide enough energy to supply about 20% of total electricity use in the state,[20] and revenue from generating energy from animal waste alone could generate as much as $50 million each year for North Carolina farmers.[21] There are even economic opportunities around commercializing new technologies to gasify coal prior to combustion which can generate significantly more energy than conventional coal combustion.

The transportation sector

North Carolina imports more than half a million barrels of oil per day, which is equivalent to sending $25 million out of the state's economy every day.[22] Each imported tanker of oil exports jobs and economic growth and undermines national security. The transportation sector emits 33% of global warming pollution in North Carolina (Figure 7, Appendix B), making it the state's second largest emitter.[23] Vehicle miles traveled are growing even faster than population (Figure 8, Appendix B). Besides being a major source of heat-trapping gasses, vehicle pollution in North Carolina plays a substantial role in the formation of ground level ozone smog. Part or all of 32 counties in North Carolina are in violation of the nation's public health standards for ozone,[24] jeopardizing federal highway funding and local economic development. The

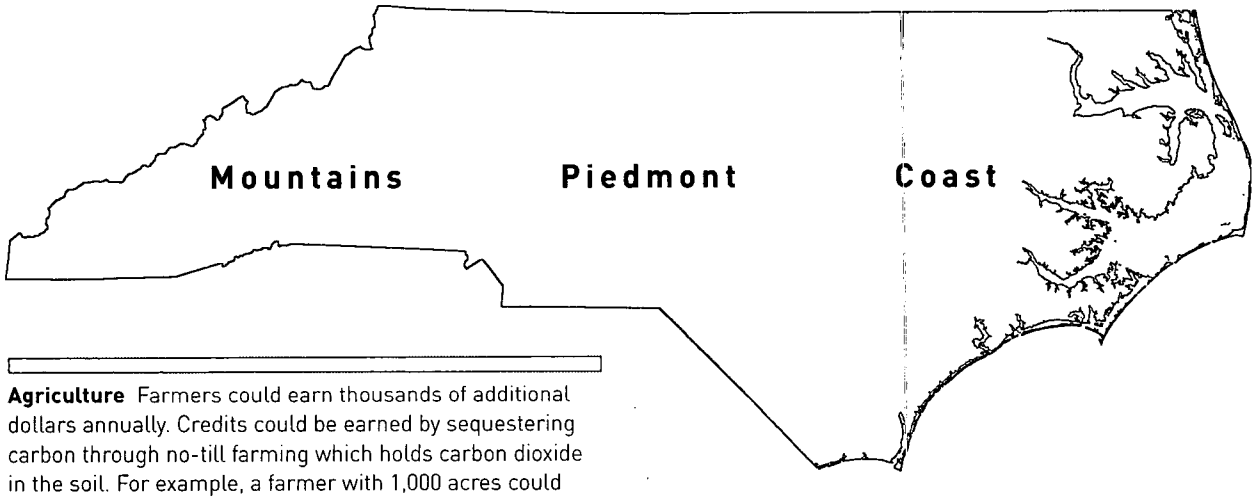
tailpipe challenge is complicated by North Carolina's rapid growth, as the population is expected to increase by 40% by 2020[25] putting even more cars on the road. More cars will intensify traffic congestion, a problem that not only increases pollution but also undermines the quality of life in the state, one of the most attractive features for recruiting new businesses. Efforts to both reduce vehicle miles traveled and automobile pollution are important in order to achieve and maintain a healthy environment for North Carolina citizens.

Despite the challenges associated with more automobiles, reducing pollution from the transportation

FIGURE 5

Economic opportunities by North Carolina region associated with a lower carbon economy

Several business sectors across North Carolina have the potential to reap substantial economic benefits by addressing global warming and participating in the carbon market.



Agriculture Farmers could earn thousands of additional dollars annually. Credits could be earned by sequestering carbon through no-till farming which holds carbon dioxide in the soil. For example, a farmer with 1,000 acres could earn more than $13,000 annually by converting his farmland to no-till practices.

Biofuels industry Potential billion dollar economic opportunity for the state. By providing an alternative source of fuel for vehicles, farmers could earn hundreds of millions of dollars a year by growing crops used for biofuels. The industry has the potential to create about 22,000 jobs in the state.

Forested croplands Owners of marginal croplands could earn thousands of dollars annually. Credits could be earned for foresting marginal lands. For example, a landowner who forested 1,000 acres of marginal land could earn more than $58,000 in carbon reduction credits annually.

Fuel cell development The national fuel cell market, currently at about $40 million, is projected to grow to more than $10 billion by 2010. North Carolina already has 15 companies associated with the manufacture and development of fuel cells, employing about 240 people across the state.

Swine industry Methane capture could supply power to the grid and could potentially generate $50 million annually in carbon reduction credits.

Wind power industry Potential economic benefit of $1.6 billion in new investments. Wind power development could also create more than 4,500 new jobs in the state.

ADDITIONAL OPPORTUNITIES FOR NORTH CAROLINA

Coastal wetlands Carbon credits could be earned for retaining carbon intact in wetland soils. Developing and implementing water management plans for peat soils on public or private lands could help these lands to serve as carbon sinks.

Solar industry Photovoltaic jobs are projected to increase nationally from 20,000 to 62,000 by 2015 with $34 billion in investments expected nationwide by 2015. North Carolina is in a strong position to take advantage of the expected growth in this sector.

sector presents North Carolina with economic opportunities ranging from clean technologies to homegrown fuels (Figure 5). For example, fuel cells may be a key technology in the creation of a cleaner fleet of vehicles. Fuel cells release energy stored in hydrogen gas. When that hydrogen gas is generated from clean energy sources such as wind power or methane captured from landfills, global warming pollution from the transportation sector can be dramatically reduced. North Carolina already has 15 companies associated with the manufacturing and development of fuel cells, employing about 240 people across the state.[26] The economic growth in the sector is potentially enormous, and other states are positioning themselves to take advantage of the opportunity. Florida, for example, has already earmarked $15 million to encourage in-state investment in the technology.[27]

Advanced technology vehicles represent an economic growth opportunity for North Carolina. Currently, public demand for hybrid gas-electric vehicles is outpacing the supply of these vehicles. Some hybrid models are available only to consumers in states that have passed "clean car standards." Nine states have adopted clean car standards, reducing evaporative emissions from vehicle fuel tanks and requiring manufacturers and auto dealers to put more advanced technology vehicles and low polluting conventional vehicles on the road.[28] In May 2005, Clean Car Standards were introduced in both the North Carolina Senate and House. The expansion of these standards across the country creates the need for research and development of advanced technology vehicles. North Carolina, with its well-established research communities and sophisticated laboratories, could support research and development efforts to commercialize new automobile technologies, creating jobs and business opportunities in several sectors.

Perhaps an even greater economic opportunity than advanced technology vehicles is alternative sources of fuel. North Carolina is rich in resources that can be used to generate biofuels like ethanol and biodiesel. Biofuels are derived from agricultural crops such as corn and soybeans, as well as animal waste. Using biofuels displaces foreign oil with cleaner energy that is grown and produced locally. Because growing crops removes carbon from the atmosphere, there is the potential, depending on crop type and other factors, for fewer overall carbon emissions compared to fossil fuels. Using methane from hog waste lagoons to make biodiesel or other energy sources prevents the potent global warming pollutant from being emitted into the atmosphere, resulting in a net reduction in the amount of heat-trapping pollution that is released.

A Rocky Mountain Institute analysis of biofuels potential for North Carolina suggests that it could be a billion dollar industry for the state, earning farmers hundreds of millions of dollars a year and creating more than 20,000 jobs.[29] Entrepreneurs in North Carolina are beginning to recognize the economic opportunities of biofuels. Piedmont Biofuels, a cooperative in Chatham County, is already producing and selling pure biodiesel known as B100 from waste vegetable oil.

CHAPTER 3

Protecting public health and North Carolina's natural assets

From the ancient Blue Ridge Mountains to the unique Outer Banks, to the life-sustaining network of freshwater rivers, and world renowned estuarine and marine systems—North Carolina is rich in natural assets. These wonders are the state's natural capital—a support system for the state's high quality of life—and are fundamental to its economy. North Carolina's natural capital supports the state's $13 billion tourism industry, [30] $60 billion agricultural sector,[31] and natural resource-based industries such as timber and minerals. It also provides services that often are not valued in traditional economic terms, such as wetlands that protect against flooding and filter pollutants out of the air and water.

While past emissions of global warming pollutants dictate that temperatures will continue to rise and that North Carolina will experience impacts as a result, it is current and future emissions that will determine the severity of those impacts and the capacity for the state's natural systems to adjust. Action now can enable North Carolina to prepare for and avoid potential economic, health and environmental costs associated with global warming including:

- **Increased temperatures are expected to lead to health problems.** Warmer temperatures will increase the number of very hot days, causing an increase in heat-related deaths and illnesses such as heat stroke. The heat wave that gripped Europe in 2003, causing between 22,000 and 35,000 deaths, is a reminder of how vulnerable sensitive populations can be to increases in temperature.[32] An increase in insect-borne diseases may accompany the warmer, insect-friendly weather that results from global warming. Ticks and mosquitoes carry a number of serious and life-threatening diseases, including Lyme disease, Dengue Fever, West Nile virus and malaria.[33]

- **Warmer temperatures may worsen North Carolina's air quality.** Some of the gains achieved by the North Carolina Clean Smokestacks Act will be offset, as warmer summers increase ground-level ozone formation and the number of unhealthy air days.[34] A 1999 study estimated that smog pollution triggered 1,900 respiratory hospital admissions, 630 asthma emergency room visits, and 240,000 asthma attacks during the summer of 1997 in North Carolina.[35] A 2002 California Air Resources Board study linked exposure to ozone pollution to increased cases of asthma.[36] More than half of North Carolinians live in counties failing to meet health based standards, and it is estimated that total summertime ozone costs North Carolina about $296 million a year in health costs or $37 per citizen.[37]

- **Sea-level rise.** North Carolina scientists predict that a sea-level rise of less than 14 inches could inundate about 770 square miles of the state's coast, an area nearly the size of Great Smoky Mountains National Park.[38] The United Nation's Intergovernmental Panel on Climate Change (IPCC) estimates that sea levels in the Atlantic Ocean are likely to rise by 19 inches by 2100.[39] Sea-level rise could come at a significant cost to North Carolina. In Dare County alone, $5.5 billion worth of property,[40] nearly $600 million in annual tourism revenue and 10,000 tourism-related jobs are at risk.[41]

- **Severe weather.** In 2002 alone, North Carolina experienced more than $678 million in weather-related losses and government expenditures.[42] The coastline will likely become even more susceptible to severe weather damage as sea-level rise increases the vulnerability of low-lying areas to storm surges.

- **Agricultural impacts.** The agriculture industry, including food crops, fibers and forestry, contributes nearly $60 billion to North Carolina's economy annually and employs about 20% of the state's workforce.[43] Scientists predict that with global warming it is likely that production patterns will shift northward and optimal growing conditions for various crops will be affected. Warmer temperatures will likely result in less soil moisture due to increased evaporation, necessitating irrigation systems at many of the state's 56,000 farms. The U.S. Environmental Protection Agency projects that North Carolina's soybean and wheat yields could decrease as temperatures rise beyond the tolerance level of these crops.[44]

- **Tourism and recreational impacts in the mountains.** North Carolina's seven ski areas currently generate $120 million each year for the state's economy. Warmer temperatures threaten this important source of revenue.

- **Forestry impacts.** Most climate models predict that North Carolina will lose the optimal growing conditions for loblolly pine, a mainstay of the state's forestry industry. As the nation's number two producer of Christmas trees, a $100 million industry especially strong in the mountains,[45] the state has good reason to be concerned about Frasier firs, which would likely be erased from the Southeast should regional temperatures rise by as much as 5.4°F.[46]

For further information on the impacts of global warming on North Carolina, see "Understanding Global Warming for North Carolina" at www.ed.org/go/ncclimate.

CHAPTER 4

Recommendations

The North Carolina Climate Stewardship Task Force concludes that taking action to address global warming presents significant near-term economic opportunities for the state. These opportunities can and should be exploited immediately by North Carolina in order to compete with neighboring states that may also take advantage of lower carbon economy opportunities. Key sectors of the economy—agriculture, forestry, swine, electric utility, manufacturers, renewable energy, transportation and tourism—stand to derive billions of dollars of near- and long-term benefits if state leaders properly position North Carolina for the lower carbon economy. Government, business and other stakeholders can and should work together to find win-win solutions and develop a rational approach to reducing the impacts of global warming while enhancing the natural and economic assets of North Carolina. The Task Force offers two recommendations:

RECOMMENDATION #1

Carbon marketplace leadership

Develop an action plan to position North Carolina to benefit economically from the lower carbon economy and establish a specific carbon reduction goal.

Carbon now has a price. It is a commodity that can be bought and sold, especially overseas where nations are embracing lower carbon economies. Reducing carbon pollution and exploiting the technologies and services associated with the reductions will be a new source of income. North Carolina energy producers, industry and agriculture can capitalize on carbon reduction strategies. State leaders should develop a statewide action plan that taps the expertise of North Carolina's academic institutions, innovative business community and civic leaders to assess the economic benefits and job creation opportunities in moving towards the new lower carbon economy. As a first step, North Carolina should establish a carbon reduction goal for the state that will draw statewide attention to global warming pollution and align future economic development with new market opportunities.

Rationale and next steps

North Carolina's ability to prepare for a lower carbon economy depends in part on collaboration between interested parties to find win-win solutions. It is time for Governor Mike Easley and the General Assembly to step forward and help all interested parties take on the challenge and opportunities associated with reducing global warming.

In particular, a carbon reduction goal will help align North Carolina's environmental and economic interests and prepare the state's economy for global warming. The benefits of a carbon reduction goal are as follows:

- **Preparing for the emerging carbon marketplace.** North Carolina businesses can potentially sell hundreds of millions of dollars worth of carbon equivalence credits to the carbon marketplace once national caps on global warming pollutants are set. A state carbon reduction goal can help companies position themselves to take advantage of these economic opportunities.
- **Economic development.** As the state plans its economic development activities, a state carbon reduction goal can help promote expansion and recruitment of renewable energy and clean

transportation technologies that cause less pollution and generate jobs in North Carolina. Homegrown renewable energy and cleaner technologies can replace or reduce the non-native coal, oil and gas that is currently the bulk of North Carolina's energy and that is purchased from out-of-state sources.

- **Addressing potential global warming impacts.** The health, economic and environmental impacts of global warming on North Carolina may be enormous. A state carbon reduction goal will draw attention to regional warming trends and their associated effects and help businesses, citizens and government prepare for the future.

- **Business responsibility.** A state goal will provide the motivation and opportunity for companies to examine their options for cost-effectively reducing their emissions. Many companies in North Carolina are already considering the need to reduce carbon dioxide in their long-term planning. A reduction goal will promote that forward thinking across the broader business community.

- **State leadership.** Companies from Duke Energy to ALCOA are calling for the federal government to act on global warming. State leadership and action will encourage the federal government to assume its responsibility. By establishing a state carbon reduction goal, North Carolina will join numerous states across the country that are already taking steps to reduce global warming pollution.

RECOMMENDATION #2

Energy independence

Pursue new technologies and conservation in the electricity and transportation sectors to increase North Carolina's energy independence.

Over the next decade, it is projected that North Carolina will spend more than $100 billion importing energy from sources outside the state. North Carolina should pursue increasing energy independence through in-state development of alternative sources of energy such as biofuels, wind and solar power, as well as energy efficiency and conservation incentives, in both the electricity and transportation sectors. Advancing these technologies in a lower carbon economy will keep energy dollars in the state and will benefit local businesses, agriculture, research institutions and consumers.

Rationale and next steps

The electric utility and transportation sectors are underpinnings of North Carolina's economic vitality, but currently these two sectors are largely dependent on the use of coal and oil, both carbon-based fossil fuels. The transition to a lower carbon economy could be one of the greatest economic drivers of the 21st century. North Carolina should embrace opportunities to conserve energy, commercialize renewable energy technologies, stem the rapid increase in vehicles miles traveled and put alternative technology cars on the road. By reducing dependence on foreign oil, these activities are predicted to increase jobs and investments. Key steps North Carolina should pursue:

- **Energy efficiency and conservation.** New energy efficient technologies create business opportunities for North Carolina, and efficiency is often the most cost-effective way to reduce pollution. North Carolina should ensure that government policies encourage energy efficiency. For example, building codes should maximize energy efficiency in new

construction, and the Public Utility Commission should ensure that the rate structure encourages efficiency rather than consumption.

- **Clean energy commitment.** Through business and government partnership, North Carolina should commit itself to dramatically increasing its renewable energy generation. North Carolina should join the 22 states that have created a meaningful Renewable Portfolio Standard. North Carolina should also find other ways to increase its commitment to renewable energy.

- **Reducing vehicle miles traveled.** North Carolina's economic prosperity depends on the convenient, safe transport of people and goods on the state's roads and highways. Yet, North Carolina cannot meet transportation needs by expanding highways alone. State and local government leaders should direct funding to policies that slow the rapid growth in the number of miles that North Carolinians drive, provide transportation choices for businesses and individuals, and keep more dollars in the local economy.

- **Alternative technology cars.** North Carolina should join the nine states that have already taken the common-sense step of adopting Clean Car standards, which provide a cost-effective strategy to increase the number of alternative technology vehicles on the road, such as fuel cell, electric or gas-electric hybrids. Clean Car standards also have provisions to reduce pollution from conventional automobiles. North Carolina already has a strong presence in fuel cell manufacturing, and the development of other clean transportation technologies offers additional economic development opportunities for the state. North Carolina is also strongly positioned to grow the feedstock to produce biofuels, which power automobiles and trucks, providing an economic boost to the agriculture sector, especially in eastern North Carolina.

CHAPTER 5

Conclusion

Taking action to address global warming is the right course to protect public health, the environment, personal property and the economy from the impacts of global warming. Detroit is remembered for the transition to automobiles, Silicon Valley for the transition to computer chips, Hollywood for being the epicenter of the entertainment business, and North Carolina's own hometown, Charlotte, for advances in the banking industry. If North Carolina leads the transition to the next generation energy economy, others will buy the technology, biofuels, equipment and expertise, enriching the state. Rather than importing energy and creating economic growth elsewhere, North Carolinians can benefit and prosper from the state's planning and participation in the lower carbon economy.

APPENDIX A

North Carolina companies acting on global warming*

Many North Carolina companies are already taking action to reduce global warming or are involved with environmental programs that may indicate a willingness to address global warming.

	Companies that have taken specific actions directed toward addressing global warming				Companies with environmental records and activities consistent with reducing global warming pollution		
Business	*Pew Center's Business Environmental Leadership Council*	*Chicago Climate Exchange*	*EPA Climate Leaders*	*U.S. Department of Energy Registry*	*NC Environmental Steward (DENR)*	*Global Environmental Management Initiative (GEMI)*	*ISO 14000 Certified Facility, 2004*
ABB	●						
Alcoa	●		●				
Ashland Inc.						●	
AT&T					◐		
Azdel, Inc.				●			
Bank of America			●				
Baxter International	●	●	●				
BP	●		●				
Carolina Power and Light				●			
Catawba Landfill Gas				●			
CH2M Hill	●						
CommScope, Inc.				●			
Corning, Inc.-Wilmington Optical Fiber Facility					◐		
Cummins, Inc.	●						
Curtis-Wright Flight Systems, Inc.							●
Dow Chemical Company		●		●		●	
Doxey Furniture Corp.				●			
Duke Energy				●		●	
DuPont	●	●				●	
Electrolux Home Products							●
FedEx						●	
GlaxoSmithKline						●	
Hanes Dye & Finishing Co.				●			
Highland Industries, Inc.				●			
IBM	●	●	●				
Intel	●					●	
Interface Inc.	●	●	●				

Business	Companies that have taken specific actions directed toward addressing global warming				Companies with environmental records and activities consistent with reducing global warming pollution		
	Pew Center's Business Environmental Leadership Council	*Chicago Climate Exchange*	*EPA Climate Leaders*	*U.S. Department of Energy Registry*	*NC Environmental Steward (DENR)*	*Global Environmental Management Initiative (GEMI)*	*ISO 14000 Certified Facility, 2004*
International Paper		●	●				
M.J. Soffe Company				●			
Mayflower Vehicle Systems							●
Maple Springs Laundry		●		●			
Naval Air Depot, Cherry Point					●		
Novartis	●					●	
Novozymes North America, Inc.			●		●		
Penn Compression Moulding, Inc.				●			
Power Transmission and Distribution, USA				●			
Rohm and Haas	●						
Smithfield Foods, Inc.						●	
Staples			●				
T.S. Designs, Inc.				●			
Teradyne Components, Molding and Stamping							●
Volvo			●				
Weyerhaeuser	●						
Wyeth-Lederle Vaccines						●	

The Pew Center's Business Environmental Leadership Council (BELC) is a group of leading companies worldwide that are responding to the challenges posed by global warming. These companies have all set global warming reduction targets. More information on Pew's BELC is available at www.pewclimate.org/companies_leading_the_way_belc/.

The Chicago Climate Exchange (CCX) is a global warming pollutant reduction and trading pilot program for emission sources and offset projects in the U.S., Canada and Mexico. The members of the CCX have made a voluntary, legally binding commitment to reduce their emissions of global warming pollutants by 4% below the average of their 1998–2001 baseline by 2006, the last year of the pilot program. Visit www.chicagoclimatex.com/ for more information.

Climate Leaders is a voluntary EPA industry-government partnership that works with companies to develop long-term comprehensive climate change strategies. Partners set a corporate-wide GHG reduction goal and inventory their emissions to measure progress. More information is available at www.epa.gov/climateleaders/index.html

The U.S. Department of Energy's Voluntary Reporting of Greenhouse Gases Program, established by Section 1605(b) of the Energy Policy Act of 1992, provides a means for organizations and individuals who have reduced their emissions to record their accomplishments and share their ideas for action. More information is available at www.eia.doe.gov/oiaf/1605/frntvrgg.html.

The NC Environmental Stewardship Initiative is designed to promote and encourage superior environmental performance by North Carolina's regulated community. This voluntary program establishes incentives to stimulate the development and implementation of programs that use pollution prevention and innovative approaches to meet and go beyond regulatory requirements. For more information visit www.p2pays.org/esi/.

Global Environmental Management Initiative (GEMI) is an organization of leading companies dedicated to fostering global environmental, health and safety (EHS) excellence through the sharing of tools and information to help business achieve EHS excellence. Through the collaborative efforts of its members, GEMI also promotes a worldwide business ethic for EHS management and sustainable development through example and leadership. More information is available at www.gemi.org/.

ISO 14000 refers to a family of voluntary standards and guidance documents to help organizations address environmental issues. Included in the family are standards for Environmental Management Systems (EMS), environmental and EMS auditing, environmental labeling, performance evaluation and life-cycle assessment. Visit www.p2pays.org/iso/emsisofaq.asp#faq6 for more information.

*The authors acknowledge that this is an incomplete list. Companies that are taking action would like to be acknowledged in future iterations of this table should please contact Michael Shore at mshore@environmentaldefense.org.

APPENDIX B

Global warming pollution trends in North Carolina

This appendix presents North Carolina trends and other basic data for major global warming pollutants.

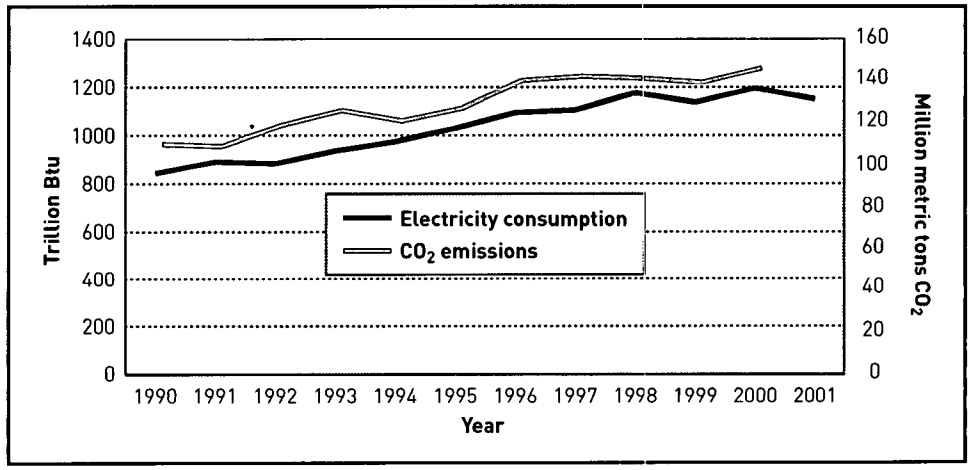
CARBON DIOXIDE

Since the Industrial Revolution, human activities have increased the amount of carbon dioxide (CO_2) in the atmosphere by more than 30%.[47] In North Carolina, CO_2 emissions have grown steadily along with increases in energy consumption, with emissions of CO_2 increasing by more than 30% since 1990 (Figure 6).[43]

FIGURE 6

North Carolina electricity consumption and CO_2 emissions

North Carolina is consuming more energy than ever before and our CO_2 emissions are increasing as a result.

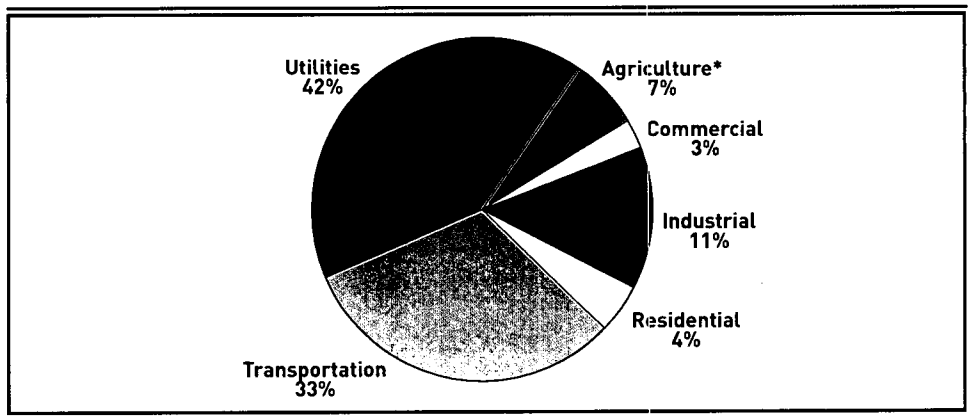


Source: United States Department of Energy (energy consumption), United States Environmental Protection Agency (CO_2 emissions)

FIGURE 7

Primary sources of global warming pollution in North Carolina, 2000 (million metric tons carbon equivalent)

Most global warming pollutants come from tailpipes and electricity use.



*Agriculture figures were derived using Environmental Protection Agency's GHG tool, selecting the default options for North Carolina.

Source: United States Environmental Protection Agency

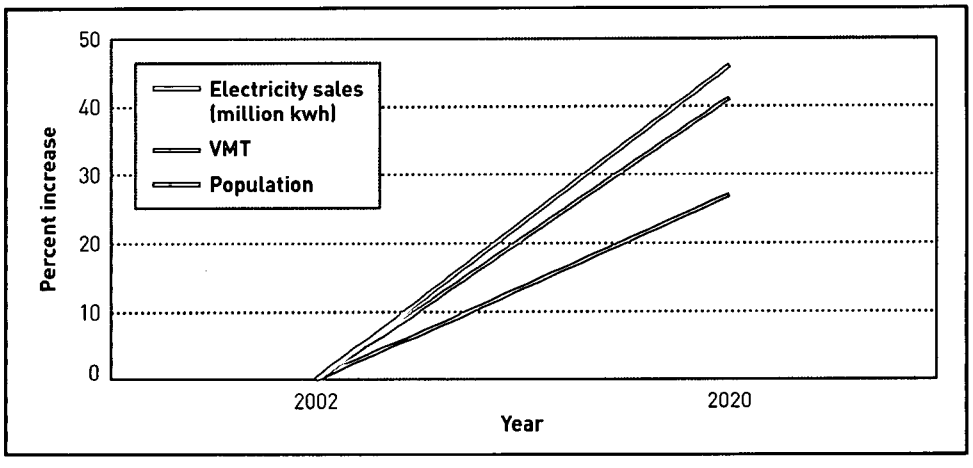
Although the state has outstanding opportunities to increase its use of renewable energy, more than 78% of the state's energy comes from fossil fuels, while about 5% comes from renewable sources.[49] Electric utilities and the transportation sector are responsible for more than half of the state's emissions (Figure 7).[50] North Carolina is challenged to decouple its carbon emissions and growth. From the year 2002 to the year 2020, North Carolina's population is expected to increase by about 27%. However, in that same timeframe, vehicle miles traveled in the state are expected to increase by more than 40% and electricity sales are expected to increase by about 46% (Figure 8).[51]

METHANE

While methane emissions are far lower than CO_2 emissions, methane is estimated to be 21 times stronger than CO_2 at trapping heat in the atmosphere over a 100-year time horizon.[52] The primary

FIGURE 8

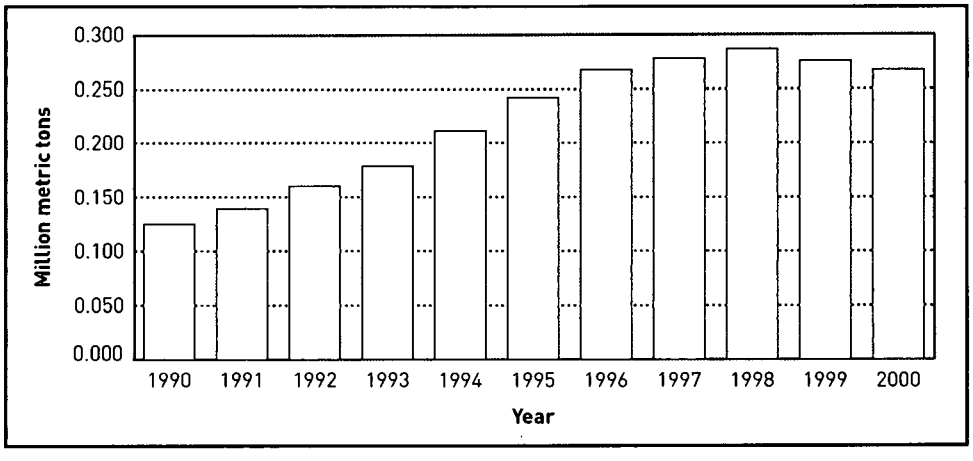
Projected increase in vehicle miles traveled (VMT), electricity sales, and population in North Carolina, 2002–2020



Source: North Carolina Energy Outlook Final Report 2003

FIGURE 9

North Carolina methane emissions from 1990



Source: United States Environmental Protection Agency, GHG Tool, NC default options

source of methane emissions in North Carolina is the agricultural sector. Methane emissions from agriculture have increased nearly 60% since 1990 (see Figure 9).[53] Most of this growth has occurred due to manure management in North Carolina's large hog and poultry industries. North Carolina's hog population, a major source of methane, has grown from 2.6 million in 1987 to over 10 million today, almost a 300% increase.[54]

Notes

[1] Environmental Defense's report "*Understanding Global Warming for North Carolina,*" gives an account of both the science of global warming and the consequences that North Carolina will face if global warming continues unabated.

[2] United Nations Framework Convention on Climate Change, http://unfccc.int/essential_background/kyoto_protocol/items/2830.php, visited on June 1, 2005

[3] Paul Anderson, Duke Energy CEO, Charlotte Business Journal's 10th annual power breakfast. http://www.duke-energy.com/news/viewpoint/050407.asp

[4] DuPont website position statement on global climate change, last updated December 12, 2002. http://www1.dupont.com/NASApp/dupontglobal/corp/index.jsp?page=/content/US/en_US/news/position/global_climate.html

[5] Candace Skarlatos, Bank of America Climate Change Position, 2005. http://www.bankofamerica.com/newsroom/presskits/view.cfm?page=climateandforests

[6] ABB's position statement on climate change, 2005. http://www.abb.com.cn/global/cnabb/cnabb050.nsf!OpenDatabase&db=/global/cnabb/cnabb053.nsf&v=C36&c=us&c=2291CE9B57C1FF3548256AA0002DD5CB

[7] Alcoa position statement on climate change, 2005. http://www.alcoa.com/global/en/environment/position_papers/climate_change.asp

[8] Black & Veatch, "Economic Impact of Renewable Energy in Pennsylvania." March 2004. Available online at http://www.bv.com/energy/eec/studies/PA_RPS_Final_Report.pdf.

[9] Point Carbon, Price for May 26, 2005. www.pointcarbon.com/

[10] *Calculation of estimate:* 238,059 metric tons CH_4 (estimate of annual methane emissions from NC hog waste lagoons) x 21 (CO_2 equivalence) x $20 (estimated price/metric ton CO_2 once the Climate Stewardship Act is passed) x 1/2 (to assume that just half of the state's methane would be captured via new technologies) = $49,992,390 (nearly $50 million) in carbon equivalence credits once the Climate Stewardship Act is passed. *Citation for this estimate:* Dollar estimate generated using: 1) methane emissions estimation methodology from U.S. EPA (2004) State Greenhouse Gas Inventory Tool (draft). Methane and Nitrous Emissions from Agriculture Module, April 2004 edition, 2) price projection per metric ton CO_2 from studies by the Massachusetts Institute of Technology (MIT) (http://web.mit.edu/globalchange/www/reports.html#pubs) and the Energy Information Administration (EIA) (http://www.eia.doe.gov/oiaf/analysispaper/sacsa/pdf/s139amend_analysis.pdf), and 3) an estimate that just half of the total annual hog waste methane emissions would be captured via new technologies. Equation used: 238,059 metric tons CH_4 x 21 (CO_2 equivalence) x $20 (projected price/ton CO_2) x 0.5 = $49,992,390.

[11] Hoover, Coeli, Journal of Forestry, 9/00, Vol 98., No. 9, p.23, calculation for tons of CO_2 sequestered/acre/year from southeastern loblolly pine plantations. (Methodology: 1,000 acre farm x 3.2 short tons CO_2 sequestered/acre/year x $20 (Projected price/ton$CO_2$ once national carbon caps are in place) = $64,000).

[12] Figure created by Jeff Tiller of the Appalachian State University Energy Center for the North Carolina Energy Office. Cost of fuel imports updated by Environmental Defense. Methodology may be requested by e-mailing mshore@environmentaldefense.org.

[13] U.S. Environmental Protection Agency, State CO_2 emissions from fossil fuel combustion 1990–2000, http://yosemite.epa.gov/oar/globalwarming.nsf/content/EmissionsStateEnergyCO2Inventories.html. Agriculture figure is an Environmental Defense estimate based on methane emissions from animal feed operations.

[14] Appalachian State University Energy Center, "Clean Energy Funding for North Carolina: An Impact Analysis of State Energy Programs." September 2004.

[15] Tellus Institute, *Clean Energy: Jobs for America's Future*, October 2001. http://www.tellus.org/energy/publications/clean_energy_jobs.pdf

[16] Union of Concerned Scientists Analysis, "Renewing North Carolina," September

2002, https://www.ucsusa.org/clean_energy/renewable_energy/page.cfm?pageID=1392

[17] U.S. GreenFiber website, http://www.cocooninsulation.com/.

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[19] American Wind Energy Association, "Wind Power Outlook 2005."

[20] State Energy Office, "North Carolina State Energy Plan," June 2003. Revised January 2005.

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[22] Energy Information Administration, "Energy Consumption Estimates by Source, 1960–2001, North Carolina." http://www.eia.doe.gov/emeu/states/sep_use/total/use_tot_nc.html#footnotes. Energy Information Administration, "World Crude Oil Prices 05/20/2005," available online at http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/weekly_petroleum_status_report/current/pdf/table13.pdf. [Methodology: 500,000 barrels/day x $50/barrel (rounded down from $41.17/barrel in EIA oil chart) = $25 million per day]

[23] U.S. Environmental Protection Agency, State CO_2 emissions from fossil fuel combustion 1990–2000, http://yosemite.epa.gov/oar/globalwarming.nsf/content/EmissionsStateEnergyCO2Inventories.html. Agriculture figure is an Environmental Defense estimate based on methane emissions from animal feed operations.

[24] U.S. Environmental Protection Agency, "8-Hour Ground-Level Ozone Designations," See www.epa.gov/ozonedesignations/regions/region4desig.htm, last visited 2/20/05

[25] State Energy Office, "North Carolina Energy Outlook—Final Report," 2003.

[26] Conversation with Jason Hoyle, North Carolina fuel cell alliance, April 2005.

[27] Florida Department of Environmental Protection, www.dep.state.fl.us, last visited May 2005.

[28] Clean Car standards are also known as LEV II standards. States that have adopted these standards to date include California, New Jersey, New York, Maine, Vermont, Massachusetts, Rhode Island, Washington and Connecticut.

[29] Rocky Mountain Institute, "Biomass potential in NC."

[30] North Carolina Department of Commerce, "North Carolina Tourism Fast Facts" http://www.nccommerce.com/tourism/econ/

[31] North Carolina Department of Agriculture and Consumer Services, http://www.agr.state.nc.us/stats/general/general1.htm, visited 06/01/05.

[32] International Federation of Red Cross and Red Crescent Societies, "World Disasters report 2004", http://www.ifrc.org/publicat/wdr2004/chapter2.asp

[33] Physicians for Social Responsibility, "Death by Degrees; the health threats of climate change in North Carolina," March 2001.

[34] National Assessment Synthesis Team, U.S. Global Change Research Program, "Climate Change Impacts on the United States; the potential consequences of climate variability and change."

[35] Abt Associates for the Clean Air Task Force, "Adverse Health Effects Associated with Ozone in the Eastern United States," October 1999.

[36] California Air Resources Board, Children's Health Study, The Lancet (Vol. 359, No. 9304), February 2, 2002.

[37] Orie L. Loucks, "Background Paper on Nitrogen Oxide Sources as a Cause of Ozone and Smog in North Carolina and Surrounding States," Miami University of Ohio, February 1999. The documents estimate of national ozone health costs of $37 per person was multiplied by 8.04 million, the population of North Carolina according to US census data.

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[40] Dare County, North Carolina Financial and Statistical Summary, www.co.dare.nc.us/Finance/1999Annual/99StatSec.pdf

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[44] U.S. Environmental Protection Agency, http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/|SHSU5BUTX6/$File/nc_impct.pdf.

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[47] Intergovernmental Panel on Climate Change, "Climate Change 2001: The Scientific Basis. Contribution of Working group One to the Third Assessment of the Intergovenmental Panel on Climate Change." Technical Summary.

[48] Energy Information Administration, http://www.eia.doe.gov/emeu/states/_use_multistate.html;

U.S. Environmental Protection Agency, http://yosemite.epa.gov/oar/globalwarming.nsf/content/EmissionsStateEnergyCO2Inventories.html

[49] U.S. Environmental Protection Agency, State CO_2 emissions from fossil fuel combustion 1990-2000, http://yosemite.epa.gov/oar/globalwarming.nsf/content/EmissionsStateEnergyCO2Inventories.html. Agriculture figure is an Environmental Defense estimate based on methane emissions from animal feed operations.

[50] Ibid.

[51] State Energy Office, "North Carolina Energy Outlook—Final Report," 2003.

[52] Intergovernmental panel on Climate Change, "Climate Change 1995: The Science of Climate Change, " Cambridge University Press. www.ipcc.ch/pub/sarsum1.htm

[53] U.S. Environmental Protection Agency, State and Local Capacity Building Branch Greenhouse Gas Tool, North Carolina agricultural sector.

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(THIS IS A DRAFT)
Minutes

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

Tuesday 7 March 2006
10:00 a.m.
Room 643 Legislative Office Building

The Legislative Commission on Global Climate Change convened its second meeting on Tuesday 7 March 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building with Mr. John Garrou, Co-Chair, presiding. Other members present were: Representative Joe Hackney, Co-Chair, Senator Charlie Albertson, Senator Janet Cowell, Senator Robert Pittenger, Representative Becky Carney, Representative Pricey Harrison; Representative Alice Underhill; Representative Winkie Wilkins, Mr. Thomas , Dr. Douglas Crawford-Brown, Mr. Walter Clark, Dr. Dolores Eggers, Dr. Edward Erickson, Mr. Barry Eveland, Dr. George Everett, Mr. Robert J. Glaser, Mr. Preston Howard, Mr. Michael Nelson, Mr. Mitchell Peele, Dr. Daniel Phaneuf, Dr. Sethu Raman, Dr. Stanley Riggs, Mr. Michael Shore, Mr. Robert Slocum, Dr. Stephen Smith, Mr. James Stephenson, Mr. Tim Toben, Mr. Ivan Urlaub, Ms. Susan Tompkins, and Dr. Godfrey Uzochukwu. Absent were Representative Wilma Sherrill, Ms. Caroline Choi, and Mr. Tom Profeta.

A copy of the meeting notice for this meeting, a copy of the agenda and the visitor's registration are attached to these minutes as **Exhibits A, B, and C**.

Mr. Garrou called the meeting to order and welcomed everyone to the second meeting of the Commission of Global Climate Change. He thought the first meeting was useful and educational and hopes everyone did too. He and Representative Hackney agree to waive opening remarks so he called on Mr. Givens to talk about our agenda for today.

Mr. Givens thanked the co-chair, greeted the members and visitors and gave a few brief items. First of all, two members of the Commission have advised me in advance they could not attend, Ms. Choi from Progress Energy and Mr. Profeta from Duke University. If you will let us know when you will be absent we will make every effort to collect materials for you and see that you get them at a later meeting.

A number of materials have been distributed, which I will note for the record, Senator Pittenger distributed two items, one on his letterhead and a folder capturing John Locke Foundation. These items are attached to these minutes as **Exhibits D and E**. We have a newspaper article reprinted which someone had distributed. The newspaper printing is from Dr. William Schlesinger who was one of our presenters at our last meeting (**Exhibit F**). We have a publication called North Carolina Coastal Federation Coast Report that was submitted by Commissioner Jim Stephenson (**Exhibit G**). You also have a sheet of information by our first presenter Dr. Robert Balling (**Exhibit H**). Our agenda today will focus again on the questions of science and also the update on the parallel process

undertaken by the Division Air Quality and the Department of Environment and Natural Resources, the Climate Action Plan Advisory Group.

Our four science speakers today are Dr. Robert Balling, he appears at the request of Senator Robert Pittenger. He is from Arizona State University. Dr. Stanley Riggs is a member of the Commission. He volunteered to present. He is a Distinguished Research Professor in the Department of Geology at East Carolina University. His specialty is sea level rise. Robert Jackson who is from Duke University is Professor of Biology and Professor of Environmental Science at the Nicholas School; and Dr. Sethu Raman a member of the Commission is the State Climatologist. There is adequate time for discussion among the members and I am sure you will take advantage of it.

We asked each of you to submit a brief one paragraph biographical statement. For legislative members, we can make one for you based on information we have but for other members we would appreciate it if you would do so. You are reminded to submit your reimbursement forms and remind visitors in the back to sign the attendance list. We will be happy to answer any questions.

Please note that we have scheduled two additional meetings, Tuesday 4 April and Tuesday 25 April in this building. The 4 April meeting will be downstairs in the Finance Committee Room 544 and the 25 April meeting will be back in this room. This is on the back of your agenda so that you will have a copy of it. Have not announced a meeting time, but I think we will continue meeting at 10:00 a.m. Mr. Givens thanked the chairman.

Mr. Garrou called on Professor Balling to present. Mr. Garrou asked Professor Balling if he preferred questions to be asked at the end or if he minded being interrupted. Professor Balling preferred to have questions at the end of his presentation.

Mr. Balling thanked the Commission for having him and started off with a graph that is seen throughout the climate change literature. The slides are attached as **Exhibit I**. It shows the build-up of carbon dioxide over the past 100 years in the atmosphere. It tells an interesting story, and obviously it shows that carbon dioxide levels continue upward. But I remind you, that international bodies have been meeting for more than 15 years to try to slow down the increase in the concentration of greenhouse gases and the reward for all the effort to date, has been the largest increase in CO_2 that occurred in 2005. So, no doubt about it, CO_2 is increasing and I am sure you are aware there is equally no doubt about it that there are other greenhouse gases that contribute to warming of planet earth. These are also gases that human activities are putting into the atmosphere. They act to trap heat energy that would otherwise escape into space. They are all part of the mix of greenhouse gases that one must deal with in this debate. This is not news. I am here to tell you that the greenhouse effect is real. We've known about this for over 100 years. We can do calculations here to show that concentrations of greenhouse gases warm the earth otherwise the earth would be uninhabitable. And I could also show you that if concentrations of greenhouse gases were to rise and all else were to be held equal we would have the planetary temperature of the earth go up.

I am not here to tell you that there is some problem with the theory of the greenhouse effect. I'm also fully aware that models are run throughout the world and the models tell us about the same story. Whether it's a fairly simple model run at my university or very sophisticated models run in Colorado, when carbon dioxide levels doubled there is no doubt that the earth warms, there is no doubt that the bulk of the warming occurs in the high latitudes, occurs at night, occurs at winter, occurs over land. This is seen over and over. North Carolina is not particularly ground zero in the warming of the world but none-the-less, North Carolina is projected to undergo warming as the concentration of greenhouse gases increases.

However, were we to go over to the library and look at the articles that are published that described the numerical models of climate on which this castrophy is based, we would find out that there are enormous uncertainties with the way the models handle clouds and rain and water balance and ocean currents and the way that handle certain energy transfers in the atmosphere and the way they handle biology and the way they handle ice, and the list goes on and on. And you would come away from the library experience fully aware that the numerical models upon the prediction is based are highly uncertain. None-the-less they are wonderful achievements in computing and demonstration of understanding of atmospheric processes and it's a prediction of warming that we cannot take lightly. These models are not that bad and they do predict warming in the future.

It's only lightly that you go out and see what was happening. And if you were to assemble the temperature record from throughout the world you get this well known and well understood in many ways presentation of the temperature of the earth. And it shows that the temperature is going up. As I look up there I see the temperature from about 1975 onward marching upward. We've heard over and over that the temperature of the earth is increasing. I am here to tell you the temperature is increasing. There is no doubt about this in the scientific community. Since a little doubt in the scientific community that at the present time, meaning over the past three decades, the temperature of the earth has been going upward.

Up until about 1975 or so it seems that we knew why. It was often pointed out that we were recovering from the little ice age. And that the planetary temperature was on the rise and it was also known that the solar output was increasing. And it appears in looking at the professional literature that up until about 1975 or 1980 the increase in solar output seemed to well explain the increase in planetary temperature. But as you will note in the diagram the solar output has not been increasing in the most recent 15 or so years and yet the temperature of the earth has continued to rise.

This brings us to the big question of why the temperature of the earth is going up when the solar output is not going up and its made it fashionable to conclude that human activities are contributing to some extent to the buildup of the planetary temperature. If you were to break down where the temperature is increasing, you would find a lot of the increase is occurring in the high latitudes at night in the winter, etc. So I, among with all other scientists, agree that there is an anthropogenic signal in the record. We don't know

if it completely explains the warming of the most recent 25 years but it certainly would contribute to the warming. And before you sit here and think well this is the most unprecedented warming that we've ever seen, I would call your attention to the same diagram and look back at 1910 to1940. The recent warming was basically replicated once before in the historical record. We are recovering from the little ice age we would expect warming to occur. I'm not sure the warming would not have occurred if no human had ever walked the earth over the past 100 years. And for at least a 15 or so year period we talked a lot on the global warming circuit about the satellite record. And the satellite record has shown here also it indicates that over the past 25/26 years that warming has occurred. Warming accentuated a bit by having a large El Niño late in the record. None-the-less the satellite record today does show that the temperature of the earth is warmer today than it was back in 1978 when the record begin. So we have compelling evidence that the temperature of the earth is on the up rise and has been on the rise for the past 2/3 decades.

So what's the debate I guess? The debate comes around when you start to place the warming in the context of what has occurred over the past 1000 years. This plot shows what has happened to the Northern Hemispheric temperature over the last 12,000 years. I think most of us would agree that thankfully we pulled out of the last glaciation about 12,000 years ago and the temperature of the earth rather rapidly increased to bring us into this rather pleasant inner glacial. And as I look at this plot, I see that over the past 10,000 years the temperature of the earth has produced various climate optima. We've had many small ice ages, we've had many climate optima and if we look up here at the last 1,000 years we see that doing the medieval warm period the temperature of the earth may have been as warm as the temperature of the Northern Hemisphere is today. We see that there was a recognizable little ice age that was well documented in the professional literature and for about 400 years humans had to cope with this little ice age. And fortunately for you and for me, about 130 years the earth rebounded from the little ice age to bring us the warm period that we enjoy today.

When I look at this diagram I see nothing unusual about the warming of the most recent 30 years. Seems to have been replicated many times during the inner glacial and from a diagram like this, one could make a credible augment that there may not be such a strong link between carbon dioxide concentrations and the warming signals seen in the northern hemisphere. But as you've seen, there are others who don't buy into the diagram that you just saw. There is a wildly juicy story in climatology about the construction of this hockey stick curve, which does make the most recent warming look highly unusual. I notice here that the medieval warm period of the Northern Hemisphere all but disappears through the ice age, all but disappears and suddenly we are left with this tremendous warm up during the period of industrialization and during a period when the carbon dioxide levels of the atmosphere rose exponentially. This diagram looks alarming, very popular with the IPCC. But all I can tell you is our same trip to the science library would revealed some interesting details about miss-calculations in constructing the diagram, it also would reveal some interesting personal stories to say the least.

Now I know in your state, you might be concerned obviously, that global warming could somehow enhance the strength and number of hurricanes. I would like to read from IPCC – says climate models give no consistent indication whether the tropical storms will increase or decrease in frequency or intensity as climate changes. Neither is there any evidence that this has occurred over the past few decades. That was the IPCC assessment in 1990. And in 1996, IPCC which I am somewhat an active member, says in conclusion it is not possible to say whether the frequency, area of occurrence, time of occurrence, mean intensity or maximum intensity of tropical cyclones will change. It's hardly a ringing endorsement to gear up for more hurricanes or more intense hurricanes in your state. And in the 2001 assessment, we see changes globally and tropical and extra tropical storm intensity and frequency are dominated by inner decadal and multi-decadal variations with no, and that's a gigantic word in IPCC, no significant trend evident over the 20th century.

You could have no end to speakers come here who are among the best hurricane scientist in the world, and they would decouple any idea that there is some link between elevated CO_2 and hurricane activity. Others continue to say that there are all sorts of problems with severe storms. IPCC is fairly clear on this. They say no systematic changes in the frequency of tornado, thunder days or hail events are evident in the limited areas analyzed.

Once again, this is hardly some ringing endorsement for the idea that we are about to face an immediate future of severe weather, elevated climate variability that has not been the conclusion of the IPCC. Your state also will confront the problem of sea-level rise and looking at the scientific literature on sea level rise, I can announce to you today that the sea level is rising. The sea level is rising at approximately 1.8 milliliters per year. The problem is it has been doing this for 8,000 years and it's been consistently moving along here after the end of the last ice age. The sea level has been rising and as Church et al. noted, it says "decadal variability in sea level is observed, but to date there is no detectable secular increase in the rate of sea level rise over the period 1950 – 2000". I would agree the sea level is rising but there is no evidence that there has been some increase in sea level rise.

I will end with this one, this is the most damaging in some way, graphic in the greenhouse debate. What this shows, in the top part of the yellow curve and this comes from IPCC and elsewhere, is the business as usual prediction of what would happen if we did absolutely nothing. We did nothing, China did nothing, Australia does nothing and its noted on the top of the yellow bar the temperature of the earth would continue to rise in our life times and achieve some of around one degree increase by the years 2050. That's fair enough. We can argue that number all day. What's interesting here is what would happen had we in 1990 stabilized the emission of greenhouse gases? That's what Kyotos is all about. Its let get the globe back to the 1990 levels of CO_2 emission. If you go back to 1990 levels of emissions, and stabilize 1990 what do you think happens? The atmosphere continues to see a build up of carbon dioxide and you follow along the bottom of the blue bar. Stabilizing emission in 1990 would have little effect what-so-ever on the climate system. There's the top of the blue bar and the top of the blue bar is

what would have happened had you walked out of Keota in December of 1997 waved a magic wan and stabilized the emission until 1990 levels. And as you note, darn blue bar goes up pretty high, gets up pretty close to where you would get anyway. Well we're not even close to stabilizing emissions of CO_2, you may know that the United States is 13, 14, or 15 percent above 1990 levels. We're nowhere near the target of seven percent below 1990 levels. And the rest of the world has a similar story to tell. So if you were to go out today and draw this, and say maybe the North Carolina Commission can somehow get Australia on board, get these European nations to suddenly start showing a decline in CO_2 emissions, get the United States on board, get Canada back on the tracks, get India and Pakistan and China to slow up a bit, I have bad news for you. That if you were to run the plot out here, you would find out that you would save no more than one hundredth to two hundredth of a degree. That's if you can get the whole globe involved, let alone just the state of North Carolina.

I know that Al Gore has a new book coming out, it's called "The Inconvenient Truth" and I just have a funny feeling this diagram is not the inconvenient truth that he'll be talking about throughout that book. And yet it is an inconvenient truth for a group like yours. I mean it's very difficult to see what you can do that will ever have any impact on the global climate system or the levels of CO_2 in the atmosphere.

I wish you luck. I've been called the greenhouse skeptic throughout my career and I must tell you that I am skeptical much could be done in North Carolina to impact the carbon dioxide levels of the atmosphere. Thank you very much.

Mr. Garrou – Thank you. Questions?

Mr. Cecich – Could I ask you to the separate the two thoughts here: first, the question of the rise of carbon dioxide in the atmosphere associated with human activity and help us understand that science and as opposed to the second part that says we in North Carolina can't really do anything that would change the build up of greenhouse gases. One is the science, which I am not sure I understood completely. You say you do agree that the increase in CO_2 is unique to this current period geologically and it is associated with human activity.

Dr. Balling – Let me answer that one. There is absolutely no one that I know of with any credibility who doesn't believe that the increase in CO_2 has been caused by human activities. You can do the calculation of how much coal China burns every year and you can do the calculation of fossil fuel consumption in the US and you can get a fair notion of how much carbon is going into the atmosphere. And there are carbon budget scientists throughout the world who are able to indicate what the residual amount might become in the atmosphere. And I know very few people who don't believe that the build-up of CO_2 is caused by human activities.

Mr. Cecich – So it is caused by human activities?

Dr. Balling – I don't think there's any question about it.

Mr. Cecich – So then, should it not be a concern to us as a society, regardless of the questions whether we do anything about it in North Carolina to effect a change. As a society, should we be equally concerned about it?

Dr. Balling – Obviously somebody is changing the atmospheric chemistry on a global scale. We should be looking into the issue what will this mean? I can't imagine how much more concern we could have. Our government is spending billions of dollars per year to show concern, do research, and find out what it will mean to the planet earth to have higher levels of CO_2? So I would argue that we're plenty concerned and that the United States and other countries of the world have made an enormous commitment in research to find out what this means. The UN has made a phenomenal commitment to assess the science of what will happen as CO_2 levels continue to rise. So of course it's a concern. I mean there are individuals who lose sleep over this and there are other people who think it's glorious that the carbon dioxide levels of the atmosphere are increasing.

Mr. Cecich – You argue that it is such a global issue, there is no sense in trying to make a change at the state level.

Dr. Balling – With all respect, you could announce today that North Carolina is about to vanish from the face of the earth and it would not show up on this diagram. Or you could announce tomorrow that we're going to buy every one in North Carolina their own SUV and have everyone double their amount of coal burning to produce water and it just doesn't show up on the diagram. The problem is trying to deal with such a global issue. We're looking at a state group and it just seems like anything you come up with will be dwarfed within minutes by the emission of CO_2 from places like China.

Dr. Smith - A couple of quick questions. Being a student of science, I know that in the scientific profession there are a number of different opinions and people tend to banter back and forth looking at things. I've got a couple of questions here, but first, how you reconcile your position with the fact that the vast majority of scientist have come together and basically say not only is obviously there is a concernable finger print on this but there is a growing number of those scientists that are becoming concerned and encouraging action. How do you reconcile your sort of out liar position there?

Dr. Balling – I don't see my position as out liar at all. There is nothing I said today that I didn't take basically from the IPCC report. I wasn't out here bringing in material from web pages almost everything I have would be from the mainstream literature. I told you today that I also think that there is a finger print and I would agree that there are scientists one after another who would say let's do something, let's do something, we only have just one planet let's do something. And so often, you say what do you want to do, the answer seems to be let's conduct research. Not a bad idea if you're scientists in my position to argue that we need to fund more research right now. So I like everyone else show concern argue that more research should be funded but by no means do I lay in bed tonight believing that by riding my bicycle to school every day, I'm helping to fight global warming.

Dr. Smith - And so along a similar track you made reference to the fact that you felt like state actions really don't matter. My experience in environmental policy is that states tend to aggregate together and nations do, there are a number of states that are obviously beginning to take action across the United States. And it just happens to be this current administration has not adopted a policy yet. But there is movement and ultimately when action is taken it's going to come back to the state and local level where those actions are going to become manifest and taken. So I guess I'm trying to understand the national government obviously needs to be a part of it but wouldn't you think that if you want to get an inflection point, that you would actually see the need for activity to be taking place at the state and local levels because indeed these are the laboratories of democracy and this is really where the rubber meets the road, where most action takes place. I just want to clarify, are you saying that you don't think that any states anywhere should take any action on this as the consensus continues to build that we need to get an inflection point in our missions and stabilize the climate, or do you feel that it's only for national governments to do?

Dr. Balling – Wow, you ask many things there. One you mentioned that this administration has really not done much so far in climate change. I remind you that previous administration had three years to present this Kyoto protocol to the senate and they never did. I remind you that John Kerry ran for president and never said one word about the Kyoto protocol and what he would do. So it's a little unfair to say one administration or another. I never saw this as political at all. Then you say you think the rubber is going to meet the road at the state level. I agree and it's at the state level where people might begin to question you and say well what is this costing me and what are we gaining by doing it? And if the state implements some policy that begins to cost the tax payer any amount of money, the tax payers are going to demand to know then what is it I get for this investment and when I stand up and tell them the answer is absolutely nothing, the rubber will hit the road and it will be at the state level.

Dr. Smith - Thank you.

Dr. Balling – You're welcome.

Mr. Garrou – Other questions?

Mr. Glasser - Dr. Balling I am from the scientific community and I appreciate your being with us today.

Dr. Balling – Thank you.

Mr. Erickson - Is it my impression that what you're saying is that regardless of what we in North Carolina do and what we do as a business community that the temperature over the next 50 – 100 years, regardless of what we put in place will not change? And secondly, I ask, is the chart that we have in front of us widely accepted in the scientific community?

Dr. Balling – I am not sure that there is nothing that North Carolina can do to make global temperature stabilize. Let's face it, the United States is only 1.54% of the earth's surface. North Carolina becomes a small part of that, the total emissions from North Carolina globally is not particularly large. And with you beginning to fiddle around with the emission levels, it would never be measured out in Hawaii where the measure of carbon dioxide is made. I believe you're absolutely correct in assumption that what happens in North Carolina is not going to have an impact on global carbon dioxide concentrations, of course. The other thing you asked about this diagram is it widely accepted in the scientific community? There are many versions of this. And some are harder to read than others. Some are more stylized than others. But if you were to go to the IPCC reports that make it painfully clear that if we want to stabilize the concentration of carbon dioxide in the atmosphere, we're going to see the need to have a massive reduction in carbon dioxide emissions worldwide. Emission of carbon dioxide is not the same as concentration. You could stabilize the emission, you would still put carbon into the atmosphere and it would still buildup and we would still achieve a doubling in the middle of this century. So I look at that diagram, and I don't know how many folks would argue that it is inaccurate, it's stylized for sure, but you would find many versions of it in the IPCC report, some easier, some harder to read. Even Jim Hanson's now saying, if we adopted the Kyoto protocol for full participation, we would still see only a few hundredths of a degree spared over the next 50 years. There might be a few argue the next 100 years when you start to see more benefit of course.

Mr. Glasser - Mr. Chairman. Follow-up? Mr. Balling if you were to take that out for another 50 years would it spike up or would it continue to run a straight line?

Dr. Balling – There would be no reason to expect it to spike up. But when you start to talk about over the next 100 years, there are all sorts of surprises out there over the next 100 years. I imagine somebody in the 1900s thinking about what North Carolina would be like in 2006. The person might be a little shocked at what happened so I think a lot of climate scientists are reluctant to go past 50 – 100 years out. But there are a few that are starting to say, look if we continue to burn fossil fuels for 200 and 300 years, that this could so dramatically change atmospheric chemistry that we could expect to melt the ice sheets and all sorts of horrible things could happen. But the overwhelming literature still deals with what happens given a doubling of carbon dioxide which will occur sometime within the next 50 or so years.

Mr. Garrou – Thank you very much. One more question.

Mr. Erickson – I've got two questions, one is just a quick summary of what you said. I am an economist and I think about cost and benefits and my take on what you said is that for North Carolina to do anything significant in terms of what happens here, it would be all cost and no benefit?

Dr. Balling – Yes, I once wrote that it would be an infinitely indefensible position. That if you are interested in cost benefits, the instant you tell me their cost and you can see effectively there is not benefit, well of course there could be benefits of having

technology that cleaner. I mean North Carolina could benefit 1000 ways from great ideas of the group, but to sell the idea that you're fighting global warming becomes absurd.

Mr. Erickson – And secondly, you didn't touch on it, but are there any benefits to an increased concentration of carbon dioxide in the earth's atmosphere?

Dr. Balling – Well sir, there are thousands of articles that have been published about the biological benefits of elevated CO_2. And obviously, plants evolved in a world with much higher CO_2 and I have one colleague who says, we're sending the Topeka system home again. They would actually prefer to be in a higher CO_2. This issue seems too good to be true at first, it seems the plants grow bigger, they are more water use efficient, they are more resistant to drought, they can say that they are less susceptible to stress of the ozone and sulfur dioxide, just sounds wonderful. I am fully aware of people, including people in this room, who published reports, well before you think it's all good, there are weeds that also like higher CO_2 levels and there are other kinds of plants that you may not want that have higher levels of CO_2. But I think most would agree that the plants of the world do very well with having higher levels of CO_2. In terms of your breathing carbon dioxide you can relax, and even if we took CO_2 into the thousandth of parts per million, which is probably going to be achieved in this room today, but there is no harm to humans who might breath that air.

Mr. Erickson – Thank you.

Mr. Garrou – Thank you very much sir.

Dr. Balling – Thank you.

Mr. Garrou – Our next speaker is Dr. Riggs from East Carolina University. And I'll ask you the same question Dr. Riggs would you rather wait until the end for questions.

Dr. Riggs – Yes.

Mr. Garrou – OK.

Dr. Riggs – As a coastal geologist, we look at modern dynamics, modern processes to understand what's happening today and we look backwards to get a history of where the earth has been (Abstract, **Exhibit I**). In the state of North Carolina we have a very incredible record of climate change and sea level change through time that we've been able to take apart. I'm going to talk a little bit about climate change and sea level change and storm dynamics. I'm going to summarize a lot of data, a lot of information and I'm going to deal with it at several different scales. I'm going to start at the very big scale and we've going to zoom down to the very small scale that the first speaker was talking about. At the end of the talk, I'm going to come back to the cost to society and to our North Carolina economy of doing nothing in response to these ongoing changes. To me the real question and the important question that we should be asking is, how does climate change affect what's going on? It's not what's causing the climate change, it's

the important questions. We can't stop the climate change but we can do something about it. The impact of climate change can be very dramatic and particularly in down east North Carolina were we're dealing with counties of land that are only a foot or two above sea level. The changes are pretty dramatic so what I'm going to do is take you on a little tour of our database. Our database is very big, we don't deal a lot with models, we deal with the earth and the samples from the earth. I co-directed this program called The North Carolina Coastal Geology Cooperative. It's a US geological survey funded program. We have 40 different scientists working on this, 20 of them at East Carolina University, the other 20 are scattered from the University of Pennsylvania, University of Delaware, VIMS, the North Carolina Geological Survey. It's a big cooperative system. We're in our sixth year of dissecting coastal North Carolina and the results of this are pretty intriguing and pretty important to the state and to the future of this.

And this is a Time cover magazine from 2001 that talks about global warming. In my opinion, global warming is just half the equation. We have to add global cooling in there like any coin, bad penny or otherwise what we're looking at are two sides of the issue and global cooling is equally as important hearing this. Now if we look at the history of the earth, most of the earth's history of its 4.6 billion years has been very warm, much warmer than it is today. If we go back, this particular plot shows a time back to 65 million years on this axis up today on this axis, the history of the earth is mostly warm. We've had four major glacial episodes during the 4.6 billion years that we've had a record of the existence of the earth. I'm not going to talk about the earlier ones. I've spent some portion of my life chasing some of these around the globe. They're very major systems, but when they happen, they're pretty dramatic and traumatic to the earth's system. We're coming back out from about 60 million years ago on this particular one. We've got nice warm conditions, hot house conditions and about 25 million years ago the climate starts to fluctuate and we begin to develop Southern Hemisphere glaciation about 25 million years ago. And it oscillates around the world's ocean went sort of crazy through this period of time and we get up here to about 1.8 million years ago and we begin to develop, the climate goes really funny at this point and time and we go in the Northern Hemisphere glaciation. Now both poles glaciated and we go into a series of temperature fluctuations that range from about 16 degree up here. The average global temperature down to about 10 degrees average global temperature and the ice and the climate oscillated back and forth through here between 10 and 20 times in the last 1.8 million years. Now this is a close up that this is the last million years of that time. This is a million years ago. And you say ok you're not interested in a million years of time. But whether we like it or not, humans were not around during those first three glacial episodes, they haven't been around in a major component for the last million years. We did have people on the earth at the point of one million years ago. But what we're dealing with today as a modern population of people till we get all the way up here. Here's zero, that line right there represents ten thousand years ago in red are the interglacial episodes, in blue are the glacial episodes. These are the cold climates, these are the warm climates, and the climate change as we went from one million years ago from warm to cold, to warm to cold, to warm to cold, warm-cold, bah, bah, bah all the way down through here and the ones we're going to focus on are these right here. I'm just going to make a simple reference to this one. But this is the last glacial maximum

when the earth was cold, which happened 18 to 20 thousand years ago. This is ten thousand years ago when we reached our approximate temperature of what the earth is today. So let's zero in on that, this is what the earth looked like 18 to 20 thousand years ago when we had glacial ice covering the northern half of North America, covered a good share of Europe, and a very large portion of Asia. The only source of this much fresh water which is up to two miles thick, is out of the world's oceans. It is evaporated out of the oceans and accumulates on land. It takes a very different climate condition to do that than we have existing today. In order to get that much water up here on land we have to get it out of the ocean.

This was the shoreline 18 thousand years ago. It's a global shoreline, we can go all the way around the world, we can find it, we can find coral reefs at that level. If you go deep sea fishing you may fish on one of those coral reefs. There's ledges eroded in the continental slope of North Carolina here where that shoreline existed. If you were living in North Carolina at this particular time, 18-20 thousand years ago, you would have had to go about, depending on Cape Hatteras, 15 miles seaward off of Wilmington, North Carolina. You would have had to go 60 miles seaward if you wanted to go fishing, swimming or anything else at the Coast.

Sea level dropped approximately 400-425 feet below where it is today to get that much water tide up on the continent. As the climate began to change, starting about 16-18 thousand years ago it started to warm, the glacier started to melt, recede and water flowed back into the ocean and sea levels started to rise, came up across the continental shelf to where it is today, which is the brown line. We still have a lot of ice left in Antarctica and Greenland. If we were to melt all that ice right now, the shoreline would be about where I-95 is today. And in fact, that is the origin of our Coastal Plain. The ocean has been back and forth across the Coastal Plain many, many times in history, the soils, the topography, the river drainage basins, the Barrier Islands, the estuaries are all a product of this glaciation/deglaciation, massive changes in the sea ice. Now as the climate changes, this glacial environment here is pretty harsh and we end up with a tunder environment that comes way down – all these climatic belts condense and migrate southward. And so in North Carolina when we core out, when we have thousands of cores out here, the basal cores that we get when we're looking at the glacial maximum sediments we find spruce and fir trees. Trees that today live in the Barrio Forest of Maine and Canada. They migrated this far south, all the pollen records show this and in fact, North Carolina would not have been a pretty place to be at the time of the maximum glacier. It was very cold, very nasty, it was semi-arid, and we had massive storms that came through. Two, three, four storms a year, that would dump anywhere from 25-50 inches of rain in an event to build a river system that doesn't exist today. The rivers exist but they were very big braided streams, the kind that you find in tunder conditions and desert conditions today. Today we are heavily vegetated, that are locked in, and it's a different, totally different climatic regime given vegetation, etc. as you well know.

Ok, 18 thousand years ago this is where the shoreline was off the edge of the slope, this is a diagrammatic figure. As we begin to change the climate, there was a general warming and as sea level rose, when we ran into a pile of sand out here, we built a Barrier Island.

We might have had an estuary behind it and then sea level rose again, we abandoned some of those out there. We did not just marsh the Barrier Islands across the continental shelf here, for reasons you will see in just a minute to where we are up there today. Now this is the old standard climate curve that's been in the literature for a long time and has been pretty well documented and re-documented. It's similar to the one that was shown by the previous speaker that goes back to 18 thousand years ago up to the present here. This is temperature along this axis, this is the average global of 15 degrees centigrade, this is the oscillation around that as we came out of the glacial maximum back here 18-16 thousand years ago. And you will notice some very major oscillations that took place here in this period of time. Some of these, and the reason I am pointing this out, is that some of these have been very dramatic. This one right here coming out of the under drias, we came out of that from almost maximum glacial conditions to almost modern conditions in several decades. And this has been documented by many people looking, not only at ice cores and sea levels data and deep sea cores and so forth. In North Carolina we have a record of this younger dryas event and we came up and flooded the system very quickly as we came around here. It got warm and then it oscillated back and forth around this sort of median level here. On the bottom axis I put the population of humans and we started back here with just a few millions of people and by the time we get up here to the industrial revolution we got about one billion people on the surface of the earth. By the time we get to the time when I was born, we have about two billion people and we are today at 6.5 billion people and growing, and with the projections to go somewhere between 7 and 9, 10 billion people. Now this is what North Carolina looked like 18 thousand years ago and I put on the outline of the Barrier Islands here just as an indicator. They did not exist at that time, but I put them on here to let you know where we are. This is Pamlico Creek, which is now Pamlico Sound. It was a drainage system, a secondary drainage system that came out here underneath the Village of Ocracoke off shore combined with the Tar River that came out here and the Neuse River that came out here under Portsmouth, they combined in here, next week we'll have a ship out here to map all this, it goes off across the continental shelf, we don't know quite where it crosses the shelf, but it goes ultimately into the Hatteras Submarine Canyon off there. This is the Roanoke River, our largest river, it came out here, the Cistacanny came down here across the continental shelf went through a canyon down into the Abyssal Plains through the Hatteras Submarine Canyon.

This drainage basis and the next drainage out here we're in the process of drawing those based on our offshore work out here. The continental shelf was coastal plain at this particular time. We have forest out there, we have peat deposits, we find oysters out there, we find land, mammals, mass (inaudible) and so forth out there that we harvest off the bottom. And of course, this is what North Carolina looks like today. So the rising sea level brought that shoreline all the way across the continental shelf to where it is today to produce this particular map.

Now we have a sea level curve that we've been developing that's based on a very extensive age dating database. This is for North Carolina. We came up, this is 10 thousand years ago, this is today and this is depth below present sea level. This is where we exist right here today. Now this is an important plot. In red are the century and

millennium scale fluctuations in the ocean levels and in blue are the decadal scales of the climate fluctuations that I'll talk about in just a minute that we know exist. It's a little harder to document the details of that because we don't have the age control, we can't age date things as fine as that. But sea level came up very fast here at first, we flooded and produced the first Barrier Islands here, and then they sort of, sea level dropped a little bit and we went up above higher than we are now, we dropped again and went up above it. We have a sequence of building of these Barrier Islands.

Now if we zero in on the last eight hundred years of sea level change, this is the little ice age come along here, same event that the previous speaker talked about, sea levels only rising at a very low rate at this point and time, it's sitting here oscillating a little bit and then by the end of the little ice age, what we call the anthroprecence, which is the beginning of the industrial revolution which took place about 1784-85 with the development of the steam engine. The earth was warming up significantly and as there is a direct correlation between the temperature of the earth and sea level. A very strong pattern because the relationship of melting of the ice and formation of the ice. And in all stages we see this, so here we have a warming period, sea level is rising fairly abruptly, 1.5 feet per 100 hundred years. You say big deal, eastern North Carolina has 5, 6, 8 counties which are all very close to sea level, Dare County, Hyde County, Tyrrell County, Pamlico County have very little land that is more than a foot, foot and a half above sea level. With a one and a half foot rise in sea level, we can see major changes out there that are taking place with every single storm event that we have.

All of North Carolina's beaches are eroding in response to this rising sea level that average rates from 3-15 feet per year, depending on where you are and some of the other variables. This happens to be at south Nags Head, if you own that cottage or house right there, you need to think about selling it. This is the rate of recession of the shoreline at south Nags Head, this is 1840, 1849 I think is the date on that to 1998 and if you look at the land lost associated with that 750 feet up here in the north to 900 feet down here in the south, you calculate it out it comes to 5-6 feet per year. Well 5-6 feet per year is misleading, first of all, I will not get into that because these are all storm driven events and it goes back 50 feet and then it might actually build up 10-20 feet and then the next storm comes up and goes back another 100 feet and so the storm impact is what drives this system.

And the storms don't only effect the Barrier Islands, we have 4000 miles of estuarine shorelines the storms come across, Pamlico Sound, Albemarle Sound, they build a tremendous storm surge back there. We took this picture of this particular shoreline in the summer of 2003 and went on the cover of a book I was producing at that time. After Hurricane Isabel went by the guy that owns this called me and said I had better get back over there and take the picture again because it wasn't the same thing. In one half hour, he stood on the bank of this thing and watched the storm surge come in, it was only an eight foot storm surge, it took about one-half hour for that storm with a storm surge up here to erode this tight clay bank and he lost 80 feet of shoreline. This red line is in line with where I took the first picture. That's his shoreline after that storm went through. And we're building a major housing development back here because the guy got tired of

losing so much land, so he thought he would pass it on to somebody from Raleigh or Ohio.

The marsh and the wetlands are eroding also at equal rates. This is false color imaginary, the red are photosynthesing plants, pines and bay trees. This is transitional vegetation and the greens in there are the marsh grasses. And this is a 1983 photograph right here. This is what that looked like at that particular time rising sea level drowns these trees. The transition zone vegetations coming in and you can just see the marsh starting. This is a picture that was taken about here and in 1983 and by 1998 you can see how far the marsh is encroached into the swamp forest. This is what it looks like today out here at the same spot. This marsh is, this is a direct response to rising sea levels and drowning of this marsh shoreline in Dare County. Now the other thing, is that we have these sites all over out there and after Isabel we went back to the site and a marsh looks like a marsh, looks like a marsh and I looked at it and I said nothing has changed here. My research assistant said you want to bet a bottle of wine, and I said yes and she proceeded to map it with her GPS and we lost 125 feet of shoreline in half an hour again in response to a very small hurricane that came across the south. Now we have 4000 miles of estuarine shoreline folks, and that's a major land lost with a minor storm.

Is global warming for real? Many natural cycles operates within the earth's heat machine, global climate change always has been and will continue to be a major part of the earth's history regardless of the human role. We've had many ice ages and many ups and downs of this system without any human influence. That's a fact, ok. There are major causes to these climate changes that include things like fluctuations and output of solar energy, the earth's orbital path around the sun, oscillates and gives us different amount of heat input, earth's testism, the movement of the plates and formation of the oceans and where the continents are at any given time and changes in the atmospheric conditions which may or may not be in part driven by humans, now that humans are on board.

Let's take a look at storms themselves and coastal dynamics. I'm going to come back to this whole business of why we should care about this and why we need to deal with this to change the focus of our questions. What is the function of a Barrier Island system? Barrier Islands and their beaches are energy absorbing sponges that have contact between the atmosphere and the ocean and the land. They are high energy systems. These systems are built by storms, they're maintained by storms, they need storms to be healthy. That's the reason they are there period. That doesn't mean we can't use them, but we had better, if we're going to use them, we had better understand some storm dynamics and sea level dynamics and things like that. And I would argue that this is not the function of a Barrier Island or a beach. And we have a lot of these in North Carolina and more coming. These in red on this particular map are the southeastern US and the Gulf Coast states which happen to be the targets of all our hurricanes. This is hurricane alley sitting in here, this is also the location of the biggest and most extensive set of Barrier Island systems in the world period. There is no place that has a Barrier Island like we have on the east coast and down in the Gulf of Mexico. These are a product of these hurricanes. That's why they're there, it's low slope, we got lots of sand, the storms come

in, they pile that sand up and build that barrier estuarine system. North Carolina alone has had 46 major hurricanes in the last 150 years. That's one per three years. But statistics don't work very well because that's not what's driving the system. It's not just every year we get the same number there are some very definite patterns and I want to talk briefly about the patterns of these storms. 2005 was an awesome storm year, we had record everything, 27 name storms, 15 hurricanes, 7 major hurricanes which are category three or higher. Only one of these affected North Carolina this year, almost every one of them came into the Gulf and that's the function of the climate set up and the weather set up at the time these things formed. I think maybe our next speaker will get into that a little bit more.

I'm going to take Katrina as an example, here. Katrina started on the hot water current here, out in what we call the Gulf Stream. And if started to build and it was headed toward North Carolina along the Gulf Stream. But there was a high pressure system here and it couldn't go that way, so it turned, went across Florida, built, built, built to a category five. Then as it came to shore, it slowed down to four as a major hurricane. And over four major hurricanes came ashore in the gulf this past year. I am going to show you the consequences. This is a category three-four storm, North Carolina hasn't had a category three or four since 1950's and 30's we had a cluster of them. We had a whole cluster in the 50's and in fact, we can work backwards and date the origin of our different Barrier Islands and to the major storm events that have happened since Europeans have been here.

This is what happened to the Barrier Islands, and when you think about Katrina from North Carolina's point of view, you need to forget about New Orleans. We don't have a big hole in the ground, New Orleans is 10 to 20 feet below sea level and it's too bad all the news focus is just on New Orleans. Mississippi and the rest of the barrier coastal system really got wiped out. This is the ocean shoreline here, it's not a Barrier Island, but there is nothing left except the trees. There is not a building left period, clean. This is what happens to the Barrier Islands.

This is Dolphin Island and you can see a few houses here, I'll show you more in just a minute. Hurricane Ivan, which was a major storm, came across and produced all these incredible tidal channels and back barrier shoal systems says it eroded the sand off the front side. This was in 2004, then Katrina came along and it completely did in the island. Now this next diagram here, this is people that are part of our project, they're mapping this using a (inaudible) system with the USGS data, where they fly the coast and they have sort of an airborne fedometer that looks at the variation and elevation. This is the most detailed piece of data I'm going to show you but it may be the most important slide I show you today. This is what the Dolphin Island looked before Hurricane Ivan and before Hurricane Katrina. This is the road, this is the ocean or the golf out here, you can see it has a little beach. This is the estuary back here. This is what it looked like after Hurricane Ivan and you can see the front row of houses is now in the surf zone, the road is buried and you can see that there are more shoals piled up on the back side here. This is what it looked like after Katrina and there aren't many houses left, there are just a couple that arrows that same house and it takes the sand off the front side and off the top

of the front side and builds the back barrier part of this system. This is what a photograph of that looked like and this takes the elevation difference from this survey and this survey and in green is the deposition and in red is erosion. Those red spots, that's where the houses were and you can see that it eroded, and deposited. If you have a rising sea level and in the island not much happens on a nice pretty summer day, you lie there on the beach and it's not going anywhere. Things don't happen on those pretty days. They happen in the storm events and they happen on the big ones. And the barriers back step during these big storms and we've watched the back step here and this is another figure from the Santa Rosa Island in Florida.

This is Hurricane Ivan and there was a geologist by the name of Stone down here that did a profile across here. And the importance of this, there is a Barrier Island, there's sea level, this is two to three meters above sea level, that's ten feet. That's pretty good elevation, you would build a house there. And what it did was the island receded this direction, took the top off of it and built it back here. What we've done is re-established the equilibrium of that Barrier Island to the new sea level event. And this is the second profile that shows the same thing. Now why is that important? That's important in North Carolina because we can look at about 75% of our coast and we can see exactly the same structures, these big (inaudible) off Dolphin Island again with a tidal channel, the big shoal systems back here on the back side that built this island about 250 years ago. They had a Katrina year that came ashore in Portsmouth and built that. We can see Pea Island, for example, we see exactly the same structure and we can see it happening because we have aerial photography and so forth in 1932, 33, 36 that shows this process happening. And most of our barriers are set by the same big storms that we've experienced in the gulf here.

Now in North Carolina, talking about storm frequency and intensity, you can do all kinds of statistics on these things and most of the statistics don't work because we only have a brief record. But there are some very definite patterns that we see. Between 93 and 2005 US mid-Atlantic Coastal reached and experienced the highest tropical storm activity in recorded history. We've had more storms here in North Carolina, we just came out of a period with 30 years with very few storms. Eleven category one and two hurricanes made land fall in North Carolina during this period. They were all small storms. Small storms are accumulative, they do a little bit of work, little bit of work. But they are sort of like a teaser, it's the big one that does the real work and we haven't had a big one since the 50's.

This particular year we only had one but what would happen if a cat. three or four hurricane like Ivan or Katrina made land fall in North Carolina coast. And the next time any of you go to the beach, I want you to think about that, a 20-30 foot storm surge coming across the Barrier Islands. This is a pattern that's real, this is what we see from the turn of the century back here up to 2000. If we plot sea surface temperature of the Gulf Stream and the Luke currents, what we see is a warm period of the ocean, a cooler period these are the surface currents, the things that feeds the hurricanes, warm period, cool period, warm period. And if we plot the hurricane patterns from that we see the cool periods as indicated here that they're exactly the same as this period and this period and

we get very few hurricanes and they don't tend not to be too big. The warmer periods where we tend to get a lot more hurricanes and we also have this cluster that goes into the gulf, we have this cluster that comes up to North Carolina. The consequence of that is this map right here which is a Noah map, billion dollar climate, weather disasters from 1980 and 2005, you see the hurricanes, the number of events in red are 16 to 20 in black are 21 to 25. All the hurricane states are in red here, I think Georgia should have been in black. But Florida and North Carolina are king here. We are the ones that catch it and we also have the best of all barriers.

Whether there are all humans in coastal dynamics, the humans play a dramatic role but I can show you all the counties have exactly the same pattern. This is a population change from about 5000 people here back in 1900 and it's just a slow, growth until we get to 1970 and then it just takes off. And we have growth rates that are 76 to 150 percent going on up here now.

But even more interesting is the pattern of hurricanes. Back here in the 30's we had a cluster of hurricanes, this is northern most North Carolina. Most of those of the 30's came in on the southern coast. But here's a very important cluster, we built a lot of our coastal system around that. In 1950 you will notice there is our category three storms, we had 1, 2, 3, 4, I can't count them. We had a whole cluster of them that came in, one year we had three in a row, just like the Gulf of Mexico. And we can date most of the big changes back to those events.

People had a big impact down here, this is a 1932 aerial photo of Kitty Hawk. This is the Highway 12 which was just paved prior to this, you can probably still smell the tar mat, fresh tar mat there. You can see an occasional house out here on the beach, but not much. Here's the old Village of Kitty Hawk, by 1999 there is not empty space in here any more. But more important, Highway 12 is now in the ocean. This is 1999, we've had a whole series of hurricanes, the rest of these houses are mostly gone. This is your DOT desperately trying to hold Highway 12 down there. This picture I took on March 31, 2003 putting in a set of sand bags, it was a house down in the surf zone. Three weeks later on April 22, this wasn't even a storm, this was just a spring tide. Took out everything and went in there and this is what's left of the highway up here you can see it's under cut and rebuilt again and we had Isabel come along and we lost the whole system again. And it's been rebuild, rebuild, rebuild. It's time to back off of that area.

Now the Outer Banks themselves, as most of our Barrier Islands used to be, is to be dominated by over washed property inlands. And this is a picture showing Pea Island, what it looks like from an airplane and what it looks like from the ground level. Now you wouldn't buy a house out here because that's not a friendly ocean out there and so what we learned back in the 30's was that if we started building a fort wall around this, we may sell this property to somebody. No locals lived out there on the beach. I may remind you that they live back in the Maritime Forest in the wide parts of the island. They go out there to fish and they use that front side but that's the highest hazard land in the world out there. Well by building this fort world, we learned all about moving sand and we were able to trap sand and we built these monster dune ridges and grass them,

from Virginia line all the way to Ocracoke. Every dune you see down there is a man made dune that's been rebuilt not once, but hundreds of times. After every storm the bulldozers are down there pushing sand as fast as we can. And DOT after some of these storms will have 20/30 bulldozers out there putting sand back. Now if you go over the top of this dune ridge, what you see on the other side is a (inaudible) dune with a next high tide. These are out of equilibrium, they do not stop shoreline recession at all and they're out of equilibrium and they erode as fast as you push it up there in response to storms.

Here's an aerial photo coming out of Avon, Highway 12, the initial Highway 12 came out to here, it went to sea, so they moved it back here. Every curve in the road out there is a move of the highway. It used to come down here, this is Highway #2 and then a storm took it out and it moved it back here Highway #3 and you can see there is double dune ridge now because we are trying desperately to save it by 1999. We had little Hurricane Dennis and here comes Highway 3 out here, it went to sea and we moved it back here now this road is back here to point where you can spit into the Pamlico Sound. There is no place to move that road any longer.

I'm going to say a few words about inlets here because we have developed a bad habit of filling these inlets to try to hold on. In 2003 our project did a big study in this area because this was our #1 site for future inlets. We ran sand mix in here, we drilled in here, we got instruments in there right now to measure what's happening to the fluid dynamics and the sand. And two months later we had a little storm called Isabel that blew an inlet exactly through where we had projected, particular inland. It was a nice experiment, but it was very costly for the state of North Carolina and for the people that lived out there.

This is the 1860 shoreline and you can see that it's receded over an island's width since 1860. The average rate of erosion is seven feet per year, but again it goes in storms. And by building this dune ridge and by putting that sand back there and closing that inlet, what we've done is stop the movement of sand across the island by natural dynamics through over washing inlets. That area needed an inlet to build a flood type delta back there. That needed it more than any place else and when you blow that hole open you can see in a matter of days, you can see the sand starting to accumulate back here as a flood type delta. Had we let that build for a few months back here, this island would have had a whole new rebirth and would have had another several hundred years in its history because we would have given it a back that it could move on to. That is the evolutionary process here. By filling that this was a severe economic problem here. There were other options, the science was never on the table, the decision was made politically to close this down and get the economy going back, which was important. But it's also important for the long term health of these barriers, to let that inlet go. We did close it down, we closed it in five weeks if I remember right at $5-6 million dollars, something like that, but it's a band aid. This is still the top #1 priority for an inlet. The next storm that comes across, it will blow that out again. We did not solve anything except putting that road back there and getting Hatteras Village back in business. But from the long term business of rising sea level, we didn't solve anything. And there's 84%, we produced as inlet vulnerability index and everything in red, green and blue, has

been and will be an inlet many times in the past and will be in the future depending on the storm as this island narrows. An island narrowing comes from what we've done as humans on here and building that dune wall preventing the natural dynamics from happening. Eighty-four percent of this could have an inlet in it tomorrow if the right storm came across. And if we put enough storms across it or big enough one, we can do more than that. Sea level is rising, ocean shore lines are receding everywhere. In North Carolina, over washed inlet dynamics are cut off by development, barrier, dune ridge and vegetation. The estuarine shoreline is now eroding so we have islands thinning or narrowing and ultimately collapse. This is how we knew that island was going to collapse and produce thinning. It's not enough sediment in that, I don't have time to get into sediment business, but sediment is a very big player and you can harvest most of the sand on these weak parts of the island in a couple of pickup trucks, probably.

This is the short term future for North Carolina Outer Banks based on the processes that are going on and what we've seen happen in the past and it would not take very much more than a Hurricane Katrina or Ivan to do this in one storm, or a whole series of small storms. This is what we call our decadal scale change if we go into a nonstormy period it could take 10-20 years for this to happen. These areas are collapsing so fast DOT can't hold roads on these spots anymore. The people who live out here want beach nourishment to hold the beach out here and so forth.

This is the long term future, it's going to drown over to the Chesapeake Bay, we're going to drown through the Alligator River here, what was the coastal swamp forest over here will evolve in the marsh. This will become an open marine bay and the good side is that we will have very high quality water and good fisheries again. We will solve our pollution problem back here. The bad side of this is that a big hunk of our Barrier Islands will be gone and that's a century scale of prognosis. And what that's based on are series of core holes back here in Pamlico Sound were we've drilled in here and when we look at the cores, just like a tree ring, the top, let's start at the bottom here. At bottom we got mud down here, and mud can only form in low energy systems. This happens to be fresh water mud and then we get marine sand coming in that was the first flooding when sea level came up. We can age date that so we know when the water finally got into North Carolina and started to flood up here. Then we went to an estuarine mud. And to get an estuarine mud, we have to build a Barrier Island system here and close that off. But we built the first barrier here and then later we go back to marine sand again and then we reform the barrier, we get an estuarine mud and then we go back to marine sand again. Now this marine sand is even more important than these others because this sand right here is dominated by all the organisms that live in the gulf stream. To get the gulf streams across the continental shelf, now the gulf stream didn't go across there, but the gulf stream waters came in. To get that back into Pamlico Sound we have to have most of these barriers gone and so if you plot that on this, we're going back and look at that same climate curve I showed you before, this is the 15 degree line right here. This goes back to about 900 years a.d. up to the present and we have the medieval warm period, the same thing that the previous speaker was talking about. And as sea level rose above this, if you remember the sea level curve, the barriers collapse due to an inadequate supply of sand. They're sitting up there in that inner stream divider, they're just sitting up on a

little ridge. And we're only talking about a meter rise in sea level, not a whole lot. And then we drop down here in the little ice age and they reformed again, they reformed starting all the barriers out there except the big fat ones began forming about 1500 a.d. That means they're not very bloody old, but they formed in here before the colonist landed here. This is the little ice age and if you were a developer, this is the time for you to have been out there on the beach developing because all the beaches were creating and they were building. And then we came out of the little ice age, we're starting to warm, the warming climate, there has been oscillations in here and we're sitting up here and if you look at the next slide, we put this whole thing together, this is our sea level map and we have the first formation of the barriers back here. And they did ok through this period of time but when sea level got up here and the climate warms in the medieval warm period, we had a Barrier Island collapse and then they reformed again and then we came up here, (inaudible) this is medieval warm period and they collapsed again and then they reformed again here.

Nobody knows where the sea level is going in the future, but there's no reason to believe it's not going to do the same thing here. We're already beyond this red line which is a line that the IPCC projected here. We're sitting here at 1.5 ft. per century already and if sea level increases or global warming increases, we'll be up to 3 ft. rise in sea level very quickly. At three feet rising sea level, North Carolina will lose probably a significant, as much as 30-40 percent of its Coastal Plain out there, the lower Coastal Plain. That's a lot of land lost, a lot of people lost, a lot of economic lost. Well the responses to this receding shoreline and rising sea levels, hard stabilization, North Carolina doesn't allow this for good reasons and I hope that we're smart enough to never allow this. Soft sand stabilization, I put soft in parenthesis because sand bags are hardly soft, that's almost a misnomer, but we do lots of things here, like beach nourishment, beach barrier dune ridges, etc. to try to stabilize this. But the reality is if we've got a rising sea level and these storms are coming in the consequences are pretty severe. This high hazard zone here which is the ocean front, it's selling for up to two million dollars a lot. It's the highest hazard land in the world and it is absolutely guaranteed to go to sea, it's guaranteed to get wiped out in the next storm. The state and federal governments are investing a lot of money trying to hold the line that we can't hold for very long. It's very temporary and we start looking long term, next generation, two generations, we got to start thinking about process here.

There are some places where I think we need to move on, retreat, critical for simple over washed island barriers, some of these Barrier Islands have no business being built on in the first place and trying to hold that there in a rising sea level changing climate, this is what hardened shore lines do everybody knows that. This is, ten years ago we went into this present hurricane cycle, North Carolina had twelve miles of beach nourishment that was being done on a regular basis, Carolina Beach, Kerry Beach, Wrightsville Beach and Figure Eight Island. Today we have 120 miles of North Carolina beaches that want nourishment projects now. They want it now. To hold the economy, to hold the line to try to stabilize everything and the questions is can we stabilize it, should we stabilize it, is that really what we want to do. We will not have Barrier Islands there very long if we do. Twenty-five miles of the Outer Banks are presently collapsing and DOT cannot hold

the road there, they have these hot spots that the science panel has to meet over frequently. Beach replenishment is proven not to be the best long term solution it's a very temporary band aid. The Atlantic margin, if you look at the history of beach replenishment projects, in red are those projects that don't last one year. In yellow are the ones that last one to five years and you can see most of them last one to five years. But if you're paying 30 million dollars and you happen to have one like this, this is at Carolina Beach, 1986, a beautiful nourished beach, you can see the old rock sitting back underneath here. Any by 1987 this is what it looked like. The cost of moving that sand, if you can find the right sand and every place does not. The best sand is already on the beach, and the sea floor is not full of sand. Onslow Bay is on rock and you can find little pockets of sand here and there, but it's a very expensive operation. It is not a long term solution.

In Cape Hatteras Lighthouse we finally decided we would put in three grinds here that were broken before they even finished building them in 1969. They caused severe upstream, downstream problems. Steel sheet piles were put in here, rocks, enumerable layers of rocks, zillion layers of sand bags and in one of the storms, I think it was a 1973 storm they even bulldozed off the parking lot and dumped it out there in a desperate effort to save it. Finally decided it is time to retreat and move that lighthouse back.

North Carolina is faced with a similar situation right now at Pea Island. We're (inaudible) a bridge here and the present position of the political world and some of the public out here are trying to hold the line. In red here are the areas that DOT can't hold the line anymore. There is no place for that road anymore there. And the cost of doing beach nourishment for the next 50 to 75 years out there is absolutely phenomenal. There's an alternate proposal to retreat again and deal with new approaches to these various problems of infrastructure out there. This would be a back barrier cause way that would get the bridge out of the area and build a road back here. These weaker parts of the barrier systems are going to have to be dealt with with respect to some very new way of thinking.

I'm going to end here reminding everybody that four major gulf storms of 2005, Hurricane Katrina everybody knows about, most people didn't pay much attention to Wilma, that went in a little further south. Rita did quite a bit of damage and Dennis was a minor storm. But right now, these four storms resulted in an estimated, and it is estimated because the money hasn't been all spent yet by any means, minimum of what, these are known numbers, 120 billion dollars in damages and almost 15 hundred deaths. One hundred and twenty billion dollars, this will probably go to 200 billion. And if we do nothing, this is what we're looking at in North Carolina. Numbers will not be that big, but we're looking at a total, we get a category three, category 4 we're not in a very healthy position down there. We can and we must do better.

Let me just finish this whole thing with a summary statement. The extent to which human activity is causing global climate warming, is not the most important question. Yes we should know that and we will know it as we keep working on it and it's controversial. That's not what we should be dealing with here. The cost of these four

hurricanes, that I mentioned, to the United States and to the local governments, the state government, in fact if any one of those storms came ashore in North Carolina, it would break the bank here. And it would be a very ugly situation. If you haven't dealt with what's going on down there in Mississippi and Louisiana, get on a plane. It's really grim. Anything other than that tsunami in December that matches the impact of these storms. And North Carolina is counting on the coastal area for its future economic development. And this is really serious stuff, and we're asking for a major, major impact on this. And I just think that this Commission is a very important commission to deal with. Thank you.

Mr. Garrou – Thank you Professor Riggs. Questions? Yes sir, Mr. Clark

Mr. Clark – Thanks to scientists like Stan Riggs we've learned a lot since 1974 when North Carolina passed what was at that time a fairly progressive piece of legislation, North Carolina's Coastal Area Management Act. But in light of what we have learned since 1974, it seems to me based on what you're saying that we really need to rethink that act and how it dictates how we develop the shoreline and what we do in response to a rising sea level. Just like your comments on that.

Professor Riggs – I don't think for a second that we abandon the Barrier Islands. I love going down there as much as anybody and there are better places on those barriers to do what we want to do. And there are some places we shouldn't be doing it. There are islands down there, I will not use any names here, if you are a real estate, you ought to pay attention to some of these maps. Some of these islands are going down fast and after each one of these storms, we have a political body that stands up and takes a hard stand, the state's not going to go back and rebuild the infrastructure. And then six months later we're doing it and we're back in the same situation. It is not very often that you can't pick up the Raleigh News and Observer after one of these storms and somebody from Ohio says why didn't somebody tell me. Well we're an educated society and we should know enough to ask these questions. However, we as the leaders in the state have not done a very good job at dealing with this as a process and the dynamics of this system. And if we want this for something beyond just our present generation, and we're bilking it, we're getting a lot of money out of it, it's a big part of North Carolina's economy. If we want this for not just your grandchildren, we're going to have to take care of it and think how we approach it in a different way. We can encase it in steel, make it an economic system, but we will not have a Barrier Island period. These barriers are absolutely unique in the world and they are resources that North Carolina can build with. To the people down there, it's a very important part of the economy. But we've got to do better because if we get a category three or four, they're wiped out, they're gone. And we ought to learn from what happened in the gulf here.

Senator Pittenger – Thank you. Dr. Riggs I appreciate your comments this morning. In one of your graphs you showed what you called the anthroprecence period from 1784 to present, couple hundred years or so, and so we see that phase in context with previous slides over tens of thousands of years with the same types of variations in climate. I believe I understood one of your slides to indicate the natural phenomenal is not induced by man. So I'm sensitive to the issues that you related for the Barrier Islands, at the same

time, I did want to clarify that from the remarks that you did give that these occurrences happen unrelated to what man has done or not done.

Professor Riggs – Absolutely, just like the first speaker said, we can't get bogged down in the question of how humans are having an impact on the earth. The population, the use of resources, we don't have to use CO_2 to justify an energy program. We're running out of energy. I spent a good share of my career as director of a international geologic society program dealing with resource development in third world countries. And I worked all over the world working with energy resources, fertilizer resources, water resources. Most of the world does not have very much and we have scraped the cream off the top of this energy resource, the fossil fuel resource here for a very brief period of time. That last 250 years of the industrial revolution, we have utilized a very major portion of that resource. And if you start thinking beyond this generation to the next generation, the generation after that and you start thinking about nine billion people on the surface of the earth and the impacts that that population and technology is going to have. Are we having an impact today? You're darned right we're having an impact today and it's getting bigger and bigger. We can move mountains, we can tear up the earth, we can change the atmosphere to the point where we destroy it. And I think that the justification for an energy program is the fact that we don't have a whole lot of cheap good energy left anymore. We got everybody booming in the world and the demands on that energy are going to be overwhelming as well as the impact on the climate. So to me that issue at the moment is a non-issue. That doesn't mean we shouldn't deal with it, I think we need to deal with it, but the energy question has its own justifications. And if we want to, we need to develop a better energy program in this country, in this state. We need to deal with that. We have to better stewards of this or our resources are gone. Our water is already down the toilet in North Carolina. We have more fresh water in the Coastal Plains than any place else in the world almost other than southern Florida. And we're losing our aquifer system at the rate of 10-12 feet per year. The rivers are coming down, they're sewers. I live on the Tar River and I watched over the years, I've watched it go to sewer. And its not big industry necessarily, it's all the people, the cumulative impact of you and me that are affecting these resources. We've got to clean up our act. We've got to do better at it and as we build, we can only build if we have a good resource base. That's the future, in North Carolina we have a resource base and we have got to deal with that.

Senator Pittenger – Thank you. I do agree that we need a better working policy as related to climate change. Your comments were well received. Thank you.

Representative Wilkins – Thank you Mr. Chair, a couple of things Dr. Riggs. There was a grant about core soil samples, it wasn't dated, am I to take that that's a 900 year period?

Dr. Riggs – I don't know which graph you're talking about.

Representative Wilkins – Ok, yes sir. Does that reflect a 900 year period, because 900 years was mentioned immediately after that.

Dr. Riggs – No, the bottom of that core is about 8000 years. The base of that was fresh water when Pamlico Creek was fresh water and so all we've got is a whole flooding cycle that started about 8000 years ago and the first time we built a piece of the Barrier Island was about 5000 years ago and we built some more of it about 3000 years ago and it collapsed and we built the last part of it 1500, sorry, 1580.

Representative Wilkins – Thank you, I picked up 900 from another graph, I guess. My other thing, I'm a surf fisherman, surf fishermen observe very closely, and talk even more than that, and they talk frequently on the coast about 20 year hurricane cycles. Any of the data that you run across, does that support it?

Dr. Riggs – Yes, in fact, that one chart I showed from the literature, which was published just this past year or two in nature showed about a 25-30 year cycle. That one that had the red and the blue temperatures, sea surface temperature on it and that's about what it was but the thing you've got to remember about these patterns and cycles, we only have a hurricane record that goes back to 120 years. And before that it's all word of mouth and historical. Now in the geological record, we can see these events, so we can pick out the really big ones, we can't pick out the little ones, can't put the details together.

Representative Wilkins – Thank you sir, thank you Mr. Chair.

Dr. Smith – Dr. Riggs you brought up some obviously profound things for people to think about and I appreciate you bringing it to our attention. I have just a couple of questions I want to clarify on some of your graphs. You had a chart where you were showing a relationship of, I take it, the sea surface temperature of some of the Luke currents and other (Dr. Riggs – that's the same one I think he was talking about). Right, and it appears that there are these cycles that we come into. I wasn't clear on the actual extent, cause it looked like we were in an up tick towards the end of where it cut off. And I noticed some of your slides were cutting off over the past 10 years or so, but there was this up tick. My question is, if there are these cycles, could you imagine a scenario where because my understanding is that the concentrations that we're seeing in CO_2 are somewhat unprecedented at least in the most recent past. And that that can have a tendency to keep temperatures elevated, obviously what we're talking about, which then was exasperate or possibly prevent some downward movement. So we could be seeing some period where we're going to see increased sea surface temperatures and Luke currents on top of whatever natural fluctuations we have with hurricanes. I mean would you say that's possible and maybe even likely. And given that there are these patterns of hurricanes that happen and we think we're entering into a phase where we're going to see increased frequency. Those are complex because of obviously upper level winds and this, that and the other. But there is clearly a relationship between sea surface temperature and hurricane intensity. My understanding is that particularly in the last few years, there's been some fairly sophisticated work coming out of MIT and Princeton and Georgia Tech that shows a relationship between actual temperature and the hurricane intensity and beginning to correlate that possibly with global warming. And you show these warming periods that the Outer Banks becomes, it looks like almost a series of

arrows just coming right after the Outer Banks. I take it from that slide that you were communicating that you're saying that as sea surface temperatures increase, the likelihood of the Outer Banks getting hit by hurricanes is going to increase pretty dramatically. Because there seems to be a relationship between those, and my point is, if you have these increased sea surface temperature, increased hurricanes, possibly increased hurricane intensity at the same time with what you described as a break down in the Barrier Islands and some people have postulated it that without these Barrier Islands, the surge comes in and this, that and the other, that you would be greatly concerned, I mean that you've got the dynamics with the population growth and whatever. But that the sea surface temperature relationships are going to cause more intense hurricanes reaching further into the state and that these two things are centerjestically coming together and going to exasperate each other.

Dr. Riggs – What do you want me to say?

Dr. Smith – Well I guess what I'm getting at is the previous speaker and then you have referenced these patterns. My concern is that normally you have these fluctuations, but we may be locking the fluctuation to the upward where we're not going to get the downward fluctuation.

Dr. Riggs – You're asking me if I believe that there's a relationship between humans and global warming?

Dr. Smith – And then the relationship to that then could cause an exasperation of what the natural cycles are and maybe not allow them to go down anymore and only up tick them which is going to cause a lot more problems.

Dr. Riggs – I personally think that we are having an effect on the CO_2. I'm not a chemist or an atmospheric scientists and I can't tell you, in fact, my understanding of the whole CO_2 question. I have spent a good share of my life as an oceanographer and I know how CO_2 moves into the oceans and moves through the system on a bigger scale. And there are times in the earth's history when CO_2 is much higher, much higher. There are times when it is much lower and it seems to be absolutely correlated with temperature. The CO_2 is a very important part of the whole limestone cycle, coral reefs and there are periods in geologic history when there's a tremendous concentration of formation of these things out of the world's oceans. And it seems to be periods of time when all these limestones are weather and the CO_2 goes back and you've got to be able to sort all that chemistry and complexity out of this thing. If you want to understand what the human overprint is on this and I surely can't do that. I don't understand it. I can show you a plot, not my work, but from the people who are doing the ice core work where we have a 750 thousand year record of climate change in those ice cores, and they're beautiful. I mean this is just an incredible data set. And they show an absolute correlation between CO_2 and air temperature back through time. A lot of these same scientists project that humans are going to increase that and show a much bigger spike on it, I can't address that. I would not be surprised if it's not true, but I also know that the ocean becomes a big sink for this. We don't know what the ocean role is in this. The modelers approach

the natural earth systems very simplistically. And there are no systems that are simple and I'm not being down on modelers, but a modeler will work with three, four, five variables (inaudible) system. When I talk about inlet probability, we have 24 variables that we plug into our inlet variable, a modeler tells me that that's ridiculous. Give me the most important ones, but we don't know the most important ones. I can intuitively sit down and deal with 24 variables and deal with everything from grain size to slope of the shelf to composition, to geometry of the system. But a modeler can't do that yet. And so I have an intuitive understanding for drilling and for knowing where these things happen in the past and how they form. They go beyond what the model capability is.

Dr. Smith – It's where the models and the empirical observation come together that you begin to develop confidence and that's what I think we're beginning to see. You've seen it in your work and I think we're beginning to see it in the climate. Mr. Chair, one last thing, when we have a break, I am going to pass around to the other members of the commission some information about sea level, which is consistent with what we are hearing, but I think gives some sources of some stuff and I would like to just let people know that I'll get it passed around soon. Thank you very much.

Senator Pittenger – Mr. Chair, could I just ask one last brief question?

Mr. Garrou – Yes sir.

Senator Pittenger – Dr. Riggs, then to confirm that CO_2 variations have occurred for thousands of years, and you say consistent with the change in temperature.

Dr. Riggs – That's what it appears to me.

Senator Pittenger – Thank you very much.

Mr. Garrou – Thank you very much Professor Riggs. Our next speaker is Robert Jackson, Professor of Biology and Environmental Sciences at Duke.

Mr. Givens – While Dr. Jackson is coming up, I just note that the lunch break is estimated and estimated not with great accuracy. We did want to hear Dr. Jackson's presentation before lunch. Then there'll be further discussion and presentation and discussion after lunch whenever that falls.

Dr. Jackson – Can people hear me without the mike?

Mr. Garrou – No, we need it for the recording.

Dr. Jackson – That was easy. Can people hear me now? (PowerPoint presentation – **Exhibit J**) Well I know you all want to go to lunch. So they asked us to keep it short and I am going to try to do that. I essentially have two points to make today, and two only. Those two points are first, that there is a direct link between human activity and greenhouse gases and the rising earth's temperature. And the second point is to stop

viewing this sort of as a migraine headache. Start viewing this as an opportunity to shape North Carolina, to shape our state in the way that we want it. By shaping I mean, both economically and environmentally. So those are the two messages for my talk and I want to go through now and give you a bit of information and background. A little bit of data as well.

So the background, I'm in the Nicholas School of the Environments Earth Science at Duke. I also direct the Center on Global Change and as part of our mandate in the Global Change Center which is in the Provost Office, I also direct the new Department of Energy, it's called Southeastern Regional National Institute for Climate Change Research. It's a brand new program that has been set up in the past year. There are four of these regional centers in the country. The one for the southeastern US is based at Duke in the Global Change Center that I run.

So I come at this with a lot of different perspectives. I mentioned my first point and that's that the consensus in the scientific evidence is overwhelming that there is a link between human activity and greenhouse gases and the warming of the earth. Now these are just three statements. We've already heard about the IPCC, the intergovernmental panel on climate change that's just finishing up its next go round right now, will be out in 2007 officially. But you're already hearing about it in the news a little bit. What did they say last time in 2001? There is new and stronger evidence that most of the warming observed of the last 50 years is attributed to human activities. Now that's a thick report, but that's right in the front. So that's a group of more than 2000 scientists and by what you're hearing in the news media, lately, the next report, five, six years later is going to be even stronger language. But it's not just about the IPCC. The IPCC has become somewhat political, in a sense people are trying to sort of push it in a political direction. So let's back up from the IPCC and say what are some of the other scientific institutions saying about this issue. So let's switch gears and go to the meteorological society, our premiere meteorological group in this country, more than eleven thousand members. Because human activities are contributing to climate change, we have a collective responsibility to develop and undertake carefully considered response actions. Not if, not whether human activities are contributing to climate change, because human activities are contributing to climate change.

All right, let's take a different group, a group that I'm intimately involved with, the American Geophysical Union more than forty thousand are scientist. I am the president of about ten sections in this society. We have about four thousand members. So I'm intimately familiar with the official climate change statement for AGU, as we abbreviate it, just as a similar organization to the Meteorological Society.

The American Geophysical Union, what's the official statement released last year. Scientific evidence strongly indicates the natural influences cannot explain the rapid increase in global near surface temperatures observed during the second half of the twentieth century. Now the pros may not be great, but the message is there. All right, so those are three bodies, thousands of people, over and over again, the message is the same.

There is a direct link between human activity and greenhouse gases and the warming of the earth. Is it the only thing that's involved, no, but there is a strong link.

You all know about the greenhouse phenomenal. The single diagram, so what do we mean by that – short wave radiation comes in, long wave radiation is admitted back from the surface like you would study in the physics class. A greenhouse works because it traps that radiation and keeps the air around those plants warm and allowing us to grow those plants under cold conditions, well clouds, carbon dioxide, water vapor in the atmosphere. These do the same thing as the earth surface is re-radiating, re-radiating that long wave radiation back up in the air, some of it is left behind. It is trapped inside the layer of the atmosphere. This is a good thing as we've already heard a couple of times today, without greenhouse gases the earth would be a frozen ball of ice and none of us would be here. So it's really no uncertainly about that, we are here because greenhouse gases are in the atmosphere. And those greenhouse gases are a good thing.

Right now a little bit of history, we've heard about some uncertainties. So let's back up and ask what did people know before my grandparents were born? How much did we know about this issue? In 1827 Jean Baptiste Fourier first describes how atmospheric gases trapped heat. He was the first person to use the analogy of a greenhouse, almost 200 years ago. In the 1890's Svante Arrenhius, a famous Swedish chemist, but really an amazing scientist, chemistry, geology, costomology, absolutely a phenomenal person - awarded the Nobel Peace Price in 1903. He and another person independently proposed in the 1890's that a build up of carbon dioxide, from fossil fuel burning would warm the earth further. Why this was over one hundred years ago. Now in a previous life, as an engineer, I knew Arrenhius and Foya, about like Shirley McClain. It's because Foya you knew from that class as Foya transforms, Arrenhius you know from your chemistry class, reaction kinetics and various things. These are scientific giants who have been thinking about this more than 100 years ago and are already established the links, fundamental links of what greenhouses do and the environment. Does that mean you know exactly how the warming is going to occur in the next 50 to 100 years? Absolutely not, are we pretty darn confident that if we keep pumping carbon dioxide and other greenhouse gases into the atmosphere, the earth's going to warm. Yes, we're pretty confident.

In 1958, the last person I have up here, Charles David Keeling. Many of you know him or of him and he's well known because he started the famous monitoring trace. The first person to set up a monitoring station at the top of a volcano to measure carbon dioxide beginning in 1958. And his measurements were important because it was the first time we documented this increase in carbon dioxide, a little bit each year, by each year, by each year as it went up. It's been going up every year since then and now more than 40 years. So there's some history here. Yes there are some uncertainties. Yes there are some things that we don't know. But there are a lot of certainties too and people have been thinking about this for well over 100 years. And there are aspects of this that are not rocket science, greenhouse gas is warm more, greenhouse gas is warm more.

There's David Keeling's trace, you've probably seen a graph like this more times than you care to count and you will probably see it again in this Commission too. On the Y

axis we have time here, dating back 1860 to 2000, I'm sorry that would be X axis on the Y axis, there's a parts per million of carbon dioxide. And you see Keeling's trace in that gold on the right as you look at the screen. So the ice core record provides the numbers on the left side of the figure and then the Keeling trace provides the right side. So not only did his data teach us that carbon dioxide is going up, they also taught us something about the way it works. Look at the oscillation in that graph, every year it seems to go up a little, every year it goes down a little bit. That's the bias for your breathing in the Northern Hemisphere. That's leaves coming out in the summer time, pulling carbon dioxide out of the air, respiring that carbon dioxide back to the atmosphere in winter. That's the bias for your breathing. But on top of that dynamic signature is this incremental march upwards which is a direct result of human activity. Regardless of what you think about climate change, there is no doubt, there is no uncertainty that we've increased the carbon dioxide concentrations to levels we haven't seen in hundreds of thousands to millions of years at least. And it is very likely that the temperature will continue to go up because of that.

That was a 150 year record let's look at a 450,000 year record. This is one of several, the famous ice core traces and as you move from left to right on the X axis you're going from back in time to present day at 0. And then on the Y axis here you have the carbon dioxide concentration in parts per million. So you see several ice age cycles embedded in that graph, when CO_2 concentrations are high, the earth is relatively warm. There's not a temperature graph on this one, I'll get to that in a minute. When CO_2 concentrations are low, we are deep in an ice age. You see these oscillations are about every 100 year time scale and have nothing to do with human activity. Then you see us come out of that last ice age about 10,000 years ago. We go up to where that dashed line is and then something different happens. That line keeps going up for carbon dioxide. That's the imprint of human activity. That's the burning of fossil fuels in the environment. So you see there it says current 2001, today we're pushing 375, 380 parts per million, well above the oscillations we seen for the last half million years.

I apologize to some of you in the back because this is a bit hard to see. But this is a similar graph, we have two Y axes in this case, we have a CO_2 graph at the top of this figure that you've just seen with time, in this case going from left to right, (inaudible), and on the other Y axis is temperature. The only thing that you really need to see with this figure, or to take home from this figure, is the correspondence between carbon dioxide and the dormant greenhouse gas and the earth's temperatures go back in these ice ages. These are put together, the temperature records are put together through a number of proxies, coil tree rings, ice topes, and many factors. Now this graph does not prove that carbon dioxide causes the ice age. The causes are answered in and out of the ice age, we don't really know exactly why we go in and out of ice ages. Nobody can answer that question yet. But it is clear that there's a very tight correspondence between the amount of carbon dioxide and other greenhouse gases in the atmosphere and the earth's temperature. You can see that with your eyes, you don't need a PhD you don't need a college degree to see that. Once again, here's where we are now about 380 parts per million in the year 2006. So again, we've sort of taken ourselves out of the natural

projectory of the last half million years and even more as you look back farther into the record.

Now let's talk a little about the last 1200 years. So this is an article that came out just a couple of weeks ago. Now I know you've already seen examples of how our wonderful pros in science, not exactly our strong point, but what you hear about on the news often are articles that come out of Science and Nature and various scientific publications. There are articles just rolling out week after week now talking about different aspects of both the climate change effects on two weeks ago on the Greenland ice cap and evidence of increased melting. A paper just this week, announced on Thursday about Antarctic data and ice lost there, I thought it was a complicated piece, but a brand new paper. I would encourage you to read, if you want to, the original articles at least to follow in the press. These data are coming fast and furious now, whether we're talking about climate, whether we're talking about butterflies, insects, birds that change their ranges in response to the warming earth. The evidence is rolling in and there's something really unusual going on here.

We've talked a little bit about sort of the hockey stick. This is an article out last month, Science, Osborn and Briffa, I'm not sure how you pronounce that last name. Two different takes on the hockey stick that we've already seen. Alright, these are two graphs with the same data but slightly different takes on normalization and statistical treatments. There is an infinite number of ways to analyze various data sets like these. So you can think of these two analyses as book ends for some of those ways. Alt the top you see an analysis that shows evidence of the medieval warm period, about 1008 years, the most obvious period there, where you see the little sharp peaks of red. You see some evidence for the recent, relatively recent cooling of the medieval cooling period around 400 years ago that blue where it dips downward.

On the top graph, now you see that giant red blob, ok that's us today. That's sort of the broken hockey stick at it's worse manifestation. The bottom figure is a different take on the data, it shows some evidence of the medieval warm period, it shows the cooling more recently, but it also shows even more dramatically this drip with fossil, this drip upwards with fossil fuels. So I guess I would say that by far, the way the prominence of the data is, doesn't suggest that the hockey stick is broken. The hockey stick may not be perfectly flat, but it's that giant red blob on the right side of those curves that what we're dealing with here. And that giant red blob, by all those statements that I've already shown you, and by many, many other pieces of evidence is linked to human activity in greenhouse gases almost certainly. And that's with as much confidence as we will ever be able to say. Almost certainly.

Another take, narrowing it even more in the last 120 years or so, our annual global surface temperatures for the land and ocean together on the top, ocean in the middle, then the land at the bottom. These are degrees centigrade or degrees Fahrenheit. Fahrenheit depending on the X and Y axis. And again you see this anomaly, the last blip in 25 or so years recently where the graph gets very red. Now as we've already seen, the earth's temperature does not track carbon dioxide and other greenhouse gases perfectly. There is

not a perfect correspondence between the increase in carbon dioxide concentration and the earth's temperature. And you see that particularly in the first 20-30 years of the century where there is upward blip that probably isn't due primarily to carbon dioxide. It has some other contributing factors like increases in the sun's rays and things like that. But there is no known natural explanation, for the last 25 years. Not volcanoes, not sun spots, not anything else that we can come up with. And that's why there's so much confidence, as year after year rolls in 2005 being the warmest year on the instrument record since the beginning of our records. So these data are rolling in. Is CO_2 the only player? Does methane and other greenhouse gases, are they the only players? No, are they major players in the earth's climate system and temperature? Absolutely, we know that, we knew that 100 years ago, almost 200 years ago.

Now personally I don't like the hockey stick graph, I don't think the hockey stick graph really tells us what it's like, what's really happening to the earth's surface. This is a different graph. So instead of asking what's happened everywhere on earth and then let's combine that together in one number, let's see what happens different places on earth. So this is a record of temperature change for the last 25 years, 1976-2000. A red dot is warming, a blue dot is cooling, a big dot is warming more, a little dot is not much change. The biggest red dot that you see, in particular, through temperature and especially northern latitudes, that one degree centigrade per decade. So in the last 25 years, of this graph's record, there are places that have warmed two and one-half degrees centigrade. Large area that have warmed two and one-half degrees, approximately four degrees Fahrenheit now.

We'll talk about global warming being 50 years or 100 years into the future. No, global warming for large parts of the earth, especially up north, is here now. It's changing right now as you look at the permafrost, fires in Borro Forest, it's our life time, we are not talking about our grandchildren. There are some blue dots on this graph. You will notice less change over the oceans. That's not so much of a surprise. The oceans have very high buffering capacity, very high heat capacity to absorb changes in temperature. You don't see a lot of dots in Antarctica for example. That doesn't necessarily mean no change, we don't have many stations in Antarctica. So we don't have very good data down there. Imagine putting 20 weather stations across the United States and then trying to conclude what's going on with Antarctica's climate or the US's climate. But there's a lot of red on that graph. Ok now, now where does it really get uncertainty, it gets uncertain when we go to the future. The uncertainty is how much warming. Alright nobody can answer that question exactly. Why is that? Well you've already heard some of the reasons. We don't have perfect knowledge of the relationship between greenhouse gases and temperature, we don't know exactly how many people there's going to be in 2050 or 2100. We don't know exactly what each person is going to use, how much they might drive, how much they will eat, what kind of home they will live in. We don't have all that data, so the best we can do is build scenarios and try and predict the amount of greenhouse gases that there will be in the atmosphere in the future and then what the effects on the climate system will be. That's really the two step process that we need for perfect certainty here. We're looking at the hockey stick again on the left, and then you're looking to where we're heading. Where the best models suggest we're heading.

Now there's a huge range on that graph and the top of that graph for those of you in the back and can't read it is about six degree centigrade at the top. Does that mean that we're going to head to six degrees centigrade? I don't know. The bottom of that graph is about two degrees centigrade for this century. So somewhere in that range, but most estimates are in the neighborhood of five degrees Fahrenheit, six degrees Fahrenheit, something like that. Nobody knows.

I guess the question I want to ask you is do you really want perfect certainty? I mean do we have to know exactly what that temperature number is going to be for North Carolina to figure out what we should do. I would hope that the answer is no. But there's lots of good evidence for this and again our mind set here is to stop thinking about climate change and global warming as a sort of migraine headache that's just a pain for us and start thinking about how we shape our state in the image that we want it.

Just a few more graphs and I'll finish. It's not just about carbon dioxide as we already heard. These are four graphs showing carbon dioxide concentrations upper left, nitrous oxide concentrations upper right, methane concentrations lower left and sulfate aerosols. They all show the same thing in the last 150 years, a dramatic up tick in those greenhouse gases. So we don't have to talk just about carbon dioxide. There are even greater uncertainties in some of these trace gases, methane's a hard beast as well. But they're all telling us essentially the same thing. Now we try and tease apart different aspects of warming. Warming is complicated as you've already heard. I will not dispute that. This is a figure from the IPCC that tries to factor in or identify or attribute aspects of warming to particular things. So anything above that solid line that you see in this figure is a warming force, a forcing factor we call it. Anything below that line is a cooling force. And that's what's happening in our climate now relative to 1750, 250 years ago. So that big giant bar on the left of the greenhouse gases, I believe these are watts per meter square the units on the graph, it not up there. But you see that big graph being the greenhouse gas is carbon dioxide is the largest one. You see a contribution for methane there that's very real. Orders of magnitude less common in our atmosphere are much stronger greenhouse gas. You see nitrous oxide, hallo carbons, the CFC's, HCFC's. These are very strong greenhouse gases.

You see ozone effects. You see a stratosphere of cooling effect. Well what in the world is that? That's the ozone whole. That's the ozone that's been removed from the stratosphere and ozone is a greenhouse gas. You can astrosphere that goes on in fact. What's that? That's pollution, that's atrospheric pollution, that smog. Then you see these other bars, sulfate, a little bit of cooling, biomass burning. These are effects that lift particles out of the atmosphere and block that sunlight from reaching the earth's surface. And then you see a large uncertainty around aerosols. There are some big uncertainties and exactly what will happen to our climate. Clouds are one, we can't predict clouds perfectly in the future and different clouds do different things, white clouds reflect light, dark clouds absorb light. Then aerosols are particulates in our atmosphere also uncertain. But again you want a first order of response greenhouse gases begin warming that giant ball on the left side. Those are our greenhouse gases. If we tackle one thing first, it makes sense to tackle the largest thing first.

My last data slide. I just want to think about time scales a little bit. I've already said that I think global warming, especially up north is occurring right now, this is a today issue in our lifetime issue. I think that's true for the state of North Carolina too. But there are time scales here that we need to think about. We've heard a little bit about stabilizing CO_2, how difficult that will be. It's going to be hard, it will take a lot of work and will take some changes to stabilize carbon dioxide. Because to stabilize carbon dioxide, which is that purple graph, the purple line there you see, it goes out about 100 years and then flattens about 150 years. To stabilize CO_2, we have got to drop CO_2 emissions dramatically. So in this figure what happens, we start on the left, CO_2 emissions peak and it says in this case, 0 –100 years from now, drops down substantially, only then over time can CO_2 stabilize.

What we're talking about here today, first and what Kyoto tries to do. Kyoto was a small step. What Kyoto tries to do is at least start to slow that projectory of increase. Kyoto on its own is not enough to stabilize carbon dioxide concentrations. Once CO_2 stabilizes, let's play the scenario game, CO_2 stabilizes a century to three centuries from now, temperature stabilizes shortly after that, that's the red line and continues to go up a little bit. There are things that are going to go up for a long time after that. Now let's just take two examples on here, we've already talked about the sea level rise a bit. Now the blue dash line is sea level due to ice melting. Well now why is that? Think about how an ice cube melts, right it doesn't melt all at once it melts from the outside in. And obviously, when we're talking about ice packs like Antarctica we have to take in account how much snow is coming in and other things. But just that simple ice cube analogy, when you bring an ice cube out on the counter and set it there, it doesn't melt like that, it melts from the outside a little bit at a time. That thousand-year time scale is what we're talking about, Grand Artica and Greenland and other ice caps. Even when temperatures stabilize, because you're melting that ice cap from outside in every year a little bit more is being sliced off and you're working your way in on that ice cap.

Now how about the other one, sea level rise due to thermal expansion. That's the solid blue line, that's also still rising in a thousand years. That's not rocket science either, that's a high school, bench top experiment where you take a beaker of water and you heat it up. And why does it take a thousand years, because most of the ocean isn't in contact with the atmosphere right now. It's hundreds of feet in some cases thousands of feet away from the atmosphere it hasn't seen the atmosphere for 500 years, in many cases 1000 years. So this is what we're looking at. I believe that the rationale for acting on global change is right now and I've already said that a couple of times. It is North Carolina today, we've already heard some reasons that CO_2 is hard and that we haven't done a good job of reducing carbon dioxide emissions. Well these data, I just want to show, to point out that these have effects for not just a couple generations but for dozens of generations.

Now, I began this talk with a list of three bodies to establish the link between greenhouse gases and warming. Let me pick three others that looks like the same slide, different groups. National Academy of Sciences 2001, the national body set up to try and answer

our scientific questions for the government. Greenhouse gases are accumulating at earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. It's pretty simple. American Association for the Advancement of Science their formal statement in 2000. These are five years old now, we're still talking about the same things. The world is warming up, pollution from greenhouse gases such as carbon dioxide and methane is at least partly to blame. We will never say more than that, no one is ever going to be able to say the earth is warming entirely due to greenhouse gas emissions. Even if it were, we could not say that because we would not know with certainty.

But again, the message is that greenhouse gases are going up and they are at least in part the blame for what we're doing. And finally, I guess a quote I've already shown you just from that recent paper. Looking at this sort of hockey stick time frame and the newest analyses are still reinforcing that the warming we're seeing in the past 25-30 years is really unusual and does not have historical precedent in our instrument record or our proxy record unless you start going back millions and millions of years to the carbon empress and other areas, hundreds of millions of years ago, tens of millions of years ago.

I'm done. So a couple of years ago I wrote a book, I published a book and I have some comments in that book. This is the first comment, this is a Raz Chaus comment, says how to deal with the upcoming recession, inflation, depression, ice age, greenhouse effect, energy crunch, population explosion and complete end of the world in the year 2000. Robinson Davies also happen to be one of my favorite writers, he has a quote from his Samuel March Banks book, the world was scheduled to end today but something must have gone wrong. I guess what I want to leave you with is that this is not about the end of the world, this is about quality of life that we have and the kind of world that we have now and for future generations. And if we think about what we want to do with this, I want to stop, I guess stop thinking about global warming alone, let's start thinking about all the different issues that face North Carolina. It's not just about global warming, is it, it's about ozone and pollution and if we lick global warming we solve most of our air quality problems too. That's the attitude that I hope the Commission will take in trying to figure out what is the right course of action in this state. And the fact that if I'm 100 pounds overweight and it hard to lose the first 10 pounds and somebody says well that's not going to solve the problem because you're still 90 pounds overweight. We need to take that first step. At some point, I need to lose that weight and if riding my bike to work does not change the international CO_2 curve, that's one thing, but it changes a little bit. Might not show up on the graph, it makes me a healthier person and it's a first step. That is the message I hope I leave you with today and this is my state, this is something I care a lot about and I want us to figure out a way to do this in ways that are least disruptive to businesses as possible. That you know, doesn't tell a power company like Duke Energy or Progress Energy to scrape a coal plant that they've just spent billions of dollars on. We need to find a way to do this intelligently, but quickly because climate change is now. Thank you very much.

Mr. Garrou – Thank you sir. Questions?

Dr. Eggers – Dr. Jackson, I especially appreciate your comments at the end about future generations because I think we sit here as a room full of stewards for not just children and grandchildren but great, great, great grandchildren and their great, great, great grandchildren. So the stakes are pretty high, they would have some things to say if they could be here. Would you please go back to the slide that was approximately like this?

Dr. Jackson – This one?

Dr. Eggers – Thank you. Yes. So we have received some materials from the John Locke Foundation and they have included the slide, this is an IPCC Northern Hemispheric temperature reconstruction for the past 1000 years. It's difficult to see because the lights are on full and things, but there is a very dark single line in the midst of all of that kind of arrow bars there. And one of the criticisms is that maybe we can't trust this because it seems to smooth out the medieval warming period and the little ice age and then show this big up spike at end. So can you explain why this seems to smooth those out?

Dr. Jackson – Sure, I will also switch to a different slide very briefly. Data analysis and smoothing depends on what time interval you take. Is it a five-year running average, is it a 25-year running average, a 100-year running average. There are all sorts of ways to analyze these data. The longer time period you use, the smoother your signal is going to look. The up ticks will be lower, the down ticks will be shorter. Now this is sort of more like the typical hockey stick sort of presentation that Robert was talking about earlier. I tried to bracket that with this new data set to show here is sort of two different approaches, bookends if you will, to what that graph might look at. So anything you see over that top red line in the upper graph is sort of what we would call a 99 percentile image. That means that there is less than one percent likelihood that this is sort of a normal phenomenal in that interval. Now you do see in that upper figure a couple of times back in this one period in particular where it ticks up above that line, that 99 percent line briefly. So that was an unusual work period, but you don't see the thickness of that bulge at any time in the record and you don't see the height of that bulge at any time in the record. So that's just kind of one book end, a different way, a different analysis and this is in a paper that just came out a couple of weeks ago in the Journal Science. The bottom one is a different take on the instrument record. That take on the instrument record says there's nothing like this that happened in the last 1000 years or so. Alright now which one of those two figures is absolutely right? I don't know. There are 1000 figures in between those two, but everyone of them shows this giant blimp of red at the end. That the overwhelming evidence suggest is due to greenhouse gases and human activity, that's the part of the figure we ought to be focusing on, in my opinion.

Senator Pittenger – Thank you Mr. Chairman, thank you Dr. Jackson for your presentation. I do appreciate it. You offered a number of quotes by some impressive organizations, I'd like to get your reaction if I could to some similar type organizations. One of which you mentioned was the National Academy of Sciences. The quote from them states a causal linkage between the build-up of greenhouse gases and the

atmosphere and the observed climate changes during the 20th century cannot be unequivalently established.

Dr. Jackson – Can you give me a little more to go on there, so when was that, what report, I don't know what the context for the statement was but the National Academy of Sciences was one of the quotes that I put up there before. I'm sorry, I'll let you answer my question as I ramble on. The National Academy right now is organizing a group of people to sort of analyze this hockey stick debate and put it to rest once and for all. That's what's going on right now. I'm sorry I interrupted you.

Senator Pittenger – That's all right. The book I think for that was called Climate Change Science: Analyses of Some Key Questions page 17?

Dr. Jackson – Ok that's right, now read the quote for me one more time please.

Senator Pittenger – I don't have it with me here, I think its 2001. But I'll have to go back, cause the others are from 2002. You mentioned projecting the future, we couldn't know for certainty what that would be and that as I understand it that there are variables in there, whether it's vapor or clouds or particles. The statement that IPCC made about that was that the clouds can either cool or warm the climate depending on their composition and let the United Nations and IPCC just state the clouds represents different source of potential error in climate control simulation. Well if this is true, shouldn't we be very reflective on what we do in terms of the impact, economic impact in our state and the answer to that I've seen show that to implement, for example, the Kyoto protocol would cost about 550 million dollars. The impact to the state tax revenue would be around three billion dollars annually. And the impact on energy cost annually to the consumer would be about 2.3 million dollars. So I'm a little bit concerned that we would be making decisions with enormous economic impact so there is not really a good understanding of why we need to do that, particularly related to the variables that are out there.

Dr. Jackson – You said a couple of things in sequence there, let me try and remember each one in order. This was a quote that I had put up before, greenhouse gases are accumulating the earth's atmosphere as a result of human activities causing surface air temperatures and subsurface ocean temperatures to rise. This was a National Academy of Sciences report, 2001. So that was my quote. I tried to tackle a little bit this issue of clouds and other things, the Senator was absolutely right, clouds are a major uncertainty – we will not totally resolve the cloud issue in my life time, I think I can say that with confidence. I can also say I still think that has essentially nothing to do with the reasons for deciding what we decide. Let me explain what I mean by that. It comes back to looking at the size of these bars, for example. You know, we have this large greenhouse gas bar on the left and we have clouds coming and going. Now you can imagine the earth's temperature going up incrementally as we load the atmosphere with CO_2 and the clouds are coming and going. Clouds are short lived phenomenal, there may be more clouds in the future in certain areas, there will likely be less clouds in some areas in the future. But that's sort of a second order signal on this greenhouse gas term that we're

loading year after year after year. And so the aerosol and clouds are two of the biggest uncertainties as I've already said, but there is no evidence and no suggestion in the scientific literature that those terms are going to overwhelm this greenhouse gas term. Now I guess another issue deals with uncertainty. Let's take an often used analogy, let's take smoking and lung cancer. If you smoke, are you always going to have lung cancer? No. If you get lung cancer, are you automatically a smoker? No. Can we predict exactly who is going to get lung cancer if you smoke? No. Does that matter to a rational policy decision about smoking? If we want to save lives and money, we don't have to know exactly who is going to get lung cancer to know that it makes prudent financial and environmental sense for us to tackle this thinking issue. There are uncertainties still today in the relationship between smoking and cancer. We can still make intelligent decisions to save ourselves money and lives, I believe, despite some of these uncertainties. Let me finish by saying there are other uncertainties that plague you too, it's not just what the exact term do to clouds, but what the exact warming or cooling do to aerosols. Let's talk about the uncertainty in our economy for not doing anything, for businesses not to know what's going to happen in the future if we allow temperature to warm slowly. Let's talk about uncertainty to our environment, to our agriculture and there may be some pluses in agriculture with increased growth, there may be some minuses with increased pest and such. We don't have perfect certainty with any of these. But there are strong costs, big cost to uncertainties in the other direction. I believe what we want to do, is to lessen that uncertainty as much as we can by keeping that greenhouse gas turned down as much as possible. It's just playing it safe, I don't believe you can attribute a particular hurricane to global warming we cannot attribute Katrina to global warming. We can only attribute things to global warming that we build up over long periods of time and with large data stats. That's the conservative nature of our business. So if somebody ask me if this heat wave is due to global warming. I don't know. I can't answer that question, but there are uncertainties with not doing something about this that affects our economy and our environment directly. I believe those uncertainties are bigger than worrying about what the precise term do to clouds or aerosols is.

Mr. Toben – Thank you Mr. Chairman, thank you Dr. Jackson. Very much appreciate your comments. I appreciate you bringing up the analogy to the tobacco industry as well. My first job after graduate school was with RJ Reynolds Tobacco Company. And I spent several years there in the 80's at a time when we were being sued by folks in most states and each of those trials we would parade out the same small handful of scientists to question, to cause a relationship between cigarette smoking and lung cancer and we got away with that for about 20 years and it's come home to roost. I hope we will not do that in this case. In looking at the data from IPCC, the osterobodies that you bring to bear, IPCC, the National Academy of Sciences, the American Geophysical Union, the American Geological Society, agree that human activity is having an impact certainly on increases in CO_2. The data that I've seen are putting 7-10 gigatons of carbon in the atmosphere but you know that growing with China and India. My question is to the point of the first speaker this morning, why would North Carolina institute policy change that would agreeable have modest impact on the global picture. Any why have countries signed on to Kyoto protocol that are smaller than North Carolina? And why have municipalities signed the mayor's climate protection act when clearly their individual

cities and towns are going to have little impact on this problem? Can you just speculate about that please?

Dr. Jackson – Yes, that a difficult issue. But first of all, the atmosphere is a sense of tragedy of the commas, right. I can dump what I want in my spot of the atmosphere and it goes everywhere and mixes around. That's one of the fundamental problems with this issue, our pollution doesn't just stay in North Carolina and other people's pollution comes here. But pollution I'm using that liberally to include carbon dioxide in this case and other greenhouse gases. So why should we use anything, we've heard earlier today about, so all this talk about greenhouse gases in 2005 was the largest emissions internationally for the world ever. Go back to that diet analogy, I'm 100 pounds overweight, the first couple, the first five pounds may not save my life, but I've got to take that first step. Now North Carolina, if you look at internationally, I believe is about 20^{th} or 25^{th}, if you looked at North Carolina as a country, we would be about 20^{th} or 25^{th} in terms of CO_2 emissions. So we're pretty big, first of all. I think there are two reasons that people are acting, one of them is because I think I have a fundamental trust in people. I'm an optimist by nature and I think people see this as is an issue that we've got to tackle one way or another and we want to do this in a way that not only does not cost us a lot of money, but can save us money and improve our environment and that takes me to my second point. People who are acting on this issue see the connections across the environment. It's not just about global warming. It's about everything, it's about our waste, it's about what we pay to the federal government if we have ozone concentrations that are too high, it's about the link between pollution and lung cancer, emphemeza, bronchitis, stroke that don't factor into the cost of coal and other forms of energy that we use. I'm not here to criticize energy companies, tobacco companies or anybody else here. I am a strong advocate that without private industry getting involved with the very early on we will not accomplish anything in this. So the reason I think the countries are acting on this is because they see this as an opportunity. They see this as a way of transforming our environment, transforming the way we use energy, the amount of money that leaves North Carolina because we have to buy energy from someone else. We ought to be looking at conservation, renewables, all kinds of other approaches. They see this as an opportunity and we're going to be left behind.

Senator Pittenger – Mr. Chair I would just like to clarify. I gave some statistics when I was talking about the cost related to implementation. The cost on higher energy cost to the consumer is 2.3 billion not million.

Mr. Glasser – Mr. Chairman thank you. Mr. Jackson thank you for being with us today and I appreciate Dr. Eggers comments regarding our children's children. My question to you on the graph that talked about the next thousand years, did you state that regardless of what action we put in place today, that the earth's temperature would not stabilize for the next 100 to 300 years?

Dr. Jackson – Did I state that the earth's temperature would not stabilize for the next 100 to 300 years? I believe that's accurate, yes.

Mr. Glasser – Does that mean that it's a waste of time?

Dr. Jackson – I don't think so, it just means that this is how the earth's system works. There are these factors that come in to play. We talked about two of them, ocean level and such, they take a long time to play out. So what that means to me is that it's going to take 100 to 300 years to stabilize the earth's temperature. If we could stabilize CO_2, not emissions but concentration today, it's going to take a couple hundred years for a lot of things to come to equilibrium and 1000 years or more for many other things to come to equilibrium. For me the take home message to that is we got to get to work. But I believe that is correct, yes.

Mr. Everett – Rob, I have a couple of questions and I'm not sure who best can answer them, maybe some of the other speakers as well. But when you look at your seventh figure, I'm interested in everybody's opinion on what made those graphs go up, historically, almost vertically. Temperature.

Dr. Jackson – Someone stop me when I get there. This one?

Mr. Everett – Yes, what makes those graphs go vertically when they go vertical historically and to be consistent with kind of what you're saying at a point where those CO_2 levels reached their zenith in the past, did sea level continue to rise for several hundred years beyond that?

Dr. Jackson – Let me try to keep track on that. I think two questions there. So one of the things you notice about this figure is that the warming and the cooling isn't even, right? There's a dramatic drop off, a dramatic cooling at times, a dramatic warming as we come out of an ice age, and the answer as to what triggers that, nobody knows. We don't know what triggers that. The person who figures that out will be a famous earth scientist. There are a lot of people working on this today, we don't know the answer. We are not sure that it's CO_2, no one can answer the question. Does CO_2 rise first dramatically and then by the earth's temperature? We don't have the resolution to suggest that. So all we know is that this is a correlation, this is not a causable relationship. So I think one thing to notice is that there is an abrupt change and then the second part of your question, George what was that one?

Mr. Everett – So what happens when CO_2 levels get to the peak and if you're following sea level rise at the same time, you know, essentially if there is this close connection you would think that the sea level would continue to rise beyond that peak in CO_2 level, is that what the data might show? I just don't know.

Dr. Jackson – Yes, I'm not certain, but I think the thing to keep in mind here is that this is a five hundred thousand year time scale with where each of those data points might be, a thousand or couple of thousand years apart at least. And that the sea level rise we're talking about, centuries maybe two thousand years, I'm not sure that the resolution is there to be able to answer that. I would refer that question to Dr. Riggs.

Dr. Riggs – Coming out of these glacial events seems to be very traumatic compared to going in them. In every one it's this way.

Dr. Jackson – There's a lot we don't know about the earth's system. This was an exciting time to be earth system scientist, but there's a lot we do know too.

Mr. Garrou – Other questions? Mr. Shore.

Mr. Shore – I have a data question and I certainly endorse or support your point about us looking at this issue in terms of opportunity and that could be a lesson for this Commission as we go forward. My data question, could you go forward one slide and I'm comparing this to data that was presented by the first presenter and also I think replicated in the John Locke information that has the graph over the last 10,000 years of temperature and this graph, although there is no source in the document which shows the medieval warm period roughly seeming to be to the same magnitude of the temperature today, which is very different from what is shown on the one on the screen. So are you able to reconcile the difference, what's going on here and are you familiar with this other presentation of the data?

Dr. Jackson – I don't know if that presentation comes from perhaps the 2003 McIntyre manuscript, I'm not sure to be honest with you. Let me take some guesses and Robert might be able to make some comments too. I think one of the reasons to encourage people to pay attention to what comes out, is because each of these analyses are based on a different proxy that we call them and by proxy, what I mean is we don't have a temperature, we don't have a thermometer out there measuring the earth's temperature 1000 years ago, we didn't have one. So we have to figure a way to infer what the temperature was. I referred to a couple of these, tree ring growth might be one of them, tree ring width, coral growth is another one, different isotopics signatures. There are a whole host of proxy records to use to try to construct these. So one possible answer to that is that it used a different set of proxies to determine what the range of temperature was. Another possibility that I've already referred to is that it used a different statistical approach to analyzing those. I am not sure without having the exact paper, but all those things come into play. What are, let me finish and I'll turn it to Robert, one of the things that's important here, this is not about one paper, it cannot be about one paper. The way science works, as we all know, and the other speakers have talked about is not just one paper, it's hundreds of papers. It's what all the data says together tell us. Not just picking out one particular one, be like trying to say something about a recession in North Carolina, by picking out a couple of households and saying well this household their income's gone up 20 percent this year and their spending is up, so there's no recession. It doesn't tell us what's going on with the economy, you get as much data as you can and you look at it together. That's what these new approaches are trying to do. So I would guess it's a combination of which proxies were used and what analysis were used. And Robert might comment.

Dr. Balling – I want to clear that up, the graph comes from a series of papers by Dansgaurd et al. and from a paper by Shonezieci. It was interesting today that when Dr.

Riggs spoke, he showed proxy records from the barrier islands. If you recall, the medieval warm period and the little ice age was painfully obvious in everything that he showed. And so he would add to the mountain of evidence that this is a very real phenomenal and certainly a real phenomenal that affected North Carolina.

Dr. Riggs – I agree with that, I would not say the medieval warm period and the little ice age are quite obvious on these graphs too. They're there. They're obvious, so I agree with Robert.

Mr. Garrou – Other questions? If not, thank you for listening. We will have a break for lunch now and we need to start promptly at 1:30.

Afternoon Meeting

Mr. Garrou – Mr. Givens is going to tell us a little bit about the handouts that you received.

Mr. Givens – I just note for the record Mr. Chairman that three items were distributed to you, the slides from Dr. Ballings' presentation (**Exhibit K**) also a one page sheet entitled Global Warming and North Carolina (**Exhibit L**) from Senator Pittenger and then material entitled Global Warming Is Real (**Exhibit M**) and that's from Commissioner Smith.

Dr. Smith – Can I just respond? There's a couple other things in there also, the first is a Scientific America article talking about global warming, towards the back you'll see a handout that was done by a scientist for us on sea level rise, it basically talks about some of the more recent papers that have come out, about some of the relationships on sea level rise and the last is just an article about the rapid ice melting that we're seeing which is somewhat unprecedented, at least in recent time. There's not just that one article, there are a couple of things towards the back that I would draw your attention to.

Mr. Garrou – Ok. Thank you. Our next presentation will come from Sethau Raman, the state climatologist and we welcome you sir.

Dr. Raman – Good afternoon, I hope you all had a good lunch and it is really a great pleasure to be here. I'm thankful for the opportunity. (Handout **Exhibit N**) The climate comes in various scales as some of the speakers have pointed out. There is a global scale, then there is the regional scale and there is the masial scale and here is a micro scale. Basically, most of the information on weather you get on TV channels or anywhere else is of micro scale. What is happening to (inaudible) air temperature? Then you have this middle scale where you have how the temperature or the precipitation, these are the two (inaudible) together weighing in on a masial scale which is of upward of 100 to 200 kilometers. This is more like sea breeze circulation. And in North Carolina, we also have this famous Sand Hills circulation which has to do with the changing soil types and soil moisture and vegetation. And then we have this regional circulation which brings in the storms of different kinds, the tropical, (inaudible), with latitude mixed with tropical

storms. And then there is this global change where we can average them all out and then try to find out the temperature change. So this afternoon I'm just going to address the regional change and the local change in the climate in North Carolina. That is the scale I will be talking about and hopefully call this presentation Climate Radiation, not calling it a climate change. So these are basically climate variations and I'm not going to talk much about the hurricanes, some people ask me are your going to talk about hurricanes, the hurricanes, the intensity as well as the frequency. We have done some research on the web site, but I'm going to mostly talk about the temperature and the precipitation trend in North Carolina.

To begin with let's just figure out whether we can wash the cars or water the lawns in the next few days and the conditions right now are related to drought conditions. This is based on input from State Climate Office and North Carolina Drought Management Advisory Council on which we are a part of. And as you can see we're basically here, so we are in the moderate drought. We're already four to five inches behind normal since January 1st and the other places are basically abnormally dry over the coastal area and even the mountains, they had so much precipitation last summer, haven't had much in the past two months as you know. So as the climate changes one of the things people have to worry about is the drought. Drought is something that creeps in before you know it's already there, unlike flash floods, which we know that it is coming and it goes in a flash, whereas the drought slowly sits in. So this is the latest drought condition I thought I should inform you coming from the State Climate Office of North Carolina.

The things I would like to talk about this afternoon is I want to give a brief introduction of what the State Climate Office of North Carolina is and what it does in addition to the climate information that we provide. And then I want to give you a brief presentation on North Carolina Teleconnections. Something happening somewhere affects North Carolina, and how does that happen and what are the findings? And then I'm going to show you a few slides on observing North Carolina's climate, which is our main job. Our focus is North Carolina and then I'll show you some results on short term trends in North Carolina that we've already done and also longer term North Carolina climate trends. Short term is more like 50 years, longer term is in the order of 100 years.

So then I'll begin with a summary slide. See North Carolina has a beautiful climate, in fact that's one of the reasons why I came here. I lived in Long Island for ten years and I had an offer from New York University and North Carolina State University. And the first thing I looked at was what the North Carolina climate is like? In fact this is the information we provide for many industries that come to North Carolina. And they look at different things and once they see our climate, they always want to come here. Such a beautiful climate, you want the cool temperatures in the summer, go to the mountains, or go to the ocean, or if you like hot and humid weather climate, stay in the Piedmont. So we have all kinds of weather climate across North Carolina. And we are blessed with very good rainfall, ranging from 100 inches over here, if you really want a lot of rainfall, 100 inches over there and about 40 inches over here, and some of you haven't seen much in the past few months. But the temperature is also beautiful, so we have a very beautiful climate and we want to hang on to it if we can, when we can, sometimes it is beyond our

control, so that's our climate. The State Climate Office of North Carolina is a public service center for climate environment interactions and these are the staff and students who work there and also I wear three hats. I teach in our department, Meteorology and Oceanography students and I do research and I'm also involved in extension and research. And we have a bit of a interaction with the Department of Geography, UNC Chapel Hill, contrary to the news, we do work with Chapel Hill people. Then, (inaudible) Board Associates Climatologist and I have several people that work with them and our major strength is in terms of graduate students and undergraduate students who work with us. So we have research projects and undergraduates sort of help us with many projects and in the process learn many things too. The history of the State Climate Office was established in 1976 when the National Weather Service decided not to be involved with climate type of forecast for agriculture and there is one in each state. Most of the 50 states have one, maybe one or two don't. And then it started in Chapel Hill, transferred to N.C. State in 1980 and then Dr. Davis and I have had the privilege of being the state climatologist since 1996. And October 1998 it became a public service center that was established by the UNC President and UNC Board of Governors. And today, this is what people say, we are the number two climate office in the US out of the 50 state climate offices, number one is Oklahoma. We are very well funded.

Our mission is to provide the most accurate climate information to the citizens of North Carolina and we also assist North Carolina state agencies in climate, environment issues and other obligations. We also establish and maintain several automated weather stations across North Carolina with a system of applications such as agricultural and environment. And we also try to increase public awareness of North Carolina climate, by going into different communities, (inaudible), schools and others. And we also do some research that is essentially related to North Carolina weather and climate. In education we start all the way from kids age 12, and undergraduate and graduate students are already mentioned.

The summer belt regions we do agricultural research, based on the data we collect, we provide advisories for crop management and we have a real time high resolution weather model for agriculture. In terms of modeling, I have done, in the past 30 years, modeling of micro scale, masical scale. I'm not a global modellist, but some of the ideas that we have in this scale are agreeable to global modeling as well. Then we do partner with state agencies for example in 2002, we connected with (inaudible) in cooperation with the Division of Water Resources and then there was a drought buster team that was formed, maybe because of that the drought ended a few months later. In 2002 we had a major drought and we worked with DNER, the air quality people, and we installed and maintained sensors, needed by the Division of Air Quality, particularly along the mountains and western North Carolina to kind of keep track of what's coming into the state, I guess. And of course we have help to save millions of dollars in federal transportation funds with providing important data. And we work with the DNER Water Resources, as I mentioned, we had an adult monitoring concept and also we are now putting together a comprehensive water resource data base where you can get everything in one place. It's almost ready. And we work with the Department of Transportation, so they need to know where it rains too much so that they work with the construction

people, to build construction, so we clearly need a web site for them. And we work with private agencies, private companies like Duke Power. We just put together and drew a drought climbing system for Catawba basin for Duke Power. And we are also working with North Carolina Electric Cooperatives to provide more automated weather stations, but here it's a site sub-station we're doing.

In education, we teach undergraduate and graduate students, but we also work with kids through 12th grade. As you can see here, these are 7th graders and 8th graders, Brad Stackhouse, Rob Collins and Alex Vall and Melissa Gregory. And they did a study on global warming and urban heating just last semester. They are just finishing it up and in fact, their project won the (CNCMS) City Neal Campus Middle School 2006 Science Fair first place. And last year the group that worked with the climate office went all the way to the state level.

Now some of the research findings we see if the climate warms and the sea surface temperature changes somewhere else, is that going to affect North Carolina? It is a critical question and the global telecommunications or teleconnections, as we call it, for example, the sea surface temperature warming up in the eastern Pacific due to El Nino/ Non El Nino cycle and it called El Nino/Southern Oscillation. We try to find if there is a warming of sea surface temperature, what will it do to North Carolina's weather and climate and based on almost 50 years of data, with many El Nino imbedded in them, they come every two to seven years. And in fact, in terms of climate prediction on a real time basis, that probably has the best signal possible. In terms of saying with assurance, saying with confidence, what will happen to the weather in the next season. First thing the people look at is whether that is an El Nino or Non El Nino or is it neutral. Right now we are in a Non El Nino phase. So for example, if you are having an El Nino what happens is in winter storms, there are a lot more winter storms, like an El Nino year, typically you can get 10 to 12. But as a Non El Nino year in the winter, you get like five. So we have major flash floods in the mountains during the last El Nino which was 1997-1998. And so this is again based on 100 years of data so basically what you see is the coastal different participation increases and then in the summer, which is June, July, August, there is a decrease in the precipitation and again during the winter the precipitation starts increasing, both for coastal, piedmont and mountain all three of them, so we have an increased precipitation in winter and decreased precipitation in summer. One of the reasons, of course, is when you have an El Nino, you have a strong year over north Atlantic and so the number of hurricanes reduces drastically. And some of the precipitation we get in the summer is due to the hurricanes making land fall either directly on the coast or as we call back door hurricanes, that make land fall from the Gulf of Mexico and then track toward the mountain region.

Then we also find that when you have an El Nino type of event in the winter you get cooler than normal temperatures and warmer than normal temperatures in the summer. In fact, during the 1997-98 El Nino, we had a fairly big drought type of situation. In fact, the one that we had at the time, declared emergency for all 50 counties, and then came hurricane Bonnie once the El Nino weakened in late August. And then we got some much wanted precipitation.

Now one of our missions is to observe North Carolina climate. The day in and day out we are looking at the climate of North Carolina. And of course, what is climate? Yesterday's weather is today's climate, so we observe weather as well as climate. So if you go our web site, we have several stations, actually 100 stations in North Carolina where you can get the previous hour's weather immediately. And then it goes into a climate data base and becomes a climadata. So we have basically more than 1000 active stations and these are, some are obsolete, some are just babies. So they have maximum temperature, minimum temperature and the accumulated precipitation for 24 hours. So this is more than 1000 stations in North Carolina. But hourly data we have only 200 sites and some of them are our own and some of them are National Weather Service, some of them are FAM municipal Air Force stations and so they all have different types of data. But others have the most comprehensive which we call the NC ECONet, that's the North Carolina Environment and Climate Observing Network, which we started a few years back. We have data for about seven or eight years now and it is continuing. We have 28 stations across North Carolina that includes five that is supported by a Division of Air Quality, and one by Emergency Management, but we are maintaining it and several university stations. So there are about 28, we hope to go to 30 pretty soon. These are all new stations and our idea is to eventually have one in each county so that our 100 data observing stations, which not only gives all the routine meteorological data, but also soil temperatures, soil moisture which is very, very important for weather forecasting, agricultural management and many other things, so this is all from all these stations. Look this is a ten meter automated weather station sending permission every hour on the hour to the State Climate Office where we do quite a bit of (inaudible) and put it on the site for public use.

Now the short term variations I wanted to talk to you about, this is one of the MS thesis topics of one of my graduate students, who is now my lead (inaudible), so where he took the 50 stations of precipitation and temperature across North Carolina and looked at how the temperature varied and how the precipitation varied over this 50 year period and then plotted contour curve. What you see here was done 50 years up to 1998, 48-98. And what we see from that, the maximum temperature trends shows the pin point 0 to 5, to defined .05 degrees Fahrenheit, apparently along the course and then there are also some areas which are cooling in those 50 years. So there is some warming along the coast and there is some cooling in the middle. And the precipitation trends again there is a deficit in precipitation in the northern coastal part and an increase in the southern part. And what we found is not enough data points here to be really confident about this tremendous increase in precipitation here. But there are precipitation trends across North Carolina of varying degrees. But this is only 50 years and so one of the main problems we have in climate data analysis is we do not have enough data. We do not have enough observation and so many times the article will have proxy type of observations, tree rings and ice cores and things like that. And they have their own assumptions and so there's nothing like actually observing what it is. This analysis I'm going to show you is from what is called the Historical Climate Network. We have only five of those stations in North Carolina. They go back 100 years, so they have data for 100 years and believe me those people who have been collecting data, these are corporately observers, they are

really within (inaudible). They don't care if it rains or snows, they will go collect the data. And we have some others archived, hand written data, meticulously recorded and those folks of our forefathers, I think they really loved bringing in this stuff than me for example. I won't say than you, but than me. They are really, really, really meticulous in collecting the data. And so this data is pretty good and these have been quality controlled by the National Climatic Data Center and that's what I'm going to show you next.

We just picked randomly some stations along the coast like Elizabeth City, Goldsboro, Southport and some stations along the piedmont region, which is like Henderson, Chapel Hill, and Monroe and then we also picked up three along the mountains, Banner Elk, Lenoir, and Waynesville. And these have 100 years of unbroken data, a few solid years, some more, some a little less. I'm just going to show you how the temperature has been varying over some of these stations and we need to do all 25 stations to be more systematic. But I will show you what I have.

And this is the coastal, Elizabeth City, this shows a mean temperature over 100 years from 1911 - 2001, this is more like 90 years, and the trend line you can see there is a lot of variation. You do have the North Carolina weather and climate response to many things that were mentioned before, one is the El Nino/Non El Nino and another is the Pacific (inaudible) oscillations, which is the change in the Pacific Ocean surface temperature over ten year cycles an El Nino/Non El Nino is just a sub-state of that. And we also have north Atlantic oscillations in temperatures changing them we have these 20 year oscillation in the preseason temperature because of the currents changing over the north Atlantic. So you can see some of these things happening there, but there is a trend at least in this data, as 3.17 degrees over 100 years. And we looked at the precipitation for the same 100 years, not much change. The weather rarely changed over 2.3 inches degrees over 100 years. And later I'll show you which variation one can believe based on statistics because we have to make sure they are statistically significant. And there is also another issue in many of these things, one of the uncertainties in climate issue is the land use pattern. We did a study many years back, an undergraduate from Shaw University did it for us, we looked at Raleigh, for example, and then looked at the temperature how it varied before organization and after organization. There's quite a big change. So the land use is another area one has to be careful about in this analysis.

Now we go from the coastal area, I'm just showing only one station because of the time but I have data for other stations also. Chapel Hill, for example, over 100 years, 1892 to 1998, I think we are going up to 2002. So it's from 1892, it's almost more than 100 years, so you see the change of about only 1.16 degrees for over this much time. And we will see later on whether this is significant or not. And there will be data also looking at the maximum temperature that was the mean temperature. So you take the maximum temperature, take the minimum temperature take the average that's the mean temperature and the maximum temperature you don't see much of a change. You see the change is fairly flat. Then if you do the minimum temperature, then you do see some change, like 1.93 degrees over 100 years and again you see that these oscillations because of other features, larger scale features. Then precipitation, the thin line is basically quality control precipitation and we only made sure that there is not much of a difference between

quality control and the raw data, so that there is no artificial quality control injected into the data. And here you see about 4.1 inch degrees over 100 years, this is in the piedmont or Chapel Hill annual precipitation has decreased. There is a hint of decrease but there is also tremendous variations and then when we do the statistically significance we may see this to be not that significant, we'll see it later.

Then the winter precipitation is basically a small decrease, almost flat, and spring is almost flat 0.28 inch over several or 100 years. And the summer there is a significant decrease at least in terms of the number. This may not pass the statistical significance test, but again there is about five inch decrease over 100 years. But in fall there has been an increase that means probably because of more hurricanes coming through this region in the time period.

Then we looked at another station, Monroe because the location of that station is a little bit off the town of Monroe. So the land use is not a major issue in there and so there we find it's about two degrees increase over 100 years. In the mountains, very little change in terms of the temperatures 0.52 degree decrease over 100 years, it's almost flat, constant. Of course there was a change in precipitation about 2.79 inches, which again we found not to be statistically significant. If you have tremendous variations and then the straight line may not be statistically significant. So in terms of changes I have just summarized here the changes for example, the ones that are in red are big changes like 3.17 increase over 100 years, is probably the leading change and the rest are kind of changes somewhat, but not very significant.

The precipitation generally there is a decreasing trend over piedmont and not much on coastal area or the mountains. This is an important slide, well which ones can you believe, which ones may be don't have enough data, we cannot say for sure. These are correlation coefficients, we can see that the data that we showed there is a statistically significant change in Elizabeth City and Goldsboro in terms of temperature, mean temperature, and then again in the piedmont, Henderson and Monroe. We took 0.6 as being statistically significant considering the number of years only 100 years. And of course in the mountains there is not much of a change. In terms of precipitation, none of them passed the significant test, the temperature, at least some of them do. And again the maximum temperature none of them are statistically significant, the variations are too much. But in terms of minimum temperature, you see that much of the average temperature increase is because of the mean temperature increase. The minimum temperature increase can come in two ways. One is in terms of land use, more oscillation or another one in terms of the greenhouse gases. And that is still to be dissolved.

So in summary, one thing we are sure, even if we have warming of the globe in other areas and the sea surface temperature go up, we can have an effect in North Carolina. And that is mainly due to larger scale circulations, like this El Nino/La Nino proves beyond doubt. But this particular significant variation in North Carolina climate at some locations particularly in the minimum temperature and one thing for sure is we need to improve the density of climate observations in North Carolina for our future generations

and also for us to make sure that we covered all grounds. So this is not only climate or environmental issues for which these observations will be very helpful. Thank you.

Mr. Garrou – Thank you sir. Are there questions for Dr. Raman?

Representative Underhill – Thank you Mr. Chairman. I was wondering what budgetary requirement would be to put such a station in every county, how much would that cost?

Dr. Raman – Oklahoma is the real good role model in this. They have 110 stations and the state appropriation it's actually funded by the state. It is like 1.1 million dollars and we did a budget estimate on this, it's about six hundred thousand dollars to maintain in North Carolina because we have other funds to do the other one.

Senator Pettinger – Thank you Mr. Chairman. I thought the one slide, yes sir, is a very good presentation, but toward the end on the mean temperatures, my eyes aren't good enough to read this, if I recall correctly, the increase in Elizabeth City was about three degree and the Charlotte area it's about 0.5.

Dr. Raman – The Charlotte area which …

Senator Pettinger – The urban area was the variation was much less than the rural coastal. I think, yes that's the one right there. That's right Elizabeth City, coastal … It was just interested that the urban area had less of a change.

Mr. Garrou – Other questions? Yes sir.

Dr. Uzochukwu – Dr. Raman do you have any information about Greensboro. We experience droughts from time to time.

Dr. Raman – Yes we do, as I mentioned in the 100 year data, although the precipitation data was not statistically significant, basically toward a 90 percent confidence interval. Because of the tremendous variations, some years we get a lot of precipitation some years we get less precipitation. But the trend is clear it looks like there is a trend toward less precipitation, drought type of conditions in the piedmont over the past 100 years, we see that is contributed by decreasing some of the precipitation. So we have, for example in 2002 and again in 2004, a high pressure system that just sneaks on us. Again in 2005 there is this high pressure system that sneaks on us so it steals the hurricanes away from us, but it also prevents conductive rainfall, thunderstorms. So in fact, believe it or not, the summer is when we have the maximum precipitation of all the seasons. That is because of thunder storm activity. And then if you have a high pressure system sitting on it the thunder storm doesn't fall and that seems to be the reason for the piedmont. So there is a trend for decreasing rainfall although it is not statistically significant, goes back 100 years.

Dr. Urlaub – Looking at your data and that you have several places where the mean temperatures didn't statistically significant in its increase, I'm wondering why is it going

up, because what I've gathered from the various scientific presentations so far, and data presentations is that we've even had Dr. Balling acknowledge that the increase in CO_2 did an incredible increase that's unprecedented in the 450,000 years is anthropogenic in nature, primarily. And that increasing CO_2 acknowledged by all of our scientists can result in increasing temperature. And then also, where's that CO_2 coming from and we had one presentation that told us about 80 percent of it is coming from use of energy resources. So I'm trying to link up the pieces and what I'm seeing here is that we have scientist that people from the outside would say come from across the political spectrum and this issue has been heavily politicized over the years. And they're all telling me the same thing, what I'm hearing is that CO_2 is going up and that would drive temperatures to go up. They agree where CO_2 is generally coming from and that can do things like add a lot of energy into the oceans and raise the temperature of the oceans and add more energy in the atmosphere, and perhaps increase the propensity of the atmosphere that dissipates that energy. And it could manifest itself as more storms and more severe storms or both. If you could entertain a question for a minute, acknowledging all of that, what does this future look like, where is this temperature increase coming from and since our CO_2 concentration is so high and if we continue with our business as usual path, we have received indication that it could more than double in concentration in the atmosphere. Where are we headed with adding all of this energy into our oceans, are we looking at more ice storms because of more humidity off of the ocean, it's a lot of potential scenarios here that I'm curious about?

Dr. Raman – Yes. Often, I have shown how the temperatures have changed over the past 100 years in several places in North Carolina. The different variations in this presentation and others are we're looking at local, regional climates. And there has always been a problem of don't kill it from global models into regional scale, into local scale, because the scale is an issue that is quite complex. So the one aspect is the land use itself, land use changes can cause changes in temperature but this is not acknowledging that major slide where land use was the small portion and then climate modelers claim that the (inaudible) reason the modeling that the greenhouse gases are the major component of this whole thing. But in terms of climate there are a lot of unanswered questions one has to deal with. So there are two issues, the greenhouse gases can increase the variation that the air receives that could change the temperature. But how does it relate to local changes, this is a difficult question right now to answer. (Inaudible) is still trying to wrestle with it.

Dr. Urlaub – Can I follow up?

Mr. Garrou – Yes.

Dr. Urlaub – Then I just read an article in Scientific American yesterday and it was fascinating that these different teams of scientists have been able to trace the isotopic signature of CO_2 and they can say what has actually come from power plant emissions and what has not. And they're looking at the CO_2 in the atmosphere and in the soil and in the ocean. They found that in the Atlantic, especially in the north Atlantic, the concentration of CO_2 that they followed the signature back to from energy generations,

electricity generations and fuel combustion. What they found is that in the Atlantic it has penetrated to very deep depths of the ocean, which is significantly changing the pH of the ocean and then also the flow of the currents. So any significant change in the future flow of the currents coupled with an increase in temperature in the ocean surface temperature that we're seeing, how would you expect that to impact North Carolina climate?

Dr. Raman – First of all, I think it's probably sulfate particles that you're talking about not CO_2 we cannot find exactly from CO_2 where it comes from but most of the fossil fuels, they emit black carbon particles, in fact I was involved in an experiment called Indian Washington experiment in 1999, where we were trying to trace back where the pollution was coming from. This was from Indian sub-continent. So from the soot particles, one can say where it's coming from, then it has to be from other generations and things like that. So that's probably what they have looked at. But there is a change in the sea surface temperature at one part of the globe, it can affect another part. The El Nino/La Nino is a very good example of that. The next El Nino I can tell you, some confident meteorologist will never tell you, do forecast that confidently as you know. But I can tell you El Nino will cause more precipitation in North Carolina in the winter. That much we know for sure.

Dr. Urlaub – But specifically I was asking about the Atlantic temperature off of hard coast, the temperature rise there, what kind of impacts do you see there?

Dr. Raman – In fact, I'm not showing it, we have looked at the precipitation distribution over Fayetteville over the past 50 years, and you see the detail oscillations because of the north Atlantic oscillation. North Atlantic temperatures do change some of the circulations. But mostly the Pacific Ocean is what we are concerned about because that's where most of the air masses come from.

Senator Pittenger – Thank you Mr. Chairman. I would just like to clarify, with due respect to the previous comment, I believe I understood that our first two speakers, Dr. Riggs and Dr. Balling, to state that there is no correlation between increased CO_2 and the climate change caused by human activities and that increased CO_2 was due to natural causes. Dr. Riggs stated that CO_2 levels in the atmosphere changed dramatically over the last tens of thousands of years.

Mr. Cecich – I thought specifically asked the question, did he correlate CO_2 increases with temperature and he said absolutely. He's not here now I take it. So I ask that question directly.

Senator Pittenger – Who's he?

Mr. Cecich – I thought the response was that yes, there was definitely a relationship. Our first speaker Dr. Balling from Oklahoma.

Senator Pittenger – I had lunch with Dr. Balling today and I can assure you he did not say that.

Mr. Cecich – I thought I heard, well we'll have to ask the other people, but that was the specific question that I asked him.

Senator Pittenger – I can get a written statement from him for you.

Mr. Garrou – We have a record of what your question was and what he said and we'll look it up. Any other questions? Thank you very much Professor. To remind you at the last meeting we determined that we would have a report each meeting from the Climate Action Plan Advisory Group of DNER and Brock Nicholson will give us that report now so that we can keep up with what they're doing as they're working in parallel to what we're doing.

Mr. Nicholson – Thank you Mr. Chairman. (Handout **Exhibit O**) What I would like to briefly do today is in this report just give you a quick review of the CAPAG, Climate Action Plan Work Group Process, very briefly. The report on our first meeting was held on February 16th. Share with you a list of members and then talk a little bit more about the work group process that we have set up and commenced, at least initially commenced. We haven't really had any first meetings yet, but I'll tell you about that and which work groups are set up and the members at this time. And then how the CAPAG and these technical work groups can help this Commission. I'll talk about that a little bit and just briefly share with you some of the emissions inventory results that were prepared actually by DNER and DOT with the assistance of consultants for our report that was submitted to the Legislature in September. This is an emissions zone, greenhouse gases both in a base year and projected. And then give you a little insight on some discussion that occurred at that first meeting regarding perhaps options to consider for policy and other mitigation options.

The purpose and goals in the CAPAG and again I hope I've sufficiently defined these acronyms, but I assume this term will take on a life of its own. But basically the charge is to develop climate action plan recommendations. And this will be a range of individual policy actions or mitigation actions. We will look particularly at the cost and benefits of these proposed actions or recommended actions and especially on economics, we want to understand the co-benefits that such an action may have for various industry sectors in North Carolina. We do believe there are plenty of opportunities for there to be positive economic benefits for various sectors, particularly the forest products industry. Across its whole range of activities, agricultural industry as well as general business and industry in terms of saving energy, quite frankly, the various measures that could be considered here. So we think it's not just a one way cost kind of issue for the benefit of the environment and reducing greenhouse gases. Certainly, that's a goal we want to achieve but we think there are also economic benefits to society to include even increased jobs in various sectors, maybe creating new industries. And part of our analyses will attempt to quantify those expected benefits including jobs.

It is a consensus, state cola process, one of the advantages we see in this effort is that we have all of the parties around the table at the same time considering these options and

doing a give and take and understanding what we really need to do in terms of analysis on these various options and the part of the advisory group is to give guidance to us and the consultants on what we need to do in terms of analyses. And certainly, last but not least to support this Legislative Commission in what you feel are important technical questions.

Again, I mentioned this is a facilitated state cola process it is consensus based decision criteria including greenhouse gas reduction potential, cost effectiveness, co-benefits and cost, like I just mentioned, feasibility issues. Is it a great blue sky idea or is it really practical and feasible? And of course again, I emphasize the economic analyses that we will do in this process.

I think I presented this last time, sort of a ten step process. The red indicates some of the activities that have already begun here. I will not read down through this, it's in your notes and hopefully not too fine a print. But basically, it's to again consider all the possible options, everybody has an equal opportunity to put options on the table at the outset and we will evaluate those, go through a process and hopefully come to some consensus on the configuration and recommendation.

The first meeting was really kind of a get together and welcome for the get started meeting. We did cover the Clean Smokestacks Act report findings and recommendations, we did talk about this process that's occurring by this body and we reviewed some of the history of state climate actions around the country. We talked about our process, settled in on that, we talked a little bit about emissions inventory and we did just go around the table and look at some suggestions that people might have on what we should be looking at or how we might begin to analyze those possible actions. And we did form the technical work groups solicited indications of interest for the technical work groups and we had some limited public input at that meeting also.

The members are from many diverse backgrounds including several from this Commission. In fact, I think my count recently is about nine or ten members from this body are also on the advisory group or on a technical committee, maybe not on the advisory group itself and we're pretty flexible about that. And I'll recommend you look at the list on the back side of the handout here. On the left hand page are the members of the advisory group and then I'll talk about the work group a little bit later. Well I guess right here, actually.

The work groups that we have broken it into are by necessity, I guess as a practical matter you have to divide it up somehow and you need to have a meaningful number. But this is the break up that I think most any optional suggestion that might be offered, we'll fit it into one of these work groups and give it a fair consideration. But energy supply, power generation of all sorts, residential, commercial, industrial energy use, and industrial processes, and of course between those two, I guess it's every aspect of energy production and consumption at various options for maybe operating in a more efficient manner. Transportation and land use, certainly, fill a broad area there. Agriculture and

forestry options and then cross-cutting issues, are reporting, registry, outreach in education and so forth.

The members, these if you would, subcommittees of the Climate Action Plan Advisory Group, 40 plus members from many diverse backgrounds, includes again, several of the Commission members on this Commission. Open to others, and I might want to emphasize this point, if there are other members of this Commission that wish to participate on a work group, you are certainly welcome. We would really welcome that additional participation if you wish. And it also includes experts who are not necessarily the advisory panel members but can offer considerable technical resource. And I commend you to see the handout, I will make one note on the handout, we inadvertently included Mayor Pat McCory on here and we're yet to solicit his agreement to participate. So I apologize to him and anyone else that we should not have had on there, but I wanted to point that out. We would like to have his involvement, but we have not secured that yet. I might mention also that as far as the technical work group and maybe I'll give a slide that gets into this a little bit later, is that we have our consultant and various members of the technical team that will be handling each of the work groups as advisors, as leaders, as technical resources, also. And that's from the Climate Change Strategy Workgroup.

The role of the technical work groups is provide recommendations, certainly, identify potential mitigation, policy options, identify early priority options for analyses, obviously this is important at the outset of the process. A crash strong proposal option, including policy design and implementation methods, proven methods for cost benefit analysis, assist with data and analysis, identifying sources of data and so forth. Assist with evaluation of additional issues, such as co-benefits and detail cost break down, as needed. Identify and develop alternative approaches for policy options. Certainly people from different diverse perspectives may have a better way to do it so to speak or propose it and we want to hear that if it's time. And contribute to drafting language for the final report and options to be carried back to the Climate Action Policy, Common Action Plan Advisory Group itself.

The first meetings which we hope to kick off here in about another week and a half to two weeks by phone. Many of these meetings will be by conference call, by the way, to the technical workers. But certainly to review and expand the list of potential options, and I'll remind you that those options are contained both in what the climate consultant has actually provided for us on 250 potential measures taking the advantage of having the people stops around the country. Plus specifically what we had in our report to the Legislature in September and it's to review the emissions inventory and forecast which I'll share with you a little bit of a summary momentarily. And to review proposed technical work plan and meeting schedule for the particular group and prepare suggestions for the next meeting.

Support, again, facilitated from upwards of 15 climate center strategies members, the task force here, as well as state agency, technical folks and there are these five work groups as

I mentioned again. And I think I mentioned there being a facilitator and lead consultant for each member of the consulting team.

Now I want to go back to just touch on a little bit the section in the legislation for this Commission and point out that some of the ways that the Climate Action Plan Advisory Group and the technical work groups can support and have in a sense provided some base line information towards this Commission, it's contained in Section 5B, C, D and F. Note how we have perhaps already given you some starting point for your work.

First of all under "B" Actions Taken By Others to Address Global Warming – We have completed a compendium of existing state and regional actions on climate change in the US for the CAPAG and that is certainly available to this Commission. And under "C" An Examination of the Emissions of Greenhouse Gases – We did deliver a base inventory plus projections for two future years as part of the Clean Smokestacks Action requirement. "D" An Evaluation of the Economic Opportunities - and as I said already, we particularly want to focus on the economic opportunities here for these various options under this charge of this legislation. That's one of our primary tasks under this effort. The cost, certainly, will be analyzed as part of this effort. In specific language in the legislation, we talked about this Commission shall consider and integrate the findings of the Clean Smokestacks Act reports that we turned in and prepared in September. They were actually a series of three reports, the last and third being submitted this past September with a number of specific recommendations in it to be further considered. And I guess on that point in terms of the ruling advantage I see in both this body and the Climate Action Plan Advisory Group, is that the Advisory Group will really be focusing, maybe a little more narrowly than this body on those particular actions or mitigation measures that makes good sense for the state. And it's done it in kind of an environment of stake holders around the table at one time. So we have the advantage of, again, that give and take in sorting through those options and certainly this Commission has full advantage of the results of that dialogue, in particular with common members. I think you will certainly share that advantage of that stake holder give and take in that process.

Our economic sectors, I think we've sort of touched on this, again, our work groups are lined somewhere along these lines and intend to cover all aspects. And particularly under waste management down there I want to emphasize we want to look at options for dealing with our immense amounts of bio-waste that we have in the state and potential for alternative fuels that can provide for North Carolina. We also have good greenhouse gas reduction benefits. Policy mechanisms, again, just as a review, recommendations could take the form of voluntary agreements, technical assistance, information and education, that's a very important one. People understand what they can do, financial incentives is probably a big one here. They don't all have to be regulations or laws or requirements with them being laid out options that make good sense from an economic incentive standpoint. The codes and standards for energy efficiency, maybe we really need to look at what codes we have and maybe where we need to fill in a little bit there. Again, market based approaches, reporting and registries, which we think is a very important aspect down the road, especially if we get to our carbon market concept where

people that take actions to help sequester carbon, really can get paid for that. I mean there is value in taking those actions, and then certainly others.

I don't know how clear this is to you, but it just gives you a quick snap shot of the percentages of where greenhouse gases come from in North Carolina versus the US. You can see electricity is a pretty big one. Transportation is a very large one at 29 percent in North Carolina. Industry wise we're a little bit less than the national US average. But electricity use and transportation together, you can see in North Carolina is 70 percent by the label up there versus about 58 in the national total. And then in terms of trends for the future up to 2020, you can see some of the sectors are, I don't know how clear it is in your handout, but the electricity again is the top one, the big one up there. And in this particular calculation, the narrow yellow line is electricity imports, so in this calculation, we do account for activity in North Carolina that demands electricity even though it's produced outside as a net electricity import in North Carolina. Then residential/commercial institutional is sort of the purple one, that's not insignificant so you can see where codes might come into play there. And transportation gasoline is the darker, sort of purple I guess, below the violet color and the diesel is the gray one below that and then they get a little bit smaller as we go down. Agriculture being near the bottom and waste management right on the bottom there, in terms of emissions of your greenhouse gases, in this case, it's the million metric tons of CO_2 equivalent, so it's other greenhouse gases that converted to CO_2 equivalent.

Well, I mentioned I was going to give you a little bit of feedback from some of the verbal suggestions when we kind of went around the room at our first meeting and it's sort of divided between policy ideas, and we like calling policy actions or mitigations measure ideas too, and then information request. I don't know that we want to spend the time going all the way down the list, but in terms of policy ideas, maybe touching on a few of them and again I hope you can read that in the fine print. Energy efficiency and conservation has got to be up there, renewable energy sources, again, nuclear power was mentioned. Environmental portfolio standard which was talked about much like a renewable portfolio standard except there more in depth broader than just production of electricity derived from certain renewable sources that includes credit for energy efficiency too from the extent it can be quantified. Our public benefits fund which are some terms perhaps you are familiar with, transportation controls, anti-idling technologies to save fuel again, a tremendous amount of diesel fuel is consumed in this country every year just by idling trucks.

Forest and agricultural carbon sequestration, I think that's an obvious one again. Forest health protection that was mentioned as something we need to pay attention to. Agricultural waste regeneration, recycling, market forces, the four regulations, make sure we get some desired results by looking at options for market and financial incentives to do it versus the regulation, kind of commanding control approach. Certainly education is a big one and the last suggestion here was link state action to regional and national policy options.

In terms of information request, ways of looking at some of the options, there were suggestions to use, what we call, full-life cycle analyses in terms of cost. Use best information and analytic resources, of course, we would want to do that. Examine how regulations effect greenhouse gas emissions. We're doing something in a regulatory context that just doesn't make sense in terms of preventing us from either getting the benefits of reduction of greenhouse gases or in itself is maybe creating more. Certainly, using a transparent means of examining benefits and cost of various policy options or action options touched on that already, we definitely want to emphasize that. And examine the cost to consumers who are producing greenhouse gas emissions with special attention to lower income sent to consumers. And understand that in natural systems, we need to insure quality of life and how to connect these to management of public and private lands, water bodies, military bases, etc. Examine the threat to disturbances to forest, and when we look at cost, ask cost to whom? Examine the win-win options, obviously, examine the regulatory barriers, somewhat akin to the one I mentioned earlier. Institutional barriers to greater energy efficiency especially are the things that we obviously need to consider in terms of (inaudible). Way of doing business that precludes getting maximum benefit to energy efficiency improvements. Ask how North Carolina can lead our cultural change towards a stable development, ask how do we educate the public about these issues, again the issue about education coming in here. How can we restructure our communities to better conserve resources and increase energy efficiency? Again, kind of touching a little bit on the land use area, examine trend toward conversion on agricultural land.

Schedule – we have our next meeting on May 15th here in Raleigh. There's a pretty good gap in time but we hope to get work groups and committees doing a good bit of work prior to the next meeting of the Clean Air or the Climate Action Plan Work Group. And we're really targeting a total of six meetings, so this will be our second of six in May and running through the spring of 07, probably June 07 is the general time frame. Certainly, the work product that we're looking for is a recommended climate action plan that will be presented to this body and to the legislature or as appropriate to the administration. So the summary here, I think I showed this slide last time, but I think it certainly describes pretty well what we feel like our process is here and we think it's one of the compliments that support the efforts of this Commission. Provides that sort of technical support to this Commission in the focus of looking at mitigation actions or policies as opposed to maybe some of the broader questions that you'll be facing here in this Commission. We sort of focus on that, provide that self service to this group too. Certainly emphasizing, economic boast to the state economy, including estimates of jobs, job gains to the extent we can do that. We'll certainly try to do that. And certainly, on going coordination with and reporting to this Commission. So with that I will be glad to answer any questions.

Mr. Garrou – Thank you Mr. Nicholson. Any questions?

Senator Pittenger – Thank you very much Mr. Chairman. Thank you for a good presentation. On the public benefits, that slide, if you could help me understand the transportation controls. What all do you mean by that?

Mr. Nicholson – Well, I think what I was reflecting there are comments that members had made, kind of going around the table and I don't know if I can correctly convey all of the thoughts that they had in mind. But certainly the broad question of since it's such a large part of our inventory, surely we need to look at possible things that could be done to look at reducing emissions from that sector, I hate to guess what some of the options could be, but I suppose they could range all the way from minimizing vehicle miles traveled through various programs, whether it be public education incentives, or even fuel economy in state vehicles, for example, or rather fleets in reducing the emissions from that sector. But I think it's the whole gimmick, I don't think we precluded or focused on any particular, narrow aspect of that now. It's any and all things that could be possibly considered in that sector.

Senator Pittenger – I would like to say I think there are a lot of excellent benefits to what some of your recommendations that are related to global climate change.

Mr. Nicholson – Right and I think that's what we want really try to draw out in this process is to understand those that just makes good sense and they're on right.

Ms. Tompkins – Mr. Nicholson are we to understand that the only states or regions that are in your compendium of the models we might look at, non of which seem to be in the southeast, is that correct? I'm looking at Appendix B in a book we got last month.

Mr. Nicholson – Well, you're probably speaking of the ones that have actually gone through a similar formal stake holder process that we're describing here, I presume.

Ms. Tompkins – Looking at the report of 2004.

Mr. Nicholson – Ok, 2004 – I'm trying to recall all that were in there, but I presume we were talking about (inaudible) Sound, Connecticut, Arizona, New Mexico and Pennsylvania and others. I don't think we're limiting ourselves, but certainly we referred to those specific processes and measures that have come up through those that we want to I guess take advantage of some thoughts that others have put into it. But, that's certainly not a limited list of potential measures for us to look at, by any means.

Ms. Tompkins – So can we understand that you will be looking at our regional and nearby states?

Mr. Nicholson – In terms of regional, one of the recommendations that we made as you recall, is for us to seek opportunities with our neighbors in this region. And we actually have initiated that process in a very informal manner so far with Georgia, South Carolina and Tennessee where we commenced calls with the air directors. And at this point and time, we are just discussing with them what we're doing, inviting them to kind of observe, if you would, and try to encourage them to look at doing similar things, especially with the question of registries and record keeping and doing those kinds of inventories. If there's a sense that to make that most meaningful, it can't be just one state doing it, kind of an isolation, it really ought to be done as a broad region if not really a

whole country. And so we'll be looking at those opportunities too. Tom Peterson, who is our consultant, I think, is going to help me with part of our response.

Mr. Peterson – I am Tom Peterson. I am the Executive Director of the Center for Climate Strategies and we've been invited to assist DNER with their process. The compendium of actions that is included in the CSA report and will be included in broader form for the DNER processes, it's based on actual state actions that have been undertaken in all 50 states and all sectors and across all different types of policy mechanisms. It includes actions that were taken directly to reduce greenhouse gases, but also includes actions that were not undertaken for that reason but have that as practical effect. So things that are coincidental in nature as well as things that were done deliberately to reduce greenhouse gas emissions, but any of that have the net effect of actually having reduced the emissions.

Mr. Garrou – Other questions of Mr. Nicholson? Thanks Tom. In the back.

Mr. Hanes – Thank you Mr. Chairman. My name is Matt Hanes, I work for Piedmont Natural Gas. Last week, the EPA issued a draft, Greenhouse Gas Emissions Inventory, for the entire United States. Has the Division of Air Quality had a chance to look at it and if so are they going to respond with any sort of comments?

Mr. Nicholson – Well I think the quick answer is no we have not had a chance to look at it. I think we want to look at it and then we'll decide what kind of response we need to give. We feel like our inventory is certainly more specific to the state and we'll certainly compare it with what EPA has compiled. I think the last point I would like to draw your attention to is this slide here which has our Division of Air Quality website on it, as well as a website that we've set up for this CAPAG process, http://www.ncclimatechange.us, so I recommend that you, they're linked together, can go directly to http://www.ncclimatechange.us, you will see essentially the report of each of the meetings, schedules and also once we start looking specifically at options, you'll see a lot of material on this site. It will be coming pretty quickly, so again I would recommend that and again I would solicit any interest by any of the members here that would like to participate. I know we have some that are and I think they're pretty enthusiastic so we would welcome any others who would like to help out on this part of the process.

Mr. Garrou – Thank you. As you will see that's the end of our formal agenda of presenters for today, but as we did last time, and I think we'll do in the future, I would like to open the floor for any discussion that the members would like to have for suggestions about future meetings and what not.

Senator Albertson – Thank you Mr. Chair, just a comment and a question, as a non-scientist, I of course have to rely on what the scientific community tells me when it comes to me having to make a decision about this issue, I know President Clinton, I've heard him say that global warming is taking place and I was reading an article that quoted President Bush at the GH Summit meeting in Glen Eagle, Scotland and I would like for staff to find out, in fact, if this is his quote. "I recognize that the surface of the earth is

warmer and that an increase in greenhouse gases causes by humans is contributing to the problem". I would just like to know if that is in fact a quote from him if someone can find out.

Dr. Crawford-Brown – On that issue I can say that is the quote, I was one of England's representatives at the GH meeting. I didn't vote for George Bush but well done, well done George. You will find that quote to be accurate. Doug Crawford-Brown. I like the presentations we've had today, I'm going to ask a question about when we'll move past those presentations for the following reason. I think there are two sins of uncertainty, one is the sin of hiding uncertainty and there are plenty of us on the environmental side that have hidden the uncertainty. A colleague of mine, Jim Hanson, sit up in congress one time and said, scientists should not be talking about the uncertainty of climate change. That it's going to play into political motives and boy I took him to task on that. There's only one thing as bad as hiding the uncertainty and that's hiding behind the uncertainty and I also want us as a committee not to do that. I think that it was nice to have Robert Balling here today, it was nice to have Robert Jackson here today, without being too controversial, I'll say I don't care what their opinion is, I don't care what the opinion of a scientist is, I care about what the opinion of science is and science has spoken through the National Academy of Sciences, through the American Association of Science and so forth. And that voice has been pretty clear, having said that though, I think the uncertainty is still pretty large and I would like for us to move past the uncertainty very quickly on this Commission but then always keep in mind that the policies that we adopt have got to be consistent with that level of uncertainty. My contention would be that uncertainty is pretty profound here, it certainly is large, larger than the uncertainty I deal with in any other environmental area. But I do want us to move pretty quickly over to asking questions like: What are we going to do now in the face of that uncertainty?

Mr. Garrou – Thank you. Mr. Toben.

Mr. Toben – I also am comfortable moving past the discussion about the uncertainties and agree that there are numerous ones. I am kind of moving to the point where it seems to me that whether it's another round of speakers or just a structural shift, that the questions of how far must we go in greenhouse gas emissions to reach this inflection point that folks are talking about, is the question that I would like to see discussed and, you know, to get to some point of understanding of, folks today said well Kyoto doesn't take us far enough. Well, what does take us, you know, far enough in order to at least begin to move that curve to hit that inflection point that folks are talking about. And then I think the other thing that I hear that folks are pretty much in agreement with is the question of how do we do that in a way that is basically net neutral to the state economy. I don't think there is anybody here that wants to slow down the economy or to depress the economy with these actions. But, you know, I read comments like the one from Paul Anderson from a year ago and these are industrial folks, these are folks that have clear vested interest in the outcomes of discussions like this and he stated in a speech on April 7, 2005, Paul Anderson of Duke Energy, "Global climate change is one of the most pressing issues of our time, few scientists disagree that the climate is changing, but there is much debate about it causing effect. Nevertheless, there is general agreement that

climate change is likely, being influenced by human activity and reducing greenhouse gas emissions has become a worldwide political and social imperative. It is an imperative where American leadership is not just needed, it is required. But it's clear to me now that we have to move to mandatory measures to get real results in a fair manner. Let me underscore an important point on global climate change, we have great faith in American innovation, demand needs to be less carbon intense that will spur the kind of technological innovation that we saw in the last century. Innovation that propelled us to become the world's leading economy. Set the right goals and Americans can and will lead the way." And then again from a company within our state here, ALCOA, has concluded in their positioning statement from 2005, that available evidence in the case of greenhouse gas emissions from human activities effect climate. We recognize the risk of significant climate changes and issues of vital importance requiring action and have committed to reducing our direct GHG emissions to 25 percent below 1990 baseline on a worldwide basis by 2010, but the potential significant additional reductions through major technology improvement. So my point in reading these two is just that, I think it would be useful to begin to move from the discussion of science, to a discussion of where we need to go and how we get there in a way that doesn't negatively impact the state.

Senator Pittenger – Mr. Chairman I would like to hear from some additional people, I have submitted three names to Mr. Givens, one from Harvard, one from MIT, and one from UPA. In fact, Dr. Vinson from MIT is a member of the National Academy of Sciences and I just think it's some good folks that have something to say to us before we make some decisions that could be a bit premature.

Senator Cowell – I think the move to work forward, I had submitted to both of you some ideas on how to break down into work groups and in terms of marrying some of the work that the, I forget what the name of the committee is, but Brock Nicholson reported parallel committee. If we could start breaking down into those groups on utilities and transportation and energy and maybe put science to as a separate work group, we could start moving at a more rapid pace and getting into some of the questions I think we all want to get to.

Mr. Garrou – Thank you, one of the things we do have to consider though is not to duplicate the effort of the DNER group. So we'll have to give some thought to how to tie the two things together. Thank you.

Dr. Crawford-Brown – I've got to respond to the idea of having more people come in. If the rules of engagement here are the one side brings in experts and then the other side brings in experts, like under the old Frye rules in court, we're going to be here all year long and the science skeptic side is going to run out of people way, way, way before we do on the other side of this issue. It's just isn't a contest in that regard, but the courts dealt with this ten years ago when they switched from the Frye rule to the Daulbert rules in science and said, look it's not an issue of whether you can get a scientist to support your position. Of course, you can do that on any issue, you can do that. The issue is how do those scientist stand in relation to the scientific bodies that have passed judgment on these issues. And again, we can do this all day long if we want to it will be the same set

of ten or eleven people who will come in on the science skeptic side. And I'll tell you as a scientist, I'm already a skeptic, you've already convinced me that uncertainty is massive in this regard.

Representative Wilkins – Mr. Chair I really didn't want to be recognized but since we're there you might as well hear from me. At some point everybody in this room is going to have to come to understand that whatever comes out of this Committee and becomes final action, it's going to have to be something that the senators and representatives can sell. If we can't see it to our colleagues, we might as well pack up and go home now.

Mr. Shore – So these are some comments on what our process could be to move from our science discussion to getting into the heart of the issues that the legislators might bring to their colleagues and so a couple of things crossed my mind. First, we have two input processes going on, one is that we are gathering information ourselves, the second is that the DNER process will provide some results to us and I think what might be helpful to start thinking about now and maybe have a discussion on during the next meeting, is what do we want the end process to look. So a year from now, we start wrapping up this work, what is it that we're delivering, are we pulling out five key recommendations, do we have a compendium of ideas that legislatures could choose from, do we have some common statement on the science, a whole ray of things. Where are the win-win opportunities, what will the carbon market place mean to North Carolina, what do we want the end result to look like and as we get a sense of that, then we can come back and figure out in the ten meetings or so, that we'll have, what needs to happen for us to get to a result. Senator Cowell mentioned subcommittee, if we were to have subcommittees, how would those be integrated with DNER's process already. So I would love to think more as a group what this process should look like.

Mr. Urlaub – Along the lines of the last few comments, I would like to say that I really would like to avoid another meeting like today. I think we've had two where we've had a lot of scientific information, a lot of duplication of even slides that were presented to us in the PowerPoint. What criteria do we want to apply here? I'm hearing statements from individuals, when we get away from the science presentations and discussion, people are sharing criteria with us, with each other here on how we want to evaluate the deliverable of this Commission. Perhaps we can have a discussion on what criteria we want to apply to our decision making process. Maybe we need some kind of filter for us all to run our discussion through. I've heard one, you know, economically cost neutral. I've heard another that we don't want to replicate other efforts. Generally, we've seen that there's this severe problem that's global and it's local and how much of a dent can we make in it, we've discussed that. Now what can we actually do and what basis do we want to make those decisions. I would really like to get to that. I think everyone's spoken their uncertainty. We've had some very convincing analogies on how uncertainty has been dealt with in the past on smoking and other issues. And we have to do right by our state economy. We have to continue growing economically and we have some serious decisions on the table we can address through climate change. So I look forward to moving on. Thank you.

Mr. Glasser – Let me suggest to everybody that everybody on this Commission comes to this issue from an entirely different place. There are some of you who have long since made up your mind about these issues based on a lot of information, a lot of reading, a lot of expertise. There are others in the Commission who are essentially new to the issue, so the decision as to how to proceed and how quickly to move to those things that all of us are interested in, has to be something of a comprise between those polar opposites.

Mr. Urlaub – Can I follow up? I would like to recommend a process that is more discussion oriented amongst the Commission members. I'm not hearing from a lot of Commission members and if they do feel that they're lacking knowledge, I would like to hear what remaining issues instead of saying I would like to hear it from scientist X, Y, and Z. Maybe I would like to better understand the issues X, Y, and Z and maybe we can go from there. I feel like a lot of these scientific issues that we've raised are ones that were resolved in the professional journals and through professional discourse in these various associations over the last seven to ten years. And I don't think all of us are PhD's in these fields and could resolve these ourselves. But we could have more discussion to figure out what we want to understand better.

Mr. Glasser – Mr. Chairperson, speaking from a businessman's point of view. I actually value the discussions both in the first meeting and today's meeting and it's interesting to hear the points that didn't come up in the first discussion that came up in the second discussion, and that is important for me to hear. The thing that's missing for me is I think the problem is readily determined and easy to understand. But what's missing and we've heard no conversation is, what's the economic cost to do anything about it. If there's anything that we should be discussing, is what's the economics of whatever plan we decide, and that conversation has been missing in the last two days. Other than a few conversations from Senator Pittenger, that's been the only comment about the economics of a fix. So if anything, I would suggest some discussion regarding the economics of anything we do decide. Thank you Mr. Chairman.

Dr. Eggers – I've had some frustration or concern about exploring uncertainty for a long time. I realize we come from different backgrounds in this room and that people have varying levels of expertise on the issue. There's a significant majority of scientists internationally on this planet who are coming to the table and basically saying approximately the same thing or agreeing to the same thing that they think global warming is real and a concern and I guess approximately next month the next IPCC report will come out and according to BBC last week, that report will contain language that is different from previous reports. Previous reports said that global warming either is happening or it's about to, we're not sure. And the report that's about to come out says we're seeing it now. So that will be kind of interesting, there's additional movement in that direction. We can bring in more people and more people and we can bring in three people who are skeptics and two people who aren't and I don't think it's a good use of our time to spend a lot of time on that. There's tremendous expertise and ability in this room that should, I think be used in other ways. Also, additional people will not change the fact the majority of scientists are weighing in on one side, and there is an increasingly

small minority on the other side. But I think a good analogy for folks who don't come out of the scientific community might be having a heart attack and we've all had not heart attacks, but we've had experiences where we've gone to doctors and gotten different opinions or perhaps a wrong opinion. And if a person has a heart attack they might say get ten opinions, let say eight or nine of those doctors say you should put in a stint. Then one doctor says what you need is goat's milk, you know. And then another doctor says go exercise and take aspirin and you'll be fine. Most people would really consider the fact that the vast majority of doctors are saying one thing and that's because we recognize the value of expertise in that area and it's the same here. So I would request to the co-chairs that you consider how we spend our time in the future, at least if there are more folks showing basically the same slides, that you also allow people to present ideas that could constructively contribute to us moving forward. Making recommendations that in the end really, you know, the legislature will decide whether they're acted on anyway.

Dr. Smith – Thank you. I want to go back to this concept of how we proceed and how we can keep the dialogue going but given that bringing everybody together, everybody's time is very valuable and we want to be as productive as possible, plus my understanding is that we'll be taking a very significant break during the legislative session. I like the idea of these committees. I don't anyway want to stifle the scientific discussion. I think it will be real positive, but much of it could happen at a subcommittee level where we do have some ongoing dialogue about the science and we could have, I think, agreements to disagree on certain points. To get to the point that the gentleman wanted to focus on economics, I think you're not going to be able to do that at a macro level, you're actually going to have to do it at a sector level to really begin to get the clarity and understanding because different responses and different potential opportunities are going to affect different sectors in different ways. And my sense from seeing the process that DNER has put together is that they made an attempt to break into some sectors and I would like to focus the conversation for a few minutes on how this group could interact with that. Because there are some of us that are serving in both capacities, I think there is a value in efficiency because much of the discussion that we will be having and struggling with here is going to be welded there and I know that I'm busy and I know that George over there at Duke Energy is busy, but we're both going to be wanting to focus in on some of the same points about the utility sector. And so I would like to understand how we might be able to interact more substantially and maybe ask Brock and the others there at DNER if, I take it there's an open invitation to participate, maybe this group can provide some guidance and charge that some of those subcommittees and see if we can work effectively together. Because I think that would be a vehicle that we can begin to dig into some of these economic questions and then be able to report back, based on not hearing it for the first time, but actually having formulated our thinking somewhat at the subcommittee level and then bringing subsistence work back to this group so that when we do get everybody together, we're not sort of randomly put together, but we're actually bringing together with a very sharp focus. But we can begin to narrow down on those points what we need to discuss at this level.

Mr. Garrou – As we consider this issue of the subcommittees I think it would be good if we could hear from you about (a) what subcommittees you think we should have and (b)

what subcommittees you might be interested in participating in, (c) how you think we could interface with DNER's efforts.

Dr. Smith – Well I think that the Senator mentioned earlier, I think clearly there is, from just looking at the break out of some of the pie charts, I mean we know that the utilities sector is going to be an area that we need to focus in on because of both it's contribution, potentially it is it's known contribution to the problem, and the fact that responses will have ripple effects through the economy, how we deal with that. We also know transportation is a significant sector that we need to address and then I think there is the opportunity and the impact associated with the industrial sector on some of the small business commercial sector. My understanding is that all three of those have been identified. There's also the Ag and forestry, which I think is both potentially impacted and potentially a winner in this in some of that. So I think those are four that I see significant overlapping that we should find ways to bridge very clearly. Now I would add, some of the comments about the science, that we ought to have a place where we can continue a robust scientific discussion and in no way to stifle it. I think a committee of those who want to engage and learn more and hear from various people might be a fifth potential option as opposed to spending 90 percent of these meetings, you know, sort of barreling back and forth. I think that we could probably crystallize some of the issues more effectively at a subcommittee level.

Senator Cowell – I think marrying some of the prothesis that some of the other states have done is not a negative but a benefit and that we can learn all of the things that they have produced, and really start on their shoulders and build from there. And I think Mr. Peterson, who was here earlier, his website, I think the breakdown by sector in addition to maybe having a science committee is pretty typical across the country from the websites I've looked at and I think that would be a good way to go.

Mr. Howard – Mr. Chairman like a lot of other people here, I'm coming at this from a not so educated perspective. I've been trying to education myself over the last couple of months. And I have a lot of respect for Dr. Crawford-Brown and what he just said. I don't disagree that the science as best I've been able to read is kind of unified around the global warming. The real question for me is that level of uncertainty and I'm trying to get my hands around that and I don't know what it is, I don't know how much to be concerned about it. But as we move forward to develop policies for our state, I want to understand what that level of uncertainty is and factor that into whatever policies that we ultimately adopt. Also, I am part of the work group that Brock and the Division of Air Quality has put together as are a number of other people sitting around this table. That group has already divided itself into some subgroups. I can't imagine that there's very much discussion that's going to take place at any one of those subgroup meeting, that I'm going to want to miss, I should say and I don't personally like the idea of separating this Commission into subgroups to study certain areas. I want to learn about the science, I want to understand science, I want to learn about what it's going to mean to the electricity sector because we're all going to have to pay for it. I want to know what it's going to mean to the manufacturers because that's who I represent. I want to know what it's going to mean to the residential home owner, because I am one. So I just want to

caution us not to in the interest of trying to satisfy those on the Commission who already are leap years ahead of me in their understanding of this issue, not to leave the rest of us behind.

Mr. Shore – I respect Preston's point at the same time that for us to be efficient, I think we need to figure out how we can best use our time as a committee and as individuals. This is a huge issue and if we are to try and eat the whole elephant at once, we will get no where. So I would encourage us to really think about what do we want this end product to look like, how do we divide up, how do we bring things back to the whole Commission so everybody has the benefit of the individual work. And also, since there are so many pieces, I don't know if there doesn't need to be some kind of steering committee or something, maybe the chairs and George Givens would do this work, but if there doesn't need to be some group that doesn't deal with the substance of the issues but here all these things are being farmed out to the various DNER committees, there might be other issues that this group decides to look into. How are all these things taken, integrated, made useful, made part of a whole.

Mr. Toben – One solution may be to pursue this parallel path of subcommittees and to report back at each full Commission meeting from each of those groups so that no party is excluded from the findings or the opportunity to question the subcommittees about their findings. It may very well be that in a scientific committee there would be a majority and a minority opinion that would come from the subcommittee process. But the discussion or the debate would not slow down the progress of any of the other subcommittees who might be able to generate ideas for mitigation measures in that meantime.

Dr. Smith – I want to respond. I think Preston makes a very good point. I think for a number of us there's a high degree of interest in participating in the number of different committees because I think that these things do ultimately intersect in many ways in our lives. But I actually would argue that subcommittees may actually be the best way to get your answers because you can focus in more ways in the subcommittees than trying to bring all the information and bounce it around in a one day process here. I think you can go deeper in a subcommittee to get answers to your questions and I think it gives you the opportunity, there's no limit to the number of subcommittees that people could participate in that they're interested in. So I would see that it actually gets you more to where you would want to go, I don't think there's any way that we need to break this or limit which ones people can participate in. The other question I would have is maybe we can ask Brock or his consultant to clarify how transparent the work that is going to be going on is, because I in no way want to encourage participation in some sort of subcommittee process that doesn't make everything completely transparent and immediately available to people if for some reason they are unable to participate so that we can understand. Because again, Michael's analogy is good, this is a very big elephant, I think we've got to break it into bite size pieces and my suggestions would be to think about how we do that.

Mr. Garrou – Mr. Nicholson you want to respond to that?

Mr. Nicholson – I do, first of all we are absolutely transparent and that's one of our program design features, certainly. We have everything on the web, all the meetings that are announced and really we have a provision for the public to observe and again, I want to emphasize that and invite anyone on this Commission to join the work groups. One of the real values we see in the work group is the way it is set up, and I know it's probably arguably a very burdensome way of doing it perhaps. But we think we have a very broad representation of all of the so called stake holders that have any interest in this, we will sit there all together in this public meeting and discuss the options: what needs to be done in terms of analyzing those options, directions to the consultant to help with that analysis, and what other sub-options or alternative options that anyone might have on that. And it goes through a process of voting, if necessary, but certainly a consensus based process on, if you would, designing that option and the right features and so forth. And that will be brought back here, so I would offer that as a very important value to the process and again we invite anyone in this group to help. Certainly, it might make sense for this Commission to have similar subcommittees. I think what we're offering is that sort of full service process if you would and maybe an option for the Commission is to utilize our DNER process subcommittees for those subject matters looking specifically at policy actions or mitigation measures, potential ones and then sorting through that process. And then those other subject areas, perhaps like the science that we're not going to focus on. Then maybe greater emphasis on this Commission for those kinds of committees, but I just offer that as a thought.

Senator Pittenger – Mr. Chairman your analysis I felt was good in terms of assessing where each of us are coming from. I feel like, respectively, that a lot of you represent organizations and you do so sincerely and with good intent. But you have a vantage point and in your advocates for significant change and policy that would address climate change. The others of us are still searching and this has been new to me. Since the day I got appointed I've been digging and reading and not that I don't have an opinion, but I'm still learning and I don't think having just two meetings to invite in some experts that we've over killed it. It maybe enough for you all, but I understand that, but I would welcome having some folks come in that are much smarter than me and say here's some facts you ought to consider.

Mr. Garrou – We've heard a lot good suggestions, and I say that sincerely, and not all of them are contradictory. So what I would suggest is those of you who made these suggestions, if you would email Mr. Givens and just sort of outline those so we'll get them in front of us. And then we'll synthesize all of this and I think we'll be able to come up with a procedure that won't make you entirely happy, but we'll address most of the issues that's been raised here today. That is we'll try to make sure that we can bring everybody along at a speed that they're comfortable with in terms of education about the issues that we deal with the economics, which we clearly need to do. But that we manage this process in a way that we can come out with a product at the end that is meaningful. That is, if we begin with the end in mind and which is what I think Mr. Shore was talking about. So we will do that, we will come back to you with our conclusions about how we should do this and I hope that we will be able to satisfy these considerations.

Representative Hackney – Let me add to that, I appreciate, like my co-chair, all the suggestions, there's an old saying among lawyers, that when all else fails go back and read the stature. And I would suggest that some of you should go back and read the legislation because the road map is pretty much there, and it doesn't tell us exactly how to get there, it doesn't tell us who to hear from, but it tells us pretty much what we're to study and what we're to do about it. And I think that you'll find that the co-chairs are going to stick pretty closely to this charge that we have in the law and that we want to do a good job of it. Keeping in mind that part of perhaps unstated goal here is public education and public discussion in North Carolina at a state government level for the first time. And I think that has value in and of itself and so I hope you have enjoyed learning about what DNER is doing, I know I have, some of you may have known more about it than others as members are very diverse. I hope you've enjoyed hearing from the expertise that we have already and I think personally, we should hear some more and not just in committees. The work that we're about is ultimately to recommend and Mr. Wilkins made a point that I will just reiterate, you need to go fast enough to get the job done and you need to go slow enough to make sure that you're bringing everybody along with you when you get to the end. So I think that's a good goal for all of us.

Dr. Uzochuckwu – Mr. Chairman, I had sent an email regarding the schedule for these meetings. Tuesdays are not very good for us because we teach and some of those classes are held once a week. Once you miss two times like the meetings coming, you miss two weeks of lecture that is not good for the students.

Dr. Smith – As we're wrapping up, at some point we're going to be struggling with solutions and I just wanted to point out that a colleague of mine is going to be mailing each member of the Commission a DVD on issues of energy and I would hope that you pay attention to it, particularly, I think that the most important part to zero in on is the last part of this video. He spends a significant amount of time, at a very personal level with his family and I think at a very lay person level talking about real solutions to a number of energy challenges that we have, obviously. So please be on the lookout for this, it is called Kilowatt Hours and I would encourage you, if you get it, to take a look at and I think it will help enlighten a little bit on some of issues that we may be struggling with.

Mr. Everett – Yes Mr. Chairman, could we get copies of the first two presentations this morning sent to us maybe?

Mr. Garrou – Surely.

Mr. Givens – With regard to Dr. Ballings we did distribute the PowerPoint and we can certainly follow those Dr. Riggs presented you with a brief abstract but he did not want to disseminate his PowerPoint at this time. Let me just say generally that we also, the staff, have been taking notes on all of these things. I would ask that each of you who have thoughts and recommendations to send them to us, detail in particularly including topics and presenters and perhaps any help you can offer in recruiting relative experts, will be welcomed. I have learned, in the last few weeks that I'm not quite as famous outside the

state of North Carolina as I am in and so we are looking at a number of people already, but any help that you can offer, there's certainly more expertise out there than there is up here on this part of the podium. One of our thoughts has been that we can continue to work on the science and talk about other topics at the same time, and we're looking for ways to do that.

Mr. Everett – Mr. Chairman I wonder if we're making a mistake by continuing to focus on the whole issue of climate change. It appears to me that when you look at the source of the problem, if there is one that Brock put up, it's an energy issue and regardless of what you think about climate change or what's happening to the climate or not happening the issue is related to energy.

Mr. Garrou – I think I agree with you, but I echo the words of the co-chairman, we've got a stature that we have to deal with.

Mr. Givens – One other comment with regard to the schedule of meetings, we only scheduled out for two more meetings and I apologize to the Dr. from A&T. He did indicate that he was having trouble meeting Tuesdays. Any consideration for scheduling that would impact us in the fall, if you would let us know those things we'll try to factor those in. It is enormously difficult to find a date that even the majority of people are comfortable with.

Dr. Riggs – Energy is an important part of this, but it's only one piece of the equation. Climate change is real, it's happening and the environment is probably going to pay for it first. And we have to keep the environment on the table at the same time as we deal with the energy component.

Mr. Garrou – If there's no other business to come before the Commission, we are adjourned. Thank you very much.

The meeting adjourned at 3:30 p.m.

Mr. John Garrou	Thelma T. Utley
Presiding Co-Chair	Committee Assistant

LIST OF EXHIBITS

EXHIBIT A	**Meeting Notice**
EXHIBIT B	**Meeting Agenda**
EXHIBIT C	**Visitor's Registration**
EXHIBIT D	**Handout provided by Senator Pittenger to Commission members on observations from leading scientists regarding natural cause to climate change and newspaper clipping on global warming in context of history**
EXHIBIT E	**Handout provided by John Locke Foundation – Spotlight – Breaking the 'Hockey Stick'**
EXHIBIT F	**Newspaper clipping provided to Commission members - Warming is here. Now what do we do? By William H. Schlesinger.**
EXHIBIT G	**North Carolina Coastal Federation – State of the Coast Report - Global Warming: The Impending Storm**
EXHIBIT H	**For Immediate Release - Dr. Robert Balling**
EXHIBIT I	**Coasts In Crisis: Climate Change, Sea-Level Rise, and Storm Dynamics by Dr. Stanley Riggs provided to Commission members.**
EXHIBIT J	**PowerPoint presentation by Dr. Rob Jackson**
EXHIBIT K	**PowerPoint presentation by Dr. Robert Balling**
EXHIBIT L	**Reading material distributed to Commission members provided by Senator Pittenger**
EXHIBIT M	**Reading material provided by Dr. Stephen Smith**
EXHIBIT N	**PowerPoint presentation by Dr. Sethu Raman**
EXHIBIT O	**PowerPoint presentation by Mr. Brock Nicholson**

SCHEDULE OF FUTURE MEETINGS:

Below is a schedule of meetings of the Legislative Commission on Global Climate Change for March and April 2006. This schedule is subject to adjustment.

Commission Meeting	Location
Tuesday 7 March 2006	643 Legislative Office Building
Tuesday 4 April 2006	544 Legislative Office Building
Tuesday 25 April 2006	643 Legislative Office Building

MEMBERSHIP LIST AND CONTACT INFORMATION:

Attached to this memorandum is the membership list and contact information for the members of the Commission. **Members are asked to review the accuracy and completeness of this information and let Commission staff know by e-mail to timd@ncleg.net of any necessary changes.**

BIOGRAPHICAL STATEMENT:

Commission staff has received several requests for information regarding the members of the Commission. **Members are asked to provide Commission staff by e-mail to timd@ncleg.net with a brief, one paragraph biographical statement that can be shared with other members of the Commission and the general public.**

COMMISSION WEBSITE:

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

http://www.ncleg.net/committees/legislativecomm_/default.htm.

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.

Tuesday 7 March 2006
Exhibit B

General Assembly of North Carolina

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

State Legislative Building
Raleigh, North Carolina

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

TIMOTHY R. DODGE
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

AGENDA

10:00 a.m. Tuesday 7 March 2006
Room 643 Legislative Office Building

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

2. Introductory remarks by Cochairs
   John. L. W. Garrou
   Representative Joe Hackney

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

4. Continuation of the discussion of the state of the science related to global climate change
   Robert C. Balling, Jr., Professor, Department of Geography,
   Arizona State University

   Stanley R. Riggs, Distinguished Research Professor, Department of Geology,
   College of Arts and Sciences, East Carolina University

   Robert B. Jackson, Jr., Faculty Director, Center on Global Change;
   Professor of Biology and Environmental Sciences, Duke University

LUNCH *– Estimated for 12:00 p.m. to 12:45 p.m.*

   Sethu Raman, State Climatologist and Professor of Meteorology,
   Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University

5. Update on activities of the Department of Environment and Natural Resources (DENR) and the Climate Action Plan Advisory Group
   Brock M. Nicholson, Deputy Director
   Division of Air Quality, DENR

6. Commission discussion and announcements

7. Adjourn

SCHEDULE OF FUTURE MEETINGS:

Below is a schedule of meetings of the Legislative Commission on Global Climate Change for April 2006. This schedule is subject to adjustment.

Commission Meeting	Location
Tuesday 4 April 2006	544 Legislative Office Building
Tuesday 25 April 2006	643 Legislative Office Building

COMMISSION WEBSITE:

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

http://www.ncleg.net/committees/legislativecomm_/default.htm.

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.

Tuesday 7 March 2006
Exhibit C

VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change — 03/07/06
Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Brock Nicholson	DENR / DAQ
Rob Jackson	Duke University
Bill Ross	NC DENR
Eric Williams	Duke University
Ann Carpenter	
Colleen Kochanek	Smith Moore
Keith Overcash	NC DAQ
Angie Harris	Marpai Taylor
Bob FORD	NC Poultry Fed.
Mia Bailey	Electricities of NC Inc.
Lisa Martin	NC Home Builders Assoc.

VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change — 03/07/06

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Travis Fisher	John Locke Foundation
Roy Covelato	" "
Michael Sanera	" "
Gary Pitt	DENR
Richard Andrews	UNC-Chapel Hill
Elizabeth Ouzts	Environment North Carolina
Amy MacTaggart	Environmental Defense / Southern Alliance for Clean Energy
Wm Schlesinger	Nicholas School Duke University
Jeanne Fragp	NC Council of Churches
Mitch Kokai	John Locke Foundation
Graham Long	Sen. Pittenger's Office

VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change — 03/07/06

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Jim Haven	Global Warming Initiatives Raleigh NC
Sonna Greene	Hunton & Williams LLP Raleigh, NC.
Matthew Kaves	Piedmont Natural Gas PO Box 33068 Charlotte, NC 28233
Sharon Stroud	State Energy Office
Sciran owen	John William Pope Civitas Institute Raleigh, NC
Nancy Thompson	NC IC
Steve Woodson	NCFS
Charles O Davis	NCDENR DAQ
Kim Garnett	NCDENR - DAQ
Patrick Butler	NCDENR - DAQ
Hoke Kimball	NCDENR - DAQ

VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change — 03/07/06

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
JOHN BONITZ	RURAL ADVANCEMENT FOUNDATION INT'L - USA PO BOX 640 PITTSBORO, NC 27312 john@rafiusa.org
Kathy Hawkins	PNGreen Energy
Rita Harris	NC Ports
ROY ERICSON	NC Utilities Commission
Roger Bove	Bove + Assoc -
Shannon Miller	CUCA
JERI GRAY	League of Women Voters
Ben Turner	Public Staff - North Carolina Utilities Commission
James McLawhorn	Public Staff - NCUC
Tom LAM	PUBLIC STAFF - NCUC
JACK FLOYD	Public Staff - NCUC

VISITOR REGISTRATION SHEET

Legislative Commission on Global Climate Change — 03/07/06

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Elizabeth Dalton	NCCB
John Goodman	Alliant Associates

Tuesday 7 March 2006
Exhibit D

North Carolina General Assembly
Senate Chamber
State Legislative Building
Raleigh 27601-2808

SENATOR ROBERT PITTENGER
ASSISTANT REPUBLICAN LEADER
39TH DISTRICT

OFFICE ADDRESS:	300 N. SALISBURY STREET, ROOM 521 RALEIGH, NC 27603-5925	DISTRICT ADDRESS:	4521 SHARON ROAD, SUITE 120 CHARLOTTE, NC 28211-3483
TELEPHONE:	(919) 733-5655 (919) 828-3508 (FAX)	TELEPHONE:	(704) 365-6038 (704) 365-0910 (FAX)
E-MAIL ADDRESS:	ROBERTP@NCLEG.NET	E-MAIL ADDRESS:	RP@PITTENGERCOMPANY.COM

COMMITTEES:
APPROPRIATIONS/BASE BUDGET
RULES AND OPERATIONS OF THE SENATE
LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

Observations From Leading Scientists Regarding Natural Cause To Climate Change

1. "The Earth's climate has never been steady; it has either warmed or cooled – without any human intervention."

Dr. S. Fred Singer
Atmospheric Physicist
University of Virginia

2. "A causal linkage between the buildup of greenhouse gases in the atmosphere and the observed climate changes during the 20th century cannot be unequivocally established."

National Academy of Sciences, Climate Change Science: An Analysis of Some Key Questions p.17

3. "The great uncertainty about this indirect aerosol climate forcing presents a severe handicap both for the interpretation of past climate change and for future assessments of climate changes."

National Academy of Sciences, Climate Change Science: An Analysis of Some Key Questions p.14

4. "Clouds represent a significant source of potential error in climate simulations"

IPCC 2001a:TS:D1

5. "We are not in a position to confidently attribute past climate change to carbon dioxide or to forecast what the climate will be in the future"

Dr. Richard Lindzen, "Scientists' Report Doesn't Support the Kyoto Treaty". The Wall Street Journal. June 11, 2001.

6. "Overall, there is no evidence that extreme weather events, or climate variability, has increased, in a global sense, through the 20th Century."

IPCC 1996a:173

"It is not possible to say whether the frequency, area of occurrence, time of occurrence, mean intensity or maximum intensity of tropical cyclones will change."

IPCC 1996a:334

8. "Of Climate Change on agriculture after adaptation are estimated to result in small percentage changes in global income, and these changes tend to be positive for a moderate global warming, especially when the effects of CO2 fertilization are taken into account."

Rotter and van de Geijn 1999:653ff

9. "On the basis of careful measurements over the past decade, NASA scientist Jay Zwally and his coauthors conclude (in the current issue of the Journal of Glaciology) that Greenland ice is growing because of increased snow accumulation. This causes a slight reduction of the ongoing rise of sea level."

Dr. Fred Singer, Professor Emeritus of Environmental Sciences, University of Virginia

10. "With colleagues, I have analyzed those and other records and published the results in peer-reviewed scientific journals. We conclude: The level of atmospheric greenhouse gases has increased markedly since the beginning of the Industrial Revolution, but we see no clear evidence of any human influence on climate warming in the past 25 years. Evidently, the theory exaggerates the human greenhouse effect, which is still hidden by the much greater natural fluctuations of the climate. For example, we note that there was a cooling trend from about 1940 to 1975, while carbon dioxide increased rapidly – evidence for a natural climate variation.

Global climate change has been the rule for all of Earth's history. A human influence may become detectable eventually, perhaps by 2100, but it will still be small compared to natural changes."

Dr. Fred Singer, Professor Emeritus of Environmental Sciences, University of Virginia

11. Is Global Warming really human-caused?

Since the beginning of the Industrial Revolution, carbon-dioxide levels in the atmosphere have risen by 35%. The level of methane, an even stronger greenhouse gas, has more than doubled. Yet we don't see the pattern of warming that greenhouse theory predicts. In fact, the Earth's climate cooled for 36 years, from 1940 to 1976. Contrary to Mr. Timothy Toben's assertion (Observer Feb 22), the cause of warming and cooling during the past century is not human but a natural climate fluctuation likely due to the Sun.

Incidentally, 2005 was not the warmest year as he claims. The NOAA Climate Center in Asheville gives 2002 as warmer --and 1998 as much warmer than 2005. One might therefore say that the climate has been cooling since 1998.

Dr. Fred Singer, Professor Emeritus of Environmental Sciences, University of Virginia

12. Timothy Toben's Feb 22 letter (Climate change is real) espouses the popular scare scenario that global warming can be attributed mainly to anthropogenic emissions of carbon dioxide. However, recent scientific findings question many of the popular premises of global warming activists.

The Legislative Commission on Climate Change needs to be aware of these facts:

*Recent ice core analyses from Greenland and Antarctica have shown that increased carbon dioxide levels in the Earth's atmosphere (over the past hundreds of thousands of years) was the **result** of global warming, not the cause!

*Carbon dioxide contributes less than 10 percent to the Earth's greenhouse gas effect; water vapor contributes about [redacted] percent.

*Warming near the surface, with little or no warming (based on satellite and balloon measurements) in the lower to mid troposphere (5,000 - 30,000 ft) is **not** a greenhouse gas signal.

The Commission should consider this as a time for scientific assessment, not a time of impulsive policy action targeted at a problem that might not be a problem, and not significantly impacted by those policies. Commission members need to familiarize themselves with the recently published data in *Shattered Consensus: The True State of Global Warming*, edited by Patrick J. Michaels, under copyright by the George C. Marshall Institute.

Charles R. Hosler
Meteorologist, U.S. EPA (Retired)

13. Carbon Dioxide content in the atmosphere has been very much higher during many periods of earth history when obviously man had nothing to do with it. During these periods there were times when the earth's temperature was warm and others when it was cool indicating no direct relationship.

What people do not want to understand is that carbon dioxide makes up only 4 percent of the earth's greenhouse gases which is the only portion man impacts. I really believe it is our arrogance that wants us to believe that we are significant in the scheme of the planets physical properties. I only wish it were true, then perhaps we could have the power to stop the terrible hurricane that destroyed New Orleans or the tsunami that spread desolation in the Indian [redacted]cean.

All man can do is adapt to nature. We can not control it.

Jay Lehr, Ph.D.
Science Director
The Heartland Institute

14. "The observational and theoretical evidence argues against a linkage between greenhouse gases, global warming and the intensification of hurricane activity."

Dr. Robert C. Balling
Arizona State University

15. "The state-of-the-art satellite-based planetary temperature measurements continue to show no warming at all. As the satellite database grows, I suspect global warming will be even more difficult to prove on empirical grounds."

Dr. Robert C. Balling
Arizona State University

Put global warming in context of history

BY JOE BASTARDI
Guest columnist

Our knowledge of the past should serve as a foundation for actions in the present. While not dismissing those who are concerned about global warming, I am disturbed that they often base their conclusions on data that, in the context of time, are only a grain of sand on the beach. They cite temperature changes from the last 10, 50, or 100 years, ignoring the fact that climate history and cycles didn't start 10 years or even 10 centuries ago.

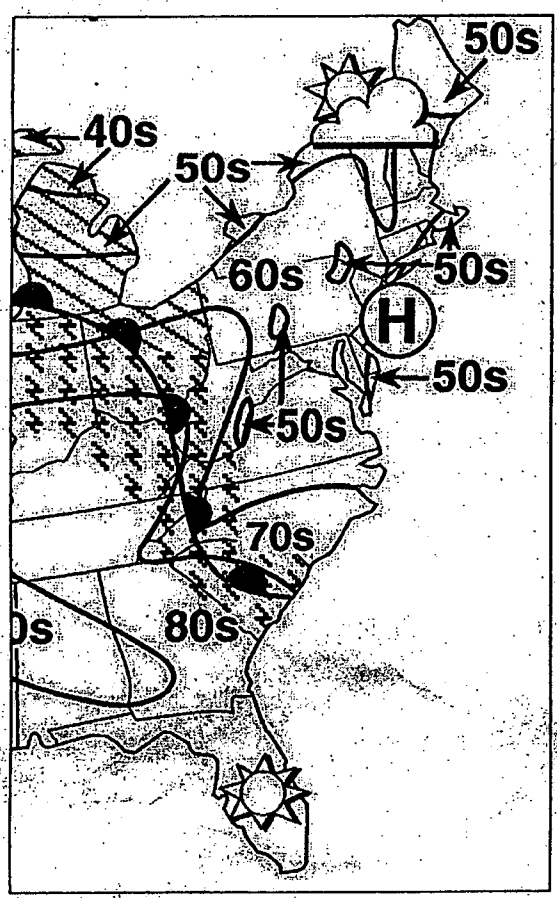
Nothing that is happening today is new or different. I have yet to have a global warming "true believer" tell me why over the past hundreds and thousands of years, before any significant or even detectable human influ- there were periods where on dioxide and temperature levels were well above those of recent experience. There are also places in our northern plains that have been covered with glaciers at one time and tropical rain forest at others, all without man's influence. There is no reason to think that this can't happen again no matter what we do. Anyone with a true understanding of climate history knows that the relatively small changes experienced over the last 100 years could easily be "natural."

After ignoring the past, some analysts then use computer projections to predict temperatures for the next 100 years or more. It is astounding to see people put so much faith in these man-made computer models, yet ignore the actual facts of the past. As someone who has made a living at pointing out the folly of worshipping the false idol of atmospheric models, I find these projections to be a classic case of being blinded by the lure of the latest technological fad. Perhaps this is the most telling difference between those re accepting of the "global ing hypothesis" and those of us who are skeptical. The former tend to base their conclusions on the guesses of computer models. We skeptics focus on actual climate history and conclude that nothing out of the ordinary is occurring.

I consider myself an environmentalist. Steps should be taken to make sure we use God's blessings with a sound sense of stewardship. This is the role of science, to provide us with the information necessary to make intelligent decisions. The advancement of science in all areas necessitates open dialogue.

Unfortunately, I fear that the policies being promoted in the name of global warming are not being driven by a search for scientific truth, but by a political agenda. Many great scientists, more gifted than I, have had their voices muffled when they dissent from what might be considered the "politically correct" version of the global warming story. For example, there are many climate scientists whose work uses actual climate data from satellite and weather balloons and shows little to no warming. Global-warming alarmists and most of the media, despite the fact that these are the most reliable data sets available, routinely ignore their work. This is just one of many examples that could be cited. As a scientist, I find it discomforting to see people trying to shut down debate on this matter by ignoring research that doesn't fit preconceived conclusions.

There are also places in our northern plains that have been covered with glaciers at one time and tropical rain forest at others, all without man's influence.



Furthermore, I fear that this political agenda may be at odds with the ideas that have led to the establishment of our nation as a beacon of freedom and prosperity. A policy aimed at reducing carbon dioxide in the atmosphere, a gas that is essential for life as we know it, would necessarily restrict human freedom and economic growth. To reduce carbon dioxide emissions, energy consumption must be reduced, with restrictions on the choices we can make about how we live, travel, and produce goods and services.

The state of North Carolina may soon consider implementing policies geared toward reducing CO2 emissions. People need to take the time to look at all sides of the issue. Unfortunately much of the rhetoric in this area is meant to appeal to a generation reared on "Fern Gully," with no sense of sound science or history. I ask people of good will to at least consider the arguments here. I sincerely hope that the fight is for the betterment of the gift God gave us, Earth — not a hasty effort based on self-guilt that could derail America's train of freedom.

And by the way, enjoy the weather; it's the only weather you got.

The writer is an Accuweither.com meteorologist and chief long range and hurricane forecaster. The opinions are his own, and do not represent the views of Accuweather.com.

John Locke FOUNDATION

spotlight

No. 281 – February 25, 2006

Breaking the 'Hockey Stick'

Global Warming's Latest Brawl

SUMMARY: Evidence from throughout the world shows that the planet was relatively warm 1,000 years ago during the Medieval Warm Period and relatively cold 500 years ago during the Little Ice Age. When the 1°C (1.8°F) of global warming of the past 100 years is considered in the context of climate variability of the last 1,000 years, the recent warming looks quite natural and nothing out of the ordinary. In 2001, the United Nations Intergovernmental Panel on Climate Change prominently featured an important graph of northern hemispheric temperatures over the past 1,000 years, and the plot resembled a hockey stick. This same graph was recently highlighted in testimony to the North Carolina Legislative Commission on Climate Change. In this graph, the Medieval Warm Period and the Little Ice Age disappeared, and after 900 years of nearly steady temperatures, warming dominates the most recent 100 years. The new "hockey stick" depiction makes the recent warming look highly unnatural, thereby lending credence to the argument that human activities are the driving force behind global warming. The fights over the hockey stick have been among the most vicious in the two decades of heated debate over global warming.

In recent months the issue of global warming has become a focus of attention for North Carolina policy makers. In 2005 the General Assembly established a commission on climate change to determine if the state can adopt policies that would generate net benefits in mitigating possible global warming.

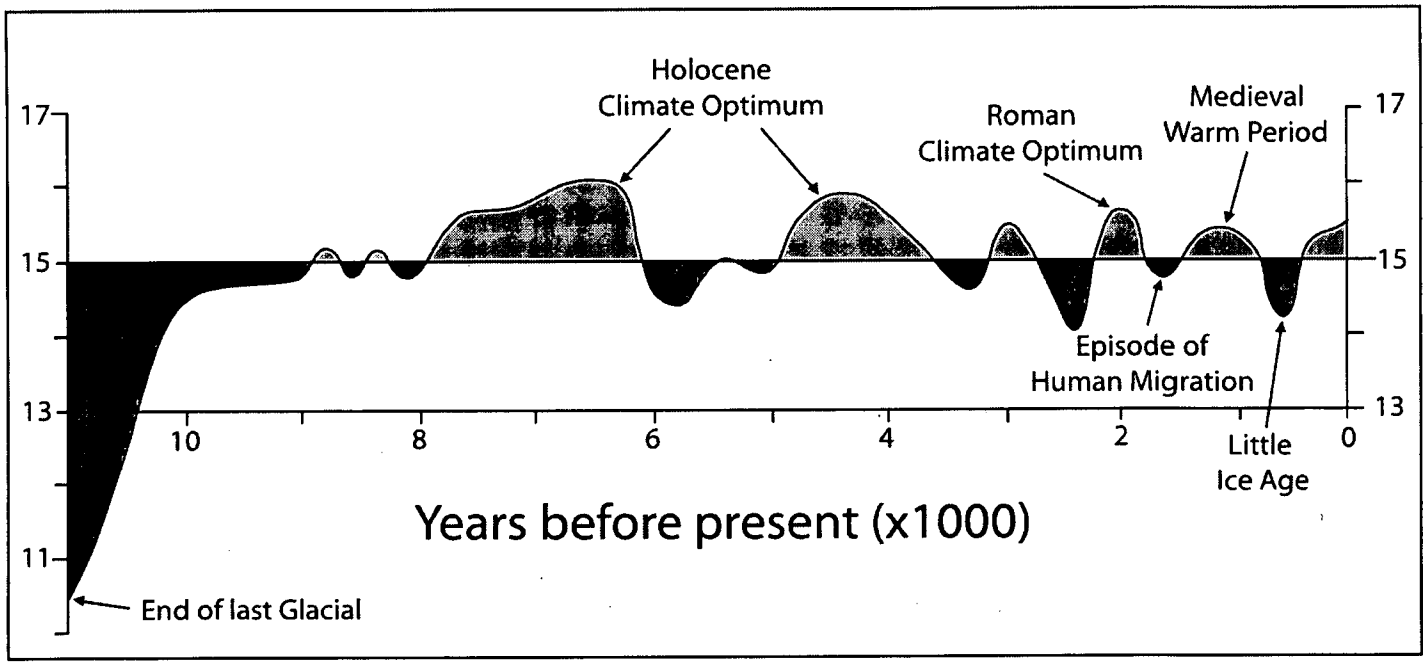
The commission held its first meeting on February 3, 2006, where it heard from a number of speakers, all of whom firmly endorsed the idea the state could and should play a role in attempting to alter global temperatures. Part of this discussion focused on a particular record of climate change over the last 1,000 years, graphically represented by what has come to be called "the hockey stick." This graph suggests that warming of the last 100 years is an anomaly.[1] On the other hand, most other analyses of climate change over this same time period and longer suggest that warming since the turn of the last century is not extraordinary.

more >>

200 W. Morgan, #200
Raleigh, NC 27601
phone: 919-828-3876
fax: 919-821-5117
www.johnlocke.org

The John Locke Foundation *is a 501(c)(3) nonprofit, nonpartisan research institute dedicated to improving public policy debate in North Carolina. Viewpoints expressed by authors do not necessarily reflect those of the staff or board of the Locke Foundation.*

Figure 1. Northern Hemispheric temperature reconstruction for the past 10,000+ years



Ten Thousand Years of Climate Change

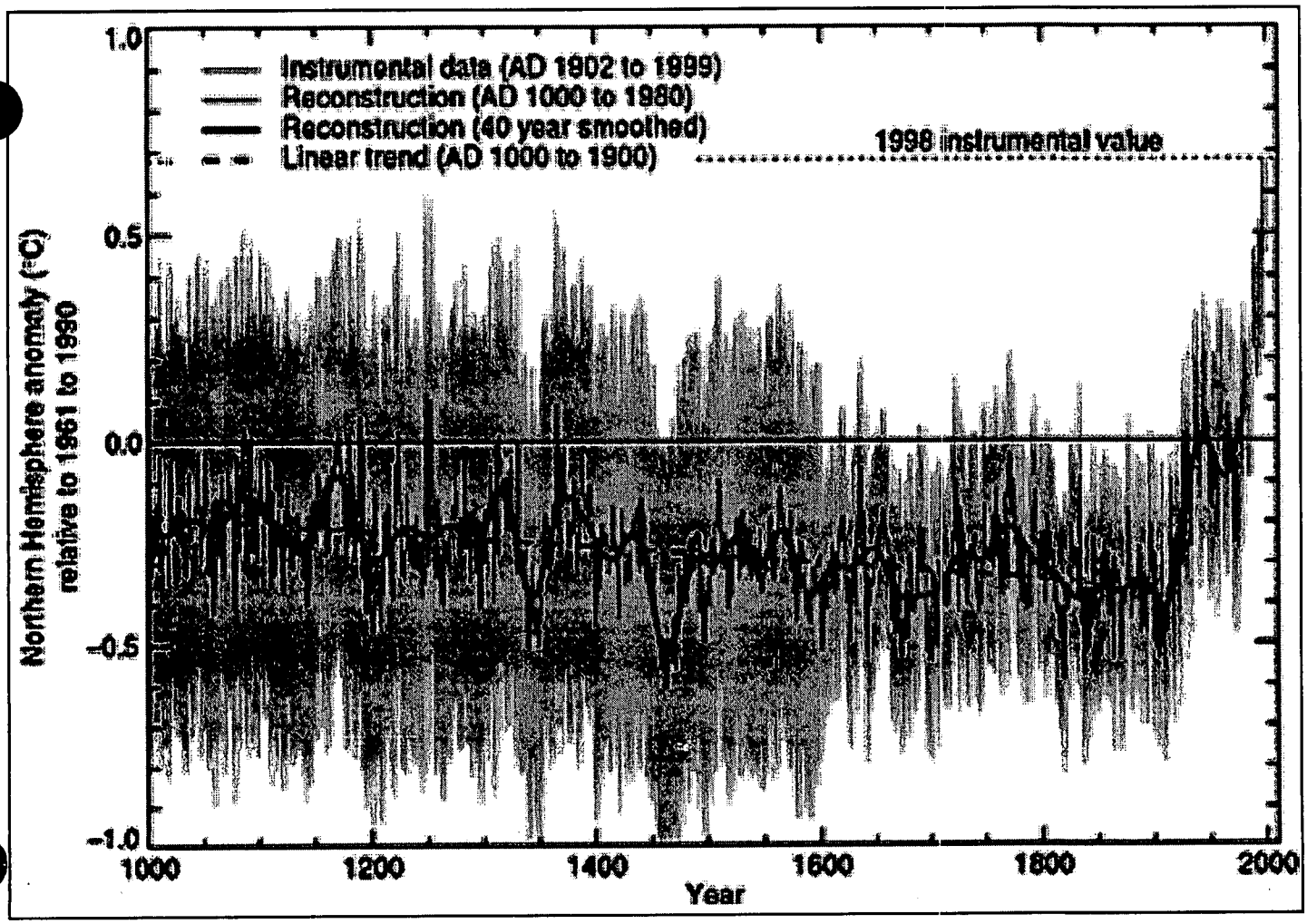
For decades, students of climatology have learned of the existence of substantial variations in the temperature of the Earth since the end of the last major ice age 10,000 years ago (Figure 1). Several "Climate Optimum" periods have graced our present interglacial period and were so named because of the relative ease humans had living in a warm world. Students have been taught that 1,000 years ago, the Earth was in the "Medieval Warm Period" when civilizations of the most northern countries were flourishing. However, approximately 450 years ago, the Earth plunged into the "Little Ice Age" and humanity struggled with no end of crop failures and famines.[2] This was a time when the Sun had very few sunspots, and many scientists believe the lower output of the Sun contributed mightily to this relatively cold period. Fortunately, the luminosity of the Sun increased, and by 1900, the Earth was clearly rebounding from hundreds of years of cold temperatures.

The enormous question facing climatologists today is whether the warming of the past 100 years is part of natural variability of the climate system or a response to the greenhouse gas concentration buildup that corresponded to the industrialization of the planet. Did we industrialize during a period of natural warming, or did our industrialization cause the observed warming?

This question has created an industry for climate scientists and policymakers worldwide, but it has also caused great tension between those who disagree about what has caused the warming and what can we do about the warming. Data are collected and analyzed, numerical climate models are run to simulate future climate, and at first glance, the greenhouse debate seems to be swimming in data and facts. But as Mark Twain once said, "Get your facts first, and then you can distort them as much as you please!" He was no doubt anticipating the global warming debate when that sentence came to his fertile mind!

The evidence for the climate variations over the past 1,000 or even 10,000 years comes from literally thousands of scientists who have carefully examined tree rings, ice cores, historical records, pollen spores, and dozen or more other clever ways to peer into the Earth's climatic past. Major books and review articles have clearly documented that the major warming and cooling episodes were apparent throughout the entire world,[3] and although there are uncertainties in reconstructing past climate patterns, the climate community has long been confident of the existence of a distinct "Medieval Warm Period" and "Little Ice Age." Along with documenting the existence of these events, climate scientists have spent an equal amount of time explaining the events. Almost all scientists agree that the Little Ice Age was caused by a reduction in solar output, and almost all agree that the warming of the Sun contributed to some extent to the warm-up of the past century. Of course, defining the "extent" is a point of controversy in the field.

Figure 2. IPCC Northern Hemispheric temperature reconstruction for the past 1,000 years



The "Hockey Stick" Controversy

As we look at Figure 1 depicting 10,000 years of climate history, there is nothing unusual about the warming of the 20th century; in fact, the warming is unimpressive compared to other events over this time period. However, five years ago, the United Nations Intergovernmental Panel of Climate Change (IPCC) issued a report entitled *Climate Change 2001: The Scientific Basis,* and a new figure was introduced showing the Northern Hemisphere's temperature over the past 1,000 years (Figure 2).[4] The figure was based on research published in 1998 by Michael Mann and two other prominent scientists that appeared in several leading peer-reviewed journals.[5] The Medieval Warm Period and Little Ice Age vanished, and now the warming of the past 100 years looked completely unlike anything observed for a 1,000 years.The greenhouse advocates made the case that the recent warming was so unnatural that only emissions of greenhouse gases could have caused the rapid global warming. The IPCC plot looked like a hockey stick, and scientists have been fighting about the shape of the curve since the day the IPCC released the report – the penalty box is plenty full of scientists as this fight seems to never end.

While there were squabbles throughout the climate community over the "hockey stick" from the time it first appeared in 1998, the situation exploded in 2003 when a paper was published in the scientific journal *Climate Research* by Harvard scientists Willie Soon and Sallie Baliunas.[6] Their controversial paper was a review of hundreds of papers showing global evidence of the Medieval Warm Period and the Little Ice Age. They concluded that "Across the world, many records reveal that the 20th century is probably not the warmest nor a uniquely extreme climatic period of the last millennium." Outrage was expressed by many leading climate scientists and questions were raised about how the paper survived the peer-review process. The editor of the journal resigned as did other members of the editorial board – the associate editor who handled the paper was severely attacked, and leading executives from the publishing

company wrote to the scientific community reassuring that the highest review standards would be the rule of the day. Nonetheless, that paper certainly documented overwhelming evidence that the Earth's temperature was anything but a flat line followed by an anomalous upward trend.

The second major brawl involved a pair of Canadians named Stephen McIntyre and Ross McKitrick who began to question both the data and the multivariate statistical techniques used by the Mann group in constructing the hockey stick. McIntyre and McKitrick set out to reproduce the results but immediately recognized that *the statistical methodology would generate a hockey-stick curve given almost any inputs.* They claimed to have found errors in Mann's data, errors in the computer code used to assemble the data, and errors in the application of the statistical methods.[7] Furthermore, they felt that the Mann team was not cooperating in sharing data and their analytical methods despite the fact that their research had been publicly funded by the National Science Foundation. In November 2003, McIntyre and McKitrick conducted a briefing on Capitol Hill, elected officials got involved, and the spotlight was brighter than ever on shortcomings of the hockey stick. In 2005, a major journal of the American Geophysical Union published a McIntyre and McKitrick paper in which they severely criticized how the hockey stick temperature graph was developed[8] – stay tuned, because the IPCC and many leading scientists are not about to concede that the hockey stick is broken!

Conclusion

The global warming issue is certain to heat up even more in the coming months. Former Vice President Al Gore has a new book on the greenhouse effect, entitled *An Inconvenient Truth*, about to hit the streets and the global warming debate will be back on the front burner. Gore is a big fan of the hockey stick, and I suspect the fight over the existence of the Medieval Warm Period and Little Ice Age will be in high gear this coming summer.

A clear point that the North Carolina policymakers should take from all this is that despite the claims of many who advocate for strong policies to combat global warming, *the science is not settled.* Any policy that the state decides to adopt needs to be carefully considered in light of this fact.

Dr. Robert C. Balling, Jr. is a professor in the climatology program at Arizona State University.

Notes

1. See, William Schlessinger, "Science of Climate Change," at http://www.ncleg.net/Committees/legislativecomm_/meetingdocument_/3february2006_/presentations_/default.htm, slide 5.
2. Grove, J. M., 1988: *The Little Ice Age*. Methuen.
3. Lamb, H. H., 1982: *Climate, History and the Modern World*. Methuen.
4. This graph was presented to the N.C. Legislative Commission on Global Climate Change.
5. Mann, M. E., R. S. Bradley, and M. K. Hughes, 1998: Global-scale temperature patterns and climate forcing over the past six centuries. *Nature*, **392**, 779-787. See also Mann, M. E., R. S. Bradley, and M. K. Hughes, 1999: Northern Hemisphere temperatures during the past millennium: Inferences, uncertainties, and limitations. *Geophys. Res. Letters*, **26**, 759-762.
6. Soon, W. and S. Baliunas, 2003: Proxy climatic and environmental changes of the past 1000 years. *Clim. Res.*, **23**, 89-110.
7. McIntyre, S. and R. McKitrick, 2003: Corrections to the Mann et al. (1998) proxy data base and northern hemispheric average temperature series. *Energy & Environment*, **14**, 751-766.
8. McIntyre, S. and R. McKitrick, 2005: Hockey sticks, principal components, and spurious significance. *Geophys. Res. Letters*, **32**, 10.1029/2004GL021750.

Put global warming in context of history

BY JOE BASTARDI
Guest columnist

There are also places in our northern plains that have been covered with glaciers at one time and tropical rain forest at others, all without man's influence.

Our knowledge of the past should serve as a foundation for actions in the present. While not dismissing those who are concerned about global warming, I am disturbed that they often base their conclusions on data that, in the context of time, are only a grain of sand on the beach. They cite temperature changes from the last 10, 50, or 100 years, ignoring the fact that climate history and cycles didn't start 10 years or even 10 centuries ago.

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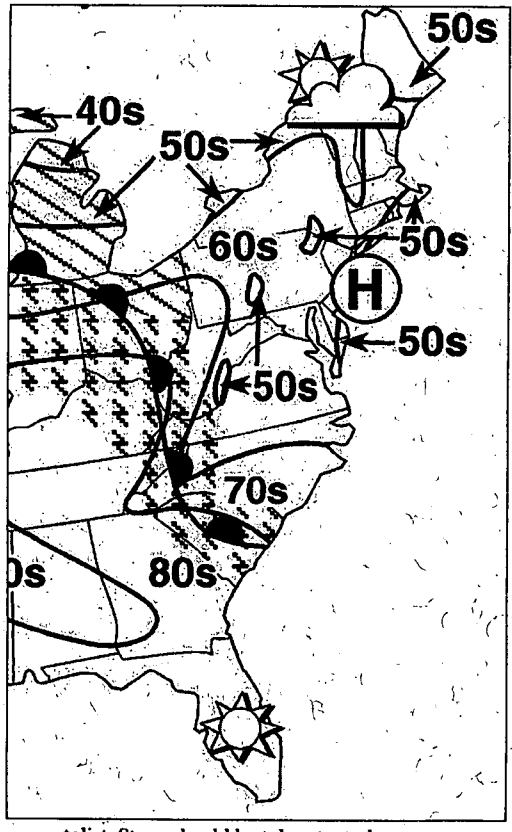
After ignoring the past, some analysts then use computer projections to predict temperatures for the next 100 years or more. It is astounding to see people put so much faith in these man-made computer models, yet ignore the actual facts of the past. As someone who has made a living at pointing out the folly of worshipping the false idol of atmospheric models, I find these projections to be a classic case of being blinded by the lure of the latest technological fad. Perhaps this is the most telling difference between those who are accepting of the "global warming hypothesis" and those of us who are skeptical. The former tend to base their conclusions on the guesses of computer models. We skeptics focus on actual climate history and conclude that nothing out of the ordinary is occurring.

I consider myself an environmentalist. Steps should be taken to make sure we use God's blessings with a sound sense of stewardship. This is the role of science, to provide us with the information necessary to make intelligent decisions. The advancement of science in all areas necessitates open dialogue.

Unfortunately, I fear that the policies being promoted in the name of global warming are not being driven by a search for scientific truth, but by a political agenda. Many great scientists, more gifted than I, have had their voices muffled when they dissent from what might be considered the "politically correct" version of the global warming story. For example, there are many climate scientists whose work uses actual climate data from satellite and weather balloons and shows little to no warming. Global-warming alarmists and most of the media, despite the fact that these are the most reliable data sets available, routinely ignore their work. This is just one of many examples that could be cited. As a scientist, I find it discomforting to see people trying to shut down debate on this matter by ignoring research that doesn't fit preconceived conclusions.



Furthermore, I fear that this political agenda may be at odds with the ideas that have led to the establishment of our nation as a beacon of freedom and prosperity. A policy aimed at reducing carbon dioxide in the atmosphere, a gas that is essential for life as we know it, would necessarily restrict human freedom and economic growth. To reduce carbon dioxide emissions, energy consumption must be reduced, with restrictions on the choices we can make about how we live, travel, and produce goods and services.

The state of North Carolina may soon consider implementing policies geared toward reducing CO2 emissions. People need to take the time to look at all sides of the issue. Unfortunately much of the rhetoric in this area is meant to appeal to a generation reared on "Fern Gully," with no sense of sound science or history. I ask people of good will to at least consider the arguments here. I sincerely hope that the fight is for the betterment of the gift God gave us, Earth — not a hasty effort based on self-guilt that could derail America's train of freedom.

And by the way, enjoy the weather; it's the only weather you got.

The writer is an Accuweather.com meteorologist and chief long range and hurricane forecaster. The opinions are his own, and do not represent the views of Accuweather.com.

THE HEARTLAND INSTITUTE

19 South LaSalle Street #903
Chicago, IL 60603
phone 312/377-4000 · fax 312/377-5000
http://www.heartland.org

Warming Likely to Have Modest Effect on Sea Level, If Any

Author: Patrick Michaels
Published: The Heartland Institute 01/01/2006

One of the great fears generated by global warming is that the oceans are about to rise and swallow our coasts. These concerns have been heightened by the substantial uptick in Atlantic hurricane activity that began in 1995.

The frequency of really strong storms striking the United States now resembles what it was in the 1940s and '50s, however, which few people (aging climatologists excepted) remember.

Little Recent Change

Those who argue global warming is an overblown issue have been claiming for years that "consensus" forecasts of sea level are equally overwrought. The United Nations' Intergovernmental Panel on Climate Change predicts a global average rise of from 3.5 to 34 inches by 2100, with a central estimate of 19 inches. Depending upon how you slice or dice the data, the last century saw a rise of maybe six inches.

Critics of this position have long argued that the predicted changes would require a substantial net melting of some combination of the world's two largest masses of land-based ice--Antarctica and Greenland. In addition, they note that observed global warming is right near the low end of the UN's projections, which means the realized sea level rise should be similarly modest.

Antarctica Not Melting

Over 15 years ago, John Sansom, who was with the New Zealand Meteorological Service at Wellington, New Zealand at the time, published a paper in the *Journal of Climate* that examined the prior 30 years of Antarctic temperature data and showed no net warming of Antarctica during that time period. While it was widely cited by critics of global warming doom talk, no one else seemed to take notice. After all, it relied on only a handful of stations. Then, in 2002, University of Illinois at Chicago researcher Peter Doran published a more comprehensive analysis in *Nature* and found a cooling trend.

At the same time, a deluge of stories appeared, paradoxically, about Antarctic warming. These studies concentrated on the tip of the Antarctic Peninsula, the narrow strip of land that juts out toward South America. That region, which comprises less than one-half of one percent of Antarctica, is warming because the surrounding ocean has warmed.

Warmer water, however, evaporates more moisture, and the colder the land surface over which that moisture passes, the more it snows. So, Antarctica as a whole should gain snow and ice.

That has been confirmed. Last year, C.H. Davis published a paper in *Science* about how this accumulating snowfall over eastern Antarctica was reducing sea level rise. This year, Duncan Wingham, at the 2005 Earth Observations summit in Brussels, demonstrated the phenomenon is being observed all over Antarctica.

Greenland Signals Mixed

The situation in Greenland is more complex. In 2000, William Krabill estimated the contribution of Greenland to sea level rise at 0.13 mm per year, or a half an inch per century. That's not very different from zero. In October, using satellite altimetry, O.M. Johannessen published a remarkable finding in *Science* that the current trend in Greenland ice is a gain of 5.4 cm (two inches) per year.

Almost all of the gain in Greenland has been in areas greater than 5,000 feet in elevation (which is most of the place). Below that, there has been glacial recession. It shouldn't be lost on anyone that because no one ventures into the hostile interior of Greenland, all we see are pictures of the receding glaciers near the coast!

The temperature situation in Greenland is more mixed than in Antarctica. Over the last 75 years, there has been cooling in the southern portion (where the recession has been greatest) and some warming in the North.

Other Glaciers Not Significant

The only other masses of ice on the planet that can contribute to sea level rise are the non-polar glaciers, but they are very few and far between. The biggest is the Himalayan ice cap, but it's so high that a substantial portion will always remain. Most of the rest are teeny objects tucked away in high-elevation nooks and crannies, like our Glacier National Park.

If all these glaciers--including the Himalayan ice cap-- melted completely, sea level could rise no more than five to seven inches, because there's just not that much mass of ice.

Science Rebuts Media Scares

It is simply impossible for the scientific community to ignore what is going on, even as prone to exaggeration of threats as it has grown to be.

The planet is warming at the low end of projections. Antarctica is undoubtedly gaining ice, not losing it. Greenland may be losing a little ice or, as shown in the recent Johannessen study, gaining ice dramatically. Clearly, it is going to take quite some time before melting ice can make the oceans rise much, if at all.

Computer models, while still shaky, are now taking account of this reality. Every one of them now says Antarctica will contribute negatively to sea level rise in the next century, while almost every model now has Greenland's contribution as a few inches, at best.

It is inevitable that one of tomorrow's headlines will be that scientists have dramatically scaled back their projections of sea level rise associated with global warming. Had they paid attention to data (and snow) that began accumulating as long as 15 years ago, they would never have made such outlandish forecasts to begin with.

Patrick Michaels (pmichaels@cato.org) is former president of the American Association of State Climatologists and is a senior fellow for environmental studies at the Cato Institute. This article appeared earlier on the Cato Institute Web site, http://www.cato.org.

John Locke FOUNDATION

spotlight

No. 277 – January 18, 2006

STATE CAN'T CHANGE THE WEATHER

Even Global CO_2 Reductions Have Little Impact

SUMMARY: Dr. Thomas Wigley from the U.S. National Center for Scientific Research has calculated that if the Kyoto Protocol were implemented with 100% compliance it would reduce the increase in global temperatures by between 0.18° F and 0.37° F in 100 years. This amount would be undetectable by standard measuring devices. It is unreasonable therefore to expect that North Carolina, acting along or in consort with other states, could do anything to mitigate future global warming.

There is very little surrounding the debate on global warming that is not controversial. Some scientists cite ground-level temperature data that shows more warming, while others cite satellite and weather balloon data that shows less. Some people focus on climate model forecasts that predict significant temperature change, while others, including AccuWeather.com meteorologist Joe Bastardi[1], focus on historical climate records, which suggest that current warming trends are consistent with natural variation.

Nevertheless, one projection has gone completely undisputed and been accepted by scientists on both sides of the global warming divide. It is a projection made by climatologist Dr. Thomas Wigley at the U.S National Center for Scientific Research. In a 1998 *Geophysical Research Letter* article, Wigley concludedthat if all the countries that were party to the original United Nations Kyoto treaty on global warming –- including the United States, which has since decided not to participate — were to comply fully with the treaty, the effects of that 100 percent compliance would be "small" and "undetectable for many decades."[2]

What did Wrigley mean by meant by "small" and "undetectable"? Wigley calculated that average global temperatures by 2050 would only be 0.126º Fahrenheit (12.6 *hundredths* of a degree) cooler under full compliance with the global-warming treaty than they would be if nothing were done, "business as usual." This amount of cooling is so small that it would be undetectable by any conventional temperature-measuring device.

For 100 years out — that is, by the year 2100 — Wigley looked at scenarios involving three different projections (see the graph on the next page) that have been debated as possible results from a doubling of carbon dioxide (CO_2) in

more >>

200 W. Morgan, #200
Raleigh, NC 27601
phone: 919-828-3876
fax: 919-821-5117
www.johnlocke.org

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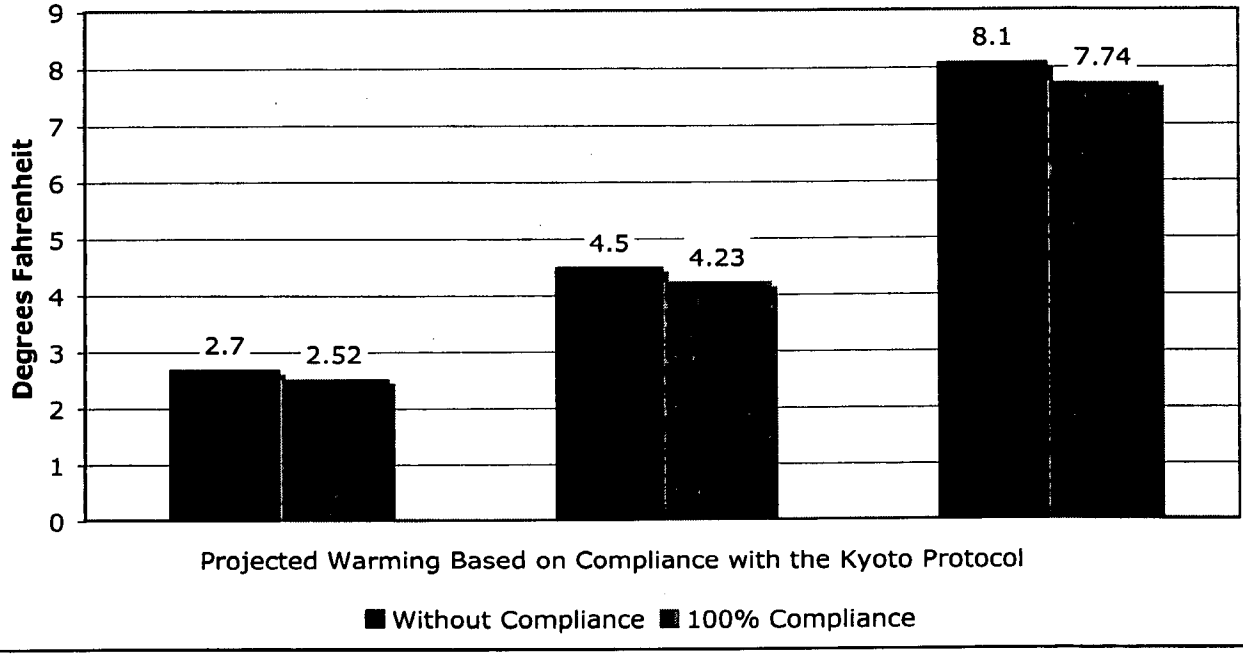
Kyoto Temperature Effects for the Year 2100: Three Warming Scenarios

This bar graph shows three projected climate scenarios for the year 2100. In each case the darker bar shows the amount of projected warming if nothing is done with respect to Kyoto (i.e., the "business as usual" scenario), and the lighter bar show Wigley's estimates of the lesser warming that would occur if the Kyoto Protocol were implemented with 100% compliance by all the nations that were originally part of the treaty.[3]



the atmosphere. CO_2 is the greenhouse gas most frequently targeted by those who argue that global warming is human-induced and should be dealt with through public policies. It is also the gas targeted for reduction by the Kyoto Protocol. As shown in the accompanying graph, even in the most extreme of the projections — an 8.1º (F) increase in temperatures — 100 percent compliance with the Kyoto agreement would bring about only the slightest reduction in warming: 0.37º (F). In other words, the global temperature would increase by 7.74º (F) instead of by the 8.1º (F) it would otherwise do under a "business as usual" scenario.

For the more modest warming projections of 2.7º or 4.5º (F), the U.N. treaty would bring about a reduction of only 0.18º or 0.27º (F) from the "business as usual" scenario. Those amounts are so small that they would be undetectable with common measuring devices.

Wigley was quoted in the March 18, 2005 *Christian Science Monitor* as saying, "we can't stop this so how do we live with it?"[4] It should be noted that Wigley is not a global warming optimist but is closely aligned with what might be called the alarmist position on climate change. He is a true believer in the notion that global warming will be dramatic and is mostly induced by human activity, as opposed to natural fluctuations in the climate.

What This Research Means for the North Carolina Global Warming Commission

The reason why Wigley's research is important for North Carolina is that a new commission has been formed by the General Assembly to examine whether the state should pursue policies that would result in a reduction in greenhouse gas emissions, primarily carbon dioxide. The foundational question that the North Carolina Legislative Commission on Global Climate Change is supposed to address relates directly to Wigley's analysis. According to the establishing legislation, the commission is to pursue "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."[5]

By working back from Wigley's estimates of the effects of the Kyoto Protocol, we can get a reasonably clear picture of the impact that greenhouse gas reductions from North Carolina would have on global climate. Greenhouse gas reductions from North Carolina wouldn't have *any* detectable impact on the global climate.

Wigley's conclusions address the last piece of the legislative mandate. It looks at the extent of the impact that the *worldwide reductions* in CO_2 required by the Kyoto Protocol would have on global climate. Again, they would be undetectable by common measuring devices — and those are after *worldwide* reductions.

Furthermore, the UN Treaty would require most industrialized countries to reduce CO_2 emissions to 5 percent below 1990 levels. It would have required the U.S., had we decided to participate, to reduce its emissions to 7 percent below 1990 levels. According to the U.S. Energy Information Agency (EIA), as of 2004 the United State was already about 16 percent above 1990 levels.[6] This means that we would need to reduce current CO_2 emissions by about 20 percent to comply with Kyoto.

Wigley estimates that even those dramatic reductions would have an imperceptible impact on global climate. The EIA, on the other hand, estimates that they would cost the U.S. about 4 percent in GDP and eliminate millions of jobs from the economy.[7] So although the benefits of the reductions would be imperceptible, the costs would be severe and painful.

Conclusion

The implication of Wigley's research is that there is nothing North Carolina can do, either acting alone or in consort with other states, to affect either the long- or the short-run trend in global temperatures.

If any policies proposed by the North Carolina Global Warming Commission are to be taken seriously, the commission must come to terms with Wigley's research. Other aspects of the commission's legislative responsibilities require it to show that the benefits of its policy proposals, in terms of global climate change, outweigh the costs. Unless the commission can show that Wigley's calculations are incorrect, this second aspect of its analysis becomes moot.

Dr. Roy Cordato is vice president for research and a resident scholar at the John Locke Foundation.

Notes

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John Locke FOUNDATION

SPOTLIGHT

No. 253— April 12, 2005

GLOBAL WARMING POLICY

NC Should Do Nothing

Summary: The NC General Assembly is considering creating a new commission to develop state policies to combat global warming. But the scientific issues involved are complex and unsettled. If North Carolina were to try and reduce greenhouse gas emissions it would have no meaningful impact on global climate or the health and wellbeing of North Carolinians. On the other hand it would destroy tens of thousands of jobs. In other words a green house gas reduction policy would have only costs and no benefits.

The "clean smokestacks" legislation, passed in 2002, mandates that a commission be established to study policy options for reducinc carbon dioxide (CO_2) emissions.[1] The General Assembly is currently considering legislation to establish such a commission. But it makes little sense for the state of North Carolina to pursue such policies. This is because there is nothing that North Carolina could do that would have any impact on the global climate, even if one believes that significant human-induced warming is occuring.

CO_2 and Global Warming

CO_2 is essential for life on earth. It is the gas that humans and animals exhale and plants, trees, and all forms of vegetation "inhale." CO_2 is also a "greenhouse gas." This means that, along with other important gasses such as water vapor (the most significant) and methane, it insulates the earth, keeping warmth from the sun from simply bouncing out to space. As Illinois Institute of Technology Professor Henry Linden points out, "without the greenhouse effect, our planet could support at most very primitive forms of life."[2]

The global warming "problem" arises because of a possible "enhanced" greenhouse effect. It is argued that because humans burn carbon-based fuels such as coal, oil, and to a lesser extent natural gas to fuel much of modern civilization, too much CO_2 is put into the atmosphere, causing excessive warming. This is the global warming hypothesis. Those who subscribe to this hypothesis use computer simulation models to predict that the Earth will warm anywhere from 1.5 to 4.5 degrees Celsius (2.7 to 8.1 degrees Fahrenheit) over the next 100 years as a result of human activities. Typically they also claim that human-induced global warming has already begun and point to increases in global temperatures, as measured by land-based thermometers over the last century, as evidence for their proposition. [3]

-more-

200 W. Morgan, #200
Raleigh, NC 27601
phone: 919-828-3876
fax: 919-821-5117
www.johnlocke.org

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Should North Carolina Take Unilateral Action?

First, it should be noted that the global warming hypothesis is controversial. Nearly every aspect of the theory is part of an ongoing debate in the scientific literature a point almost never recognized in the media. But assuming that the hypothesis is correct and that it implies that public policy action at some level should be taken to correct for global warming, should our state unilaterally force restrictions of CO_2 emissions? All evidence suggests that the answer is no.

Any action that North Carolina could take would involve all costs and no benefits, either to North Carolina citizens or in terms of improved global or local climate conditions. Not only is CO_2 necessary for life on earth but it has no adverse health effects and is generally not considered a pollutant. It has never been listed as a pollutant under the Clean Air Act and according to most observers would not qualify as a pollutant under any of the Act's provisions.[4] A reduction in the state's CO_2 emissions would bring about no improvement to the health or well-being of North Carolina's citizens.

Since CO_2 is stored in anything that is or once was plant life, like trees, coal, and oil, burning any of these things, whether for fuel or in a forest fire, will release that stored CO_2 back into the atmosphere. CO_2 emissions are therefore an inescapable by-product of burning carbon-based fuels and the only way to reduce these emissions, at least in any kind of reasonable time horizon, is for people to use less energy. But to force people to use less energy will make them worse off.

The problem is that energy use is not an end in itself but a means by which people make their lives better and more convenient. To assume that people are "wasting energy" is paternalistic. It is based on the presumption that there are some goals that people are using energy to accomplish that shouldn't be pursued. The fact is that if people could remain as satisfied with their lives as they are now while consuming less energy, it would already be in their interest to do so. Efforts to force our citizens to use less energy, through higher taxes or other coercive means, will necessarily make them worse off. Consequently, it should be no surprise that former President Bill Clinton's own Department of Energy concluded that to comply with the United Nations Treaty on Global Warming would cost the U.S. over $400 billion a year (4 percent of GDP) and reduce employment by1.4 million jobs.[5]

Since CO_2 has no direct harmful effects on human health, the question for N.C. policy makers is: Would there be indirect benefits for global climate change from a state-based CO_2 reduction plan? Even if one accepts the relationship between CO_2 emissions and global temperatures that is hypothesized above, the undeniable answer is no.

In 1998, Dr. Thomas Wigley, Senior Scientist at the U.S. National Center for Scientific Research, estimated the effect on global climate that would occur if all of the signers of the UN Treaty on Global Warming known as the Kyoto Protocol adhered to its provisions with 100 percent compliance. The treaty calls on industrial nations to reduce CO_2 emissions to 7 percent below 1990 levels by 2012. For the United States this would mean about a 35 percent to 40 percent reduction from levels that would otherwise be obtained. Wigley's results have implications for any policy that might be put forth by North Carolina. He found that 100 percent compliance with the UN treaty would result in global temperatures that would be a mere 0.13 degrees Fahrenheit lower than they otherwise would be by the year 2050.[6]

As University of Virginia climatologist Patrick Michaels has noted, "This amount would be undetectable with land-based thermometers."[7] Clearly, if global adherence to the Kyoto protocols would have such an insignificant impact on global climate then nothing North Carolina could do to reduce CO_2 emissions would be anything but symbolic.

Throwing People Out of Work

In 1997 a comprehensive study of the costs of carbon dioxide strategies was done by DRI/McGraw-Hill, a leading econometric forecasting and economic research group. In this study they looked at the employment effects on individual states of national policies to reduce CO_2 emissions to 1990 levels.[8]

The impact on North Carolina would be significant, with tens of thousands of jobs being lost (see table). The study predicts that there would be a 1.8 percent reduction in employ-

Projected N.C. Job Losses from a National Policy to Cut CO2 Emissions to 1990 Levels

	Total Employment	Manufacturing	Mining
After 5 yrs	53,036	8,146	163
% change	-1.40%	-1.40%	-4.60%
After 10 yrs	68,189	7,564	291
% change	-1.80%	-1.30%	-8.20%
After 15 yrs	45,459	6,400	429
% change	-1.20%	-1.10%	-12.10%
After 20 yrs	34,094	9,309	578
% change	-0.90%	-1.60%	-16.30%

Sources: DRI/McGraw-Hill and US Bureau of Labor Statistics, Employment and Earnings Data Series, 3rd Quarter 2004

ment statewide after 10 years. At 2004 employment levels this would translate into more than 68,000 lost jobs. Particularly hard hit would be the manufacturing sector with over 7,500 jobs lost after 10years and over 9,000 lost after 20 years. But by far the hardest hit in terms of percentage of jobs lost would be North Carolina's mining industry, which would lose over 8 percent of its jobs after 10 years and over 16 percent after 20 years.

These numbers do not tell us what the job loss will be for any particular set of policies that might be implemented by N.C. policy makers. On the other hand, they do give us an idea of the kinds of costs that can be imposed on the economy if policies are pursued to significantly reduce the state's CO_2 emissions. And as has been discussed, these will be costs that will generate no accompanying benefits to either North Carolina's citizens or the global environment.

Is the Science Settled?

Despite media hype and the proclamations of environmental activists, the global warming hypothesis *is* controversial. For example, the National Academy of Sciences, in a highly publicized but mischaracterized report on global warming,[9] stated that "a causal linkage between the buildup of greenhouse gases in the atmosphere and the observed climate changes during the 20th century cannot be unequivocally established" (p. 17).

The report also notes other facts about the warming that has occurred over the last 20 years. It points out that due to inadequacies in the global warming computer simulations, there is no way to tell whether this warming is anything more than natural climate variation. "The fact that the magnitude of observed warming is large compared to natural variability as simulated in climate models does not constitute proof of a linkage [to increases in greenhouse gases] because the model simulations could be deficient in natural variability"(p. 23).

The NAS report also notes that land-based measurements of global temperatures are inconsistent with satellite readings, which have shown modest warming. "Satellite measurements beginning in 1979 show little warming of air temperature in the troposphere" (p. 17). This is especially significant because the global warming hypothesis predicts that temperatures in the upper atmosphere should show warming prior to warming at the surface. The NAS report acknowledges that they have no explanation for this theoretical contradiction: "The finding that surface and troposphere temperature trends have been as different as observed over intervals as long as a decade or two is difficult to reconcile with our current understanding of the processes that control the vertical distribution of temperature in the atmosphere" (p. 17).

In fact, this appears to be evidence that directly contradicts the global warming hypothesis, suggesting that the surface warming is not part of a pattern of human-induced global warming. As an aside, it is important to note that there are three measurements of global temperatures land-based, satellite, and weather balloon and only the land-based thermometers show significant warming over the last 25 years.[10]

Immediately after the release of the study and the misleading media reports that followed, Dr. Richard Lindzen, an MIT scientist and member of the NAS panel that conducted the study, wrote an article for *The Wall Street Journal* which attempted to set the record straight. "The full report make[s] it clear that there is no consensus, unanimous or otherwise, about long term climate trends and what causes them," he wrote. "Our primary conclusion was that despite some knowledge and agreement, the science is by no means settled."[11]

Conclusion

Even if one accepts the global warming hypothesis, it is clear that there is nothing that North Carolina should or can do about it. Any policies that lead to significant reductions in CO_2 emissions would cost the state tens of thousands of jobs while offering no compensating benefits. The idea of a costly state-based CO_2 mitigation policy becomes even more absurd in light of the fact that the science is by no means settled.

The "clean smokestacks" legislation calls for the establishment of a committee to make recommendations on policies to reduce CO_2 emissions. The mandate to form such a committee was not considered in light of sound science or economics. A CO_2 reduction policy for North Carolina would do nothing to either affect global climate or improve the health and well-being of North Carolina's citizens.

Dr. Roy Cordato, Vice President for Research and Resident Scholar

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SUNDAY FORUM

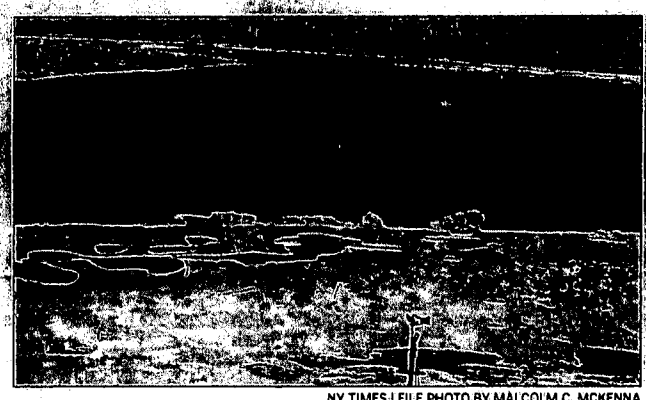
Warming is here. Now what do we do?

BY WILLIAM H. SCHLESINGER
Guest columnist

Like it or not, global warming is upon us. Weather station records show it, and so do the Navy's historic oceanographic records, NASA's satellite data, and scientists' observations of plants, animals, and icepacks. The real questions facing us are: Is this warming unusual? Is it the result of human activities? Should we be worried about warming? And can we do anything about it?

As a global change scientist, I am often asked these questions. I believe the answer to each of them is "yes."

What are the facts? The Earth has shown large fluctuations in temperature in its geologic history. About 18,000 years ago, much of North America was covered with an ice pack, which was a mile thick over most of New England. The climate warmed rapidly at the end of the last ice age to the more favorable conditions of today. Glacial periods, certainly more than 12 of them, appear to have been part of a natural cycle during the Pleistocene beginning 2 million years ago. Today, we are in an interglacial period — a warm period between the last and the next continental glaciation, which should reach its peak in another 100,000 years.



NY TIMES | FILE PHOTO BY MALCOLM C. MCKENNA

The thick ice that has covered the Arctic Ocean at the pole for millions of years now has areas of open water at times, which scientists attribute to global warming.

Something close to the climate of today has persisted for most of the past 8,000 to 10,000 years of Earth's history. This period spans the entire history of organized human society — the development of agriculture, cities, trade, culture, and the amenities of modern life. Sure, there were minor fluctuations in the Earth's average temperature — a Medieval Warm Period from 890 to 1170 A.D. and the Little Ice Age from 1580 to 1850 A.D. — but those periods were only about one degree (Fahrenheit) warmer or cooler than the long-term average global temperature.

CO2 on the rise

At the beginning of the Industrial Revolution in the mid-1800s, humans began to burn fossil fuels (coal, oil and natural gas) that release carbon dioxide (CO2) to the atmosphere. Even then, physicists agreed that CO2 would act as a greenhouse gas in Earth's atmosphere — it absorbs outgoing heat radiation and warms the planet. CO2 is one of several gases that have this effect; water vapor is the most important greenhouse gas, accounting for about two-thirds of the Earth's natural greenhouse effect.

We should be thankful for Earth's natural greenhouse effect, which warms our planet above the freezing point of water. But we should also be watchful of our impact upon the greenhouse effect. Rising carbon dioxide from fossil fuel combustion will raise the temperature of our planet. Rising levels of water vapor might be expected to do the same, but there is no indication that humans have changed the content of water vapor (humidity) in the atmosphere except over some areas of irrigated desert.

Good records on carbon

Our interest focuses on carbon dioxide because we have good records that the concentration of carbon dioxide has increased from about 275 ppm (parts per million or 0.0275 percent) 150 years ago to today's value of about 380 ppm. Carbon dioxide is a gas that naturally cycles in and out of Earth's atmosphere. Volcanoes release a small amount to the atmosphere each year, and the weathering of rocks consumes a similar amount — about 0.05 percent of the atmospheric content each year. Animals and decomposing organisms break down organic materials and release carbon dioxide to the air. Plants take up carbon dioxide when they grow, so as to provide the food, fuel and other organic materials that we use in daily life. A large amount of carbon dioxide also moves in and out of the world's oceans each year — easily dissolved in cold polar waters and released from deep ocean waters at tropical latitudes.

Today, the concentration of carbon dioxide shows a seasonal fluctuation of about 6 ppm. Relatively stable levels of carbon dioxide before the Industrial Revolution indicate a close balance then between processes that add or subtract carbon dioxide from the Earth's atmosphere before humans discovered fossil fuels. Carbon dioxide is now rising about 1.5 ppm each year, so its rise over the past four decades dwarfs the annual fluctuations.

Volcanoes aren't helping

In the face of global warming from rising CO2, there are some processes that might be expected to cool the atmosphere, such as volcanic eruptions that inject large amounts of dust into the stratosphere. After the eruption of Tambora in Indonesia, 1816 was known as the year without a summer due to the global distribution of its dust, which cooled the atmosphere by reflecting sunlight away from the Earth. However, there is no indication that the rate of volcanic eruptions has increased globally during the Industrial Revolution, so as to counteract the rising concentrations of greenhouse gases during the past 150 years.

Jet contrails and particulate air pollutants also alter the receipt and loss of the sun's radiation to space. There is some indication that air pollutants have cooled regions of the Earth during the past 50 years, and the Earth's overall reflectivity or albedo has apparently increased since 2001. Despite these mitigating factors, the overall average temperature, as recorded by weather stations and other records, shows a distinct pattern of unusual warming of our planet. Individual stations may vary, but in Europe, Jurg Luterbacher and his coworkers at the University of Bern found that the summer of 2003 was the hottest summer in 500 years.

Heat wave forecast

What can we expect from future global warming? The temperatures in North Carolina are projected to rise between 5 and 9 degrees Fahrenheit before the end of this century. Even larger increases are projected in polar regions, where melting ice caps in Greenland and Antarctica are expected to yield about 18 inches of sea level rise. The ice in Greenland is already in rapid retreat, while that in the Antarctic ice pack has shown a small decrease since organized efforts to measure it began in 1978, as reported by Eric Rignot of NASA's Jet Propulsion Lab in Pasadena. Loss of polar ice, with its high reflectivity to incoming sunlight, can be expected to further warm the planet.

Most plants, animals, and disease organisms show strong correlations with climate. Warming temperatures will allow these organisms to occur farther north. One projection from the U.S. Forest Service shows sugar maple retreating from the United States into Canada before the end of this century. We can expect similar dramatic changes in forest trees in North Carolina. Farmers may have to abandon traditional crops in favor of those that thrive in a warmer climate. Global warming is likely to bring droughts to much of the American Great Plains, where a large percentage of our food is produced.

A warmer planet will have warmer oceans, and the record of rising sea-surface temperature compiled by Sydeny Levitus at NOAA's Laboratory in Silver Spring, Maryland, is consistent with other records of global warming. Each fall, we see hurricanes gather and strengthen over warm tropical seas. There is every reason to expect a greater intensity of hurricanes in warmer conditions of the future. No climate scientist can point to Hurricane Katrina and say that that specific hurricane was due to global warming, but the trend of a greater number of intense hurricanes in recent years is certainly consistent with global warming. Together with higher sea level, intense hurricanes are certain to cause major damage to low lying coastal areas.

Impact on flora

In addition to raising the Earth's temperature, rising CO2 in the atmosphere has direct effects on plants — some appearing beneficial and some problematic. An experiment in Duke Forest has shown 16 percent increases in the growth of loblolly pine exposed to high CO2 for the past eight years. This may sound desirable, but we have also noted a 70 percent increase in the growth of poison ivy and a large increase in the production of pollen. Those with hay fever, asthma and emphysema have much to fear from a future high-CO2 world.

What can we do? It is easier to say that we should wean ourselves from fossil fuels than to do so. Fossil fuels have been the economic driver behind modern society, freeing humans from the manual labor that limited how much we could accomplish each day. Yet when we see fossil fuels affecting basic characteristics of the planet, such as its climate, it is time to ask if we are fouling our own nest, with real costs to our health and economy.

Efficiency has rewards

Many nations produce more economic output per unit of fossil energy than the United States. In many cases, the difference stems from a higher efficiency of energy use in manufacturing and transport. Companies that increase their efficiency are rewarded at the bottom line, especially as the cost of petroleum has risen.

Recently, the North Carolina Legislative Committee on Climate Change began to grapple with the issue of climate change and what we can do to avoid its negative consequences. Certainly a combination of thoughtful tax incentives and taxes can help motivate more efficient use of fossil fuels in this state. This is not to recommend higher overall taxes. A new tax on the emission of fossil carbon could replace the current income tax that we send to Raleigh on April 15. Rather than higher tax bills, we can redesign the system to instill this thought on the public — if I use less fuel, I will pay less tax.

Whatever policies we institute to prevent climate change must be simple, fair and effective. We all live on the same planet and stand to suffer the same costs by our current inaction. Time is of essence; each molecule of CO2 that we add to the atmosphere is destined to affect our climate for more than 100 years.

William H. Schlesinger is the James B. Duke Professor of Biogeochemistry and Dean of the Nicholas School of the Environment and Earth Sciences at Duke University.

Tuesday 7 March 2006
Exhibit F

FOR IMMEDIATE RELEASE:

March 7, 2006

Robert Balling:

Education:

1974: AB, Wittenberg University
1975: MA, Bowling Green State University
1979: PhD in geography from the University of Oklahoma

Balling has acknowledged that he had received $408,000 in research funding from the fossil fuel industry over the last decade (of which his University takes 50% for overhead). Contributors include ExxonMobil, the British Coal Corporation, Cyprus Minerals and OPEC. [1] (http://www.mtn.org/~newscncl/complaints/hearings/det_118.html)

His views have led to his enthusiastic adoption by various members of the free-market extremist Atlas Economic Research Foundation network. He writes regularly for the Cato Institute, Tech Central Station and the Competitive Enterprise Institute.

His writings find him regularly in the company of other prominent climate change skeptics, including Sallie L. Baliunas, and S. Fred Singer of the Science and Environmental Policy Project.

In August 2004 Balling told Business Week "I'm convinced there will be engineering schemes that will allow our children's children to have whatever climate they want". [2] (http://www.businessweek.com/magazine/content/04_33/b3896001_mz001.htm)

http;//www.sourcewatch.org

COASTS IN CRISIS: CLIMATE CHANGE, SEA-LEVEL RISE, AND STORM DYNAMICS

Dr. Stanley Riggs
Distinguished Research Professor
Geology Department, East Carolina University
Greenville, NC 27858
March 7, 2006

ABSTRACT

I will be giving a presentation concerning the results of our long-term research on environmental change and its relationship to sea level rise and storm dynamics in coastal North Carolina. I am co-director of the North Carolina Coastal Geology Cooperative Research Program (ECU-USGS-NCGS-UPENN-UDEL-VIMS supported by federal and state funds with about 40 research scientists) dealing with the origin and evolution of NC's coastal system. As coastal geologists, we look backwards to understand where we have been and project where we are going. Thus, we are developing a very detailed history of environmental and sea level change in the NC coastal system at numerous time scales. These data represent hard cold facts, and reflect ongoing processes that have major economic consequences to NC and her citizens into the future that can not be ignored.

The natural processes of environment and sea level change are real and extremely dramatic--this is what we need to understand! Yes, it is important also to know how humans play into this, but let's not get bogged down with this latter question. The historical rise and fall of past civilizations have been intimately tied to natural shifts in the environment long before the industrial revolution. The natural earth system is incredibly dynamic and we had better understand this--to do nothing concerning the natural and ongoing changes of storm dynamics and sea level will cost us far more in terms of catastrophic losses of life, property, and resources than small changes in the way we live with, utilize, and manage our valuable state's resources. North Carolina, the U.S., and the World have a lot at stake at this point in time and our economic growth and development must move forward based upon on a solid scientific framework of earth processes and resources. Humans happen to be a natural part of these processes and now with our exploding technology (industrial revolution) and population (~6.5 billion and growing), we have become a major earth force--but to sort out the details of this "controversial" factor requires that we understand the basic earth processes first.

Greenhouse Gases and Global Warming
General Assembly of North Carolina
Legislative Commission on Global Climate Change
March 7th, 2006

Rob Jackson

CENTER ON GLOBAL CHANGE

NICHOLAS SCHOOL OF THE ENVIRONMENT AND EARTH SCIENCES
DUKE UNIVERSITY

Recent reports conclude that increased greenhouse gas concentrations are warming the earth

"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."
Intergovernmental Panel on Climate Change, 2001
synthesis report, >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

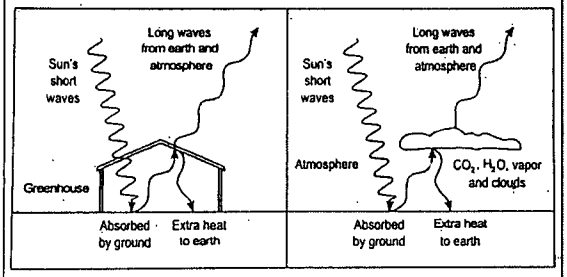


Figure 1:2 The greenhouse analogy (Gedzelman, 1980).

A brief history of greenhouse gases and global warming

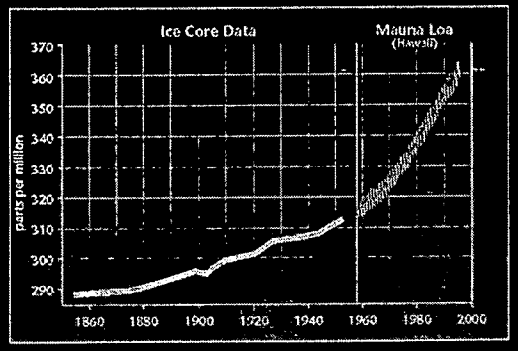
1827 Jean Baptiste Fourier first describes how the atmosphere traps infrared radiation, using a greenhouse as his analogy

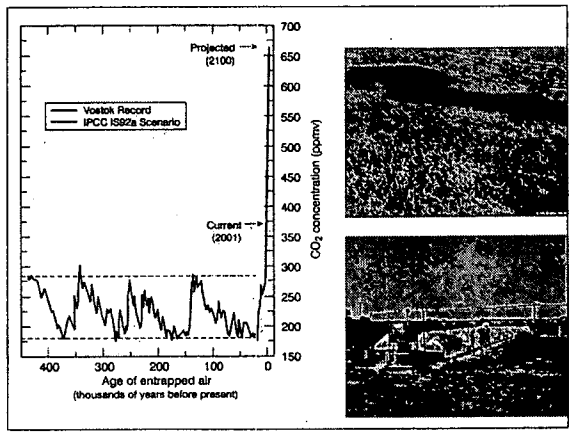
1890s Svante Arrenhius and P.C. Chamberlain independently propose that a build-up of CO_2 from fossil fuel burning would further warm the earth.

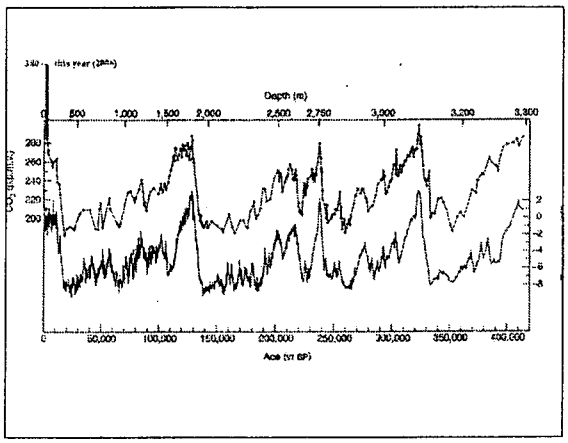
S. Arrhenius, Nobel Prize in Chemistry, 1903

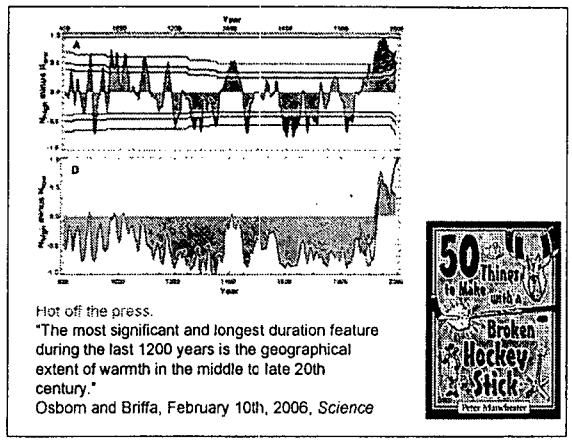
1958 Charles David Keeling begins his measurements at Mauna Loa showing a steady increase in atmospheric CO_2

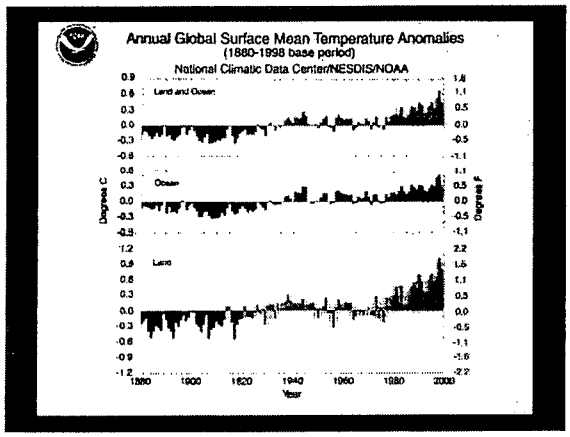
Carbon Dioxide Concentrations

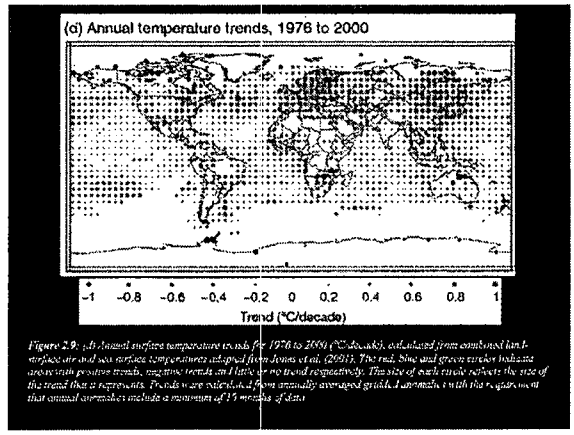


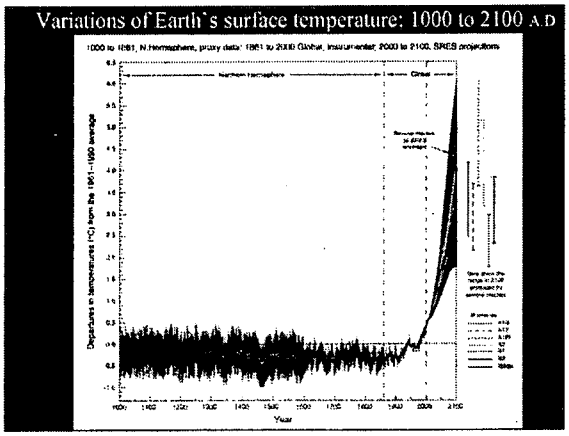


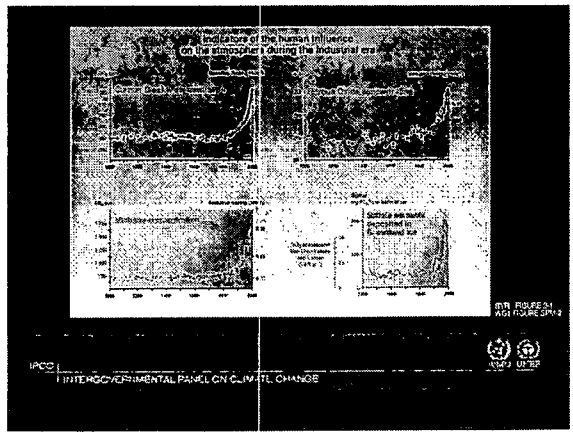

Depth (m)
0
500
1,000
1,500
2,000
2,500
2,750
3,000
3,200
3,350
280
260
240
220
200
CO2 (ppmv)
Deuterium
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
400,000
Age (yr BP)

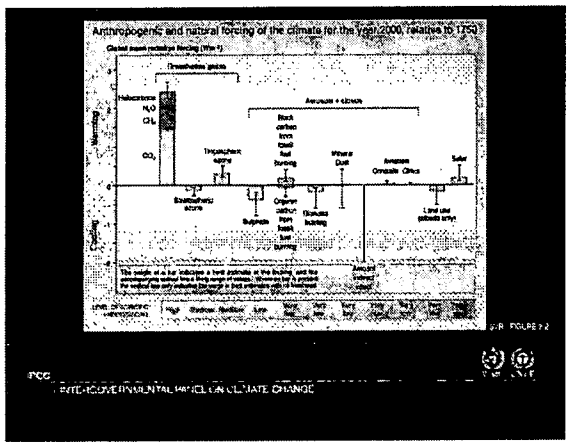

A
B
Year
Hot off the press.
"The most significant and longest duration feature during the last 1200 years is the geographical extent of warmth in the middle to late 20th century."
Osborn and Briffa, February 10th, 2006, Science
50 Thinner Is Make With A
Broken Hockey Stick
Peter Manchester

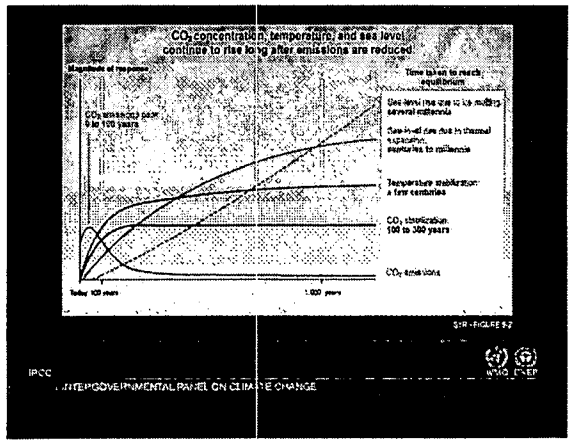

Annual Global Surface Mean Temperature Anomalies
(1880-1998 base period)
National Climatic Data Center/NESDIS/NOAA
Land and Ocean
Ocean
Land
Degrees C
Degrees F
1880
1900
1920
1940
1960
1980
2000
Year


(d) Annual temperature trends, 1976 to 2000
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
Trend (°C/decade)


Variations of Earth's surface temperature: 1000 to 2100 A.D
Year


IPCC
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



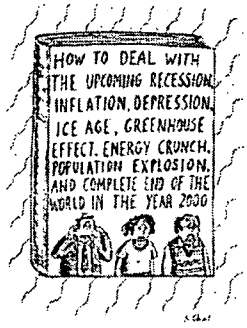


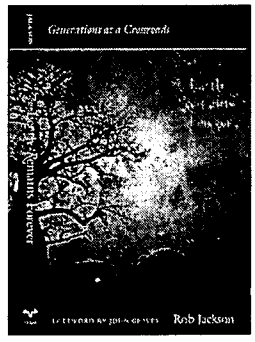
Recent reports conclude that increased greenhouse gas concentrations are warming the earth

"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

The world is warming up. ... Pollution from "greenhouse gases" such as carbon dioxide (CO_2) and methane is at least partly to blame "
American Association for the Advancement of Science, 2000

And hot off the press:
"The most significant and longest duration feature during the last 1200 years is the geographical extent of warmth in the middle to late 20th century."
Osborn and Briffa, February 10th, 2006, *Science*

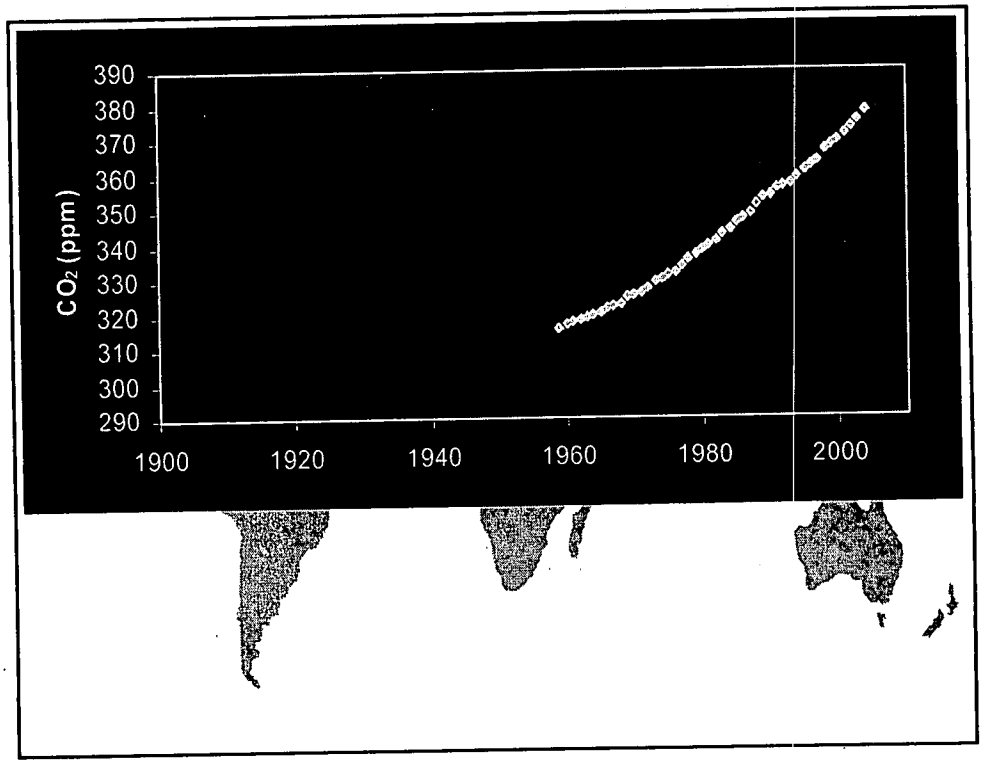


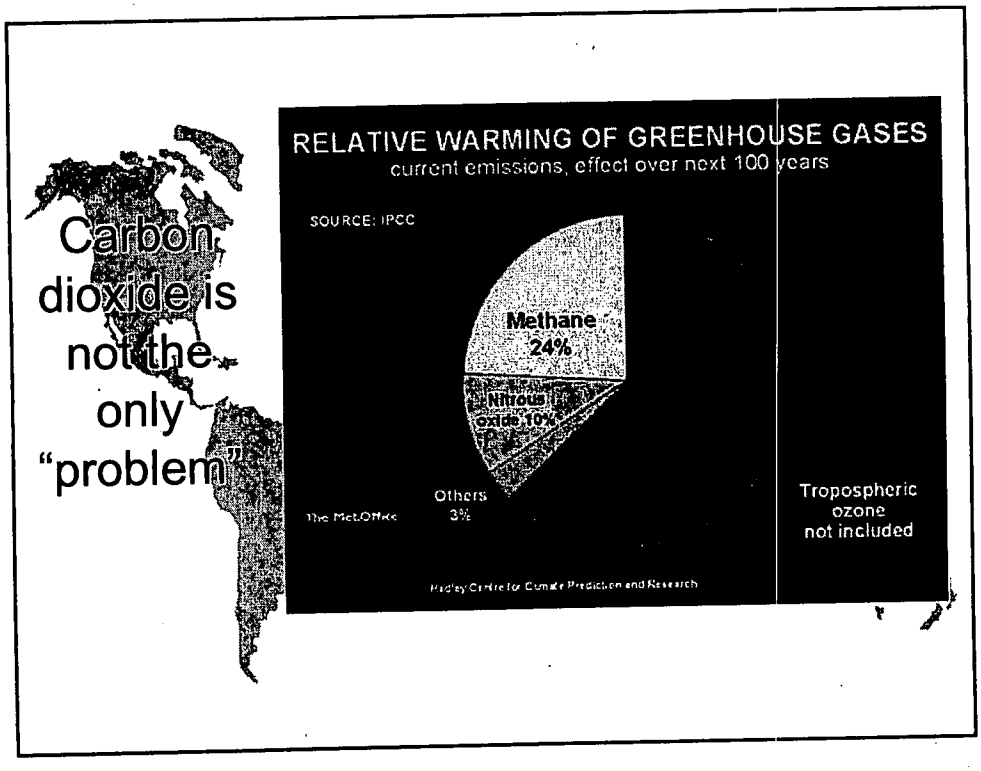


"The world was scheduled to end today, but something must have gone wrong."
Robertson Davies, The Papers of Samuel Marchbanks.

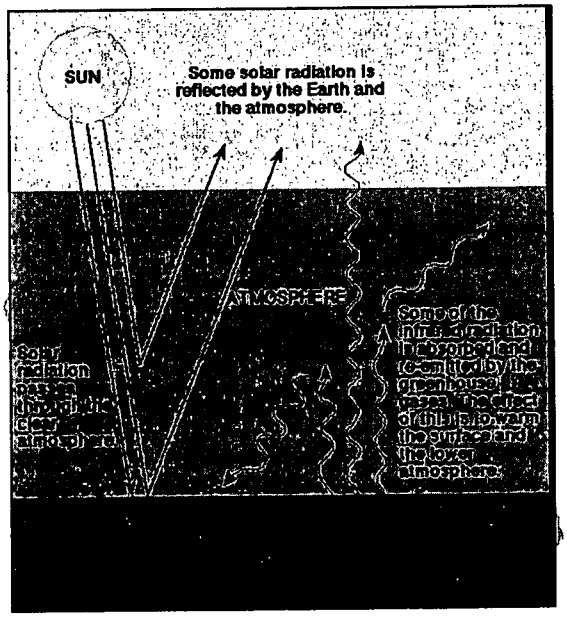
CGCC – Balling
3/7/2006

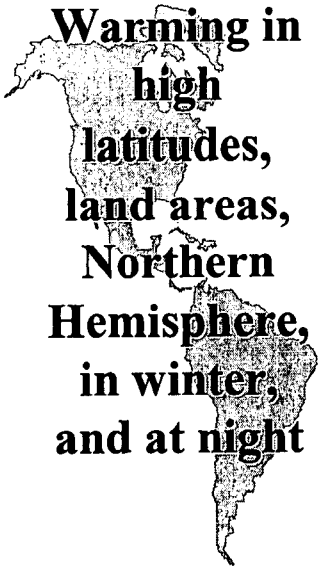
Tuesday 7 March 2006
Exhibit K



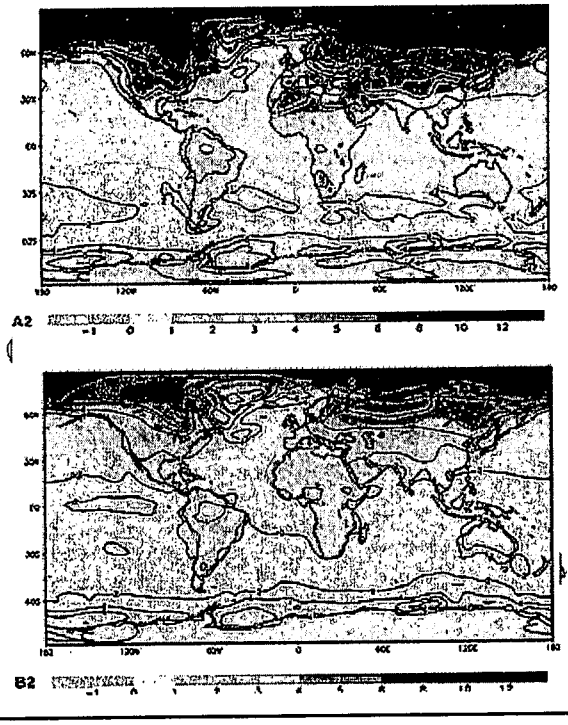


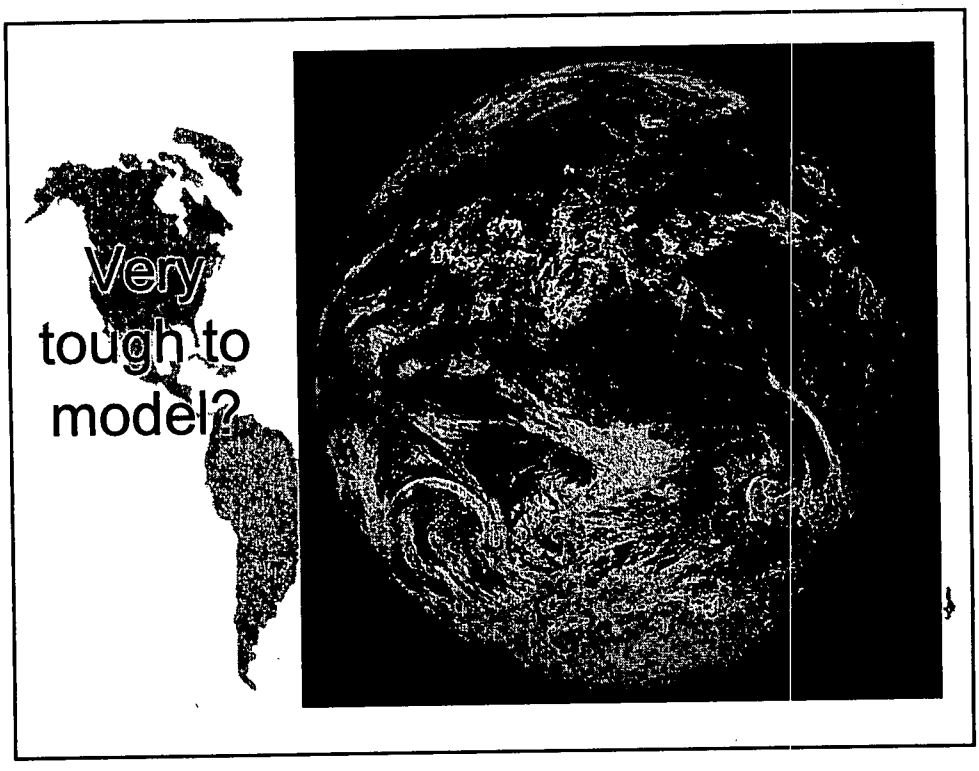
The greenhouse effect is real!

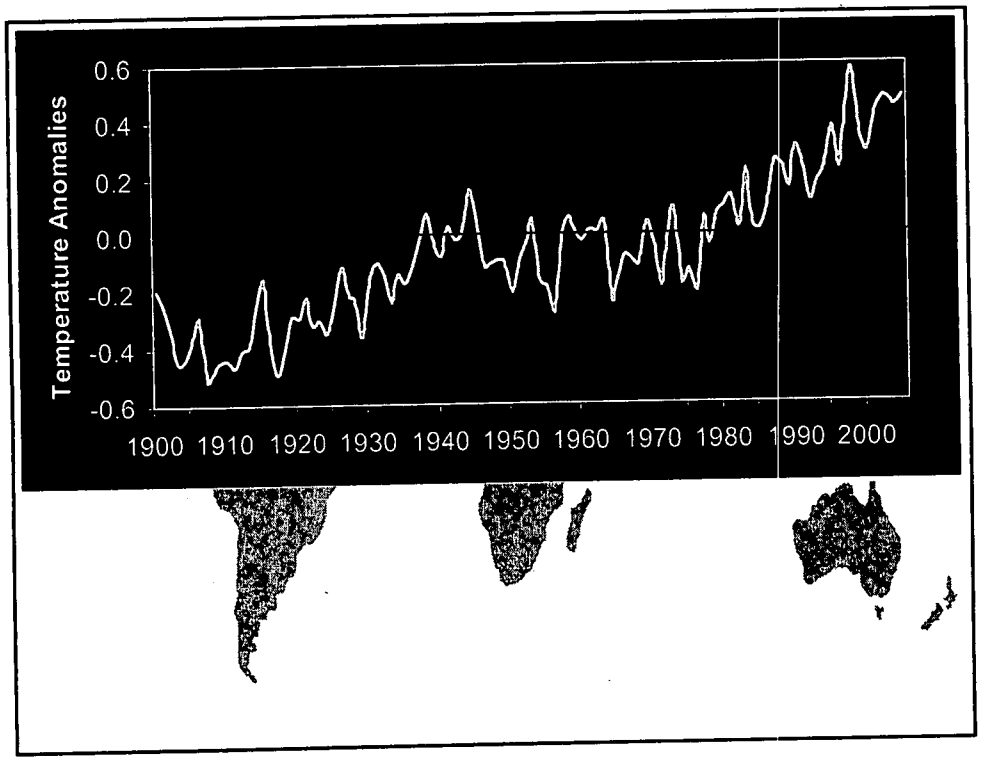


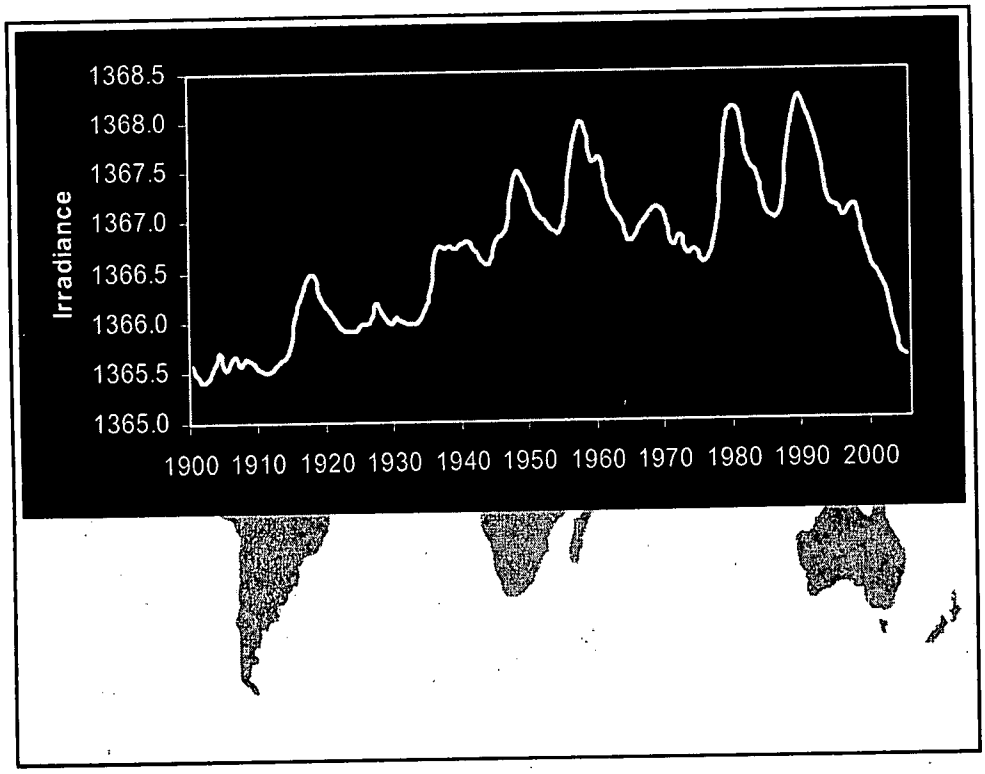


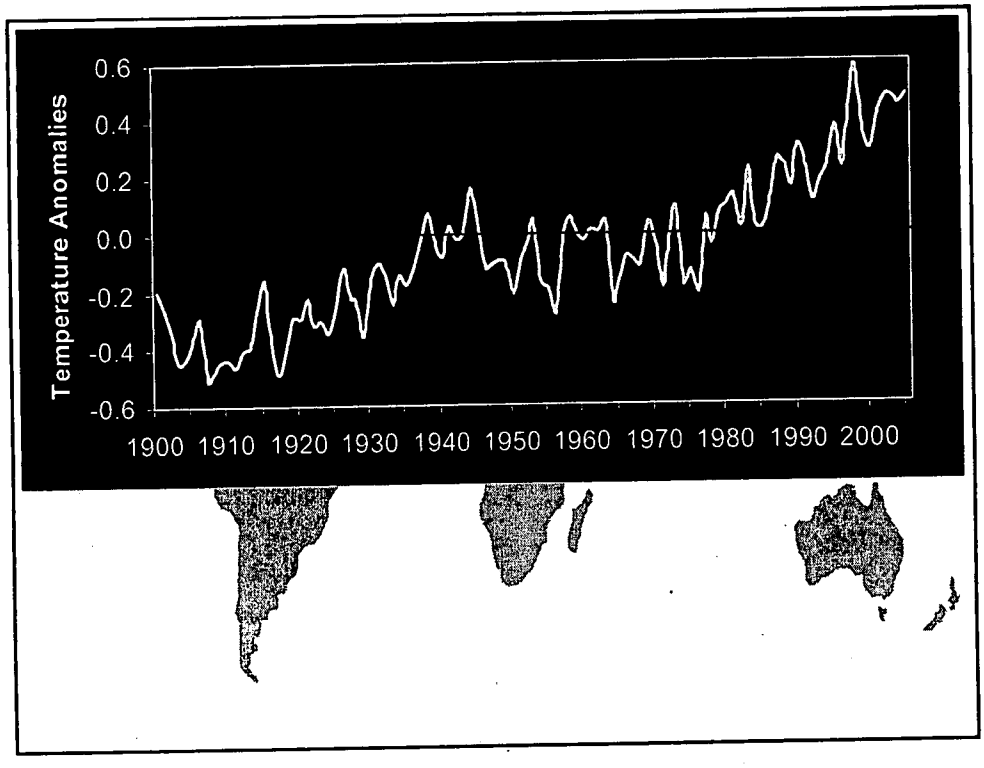
Warming in high latitudes, land areas, Northern Hemisphere, in winter, and at night

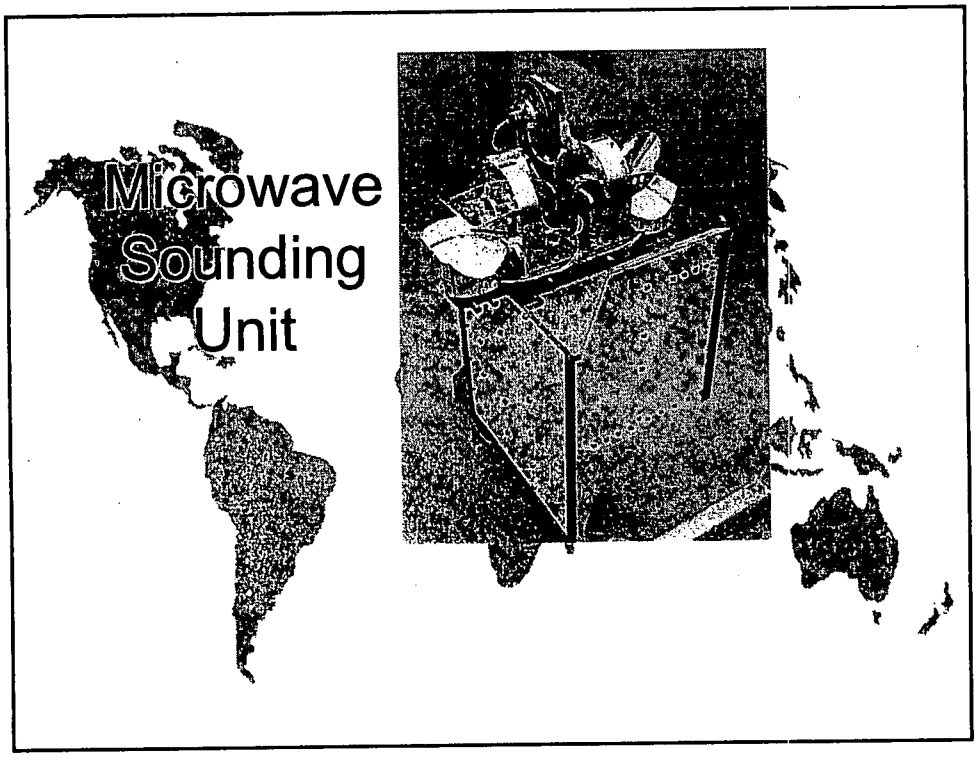


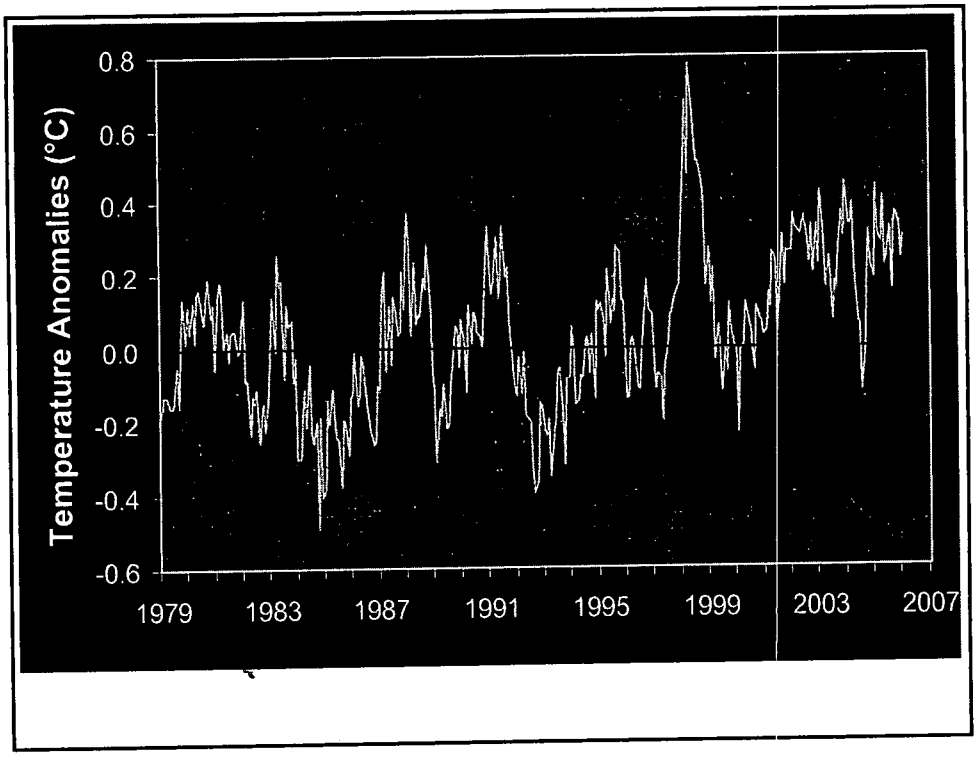

Very
tough to
model?

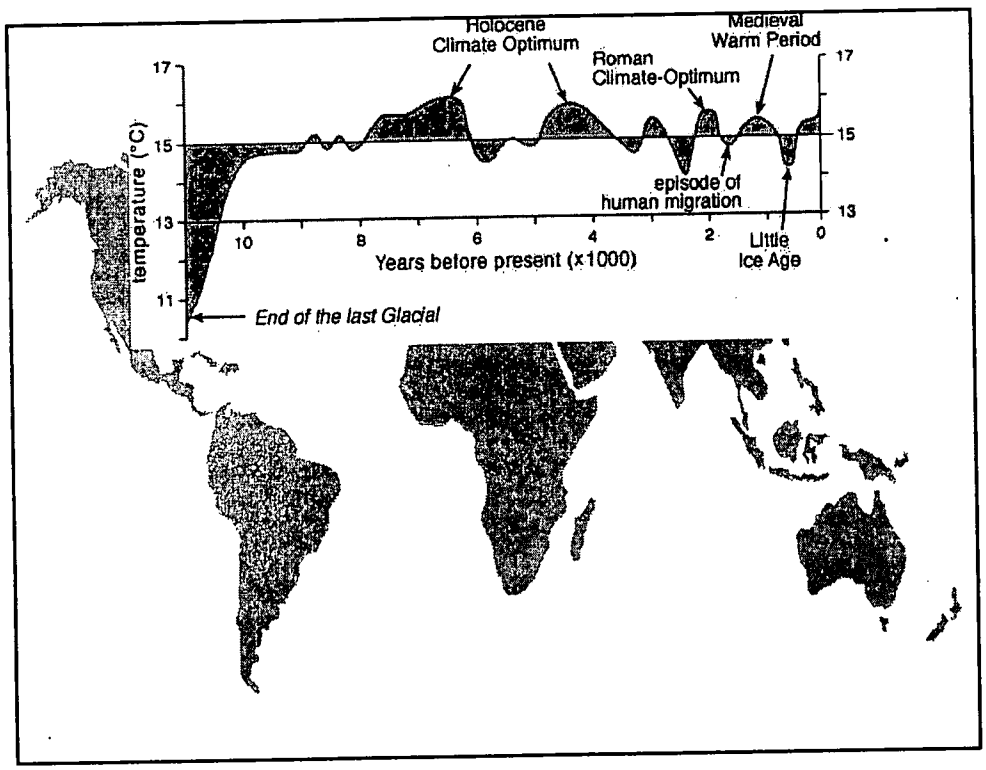

Temperature Anomalies
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000

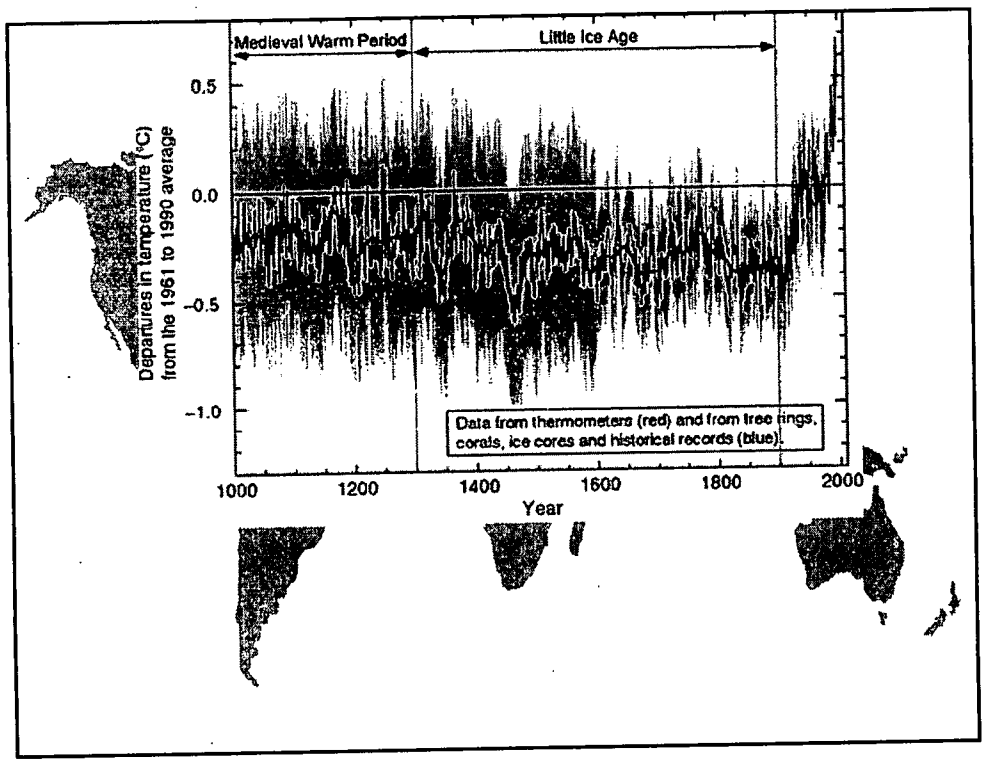

Irradiance
1368.5
1368.0
1367.5
1367.0
1366.5
1366.0
1365.5
1365.0
1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000

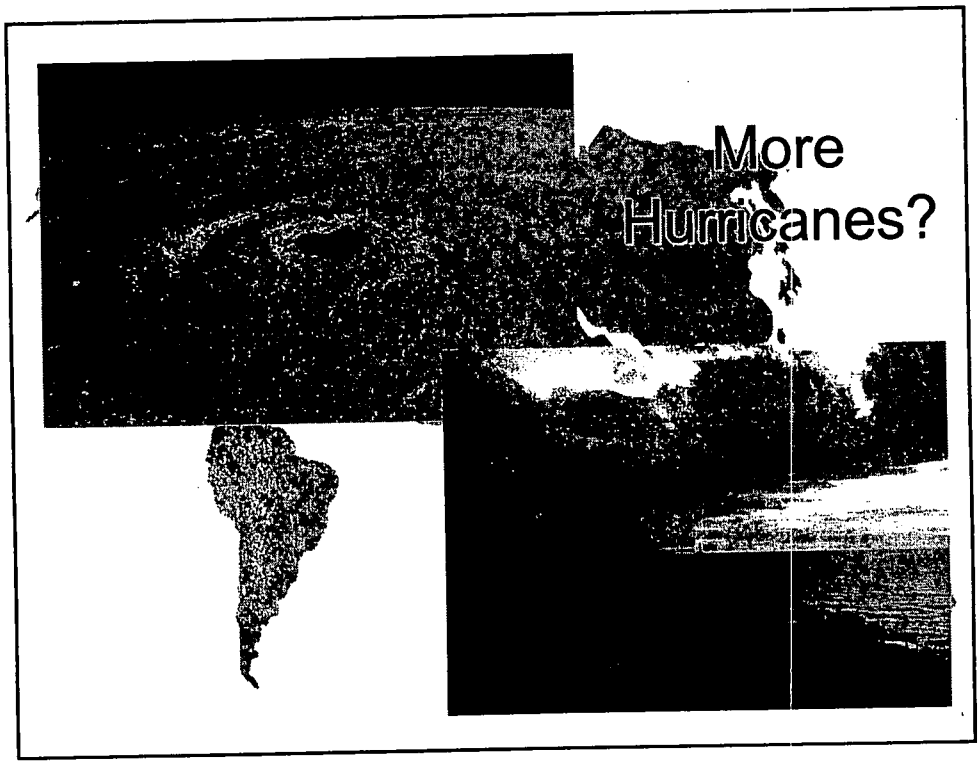

Temperature Anomalies
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000


Microwave
Sounding
Unit


Temperature Anomalies (°C)
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
1979
1983
1987
1991
1995
1999
2003
2007

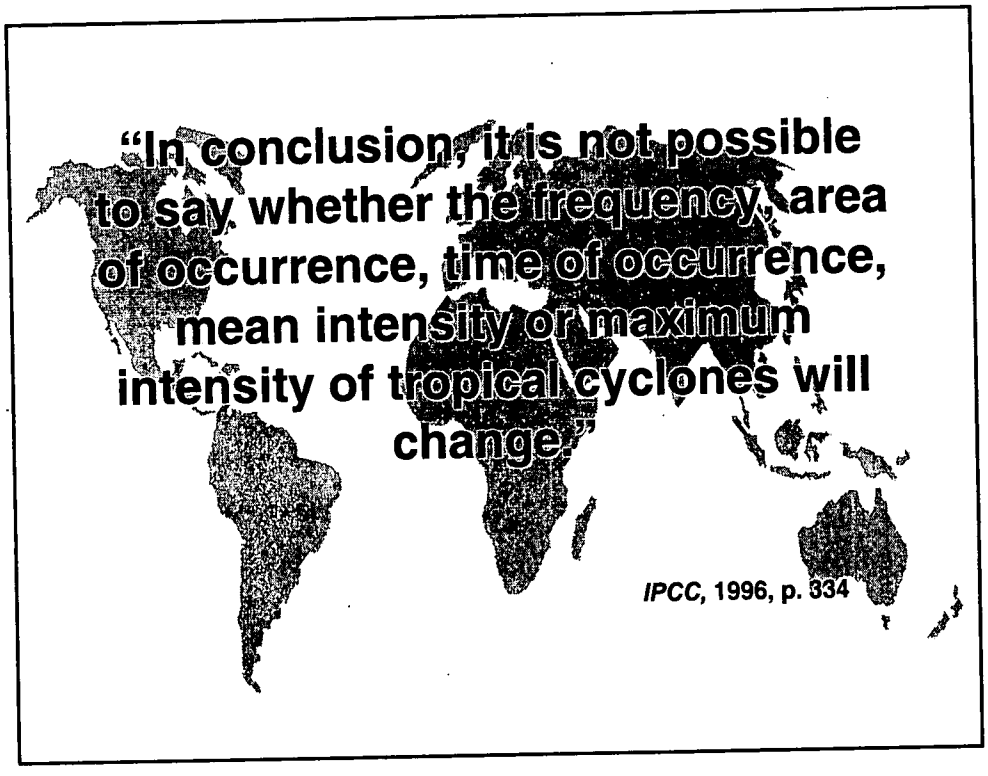

Holocene
Climate Optimum
Roman
Climate-Optimum
Medieval
Warm Period
episode of
human migration
Little
Ice Age
temperature (°C)
17
15
13
11
10
8
6
4
2
0
Years before present (x1000)
End of the last Glacial

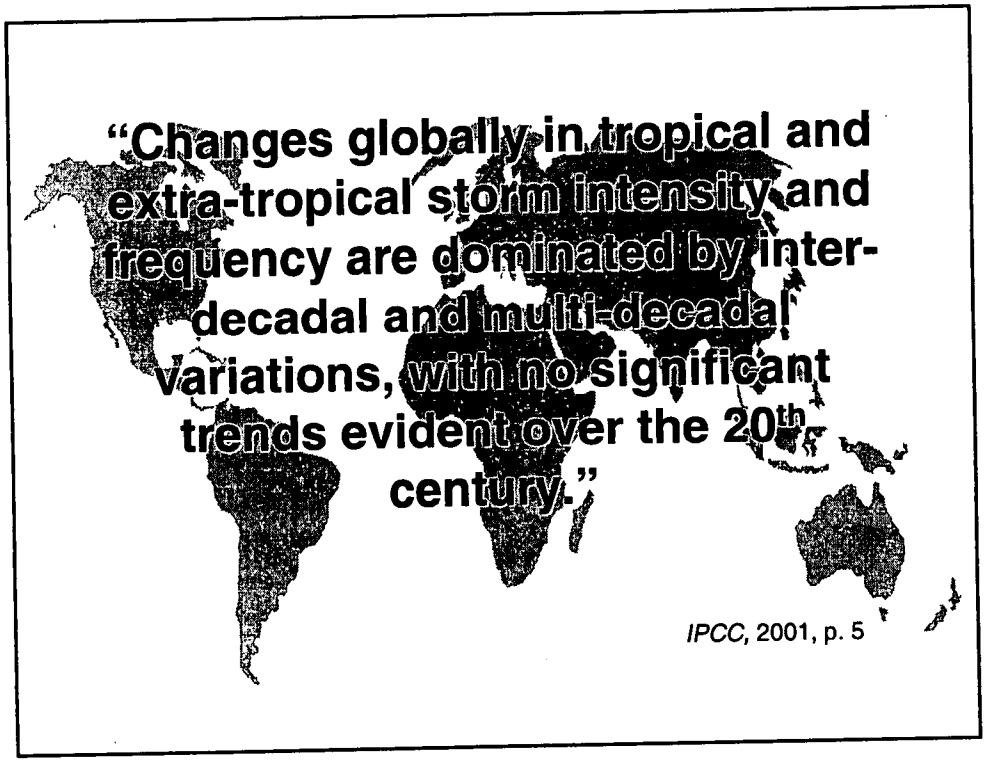

Medieval Warm Period
Little Ice Age
Departures in temperature (°C)
from the 1961 to 1990 average
0.5
0.0
-0.5
-1.0
Data from thermometers (red) and from tree rings,
corals, ice cores and historical records (blue).
1000
1200
1400
1600
1800
2000
Year

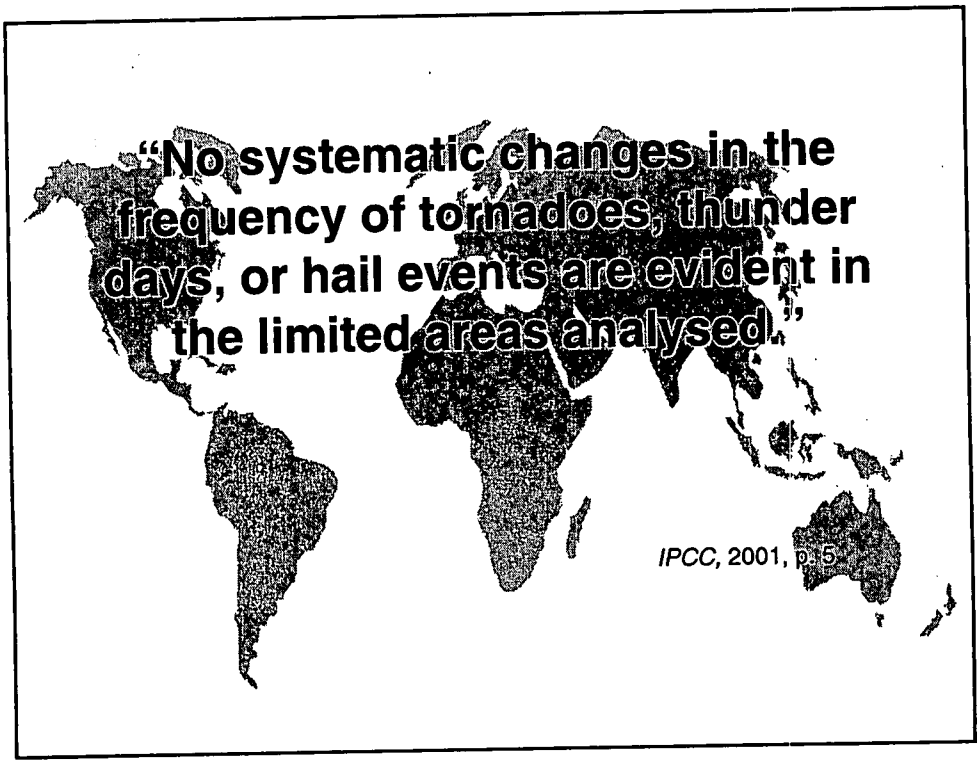


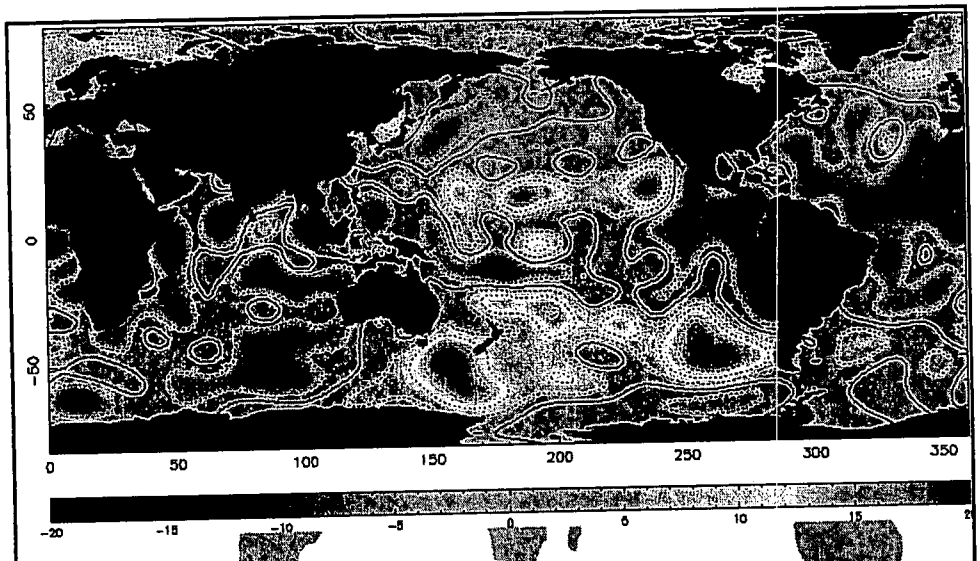
"... climate models give no consistent indication whether tropical storms will increase or decrease in frequency or intensity as climate changes; neither is there any evidence that this has occurred over the past few decades."

IPCC, 1990 (p. xxv)

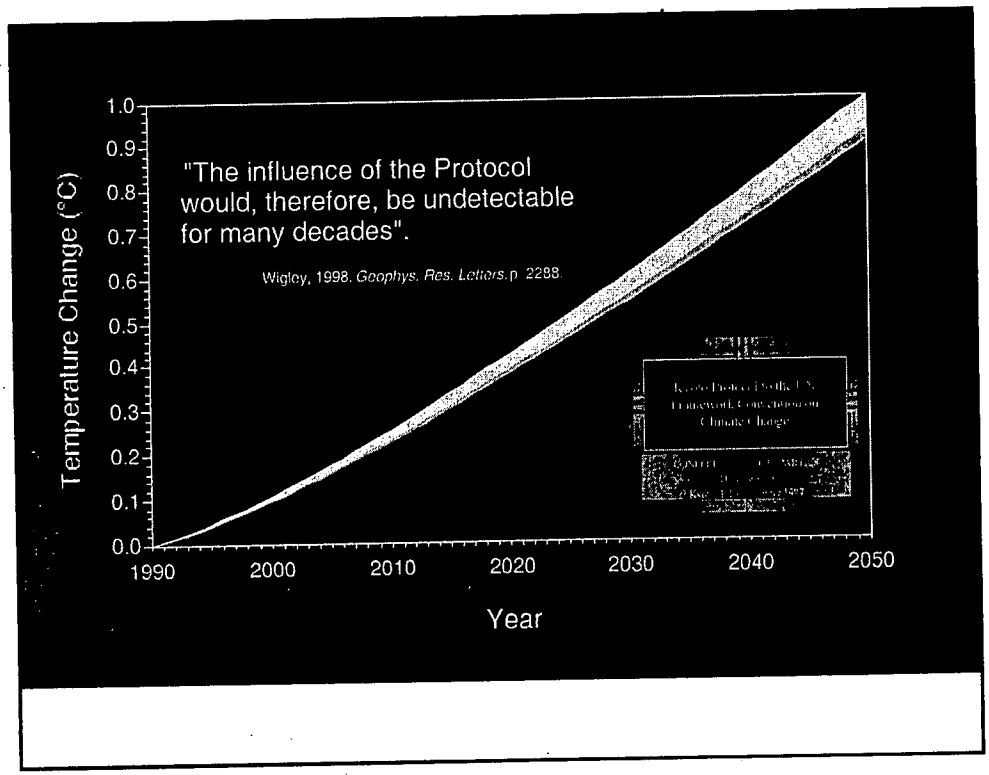

"In conclusion, it is not possible to say whether the frequency, area of occurrence, time of occurrence, mean intensity or maximum intensity of tropical cyclones will change."
IPCC, 1996, p. 334


"Changes globally in tropical and extra-tropical storm intensity and frequency are dominated by inter-decadal and multi-decadal variations, with no significant trends evident over the 20th century."
IPCC, 2001, p. 5

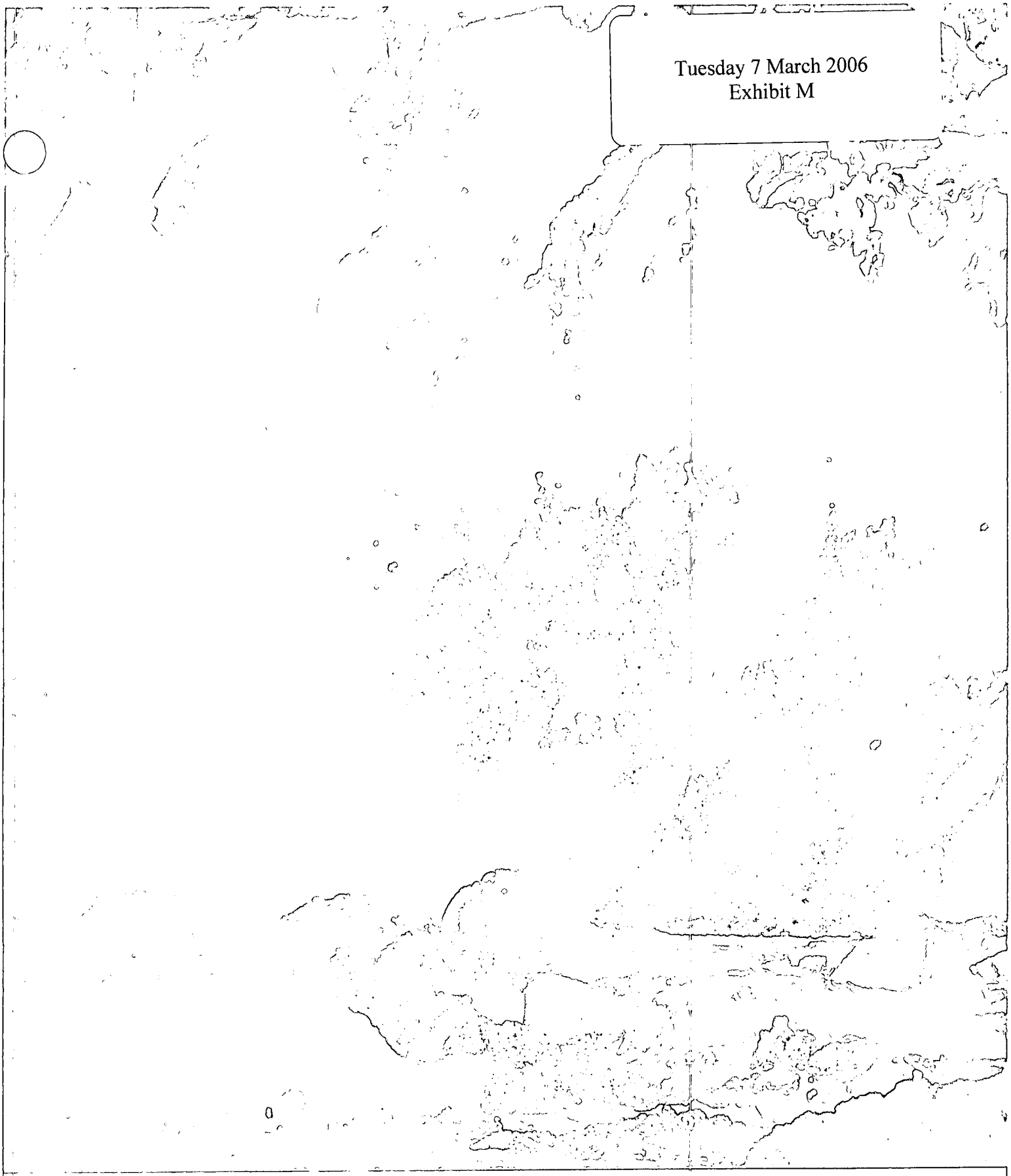




"decadal variability in sea level is observed, but to date there is no detectable secular increase in the rate of sea level rise over the period 1950-2000" Church et al., *J. Climate*, 2004, p. 2624.


"The influence of the Protocol would, therefore, be undetectable for many decades".
Wigley, 1998. Geophys. Res. Letters,p 2288.
Temperature Change (°C)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1990
2000
2010
2020
2030
2040
2050
Year

Tuesday 7 March 2006
Exhibit M



ICEBERG BREAKS OFF the San Rafael Glacier in Chile. Global disintegration of ice masses has the potential to raise sea level by several meters or more. The grim consequences of a rising sea level set a low threshold for how much the planet can warm without disrupting human society.

Global warming is real, and

Nevertheless, practical actions, which

Defusing the Global Warming TIME BOMB

BY JAMES HANSEN

the consequences are potentially disastrous.

would also yield a cleaner, healthier atmosphere, could slow, and eventually stop, the process

paradox in the notion of human-made global warming became strikingly apparent to me one summer afternoon in 1976 on Jones Beach, Long Island. Arriving at midday, my wife, son and I found a spot near the water to avoid the scorching hot sand. As the sun sank in the late afternoon, a brisk wind from the ocean whipped up whitecaps. My son and I had goose bumps as we ran along the foamy shoreline and watched the churning waves.

That same summer Andy Lacis and I, along with other colleagues at the NASA Goddard Institute for Space Studies, had estimated the effects of greenhouse gases on climate. It was well known by then that human-made greenhouse gases, especially carbon dioxide and chlorofluorocarbons (CFCs), were accumulating in the atmosphere. These gases are a climate "forcing," a perturbation imposed on the energy budget of the planet. Like a blanket, they absorb infrared (heat) radiation that would otherwise escape from the earth's surface and atmosphere to space.

Our group had calculated that these human-made gases were heating the earth's surface at a rate of almost two watts per square meter. A miniature Christmas tree bulb dissipates about one watt, mostly in the form of heat. So it was as if humans had placed two of these tiny bulbs over every square meter of the earth's surface, burning night and day.

The paradox that this result presented was the contrast between the awesome forces of nature and the tiny lightbulbs. Surely their feeble heating could not command the wind and waves or smooth our goose bumps. Even their imperceptible heating of the ocean surface must be quickly dissipated to great depths, so it must take many years, perhaps centuries, for the ultimate surface warming to be achieved.

This seeming paradox has now been largely resolved through study of the history of the earth's climate, which reveals that small forces, maintained long enough, can cause large climate change. And, consistent with the historical evidence, the earth has begun to warm in recent decades at a rate predicted by climate models that take account of the atmospheric accumulation of human-made greenhouse gases. The warming is having noticeable impacts as glaciers are retreating worldwide, Arctic sea ice has thinned, and spring comes about one week earlier than when I grew up in the 1950s.

Yet many issues remain unresolved. How much will climate change in coming decades? What will be the practical consequences? What, if anything, should we do about it? The debate over these questions is highly charged because of the inherent economic stakes.

Objective analysis of global warming requires quantitative knowledge of three issues: the sensitivity of the climate system to forcings, the forcings that humans are introducing, and the time required for climate to respond. All these issues can be studied with global climate models, which are numerical simulations on computers. But our most accurate knowledge about climate sensitivity, at least so far, is based on empirical data from the earth's history.

Overview/*Global Warming*

- At present, our most accurate knowledge about climate sensitivity is based on data from the earth's history, and this evidence reveals that small forces, maintained long enough, can cause large climate change.
- Human-made forces, especially greenhouse gases, soot and other small particles, now exceed natural forces, and the world has begun to warm at a rate predicted by climate models.
- The stability of the great ice sheets on Greenland and Antarctica and the need to preserve global coastlines set a low limit on the global warming that will constitute "dangerous anthropogenic interference" with climate.
- Halting global warming requires urgent, unprecedented international cooperation, but the needed actions are feasible and have additional benefits for human health, agriculture and the environment.

The Lessons of History

OVER THE PAST few million years the earth's climate has swung repeatedly between ice ages and warm interglacial periods. A 400,000-year record of temperature is preserved in the Antarctic ice sheet, which, except for coastal fringes, escaped melting even in the warmest interglacial periods. This record [*see box on opposite page*] suggests that the present interglacial period (the Holocene), now about 12,000 years old, is already long of tooth.

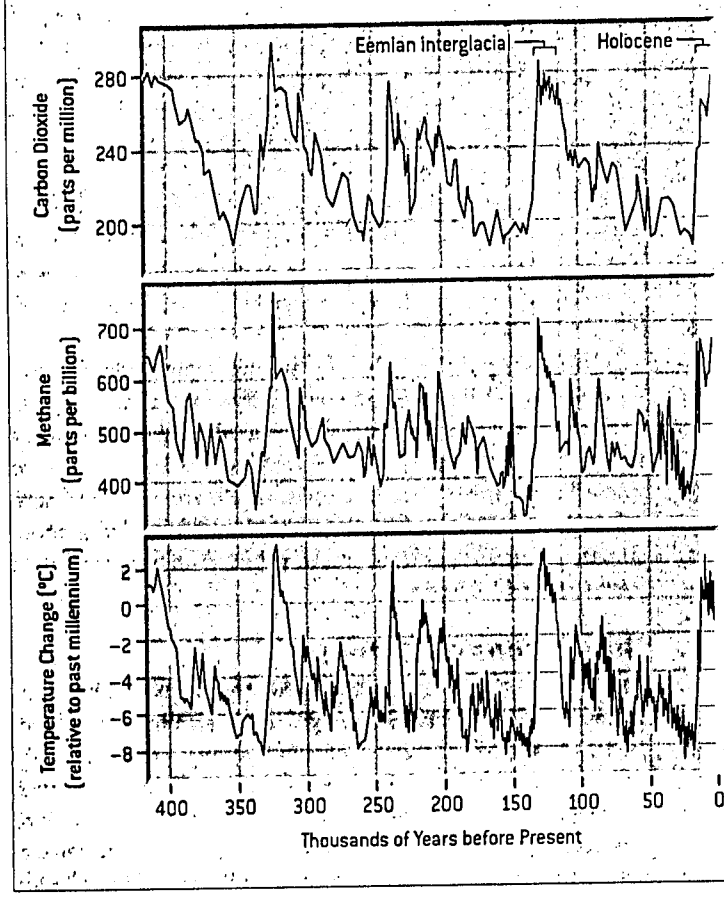
The natural millennial climate swings are associated with slow variations of the earth's orbit induced by the gravity of other planets, mainly Jupiter and Saturn (because they are so heavy) and Venus (because it comes so close). These perturbations hardly affect the annual mean solar energy striking the earth, but they alter the geographical and seasonal distribution of incoming solar energy, or insolation, as much as 20 percent. The insolation changes, over long periods, affect the building and melting of ice sheets.

Insolation and climate changes also affect uptake and release of carbon dioxide and methane by plants, soil and the ocean. Climatologists are still developing a quantitative understanding of the mechanisms by which the ocean and land release carbon dioxide and methane as the earth warms, but the paleoclimate data are already a gold mine of information. The most critical insight that the ice age climate swings provide is an empirical measure of climate sensitivity.

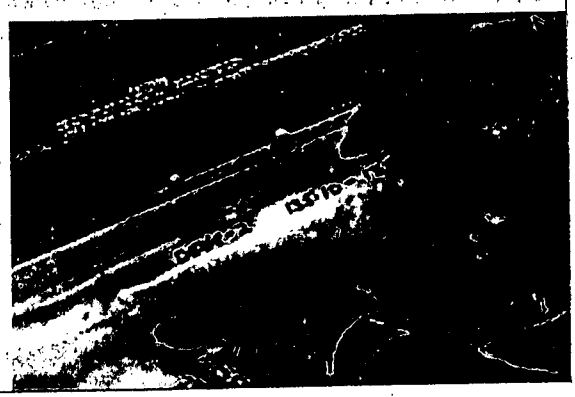
The composition of the ice age atmosphere is known precisely from air bubbles trapped as the Antarctic and Greenland ice sheets and numerous mountain glaciers built up from annual snowfall. Furthermore, the geographical distributions of the ice sheets, vegetation cover and coastlines during the ice age are well mapped. From these data we know that the change of

RIC ERGENBRIGHT *Corbis (preceding pages)*

400,000 YEARS OF CLIMATE CHANGE



ANTARCTIC ICE has preserved a 400,000-year record of temperature and of levels of carbon dioxide and methane in the atmosphere. Scientists study gases trapped in air bubbles in the ice—generally using ice cores (*photograph*) extracted from the ice sheet and transported to a laboratory. The historical record provides us with two critical measures: Comparison of the current interglacial period (the Holocene) with the most recent ice age (20,000 years ago) gives an accurate measure of climate sensitivity to forcings. The temperature in the previous interglacial period (the Eemian), when sea level was several meters higher than today, defines an estimate of the warming that today's civilization would consider to be dangerous anthropogenic interference with climate.



JEN CHRISTIANSEN; SOURCE: J. R. PETIT ET AL. IN *NATURE*, VOL. 399, PAGES 429–436; JUNE 3, 1999 (*graphs*); CSIRO/SIMON FRASER *Photo Researchers, Inc.* (*photograph*)

climate forcing between the ice age and today was about 6.5 watts per square meter. This forcing maintains a global temperature change of 5 degrees Celsius (9 degrees Fahrenheit), implying a climate sensitivity of 0.75 ± 0.25 degrees C per watt per square meter. Climate models yield a similar climate sensitivity. The empirical result is more precise and reliable, however, because it includes all the processes operating in the real world, even those we have not yet been smart enough to include in the models.

The paleodata provide another important insight. Changes of the earth's orbit instigate climate change, but they operate by altering atmosphere and surface properties and thus the planetary energy balance. These atmosphere and surface properties are now influenced more by humans than by our planet's orbital variations.

Climate-Forcing Agents Today

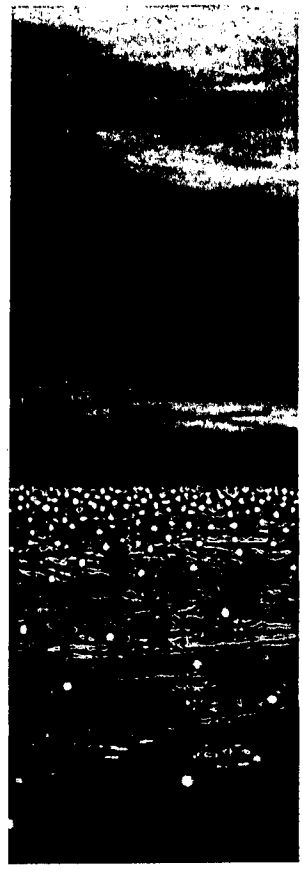
THE LARGEST change of climate forcings in recent centuries is caused by human-made greenhouse gases. Greenhouse gases in the atmosphere absorb heat radiation rather than letting it escape into space. In effect, they make the proverbial blanket thicker, returning more heat toward the ground rather than letting it escape to space. The earth then is radiating less energy to space than it absorbs from the sun. This temporary planetary energy imbalance results in the earth's gradual warming.

Because of the large capacity of the oceans to absorb heat, it takes the earth about a century to approach a new balance—that is, for it to once again receive the same amount of energy from the sun that it radiates to space. And of course the balance is reset at a higher temperature. In the meantime, before it achieves this equilibrium, more forcings may be added.

The single most important human-made greenhouse gas is carbon dioxide, which comes mainly from burning fossil fuels (coal, oil and gas). Yet the combined effect of the other human-made gases is comparable. These other gases, especially tropospheric ozone and its precursors, including methane, are ingredients in smog that damage human health and agricultural productivity.

Aerosols (fine particles in the air) are the other main human-made climate forcing. Their effect is more complex. Some "white" aerosols, such as sulfates arising from sulfur in fossil fuels, are highly reflective and thus reduce solar heating of the earth; however, black carbon (soot), a product of incomplete combustion of fossil fuels, biofuels and outdoor biomass burning, absorbs sunlight and thus heats the atmosphere. This aerosol direct climate forcing is uncertain by at least 50 percent, in part because aerosol amounts are not well measured and in part because of their complexity.

small forces, maintained long enough, can cause large climate change



Aerosols also cause an indirect climate forcing by altering the properties of clouds. The resulting brighter, longer-lived clouds reduce the amount of sunlight absorbed by the earth, so the indirect effect of aerosols is a negative forcing that causes cooling.

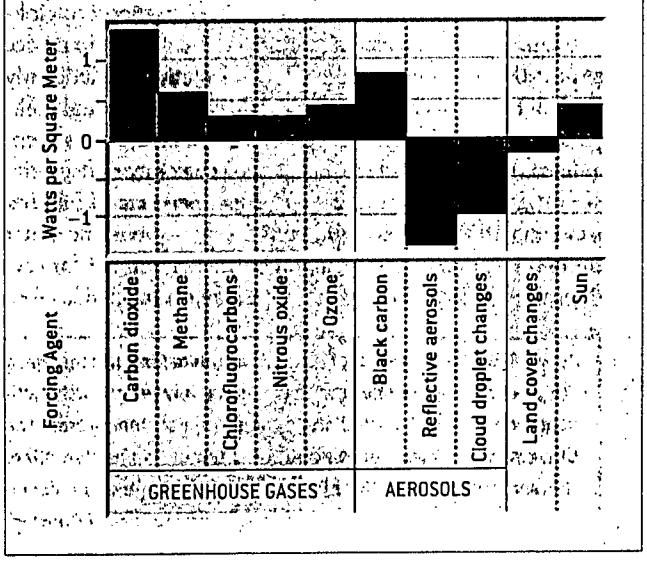
Other human-made climate forcings include replacement of forests by cropland. Forests are dark even with snow on the ground, so their removal reduces solar heating.

Natural forcings, such as volcanic eruptions and fluctuations of the sun's brightness, probably have little trend on a timescale of 1,000 years. But evidence of a small solar brightening over the past 150 years implies a climate forcing of a few tenths of a watt per square meter.

The net value of the forcings added since 1850 is 1.6 ± 1.0 watts per square meter. Despite the large uncertainties, there is evidence that this estimated net forcing is approximately correct. One piece of evidence is the close agreement of observed global temperature during the past several decades with climate models driven by these forcings. More fundamentally, the observed heat gain by the world ocean in the past 50 years is consistent with the estimated net climate forcing.

CLIMATE FORCINGS

A CLIMATE FORCING is a mechanism that alters the global energy balance. A forcing can be natural—fluctuations in the earth's orbit, for example—or human-made, such as aerosols and greenhouse gases. Human-made climate forcings now dominate natural forcings. Carbon dioxide is the largest forcing, but air pollutants (black carbon, ozone, methane) together are comparable. (Aerosol effects are not known accurately.)



Global Warming

GLOBAL AVERAGE surface temperature has increased about 0.75 degree C during the period of extensive instrumental measurements, which began in the late 1800s. Most of the warming, about 0.5 degree C, occurred after 1950. The causes of observed warming can be investigated best for the past 50 years, because most climate forcings were observed then, especially since satellite measurements of the sun, stratospheric aerosols and ozone began in the 1970s. Furthermore, 70 percent of the anthropogenic increase of greenhouse gases occurred after 1950.

The most important quantity is the planetary energy imbalance [*see box on page 75*]. This imbalance is a consequence of the long time that it takes the ocean to warm. We conclude that the earth is now out of balance by something between 0.5 and one watt per square meter—that much more solar radiation is being absorbed by the earth than is being emitted as heat to space. Even if atmospheric composition does not change further, the earth's surface will therefore eventually warm another 0.4 to 0.7 degree C.

Most of the energy imbalance has been heat going into the ocean. Sydney Levitus of the National Oceanic and Atmospheric Administration has analyzed ocean temperature changes of the past 50 years, finding that the world ocean heat content increased about 10 watt-years per square meter in the past 50 years. He also finds that the rate of ocean heat storage in recent years is consistent with our estimate that the earth is now out of energy balance by 0.5 to one watt per square meter. Note that the amount of heat required to melt enough ice to raise sea level one meter is about 12 watt-years (averaged over the planet), energy that could be accumulated in 12 years if the planet is out of balance by one watt per square meter.

The agreement with observations, for both the modeled temperature change and ocean heat storage, leaves no doubt that observed global climate change is being driven by natural and anthropogenic forcings. The current rate of ocean heat storage is a critical planetary metric: it not only determines the amount of additional global warming already in the pipeline, but it also equals the reduction in climate forcings needed to stabilize the earth's present climate.

The Time Bomb

THE GOAL OF the United Nations Framework Convention on Climate Change, produced in Rio de Janeiro in 1989, is to stabilize atmospheric composition to "prevent dangerous anthropogenic interference with the climate system" and to

JEN CHRISTIANSEN; SOURCE: JAMES HANSEN

HUMAN-MADE climate forcings, mainly greenhouse gases, heat the earth's surface at a rate of about two watts per square meter—the equivalent of two tiny one-watt bulbs burning over every square meter of the planet. The full effect of the warming is slowed by the ocean, because it can absorb so much heat. The ocean's surface begins to warm, but before it can heat up much, the surface water is mixed down and replaced by colder water from below. Scientists now think it takes about a century for the ocean to approach its new temperature.

RANDY HARRIS

achieve that goal in ways that do not disrupt the global economy. Defining the level of warming that constitutes "dangerous anthropogenic interference" is thus a crucial but difficult part of the problem.

The U.N. established an Intergovernmental Panel on Climate Change (IPCC) with responsibility for analysis of global warming. The IPCC has defined climate-forcing scenarios, used these for simulations of 21st-century climate, and estimated the impact of temperature and precipitation changes on agriculture, natural ecosystems, wildlife and other matters. The IPCC estimates sea-level change as large as several tens of centimeters in 100 years, if global warming reaches several degrees Celsius. The group's calculated sea-level change is due mainly to thermal expansion of ocean water, with little change in ice-sheet volume.

These moderate climate effects, even with rapidly increasing greenhouse gases, leave the impression that we are not close to dangerous anthropogenic interference. I will argue, however, that we are much closer than is generally realized, and thus the emphasis should be on mitigating the changes rather than just adapting to them.

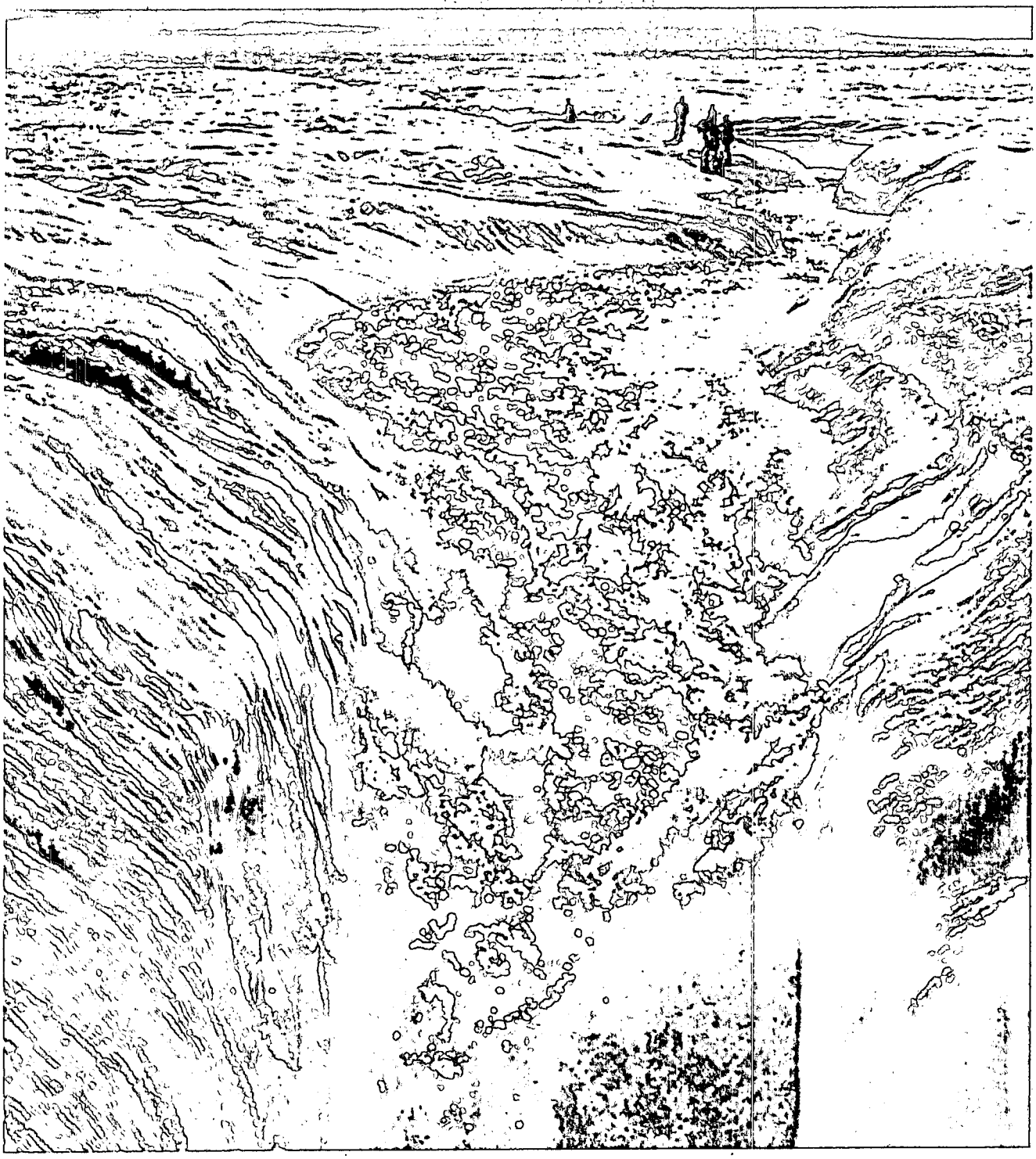
The dominant issue in global warming, in my opinion, is sea-level change and the question of how fast ice sheets can disintegrate. A large portion of the world's people live within a few meters of sea level, with trillions of dollars of infrastructure. The need to preserve global coastlines sets a low ceiling on the level of global warming that would constitute dangerous anthropogenic interference.

The history of the earth and the present human-made planetary energy imbalance together paint a disturbing picture about prospects for sea-level change. Data from the Antarctic temperature record show that the warming of the past 50 years has taken global temperature back to approximately the peak of the current interglacial (the Holocene). There is some additional warming in the pipeline that will take us about halfway to the highest global temperature level of the previous interglacial (the Eemian), which was warmer than the Holocene, with sea level estimated to have been five to six meters higher. One additional watt per square meter of forcing, over and above that today, will take global temperature approximately to the maximum level of the Eemian.

The main issue is: How fast will ice sheets respond to global warming? The IPCC calculates only a slight change in the ice sheets in 100 years; however, the IPCC calculations include only the gradual effects of changes in snowfall, evaporation and melting. In the real world, ice-sheet disintegration is driven by highly nonlinear processes and feedbacks. The peak rate of deglaciation following the last ice age was a sustained rate of melting of more than 14,000 cubic kilometers a year—about one meter of sea-level rise every 20 years, which was maintained for several centuries. This period of most rapid melt coincided, as well

THE AUTHOR

JAMES HANSEN is director of the NASA Goddard Institute for Space Studies and a researcher at the Columbia University Earth Institute. He received his Ph.D. in physics and astronomy from the University of Iowa, where he studied under James Van Allen. Hansen is best known for his testimony to congressional committees in the 1980s that helped to raise awareness of the global warming issue.



ON A SLIPPERY SLOPE to disaster, a stream of snowmelt cascades down a moulin on the Greenland ice sheet during a recent summer. The moulin, a near-vertical shaft worn in the ice by surface water, carries water to the base of the ice sheet. There the water is a lubricating fluid that speeds motion and disintegration of the ice sheet. Ice sheet growth is a slow, dry process, inherently limited by the snowfall rate, but disintegration is a wet process, driven by positive feedbacks, and once well under way it can be explosively rapid.

as can be measured, with the time of most rapid warming.

Given the present unusual global warming rate on an already warm planet, we can anticipate that areas with summer melt and rain will expand over larger areas of Greenland and fringes of Antarctica. Rising sea level itself tends to lift marine ice shelves that buttress land ice, unhinging them from anchor points. As ice shelves break up, this accelerates movement of land ice to the ocean. Although building of glaciers is slow, once an ice sheet begins to collapse, its demise can be spectacularly rapid.

The human-induced planetary energy imbalance provides an ample supply of energy for melting ice. Furthermore, this energy source is supplemented by increased absorption of sunlight by ice sheets darkened by black-carbon aerosols, and the positive feedback process as meltwater darkens the ice surface.

These considerations do not mean that we should expect large sea-level change in the next few years. Preconditioning of ice sheets for accelerated breakup may require a long time, perhaps many centuries. (The satellite ICESat, recently launched by NASA, may be able to detect early signs of accelerating ice-sheet breakup.) Yet I suspect that significant sea-level rise could begin much sooner if the planetary energy imbalance continues

R. J. BRAITHWAITE, REPRINTED WITH PERMISSION FROM *SCIENCE*, VOL. 297, NO. 5579, JULY 12, 2002. © 2002 AAAS

we are much closer to **dangerous anthropogenic interference** than is generally realized

to increase. It seems clear that global warming beyond some limit will make a large sea-level change inevitable for future generations. And once large-scale ice-sheet breakup is under way, it will be impractical to stop. Dikes may protect limited regions, such as Manhattan and the Netherlands, but most of the global coastlines will be inundated.

I argue that the level of dangerous anthropogenic influence is likely to be set by the global temperature and planetary radiation imbalance at which substantial deglaciation becomes practically impossible to avoid. Based on the paleoclimate evidence, I suggest that the highest prudent level of additional global warming is not more than about one degree C. This means that additional climate forcing should not exceed about one watt per square meter.

Climate-Forcing Scenarios

THE IPCC defines many climate-forcing scenarios for the 21st century based on multifarious "story lines" for population growth, economic development and energy sources. It estimates that added climate forcing in the next 50 years is one to three watts per square meter for carbon dioxide and two to four watts per square meter with other gases and aerosols included. Even the IPCC's minimum added forcing would cause dangerous anthropogenic interference with the climate system based on our criterion.

The IPCC scenarios may be unduly pessimistic, however. First, they ignore changes in emissions, some already under way, because of concerns about global warming. Second, they assume that true air pollution will continue to get worse, with ozone, methane and black carbon all greater in 2050 than in 2000. Third, they give short shrift to technology advances that can reduce emissions in the next 50 years.

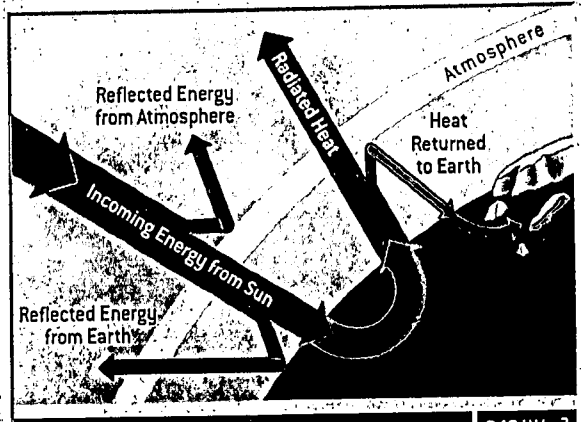
An alternative way to define scenarios is to examine current trends of climate-forcing agents, to ask why they are changing as observed, and to try to understand whether reasonable actions could encourage further changes in the growth rates.

The growth rate of the greenhouse-gas climate forcing peaked in the early 1980s at almost 0.5 watt per square meter per decade but declined by the 1990s to about 0.3 watt per square meter per decade. The primary reason for the decline was reduced emissions of chlorofluorocarbons, whose production was phased out because of their destructive effect on stratospheric ozone.

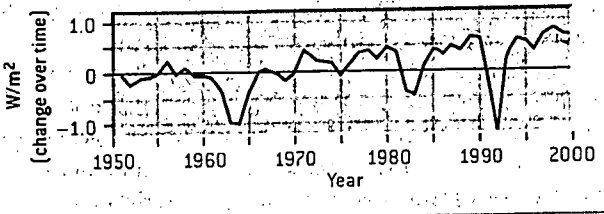
The two most important greenhouse gases, with chlorofluorocarbons on the decline, are carbon dioxide and methane. The growth rate of carbon dioxide surged after World War II, flattened out from the mid-1970s to the mid-1990s, and rose moderately in recent years to the current growth rate of about two parts per million per year. The methane growth rate has declined dramatically in the past 20 years, by at least two thirds.

EARTH'S ENERGY IMBALANCE

THE EARTH'S ENERGY is balanced when the outgoing heat from the earth equals the incoming energy from the sun. At present the energy budget is not balanced (*diagram* and *table*). Human-made aerosols have increased reflection of sunlight by the earth, but this reflection is more than offset by the trapping of heat radiation by greenhouse gases. The excess energy—about one watt per square meter—warms the ocean and melts ice. The simulated planetary energy imbalance (*graph*) is confirmed by measurements of heat stored in the oceans. The planetary energy imbalance is a critical metric, in that it measures the net climate forcing and foretells future global warming already in the pipeline.



TOTAL INCOMING SOLAR ENERGY	**340 W/m²**
TOTAL OUTGOING ENERGY	**339 W/m²**
REFLECTED ENERGY (from atmosphere and surface)	101 W/m²
100 W/m² because of natural processes	
1 W/m² because of human-made aerosols	
RADIATED HEAT (from land and ocean sinks)	238 W/m²
240 W/m² because of natural processes	
−2 W/m² because of human-made greenhouse gases, which return heat to the surface	
NET RESULT	**1 W/m²**
1 W/m² of excess energy, which warms the oceans and melts glaciers and ice sheets	



JEN CHRISTIANSEN; SOURCE: JAMES HANSEN

the emphasis should be on **mitigating the changes rather than just adapting to them**

These growth rates are related to the rate of global fossil-fuel use. Fossil-fuel emissions increased by more than 4 percent a year from the end of World War II until 1975 but subsequently by only about 1 percent a year. The change in fossil-fuel growth rate occurred after the oil embargo and price increases of the 1970s, with subsequent emphasis on energy efficiency. Methane growth has also been affected by other factors, including changes in rice farming and increased efforts to capture methane at landfills and in mining operations.

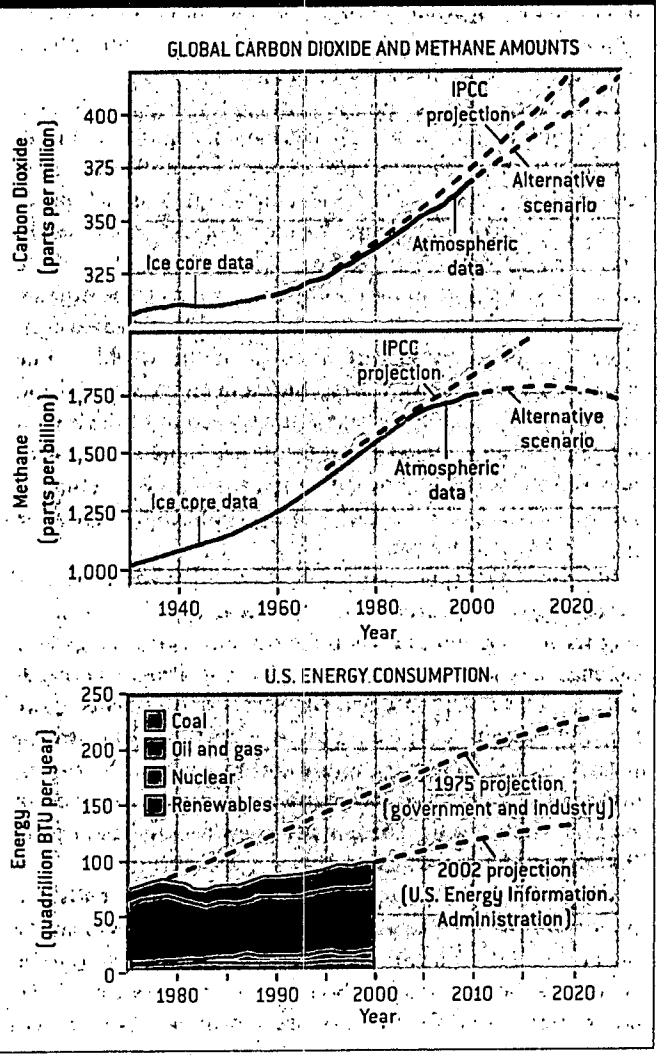
If recent growth rates of these greenhouse gases continued, the added climate forcing in the next 50 years would be about 1.5 watts per square meter. To this must be added the change caused by other forcings, such as atmospheric ozone and aerosols. These forcings are not well monitored globally, but it is known that they are increasing in some countries while decreasing in others. Their net effect should be small, but it could add as much as 0.5 watt per square meter. Thus, if there is no slowing of emission rates, the human-made climate forcing could increase by two watts per square meter in the next 50 years.

This "current trends" growth rate of climate forcings is at the low end of the IPCC range of two to four watts per square meter. The IPCC four watts per square meter scenario requires 4 percent a year exponential growth of carbon dioxide emissions maintained for 50 years and large growth of air pollution; it is implausible.

Nevertheless, the "current trends" scenario is larger than the one watt per square meter level that I suggested as our current best estimate for the level of dangerous anthropogenic in-

REDUCING EMISSIONS

OBSERVED AMOUNTS of carbon dioxide and methane (*top two graphs*) fall below IPCC estimates, which have proved consistently pessimistic. Although the author's alternative scenario agrees better with observations, continuation on that path requires a gradual slowdown in carbon dioxide and methane emissions. Improvements in energy efficiency (*bottom graph*) have allowed energy use in the U.S. to fall below projections in recent decades, but more rapid efficiency gains are needed to achieve the carbon dioxide emissions of the alternative scenario, unless nuclear power and renewable energies grow substantially.



JEN CHRISTIANSEN; SOURCE: JAMES HANSEN (*graphs*); MARK BOULTON *Photo Researchers, Inc.* (*photograph*)

fluence. This raises the question of whether there is a feasible scenario with still lower climate forcing.

A Brighter Future

I HAVE DEVELOPED a specific alternative scenario that keeps added climate forcing in the next 50 years at about one watt per square meter. It has two components: first, halt or reverse growth of air pollutants, specifically soot, atmospheric ozone and methane; second, keep average fossil-fuel carbon dioxide emissions in the next 50 years about the same as today. The carbon dioxide and non–carbon dioxide portions of the scenario are equally important. I argue that they are feasible and at the same time protect human health and increase agricultural productivity.

In addressing air pollution, we should emphasize the constituents that contribute most to global warming. Methane offers a great opportunity. If human sources of methane are reduced, it may even be possible to get the atmospheric methane amount to decline, thus providing a cooling that would partially offset the carbon dioxide increase. Reductions of black-carbon aerosols would help counter the warming effect of reductions in sulfate aerosols. Atmospheric ozone precursors, besides methane, especially nitrogen oxides and volatile organic compounds, must be reduced to decrease low-level atmospheric ozone, the prime component of smog.

Actions needed to reduce methane, such as methane capture at landfills and at waste management facilities and during the mining of fossil fuels, have economic benefits that partially offset the costs. In some cases, methane's value as a fuel entirely pays for the cost of capture. Reducing black carbon would also have economic benefits, both in the decreased loss of life and work-years (minuscule soot particles carry toxic organic compounds and metals deep into lungs) and in increased agricultural productivity in certain parts of the world. Prime sources of black carbon are diesel fuels and biofuels (wood and cow dung, for example). These sources need to be dealt with for health reasons. Diesel could be burned more cleanly with improved technologies; however, there may be even better solutions, such as hydrogen fuel, which would eliminate ozone precursors as well as soot.

Improved energy efficiency and increased use of renewable energies might level carbon dioxide emissions in the near term. Long-term reduction of carbon dioxide emissions is a greater challenge, as energy use will continue to rise. Progress is needed across the board: continued efficiency improvements, more renewable energy, and new technologies that produce little or no carbon dioxide or that capture and sequester it. Next-generation nuclear power, if acceptable to the public, could be an important contributor. There may be new technologies before 2050 that we have not imagined.

Observed global carbon dioxide and methane trends [*see box on opposite page*] for the past several years show that the real world is falling below all IPCC scenarios. It remains to be proved whether the smaller observed growth rates are a fluke, soon to return to IPCC rates, or are a meaningful difference. In contrast, the projections of my alternative scenario and the observed growth rates are in agreement. This is not surprising, because that scenario was defined with observations in mind. And in the three years since the alternative scenario was defined, observations have continued on that path. I am not suggesting, however, that the alternative scenario can be achieved without concerted efforts to reduce anthropogenic climate forcings.

How can I be optimistic if climate is closer to the level of dangerous anthropogenic interference than has been realized? If we compare the situation today with that 10 to 15 years ago, we note that the main elements required to halt climate change have come into being with remarkable rapidity. I realize that it will not be easy to stabilize greenhouse-gas concentrations, but I am optimistic because I expect that empirical evidence for climate change and its impacts will continue to accumulate and that this will influence the public, public-interest groups, industry and governments at various levels. The question is: Will we act soon enough? SA

For an expanded version of this article, including more data and additional sources, see www.sciam.com/ontheweb

BUT WHAT ABOUT ...

"Last winter was so cold! I don't notice any global warming!"

Global warming is ubiquitous, but its magnitude so far is only about one degree Fahrenheit. Day-to-day weather fluctuations are roughly 10 degrees F. Even averaged over a season this natural year-to-year variability is about two degrees F, so global warming does not make every season warmer than a few decades ago. But global warming already makes the probability of a warmer than "normal" season about 60 percent, rather than the 30 percent that prevailed from 1950 to 1980.

"The warming of the past century is just a natural rebound from the little ice age."

Any rebound from the European little ice age, which peaked in 1650–1750, would have been largely complete by the 20th century. Indeed, the natural long-term climate trend today would be toward a colder climate were it not for human activities.

"Isn't human-made global warming saving us from the next ice age?"

Yes, but the gases that we have added to the atmosphere are already far more than needed for that purpose.

"The surface warming is mainly urban 'heat island' effects near weather stations."

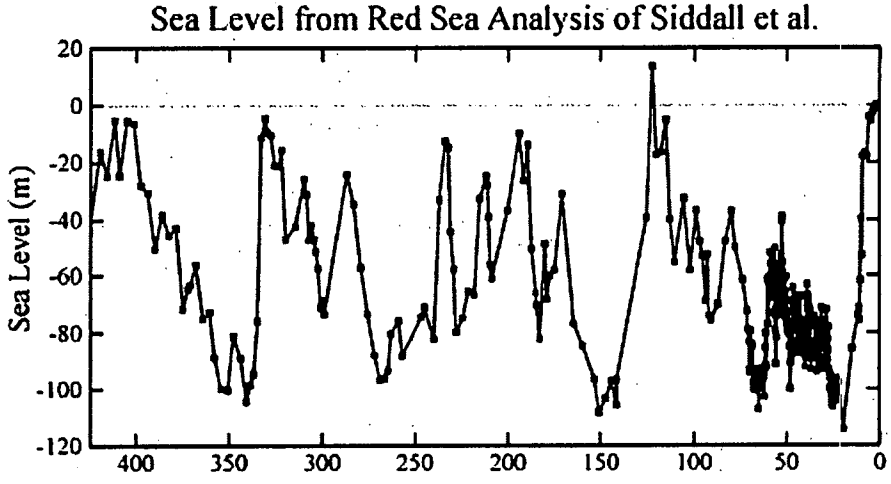
Not so. As predicted, the greatest warming is found in remote regions such as central Asia and Alaska. The largest areas of surface warming are over the ocean, far from urban locations [see maps at www.giss.nasa.gov/data/update/gistemp]. Temperature profiles in the solid earth, at hundreds of boreholes around the world, imply a warming of the continental surfaces between 0.5 and one degree C in the past century.

JAMES HANSEN

Summary of status of sea level rise and recent papers
Ellen Baum, Clean Air Task Force (www.catf.us)
March 1, 2006

Fluctuations in global sea level result from changes in the volume of water in the ocean. Water-volume fluctuations are dominated by growth and decay of continental ice sheets. Other processes affecting water volume are: thermal expansion and contraction of seawater; variations in groundwater and lake storage; and loss and gain of waters from marginal seas – oceans partially enclosed by islands, archipelagos or peninsulas.

Sea level changes are estimated from satellite measurements, tide gauges, shoreline markers, reefs and atolls, oxygen isotopes, and the flooding history of continents. Of these, satellite measurements are limited to the past 10 years, and tide gauge records extend back only 150 years.



Global sea level extracted, via a hydraulic model, from an oxygen isotope record for the Red Sea over the past 470 kyr (concatenates Siddall's MD921017, Byrd, & Glacial Recovery data sets; AMS radiocarbon dating).
Source: Siddall et al., *Nature*, 423, 853-858, 2003.

Using the combination of available tools, reconstruction since the Last Glacial Maximum that occurred about 20,000 years ago, show:

- A global sea level rise of over 120 meters, with a rapid rise averaging 10 millimeters (mm)/year between 15,000 and 6,000 years ago.
- Global average sea level rise at an average rate of about 0.5 mm/yr over the last 6,000 years and at an average rate of 0.1 to 0.2 mm/yr over the last 3,000 years.
- Over the past 100 years, ocean levels have been rising between 1 to 2 mm per year, or 10 to 20 cm (4-8 inches) – a speed of rise that is about 10 times more than geological data suggest occurred in the previous 3000 years.

Continental glacier and ice melting (eustatic) and thermal expansion (steric) are responsible for nearly all this rise. Note that melting of sea ice does not affect sea level rise.

Globally-averaged numbers do not reveal the fact that local differences make some areas particularly vulnerable to rising sea levels. Local sea level is affected by:

- ***Land subsidence,*** caused by withdrawing oil, gas and water and draining wetlands.
- ***Subsidence*** caused by crustal adjustment that is still taking place following the melting of glacier ice.
- ***Crustal downwarping*** in areas that are tectonically active
- ***Changes in sediment supply*** from embankments, dams and reservoirs, and loss of natural buffers and wetlands.

The Intergovernmental Panel on Climate Change (IPCC) projects sea level rise using 35 different emissions scenarios (SRES – Special Report on Emissions Scenarios). These scenarios have CO_2 levels ranging from 450 to 950 ppm by 2100 and project a sea level rise of 0.09 to 0.88 m for 1990 to 2100, with a central value of 0.48 m. This central value, is an average of 2.2 to 4.4 times the rate of rise from the 20th century. The projected range comes from:

- Thermal expansion: 0.11 to 0.43 m, accelerating through the 21st century
- Mountain glaciers and icecaps: 0.01 to 0.23 m
- Greenland: ¯0.02 to 0.09 m
- West Antarctic: ¯0.17 to 0.02 m

Should conditions develop such that melting of the Greenland and West Antarctica Ice Sheet (WAIS) occurs, sea level could rise 12 m (7m from Greenland and 5m from WAIS) and could dwarf the impact from thermal expansion.

Since the IPCC last report was published in 2001, there have been a number of studies that have added to the debate about the rate of sea level rise, sea level rise commitment, and the relative roles of glacial and ice sheet melting and thermal expansion. Some of the seminal papers, each dealing with different aspects of sea level rise, are summarized below. Presumably these papers will be taken into consideration for the fourth IPCC assessment scheduled for completion in 2007.

Accelerated Ice Discharge from Greenland Ice Sheet.

Rignot, et. al.,[1] using remote-sensing satellites, have detected that 1) the flow rate of several large glaciers draining the Greenland ice sheets has recently doubled, and 2) that more surface area melted in 2005 than anytime since satellite monitoring began in 1979. Increased meltwater production reaches the glacier bed through crevasses, allowing for enhanced flow through lubrication and sliding. The combination of increased velocity and ice thinning suggest that current IPCC projections of sea level

rise over the next century are probably underestimated, and the Greenland ice sheet probably contributes more than .5 mm year to global sea level rise. The Rignot team suggests that the only prospect of short-term amelioration of melting is increased snow on the island's interior.

Jay Zwally, a glaciologist with the NASA Goddard Space Flight Center in Greenbelt, Maryland, in a paper to be published later this year in the *Journal of Glaciology,* will argue that, at least for now, increased precipitation in the middle of Greenland is compensating for the ice loss and glacial thinning on the edges. However, the compensation is not expected to last, if warming continues.

Loss of Greenland Ice Sheet is Irreversible

Warmer climate conditions persisting for a period of many centuries could lead to the disappearance of the Greenland ice sheet, with a related 7-m rise in sea level. Toniazzo, et.al.[2] investigate the extreme scenario in which the ice sheet disappears completely and, using two models, conclude that the ice sheets could not reform with a return to present day climate.

Loss of Larsen B Ice Shelf Accelerates Antarctic Glacier Flow

Scambos[3] and Rignot[4] investigated the area on the Antarctic Peninsula on the western side of the continent where the Larsen B ice shelf broke apart in 2002. While the melting ice shelf does not in itself affect sea level because floating ice displaces its equivalent volume of water, both researchers found that glaciers flowing into the area formerly buttressed by the Larsen B ice shelf have all accelerated and that higher flow rates have stretched and thinned the ice. The main implication is that a feedback system could kick in, accelerating glacier melting and producing significant rises in sea level.

West Antarctica Ice Sheet Catchment Basin Out of Balance

Recent aircraft and satellite surveys of the Amundsen Sea sector of West Antarctica show that local glaciers are discharging about 250 cubic km per year of ice to the ocean, making the catchment 60 percent out of balance between accretion and discharge, and sufficient to raise sea level by more than 0.2 mm per year. Glacier thinning rates near the coast for 2002-03 are much larger than those observed during the 1990s.[5]

Contribution from Mountain Glaciers may be Smaller than Previous Projections

Raper, et. al [6] project sea level rise due to melting of mountain glaciers and icecaps to be 0.046 and 0.051m by 2100, which is about half that of previous projections. Excluded, however, from this analysis are mountain glaciers and icecaps around the Greenland and Antarctic ice sheets.

Sea level Rise Faster than Previous Studies Showed

Miller, et. al., [7] using data from tidal gauges and reviewing findings from previous studies, have constructed a new sea level record covering the last 100 million years and have calculated the present rate of rise at 2mm per year – the high end of the IPCC report. Their works shows that over the past 150 years, sea levels have been rising twice as fast as in previous centuries.

Sea level rise commitment

The concept of sea level rise commitment is the same concept as a warming commitment – or the amount of warming already in the pipeline due to the long lifetime of CO_2.

Thermal expansion

Meehl, et. al. [8] contend that the full effect of elevated CO_2, even at 2100 levels will take centuries to unfold. Considering just thermal expansion and not contributions to sea level rise due to ice sheet or glacier melting, the authors find that we are already committed to a sea level rise of 13 and 18 cm, independent of future emissions.

If concentrations of all GHGs and other atmospheric constituents in their simulations are held steady at year 2100 values, sea levels will keep rising due to thermal expansion, depending on the stabilization level. By 2200, there is an additional rise of 12 and 21 cm and by 2300, an additional increase of 10 to 21 cm. Sea level rise would continue for at least two more centuries beyond 2300.

By not factoring in ice sheet or glacial melting, the sea level rise calculations are probably at least a factor of three too small.

Glaciers and small ice caps

Three CO_2 stabilization cases were considered to extend IPCC modeling for glaciers and small ice caps beyond 2100. [9] These were 2.0 C to 4.5 C at stabilization levels of 350 ppm to 750 ppm. Melting was negative to small in the first two centuries, with a range of -24% to+10% relative to 550 ppm stabilization. However, by 2400, even for CO_2 stabilization at 350 ppm, 73% of the available ice melted and 94% melted at a stabilization of 750 ppm.

Soot on snow

Soot may be contributing to changes happening in the Arctic, such as increasing melting of sea ice and snow and warming atmospheric temperatures. [10] Black carbon in snow and ice has been identified as one of the largest uncertainties in estimates of global radiative forcing for climate change (albedo effect). Soot in the higher latitudes of the Earth, where ice is more common, absorbs more of the sun's energy and warmth than an icy, white background. Dark-colored black carbon, or soot, absorbs sunlight, while lighter colored ice reflects sunlight. As snow- and ice-covered areas begin melting, the warming effect increases, as the soot becomes more concentrated

on the snow surface, providing a positive feedback (i.e. warming); since as glaciers and ice sheets melt, they tend to get even dirtier.

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[1] Rignot, Eric and Pannir Kanagaratnam, 2006. Changes in the Velocity Structure of the Greenand Ice Sheet. *Science*, 311: 986-990.

[2] Toniazzo, T. et.al, 2004. Climatic Impact of a Greenland Deglaciation and Its Possible Irreversibility. Jouranl of Climate,17: 21-34.

[3] Scambos T. A., et. al,. 2004. Glacier acceleration and thinning after ice shelf collapse in the Larsen B embayment, Antarctica, Geophysical Research Letters, 31. L18402, doi:10.1029/2004GL020670.

[4] Rignot E., *et al.*, 2004. Accelerated ice discharge from the Antarctic Peninsula following the collapse of Larsen B ice shelf, Geophysical Research Letters, 31. L18401, doi:10.1029/2004GL020697.

[5] Thomas, R. 2004. Accelerated Sea-Level Rise from West Antarctica, Science Express, Published online 23 September 2004;10.1126/science.1099650

[6] Raper, Sarah C. B. and Roger J. Braithwaite, 2006. Low sea level rise projections from mountain glaciers and icecaps under global warming, Nature 439, 311-319.

[7] Miller, Kenneth, et. al. 2005. The Phanerozoic Record of Global Sea-Level Change. Science, 310: 1293-1298.

[8] Meehl, Gerald, et.al. 2005. How Much More Global Warming and Sea Level Rise?, Science. 307: 1769-1783.

[9]Wigley, T. M. L. and S. C. B. Raper, 2005. Extended scenarios for glacier melt due to anthropogenic forcing, GEOPHYSICAL RESEARCH LETTERS, VOL. 32, L05704, doi:10.1029/2004GL021238

[10] Hansen, J., and L. Nazarenko 2004. Soot climate forcing via snow and ice albedos. Proc. Natl. Acad. Sci. 101, 423-428, doi:10.1073/pnas.2237157100.

CURRENTS

The Big Meltdown

[redacted]mething's Happening at both Poles

Colin Woodard

When Antarctica's Larsen-B ice shelf—a 10,000-year-old, 650-foot thick expanse of floating ice the size of Rhode Island—collapsed three years ago, Pedro Skvarca had a front-row seat. With the Antarctic Peninsula being swept by an unprecedented summer heat wave in February 2002, Skvarca, a glaciologist with the Argentine Antarctic Institute, jumped in a rugged twin-engine turboprop and flew off from his Antarctic research station to inspect the cliff-like seaward edge of the remote ice shelf.

What he saw, Skvarca recalls, was astonishing. "The surface of the ice shelf was almost totally covered by melt ponds and lakes, and waterfalls were spilling over the top and into the ocean," he says. Great slices of the Larsen-B's leading edge had broken off, filling the Weddell Sea with icebergs and slush. Two weeks later, almost the entire ice shelf had disintegrated. "It was unbelievable to see how fast it had broken up. The coastline hadn't changed for more than 9,000 years and then it changed completely in just a few weeks."

Now scientists studying the aftermath of the collapse say it will very likely have unpleasant implications for the rest of us. The collapse of the Larsen-B and its smaller northern neighbors, the Larsen-A and Wordie Ice shelves, in the face of warmer summer temperatures has caused the vast glaciers and ice sheets behind them to begin sliding into the sea at a remarkable pace. Aerial and satellite imagery show that the glaciers behind the Larsen-B increased their seaward flow by two to six times in the months after the ice shelf's collapse, with some of them thinning by more than 100 feet. Unlike the floating ice shelves, thinning glaciers contribute to global sea-level rise.

"The glaciers took off like a race horse after the ice shelves were removed," says Ted Scambos, a researcher at the National Snow and Ice Data Center in Boulder, Colorado. "Just a decade ago we glaciologists were talking about gradual changes in glaciers taking place over centuries. Now we're seeing things that we didn't think glaciers could do in terms of their speed of response."

[redacted]nd it's not just happening on the Antarctic Peninsula. Similar studies of glaciers entering the Amundsen Sea, some 1,200 miles away in West Antarctica, show them doubling their flow since the 1990s. This is especially worrying because the glaciers in this area drain the West Antarctic Ice Sheet, a precariously balanced portion of the southern ice cap that contains enough ice to raise sea levels by 20 feet. By comparison, the sea-level rise predictions endorsed by the 2,600 scientists of the Intergovernmental Panel on Climate Change are only about two feet by 2100.

If anything, the news from the Arctic is even more troubling. In November an international team of 300 scientists completed an unprecedented four-year study of the region that found it is warming at nearly twice the rate of the rest of the planet. Average winter temperatures in much of the region have increased by as much as four to seven degrees Fahrenheit in the past 50 years, and they are expected to warm by another seven to 13 degrees by the end of the century. During that time, the scientists predict that half of the Arctic's summer sea ice will melt, along with much of the Greenland Ice Sheet, which contains enough ice to raise sea level by some 23 feet.

"The preponderance of evidence suggests that the warming of the past 50 years has mostly come from greenhouse gas emissions and everything we're seeing in the Arctic is 100 percent consistent with that," says Robert Corell, a senior fellow at the American Meteorological Society in Washington, D.C. and chairperson of study for the Arctic Climate Impact Assessment.

Arctic people are already feeling the effects of this polar thaw. Several Inuit communities in Canada, Alaska and Russia are washing into the sea because the sea ice that used to dampen waves is vanishing. The area covered by sea ice has shrunk by more than six percent since 1978. And in the central Arctic, submarine measurements indicate that the average thickness has declined by 40 percent in recent decades. If trends continue, scientists warn that polar bears, seals and other animals northern people rely on will be driven towards extinction.

[redacted]Until recently, many parts of the Arctic were more accessible in winter, when ice roads made truck transport

possible. But warmer temperatures are turning those roads into impassable tracks of mud for more and more of the year. Over the past 30 years, the Alaskan Department of Natural Resources has been forced to halve the number of ice road travel days from 200 to 100. In northern Russia, melting permafrost has damaged roads, railways, apartment buildings and airport runways and ruptured several oil and gas pipelines.

In Iceland and Greenland, glaciers have been in rapid retreat, with the Greenland ice sheet experiencing summertime surface melting over 16 percent more of its surface area since 1979. "Greenland is melting much more rapidly in the past two or three years than anyone imagined possible," Corell says. "The ice is so bad in eastern Greenland that people are killing their sled dogs because they cannot hunt enough seal to keep them."

After the report's release, Shelia Watt-Cloutier, the Nunavut, Canada-based chairperson of the Inuit Circumpolar Conference, traveled to Washington to urge the Bush administration to take global warming seriously. "By looking at what is already happening in remote Inuit villages in Alaska...you can understand the future dangers for more populated areas of the world such as Florida, Louisiana or California," she told a Senate committee hearing. "Use us in the Arctic as your early warning system."

CONTACTS

Arctic Climate Impact Assessment
Phone: (011)+47-22-85-87-84/50

The Antarctic and Southern Ocean Coalition
Phone: (202) 234-2480

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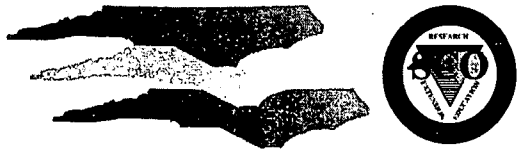
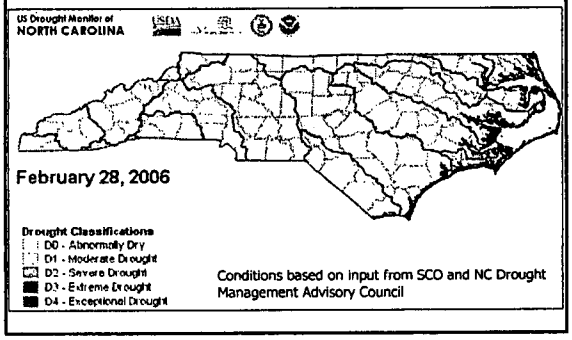
North Carolina Climate Variations



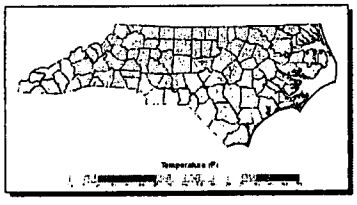
Sethu Raman
Professor of Atmospheric and Marine Sciences
and State Climatologist
State Climate Office of North Carolina
North Carolina State University

Latest Drought Conditions



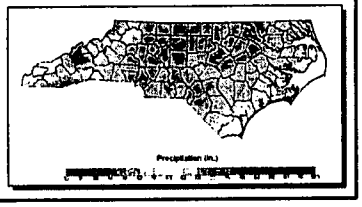
Way Points

- State Climate Office of NC, brief introduction
- NC teleconnections
- Observing NC climate
- Short term trends in NC climate
- Longer term NC climate trends
- Summary



Normal Annual Mean Temperature
(based on 1971-2000 normals)

Normal Annual Precipitation
(based on 1971-2000 normals)



State Climate Office of North Carolina

A Public Service Center for Climate - Environment Interactions

SCO Staff and Students

- Sethu Raman, Director and State Climatologist
- Peter Robinson, NC Climate Program Coordinator
- Ryan Boyles, Associate State Climatologist
- Ameenulla Syed, Instrumentation Meteorologist
- Aaron Sims, Environmental Meteorologist
- Mark Brooks, Environmental Meteorologist
- Ashley Frazier, Meteorologist
- 20 Graduate Students in past 10 years
- 30 Undergraduate Students in past 10 years

History of SCO

1976	SCO established at UNC-CH
1976-1980	Dr. Peter Robinson, *State Climatologist*
1980	SCO transferred to NC State
1981-1996	Dr. Jerry Davis, *State Climatologist*
Sept 1996- *present* ...	Dr. Sethu Raman, *State Climatologist*
October 1998	Public Service Center for Climate – Environment Interactions
Today	**#2 Climate Office in US**

Mission

EXTENSION & OUTREACH

- Provide the most accurate climate information available to the citizens of North Carolina.
- Assist North Carolina state agencies in climate-environment issues and related applications.
- Establish, operate, and maintain an extensive meteorological network across North Carolina and archive and disseminate this data to the public in a timely fashion.
- Assist in applications such as agriculture and environment.
- Increase public awareness of North Carolina climate.

Mission

RESEARCH

- Study North Carolina's climate and its interaction with the environment.
- Investigate the effects of climatic variations on agriculture, air pollution, and natural resources and develop forecast techniques for resource management.

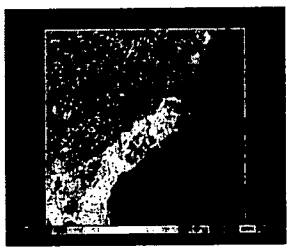
EDUCATION

- Interact with K-12, undergraduate and graduate students, and with community organizations.

Agriculture Outreach

Advisories for crop management

Real-time high resolution weather model for agriculture



Soil moisture forecast for Mar 4, 2006

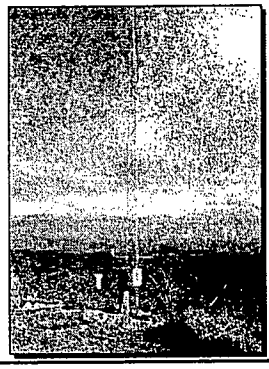
Partnering with State Agencies

2002 Drought Conference

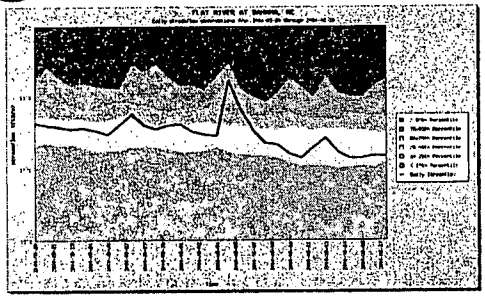
DENR Air Quality

Install and maintain monitoring sensors needed by DAQ

In 2005, helped DAQ save NC $650 million in federal transportation funds



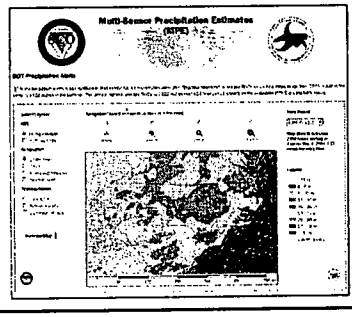
DENR Water Resources



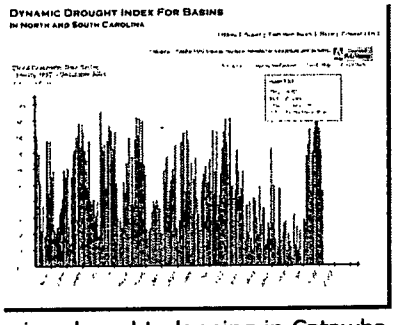
Creating comprehensive water resource database

NC DOT Roadside Environmental Unit

Developing a heavy rainfall alert tool using radar and surface gage data



Duke Power



Improving drought planning in Catawba Basin

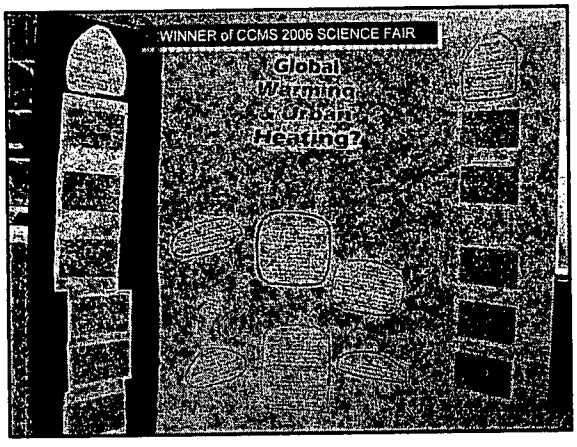
NC Electric Cooperatives

Providing climate data for short- and long-term energy planning

New weather monitors at peaking plants in Anson, Richmond Counties

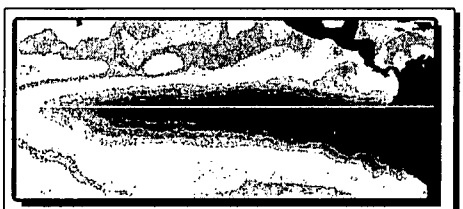
Education

- Education & Training of Undergraduate and Graduate Students
- K-12 Outreach: Classroom presentations, host student interns



Global Teleconnections and North Carolina

El Nino / Southern Oscillation



El Niño is the abnormal warming of ocean temperatures in the eastern tropical Pacific Ocean. La Niña is the opposite - the cooling of ocean temperatures in the tropical Pacific. These patterns which occur every 2 -7 years affect the climate in North Carolina.

Surface Weather Map @ 7:00 AM EST Jan 28, 1998

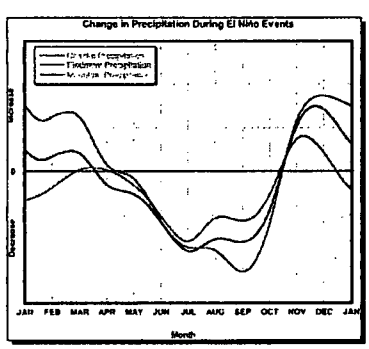
Winter Storm Frequency

Average Number of Strong Winter Storms during December through February

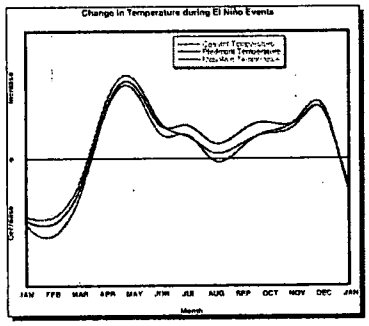
El Niño Year	Non-El Niño
12	5

This classic "Nor'easter" quickly formed off the coast of North Carolina January 27-28, 1998. The storm dumped up to 40 inches of snow in the mountains of North Carolina and over 2 inches of rain along the coast.

ENSO Affects NC Precipitation



ENSO Affects NC Temperatures



Observing North Carolina Climate

Observations from >1000 Active Stations

Hourly Data from >200 Sites

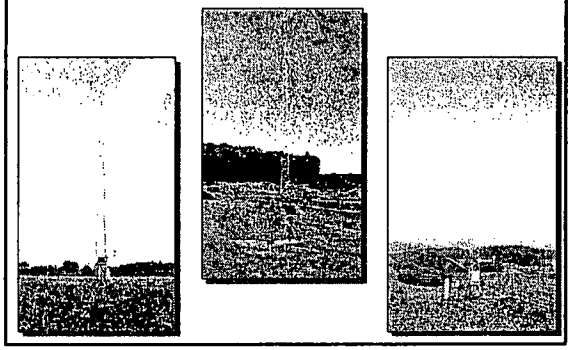
NC ECONet

N*orth*
C*arolina*
E*nvironment &*
C*limate*
O*bserving*
Net*work*

Concept....

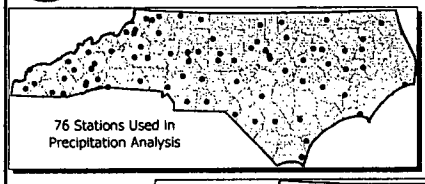
- **Provide unique measurements – soil temperature, soil moisture, solar radiation, evaporation**
- **An advanced, state-of-the-art network for climate and environmental observations.**
- **The NC ECONet, in its full capacity, will have more than 100 weather and environmental observing stations across North Carolina with a minimum of one per county!**

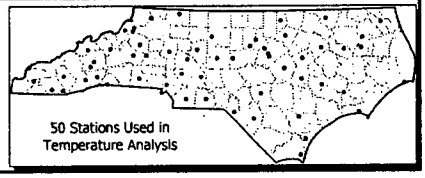
10 m Towers and Sensors at International Standards



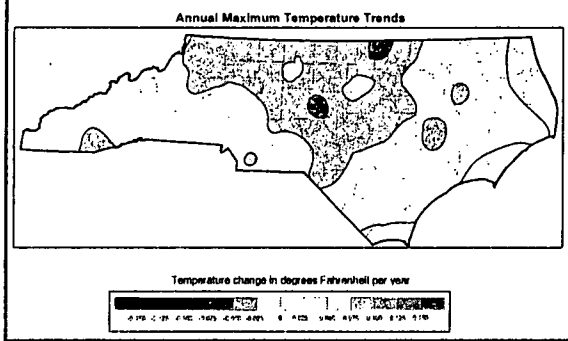
Climate Variations over the past 50 years

Temperature & Precipitation 1949-1998

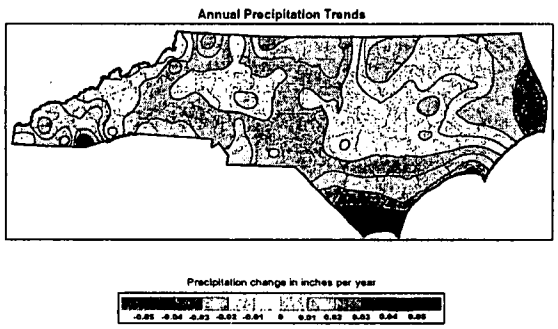




Maximum Temperature Trends

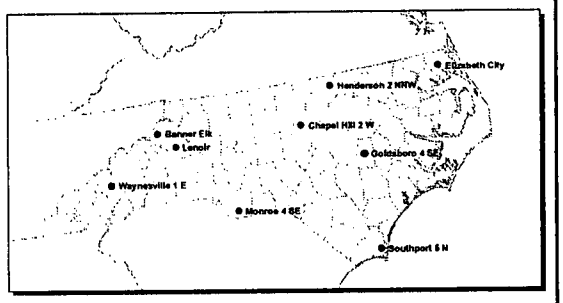


Precipitation Trends



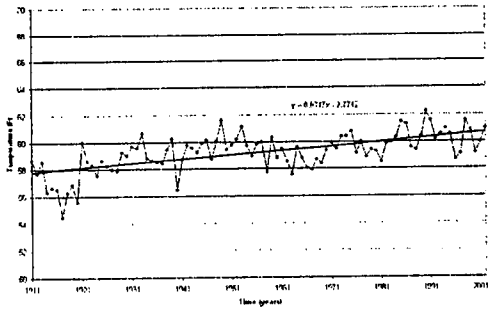
Historical Climate Network
25 stations in NC

Stations Analyzed



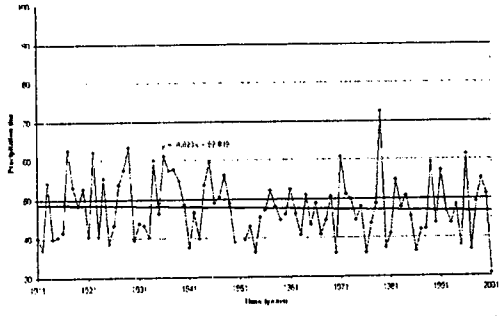
Coastal: Elizabeth City (Mean T)

~3.17°F increase over 100 years



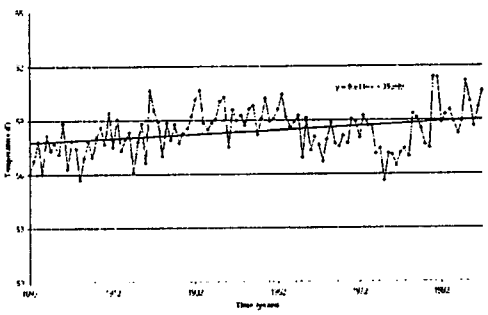
Coastal: Elizabeth City (Annual)

~2.3 in decrease over 100 years



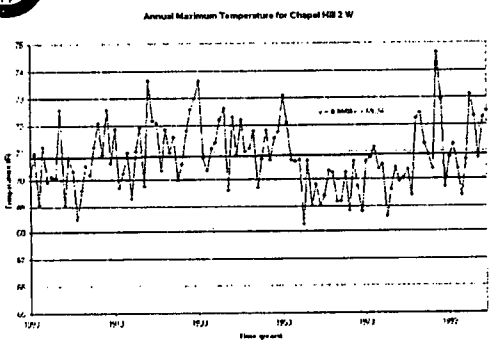
Piedmont: Chapel Hill 2 W (Mean T)

~1.16°F increase over 100 years



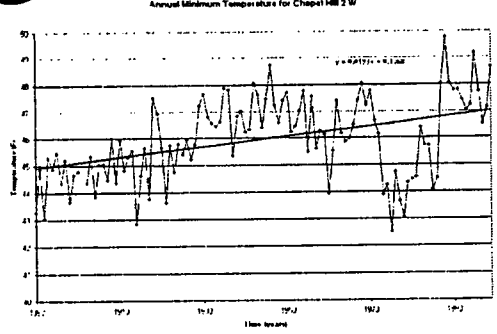
Piedmont: Chapel Hill 2 W (Maximum T)

~0.08°F increase over 100 years



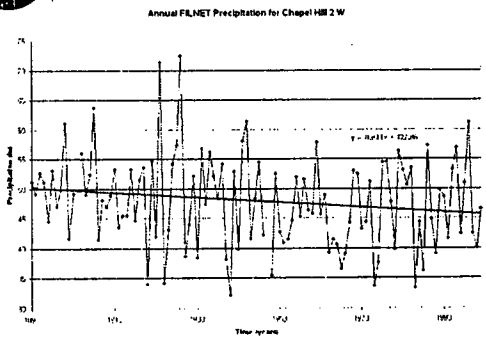
Piedmont: Chapel Hill 2 W (Minimum T)

~1.93°F increase over 100 years



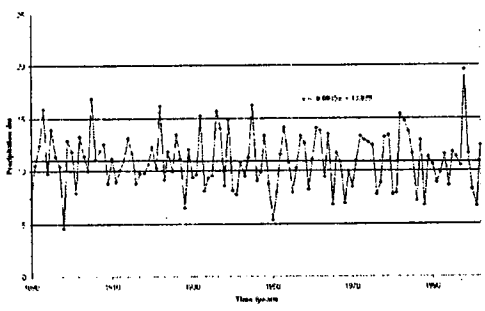
Piedmont: Chapel Hill 2 W (Annual)

~4.1 in decrease over 100 years



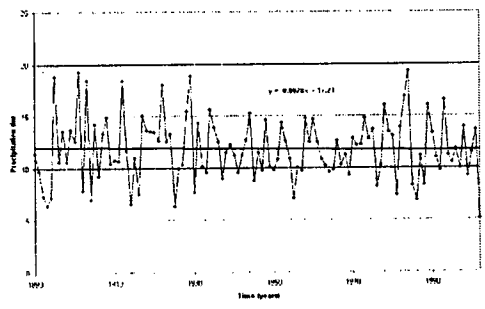
Piedmont: Chapel Hill 2 W (Winter Precip)

~0.15 in decrease over 100 years



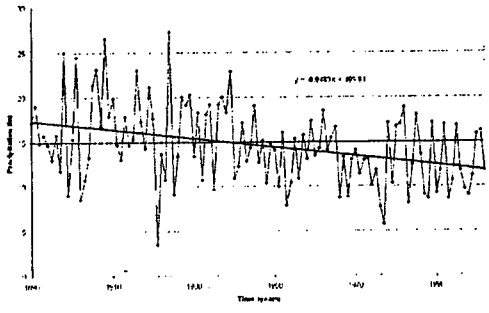
Piedmont: Chapel Hill 2 W (Spring)

~0.28 in decrease over 100 years



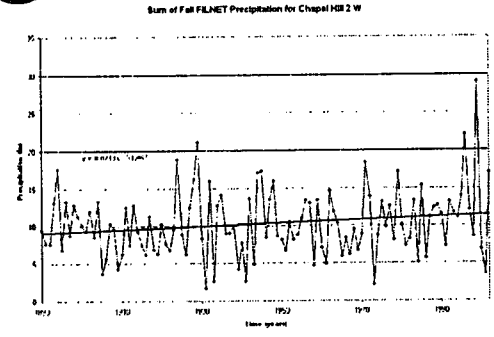
Piedmont: Chapel Hill 2 W (Summer)

~ 4.89 in decrease over 100 years



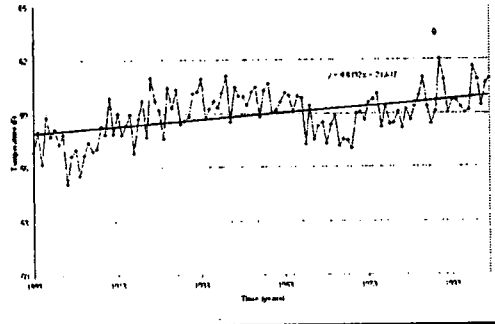
Piedmont: Chapel Hill 2 W (Fall)

~ 2.13 in increase over 100 years

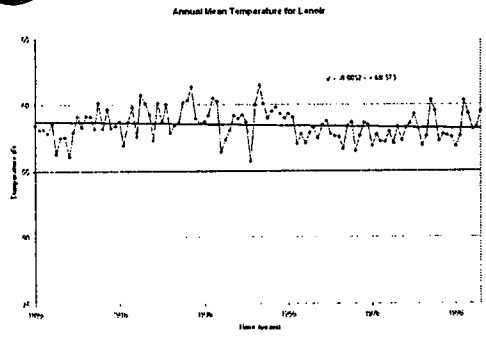


Piedmont: Monroe 4 SE

~1.92°F increase over 100 years



Mountain: Lenoir
~0.52°F decrease over 100 years



Mountain: Lenoir (cont'd)
~2.79 in increase over 100 years

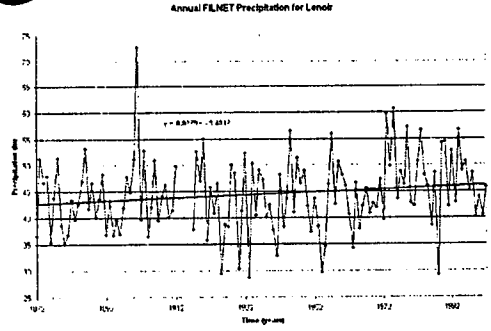


Table of Changes in Annual Mean Temperature

Station	Region	Begin Year	End Year	Total Change (F)	Total Change (C)	Change Per Year (F)	Change Per Year (C)
Chapel Hill 2 W	piedmont	1893	2002	1.16	0.6444	0.0106	0.0059
Charlotte Douglas AP	piedmont	1948	2002	0.53	0.2944	0.0098	0.0055
Elizabeth City	coastal	1911	2002	0.17	0.0931	0.0049	0.0104
Henderson 2 NNW	piedmont	1893	2002	1.38	0.7667	0.0127	0.0070
Goldsboro 4 SE	coastal	1893	2002	1.72	0.9556	0.0158	0.0088
Lenoir	mountain	1896	2002	-0.52	-0.2889	-0.0049	-0.0027
Monroe 4 SE	piedmont	1896	2002	1.92	1.0667	0.0181	0.0101
Banner Elk	mountain	1907	2002	0.62	0.3444	0.0065	0.0036
Southport 5 N	coastal	1893	2002	0.6	0.3333	0.0055	0.0031
Wilmington 1 E	coastal	1894	2002	3.19	1.7722	0.0331	0.0184

Red: greatest positive change | **Green:** least change | **Blue:** greatest negative change

Table of Changes in Annual Precipitation

Station	Region	Begin Year	End Year	Total Change (in)	Change Per Year (in)
Chapel Hill 2 W	piedmont	1893	2002	4.1	0.0370
Charlotte Douglas AP	piedmont	1948	2002	0.95	0.0176
Elizabeth City	coastal	1911	2002	-2.3	-0.0253
Henderson 2 NNW	piedmont	1893	2002	-3.41	-0.0313
Goldsboro 4 SE	coastal	1893	2002	-0.62	-0.0057
Lenoir	mountain	1896	2002	2.79	0.0263
Monroe 4 SE	piedmont	1896	2002	-0.86	-0.0081
Banner Elk	mountain	1908	2002	3.33	0.0354
Southport 5 N	coastal	1893	2002	-2.19	-0.0201
Waynesville 1 E	mountain	1894	2002	1.65	0.0153

Red: greatest positive change Green: least change Blue: greatest negative change

Correlation Coefficients

Station	TAVG	TMAX	TMIN	PRCP
Southport 5 N	0.41	0.52	0.32	-0.27
Elizabeth City	0.78	0.49	0.68	-0.28
Goldsboro 4 SE	0.65	0.55	0.51	-0.16
Chapel Hill 2 W	0.55	0.14	0.64	-0.41
Henderson 2 NNW	0.60	0.19	0.60	-0.39
Monroe 4 SE	0.68	0.42	0.69	-0.19
Banner Elk	0.39	0.30	0.51	0.35
Lenoir	0.37	0.51	0.47	0.39

Summary

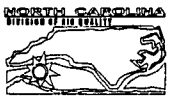
- North Carolina climate is influenced by global tele-connections
- There are (statistically) significant variations in North Carolina climate at different locations during the past 100 years
- There is a need for improved density of climate observations (at least one in each county) in North Carolina

Legislative Commission on Global Climate Change

Climate Action Plan Advisory Group (CAPAG)

Update of Activities

March 7, 2006



Brock M. Nicholson, P.E.
Deputy Director
Division of Air Quality

CAPAG Purpose & Goals

- ***Develop Climate Action Plan Recommendations***
  - *Range of individual policy actions*
  - *Benefits and Costs Analysis*
    - *Economic Benefit Determined*
  - *Consensus of Stakeholders*
  - *Support Legislative Commission on Global Climate Change (LCGCC)*

Selection of State Mitigation Actions / Policies - Process

- **Facilitated Stakeholder**
- **Consensus Based**
- **Decision Criteria Include**
  - GHG reduction potential
  - Cost effectiveness
  - Co-benefits and costs
  - Feasibility issues
- **Economic Analysis Is Crucial**

Ten Step Work Plan

1. Develop initial GHG inventories and forecasts
2. Identify potential GHG mitigation options
3. Identify initial policy priorities for evaluation
4. Evaluate benefits, costs, other key issues
5. Identify barriers, alternative policy approaches
6. Modify, add or subtract options as needed
7. Evaluate cumulative results of policy options
8. Iterate to consensus, with votes as needed
9. Aggregate options into implementation scenarios
10. Finalize recommendations and report language

CAPAG Meeting #1

- Materials and meeting summary posted to the project website: www.ncclimatechange.us
- Key Agenda Items:
  - CSA Report Findings and Recommendations
  - Global Warming Commission Process
  - History and Status of State Climate Actions
  - CAPAG Process
  - NC Emissions Inventory & Forecast
  - Early Suggestions of Mitigation / Policy Opportunities
  - Formation of Technical Work Groups (TWGs)
  - Public Input

CAPAG Members

- **Members from many diverse backgrounds**
- **Includes several LCGCC members**
- **CAPAG members also serve on five TWG subcommittees**
- **See handout**

Sector Based Technical Work Groups (TWGs)

1. Energy Supply (power generation)
2. Residential, Commercial, Industrial (energy use and industrial process)
3. Transportation and Land Use
4. Agriculture and Forestry
5. Cross Cutting Issues (reporting, registries, education)

TWG Members

- Subcommittees of the CAPAG
- 40 + members from many diverse backgrounds
- Includes several LCGCC members
- Open to other LCGCC members who may be interested
- Includes experts who are not CAPAG members, as needed
- See Handout

Role of the TWGs

- *Provide Recommendations to the CAPAG*
  1. *Identify potential mitigation / policy options*
  2. *Identify early priority options for analysis*
  3. *Craft straw proposed options, including policy design and implementation methods*
  4. *Approve methods for cost-benefit analysis*
  5. *Assist with data and analysis*
  6. *Assist with evaluation of additional issues, such as co-benefits, detailed cost breakdowns, as needed*
  7. *Identify and develop alternative approaches for policy options, as needed*
  8. *Contribute to drafting of language for the final report*

First TWG Meetings

1. Review/expand list of potential options
2. Identify initial priorities for analysis
3. Review emissions inventory & forecast
4. Review proposed technical work plan and meeting schedule
5. Prepare suggestions for next CAPAG meeting

CAPAG and TWG Support

- **CAPAG**
  - Facilitator and consulting team (15 CCS members)
  - State agency technical advisors
- **Five TWGs**
  - Facilitator and Lead Consultant for each
  - Provide facilitation and technical analysis
  - Broad expertise in GHG issues, analysis, modeling, consensus building, conflict resolution
  - Additional consultants and agency advisors as needed

DENR/CAPAG Assistance to Legislative Commission

- Provides inputs and responses to fact finding requirements of Section 5 - b, c, d, f...
- Responds to questions of the LCGCC as they relate to state policy actions

Section 5 Assistance

- *"b. Actions taken by others to address global warming."*
  - *DENR has completed a compendium of existing state and regional actions on climate change in the US for the CAPAG that is available for LCGCC use*

"c. An examination of the emissions of greenhouse gases

- *DENR has completed an initial inventory and forecast of state GHG emissions for CAPAG review and finalization*

Section 5 Assistance...

- *"d. An evaluation of the economic opportunities*
  - *The CAPAG process will identify a list of specific policy options for reducing GHGs and conduct analysis on their economic benefits, including jobs and community level impacts for key actions, and analysis of co-benefits, as needed*

Section 5 Assistance...

- *"f. The costs of any action*
  - *The CAPAG process will identify a list of specific mitigation / policy options for reducing GHGs and conduct analysis on their economic costs, including detailed analysis of impacts on different income brackets and business types for key actions*

Section 5 Assistance...

- *Commission shall "consider and integrate" the findings and recommendations ...*
  - *DENR prepared a September 1, 2005 report to the ERC with a series of findings and recommendations, many of which will be subject to further development by the CAPAG*

Economic Sectors

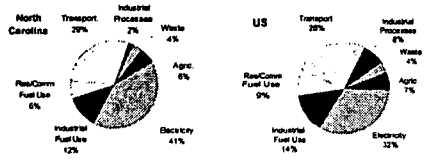
- Agriculture
- Forestry
- Electricity and Fuel Production (energy supply)
- Residential, Commercial, Industrial Energy Use and Process
- Transportation and Land Use
- Waste Management

Policy Mechanisms

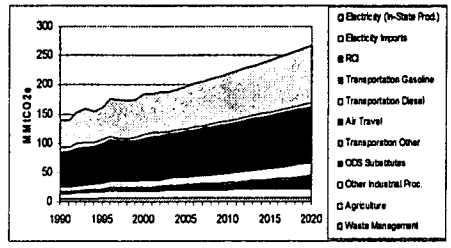
- Voluntary Agreements
- Technical Assistance
- Information and Education
- Financial Incentives
- Codes and Standards
- Market Based Approaches
- Reporting and Registries
- Others In Development...

NC, U.S. Emissions by Sector

- Electricity use and transportation are principal GHG emissions sources:
  - NC = 70% of state total; U.S. = 58% of national total



NC GHG Emissions 1990-2020



Early feedback from the first CAPAG meeting

- Policy ideas
- Information requests

CAPAG Policy Ideas

- Inputs to TWG discussions include:
  - Energy Efficiency and Conservation
  - Renewable Energy Sources
  - Nuclear Power Generation
  - Environmental Portfolio Standard
  - Public Benefits Fund
  - Transportation Controls
  - "Anti-Idling" Technologies
  - Forest and Agriculture Carbon Sequestration
  - Forest Health Protection
  - Agriculture Waste Regeneration
  - Recycling
  - Market Forces Before Regulation
  - Education
  - Link State Action to Regional or National Policy Options

Information Requests

- Inputs to TWG discussions include:
  - Use full lifecycle analysis
  - Use the best information and analytic resources
  - Examine how regulations affect GHG emissions
  - Use a transparent means of examining benefits and costs of various GHG policy options
  - Examine the costs to consumers of reducing GHG emissions, with special attention to lower income consumers

Information Requests...

- Inputs to TWG discussions include...
  - Understand the natural systems we need to ensure a quality life and how to connect these to management of public and private lands, water bodies, military bases, etc.
  - Examine the threat of disturbances to forests
  - When we look at costs, ask "costs to whom?"
  - Examine "win-wins"
  - Examine regulatory barriers/institutional barriers to greater energy efficiency

Information Requests...

- Inputs to TWG discussions include...
  - Ask: How can NC lead a cultural change toward sustainable development? Ask: how do we educate public about these issues?
  - How can we restructure our communities to better conserve resources and increase energy efficiency.
  - Examine trend toward conversion of agricultural land

CAPAG Schedule

- Next CAPAG meeting May 15, 2006
- CAPAG meetings through Spring 2007
  - Technical work group discussions in between CAPAG meetings
- Work Product – Recommended Climate Action Plan

Summary: The Relationship of CAPAG to the Legislative Climate Change Commission?

- Complements and Supports the Efforts of the Legislative Commission
- Provides Technical Support and Knowledge on GHG Reductions to Include Costs and Benefits
- Benefits Include Economic Boost to the State Economy – Including Estimates of Job Gains
- Ongoing Coordination with and Reporting to Commission

Questions?

Reference / Contact

- *www.ncair.org*
- www.ncclimatechange.us
- *Brock.Nicholson@ncmail.net*
  919-715-0587

North Carolina Climate Action Plan Advisory Group

Member	Affiliation
Besse, Daniel	Local Elected Official
Blizzard, Rolf	NCCBI
Cecich, Thomas F.	Pharmaceutical Consultant
Choi, Caroline	Progress Energy
Church, Brett	Cardinal Logistics Mgmt. (Trucking)
Coker, Jerry	Weyerhauser
Deerhake, Marion	Environmental Management Commission
Everett, George, PhD	Duke Energy
Fain, Jim	Secretary. Dept of Commerce
Givens, George	Environmental Review Commission
Grady, Dennis, PhD	Appalachian State University
Halsted, Rev. Steve	NC Council of Churches
Hazel, Bob	Senior Citizens Interest
Hazel, Dennis, Dr.	NC State Forestry & Environmental Outreach
Hobbs, Alex	NCSU Solar Center
Holman, Bill	Clean Water Management Trust Fund
Howard, Preston	Manufacturer Chemical Industry Council
Hunt, Gary	Pollution Prevention/Sustainability
Jackson, Robert PhD	Enviro & Earth Sciences Duke University
Koger, Robert Dr.	NC Green Power/Advanced Energy
McCormick, Carolyn	Outer Banks Visitors Bureau
McDonald, Jack	Mc Donald-York Developers
McNulty, Steven, PhD	US Dept. of Agriculture-Forest Service
Nixon, Marily	Southern Environmental Law Center
Peele, Mitch	NC Farm Bureau
Pickering, Chuck	Biltmore Estate
Riegel, Lisa	NC Natural HeritageTrust Fund
Rich, Simon	Energy Industry
Sanford, Jo Anne	NC Utilities Commission
Sheats, Roger	Global Warming Initiatives
Shirley, Larry	State Energy Office
Shore, Michael	Environmental Defense
Smith, Stephen	Southern Alliance for Clean Energy
Stephenson, Jim	N C Coastal Federation
Szlosberg, Nina S.	Dept. of Transportation
Taylor, Anne	NC Enviro. Education Fund
Toben, Tim	Carolina Green Energy
Urlaub, Ivan	NC Sustainable Energy
Westerbeek, Kraig	Murphy-Brown Farms
Whitfield, Stephen	NC Woodlands
Witkowski, Jim	International Paper
Yeakel, Skip	Volvo Trucks of North America

North Carolina Climate Action Plan Advisory Group

		Workgroups				
		Agriculture and Forestry	Energy Supply	Residential, Commercial, & Industrial	Transportation & Land Use	Cross Cutting
1	Adam Costanza			X		
2	Bakst, Daren				X	
3	Ballantine, Clay, Dr.					X
4	Besse, Daniel					X
5	Blizzard, Rolf			X		
6	Cecich, Thomas F.					X
7	Choi, Caroline		X			
8	Choy, Denise				X	
9	Church, Brett				X	
10	Coan, Anne				X	
11	Coker, Jerry			X		
12	Deerhake, Marion		X		X	
13	Everett, George, PhD		X			
14	Fain, Jim			X		
15	Farren, David		X			
16	Givens, George					X
17	Grady, Dennis, PhD				X	
18	Halsted, Rev. Steve			X		
19	Hazel, Bob	X				
20	Hazel, Dennis, Dr.	X				
21	Hobbs, Alex		X			
22	Hoey, Len			X		
23	Holman, Bill	X			X	
24	Howard, Preston		X			
25	Hunt, Gary			X		
26	Jackson, Robert PhD	X				
27	Kalland, Steve			X		
28	Koger, Robert Dr.		X			
29	McCormick, Carolyn				X	
30	McCroy, Patrick				X	
31	McDonald, Amy	X				
32	McDonald, Jack				X	
33	McDowell, Pete		X			
34	Mcleod, David S.				X	
35	McNulty, Steven, PhD			X		X
36	Nixon, Marily		X			
37	Nolen, Janice					X
38	Peele, Mitch	X				
39	Pickering, Chuck					X
40	Reeves, Ulla					X
41	Riegel, Lisa					X
42	Rich, Simon		X		X	
43	Sanford, Jo Anne		X			
44	Sheats, Roger			X	X	
45	Shirley, Larry					X
46	Shore, Michael		X			
47	Smith, David	X				
48	Smith, Stephen	X	X			
49	Stephenson, Jim		X			
50	Szlosberg, Nina S.				X	
51	Taylor, Anne					X
52	Toben, Tim		X			
53	Urlaub, Ivan		X			
54	Westerbeek, Kraig	X				
55	Whitfield, Stephen	X				
56	Witkowski, Jim	X				
57	Yeakel, Skip				X	

2006

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

MINUTES

(THIS IS ONLY A DRAFT)

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LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

Tuesday 4 April 2006
10:00 a.m.
Room 544, Legislative Office Building

The Legislative Commission on Global Climate Change met on Tuesday 4 April 2006 at 10:00 a.m. in Room 544 of the Legislative Office Building with Representative Joe Hackney, Co-Chair, presiding. Other members present were Mr. John Garrou, Co-Chair, Senators Albertson, Pittenger, Representatives Harrison, Underhill and Wilkins. Other members present were Mr. Walter Clark, Dr. Dolores Eggers, Dr. Edward W. Erickson, Mr. Tim Toben, Mr. Ivan Urlaub, Mr. Robert J. Glaser, Ms. Susan Tompkins, Ms. Caroline Choi, Mr. Barry Eveland, George Everett, Ph.D., Mr. Preston Howard, Mr. Michael Nelson, Mr. Mitchell Peele, Dr. Daniel Phaneuf, Mr. Tim Profeta, Dr. Sethu Raman, Dr. Stanley Riggs, Mr. Michael Shore, Mr. Robert Slocum, Stephen Smith, D.V.M., and Dr. Godfrey Uzochukwu and Mr. James Stephenson. Staff members present were George Givens, Commission Counsel, Jeff Hudson, Commission Counsel, Jennifer McGinnis, Commission Counsel, Susan Iddings, Commission Counsel, Tim Dodge, Research Analyst, Thelma Utley, Commission Clerk and Mary Watson, Commission Clerk.

A copy of the meeting notice for this meeting, a copy of the agenda and the visitor's registration are attached to these minutes as **Exhibits A, B and C.**

Representative Hackney opened the meeting, welcomed guests and asked them sign the visitor's registration.

Representative Hackney called on Mr. Givens for his remarks and to explain the agenda. Mr. Givens said that Sen. Cowell and Mr. Cecich notified staff of their absence at today's meeting. Mr. Givens told members that draft minutes of the 3 February 2006 minutes were handed out to members and to please notify staff of any changes that needed to be made.

Mr. Givens said that the agenda consisted of two topics; the continuation of the discussion of science and what specific businesses are doing with regard to global climate change.

Mr. Givens said that there is one more meeting scheduled on 25 April 2006, before the legislative session. At that time, current plans are to shift the focus on the economics of climate change and on technology options by economic sectors, beginning with transportation, buildings and electricity.

Mr. B. Keith Overcash, Director, Division of Air Quality, DENR, gave an update on activities of the Department of Environment and Natural Resources (DENR) and the Climate Action Plan Advisory Group (CAPAG). A copy of Mr. Overcash's presentation is listed as **Exhibit D**.

Mr. Overcash said that CAPAG was formed as a result of the Clean Smokestack's Act signed into law into 2002. One of the requirements of this law was to study carbon dioxide emissions from stationery sources in North Carolina. It was discovered that stationery sources is not the only emitter of carbon dioxide; thereby concluding that greenhouse gas emissions from various sectors was another source of carbon dioxide emissions. As part of the final report, CAPAG recommended that a stakeholder process be established to look at a long range plan for climate action in NC. The Division of Air Quality (DAQ) and DENR are the sponsors of CAPAG.

Mr. Overcash said that the first meeting of CAPAG was held on 16 February 2006 where ground rules were set for members. Discussions included 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. There is a second meeting scheduled for 23 May 2006 and a third meeting in July 2006. The process will continue through 2006 with plans for a final report and recommendation to the Environmental Review Commission (ERC) and the Environmental Management Commission (EMC) around April 2007. Mr. Overcash said that CAPAG had established five technical workgroups to work through the process. These workgroups and their members are listed in Exhibit D. All of these workgroups will be meeting in the next week to begin looking at mitigation opportunities that have already been developed. A list of these mitigation opportunities is listed in Exhibit D. Workgroups will take these lists of measures, discuss and decide what priority to place on them with regard to cost benefit, and go forward and extract opportunities for greenhouse gas emission reductions. Mr. Overcash said that a website had been established for CAPAG www.ncclimatechange.us and would be posted on the Global Climate Change Commission website in the near future.

Ms. Tompkins asked Mr. Overcash if there was a reason why land use could not be separated from transportation. She said it appeared that land use was a large cause of climate change. Mr. Overcash said that this could be discussed with the CAPAG facilitators. Representative Hackney asked Mr. Overcash who the facilitators are for CAPAG. Mr. Overcash said that the facilitator was Mr. Peterson, a contractor at the Center for Climate Strategies. Mr. Profeta asked Mr. Overcash if land use focused more on growth patterns and development. He said that he considered agriculture and forestry as the larger piece of the land use puzzle that has its own separate working group. Mr. Profeta asked what land use means in the context of land use and transportation. Mr. Overcash said that he could not answer this question; however, land use patterns were being reviewed as well as planning. Transportation comes into play with that type of land use planning. Mr. Profeta said that this may need to be paired with transportation.

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. A copy of Mr. Easterling's presentation is listed as **Exhibit E**.

Mr. Easterling said that he was born, raised, and educated in Chapel Hill and received his Ph.D. at UNC-CH in 1987. He taught at Indiana University for three years and then moved to the National Climatic Data Center in Asheville in 1990. Mr.

Easterling told members that, by the time all of the presentations are made, everyone should have a good idea of how the state of the science is related to global climate change. For example, is there a natural greenhouse effect on earth and what are its consequences? The answer is yes, there is a natural greenhouse effect to keep temperatures warm enough to sustain life on earth. What they are dealing with in terms of climate change is an enhancement of that greenhouse effect. Are the oceans warming as well? His expertise is the observed record—what has been seen in the past. Mr. Easterling said that he would provide evidence showing how the climate has changed over the last 100 years or so. He would show examples of observed climate change—observations and models, precipitation over the globe, and examples of extreme events and how confident we are with the results. He said he would also touch on land use and how that effects climate change.

Mr. Easterling showed slides of the global temperature curve started in 1880 to present. It decreases somewhat in the 1880's to about 1910 and then increases to the 1940's. It then goes flat and warms quite a bit starting in the mid 1970's. The National Climatic Data Center produces reports that take what happened in the last year and puts it into historical perspective. The period from the mid 1970's to the present is the period that has been mostly attributed to increasing greenhouse gases and anthropogenic climate change. The warming from 1910 to the 1940's could be due to greenhouse gases and changes in solar energy received from the sun. Mr. Easterling showed a slide of a map showing where the earth is warming. The higher latitudes in Canada, Central Asia and the oceans surrounding them are warming rapidly. There are areas of cooling in the North Atlantic and the southeastern United States over the entire 20th century, showing some evidence of cooling. This cooling could be due to sulfate aerosols and emissions from power plants. The main point is, although the globally average temperature has gone up about seven tenths of a degree over the 20th century; it is not warming the same everywhere. The highest latitudes will more than likely see the greatest warming. Mr. Easterling said that one of the big questions that have come about is the difference between what is happening at surface air temperatures taken about a meter above the ground. What is happening at the atmosphere above the ground in the layer from the surface up to about 20,000 feet or so is measured through satellites and through weather balloons. Mr. Easterling said that the largest trend of warming has been in the Pacific Northwest as well as in Alaska. Other evidence of warming, measured from sea level change, shows sea level has risen 30 millimeters (or slightly more than an inch).

Mr. Easterling explained that a climate model is a complex computer program that has a set of equations that govern the workings of the atmosphere, simulating winds, clouds, and temperature. Climate models for the 21st century compares daytime highs, using a low greenhouse gas scenario, show minimal warming. Mr. Easterling said that global precipitation appears to have increased since the late 1800's. The world has entered a more active phase of tropical occurrences thereby producing an Atlantic Multi-decadal Oscillation. He showed a slide of billion dollar climate and weather disasters from 1980 with North Carolina being in the top three, along with Florida and Georgia. Mr. Easterling said that global temperatures have warmed about 0.7 percent Centigrade since the late 1800's. Troposphere temperatures since 1979 now show warming consistent with surface warming. Warming since the 1970's, contributed mostly to greenhouse gas increases, is about two tenths of a degree C per decade. Sea ice decrease, snow cover decrease, changes in the number of frost days and days exceeding other thresholds all point to warming.

Precipitation appears to have increased since the late 1800's, with a heavy increase in daily precipitation. Hurricanes have increased with oscillation in the ocean temperatures. It is unclear if there is global warming contributing to this precipitation.

Dr. Smith asked Mr. Easterling if his slide on heavy precipitation was indicating that loading more energy into the climatic system would affect extreme thunderstorms and rapid precipitation as opposed to longer, slower, steadier precipitation. Is there some concern with impact to agriculture, given these extreme rains?

Mr. Easterling said that they are looking at heavier rainfall rates as you warm the climate because the atmosphere can hold much more moisture. This increased rainfall can affect runoff. Some climate models show mid-continental drying, which shows increased temperatures enhancing evaporation to counteract rainfall, resulting in drying and drought.

Mr. Glaser asked Mr. Easterling why the western part of the United States was warming faster than the eastern part of the US and what the impact of volcanic activity was on greenhouse gases in the atmosphere. Mr. Easterling said that the earth was warming more in the west possibly due to sulfate aerosols and emissions from power plants in the eastern US. Erupting volcanoes emit aerosols in the atmosphere, circle the earth, and tend to have a slight cooling effect. Eventually, they dissipate and temperatures rebound. It does not have an impact on greenhouse gases.

Senator Pittenger asked Mr. Easterling if clouds have an affect on the accuracy of climate models. Mr. Easterling said that biggest issue of climate models is how they handle clouds. This is due to how they are handled. When sulfate aerosols interact with enhanced clouds, they decrease rainfall. Senator Pittenger asked Mr. Easterling if the IPCC report was correct in stating that clouds make it impossible to have a sound basis in the climate models. Mr. Easterling said he disagreed with that report. Senator Pittenger asked Mr. Easterling to comment on carbon dioxide as it correlates to climate change without an anthropogenic cause. Mr. Easterling said that carbon dioxide has gone up and gone down, climates have been warmer and colder. If you looked at the last ice age, carbon dioxide levels were down. The real issue is not that the climate has varied in the past; the real question is why we are decreasing greenhouse gases due to emissions. We know that carbon dioxide is a greenhouse gas through laboratory experiments and know that it absorbs infrared radiation. By absorbing infrared radiation, it is going to warm the atmosphere. The real question is, if we are increasing greenhouse gases to the point that it is going to outstrip natural variability and go up faster than human and natural systems can keep up, are we willing to live with the consequences of that.

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. A copy of his slide presentation is listed as **Exhibit F**. Dr. Michaels said, as a state climatologist, he deals with the public on a day by day basis on issues such as climate change. Dr. Michaels explained how bias enters into forecast. The public is not receiving a balanced flow of information which unfortunately creates pressure for political change and pressure for adaptation or limits on carbon dioxide, etc. Dr. Michaels referenced a book he had written and handed out to members entitled **"Meltdown"**.

Dr. Michaels said that one of the things that bother him about the issue of global climate change is the polarization with which it is presented in the public. He referenced a book from the first book that popularized that climate changes on time and space scales could be important to societies, published by Emmanuel Laudurie in 1971, and entitled **Times of Feast, Times of Famine, Climate Since the Year 1000**. This was published because we were in an era of slight global cooling and there was concern that this cooling was caused by the emissions of aerosols and this was over dominating the changes in carbon dioxide. If we didn't do something, we would go into an Ice Age. He showed comparative slides of the Argentiere Glacier from 1850 and 1966, which showed the glacier going down the mountain. This is the nexus of the debate and discussion on climate change. He asked members to think about the debate of the 21st century, we have the technology to put the surface temperature of the planet where we want to put it; the question is where we want to put it. The IPCC reports show that temperatures were about one to two degrees C warmer than they are today when civilization was developed. The high latitudes were one to two degrees warmer than they are today. Ninety five percent of the last one hundred million years show the mean surface temperature of the planet as being warmer than it is today. That is the debate we have to think about.

Dr. Michaels showed a slide indicating a portion of Antarctica with 60 percent of it cooling and about 40 percent of it warming, annually. Dr. Michaels said that the area that is losing the most of its ice is in Greenland. The net temperature trend from the 1920's to present is negative. The article on the melting of Greenland was based on the logical argument that, during the last interglacial, when the Arctic was about five to six degrees C warmer than today, much of the Greenland ice was gone and the sea levels were 10 to 12 feet higher than today. Unchecked, we will reach temperatures slightly exceeding those levels by the year 2100. Therefore, Greenland will contribute a massive amount of water to the ocean, raising sea levels to where they were in the last interglacial. Dr. Michaels said that this information is misleading. Dr. Michaels showed slides of hurricanes in the Atlantic basin. He pointed out that 2005 was a big year for hurricanes. Since 1970, there has been a clear increase in the proportion of category 4 and 5 storms. On the Outer Banks of North Carolina, we are adapted to a 12 foot sea level rise in 30 minutes, known as a hurricane storm surge. Dr. Michaels said that he has recognized that weak hurricanes, category one or a tropical storm, is capable of inflicting large damages because of the flood potential. We are now naming and watching storms that we may not have been named or watched before because we recognize the damage potential, even from weak systems. Dr. Michaels said that many scientists believe that El Niño becomes more frequent or consistent in a warmed world. He said that the warming of the west, in Alaska, has to do with increased El Niño frequency and increased precipitation. Dr. Michaels said that increased sea surface temperature raises the intensity of hurricanes because the area of the ocean is raised that can reach 28 degrees C. This is important to North Carolina because they are on the northern end of this which spreads to the north. However, the Gulf Stream will remain constant, providing a buffering near landfall.

Dr. Michaels spoke to climate change and mortality issues. To meet Kyoto Protocol, we would have to reduce our emissions 25 percent. The question of adaptation is do people adapt to their changing environment. IPCC said that the annual number of heat related deaths will double by 2020 and increase several fold by 2050. Our cities

have been warming up, with or without global warming. The range of warming projected by the United Nations runs from 1.4 to 5.8 degrees C. Dr. Michaels said he has a problem with this. In science we have data from the past and hypotheses or models, which are the future. So, what is the consensus of models? Dr. Michaels showed slides of four studies, called coupled modeled comparison projects, all showing something similar. The consensus of scientists is not the consensus of models, which is all we have for the future. However, to make these models comparable, they increase their carbon dioxide in their atmosphere by one percent per year. The increase in parts per million in the atmosphere in the last 10 years was .49 percent. In the previous ten years before that, it was .42 percent and ten years before that it was .43 percent. That is less than one-half of the rates of increase that is fed these models. It turns out that the temperature response is quite linear with percentage increase in these models. If we stop emitting today, we would still warm some because the pulse of carbon dioxide takes time to warm. Because these models have been fed the wrong carbon dioxide increase, the last thirty years being one-half of what is going in, means that the models have to be over predicting warming. Dr. Michaels said that his solution to the questions on global warming is that Kyoto is expensive and causes long term economic problems. It costs between one half and two percent of our GDP per year. Dr. Michaels said that a better idea is to do nothing now, but encourage economic development, not only here but around the world. Why, because that puts capital in people's pocket. Dr. Michaels said the future belongs to the efficient, so people tend to invest in companies that produce things efficiently or develop efficient technologies. Don't overreact to the 15 to 1 information bias that you are seeing. Keep a calm head, a cool outlook, and help guide us to a more efficient future.

Mr. Shore asked Dr. Michaels where the scientific consensus is on polarization. Dr. Michaels said that scientific consensus is an extremely slippery issue. He said that today's consensus is not necessarily tomorrow's consensus and you have to be careful of that. Also, the way that we fund science in this country is by presenting issues in public, in large programmatic themes. These issues compete with each other. That creates a culture, which creates a consensus.

Mr. Profeta asked Dr. Michaels to clarify that we do have a warming trend that we have bought ourselves at this point, and it is related to carbon dioxide. And that the policy argument is to hang our hat on economic development and allow ourselves to adapt and engineer our way around it. Dr. Michaels said that the only way we can adapt is with money. He said that people did not live in the Outer Banks until people built flat top houses underneath the dune line because they were afraid of the wind. They discovered it wasn't the wind at all, it was the water. So they put houses on stilts, high enough to see the sound on one side and the ocean on the other side. This is an example of adaptation.

Mr. Profeta asked Dr. Michael's if, as a scientist, he believes we are better off going with economic development. Dr. Michael's said that Kyoto was a noble attempt but not the way for us to go.

Mr. Urlaub asked Dr. Michael's about eastern North Carolina and the inundation from sea level rise. He said that approximately 300,000 households in NC qualify for home weatherization assistance because they cannot afford the current technology available to them to weatherize their home. Where does the State step in and help

pay for all of this with taxpayer dollars and what do we really advocate for economic development that specifically enables us to adapt as opposed to reduce greenhouse gases. What do you think the cost will be to just adapt? Dr. Michael's said that Tidewater Virginia saw sea level rise of one foot in the last century, mainly because of geologic activity. They adapted to it. You have to tax energy to prevent its usage in order to draw down emissions. The other cost is the cost of adaptation. If the capital is taken out of the system by drawing down emissions, and we know that we are going to get warming anyway, you are taking capital away that can go to adaptation.

Dr. Riggs said that Pine Island represents adaptation and what follows is extinction. That is a system that is changing dramatically and we have to do better than adaptation.

William L. Chameides, Ph.D., Chief Scientist, Environmental Defense, New York, New York gave a presentation on the state of the science related to global climate change. A copy of his presentation is listed as **Exhibit G**. Dr. Chameides said that he, like most scientists, started out looking at climate change skeptically. He decided he needed to do something about his grandchildren's future, so he gave up his professorship at Georgia Tech to go to work with Environmental Defense. Dr. Chameides said that with regard to scientific consensus, the National Academy of Sciences (NAS) was chartered by Congress, when Lincoln was President, with the express purpose of advising the nation on scientific and technical issues. The National Academy of Sciences is not supported by the Government; it is independently supported, and governed and run by scientists. The NAS has been praised by a variety of different sources, including the administration which called the NAS the gold standard of scientific review. The NAS has spoken on global warming in a report asked for by President Bush. In June 2005, NAS said the scientific understanding of climate change is not sufficiently clear to justify nations taking prompt action. They urged all nations to take prompt action to reduce the causes of climate change. Dr. Chameides said if this was not a scientific consensus, he did not know what is.

Dr. Chameides said that global warming science is portrayed like a house of cards. If an individual could identify one, two or three things about global warming science and say it is a little uncertain, the implication is like pulling one of the cards out and the whole house of cards will come down. That is not the way most science works and is not the way global change science works. He gave the analogy of a jigsaw puzzle without the box cover to give the picture. As you put the pieces in place, a picture starts to emerge. Eventually, all of the pieces may not be in place but at some point you can see what that picture looks like. Dr. Chameides said that global science change is like that. The basic fundamentals and understanding of global warming and the need for action is in place. Dr. Chameides said that the scientific foundation for action relates to the fact that carbon dioxide is a greenhouse gas and it warms the atmosphere. Carbon dioxide concentrations are increasing because of human activities and the globe is warming. Dr. Chameides spoke to the effect that warming can be attributed to human emissions of carbon dioxide and other greenhouse gases. Future warming and impacts depend on future emissions of carbon dioxide and other greenhouse gases. Technologies are needed to take first steps and we need to decide how best to do that.

Dr. Chameides said that enhanced greenhouse effect provides the only quantitative explanation of global warming. Climate change is the rule, not the exception. He showed a slide of Ice Age Temperature Changes over a thousand years ago. Glaciations and short punctuated periods of warming have been in place in our climate for over two million years. Over this period, we have had fairly long ice ages of about 100 thousand years, with short periods of warm temperatures, with the last ice age ending about 10,000 to 12,000 years ago. We are currently in a warm period. We have a good idea of what causes most major climate shifts. These temperature variations were triggered by variations in earth's orbit about the sun. As the earth changes, the amount of energy absorbed by the earth changes, triggering ice ages and warm periods. Other longer periods of climate changes that occur relate to the assembly of the breakup of super continents. These natural variations are slow variations of temperature and do not relate to the timescales that we are talking about for global warming, which are on decadal to century timescales. Dr. Chameides said that the triggering of those ice ages and warm periods related to variations in the earth's orbit is the trigger for the large changes in temperature, but we now know are not the reasons for the large temperature changes. The reasons for those large temperature changes is that there are feedbacks in the earth's system that lead to large changes in greenhouse gases; for example, carbon dioxide. There is a large discussion in the scientific community about the sensitivity of the climate system to carbon dioxide. This ultimate sensitivity is fundamentally based in some empirical information. Dr. Chameides said that the current concentration of carbon dioxide is now at about 380 parts per million. The pre-industrial concentration was 280 parts per million. There is data suggesting that it has never been this high for 650,000 years and has probably not been this high for two million years.

Dr. Chameides said that current increase in carbon dioxide is not due to natural processes but is due to burning of fossil fuel. How can we be sure that this is not due to natural processes? If the earth was cooler and now it is warmer, source of heat must come from somewhere to cause the earth to warm. One of the sources of heat that could possibly explain the global warming in the last 40 or 50 years is the greenhouse effect. Another source is increased solar output. There has been some increase in solar output but the amount of that increase is not sufficient to explain the current warming. Another possible source is decreasing planetary reflectivity. Over a rapid period of warming, there is a process called global dimming where the earth has become more reflective; however, the earth has become less reflective thereby causing global warming. The fourth explanation has to do with internal variations. The only realistic source of heat that could lead to global warming is from the oceans. Over the last year, there is data that shows that the oceans are warming and increasing their heat reservoir. The atmosphere is supplying heat to the ocean. There is no internal oscillation that can explain this warming. In fact, the oceans have absorbed about 85 percent of the heat from the greenhouse gases. Dr. Chameides said that because the oceans are absorbing the heat, the atmosphere is heated up more slowly. The bad news is that the system has an incredible amount of inertia. When you take into account the amount of heat in the ocean and the amount of heat in the atmosphere, and the extra heat from the greenhouse gases, you get an energy budget which balances.

Dr. Chameides said that as we study the climate, it is becoming clearer that there are things, which we call tipping points, where the atmosphere can switch from one type of system to another type of system. When we pass this tipping point, we have

reached an irreversible point where it will be impossible for us to go back. One of the closest tipping points we are looking about has to do with the loss of the Greenland ice sheet and a 20 foot increase in sea level. An ice sheet is a big block of ice that sits on the continent and is like a river slowly flowing into the ocean. An equilibrium as slowly as that ice sheet flows into the ocean, ice forms from precipitation at the top of the ice sheet. The initial models of the way ice sheets melted was a big block moving as one thing and slowly creeps down to the ocean. We now understand that, as an ice sheet melts, tracks form and melted water ends up getting down to the bottom of the ice sheet and lubricates that ice sheet. The ice sheet will then begin to slide down the mountain and it cannot be stopped. If temperatures increase by about two degrees above pre-industrial, we would end up with an irreversible system where the Greenland ice sheet would melt. Even if this happens, it would take a century or two for it to melt and 20 feet will increase in sea level rise.

Dr. Chameides said there were other more immediate and more frightening tipping points. One of them relates to the loss of the Amazon Tropical Rain Forest. Another has to do with the melting of the permafrost and the release of greenhouse gases from that permafrost. Right now, the scientific community is working on how we can avoid these irreversible and dangerous climate changes. The accepted wisdom is that we need to begin do something to avoid a temperature of about two degrees centigrade. In order to avoid that temperature increase, it is not adequate to simply wait forty or fifty years for those new technologies to come along. The problem is to get from here to there. The models suggest that it is very likely there is a fifty percent chance or better that if we don't act now, we will not be able to avoid passing that tipping point. What we are now looking at is coming up with strategies that give us a fifty percent chance of avoiding the irreversible melting of the Greenland ice sheet. How do we get there? Over the next forty to fifty years, we need to stabilize emissions. By the middle of the century, we hope that new technologies come along that will allow us to significantly decrease emissions by about 40 to 60 percent. To get to the middle of the century, we need to start acting now. The good news is that is does not require major economic hardship or major new technologies. A paper, presented by Pacala and Socolow, point out that there are probably 15 technologies already existing. We need to pick out seven of those 15 technologies. By putting all of those wedges together, we can essentially reverse the increase in greenhouse gas emissions and keep them stable until 2050. Those wedges include conservation, efficiency, renewable energy, bioenergy, nuclear power, and clean coal with sequestration. How do you choose from that menu? One of the ways to choose from that menu is to hope that it happens or we can pick the winning technologies and subsidize them. This is not a very good idea. A market-based, cap and trade system probably is the most efficient way to allow these wedges to compete and provide the most cost-effective emission cuts. All of the money that goes into these technologies stays in the marketplace. The government caps emissions at a certain level necessary and allows the marketplace to decide the most effective way or cutting emissions.

Dr. Chameides that in order for us to avoid these dangerous climate changes, this has to be a global effort. Countries like China and India are going to have to take a part in a global discussion. The U.S. is the largest emitter of greenhouse gases in the world and probably will continue to be for the next 20 years. In order for the U. S. to do their part in avoiding dangerous climate change, we would need to cap greenhouse gas emissions at about 10 percent of their current level. We are not

talking about the U.S. doing Kyoto; we are talking about the U.S. doing something very different and more modest than Kyoto. If all developed countries were to take this cap as well, they would have an advantage over us. Kyoto went into effect over a year ago, and countries do not need to meet their targets until 2012. If we took a cap at 10 percent below present levels and we take into account business as usual, we would have to cut our greenhouse gas emissions by about 2,000 megatons per year. The USEPA estimates that with land management practices, such as growing trees, no till farming, and capturing methane from hog waste to generate energy, at $15 a ton for carbon, we could cut 1500 million tons of carbon emissions by 2025. The current farm subsidy in the United States is about $20 billion per year. Lawrence Berkeley Laboratory estimates that at $15 a ton, just from efficiency alone, we could save about 2000 million tons of carbon dioxide emissions a year. This ultimately saves us money, helps us become oil independent, and will not cause major dislocation. The other importance of cap and trade and carbon markets is that it will make a tiny difference in the ultimate temperature change. That argument misses the fact that by doing cap and trade, you send a signal to the marketplace that there is money to be made through low carbon technologies. Dr. Chameides said that we need to send a signal to our industry that there is money to be made through a carbon economy. Specially, in North Carolina, there is money to be made in part due to new technologies. A carbon cap is on its way. In fact, the U. S. Senate, in 2005, passed a resolution saying: "it is the sense of the Senate that Congress should enact a comprehensive and effective national program of mandatory, market-based limits and incentives on emissions of greenhouse gases." Dr. Chameides said that America is moving forward on global warming. States, cities and corporations throughout the country have already made it clear that they are getting on board. The northeastern states have started the Regional Greenhouse Gas Initiative. They have a carbon cap on power plant emissions. California has a global warming initiative and other states have indicated similar types of intentions. States that have carbon caps are going to be sending signals to their technologies in their states that they can make money by developing new technologies. North Carolina would be wise to get on board with similar initiatives.

Dr. Chameides said that China mandated catalytic converters on all of their cars. The catalytic converter was invented in the U.S. and ended up being an international technology. Will the U.S. be an exporter of new technologies? The best way for us to get that system going is through a cap, not through subsidies, but through a carbon cap that forces everyone to look at carbon emissions and develop the best technologies.

Senator Pittenger asked Dr. Chameides to respond to the statement by the NAS, saying that "the casual linkage between the buildup of greenhouse gases in the atmosphere and the observed climate changes during the 20th century cannot be unequivocally established." Dr. Chameides said that report was written in 2001. He also said you have to ask yourself what unequivocal means. There is a certain level of proof that scientists demand that is a level of proof that is much higher than most other human activities or reasonable doubt. The evidence that this is occurring due to greenhouse gases is way past that level. The other thing to point out is, since that report was written in 2001, an incredible amount of new data has been established and new studies done that strengthen that conclusion rather than weaken it. Anyone who reads science or nature magazines know that virtually every study that has come out in the last four to five years has confirmed that human activities are causing

the global warming and has confirmed that the impacts and the signs of global warming are occurring much faster and much more significantly than we have predicated, even five years ago. For example, with regard to attribution, five years ago we were not sure that the oceans were warming. Now, we are sure that the oceans are warming. And, once we are able to know that the oceans are absorbing heat, there was the last data needed to know for sure that the oceans are warming. That is why the NAS, in 2005, said the scientific understanding of climate change is now sufficiently clear to justify nations taking prompt action to reduce the causes of climate change.

Senator Pittenger asked Dr. Chameides if he was sounding an alarm to the country that we need to do something and we need to do it now. Dr. Chameides said that he did not feel that Environmental Defense was sounding an alarm but were letting the public know there is a serious problem out there. Senator Pittenger asked Dr. Chameides to respond to several quotes from the 1970's. Science Magazine, December 10, 1976, quoted "a warming of extensive northern hemisphere glaciations"; Science Digest, February 1973, reported that "the world's climatologists are agreed that we must prepare for the next ice age"; Christian Science Monitor warned that "the earth's climate is changing faster than even experts expect"; April 27, 1974 reported that "the glaciers have begun to advance, growing seasons in England and Scandinavia are getting shorter, and the northern Atlantic is cooling down about as fast as an ocean can cool"; and Newsweek, April 28, 1975, "the meteorologists are almost unanimous that catastrophic famines might result from the global cooling", and a quote from The New York Times, stating that "September 14 may mark the return of another ice age". Dr. Chameides said he could not speak for any of these magazines quotes but could speak for scientific literature. In the 1970's, that link to the ice age was made and there was much discussion about climate change occurring on timescales of many thousands of years. When we recognized that there was a cycle between ice ages and inter glaciations, and we were in a warm period that was lasting about 10,000 years, scientists began to say that in the next several thousand years, we might come to a new ice age. Dr. Chameides quoted from Science Magazine that "Having presented evidence that major changes in past climate were associated with geometry or the earth's orbit, we should be able to predict the trend of future climate. Such forecasts must be qualified in two ways. First, they apply only to the natural component of future climate trend and not to anthropogenic effects such as those due to the burning of fossil fuels. Second, they describe only the long term trends because they are linked to orbital variations with periods of 20,000 years or longer climatic oscillations at higher frequencies which means shorter time periods, are not predicted by this return to an ice age." The scientific community was never saying that within the next 10 to 100 years, we were going to have another ice age.

Dr. Everett asked Dr. Chameides if it was clear that the Senate was going to do something in the cap and trade field. And, assuming that is the case is there some reason that we need to act here in North Carolina. Dr. Chameides said, that to some extent, the Senate is responding to the movement that they are seeing at the state level. The other point is whether the U.S. is going to be a leader or a follower for new technologies.

Michael MacCracken, Ph.D., Chief Scientist for Climate Change Programs, Climate Institute, Washington, D.C. gave his presentation on understanding and projecting climate change. A copy of his presentation is listed as **Exhibit H**.

Dr. MacCracken said that his background was in climate modeling and that he had been working with climate modeling since the 1960's. He then took an assignment in Washington, in 1993, to coordinate interagency research among ten federal agencies to work on the U.S. National Assessment. Dr. MacCracken said that two states in particular are really trying to press ahead with things—one is California and one is New York. California's electricity use, per person, is half the national average. They have imposed standards to trying and reduce electric energy use and estimate a savings to each family of $1,000 a year in electricity cost. They had an energy crisis when everything went up, got that signal, and are doing something about it.

Dr. MacCracken said he gave a talk in New York in January and was fascinated to hear that Governor Pataki was focusing on this field. The Secretary to Governor Pataki said they had done a calculation in New York that the state is spending $55 billion dollars a year on energy, exporting that money from their state. That is about $2,000 a person. Their transportation system is about 95 percent based on imported fossil fuels. Governor Pataki has implemented a program to limit elimination from utilities and is pushing flexible fuel, plug-in electric hybrid cars, and installing the ethanol gas fuel system all along the freeway. They are setting up a program to help people convert over to ethanol fuel and are proposing $25 million dollars to the first company that can come up with and build a refinery that will make biofuels out of products that are grown in NY State. There seems to be a competition between NY and CA to see who is ahead. Dr. MacCracken said that we can really see that humans are having an influence on climate change. We have to acknowledge that 80 percent of the world's energy is coming from fossil fuels and it is a tremendous challenge to switch over to different sources.

Dr. MacCracken quoted Pittock (2005) who stated "uncertainly about the future is inevitable, but risk is certain". Scientists focus on the uncertainties and if you are going to get hung up on the uncertainties, you are not going to get to the issue of the thing that is certain, which is, climate change is a tremendous risk to the planet. Dr. MacCracken said that IPPC's members are the nations of the world. They convene author teams that undertake preparations of scientific reviews and try to reach consensus. A draft of their report is then sent out for review to the scientific community. The IPCC, which was formed in 1989, has put out three assessments in 1990, 1995 and 2001. These assessments from the countries of the world have unanimously agreed to a summary for policymakers on global change. Dr. MacCracken said that no organization that gets unanimous agreement from 150 countries is cutting edge.

Dr. MacCracken talked about the future impacts of global climate change. He said that the sense we have about the future is the huge population that is occurring. As the population raises its standard of living, there will be a lot more need for energy and energy will be coming from places like India and China, quite probably from coal and other fossil fuels. But this is mainly a coal and oil issue, not natural gas and oil. There is potential for large increases on what is happening with carbon dioxide. We are presently emitting about six billion tons of carbon per year into the atmosphere, there are about six billion people on the planet, and everybody is responsible for one

ton of carbon, on average. However, it isn't spread evenly. In the developing countries it is maybe a few tenths, in Europe it's about three, and in the US it's about five or six. Across states, it goes from about three to about thirty. The projection for the future is a relatively conservative one. We are going from one ton of carbon per person, up to two, for the world as an average. Ten billion people and two tons of carbon: that is 20 billion tons of carbon per year, three times the present estimate. Still, that is 60 percent less per person on average than we use in the U.S. right now.

Dr. MacCracken said that the reason Dr. Michael's linear extrapolation doesn't work is that aerosols have a lifetime in the atmosphere of only a week or so. You put the sulfur up, it turns to sulfate, and it comes down as acid rain. On the other hand, carbon dioxide goes up in the atmosphere and stays for centuries. So what we have seen in the past is sulfate and carbon dioxide going along. Carbon dioxide is taking off, emissions is starting to take off as the countries' population grows.

Dr. MacCracken showed a model of the global pattern of warming suggesting greater warming in mid-to high latitudes, over land, and during the winter. We are putting back carbon dioxide into the atmosphere in 100 or 200 years that just hasn't been there for tens of millions of years. The trend in emissions is changing. If we cut back emissions, the sulfate comes out of the atmosphere very quickly and the carbon dioxide stays for centuries. So, we are stuck with going to numerical models and they are trying to represent all of these various processes. Clouds are a real challenge but you can get a sense of what is happening with clouds. There have been clouds in models since the 1960's. The first thing you do is have a representation of how much water vapor there is in the atmosphere. You know if it's more humid you are more likely to have clouds. That is one way of doing it. You can also look at the vertical temperature gradient. If it is really warm at the surface, you are going to get some penetrating kind of convective clouds. The issue isn't whether or not you have clouds, but how the nature of clouds will change as the climate changes. We have a sense as you go from the high latitudes where it is cold to low latitudes where it is warm. You get more convective clouds. These models around the world put in representations of the physics that represent what is happening with the various kinds of conditions around the world. Dr. MacCracken said that models don't do as well in the mountainous areas. Models don't do as well on precipitation as temperature. The reason you get more warming in high latitudes is due to snow and ice and the reason you get less warming is low latitudes relates to the question of why it is warming more on the west than in the eastern U.S. In moist regions, more of that energy goes into evaporation. If you go to a dry area, there is no moisture to evaporate, so the energy goes into warming the temperatures. So, what really matters is whether there is soil moisture around that can evaporate. In low latitudes and over the oceans there is plenty of moisture around which keeps the temperature changes less.

Dr. MacCracken said that fossil fuels provide a tremendous benefit to society. If you are going to do something about fossil fuels, then you are going to look for major reasons and impacts to society that you may be concerned about. If you affect peoples' health, that would be an important issue. So, there are weather related issues on health. If you affect food supply (agriculture), that could have a big effect on people. There was a major study done in the U.S., looking at what the consequences were. A federal advisory committee tried to pull things together and put out a report, but each region had its own report, based on the university in that

region. So, there is a southeast region report, based at the University of Alabama. There are also sector reports, for example, what will happen along coastlines. Those were all based in universities. Dr. MacCracken said it was hard trying to get federal agencies to give up control and let the universities and the regions do it. You therefore see differences of across some of these reports because each university was in charge of their own report.

Dr. MacCracken showed highlights from two of the reports that are of most interest to the State of North Carolina. The 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. However, there were some additional issues that they recognized but did not get into. The coastal issue has a whole lot of things about what could happen along with sea level rise and other things that are happening in the ocean. Forget climate change for the moment, just putting carbon dioxide in the atmosphere causes some impacts. Carbon dioxide is a nutrient for plants. Agriculture can do better if there is enough soil moisture. In the U.S., the issue is not so much growing enough food, but that we grow too much food and subsidize it with commodity prices. If we grow even more, the price will drop. That is good for the consumer but it can be very hard for the farmers. So, for a farmer, important issues are competition of one crop versus another, and what the demand is.

Dr. MacCracken said that the important issue in the ocean is coral reefs. Ocean waters are being acidified and coral reefs will be compromised. However, that also applies to some of the other organisms that form such as calcium shells. For carbon dioxide alone, there is a serious issue for the world. With affect to warming, what the models showed were different results. One tended to get a little more heat and dried things out and one was a moist, warm scenario. The new IPCC report will be looking at the new results and providing some new answers.

Dr. MacCracken showed slides of what models showed with regard to ecosystems. If you get moist and hotter, you keep the forests in the southeast. However, if you get dry air, you get the potential to turn over to a Savannah. If you get dry conditions, then you get fires and transformation. It is already happening in Alaska where five to six million acres have burned and the transformation of their ecosystem is going down rapidly. Dr. MacCracken said that along with the changes in the ecosystems, changes will affect migrating species moving up and down the coast. Water resources will also be altered in a lot of different ways. In every region of the U.S., water is the most important issue. There is a natural distribution of conditions in the climate. More precipitation is coming down in the heavy events and models predict this to continue in the future. With regard to hurricanes, we are putting more energy into the atmosphere, and that has to be released someway. There is a lot of uncertainty with future number of hurricanes. We are seeing hurricanes with higher intensity around the world. Sea level rise is going up in most regions; however, there are some regions where it is going down. The projection for the IPCC has it going up in the range of 18 inches.

Dr. MacCracken said that the coastline is endangered. There are also a range of health effects such as heat-related illness. The temperature is going up but so is the humidity. The U.S. can keep the pandemic epidemics at bay if it really works at it. There are disease vectors coming in all of the time from people traveling. Across the U.S., there were different effects in different regions. One of the things that have not

been considered much in most of these reports is the couplings with the rest of the world. We depend on the rest of the world and they depend on us with regard to health, shared resources, migrating species, etc.

Dr. MacCracken said that he did not believe that the IPCC had looked into how much infrastructure is vulnerable along the coastline. A few years ago, Maryland and Virginia were worried about what was going to happen with the Chesapeake Bay and held a conference on sea level rise. They invited a couple of Dutch engineers to consult with them on this. The Dutch engineers told these states they were negligent in not already having a plan to put a barrier across Chesapeake Bay to protect and control things.

Representative Harrison asked Dr. MacCracken to clarify the slide regarding groundwater impacts in the southeast, shown on page six of Exhibit H. Dr. MacCracken said that what happens is a balance between what the demand is for groundwater and how much is coming in at various times. Are you getting precipitation that is running off or seeping in, or do you have to pull water out of the ground. The concern that people in the southeast region had was that you have this stress between how much water you are trying to extract and how much is going in. This will keep building up and intensify.

Dr. Smith asked Dr. MacCracken when the next IPCC report is due out. Dr. MacCracken it would be out a year from now. Dr. Smith asked if the projections on sea level rise would higher than what they were in the last report, based on new information. Dr. MacCracken said that people have become much more concerned about the risk from the west Antarctic ice sheet and from Greenland because the ice is melting much more rapidly. Dr. Smith asked Dr. MacCracken what year the Southeast Assessment was completed. Dr. MacCracken said it was completed in December 2002. Dr. Smith asked if there were plans to keep the Southeast Assessment updated. Dr. MacCracken said that Congress had called for that in a law passed in 1990.

Senator Pittenger asked Dr. MacCracken to respond to a quote from IPCC. "Climate models give no consistent indication of whether tropical storms will increase or decrease in frequency or intensity as climate changes. Neither is there any evidence that this has occurred over the past few decades. It is not possible to say whether the frequency area of occurrence, time of occurrence, mean intensity or maximum intensity of tropical cyclones will change." Dr. MacCracken said what has happened and is in a state of tremendous change and debate going on right now, is the way we have looked at trends is to see a linear increase. That was what was being done in looking for a northern hemisphere temperature surface temperature change in the early 1990's. Then, what happened in the IPCC assessment in 1995, we realized that we can't just look at what is happening just with carbon dioxide but we have to look at what is happening due to carbon dioxide, aerosols, and natural influences. If you look at the record of the human influence on temperature in the northern hemisphere, over the 20th century, it shows some warming earlier and then it went down due to sulfate aerosols dominating, and then it has come up at the end. So, a natural thing to say is why a linear trend should be looked for when it fluctuated. That is what was done early on, looking for the carbon dioxide effect, it is basically the first thing you do, but it doesn't prove that there is no human influence. It turns out that this up, down, up, influence, due to sulfate aerosols, was predominately occurring

over the North Atlantic Ocean. Dr. MacCracken said that, in his opinion, the conclusion that there is no influence has been strongly overstated

Senator Pittenger asked Dr. MacCracken to respond to a quote from the 2001 IPCC report on clouds. "Clouds represent a significant source potential error in climate simulations". Dr. MacCracken said that scientists don't like to be wrong, so they try and choose a range of possible things for the future. You saw one that existed for what the emissions will be in the future. That causes about half of the influence of the 1.4 to 5.8 degrees. The other half comes from trying to get a sense of how the climate will respond and what will happen to carbon dioxide in the present. The range that they use is that it will be three degrees, plus or minus one and one-half degrees. Most of the one and one-half degrees relates to how the clouds will respond if climate will change. In the IPCC report, to come to an agreement, they have chosen a relatively wide range for allowing how the clouds can be. There is experience on record on how the ice age has worked, and if you don't have climate sensitivity in this range, you cannot explain past geological climate change. Senator Pittenger said that the backup he saw had a lot greater variables than just three degrees on the climate models representing the differences with the clouds.

Dr. Riggs asked Representative Hackney if it would be possible for the Commission to receive a copy of the southeast report. Dr. MacCracken said it was posted on the web at http://www.usgcrp.gov/usgcrp/nacc/default.htm

Following the lunch break, Representative Hackney noted that several handouts were placed at each member's desk and would be noted for record. A CD from Dr. Eggers on the "60 Minutes" program on Climate Change, a handout from Senator Pittenger on Climate Change that has been put into the record, a booklet from the George Marshall Institute, provided by Dr. Erickson, and a handout from Progress Energy provided by Ms. Choi. Mr. Profeta said that he was a part of a number of hearings over the past five years in the U. S. House and Senate on this topic and thought it would be of value to this Commission to provide record of those hearings for consideration.

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 give a report on activities taken by businesses in the state and the United States to address global climate change. A copy of Mr. Semans's presentation is listed as **Exhibit I**.
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Mr. Semans said that he would introduce the next three speakers and tell what he would achieve as part of the panel discussion. He said there were a number of corporate leaders doing quite a lot directly or indirectly aimed at cutting greenhouse gas emissions and at the same time boost profitability. This is good for the states where they do business. These companies are taking advantage of the technologies available today that have a positive return and justifiable to shareholders. What differentiates the true leaders are companies that are willing to go beyond that to look at new areas of business opportunity, to look forward into the future, and understand risks to their business and to their clientele and to act on those now, before they really come to pass. Another theme is that most expect regulation to come at some point in the future. Getting the rank and file of the business community to do the kinds of things that the corporate leaders are doing, especially with respect to developing the next generation of technologies that are cleaner and leaner and

provide new business opportunities for the State of North Carolina, will involve a clearer role for efficient steps by government in partnership with the business community to stimulate private investment, research development and commercialization of some of these technologies. Mr. Seaman's said that today's discussion would be a look into what some of the larger businesses are doing and offered to bring to the Commission the new business opportunities associated with clean energy technologies and how they fit with economic development in North Carolina.

Mr. Semans gave an overview of some of the things they have heard in working with large corporations and use that as a springboard to dive deeper with the panelists. Mr. Semans introduced Tom Darden, CEO of Cherokee Investment Partner, a private equity fund with over one billion dollars under management for investing in Brownfields. Cherokee has offices in North Carolina and several other states. Mr. Darden has served for many years as the Chairman of the Cherokee Sanford Group, which is a privately held brick manufacturing company in the U.S. and was the largest southeast remediation company. He was a consultant for several years with Dane and Company in Boston and worked from 1977-78 as an environmental planner for the Crete Institute of Science and Technology in Seoul Korea.

Mr. Semans introduced William F. Bailey, Principal Consultant with DuPont, Charlotte, NC. Mr. Bailey joined DuPont in 1978, after receiving his B.S. in Mechanical Engineering from Virginia Tech. He is currently a principal consultant in DuPont's Energy Engineering Group and has over 25 years experience in industrial power and energy. He leads the energy center of competency within DuPont, which is responsible for driving forward their energy efficiency across their operations. He is also a leader of DuPont's Energy Technology Network, Global Information Sharing Network of over 600 professionals that are dedicated to improving the safety and reliability and efficiency of the company's energy related assets.

Mr. Semans introduced Mr. Robert L. Kee, Senior Vice President, Document Management, Bank of America, Charlotte, NC. Mr. Kee is responsible for the whole life cycle of digital and hard copy documents for BOA. He manages an operation which is responsible for $1.5 billion in annual spend. The Document Management Group is global, so it cuts across all aspects of the enterprise of BOA. It leads him to be an innovator across all sorts of business processes within the bank. Mr. Kee is a graduate of Texas Tech and sits on the advisory body to the U.S. Postal Service.

Mr. Semans said that the Pew Center for Global Climate Change was formed in 1998 to promote and develop sensible solutions to the problem of climate change. They work with policymakers at the state, federal and international level. He said he runs the Business Environmental Leadership Council for the Pew Center. This is 41 fortune 500 corporations that are active on climate and the largest climate focused association of companies based in the U.S. Collectively these companies employ over 3 million people and account for over two trillion dollars in combined market capitalization. They are also large emitters, either directly or indirectly. Whether it is through the electric power that they use or the energy and emissions associated with their products, they account for more than five percent of total global emissions. These companies also have very diverse business interests and are not going to align on issues of policy and business but do agree on the need for corporate and

government action to deal with climate change. Mr. Semans said that the Pew Center sits as an advisor on Wal Mart's Greenhouse Gas Strategy Network.

Mr. Semans said that they hear from the corporations on how climate and energy fit into their business strategy. There are three main buckets—first are reducing greenhouse gas emissions, second is in capturing some type of a competitive advantage in a business opportunity associated with energy and climate change; and third is with constructive, external engagement. There is a fourth area that really cuts through all of these which is in the area of risk management which Mr. Kee will be touching on later. Companies also have to deal with climate related changes in market demand, risk associated with government regulations that may occur in the future, and also climate change impacts to their infrastructure. Mr. Semans concluded by saying that in terms of reducing greenhouse gas emissions, there are two broad approaches—one is energy efficiency and reducing greenhouse gas reductions from operations and the other is in reducing the broad footprint of the products and services that a company makes. An example is Alcoa who has reduced the electricity required to produce a ton of aluminum by over 7 and one-half percent in the last 20 years. One way of thinking about the importance of that is that energy (as a matter of cost) constitutes over 80 percent of the value of the aluminum that comes out of their processes. When you come to reducing the footprint, each kilogram of aluminum that replaces a higher density material in a car, airplane or truck, can save 20 kilograms of carbon dioxide equivalent through better fuel economy and recyclables. There is a close tie-in with becoming more energy efficient and in industry cost leadership which something that DuPont exemplifies as well as number of other companies the Pew Center works with. When energy or energy products are an important input into your business, it is clear that quite a range of energy efficient activities that are consistent with reducing greenhouse gas emissions are also going to be good for the bottom line. However, to get this done across the sector, as a whole, you need a level playing field. This is one of the tie-ins that the Commission will be thinking through in the weeks and months ahead on policy. Another area is around boosting demand for products and services and things that are in the pipeline. General Electric has committed to double its annual investment in cleaner technologies from $700 million annually to $1.5 billion annually. They have launched a multi-million dollar campaign to encourage the use of cleaner technologies while also engaging extensively with academics, nonprofits, and other businesses and policymakers on the climate issue. There is another great example around new products and services in BP. BP just announced plans to enter the electric power business in the US. They want to build a power plant in Los Angeles that would take a pretty nasty byproduct of the petroleum refining process, called petroleum coke, gasify it, burn hydrogen in a power plant and take the strip off the carbon dioxide which they would sell to Occidental for use in enhanced oil recovery. This is an important example of a technology where a few people are stepping out front, trying things that don't have a clear return on investment but would if we take the steps that some countries have done in the world, to adjust the market to accurately reflect the costs of greenhouse gas emissions and the benefits of reducing greenhouse gas emissions. The exact cost and benefits are not exactly clear, but we know them in ranges and BP has committed to this investment as well as a broader investment to consolidate all of their businesses related to clean energy into an entirely new business line. They believe that regulation is coming and believe that the economic viability of developing and deploying these next generation technologies depend on allowing the marketplace to function correctly and price in

climate change. Mr. Semans noted that GE would like to come in and discuss the nuclear business which they believe is part of the answer to climate change.

Mr. Semans discussed constructive external engagement. He showed a slide of all of the companies who are examples of those who have engaged in this policy process. Most of these companies are involved in disclosure and public awareness process. A lot of investment houses have demanded of the portfolio companies that they invest in, to disclose what both their climate related risks and business opportunities are. In the area of collaboration, up and down the supply chain within sectors will also be covered by Mr. Kee.

Mr. Semans ended by telling a story about Wal Mart, which is the equivalent of the fifth largest city in the U.S. It is one of the top ten largest trading partners of China and employee 1.7 million people. The CEO of Wal Mart, Lee Scott, has made a set of very ambitious commitments to address climate change in the operations of the company, including a long term goal of powering what Wal Mart does on 100 percent renewable energy. One of the things is going to do is to try to push energy efficiency and clean energy up and down their supply chain. They are instituting a supplier score card and work with producers to come up with and to market a new set of technologies, such as more efficient light bulbs and appliances, etc. Mr. Semans said that Wal Mart recognizes that this is not going to happen without policy engagement and is one of the reason why they have come out and called for the kind of regulatory certainty that allows them to make plans as they are building new stores, the same that the electric power industry, the cement industry, glass, chemicals have to really understand the future when they are making large capital investments that they make today.

Mr. Semans said that he was recently outside of Detroit at what was once the largest cement factory in the U.S. That factory will last for 100 years and it basically puts out a ton of carbon dioxide for every ton of product that it makes. They need to know what the regulatory future looks like and is one of the reasons why they are engaged in this issue. In the interim, they are incredible innovators in energy efficiency and capturing that low hanging fruit. That is what you are going to hear about today from Tom, from Bob and from Bill. Mr. Semans said that he would take any questions from members after the next three speakers had concluded their talks.

Mr. Tom Darden, Chief Executive Officer, Cherokee Investment Partners, Raleigh, NC, spoke about what Cherokee Investments is doing to address global climate change. A copy of Mr. Darden's Perspectives on Energy Reduction and Environmental Innovation and a copy of Cherokee Investment's 2004 Sustainability Report are listed as **Exhibit J.**

Mr. Darden said that he was not an expert on Global Warming or an expert on carbon, not a scientist but he happens to be in a business that is maybe adjacent to or kind of in the general vicinity of a lot of these issues and they have chosen to address some of these issues for a variety of reasons. He said he was happy to speak about them and tell what Cherokee Investments is doing. He said it was highly anecdotal and hoped it was of some use to the Commission. He caveated his remarks by saying that he was very much a lay person and the focus of his efforts associated with this are not specifically targeted at global warming, per se, but were trying to address a set of issues that may have a positive affect.

Mr. Darden said that he went to graduate school at UNC-Chapel Hill in City and Regional Planning, studying environmental planning. He was quite interested in environmental issues back in the 1976-77 and ended up buying some brick plants in North Carolina with a plan to convert them from burning natural gas to burning wood waste. The bad news was that the sites were contaminated from leaking fuel storage tanks that was discovered in 1985. He got a call from their engineering consultant who said that a certified letter had been sent to the regulators because they were perceived to require notifying the regulators within 24 hours of having discovered any contamination in the ground.

Mr. Darden said that out of this concern, they created a business of treating fuel contaminated soil, mostly with bacteria by remediation. They started buying contaminated property in 1990, cleaning up the sites and selling the sites. They didn't have a lot of money to do this with, so they went out and raised $50 million dollars for this purpose in 1995-96 and spent that money. When this money ran out, they went back to the market and raised $250 million in 1998 from a number of funds, including a large pension fund from the State of Washington, who invested $100 million. Later, $620 million of equity was raised in 2002. For every dollar of equity, there was about $2 of purchasing power. Mr. Darden said that a fourth fund closed in December 2005 at $850 million, which will end up being about $1.2 billion of equity. He said he thought it was interesting that these investors would have such an appetite for investing in urban infield, urban redevelopment, and the purchase or contaminated property. Mr. Darden said that all of this money comes from large pension funds and university endowments. Mr. Darden said that Cherokee has purchased, since 1993, 520 sites around the U.S., Canada and Europe and the remediation costs of those 520 sites would be $250 million of in the ground remediation cost.

Mr. Darden added that they buy these sites and assume the liability for the cleanup. They cannot release the owner of the polluter from liability because under the strict liability regiment, the liability is attached permanently. However, they can step in front of them from a liability standpoint. They assume the responsibility for the cleanup of the sites, remediate the sites, and work with local planning agencies to plan and rezone the sites. These sites are then sold to somebody else in the chain that would build on them or do with them whatever they wanted to do. Mr. Darden said they bought property from kind of who's who of corporate entities such as Exxon, G.M., KKR, American Airlines, ICI and mostly large companies. Mostly their focus is on very large, urban redevelopment sites. They bought 31 sites, adjacent to one another in a series of purchases in Charleston, SC, on the peninsula, to assemble about 500 acres into what will be a new town adjacent to Charleston. This is in conjunction with the mayor's plan for the development of the peninsula in an effort to combat the growth of the people leaving Charleston and moving out into the suburban areas outside of Charleston. Mr. Darden said that they had 2,000 acres of land, five miles from Manhattan in the midlands of New Jersey, former landfill sites, which will be capped and contained. A methane collection system will be installed. In exchange for doing this, they have development rights for some property near the landfills. Golf courses will be put on top of the landfills, which will enhance the value of the surrounding property. They have development rights to develop about 3,000 homes, a hotel, and some office space and retail uses around the landfills. The

value of those planning consents to that land will be used to pay for the remediation of the sites.

Mr. Darden added that if you clean up contaminated land, it is a good thing from an environmental perspective; however, the social and longer term environmental implications of a built environment are pretty important. Historically, they did not think about this so much but focused on what was in the ground. But, they began to think more about that because communities care, especially as the sites got larger. They feel a great sense of responsibility and as an organization they try to incorporate as a set of values, a broad sense of responsibility for social issues. Workforce housing is an example—what will the 500 acres that are a part of Charleston going to look like and what kind of uses will be there and how will it fit into the social fabric of the community. If you are going to sell real estate, it needs to fit some economic model. By far, the largest environmental impact of the developments is in the buildings that are built on the sites. They try to have some input into what is built on their sites. They perceive that the environmental impact on the environment is significant and if they could do a better job with respect to that, they could have a big impact. What are they doing with respect to that? They are trying to do this in the context of an economic model. They are willing to make green, building investments that generate fairly lousy returns in the scope of a large project. These are large redevelopments and as a rule they probably have a little bit of slack in there to add amenities in there to these developments, the economics of which are a little bit hard to define. So, there are all kind of decisions made and can be debatable as to the economic return. They are fiduciaries for their investors' capital and need to be getting an economic return.

Mr. Darden said that the biggest impact from greenhouse gas or carbon effect, from his perspective, is energy consumption from the buildings that will be built on these sites. Unique to his situation, they have an opportunity because they deal with a fair number of landfill closures. This gives them development rights around the sites by using their money instead of them having to find funds to close these landfills. In turn, they have an opportunity to capture methane coming off of these landfills. The methane capture associated with the larger landfills has a fairly significant carbon dioxide equivalent impact. The biggest impact is reducing energy. Some research is being done on this subject, the purpose being to mandate to purchasers of land that they implement some of these practices. It cannot be a mandate with no information or knowledge.

Mr. Darden said that ground was broken yesterday on an interesting project in Raleigh called the mainstream green home. They believe that if these practices are going to be developed, it has to happen in the context of real estate. It needs to look and feel like conventional real estate. They took a lot in a conventional subdivision near Rex Hospital. Someone who works at Cherokee bought the lot and is developing a home, consistent with the practices of reducing energy. A webcam will document this building process at http://www.mainstream.dreamhome.com which will follow the process, talk about the technologies being used in the house, and monitor the energy produced by the house after it is occupied. This information will be made available to home builders and to people who are buying their sites. They will mandate that the ten attributes will need to be achieved when they build on these sites. It can be a difficult conversation because most of the people who buy the sites are very large homebuilders and real estate developers like Pulte or Centex. It is not

in the DNA to address these issues, although they are getting more interested. It is selling the notion that their customers will appreciate the attributes of these developments.

Mr. Darden said that Cherokee was a private business and has no dog in the policy discussions. So what is their motive for addressing these issues? Some of it is personal curiosity; however, mostly they are rational decisions. There will be over 100,000 people living on property that Cherokee owns and with the new fund being raised, that number will get close to a million people who will live on a site that Cherokee Investment partners owns or will own with the capital they are raising in their fourth fund. About a comparable amount of square footage will be developed as either retail or office space or other uses. He said he does not know who much energy 100,000 people use, but it is a lot. It seems to him that if you have that in your hands, you need to think about it. This is an anti-waste or efficiency ethos—a notion that waste is bad. It is clear that quality is associated with less cost. We will eventually get to the point that the same is true for environmental issues. Pollution is a form of waste. It is money going out the door or up the stack. So, just at a waste level, we need to find ways to reduce our pollution and be stewards of the investors' capital. Mr. Darden said he believed that energy prices are going to rise and he is willing to make an investor bet on that. They are willing to spend money on low return energy investments, right now. So, if they can figure out ways to produce energy or to save energy and capture the benefit of those energy savings in their developments, they can generate good returns, long term.

Mr. Darden said this was a national security issue and believes we all should be concerned about this. He is concerned about national security implications of energy. He used to tell his children, when they were facing a complicated decision, what happens if you are wrong and what happens if you are right. If we take action, and we are wrong, then how bad is that? Or, if we take action and we are right, they how good is that? If human activity is affecting global warming, and we do something about it, then we will be happy that we did. But, what if we are wrong? He said he was not willing to believe that the economics that are tossed about in this argument are really valid. He said that the economics are gross economics, not net economics. It is the gross cost, not the net cost because if we really try hard, we can figure out ways to do these things and not net spend incremental money doing that. If we do this and we are wrong, we have permanently improved the efficiency of the economy, because we have reduced our energy consumption, we have reduced our waste and have permanently improved our national security situation and hedged against future energy price increases.

Dr. Eggers asked Mr. Darden what some of the major barriers are to make what they are doing less attractive, and what are some of the ways that what they are doing can become more of an incentive, from a policy perspective. Mr. Darden said that the thought has crossed his mind, as we cap and contain the methane in these landfills, if there were to be carbon credit associated with this, it would be foolish for us to do it now instead of doing it after we get the benefit of the carbon credits. In other words, you do not get the credits if it has already been done. If you build something new and have less carbon impact, you do not get a benefit from it. Cherokee has a dog in the policy fight from the sense that we all should be concerned about the environment; however, he had not spent a lot of time thinking

about specific programs. The tax credits associated with solar energy will possibly be extremely important in their New Jersey project.

Mr. Shore asked Mr. Darden what the penalty would be for taking early action and how do we reward companies taking early action, and what should be North Carolina's role in this issue. Mr. Darden said that he has not ever been comfortable taking a position that his efforts would not make a difference and therefore he should not do anything. It appears to be a state versus national policy issue which is beyond the scope of his thoughts about this. Since most of Cherokee's activity is not in North Carolina, he has wondered about the implications of different programs in different states. He said if you are in a position to do something to possibly affect a problem, then somebody needs to step up. However, he was not making policy recommendations.

Representative Hackney said that we had a green building entrepreneur among the Commission membership, Tim Toben of Orange County.

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 said that Bank of America is one of the world's largest financial institutions. Forbes listed them as the third largest corporation. They lend to 97 percent of Fortune 500 companies, 79 percent of the global 500 companies and have over 40 million customers in domestic United States, 5800 retail banking centers, and are the largest lender to small business in the United States.

Mr. Kee said he was not a scientist but was in the supply chain group within Bank of America. BOA developed an environmental council to consider environmental issues, including climate change. The environmental council is comprised of senior executives across the Bank, including him, who represents major lines of business. The chair of that council reports to Ken Lewis, CEO of BOA, on environmental issues. Mr. Kee said that the environmental council has carefully weighed in on the issue of climate change and has identified it as a significant risk in terms of doing business. When they use the term risk, banking is all about managing risk, therefore it is a significant element in the lending portfolio and in procurement space. They are charged with finding market based solutions to address climate change.

Mr. Kee said that there BOA affects the environment—one is in their credit policy and the other in their procurement policy. Mr. Kee said that when BOA first started addressing the environment, it was more in the credit portfolio and prompted by the regulation related to superfund issues, hazardous environmental spaces, etc. From that, the bank was motivated to develop environmental specialists in those spaces, to help guide the lending practices and policies. That grew significant expertise in that space and lending processes were developed, relating to the remediation of contaminated real estate. They are begun to address illegal logging issues with the largest forest lender in the world. Mr. Kee said that in an operation space, which the area he is most comfortable talking about is, one of every 225 pieces of paper in the United States is consumed by BOA. In that regard, if they have influence in an area, they therefore have responsibility in that area. Over ten years ago, the company set forth a goal to reduce paper consumption by 25 percent over three years and co founded the Recycled Paper Coalition (RPC). BOA recycles about 28,000 tons of paper, which is two and one-half times more than they produce internally.

Mr. Kee said that BOA implemented a paper purchasing policy simultaneous to the RPC, and were able to reduce the consumption of internal paper by over 32 percent that has multiple million dollars worth of savings. If you look at the difference between carbon dioxide emissions in 2005 versus the year 2000, it represents something like 46 million pounds of carbon dioxide equivalents that were eliminated, 45 million pounds of solid waste that did not reach the landfill, the equivalent of the BTU's it takes to drive a city of 10,000 people for a year. Just the interaction in the paper space, which is a relatively minor expense in what the Bank does, has significant environmental considerations. The Bank has launched the Electronification of Paper Program, to look at where paper is utilized in any of the Bank's initiatives, and to develop digital means to have those communications. This is simple when you are working in internal operations because you basically own both sides of the equation. But, because the Bank has a lot of customer facing communications, they are also looking for methodologies to drive more digital approaches in communications. Out of the 40 million customers, roughly 15 to 16 million of them do online banking with BOA. Over five million customers have opted out of receiving their statements electronically, at a six to seven dollar a year savings per person. Mr. Kee said that the environmental credit policies are certainly not due to the bank. They continue to look at balance at how they approach the environment. Aside from taking a look at specifying what they consume and diminishing what they consume, they also extended their procurement influence into the forestry area where the lending side of the business had developed a forest lending policy related to illegal logging and carbon dioxide emissions. On the other side of the equation, they decided they were going to ask for those same sorts of parameters to be extended to their paper suppliers. Last year, BOA signed their forest lending practices policy that requires any company that BOA purchases paper products from can trace its pulp back from a sustainable site; it avoids old timber sites, and avoids areas that are involved in illegal logging. BOA feels that if they have influence in an area, it is their responsibility to manage that and use that influence in a constructive manner.

Mr. Kee explained why climate change is a significant issue for BOA. As a risk issue, it is nothing new to BOA. As a global financial services provider, BOA is in the risk management business. To be competitive and create a return for shareholders, they have to balance these risk factors or credit, market, operational, and reputation risks with opportunity. BOA's health, as a company, is reflected by the health of its customers. Being more involved in the climate change space is just a case of enlightened self interest. Mr. Kee said that the role of business and government go in hand and business needs to take a leadership stance and be principally responsible on this issue and help push for solutions. BOA has made this move with its own commitments to address greenhouse gas emissions in their public support of regional initiatives such as the Regional Greenhouse Gas Initiative in the northeast. They believe that government needs to continue to move forward in these initiatives. As they learn more and more about this space, they are making measurable commitments. When they talk about the lending space, they are actually saying that in their utility and credit portfolio, they have spent the last several years benchmarking what the carbon footprint looks like and have made a commitment to reduce the carbon dioxide emissions in that area by seven percent by the year 2008, by simply making more astute decisions about who they are going to lend money to and moving away from more intensive sorts of businesses. When they take a look at

their own direct emissions from operations they generate from their own facilities, BOA has set an aggressive voluntary goal with EPA climate leaders to reduce greenhouse gas emissions by nine percent by 2009, based on a benchmark of 2004. This is no small initiative since BOA has 6,347 properties, totaling 65 million square feet. Mr. Kee said the capstone to that initiative will be their new building in New York at One Bryant Park. It will be the second tallest building in the Manhattan skyline and will be rated a platinum environmental rating. So, they are making this building the showcase of their stance from a facility standpoint. Mr. Kee said these efforts have included benefits in NC. In April 2005, BOA received the NC Leadership and Sustainable Energy Award acknowledging the company for outstanding contributions in helping the State in achieving its energy efficiency, renewable energy and sustainable goals. From the procurement side of the house, those areas they have good metrics on what the carbon footprint is, goals have been set that are the equivalent of what they are trying to do in their lending portfolio of reducing their footprint by seven percent by 2008. In addition, they are really disturbed about what they don't know. They have recently provided a grant to UNC-Chapel Hill to have a study done on the products and services BOA acquires in the United States and to describe to BOA, in measurable form, what their environmental impact looks like so that they can move their resources to mitigate where they have the largest impacts, not what they understand in a traditional manner.

Mr. Kee concluded by saying that BOA, as a corporation, touches many aspects of the environment. They have learned that their leadership influences economic fatality, the well-being of their communities and even the way people live. This commitment stretches from their energy and utility portfolio to making sure that they turn the lights off at the local branch. They know that addressing climate change is the right thing to do. It is the right thing to do for the investors, for their associates, and most importantly for the communities we all live in. BOA weighs in on this issue because they are committed to the long term sustainability of their business and that of the communities which they serve. By being focused on the long term, climate change comes clearly into focus. They recognize that there is an urgent need to act quickly to address climate change and they support mechanisms such as regional initiatives aligned with this objective.

Dr. Eggers asked Mr. Kee what the baseline year was on BOA's portfolio goal. Mr. Kee said the baseline year was 2004. Dr. Eggers asked if that means that the borrowers need to report annually their climate footprint. Mr. Kee said that was correct. Dr. Eggers asked if these reports from borrowers on greenhouse gas emissions, just based on energy consumption. Mr. Kee said there is a website he would make available on how that data is collected and reported. He said that on the flipside, in terms of looking at BOA's footprint, when they take a look at the 200,000 associates that commute to work, they have expectations that this will be the second or third largest impact. BOA is creating satellite sites that are much closer to the concentration of folks, so that they can cut their commute.

Senator Pittenger asked Mr. Kee what role the government plays in the efforts that BOA has employed. Mr. Kee said that when you talk about the procurement side, he would say government plays essentially no role. It has been driven by leaning processes. It is the right thing to do economically. Originally on the lending side, it may have been significantly stimulated by regulations related to the Superfund and hazardous waste sites, originally, in terms of recognizing that if there was a default on

the loan and they acquired property, they would acquire all of the environmental liability that went with it. Senator Pittenger asked Mr. Kee if most of BOA's incentives had been market driven, good for business and good for the environment. Mr. Kee said that was correct.

Mr. Toben asked Mr. Kee if BOA had found, in the insurance and reinsurance sector, that the sensitivity to these climate change issues is also high, and within bank and financial sector associations BOA is affiliated with, are they finding that the level of activity and response that BOA is exhibiting is typical of the financial services sector or is BOA ahead of the curve. Mr. Kee said he was completely unqualified to answer this question but would provide the name of the individual who could provide him with some good answers in that respect. Mr. Kee said he believed BOA had been a leader on the environmental side of the equation and thinks it is becoming more type of mind for other financial institutions to follow suit. Wells Fargo just recently appointed a pretty significant environmental committee of renowned scientists to provide them some guidance. City Corps is doing things, but his perception is that BOA has been a leader in that space.

Dr. Smith asked Mr. Kee if BOA feels that it is appropriate for the State of North Carolina to set a target reduction goal. He also asked Mr. Kee to talk more about BOA's support for the regional initiative in the northeast and why BOA feels it is important. Mr. Kee said that BOA has a pretty significant presence in the northeast and feel that this initiative will stimulate a lot of market growth in innovative new businesses, moving to more clean technologies. This stimulates jobs and investment opportunities; therefore it is good for the communities in that space. Mr. Kee said that his personal opinion about setting some goals for the State is things that are not measured, rarely get done, so for the North Carolina to set some goals would be a very healthy thing.

Mr. William F. Bailey, Principal Consultant, DuPont, Charlotte, North Carolina, gave a presentation on DuPont's activities with regard to addressing global climate change. A copy of Mr. Bailey's slides is included in a handout marked **Exhibit K**.

Representative Hackney asked Mr. Bailey to explain what a Principal Consultant is. Mr. Bailey said that DuPont has an internal consulting organization of which he is one of the principals.

Mr. Bailey said that DuPont is a global science company, solving problems in ways that make people's lives better, safer and easier. They currently operate 135 manufacturing plants across the world in 70 countries and have 80 research and development (R&D) facilities, with five locations in North Carolina. These locations are in Fayetteville, Cedar Creek, RTP, Charlotte and Kinston. The major business segments in DuPont include agriculture and nutrition products, coatings and color technologies, electronics and communications, performance materials, and safety and protection. As a company, DuPont is one of the oldest companies in the Fortune 500. The company began over 200 years ago on the banks of the Brandywine River in Wilmington, Delaware, when its founder, DuPont decided to make gunpowder. Trying to make gunpowder was a very hazardous undertaking and Mr. DuPont recognized that if he was going to be successful, he needed to protect his most valuable assets, his people and his equipment. So, from day one, DuPont has a deeply engrained concern for the wellbeing and safety of its employees and their

health. That deeply engrained concern for employees has grown over the years to what they now come to represent as their core values, the DNA of DuPont. Mr. Bailey said these core values are safety, health, and environmental stewardship, integrity and high ethical standards, and fair and respectful treatment of people. These are the values that DuPont strives to live by. Going forward into the third century, they recognize that their operations have a global impact. If you are operating 135 manufacturing plants in 70 countries, you better be concerned about what is going on in the world around you, and DuPont is.

Mr. Bailey said that the challenge for DuPont is to address issues such as climate change in a way that makes business sense and upholds its core values, sustainable growth. Sustainable growth means to DuPont, increasing shareholder and societal value while decreasing the footprint of its operations along the value chains in which they operate. The word footprint is an interesting term to apply to what they do, but when they use it, they mean injuries, illnesses, waste, emissions and depletable forms of raw materials and energy. A vision for sustainable growth like that is very much aligned with a core value of safety, health and environmental stewardship.

Mr. Bailey said that DuPont's view on global climate change is based on CFC/Ozone issue in the 1980's which helped them to understand the implications of environmental issues that are global in scope and decades-to-centuries in duration. Global climate change is really an extension of the experience that DuPont gathered when they went through the CFC/Ozone issue. They studied the science relative to global climate change and concluded that there is reasonable cause for concern. They recognize that this is a global issue, not just a North Carolina issue in the five communities where they do business here. They also recognize that their greenhouse gas emissions are significant. So, they decided to take responsible action to reduce their emissions footprint and be part of the solution to this problem they believe exists in global warming.

Mr. Bailey said that in 1999, DuPont made a public commitment to achieve the following three goals, related to energy and the environment, by the year 2010. First of all, DuPont committed to reduce their greenhouse gas emissions by 65 percent versus a 1990 baseline. Secondly, they committed to hold total energy use, flat, versus a 1990 baseline and that's not just energy efficiency or BTU's being flat, that is total energy use, period. Thirdly, DuPont committed to supply ten percent of their total energy needs from renewable resources at a cost, competitive with the best fossil-derived alternatives. DuPont reports its progress annually on these three, 2010 energy and environment goals in a document called The DuPont Sustainable Growth Report. It is also reported to the USEPA as part their 1605(b) report. Anyone interested in reading can go to http://www2.dupont.com/Social_Commitment/en_US/

Mr. Bailey said that DuPont's approach to reducing greenhouse gas emissions really took the following track by finding out what they had. They had to develop an inventory of global greenhouse gas emissions and then track them over time. They had to know what they were emitting in 1990 in order to measure their progress versus that baseline. That inventory of carbon dioxide and other greenhouse gas emissions was very important to establish what it was they were going to be reducing against. Secondly, DuPont had to identify emission reduction opportunities and thirdly had to implement the projects that reduced the most but cost the least. Mr. Bailey said that the Flat Energy Use Goal was the hardest of the three to achieve

because that is what he spends his nine to five life working on everyday. If you want to make more pounds of whatever, in order grow the value of your company, then you have to find the way to use less energy per pound of product. DuPont very much wants to be a growth company like most investor held companies do these days. Improving the energy efficiency in their manufacturing plants is no small task for DuPont. Mr. Bailey said that most of their assets had been on the ground for 30 or 40 years and the economics for energy using equipment are not such that they can afford to throw out everything they have on the ground and install brand new, high efficiency equipment. But in addition to that, energy use on their plants is literally disbursed among hundreds of different devices. Secondly, inefficiency in energy use is very difficult to spot. In many cases, they are invisible. It is like owning a car, the combustion of the car is not very good and may be making some noise, and you know if you take it to the shop for work, it will improve the fuel economy and the noise will go away. That is kind of an invisible indicator that you have a problem with energy efficiency that needs addressing. Third, the data that is required to pinpoint inefficiencies in energy use is frequently unavailable in our plant sites. And, like many companies, DuPont has undergone restructuring programs over the last 10 to 15 years and have far fewer people in the plants to look at things like making improvements in energy use. Lastly, and perhaps most importantly, energy efficiency is not a product, quality variable. This means that customers who buy most of their products really don't care at this particular point and time how much energy it takes for them to make their products. They want a product that meets their quality specifications and a product at a competitive cost. If it takes the company ten percent more energy to make that product, many of the customers probably would not care. That puts the company in a very unusual position in their manufacturing plants where employees are focused on giving the customer what the customer wants. The plants have to learn how to improve something that the customer generally doesn't care about. DuPont is paying much more attention this year relative to energy use in the plants because they are paying so much more for the fuel used to make the steam and drive their plants. Their sustainable growth focus and core values around environmental stewardship are really providing the long term support for a program to continually work on improving plant energy efficiency. They have taken a very strategic approach to help the manufacturing plants to see that this is something that is equally important as demands of the customer. For example, each of their largest plant sites, 45 globally at this time, have set an annual energy reduction target. They have appointed individuals at those sites to lead a site energy efficiency program that is designed to implement improvements to operations that will enable us to achieve those targets. DuPont's plant managers are now accountable for delivering results against the targets that their plants set. Plant managers' bonuses may be determined by whether his site meets the energy cost reduction target that it has set.

Mr. Bradley said that DuPont has established a center of competency, relative to energy use in the company, to share best practices and educate the few people who are left to run their manufacturing plants. Lastly, they have standardized in DuPont on an improvement methodology. Low hanging fruit, mentioned earlier, is something that DuPont has been working on since 1999 and the low hanging fruit is gone. They are way up the ladder trying to find ways to further improve energy efficiency and having a standardized improvement methodology such as Six Sigma is enabling them to do that and pick the fruit in a way that it doesn't grow back.

Mr. Bradley said that with regard to how DuPont is doing versus its goals, they report recently that their greenhouse gas emissions are down 60 percent from 1990 levels, at year end 2004. Their total energy consumption has decreased six percent while their production has increased 41 percent. So, they are 60 percent below their flat energy use goal while their production has grown over 40 percent. Efficiency improvement has saved the company over two billion dollars since 1991, versus a business as usual approach, where no improvements were made in energy efficiency. Mr. Bradley said that over five percent of their total energy, worldwide, is now supplied from renewables. The largest contributors in the two most recent years are landfill gas projects and wood-fired projects.

Mr. Bradley said it was hard work to go to work everyday and work on energy efficiency when you know that DuPont's customers, in general, don't care a whole lot about it. So, it is very rewarding when this work is recognized by people outside of the company. In the December 12, 2005 issue of BusinessWeek, entitled "Battling Climate Change", DuPont was recognized as the top company of the decade, based on total reduction of greenhouse gases. The article said that "DuPont reduced energy consumption 70 percent below 1990 levels, saving more than $2 billion dollars including at least $10 million a year by using renewable sources." Mr. Bradley added that two weeks ago, Ceres, a group of investors and environmentalists who are all about sustaining prosperity, ranked DuPont number one in the U.S. and number two, globally, in its first ever ranking of companies on climate change strategies.

Mr. Bradley said that DuPont also provides a broad array of enabling technologies that can help their customers reduce their greenhouse gas emissions footprint. They make biofuels and bio-based raw materials like bio propanediol (PDO) for Sorona polymer. This material is made by taking corn and feed it to genetically modified bacteria which then excrete PDO. They are taking what used to be a depletable resource and replacing the raw material with a truly renewable resource in the form of corn. DuPont is very much committed to bio-based technology as shown in the announcement last November in Kinston. This announcement was that DuPont would increase its capacity to make bio-based PDO to 85 million pounds when that plant starts up in the third quarter of next year. Secondly, DuPont makes a broad array of engineered plastics and composites that can help reduce weight in automobiles. DuPont makes Tyvek house wrap, which makes homes more energy efficient by reducing infiltration and energy leakage. They also make fuel cells and components that can be used in photovoltaic systems. DuPont's Kevlar is being used in windmill blades to make them more efficient by reducing the weight that would otherwise be taken up by a metal windmill blade.

Mr. Bradley concluded by saying that DuPont believes that enough is known about global climate change to provide a basis for concern and to warrant prudent action. They have set aggressive goals to reduce their environmental footprint, including greenhouse gas emissions and energy use. They are making good progress on all of their goals and on track to meet the commitments they publicly made for the year 2010. Climate change is an environmental and economic challenge, not only for DuPont but for everyone. And, a successful strategy to address this issue must address both of these elements.

Representative Hackney told Mr. Bradley that if DuPont was in the market for buying methane, eastern North Carolina had plenty of it. He said that our Commission Counsel could put him in touch with lots of hog farmers who have lagoons and they could work together. Mr. Bradley said, "let's talk".

Senator Pittenger asked what role government had in DuPont's success in achieving their goals. Mr. Bradley said that it was essentially zero. Mr. Bradley agreed with Mr. Kee that his company sees this as the right thing to do.

Mr. Profeta asked Mr. Bradley what the reason and rationale was for DuPont's involvement and development of common change policy. Mr. Bradley said that he was not a policy person but an energy engineer and preferred not to answer the question. He personally believes that DuPont is doing this because they believe it's the right thing to do and it has made good business sense for them to do it.

Representative Hackney noted for the record that additional handouts were out passed by Senator Pittenger with reference to a recent George Will article, he also noted for the record that a copy of the book, Meltdown, was also handed out.

Mr. Shore asked Mr. Bradley if DuPont would have made some of the progress on the global warming pollution reductions and the energy efficiency had they not set goals for the future. And, would it be good for North Carolina to consider such goals.

Mr. Bradley said that eight years ago, prior to the announcement of their 2010 goals, if anyone had suggested that DuPont would be interested in buying landfill gas to run even part of its operations, they would have been laughed out of the room. The reliability of the supply and all of the issues associated with it, being connected with something that had to do with an odious part of the environment, they would have preferred to avoid utilization of landfill gas. When they set a goal in 1999, to procure ten percent of their raw energy from renewable resources, they had to reconsider those kinds of approaches. All of a sudden, landfill gas became a lot more attractive fuel alternative for DuPont because it was one of the most cost effective renewable out there, especially in locations where there was a landfill less than ten miles from one of their plants that burned natural gas. Mr. Bradley said that DuPont had implemented three landfill gas projects in the last five years. The driver for this was that goal to source ten percent of renewable energy from them, but the people who authorize those projects are looking like heroes, because that stuff is a lot cheaper than natural gas that it replaced. Mr. Bradley said that the goals have driven DuPont to do things they otherwise would not even have considered doing.

Representative Hackney asked Mr. Bradley if he had studied Interface Corporation and Ray Anderson, or did he consider himself a predecessor of what they have done. Mr. Bradley said he was not familiar enough with their work to comment. Representative Hackney said that there was a wonderful book entitled, Mid Course Correction, about Ray Anderson's attempt to bring his company to as close to zero energy use as possible.

Mr. Garrou asked Mr. Bradley if the goal had been to save $2 billion from energy efficiencies, how different would the strategies that he pursued have been, if at all. Mr. Bradley said that he was not sure the strategies would have been a great deal different because in order to generate the dollar savings, they would have had to

known what needed to be changed in the operations in order to produce those kinds of economies. As a publicly traded company, DuPont is very concerned about what happens quarter to quarter. A goal that set strictly on economics may have a great deal of weight behind it one quarter. But, if they have a poor quarter in terms of meeting their objectives, those kind of goals can receive much less prominence in their day to day operations than a goal that goes back to core values of safety, health and environmental stewardship. Mr. Bradley said that he did not know if the leaders who set those goals thought about that when they did it, but it turned out to be a great way for them to present their goals.

Senator Pittenger asked Mr. Kee to clarify if he sees the role of the state as setting goals or mandates. Mr. Kee said that his comments were related to goals, not to mandates. He said he thinks that corporations set goals that are in their long term economic, strategic interest and that is the way BOA prefers to set their goals.

Dr. Everett said he thought that one of his comments may have been misunderstood. In the presentation by Bill Chameides of Environmental Defense, he asked a question about one of his slides which is the one that says America is moving forward on global warming and the sense of the Senate resolution. It is the sense of the Senate that Congress should enact a comprehensive and effective national program of mandatory market based limits. Dr. Everett said that Duke is on record as supporting just a move by Congress.

Dr. Eggers added that government establishes the rules of markets. Governments establish how companies win and we have some great opportunities to tweak the playing field so that people can still make lots of money and future generations will still be healthy and the onerous is on the government to set the rules by which the game is played.

The meeting was adjourned at 4:11 PM.

Representative Joe Hackney	Mary R. Watson
Presiding Co-Chair	Committee Assistant

LIST OF EXHIBITS

EXHIBIT A	Meeting Notice
EXHIBIT B	Meeting Agenda
EXHIBIT C	Visitor's Registration
EXHIBIT D	Presentation by Keith Overcash, Director, Division of Air Quality, DENR, gave an update on activities of the Department of Environment and Natural Resources (DENR) and the Climate Action Plan Advisory Group (CAPAG).
EXHIBIT E	Presentation by Mr. David R. Easterling, Chief, Scientific Services Division, National Climatic Data Center, National Oceanic and Atmospheric Administration (NOAA), Asheville, North Carolina, on the state of the science related to global climate change
EXHIBIT F	Presentation by Patrick J. Michaels, Ph.D., Research Professor and State Climatologist, Virginia State Climatology Office, University of Virginia, Charlottesville, Virginia, on the view of the state of the science related to global climate change
EXHIBIT G	Presentation by William L. Chameides, Ph.D., Chief Scientist, Environmental Defense, New York, New York on the state of the science related to global climate change
EXHIBIT H	Presentation by Michael MacCracken, Ph.D., Chief Scientist for Climate Change Programs, Climate Institute, Washington, D.C. on understanding and projecting climate change
EXHIBIT I	Report given by Mr. Truman T. Semans, Director for Markets and Business Strategy, Pew Center for Global Climate Change, Washington, DC, on activities taken by businesses in the state and the United States to address global climate change
EXHIBIT J	Presentation by Mr. Tom Darden, Chief Executive Officer, Cherokee Investment Partners, Raleigh, NC, on what Cherokee Investments is doing to address global climate change. A copy of Mr. Darden's Perspectives on Energy Reduction and Environmental Innovation and a copy of Cherokee Investment's 2004 Sustainability Report
EXHIBIT K	Presentation by Mr. William F. Bailey, Principal Consultant, DuPont, Charlotte, North Carolina, on DuPont's activities with regard to addressing global climate change

GENERAL ASSEMBLY NORTH CAROLINA

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

State Legislative Building
Raleigh, North Carolina

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

TIMOTHY R. DODGE
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

27 March 2006

TO: Members of the Legislative Commission on Global Climate Change
Interested Parties

FROM: George F. Givens, Commission Counsel

RE: **Reminder of Meeting**
Schedule of Future Meetings
Commission Website
Additional Information

COMMISSION MEETING:

The Legislative Commission on Global Climate Change will meet at 10:00 a.m. on Tuesday 4 April 2006 in Room 544 of the Legislative Office Building.

Potential agenda items for the 4 April meeting include:

1. Report on activities taken by businesses in the State and the United States to address global climate change.

2. Continuation of the discussion of the state of the science related to global climate change.

3. Update on activities of the Department of Environment and Natural Resources and the Climate Action Plan Advisory Group.

4. Other matters related to the powers and duties of the Commission.

SCHEDULE OF FUTURE MEETINGS:

Below is a schedule of meetings of the Legislative Commission on Global Climate Change for April 2006. This schedule is subject to adjustment.

Commission Meeting	Location
Tuesday 4 April 2006	544 Legislative Office Building
Tuesday 25 April 2006	643 Legislative Office Building

COMMISSION WEBSITE:

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

http://www.ncleg.net/committees/legislativecomm_/default.htm.

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 C...

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

State Legislative Building
Raleigh, North Carolina

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

TIMOTHY R. DODGE
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

AGENDA

10:00 a.m. Tuesday 4 April 2006
Room 544 Legislative Office Building

1. Call to order
   Representative Joe Hackney, Presiding

2. Introductory remarks by Cochairs
   Representative Joe Hackney
   John. L. W. Garrou

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

4. Update on activities of the Department of Environment and Natural Resources (DENR) and the Climate Action Plan Advisory Group
   B. Keith Overcash, Director
   Division of Air Quality, DENR

5. Discussion of the state of the science related to global climate change
   David R. Easterling, Chief
   Scientific Services Division, National Climatic Data Center,
   National Oceanic and Atmospheric Administration (NOAA)
   Asheville, North Carolina

   Patrick J. Michaels, Research Professor and State Climatologist
   Virginia State Climatology Office, University of Virginia
   Charlottesville, Virginia

   William L. Chameides, Chief Scientist
   Environmental Defense
   New York, New York

   Michael C. MacCracken, Chief Scientist for Climate Change Programs
   Climate Institute
   Washington, D.C.

LUNCH BREAK *– Estimated for 12:30 p.m. to 1:00 p.m.*

6. Discussion of activities taken by businesses in the State and the United States to address global climate change

   Truman T. Semans, Director for Markets and Business Strategy
   Pew Center on Global Climate Change
   Washington, D.C.

   Robert L. Kee, Senior Vice President
   Document Management, Bank of America
   Charlotte, North Carolina

   William F. Bailey, Principal Consultant
   DuPont
   Charlotte, North Carolina

   Thomas F. Darden, Chief Executive Officer
   Cherokee Investment Partners
   Raleigh, NC

7. Commission discussion and announcements

8. Adjourn

SCHEDULE OF FUTURE MEETINGS:

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Tuesday 25 April 2006	643 Legislative Office Building

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VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — April 4, 2006
Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Robert Kee	Bank of America 525 N. Tryon Charlotte
Henry Jones	Attorney - Raleigh
[illegible]	[illegible]
Heather Hawkins	NC DAQ
KIM GARNETT	NC-DAQ
LISA RIEGEL	NHTF
Richard Andrews	UNC-CH
Alice Loyd	NC Council of Churches/Interfaith Power + Light
ROGER SHEATS	Global Warming Initiative
JAMES HAVEN	" " "
Shannon Miller	CUCA

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — April 4, 2006

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Mia Bailey	Electricities of NC
Steve Woodson	NC Farm Bureau
TIMOTHY JULIANI	PEW CENTER ON GLOBAL CLIMATE CHANGE
Ulla Reeves	So. Alliance for Clean Energy
Amy MacDonald	" " & Enviro Defense
Johanna Reese	DENR
Matthew Kanes	Piedmont Natural Gas, PO Box 33068, Charlotte, NC 28233
Tom Lam	PUBLIC STAFF - NCUC
James McLawhorn	" "
ELISE COX	
Jeri Gray	League of Women Voters

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — April 4, 2006

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Wade Rawlins	The News & Observer
Chad Hinton	Caritas Institute
Tom Mather	NC Division of Air Quality
John Mabry	Governor
Patrick J. Michaels	U of Virginia
Michael SANTOS	John Locke Fdn
Mitch Kokai	" " "
Patrick Butler	Division of Air Quality
Jim Southerland	Division of Air Quality
Charles O. Davis	Division of Air Quality

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — April 4, 2006

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Keith Overcash	NC DAQ
Bill Chamberlain	Env. Def
Michael MacCracken	Climate Institute 1785 Massachusetts Ave NW Washington DC 20036

Legislative Commission on Global Climate Change

Climate Action Plan Advisory Group (CAPAG) – Update of Activities

April 4, 2006

Keith Overcash, P.E.,
Director
Division of Air Quality

Items Covered today

- *Report on Meetings Held*
- *CAPAG Meeting and TWG Call / Meeting Schedule*
- *Membership of CAPAG and Technical Workgroups (TWGs)*
- *List of Potential Mitigation Measures / Actions to be Considered by CAPAG*

CAPAG

- First Meeting
  - February 16, 2006 Raleigh
- Second Meeting
  - Scheduled for May 23, 2006
- Third Meeting
  - Scheduled for July 2006

Workgroups

- Agriculture and Forestry
- Energy Supply
- Residential, Commercial, Industrial Energy Use
- Transportation and Land Use
- Cross Cutting

Technical Workgroups – Schedule of Calls

- Agriculture and Forestry –
  - Apr 13, 9:00 – 10:30
- Energy Supply –
  - Apr 11, 9:00 – 10:30
- Residential, Commercial, Industrial Energy Use –
  - Apr 13, 1:00 – 2:30
- Transportation and Land Use -
  - Apr 11, 3:00 - 4:30
- Cross Cutting –
  - Apr 12, 9:00 – 10:30 (tentative)
- All Workgroups –
  - May 3rd,4th and 5th

Members of CAPAG and TWGs

- *(Please See Attached Lists)*

List of Potential Mitigation Measures / Actions to be Considered

- *(Please See Attached List)*

References

- *www.ncclimatechange.us*
- *www.ncair.org*
- *Brock.Nicholson@ncmail.net*
  919-715-0587

WWW.NCCLIMATECHANGE.US

Stan Adams
NCDENR Div. Forest Services

Daniel Besse
Elected Official

Rolf Blizzard
NC Citizens for Business & Industry

Thomas Cecich
Pharmaceutical Consultant

Caroline Choi
Progress Energy

Brett Church
Cardinal Logistics Management

Jerry Coker
Weyerhauser

Marion Deerhake
Environmental Management Commission

George Everett
Duke Power

Jim Fain
NC Dept. of Commerce

George Givens
Environmental Review Commission

Dennis Grady
Appalachian State University

Steve Halstead
North Carolina Council of Churches

Bob Hazel
Senior Citizens Interest

Dennis Hazel
NCSU Forestry & Environmental Outreach

Gary Hunt
NCDENR Pollution Prevention & Sustainability

Alex Hobbs
North Carolina Solar Center

Bill Holman
Clean Water Management Fund

Preston Howard
Manufacturers & Chemical Industry Council

Robert Jackson
Duke University

Robert Koger
North Carolina Green Power

Carolyn McCormick
Outer Banks Visitor Bureau

Davis McLeod
Environmental Review Commission

Steven McNulty
USDA Forest Service

Marily Nixon
Southern Environmental Law Center

Mitch Peele
North Carolina Farm Bureau

Chuck Pickering
The Biltmore Company

Lisa Riegel
NC Natural Heritage Fund

Simon Rich
Energy Industry

Jo Anne Sanford
NC Utilities Commission

Roger Sheats
Global Warming Initiatives

Larry Shirley
NC State Energy Office

Michael Shore
Environmental Defense

David Smith
NC Dept. Agriculture and Consumer Services

Steven Smith
Southern Alliance for Clean Energy

Jim Stephenson
NC Coastal Federation

Nina Szlosberg
NC Board of Transportation

Anne Taylor
Environmental Education Fund

Tim Toben
Carolina Clean Energy

Ivan Urlaub
NC Sustainable Energy

Kraig Westerbeek
Murphy-Brown

Stephen Whitfield
North Carolina Woodlands

Jim Witkowski
International Paper

Skip Yeakel
VolvoTrucks North America

Advisory Group Alternates

Anne Coan
North Carolina Farm Bureau

Adam Costanza
International Paper

Steve Kalland
NC Solar Center

NC Dept. of Environment & Natural Resources Division Of Air Quality

Bill Ross
Secretary DENR

Keith Overcash
Director Division of Air Quality

Brock Nicholson,
Deputy Director DAQ, Committee Facilitator

James Southerland
Program Coordinator DAQ – Liaison

Charles Davis
DAQ - Liaison

Kimberly Garnett
DAQ - Liaison

Heather Hawkins
DAQ - Liaison

Phyllis Jones
DAQ - Liaison

Hoke Kimball
DAQ – Liaison

Center for Climate Strategies

Tom Peterson
Committee Facilitator

Ken Colburn
Facilitator

Karl Hausker
Facilitator

David Von Hippel
Facilitator

Steve Roe
Facilitator

North Carolina
Climate Action Plan Advisory Group

WWW.NCCLIMATECHANGE.US

Agriculture & Forestry Technical Workgroup

Stan Adams *
NCDENR Division of Forest Resources

John Bonitz
Rural Advancement Foundation

Anne Coan
North Carolina Farm Bureau

Marion Deerhake *
Environmental Management Commission

Bob Hazel *
Senior Citizen's Interest

Dennis Hazel *
NCSU, Forestry & Environmental Outreach

Bill Holman *
Clean Water Management Fund

Robert Jackson*
Duke University, Environ and Earth Sciences

Amy McDonald
Environmental Defense

Mitch Peele *
North Carolina Farm Bureau

David Smith *
NC Dept. of Agriculture and Consumer Services

Kraig Westerbeek *
Murphy-Brown Farms

Stephen Whitfield *
North Carolina Woodlands

Jim Witkowski *
International Paper

* North Carolina Climate Action Plan Advisory Group Member

Steve Roe - Facilitator
Center for Climate Strategies/E.H. Pechan

Hoke Kimball - Liaison
NCDENR Division of Air Quality

Brock Nicholson - Committee Facilitator
NCDENR Division of Air Quality

Thomas Peterson - Committee Facilitator
Center for Climate Strategies

North Carolina
Climate Action Plan Advisory Group

WWW.NCCLIMATECHANGE.US

Energy Supply Technical Workgroup

Caroline Choi *
Progress Energy

Marion Deerhake *
Environmental Management Commission

George Everett *
Duke Power

Alex Hobbs *
North Carolina Solar Center

Preston Howard *
Manufacturer Chemical Industry Council

Matthew Kanes
Piedmont Natural Gas

Robert Koger *
North Carolina Green Power

Pete McDowell
NC Waste Awareness and Reduction

James McLawthorn
Public Staff NC Utilities Commission

Marily Nixon *
Southern Environmental Law Center

Simon Rich *
Energy Industry

Jo Anne Sanford *
North Carolina Utilities Commission

Larry Shirley *
North Carolina State Energy Office

Michael Shore *
Environmental Defense

Stephen Smith *
Southern Alliance for Clean Energy

Jim Stephenson *
North Carolina Coastal Federation

Tim Tobin *
Carolina Green Energy

Ivan Urlaub *
North Carolina Sustainable Energy

* North Carolina Climate Action Plan Advisory Group Member

Ken Colburn - Facilitator
Center for Climate Strategies/Symbiotic Strategies

Kimberly Garnett - Liaison
DENR Division of Air Quality

Brock Nicholson - Committee Facilitator
DENR Division of Air Quality

Thomas Peterson - Committee Facilitator
Center for Climate Strategies

North Carolina

Climate Action Plan Advisory Group

WWW.NCCLIMATECHANGE.US

Transportation and Land Use Technical Workgroup

Daren Bakst
John Locke Foundation

Danise Choy
Environmental Defense

Brett Church *
Cardinal Logistics Management

Anne Coan
North Carolina Farm Bureau

Dennis Grady *
Appalachian Sate University

Len Hoey
North Carolina State Energy Office

Bill Holman *
Clean Water Management Trust Fund

Tom Lam
Public Staff North Carolina Utilities Commission

Carolyn McCormick *
Outer Banks Visitor Bureau

Jack McDonald
McDonald-York Developers

David McLeod *
NC Dept. of Agriculture & Consumer Services

Marily Nixon *
Southern Environmental Law Center

Simon Rich *
Energy Industry

Roger Sheats *
Global Warming Initiatives

Nina Szlosberg *
North Carolina Dept. of Transportation

Skip Yeakel *
Volvo Trucks North America

* North Carolina Climate Action Plan Advisory Group Member

Karl Hausker - Facilitator
Center for Climate Strategies

Phyllis Jones - Liaison
NCDENR Division of Air Quality

Brock Nicholson - Committee Facilitator
NCDENR Division of Air Quality

Thomas Peterson - Committee Facilitator
Center for Climate Strategies

WWW.NCCLIMATECHANGE.US

Residential, Commercial, & Industrial Technical Workgroup

Adam Costanza
International Paper

Rolf Blizzard *
North Carolina Citizens for Business and Industry

Jerry Coker *
Weyerhauser

Jim Fain *
North Carolina Dept. of Commerce

Steve Halsted *
North Carolina Council of Churches

Len Hoey
North Carolina State Energy Office

Gary Hunt *
NCDENR Division of Pollution Prevention and Sustainability

Steve Kalland
North Carolina Solar Center

James McLawthorn
Public Staff NC Utilities Commission

Steven McNulty
USDA Forest Service Southern Global Change Program

* North Carolina Climate Action Plan Advisory Group Member

David Von Hippel - Facilitator
Center for Climate Strategies

Charles Davis - Liaison
NCDENR Division of Air Quality

Brock Nicholson - Committee Facilitator
NCDENR Division of Air Quality

Thomas Peterson - Committee Facilitator
Center for Climate Strategies

North Carolina
Climate Action Plan Advisory Group

WWW.NCCLIMATECHANGE.US

Cross Cutting Issues Technical Workgroup

Clay Ballantine
Asheville Hospitalist Group

Daniel Besse *
Elected Official

Thomas Cecich *
Pharmaceutical Consultant

George Givens *
Environmental Review Commission

Steven McNulty *
USDA Forest Service Southern Global Change Program

Chuck Pickering
The Biltmore Company

Ulla Reeves
Southern Alliance for Clean Energy

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North Carolina Natural Heritage Fund

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North Carolina State Energy Office

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North Carolina Environmental Education Fund

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Center for Climate Strategies/Symbiotic Strategies

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NCDENR Division of Air Quality

Brock Nicholson - Committee Facilitator
NCDENR Division of Air Quality

Thomas Peterson - Committee Facilitator
Center for Climate Strategies

North Carolina

Climate Action Plan Advisory Group

WWW.NCCLIMATECHANGE.US

Catalog of State Climate Mitigation Options

This catalog of state climate mitigation options is based on a review of actions undertaken or considered by US states by the Center for Climate Strategies. It covers all sectors of the economy, all greenhouse gases, and includes a wide variety of implementation programs. It was prepared for the North Carolina Climate Action Plan Advisory Group (CAPAG) and its Technical Work Groups (TWGs), as well as the North Carolina Legislative Commission on Climate Change (LCCC), to assist with identification and screening of potentially applicable actions in North Carolina. This list will be used as a reference and expanded on an ongoing basis during the CAPAG process. Presently it includes some but not all actions included in the State Energy Plan, and will be expanded in the near future with additional actions identified by the North Carolina State Energy Office.

Tables of State Climate Mitigation Options:

Table	Sectors Covered
1.	Residential, Commercial, Industrial (RCI)
2.	Energy Supply (ES)
3.	Transportation and Land Use (TLU)
4.	Agriculture, Forestry and Waste Management (AFW)
5.	Cross Cutting Issues - Reporting, Registries, Education (CC)

Key To Future Rankings of Options in the Tables that Follow:

Potential Emission Reductions 1/	Potential Cost or Cost Savings 1/ 2/
High (H): At least 1 Million Metric Tons (MMT) carbon dioxide equivalent (CO_2e) per year by 2020 (~1% of current NC emissions)	**High (H):** $50 per Metric Ton CO_2e ($MTCO_2e$) or above
Medium (M): From 0.1 to 1 MMT CO_2e per year by 2020	**Medium (M):** $5-50/$MTCO_2e$
Low (L): Less than 0.1 MMT CO_2e per year by 2020, or 1 MMT CO2e by 2050	**Low (L):** Less than $5/$MTCO_2e$
Uncertain (U): Not able to estimate at this time	**Uncertain (U):** Not able to estimate at this time

1/ Several measures may overlap in terms of emissions reductions and/or cost impacts. Estimates assume measures would be implemented independently from other measures.
2/ Costs are denoted by a positive number. Cost savings (i.e., "negative costs") are denoted by a negative number.

Definition of "Priorities for Analysis":

- **High:** High priority options will be analyzed first.
- **Medium:** Medium priority options will be analyzed next, time and resources permitting.
- **Low**: Low priority options will be analyzed last, time and resources permitting.

Notation of Options:

*** Options marked with an asterisk (*) indicate options that are at least partially "base case" policies, i.e., that have been considered or undertaken at some level in North Carolina.**
**** Options marked with a double asterisk (**) indicate options that are included as recommendations in the September 1, 2005 NC DENR Report under the Clean Smokestacks Act of 2002.**

Table 1 - Residential, Commercial, Industrial (RCI)

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
RCI-1	**ENERGY EFFICIENCY PROGRAMS, FUNDS, AND GOALS**					
1.1	Utility Demand Side Management (DSM) Programs for electricity, natural gas, propane, fuel oil*					
1.2	Energy Efficiency Funds (e.g. Public Benefit Funds) administered by State agency, utility, or 3rd party (e.g. Energy Trust)**					
RCI-1	**ENERGY EFFICIENCY PROGRAMS, FUNDS, AND GOALS (CONTINUED)**					
1.3	Energy Efficiency Requirements (e.g. Utility Savings Goals or Energy Portfolio Standards) **					
1.4	Market transformation and technology development programs					
RCI-2	**APPLIANCE STANDARDS**					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
2.1	Expansion of State-level Appliance Efficiency Standards					
2.2	Support for Federal-level Appliance Efficiency Standards					
RCI-3	**BUILDINGS**					
3.1	Improved Building Codes*					
3.2	Promotion and Incentives for Improved Design and Construction (e.g. LEED[1], green buildings) *					
3.3	Training and Education for Builders and Contractors (e.g. HVAC[2] sizing, duct sealing)					
3.4	Training of Building Code and other Officials in Energy Code Enforcement*					
RCI-3	**BUILDINGS (CONTINUED)**					
3.5	Building Commissioning and Recommissioning,					

[1] LEED = Leadership in Energy Efficiency Design, a national building certification program.
[2] HVAC = Heating, Ventilation, and Air Conditioning

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
	including Energy Tracking and Benchmarking					
3.6	Energy Management Training/Training of Building Operators					
3.7	Increased Use of Blended Cement (substituting fly ash or other pozzolans for clinker reduces CO_2 emissions)					
3.8	Reduction of Emissions from Diesel Engines Used in New Construction Developments					
RCI-4	**EDUCATION AND OUTREACH**					
4.1	Consumer education programs**					
4.2	Introduce in School Curriculum					
RCI-5	**PRICING AND PURCHASING**					
5.1	Green Power Purchasing					
5.2	Bulk Purchasing Programs for Energy Efficiency or other Equipment (Public or Private sector)					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
5.3	Net-metering policies					
5.4	Time of Use Rates					
RCI-6	**TECHNOLOGY-SPECIFIC POLICIES**					
6.1	Incentives for Renewable Energy Applications (Solar roofs, water heaters, etc.)					
6.2	Clean Combined Heat and Power					
6.3	Promotion and Tax or Other Incentives (e.g. EnergyStar, credits for solar hot water)					
6.4	Appliance Recycling/Pick-Up Programs					
6.5	White Roofs, Rooftop Gardens, and Landscaping (including Shade Tree Programs)					
RCI-6	**TECHNOLOGY-SPECIFIC POLICIES (CONTINUED)**					
6.6	Focus on specific end-uses/technologies: window AC units, lighting, water heating, plug loads, networked PC management, power					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
	supplies, motors, pumps, boilers, etc. Consumer products programs, may include incentives, retailer training, marketing and promotion, education, etc *, **					
RCI-7	**NON-ENERGY EMISSIONS (HFCS, PFCS, SF_6, CO_2 PROCESS EMISSIONS**					
7.1	Participation in Voluntary Industry-Government Partnerships					
7.2	Process Changes/ Optimization					
7.3	Leak Reduction /Capture, Recovery and Recycling of Process Gases					
7.4	Use of Alternative Gases (other HFCs, hydrocarbon coolants/refrigerants, etc.)					
7.5	Cement Industry: Use of Alternative Fuels					
RCI-8	**GHG EMISSIONS-SPECIFIC GOALS AND POLICIES**					
8.1	Support for switching to less carbon-intensive fuels (coal and oil to natural gas					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
	or biomass)					
8.2	Industry-Specific Emissions Cap and Trade Programs					
8.3	Voluntary emissions targets					
8.4	Small-source Aggregation					
8.5	Negotiated Emissions or Energy Savings Agreements					
RCI-9	**OTHER**					
9.1	Government Agency Requirements and Goals (including procurement)*					
9.2	Focus on specific market segments: existing homes (weatherization), new construction, apartments, low income, etc. *					
9.3	Reinvestment Fund*					
9.4	Municipal Energy Management					
9.5	Focus on Small and Medium Enterprises (SMEs)*					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
9.6	Industrial ecology/ by-product synergy					
9.7	Industrial Audits*					

Table 2 - Energy Supply (ES)

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
ES-1	**RENEWABLE ENERGY**					
1.1	Environmental Portfolio Standard (renewables and energy efficiency) with renewable energy credit trading**					
1.2	NC Greenpower renewable resources program*					
1.3	State purchase of electricity through the NC Greenpower renewable resources program**					
1.4	Public Benefit Charge Funds**					
1.5	Renewable Energy Incentives (biomass, wind, solar, geothermal)*					
1.6	Green Power Purchases and Marketing*					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
1.7	Renewable energy development issues (zoning, siting, etc.)					
1.8	Research and Development (R&D)					
1.9	Landfill Gas Recovery (see also Waste)					
1.10	Waste to Energy (see also Waste) **					
ES-2	**DISTRIBUTED GENERATION (DG)**					
2.1	Incentives for combined heat and power (CHP) and clean DG**					
2.2	Removing barriers to CHP and clean DG (including utility rate and interconnection barriers, financing, information, etc.)**					
2.3	Interconnection Rules for clean, distributed generation*,**					
2.4	Net Metering*,**					
2.5	Pricing strategies					
ES-3	**ADVANCED FOSSIL FUEL**					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
3.1	Incentives for advanced coal, including IGCC and carbon capture and storage (CCS)					
3.2	Incentives for CO2 pipelines for CCS					
3.3	Fuel Cell Development Incentives					
3.4	Combined H2/electricity production from fossil fuels with sequestration					
3.5	Research and Development (R&D)					
ES-4	**NUCLEAR**					
4.1	New Nuclear Capacity and Licensing					
4.2	Nuclear Plant Relicensing					
4.3	Nuclear Plant Uprating					
ES-5	**OTHER ELECTRICITY MEASURES**					
5.1	Efficiency Improvements and Repowering Existing Plants					
5.2	Transmission System Upgrading					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts; Feasibility Considerations	Notes
5.3	Reduce Transmission and Distribution Line Loss					
ES-6	**EMISSIONS POLICIES**					
6.1	CO2 Tax					
6.2	GHG Cap and Trade					
6.3	Generation Performance Standards					
6.4	GHG Offset/mitigation requirements for new power plants					
6.5	GHG Offset/mitigation requirements for existing power plants					
6.6	Voluntary Utility CO2 Targets					
ES-7	**EDUCATION/AWARENESS**					
7.1	Brownfield Re-development					
7.2	Environmental (emissions) Disclosure					
7.3	Public Education					

Table 3 - Transportation and Land Use (TLU)

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
TLU-1	**PASSENGER VEHICLE GHG EMISSION RATES**					
TLU-1.1	**VEHICLE TECHNOLOGY**					
1.1.1	Tailpipe GHG Emission Standards **					
1.1.2	ZEV/LEV-2 Implementation **					
1.1.3	R&D on Low-GHG Vehicle Technology (e.g., fuel cell)					
1.1.4	Add-on Technologies (Low Friction Oil, Low-Rolling Resistance Tires)					
TLU-1.2	**VEHICLE OPERATION**					
1.2.1	Enforce Speed Limits					
1.2.2	Vehicle Maintenance, Driver Training					
1.2.3	Transportation System Management					
TLU-1.3	**INCENTIVES & DISINCENTIVES**					
1.3.1	Procurement of Efficient Fleet Vehicles **					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
1.3.2	Feebates (state-specific or regional) **					
1.3.3	CO_2-based registration fees					
1.3.4	Tax Credits for Efficient Vehicles **					
1.3.5	Vehicle Scrappage					
TLU-2	**LAND USE AND LOCATION EFFICIENCY**					
TLU-2.1	**GENERAL**					
2.1.1	Infill, Brownfield Re-development					
2.1.2	Transit-Oriented Development *					
2.1.3	Smart Growth Planning, Modeling, Tools **					
2.1.4	Targeted Open Space Protection					
TLU-2.2	**INCREASING LOW-GHG TRAVEL OPTIONS**					
2.2.1	Make full use of CMAQ funds					
2.2.2	Improve Transit Service (frequency, convenience, quality) **					
2.2.3	Transit Marketing and Promotion *					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
2.2.4	Bike and Pedestrian Infrastructure					
2.2.5	Expand Transit Infrastructure (rail, bus, BRT) *					
2.2.6	HOV lanes					
2.2.7	"Fix-it-First"					
2.2.8	Transit Prioritization (signal prioritization, HOV lanes)					
2.2.9	Telecommute and Live-Near-Your-Work					
2.2.10	Car sharing					
2.2.11	E-Commerce					
TLU-2.3	**INCENTIVES & DISINCENTIVES**					
2.3.1	Commuter Choice/Parking Cash Out					
2.3.2	VMT Tax					
2.3.3	Pay As You Drive Insurance					
2.3.4	Increased Fuel Tax (w/ targeted use of revenue towards travel alternatives)					
2.3.5	Location-Efficient Mortgages					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
2.3.6	Congestion Pricing (or tolls) (w/ targeted use of revenue towards travel alternatives)					
2.3.7	Parking Pricing or Supply Restrictions					
2.3.8	Transit Repositioning					
2.3.9	Transit Pricing Incentives *					
2.3.10	VMT/GHG Offset Requirements for Large Developments					
2.3.11	Benefits for Low GHG Vehicles (preferential parking, use of HOV lanes)					
TLU-2.4	**FUEL MEASURES**					
2.4.1	Low-GHG Fuel Standard (e.g., renewable)					
2.4.2	Low-GHG Fuel for State Fleets (e.g., CNG, biodiesel) *					
2.4.3	Biofuel expansion (biodiesel, CNG, LPG, cellulosic ethanol)					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
2.4.4	Alternative Fuel Infrastructure Development *					
TLU-3	**FREIGHT**					
TLU-3.1	**VEHICLE TECHNOLOGY**					
3.1.1	Vehicle Technology Improvements (e.g., aerodynamics)					
3.1.2	R&D on Low-GHG Vehicle Technology					
3.1.3	Low-sulfur diesel					
3.1.4	Black carbon control technologies (e.g., use of particulate traps, other complementary technologies) **					
TLU-3.2	**VEHICLE OPERATION**					
3.2.1	Freight Logistics Improvements/GIS					
3.2.2	Enforce Speed Limits					
3.2.3	Improve Traffic Flow					
3.2.4	Increased Size & Weight of Trucks					
3.2.5	Increase the Number of Rest Areas					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
3.2.6	Pre-clearance at Scale Houses					
3.2.7	Truck Stop Electrification **					
3.2.8	Enforce Anti-Idling **					
TLU-3.3	**INCREASING LOW-GHG TRAVEL OPTIONS**					
3.3.1	Intermodal Freight Initiatives **					
3.3.2	Feeder Barge Container Service					
TLU-3.4	**INCENTIVES & DISINCENTIVES**					
3.4.1	Procurement of Efficient Fleet Vehicles (public, private or other)					
3.4.2	Incentives to Retire or Improve Older Less Efficient Vehicles					
3.4.3	Maintenance and Driver Training					
3.4.4	Increased Truck Tolls or Highway User Fees					
TLU-4	**INTERCITY TRAVEL: AVIATION, HIGH SPEED RAIL, BUS**					
4.1	High-speed Rail					
4.2	Integrated Aviation, Rail, Bus Networks					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
4.3	Aircraft emissions					
4.4	Airport Ground Equipment					
TLU-5	**OFF-ROAD VEHICLES (CONSTRUCTION EQUIPMENT, OUT-BOARD MOTORS, ATVS, ETC)**					
5.1	Incentives for Purchase of Efficient Vehicles/Equipment					
5.2	Improved Operations, Operator Training					
5.3	Maintenance Improvements					
5.4	Increased Use of Alternative Fuels or Low Sulfur Diesel					

Table 4 - Agriculture, Forestry, Waste Management (AFW)

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
AFW-1	**AGRICULTURE – PRODUCTION OF FUELS AND ELECTRICITY**					
1.1	Manure Digesters/Other Waste Energy Utilization**					
1.2	Biodiesel Production (incentives for feedstocks and production plants)					
1.3	Biomass Feedstocks for Electricity or Steam Production**					
1.4	Ethanol Production					
AFW-2	**AGRICULTURE – FERTILIZER AND MANURE MANAGEMENT**					
2.1	Nutrient Management (improve efficiency of fertilizer use) **					
2.2	Manure Management (improve application methods) *					
2.3	Manure Composting					
2.4	Change Feedstocks (optimize nitrogen for N_2O reduction)					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
2.5	Reduce Non-Farm (Residential and Commercial) Fertilizer Use **					
AFW-3	**AGRICULTURE – SOIL CARBON MANAGEMENT**					
3.1	Conservation Tillage/No-Till (carbon sequestration and reduced energy use) *					
3.2	Reduce Summer Fallow (increase soil C content, reduce N_2O emissions)					
3.3	Increase Winter Cover Crops (increase soil C content, increase soil N content)					
3.4	Improve Water and Nutrient Use (to minimize soil C loss)					
3.5	Rotational Grazing/Improve Grazing Crops and/or Management					
AFW-4	**AGRICULTURE – LAND USE CHANGE**					
4.1	Convert Land to Grassland or Forest					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
4.2	Preserve Open Space/Agricultural Land**					
4.3	Promote "No Net Loss" of Agricultural Land					
AFW-5	**AGRICULTURE – FARMING PRACTICES**					
5.1	Convert Diesel Farm Equipment to LNG/CNG or Hybrid Technology					
5.2	Organic Farming*					
5.3	Programs to Support Local Farming/Buy Local**					
AFW-6	**FORESTRY – BIOMASS PROTECTION AND MANAGEMENT**					
6.1	Forest Protection – Reduced Clearing And Conversion to Nonforest Cover**					
6.2	Increase Maintenance of Urban and Residential Trees**					
6.3	Afforestation and/or Restoration of Nonforested Lands*					
6.4	Reforestation/Restoration of Managed Stands*					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
6.5	Increased Stocking of Poorly Stocked Lands*					
6.6	Age Extension of Managed Stands					
6.7	Thinning and Density Management of Managed Stands**					
6.8	Fertilization and Waste Recycling					
6.9	Expand Short Rotation Woody Crops (for fiber and energy)					
6.10	Expanded Use of Genetically Preferred Species					
6.11	Modified Biomass Removal Practices (reduced decay and energy use)					
6.12	Fire Management and Risk Reduction Programs*					
6.13	Ecosystem Health Risk Reduction Programs (pest/disease, invasive species)					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
6.14	Drought Management Programs (tree selection, placement, protection)					
6.15	Flood and Riparian Management Programs (tree selection, placement, protection) *					
6.16	Watershed Management Programs (stand retention, enhancement and management) *					
6.17	Habitat Management Programs (stand retention, enhancement and management) *					
AFW-7	**FORESTRY - WOOD PRODUCTS AND WASTE**					
7.1	Improved Mill Waste Recovery					
7.2	Improved Logging Residue Recovery					
7.3	Expanded Use of Wood Products for Building Materials**					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
7.4	Expanded Use of State and Locally-Grown Wood Products					
AFW-8	**FORESTRY – ENERGY PRODUCTION**					
8.1	Expanded Use of Forest Biomass Feedstocks for Electricity (fuel switching) **					
8.2	Expanded Use of Forest Biomass Feedstocks for Residential, Commercial/Institutional, or Industrial Heating**					
8.3	Improved Efficiency of Wood Burning Stoves and Direct Heat					
8.4	Improved Energy Capture from Wood Waste Combustion					
8.5	Expanded Landfill Methane Recapture (wood products waste)					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
8.6	Improved Commercialization of Biomass Gasification and Combined Cycle					
AFW-9	**WASTE MANAGEMENT – WASTE MANAGEMENT STRATEGIES**					
9.1	Advanced Recycling and Composting					
9.2	Advanced Municipal Solid Waste Management Practices (e.g., bioreactors)					
9.3	Source Reduction Strategies					
9.4	Resource Management Contracting					
9.5	Manure Digesters**					
9.6	Waste Coal Recapture					
AFW-10	**WASTE MANAGEMENT – LANDFILL GAS STRATEGIES**					
10.1	Flare Landfill Methane at non-NSPS (smaller) sites					
10.2	Methane and Biogas Energy Programs					
10.3	Convert Landfill Methane to Electric Power, Space Heat, or LNG					
AFW-11	**WASTE MANAGEMENT – WASTEWATER ACTIVITIES**					

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
11.1	Energy Efficiency Improvements					
11.2	Lower Waste Processing Needs (lower water consumption, waste production)					
11.3	Install Digesters and Turbines					
11.4	Install Fuel Cells					

Table 5 - Cross Cutting Issues (CC)

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
CC-1	**INVENTORIES, FORECASTING AND MONITORING**					
1.1	Establish & fund mandatory GHG emission inventory function at DAQ**				•	
1.2	GHG Emissions Forecasting				•	
1.3	GHG Emissions Monitoring				•	
CC-2	**REPORTING**					
2.1	GHG Reporting				•	
2.2	Report NC emissions from state facilities & vehicles to public & 1605(b) **				•	
2.3	Include non-CO2 GHGs **				•	
2.4	Define CO2 & non-CO2 GHGs as pollutants **				•	
2.5	Require mandatory GHG reporting for major sources **				•	

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
2.6	Provide assistance to facilities in reporting & registering GHG emissions **				•	
CC-3	**REGISTRY**					
3.1	RGGR Registry				•	
3.2	Register reductions in state facility & vehicle emissions for future market use (within 3 years after resources authorized) **				•	
3.3	Register increased sequestration associated with Ag/Forestry practices **				•	
CC-4	**EDUCATION**					
4.1	Reinforce sources of GHG, need for State Energy Plan implementation**				•	
4.2	Promote clean fuel technologies**				•	
4.3	Promote energy-tech economic development **				•	

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
4.4	Promote R&D & demo projects for economic development **				•	
4.5	Extend training programs for RCI building operators **				•	
4.6	Public education initiatives **				•	
4.7	Promote green power **				•	
4.8	Promote CHP **				•	
4.9	Require environmental disclosure on utility bills **				•	
4.10	Promote local farm produce **				•	
4.11	Augment existing education efforts **				•	
4.12	Add GHG to Air Awareness efforts **				•	

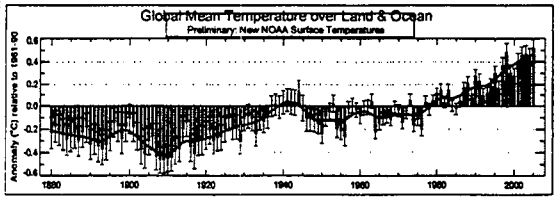
Observed Climate Variability and Change: Evidence and Issues Related to Uncertainty

David R. Easterling
National Climatic Data Center
Asheville, North Carolina

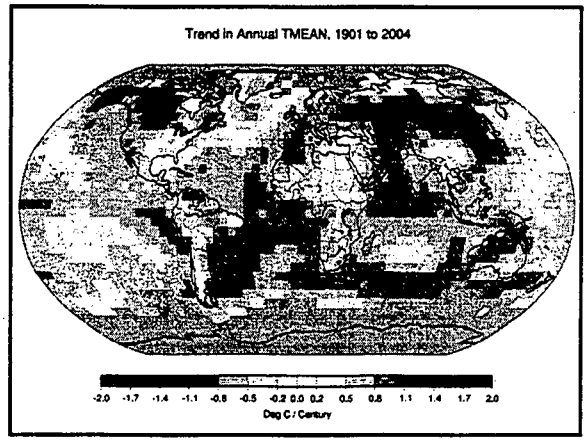
Overview

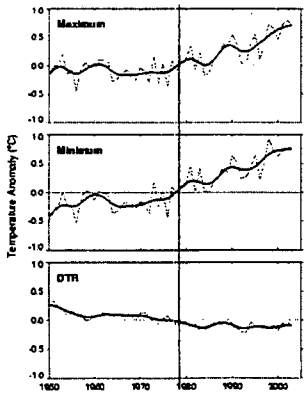
- ❑Some examples of observed climate change.
  - Has it warmed?
    - Observations and models.
  - Has precipitation changed?
  - Have extreme events changed?
- ❑How confident are we in these results?
  - Data and Observational Issues that can lead to uncertainties

Experimental Land & Ocean Blend



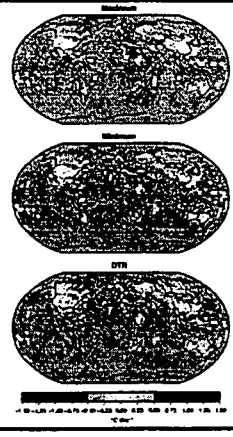
- No one year definitively warmest on record
- Sampling, Random and Bias Errors analyzed to estimate uncertainty in annual anomalies
  - Sampling and Random Errors decrease with time due to improved coverage and better instruments and measurement techniques





Globally Averaged Maximum, Minimum and Diurnal Temperature Range 1950-2004.

From Vose et al. 2005

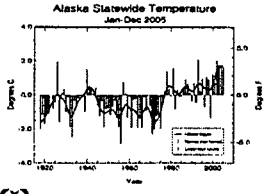


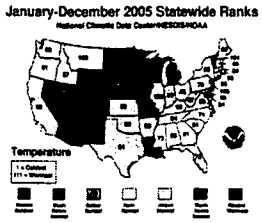
Maximum, Minimum and Diurnal Temperature Range Trends. 1950-2004

From Vose et al. 2005

US Temperatures

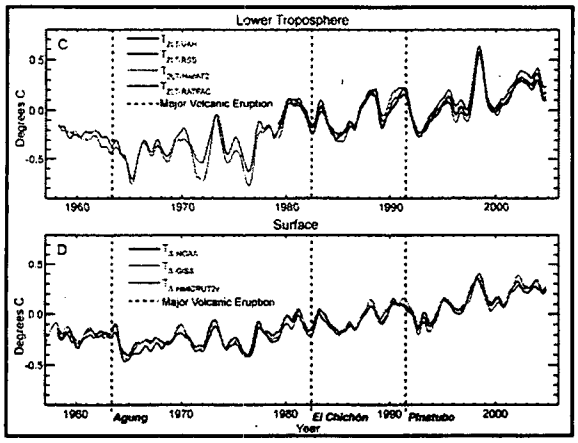
- **2005 Annual Temperature 13th warmest on record**
- **17 of past 20 years warmer than average**





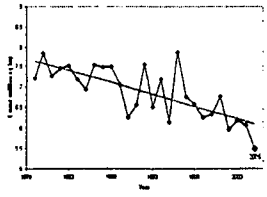
- **No state colder than average**
- **Alaska: 6th warmest year since 1918**

- What about the difference between surface and tropospheric warming?
  - Old: satellites show little or no warming of the lower troposphere, while surface warms.
  - New: satellites and weather balloon observations of troposphere and surface temperatures now much closer, both show warming.



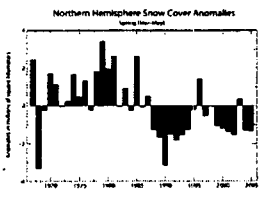
Record Low Arctic Sea Ice Extent

- Largest temperature anomalies in high latitudes of Northern Hemisphere
- Reflecting this warmth was a record low arctic sea ice extent in September
- 8% / Decade decline in end-of-summer sea ice since 1979



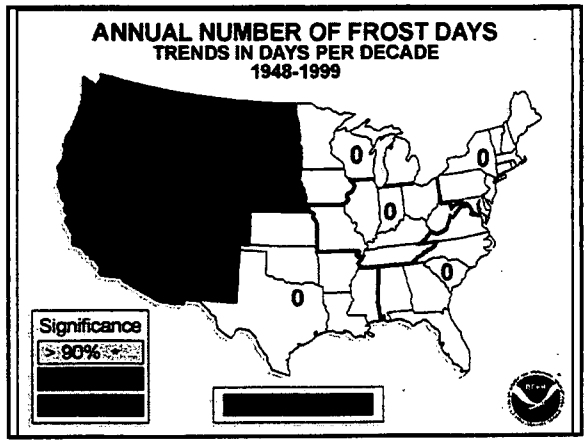
September Arctic Sea Ice Extent
Provided by NSIDC

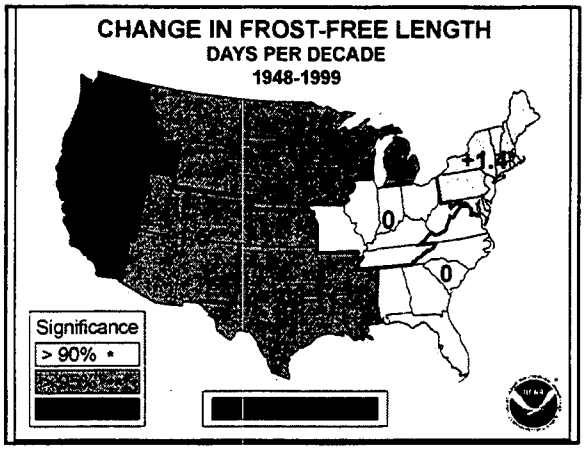
N. Hem. Spring Snow Cover Extent

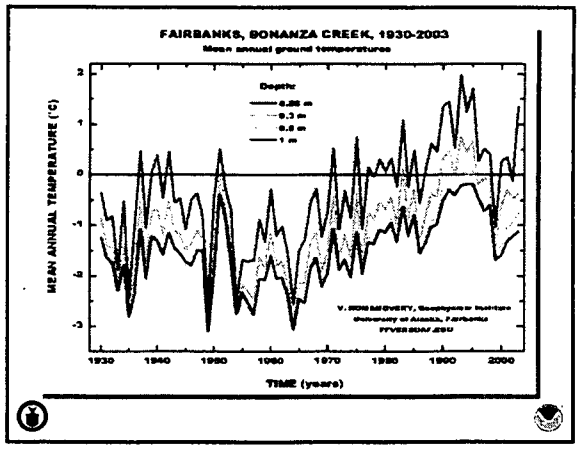


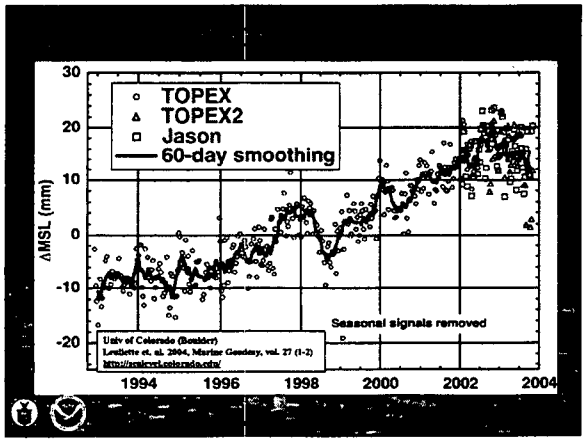
Provided by Rutgers Univ. Snow Lab

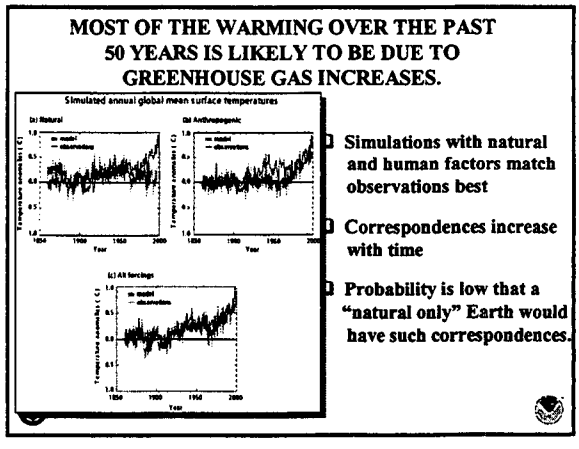
- 2-decade pattern in below average boreal spring snow cover extent continued
- Snow extent below average in 17 of past 20 springs

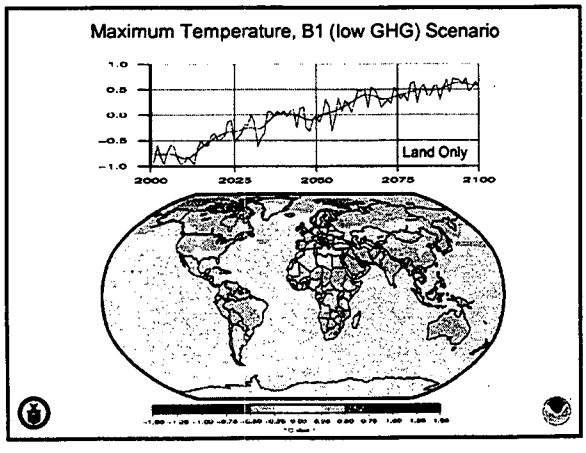


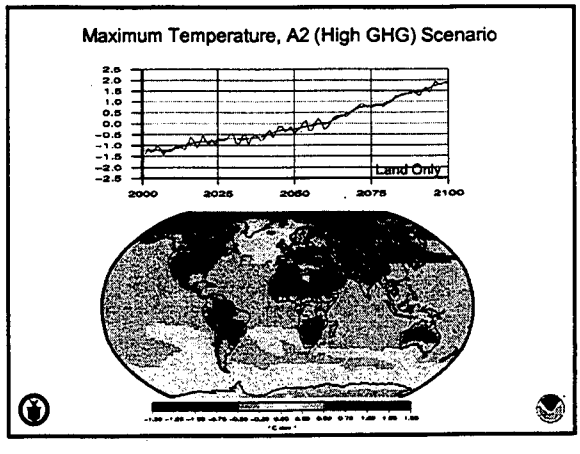

CHANGE IN FROST-FREE LENGTH
DAYS PER DECADE
1948-1999
+1.4
0
0
Significance
> 90% *

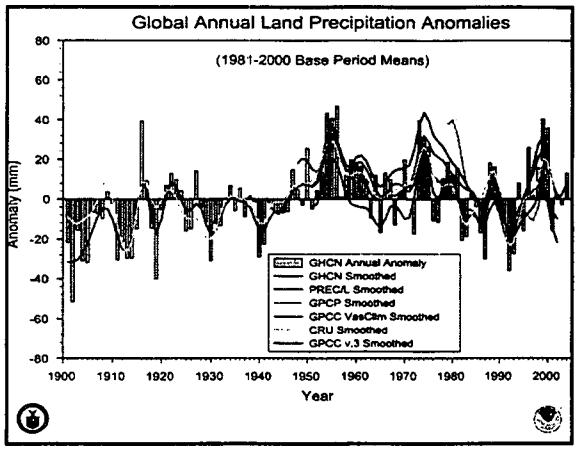

FAIRBANKS, BONANZA CREEK, 1930-2003
MEAN ANNUAL TEMPERATURE (°C)
TIME (years)
1930
1940
1950
1960
1970
1980
1990
2000

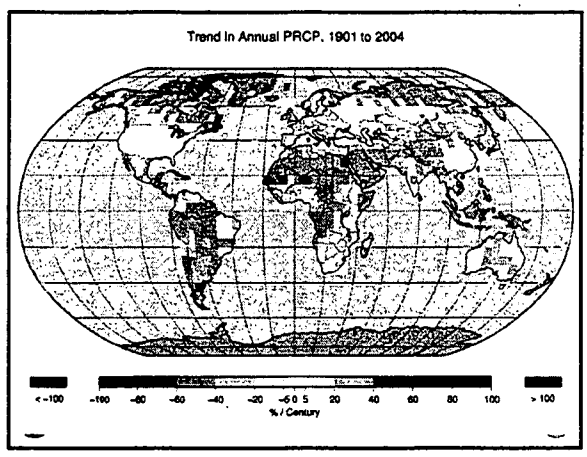

TOPEX
TOPEX2
Jason
60-day smoothing
ΔMSL (mm)
Seasonal signals removed
1994
1996
1998
2000
2002
2004


MOST OF THE WARMING OVER THE PAST 50 YEARS IS LIKELY TO BE DUE TO GREENHOUSE GAS INCREASES.
Simulated annual global mean surface temperatures
Simulations with natural and human factors match observations best
Correspondences increase with time
Probability is low that a "natural only" Earth would have such correspondences.

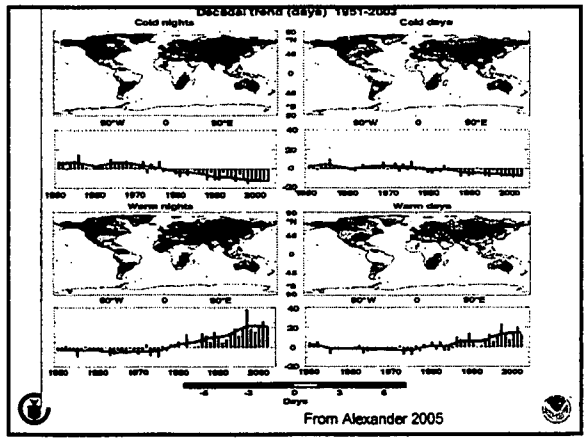

Maximum Temperature, B1 (low GHG) Scenario
Land Only
2000
2025
2050
2075
2100


Maximum Temperature, A2 (High GHG) Scenario
Land Only
2000
2025
2050
2075
2100



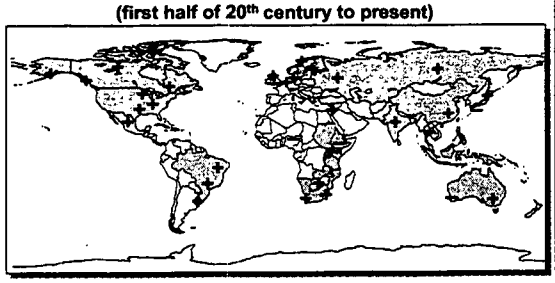


Extreme Events

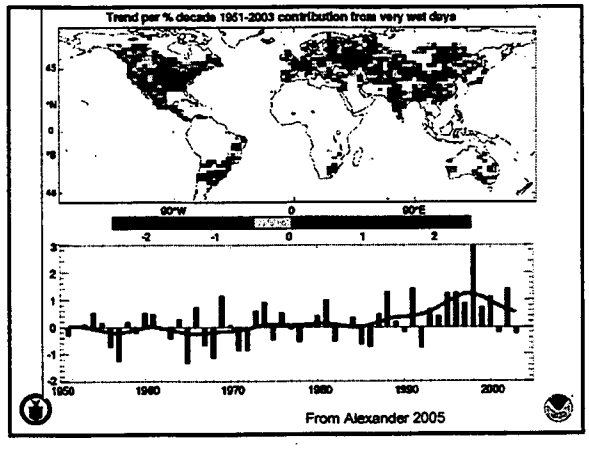


Regions where disproportionate changes in heavy and very heavy precipitation occurred compared to the mean

(first half of 20th century to present)

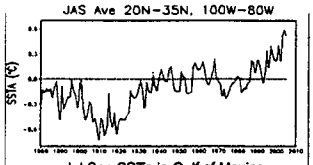


from Easterling et al. 2000



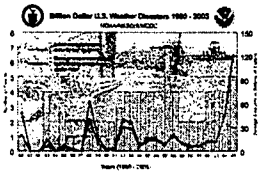
Atlantic Tropical Cyclones

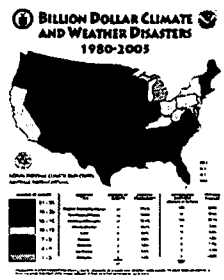
- Active season has been attributed to:
  - Century scale trend in sea surface temperatures contributing to anomalous warmth in Atlantic and Gulf of Mexico
  - Active phase of multi-decadal oscillation
- Recent research points to link between warming ocean temperatures and frequency of strongest tropical cyclones --- BUT



Jul-Sep SSTs in Gulf of Mexico

Billion Dollar Disasters





- Inflation adjusted costs of weather-related extremes continue to rise
  - Record losses in 2005
- Greatest number of billion-dollar disasters in the southern and southeastern U.S. since 1980

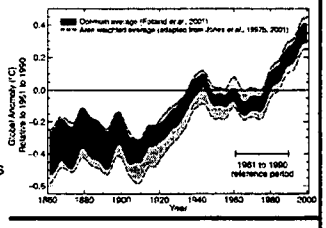
How significant are the uncertainties?

✓ State and Forcings Variables

- Few have quantitative confidence intervals (CIs) (including time-dependent biases) e.g., global surface temperature, CO_2
- Most CIs do not include time-dependent biases
- For many, CIs are uncertain or unknown

✓ Why?

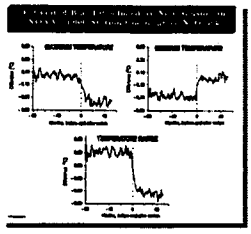
- Examples provide numerous insights into observing and data system deficiencies

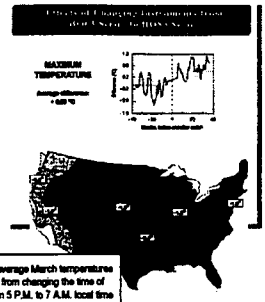


Smoothed annual anomalies of global combined land-surface air and sea surface temperatures (°C)

Observing and Data System Deficiencies

✓ Issues with Surface-based observations



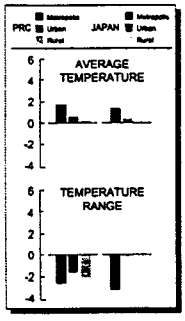


✓ Most observations taken for other purposes, e.g., weather forecasting

Change in the average March temperatures (°C) resulting from changing the time of observation from 5 P.M. to 7 A.M. local time

Observing and Data System Deficiencies

✓ Urban Heat Island Effects



✓ Land use vs temperature

Summary

- Has it warmed?
  - Global temperatures have warmed about 0.7°C since the late 1800s.
  - Tropospheric temperatures since 1979 now show warming consistent with surface.
  - Warming since 1970s 0.2°C per decade.
  - Other evidence
    - Sea Ice decrease
    - Snow cover decrease
    - Changes in frost days and days exceeding other thresholds

Summary

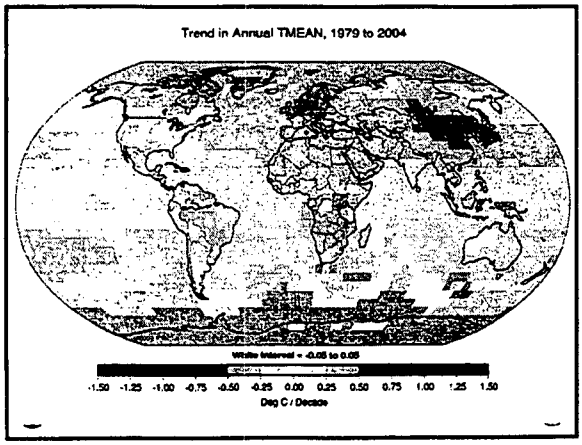
- Has precipitation changed?
  - Global precipitation appears to have increased since the late 1800s.
  - Other evidence
    - Heavy daily precipitation shows signs of increase.
- Confidence?
- Greatest in temperature changes
- Less in precipitation changes.

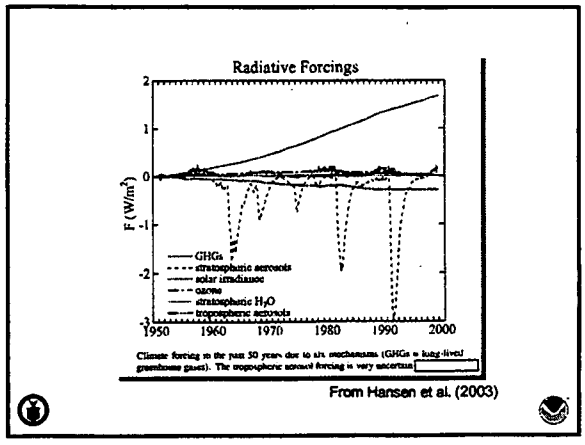
Summary

- Hurricanes?
  - We have entered a more active phase
  - Atlantic Multi-decadal Oscillation
  - Is there some Global Warming contribution?

The End

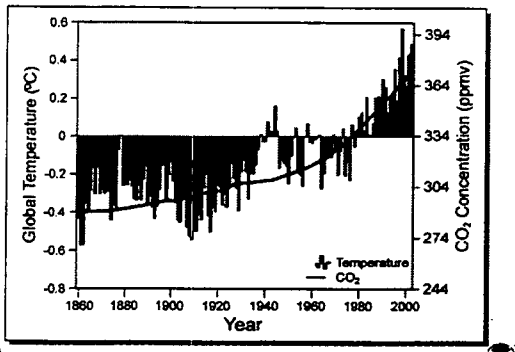
Backup Slides



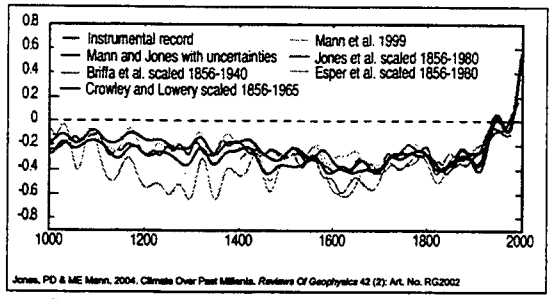


From Hansen et al. (2003)

Global Temperature Change vs CO_2 Change



1000-Year NH Temperature Record



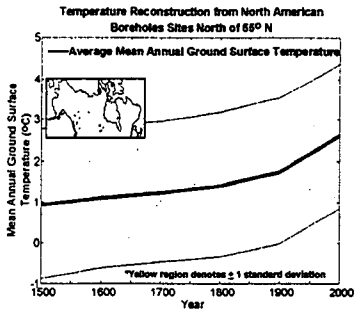
Temperature reconstruction created from tree rings, ice cores, ice melt, corals, lengthy instrumental records.

Past Climate From Borehole Records

16 borehole temperature records were averaged to create a temperature reconstruction for High Latitude North America

20th century temperatures show a major upturn relative to prior 4 centuries

Temperatures rose at a rate of 1.5°F in the 20th Century



www.ngdc.noaa.gov/paleo

Abrupt Climate Change

- What is it?

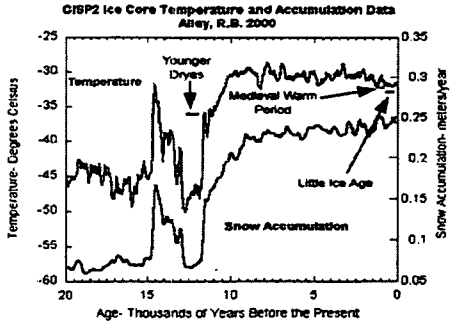
Mechanistic definition

– Transition of the climate system into a different state (of temperature, rainfall, and other aspects) on a time scale that is faster than the responsible forcing.

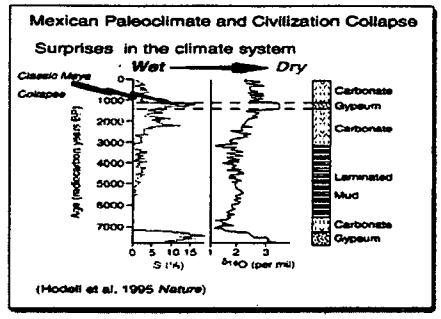
Impacts based definition

– Change of the climate system that is faster than the adaptation time of social and/or ecosystems.

Abrupt Climate Change



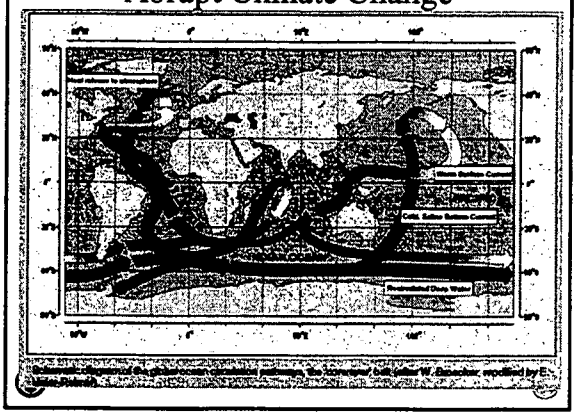
Abrupt Climate Change



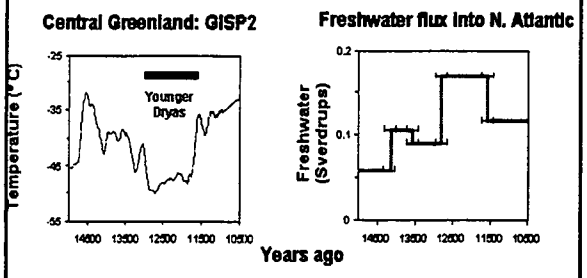
Abrupt Climate Change

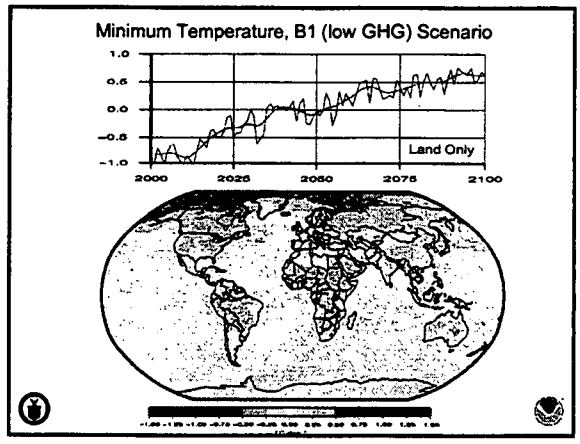
- What about future abrupt change?
  - –One scenario, shutdown of the North Atlantic Thermohaline Circulation.

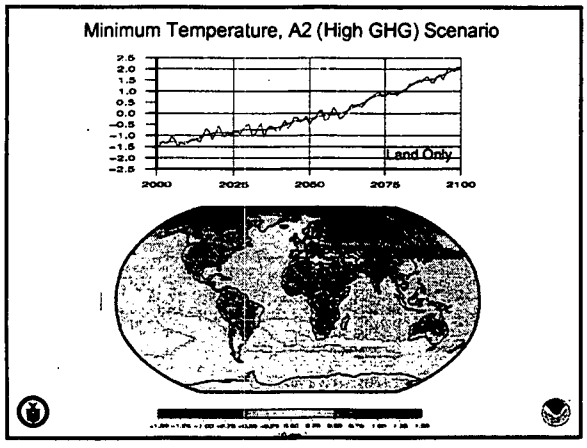
Abrupt Climate Change



Abrupt Climate Change



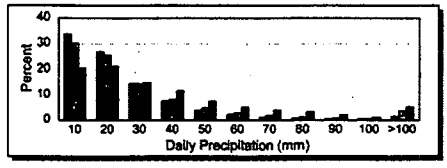


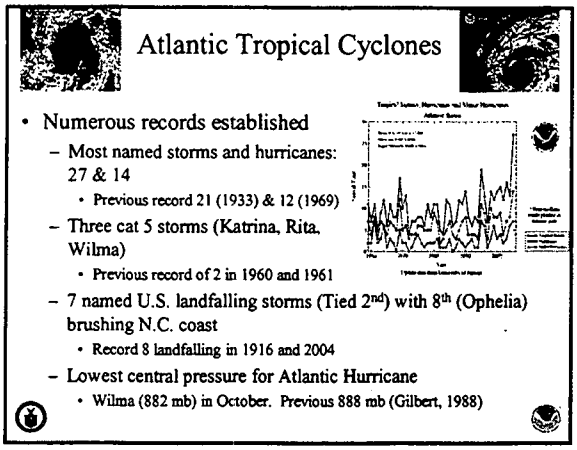


Changes in the Hydrologic Cycle

- Global heating - - - accelerated land surface drying and more water in the atmosphere
  - Increased severity of droughts
  - Increased risk of heavy and extreme precipitation events
    - Even with no change in total precipitation
    - Even stronger when precipitation increases

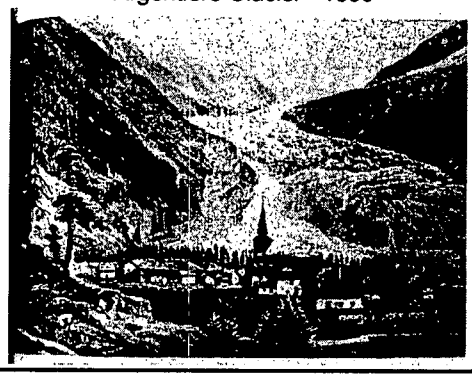
Observed climatology of daily precipitation intensity (as a percentage of seasonal totals) as a function of observed mean temperature based on 100 worldwide stations



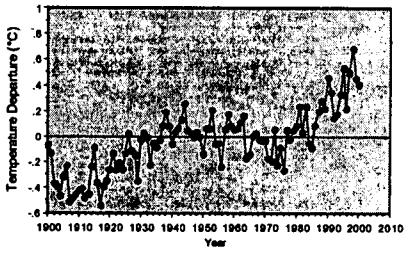

Atlantic Tropical Cyclones
• Numerous records established
– Most named storms and hurricanes: 27 & 14
• Previous record 21 (1933) & 12 (1969)
– Three cat 5 storms (Katrina, Rita, Wilma)
• Previous record of 2 in 1960 and 1961
– 7 named U.S. landfalling storms (Tied 2nd) with 8th (Ophelia) brushing N.C. coast
• Record 8 landfalling in 1916 and 2004
– Lowest central pressure for Atlantic Hurricane
• Wilma (882 mb) in October. Previous 888 mb (Gilbert, 1988)

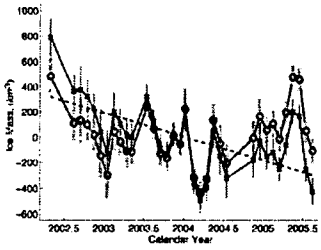
Argentiere Glacier - 1966

Argentiere Glacier - 1850

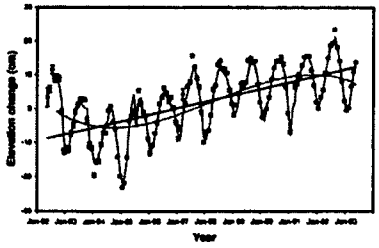


IPCC Northern Hemisphere Temperature History





East Antarctic Ice Sheet, Davis, 2003



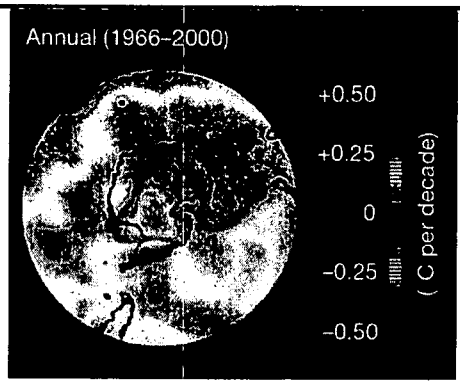
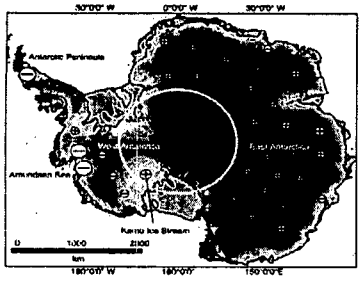


Table 1 Proportions of Antarctica warming and cooling (1966–2000)

Period	Antarctica	Antarctica without the Antarctic Peninsula
Annual	+41.4%, –58.3%	+33.8%, –65.9%
Winter (June–Aug.)	+62.5%, –37.3%,	+56.3%, –43.4%,
Spring (Sept.–Nov.)	+54.1%, –45.7%	+49.4%, –50.4%
Summer (Dec.–Feb.)	+31.7%, –67.4%	+22.8%, –76.3%
Autumn (Mar.–May)	+12.6%, –87.4%	+0.3%, –99.7%

Plus signs indicate the proportions warming; minus signs indicate the proportions cooling. The Antarctic Peninsula is defined as the area north of 80° S and east of 80° W.

Vaughn, 2005

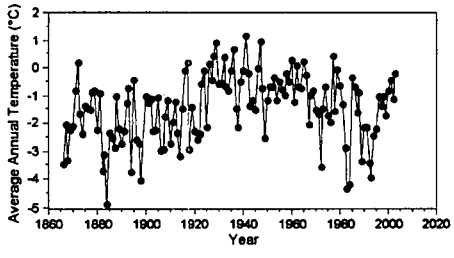


Headline: "Arctic Ice is Melting at Record Levels," Scientists Say

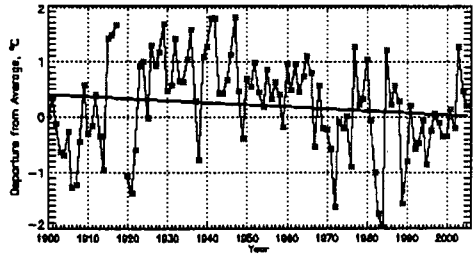
First sentence: "The melting of Greenland glaciers and Arctic Ocean sea ice this past summer reached levels not seen in decades, scientists reported today."

-*New York Times*, December 8, 2002.

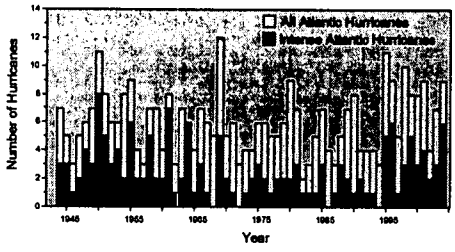
Southwest Greenland Temperature History



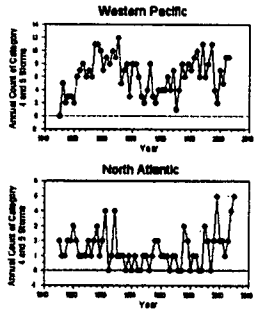
Southern Greenland Temperature



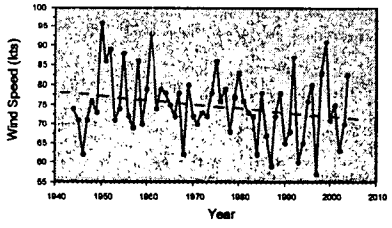
Annual Number of Hurricanes in the Atlantic Basin 1944-2004



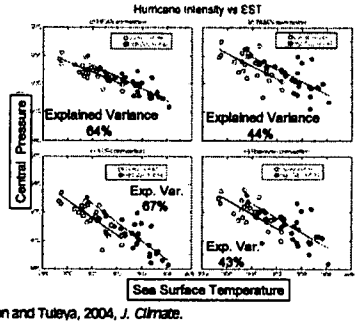
Annual Number of Category 4 and 5 Hurricanes



Maximum Wind Speeds in Atlantic Tropical Systems 1944-2004

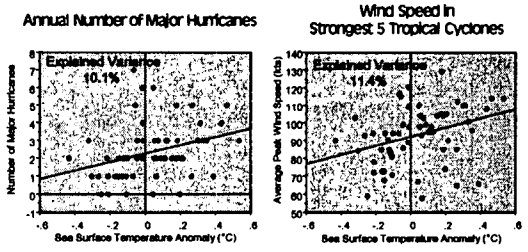


Modeled Tropical Cyclone Intensity vs. SST



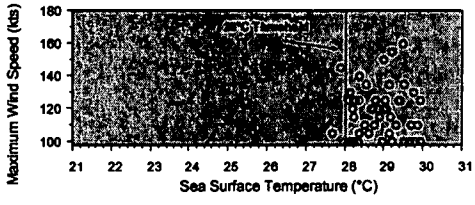
Source: Knutson and Tuleya, 2004, *J. Climate*.

Observed Tropical Cyclone Characteristics vs. SST

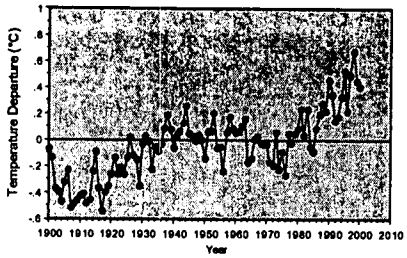


Source: Michaels, Knappenberger, and Landsea, 2005, *J. Climate*, in press

Maximum Wind Speed (Category 3 or greater) vs. Highest SST Encountered

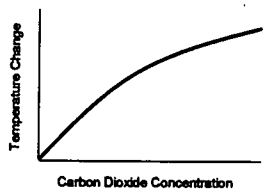


IPCC Northern Hemisphere Temperature History



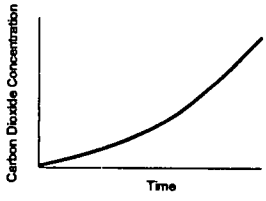
The response to greenhouse gas increases is:

LOGARITHMIC



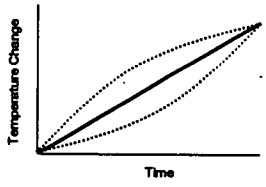
The increase in greenhouse gases WAS

A LOW ORDER EXPONENT

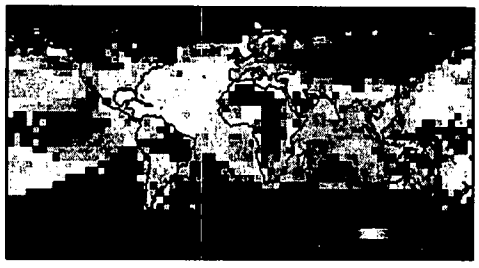


The combination of the two results in:

A STRAIGHT LINE

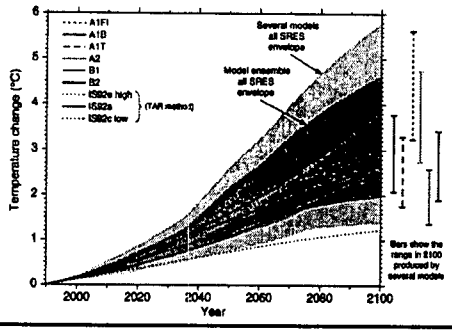


Cold Season Temperature Trends
(1946-1995)

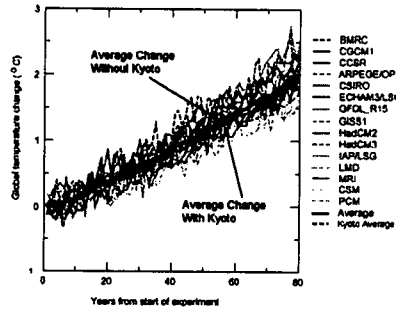


Warm Season Temperature Trends
(1946-1995)

Projections of Future Temperature in the IPCC Third Assessment Report (TAR)



Predicted Global Temperature Change



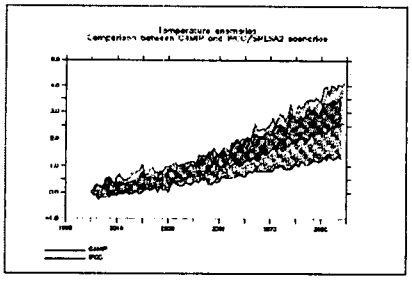
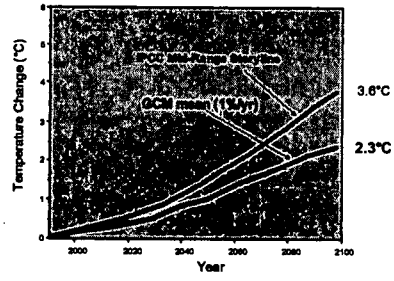
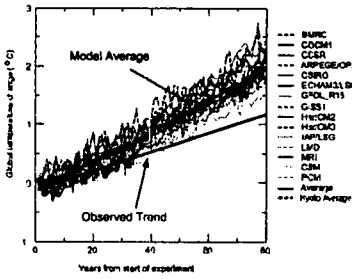


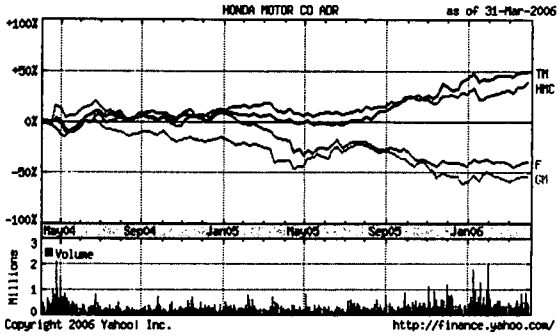
Figure 10.4.2. Envelopes of the global temperature change over the 21st century, simulated by the CAMP models (in red) and by the IPCC-AR4 climate models for the SRES-A2 scenario (in grey)

Temperature Projections



Observed and Predicted Global Temperature Change





ENVIRONMENTAL DEFENSE

North Carolina Legislative Commission on Global Climate Change:

Science Panel

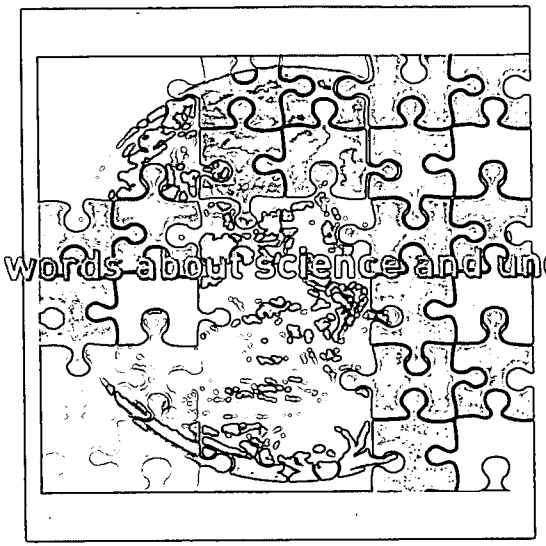
April 4, 2006

Bill Chameides
Chief Scientist
e
ENVIRONMENTAL DEFENSE
finding the ways that work

Global Climate Change Commission
Minutes – April 4, 2006
Exhibit G

ENVIRONMENTAL DEFENSE

A few words about science and uncertainty



GLOBAL WARMING SCIENCE

ENVIRONMENTAL DEFENSE

There is a clear scientific consensus

- U.S. National Academy of Sciences
  - "Greenhouse gases are accumulating in the Earth's atmosphere as a result of human activities, causing surface air temperatures ... to rise." NRC, 2001
  - "We urge all nations ... to take prompt action to reduce the causes of climate change." June, 2005

GLOBAL WARMING SCIENCE

ENVIRONMENTAL DEFENSE

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  - "Greenhouse gases are accumulating in the Earth's atmosphere as a result of human activities, causing surface air temperatures ... to rise." NRC, 2001
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"The National Academy is the gold standard of independent scientific review." *White House Spokesperson January, 2005*

GLOBAL WARMING SCIENCE

ENVIRONMENTAL DEFENSE

THE SCIENTIFIC FOUNDATION FOR ACTION

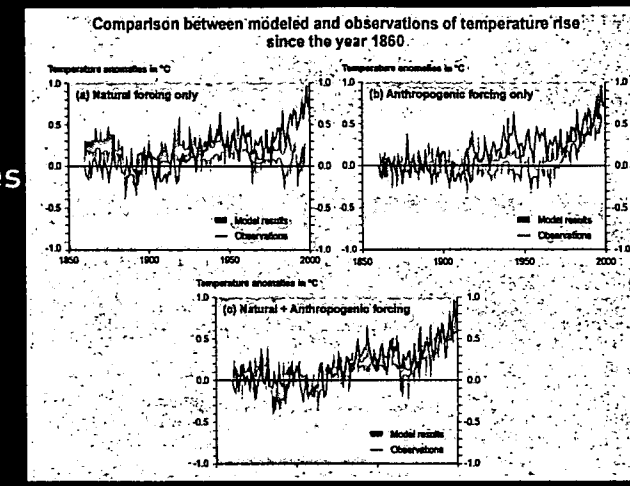
- CO2 warms the Earth
- CO2 concentrations are increasing because of human activities
- The globe is warming
- Warming can be attributed to "human-emitted" CO2 and other GHGs
- Future warming and impacts depend on future emissions of CO2 and other GHGs
- Technologies needed to take first steps are in hand

GLOBAL WARMING SCIENCE

ENVIRONMENTAL DEFENSE

Attribution: Climate models tell us ...

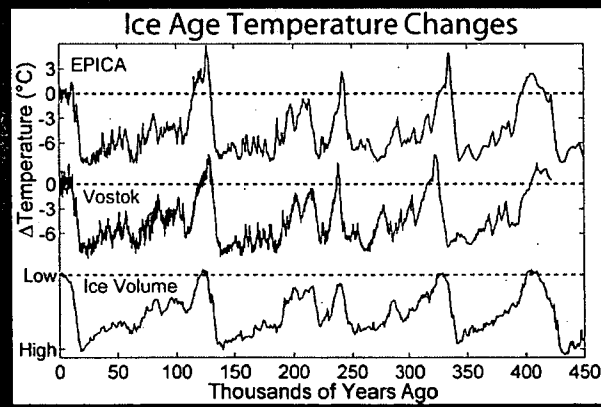
- Enhanced greenhouse effect provides the only quantitative explanation
- But there's more ...



GLOBAL WARMING SCIENCE

ENVIRONMENTAL DEFENSE

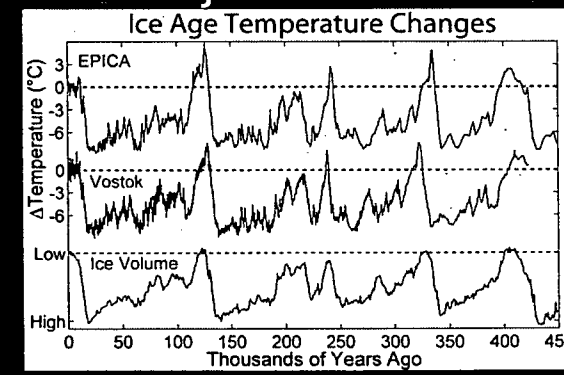
While climate change is the rule, not the exception...



GLOBAL WARMING SCIENCE

ENVIRONMENTAL DEFENSE

...we have a good idea what caused most major climate shift.

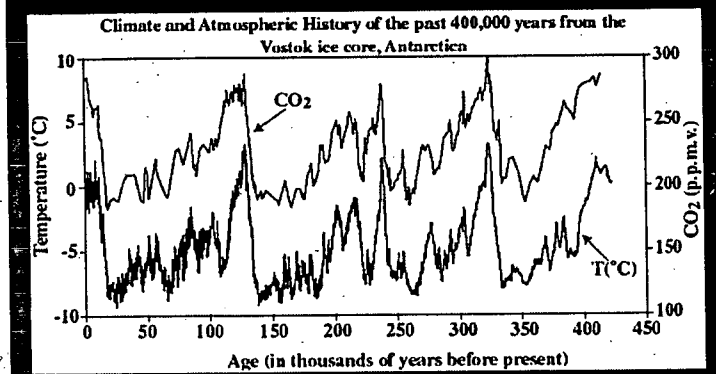


These temperature variations were triggered by variations in earth's orbit about the sun

GLOBAL WARMING SCIENCE

ENVIRONMENTAL DEFENSE

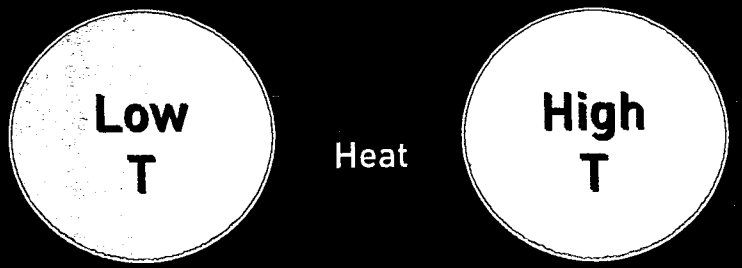
...and carbon dioxide played a major amplifying role.



Worrying implication: There are positive feedbacks in system that will amplify cause of current warning.

ENVIRONMENTAL DEFENSE

Any explanation of warming must have a physical basis: Global warming requires a source of heat



ENVIRONMENTAL DEFENSE

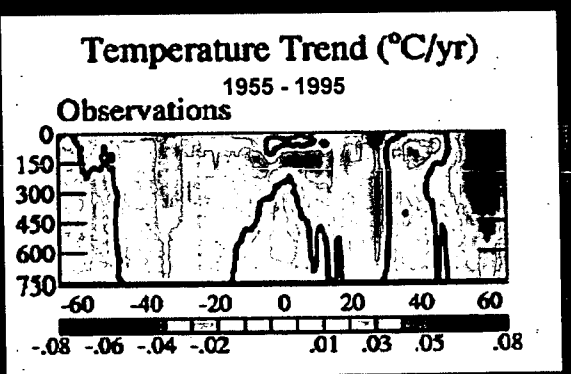
Warming Requires a Source of Heat

- The possible sources are
  - Greenhouse Effect √
  - Increased solar output X (small contribution)
  - Decreasing Planetary Reflectivity X
  - Internal variations – Heat from oceans X

ENVIRONMENTAL DEFENSE

Oceans have heated up!

- About 85% of heat from GHGs has gone to oceans



After Hansen et al. 2005 and based on analysis of Levitas et al. 1999

ENVIRONMENTAL DEFENSE

And we are approaching dangerous tipping points.

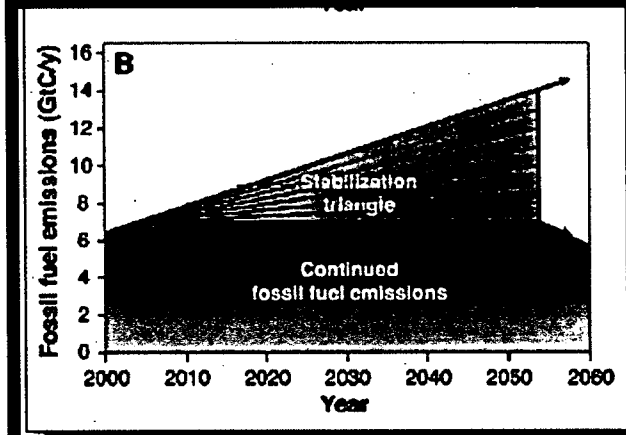
For example:

If we fail to act we could pass a threshold in as little as 30 years that will commit the world to the melting of the Greenland ice sheet and a 20 foot increase in sea level.

GLOBAL WARMING SCIENCE

Pacala and Socolow formula:

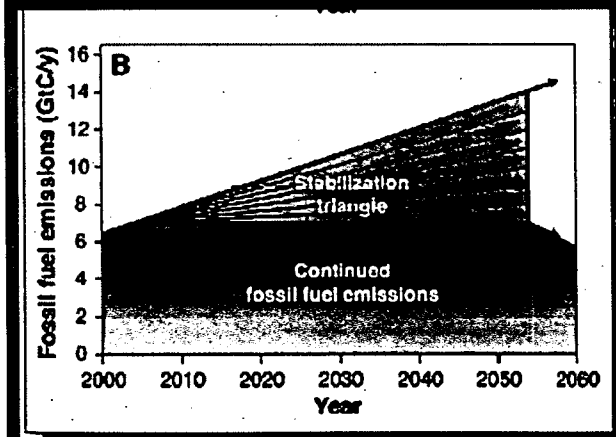
Avoid dangerous climate change through mid-century using ~ 7 of 15 existing technological/policy "wedges."



Wedges include:
- Conservation
- Efficiency
- Renewables
- Bioenergy
- Nuclear
- Clean coal with sequestration

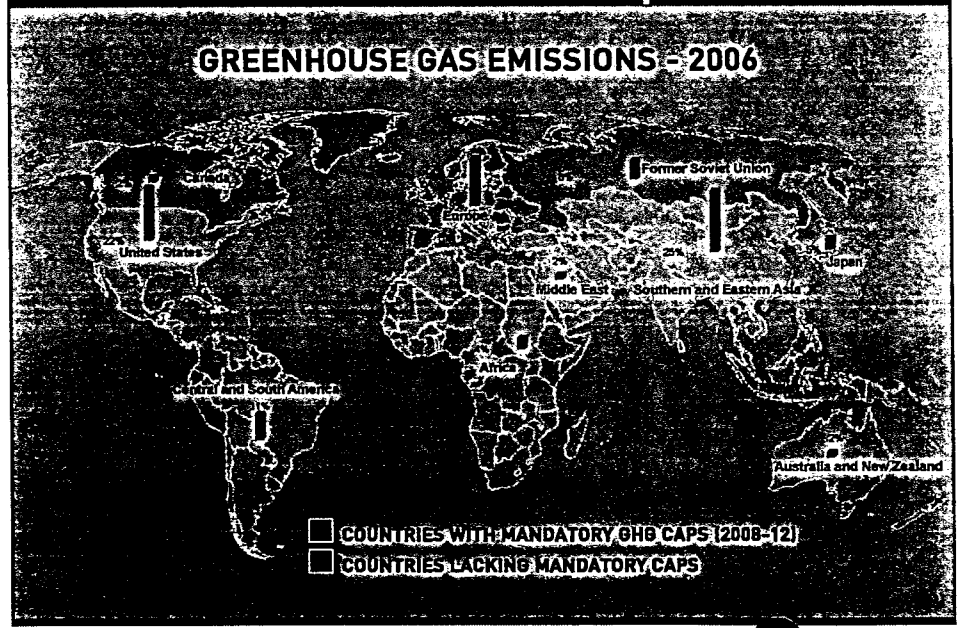
Pacala and Socolow formula:

Avoid dangerous climate change through mid-century using ~ 7 of 15 existing technological/policy "wedges."



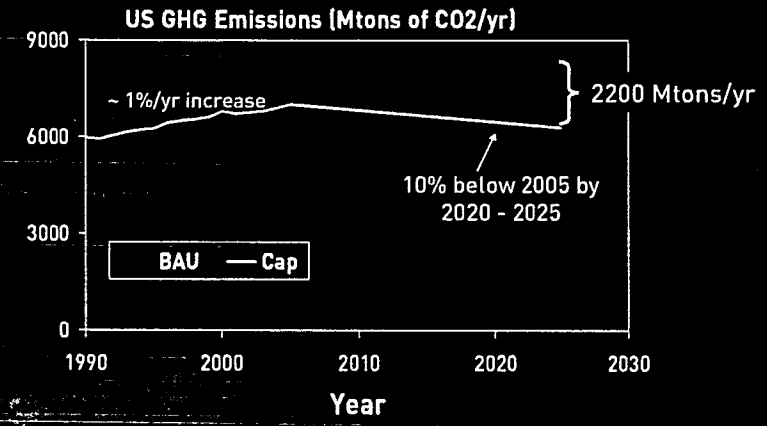
Market-based, cap-and-trade system probably the most efficient way to allow these wedges to compete and provide the most cost-effective emission cuts.

US needs to do its part...



ENVIRONMENTAL DEFENSE

What does this mean for US in the next 10 – 15 years?



GLOBAL WARMING SCIENCE

ENVIRONMENTAL DEFENSE

Is it possible to cut US emissions by 2000 million tons/yr?

- U.S EPA: Land Management Practices
  - At $15/ton: cut 1500 million tons/yr by 2025
  - At $50/ton: cut 2000 million tons/yr by 2025
- Lawrence Berkeley Laboratory: Efficiency
  - At $50/ton: cut 2000 million tons/yr

GLOBAL WARMING SCIENCE

ENVIRONMENTAL DEFENSE

America is moving forward on global warming:

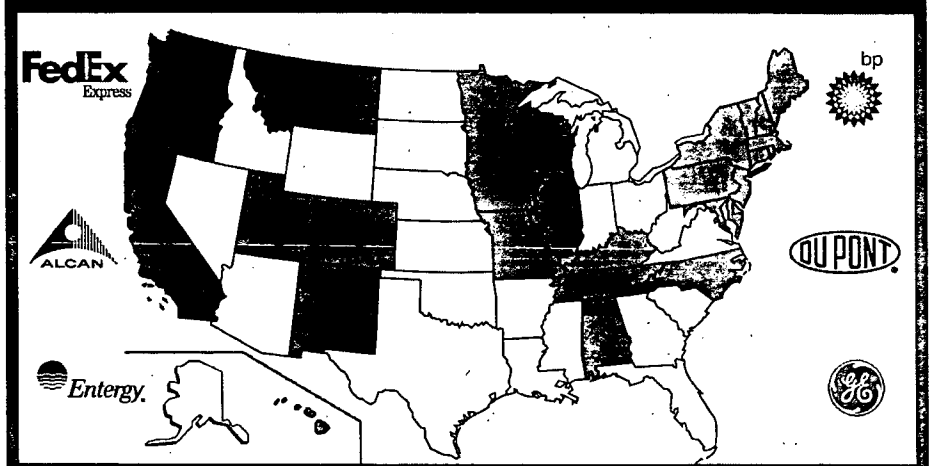
US Senate, 2005:

"It is the sense of the Senate that Congress should enact a comprehensive and effective national program of mandatory, market-based limits and incentives on emissions of greenhouse gases."

GLOBAL WARMING SCIENCE

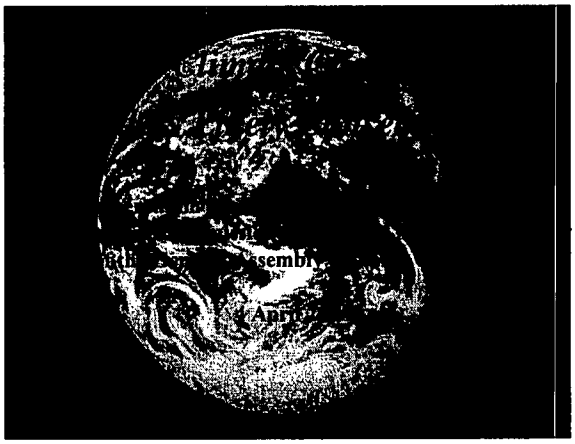
ENVIRONMENTAL DEFENSE

America is moving forward on global warming:



ALL STATES TAKING ACTION AND CORPORATE LEADERS

GLOBAL WARMING SCIENCE



The World at Night Gives an Indication of the Global Extent of Human Influences

Understanding and Projecting Climate Change is (arguably) the Most Difficult Scientific Challenge

- While rigorous physical and chemical conservation laws provide some insights, the problem also involves complex biological, technological, and sociological relationships and decisions
- We have only one "Earth"--we have only a limited record of the one path of many that it could have taken (and there are no close analogs to what is happening in the climate record)
- We are asked to project ahead for a century and more, and to do so at relatively fine time and space scales
- The problem we are dealing with is central to the operation and experience of society--it requires bridging science and society

"Uncertainty is inevitable, but risk is certain"--Pittock (2005)

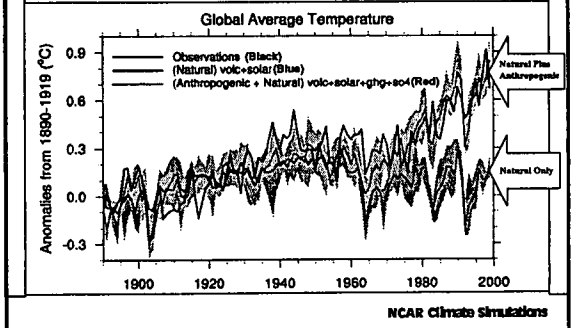
Scientific understanding has been summarized in the Intergovernmental Panel on Climate Change (IPCC), Arctic, and the US National Assessments

- The results presented here generally draw from the periodic assessments of the Intergovernmental Panel on Climate Change (IPCC) and similar widely reviewed reports.
- They represent the consensus views of the most plausible explanations, even though scientific uncertainties of various types remain and continue to be investigated.
- While science advances by resolving conflicts in observations and theory, government and business leaders, the public and other decision-makers generally decide what to do based on relative likelihood--not absolute certainty.

Six Key Findings Summarize the Last 100 Years of Research on Climate Change (i.e., "Global Warming")

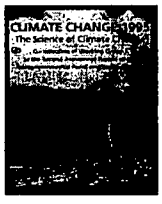
1. Emissions from human activities are changing atmospheric composition
2. Enhancing the natural greenhouse effect will lead to long-term global warming
3. Changes in the climate are already evident, and consistent with a human influence
4. Future warming is projected to be substantial
5. The environment and society will both be impacted
6. Substantially slowing the ongoing change will require substantial early actions, with payoffs coming mainly after several generations

Model simulations of the 20th C indicate that human influences are the cause of the late-century warming



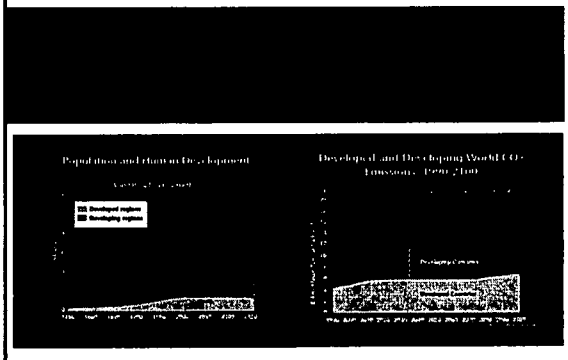
NCAR Climate Simulations

The IPCC Has Concluded that the Evidence for Human Influences on Climate is Getting Stronger

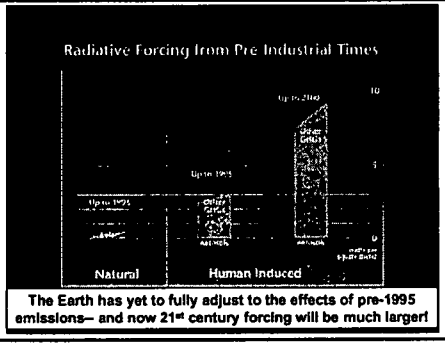


"The balance of evidence suggests a discernible human influence on global climate"

"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities"

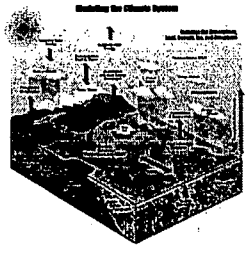


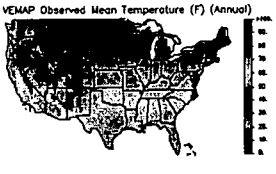
Past emissions came primarily from developed countries, but future emissions will come primarily from developing countries--even though their per capita use will remain significantly less than in the developed nations



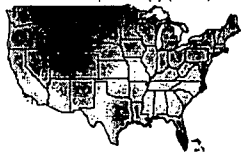
The Earth has yet to fully adjust to the effects of pre-1995 emissions– and now 21st century forcing will be much larger!

- 1. Laboratory and field experiments are too limited
- 2. Mathematical analyses must greatly simplify the Earth system
- 3. Analogs from the past are suggestive, but insufficiently similar to the current situation
- 4. Trend extrapolation is difficult due to natural variability and the uniquely changing conditions
- 5. Numerical models are theoretical constructs, but can treat the expected types of changes

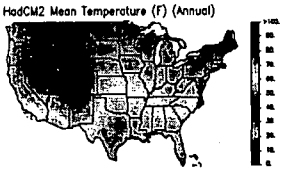


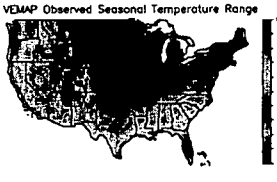


Canadian Model



Hadley (UK) Model





Canadian Model

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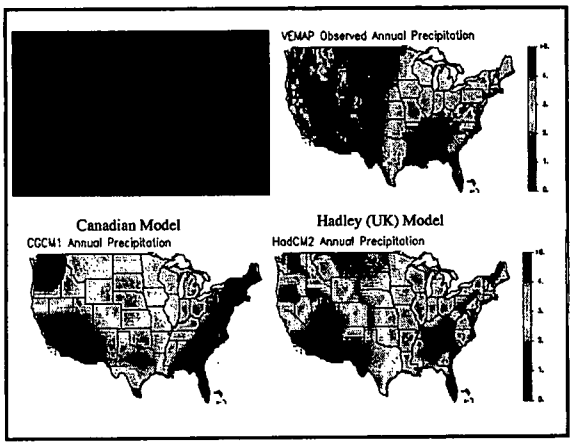
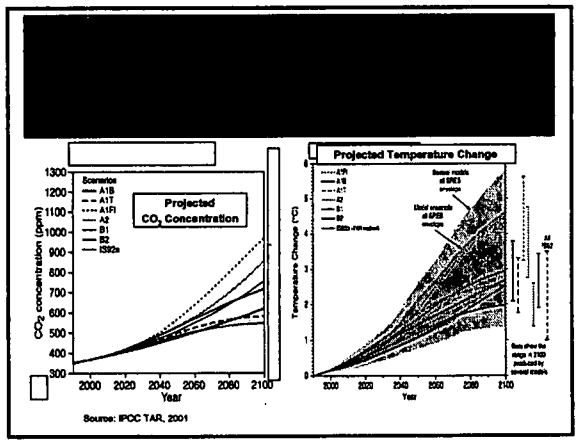
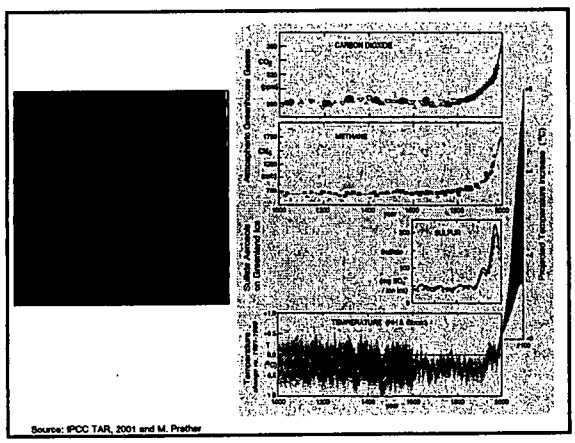


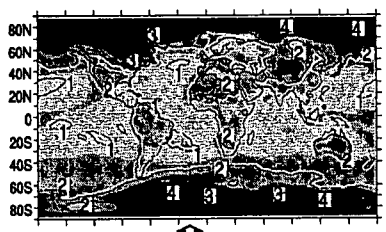




Model simulations project greater warming over land areas and in polar regions

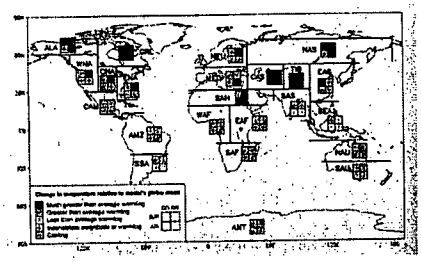
(values in °C, roughly double for °F)

In most current climate models, the projection of the carbon dioxide (CO_2) concentration is prescribed and the results are then compared the results from a control run without a CO_2 increase. The newest models are actually simulating the full carbon cycle.



Simulated change in annual mean temperature (°C) resulting from a doubling of CO_2 in the atmosphere in a typical climate model.
Source: Govindasamy and Caldeira (2000)

Model simulations of the global pattern of warming suggest greater warming in mid- to high latitudes, over land, and during the winter



- Warming is very likely to be greater in high than low latitudes, greater in winter than in summer, and greater over land than over the oceans
- Total evaporation is very likely to increase, more rapidly leading to dry soil conditions and drought
- Total global precipitation is very likely to increase, coming especially in relatively intense events that could increase flood likelihood in some regions.
- The highest percentage increase in precipitation is likely to occur in mid- to high-latitudes.
- The potential for unexpected changes is high as balancing influences are disrupted and thresholds are exceeded

Climate change is likely to lead to a range of important environmental and societal impacts

Adapted from EPA

Climate Changes
- Temperature
- Precipitation
- Sea Level Rise

Societal Impacts
Indigenous peoples and developing nations
Exacerbated impacts on the poor
Dramatically different situation for future generations

Health Impacts
Weather-related mortality/heat stress
Infectious diseases
Air quality-induced respiratory effects

Agriculture Impacts
Crop yields and commodity prices
Irrigation demands
Pests and weed

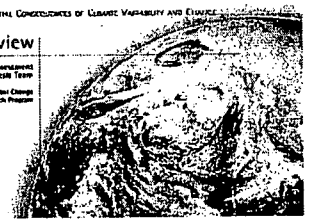
Forest Impacts
Change in forest composition
Shift geographic range of forests
Forest health and productivity

Water Resource Impacts
Changes in water supply and timing
Water quality
Increased competition for water

Coastal Area Impacts
Erosion of beaches
Inundation of coastal wetlands
Costs to defend coastal communities

Ecosystem Impacts
Shifts in ecological zones
Loss of habitat and species
Coral reefs threatened

The US National Assessment (1997-2000) prepared national, regional, and sectoral reports about past impacts and likely future consequences. These are downloadable from: http://www.usgcrp.gov/usgcrp/nacc/default.htm



This National Overview report is also available from Cambridge University Press

The Southeast region report is available at http://www.usgcrp.gov/usgcrp/nacc/seregion.htm

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For North Carolina, the two most relevant assessments were Southeast and Coastal

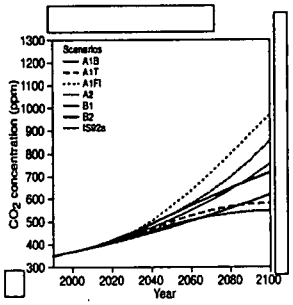
Key Issues from the Southeast Regional Assessment:
- Agriculture
- Forests and forest economics
- Water quality
- Air quality
- Extreme weather events

Additional issues recognized but not dealt with by regional assessment:
- Land use change
- Water resources
- Coastal ecosystems and services
- Health and water quality
- Socioeconomic and insurance issues
- Urban issues (building design and construction, infrastructure, etc.)

Key Issues from the Coastal Assessment:
- Shorelines and coastal development
- Wetlands
- Estuaries
- Coral reefs
- Ocean margins and fishery resources

Additional topics and issues mentioned:
- Coastal areas and populations
- The importance of coastal resources
- Ocean temperatures and currents
- Hurricanes and extratropical storms
- Precipitation and freshwater runoff
- Sea level change

The rising CO_2 concentration itself will have important consequences for the environment



Both the marine and terrestrial environments will be (are already being) affected

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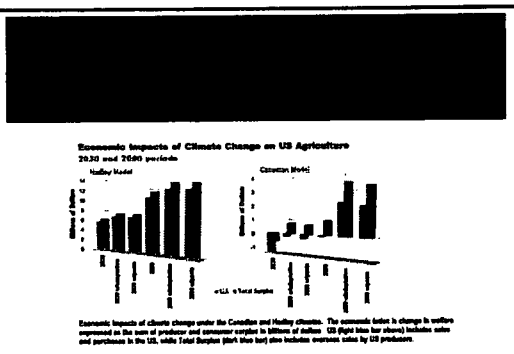

With increased production, commodity prices would be expected to fall, benefiting consumers, but causing economic harm in marginal farming areas. Issues of changes in pests and plant diseases have yet to be evaluated

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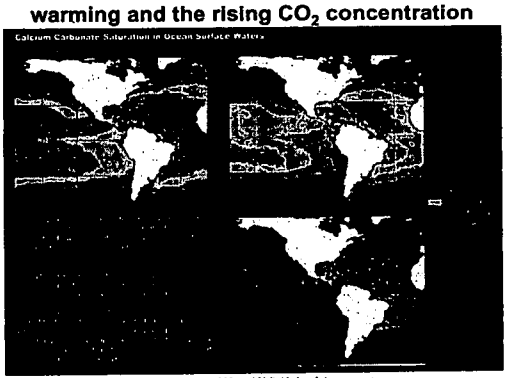
Coral reefs are threatened by both ocean warming and the rising CO_2 concentration



Source: Kleypas, Buddemeier, et al., Science, 1999; and U.S. National Assessment.

[redacted]

Canadian model scenario for increase by 2100

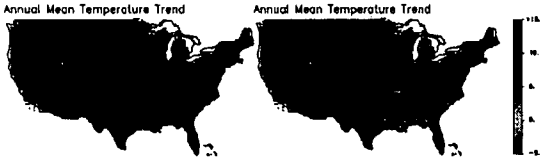
Canadian 21st Century

Annual Mean Temperature Trend

Hadley (UK)model scenario for increase by 2100

Hadley 21st Century

Annual Mean Temperature Trend



Plots show the projected change in annual average temperature (°F) over the 21st century

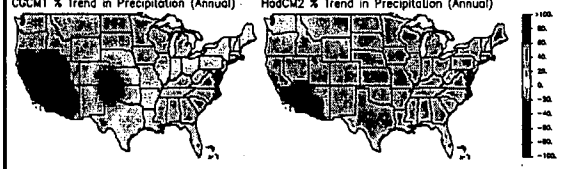
Model projections of the change in precipitation suggest the potential for "hot-dry" or "warm-moist" conditions

Canadian model scenario for change by 2100

CGCM1 % Trend in Precipitation (Annual)

Hadley model scenario for increase by 2100

HadCM2 % Trend in Precipitation (Annual)



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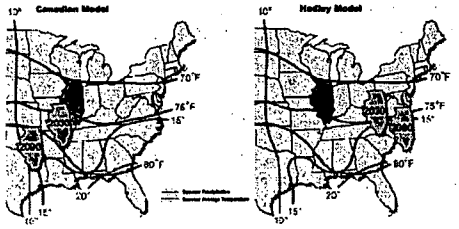
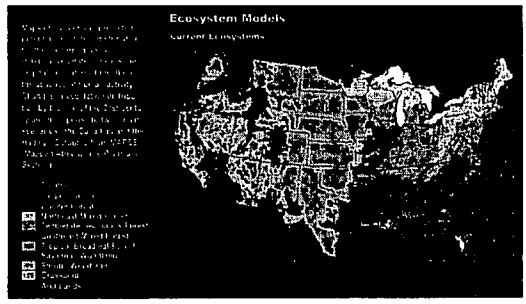


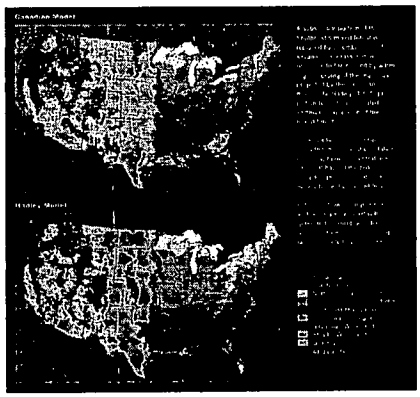
Illustration of how the summer climate of Illinois would shift under the Canadian and Hadley model scenarios. Under the Canadian scenario, the summer climate of Illinois would become more like the current climate of southern Missouri in 2030 and more like Oklahoma's current climate in 2090. The primary difference in the resulting climates of the two models relates to the amount of summer rainfall.

[redacted]



Projected Ecosystem Impacts by 2100

Even accounting for the effects of CO_2 fertilization and enhancement, changes in the climate will lead to regional changes in the predominant vegetation type and, as a result, in the extant wildlife. Some of the transition is likely to occur relatively rapidly as a result of fires and other disturbances



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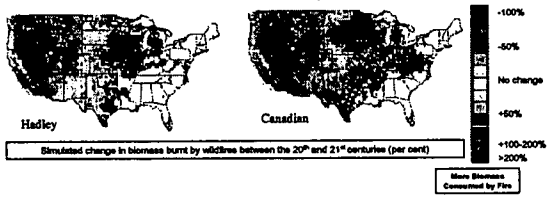
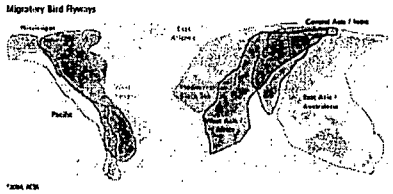


For hot, dry summertime conditions (the Canadian model scenario), the forest mass burned is projected to increase significantly, especially in the western US and the lower Mississippi-central Appalachians region. For warm, moist conditions (the Hadley model scenario), increased fire likelihood is projected to occur mainly in the western US

Conditions will be changing at the ends and all along the pathways of migrating species, with the potential for significant disruption



Several hundred million birds migrate to the Arctic each summer and their success in the Arctic determines their populations at lower latitudes. Important breeding and nesting areas are projected to decrease sharply as treeline advances northward, encroaching on tundra and because the timing of bird arrival in the Arctic might no longer coincide with the availability of their insect food sources. At the same time, sea-level rise will erode tundra estuaries from the north in many areas, further shrinking important habitat for many living things. A number of bird species, including several globally endangered seabird species, are projected to lose more than 50% of their breeding area during this century.

[redacted]

- **Storm intensity, track, and number** are likely to shift, although most types of changes remain uncertain
- Warmer conditions will lead to **reduced springtime snowpack** and altered timing of river runoff (with less in summer)
- A larger fraction of the precipitation is likely to come in **intense storms**, continuing the 20th century trend
- Warmer conditions will lead to **warmer water temperatures and faster drying of soils** between storms
- **Average river flows and lake levels** will be lower, especially in summer, creating greater competition for water resources)

[redacted]

WATER ISSUES

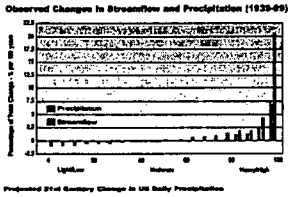
Region	Floods	Droughts	Snowpack/ Snowcover	Groundwater	L re
Northeast	X	X	X	X	
Southeast	X	X		X	
Midwest	X	X	X	X	
Great Plains	X	X	X	X	
West	X	X	X	X	
Northwest	X	X	X		
Alaska		X	X		
Islands	X	X		X	

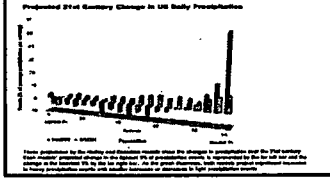
Shifts in climate are expected to lead to changes in the frequency and intensity of extremes

As an example, an increase in the average temperature is expected to lead to a very large increase in the probability that hot extremes may be experienced.

[redacted]

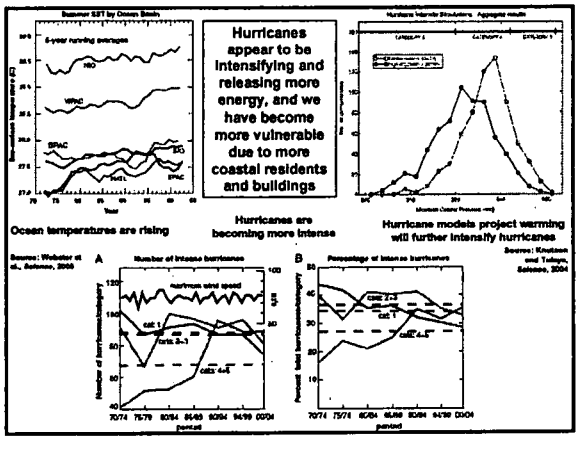
Precipitation has been Becoming More Intense, and Models Project this Tendency to Continue

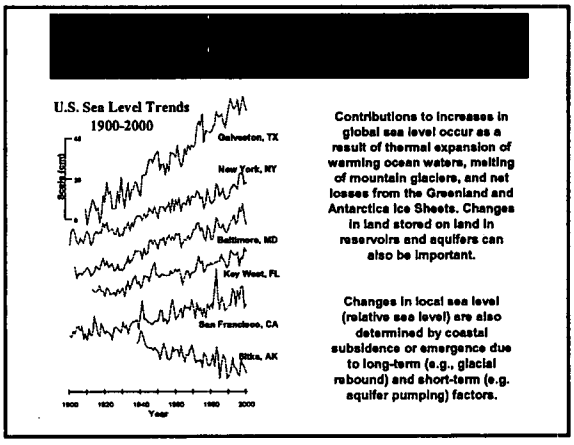




A greater share of precipitation has been occurring during the most intense rainfall events, leading to more intense stream flows. This has been occurring in the US and around the world

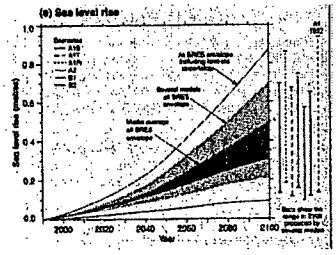
Projections from all models indicate that the increase in temperature and atmospheric humidity will lead to a greater share of precipitation occurring during the most intense rainfall events





Contributions to increases in global sea level occur as a result of thermal expansion of warming ocean waters, melting of mountain glaciers, and net losses from the Greenland and Antarctica ice Sheets. Changes in land stored on land in reservoirs and aquifers can also be important.

Changes in local sea level (relative sea level) are also determined by coastal subsidence or emergence due to long-term (e.g., glacial rebound) and short-term (e.g. aquifer pumping) factors.

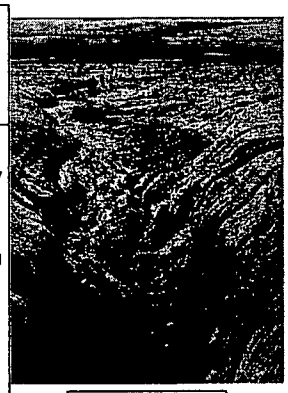


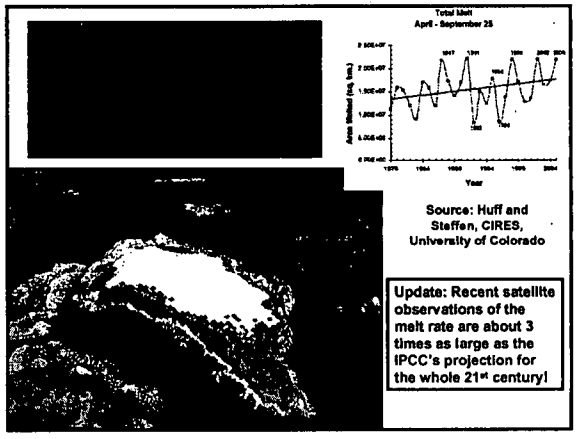
Contributions to global sea level rise are projected to come mainly from thermal expansion of ocean waters and melting of mountain glaciers. These IPCC (2001) estimates suggested that melting of the Greenland and Antarctica Ice Sheets would be small, but more recent indications are that there will be more significant contributions.

The Greenland Ice Sheet Dominates Land Ice in the Arctic--and it is Melting at an Accelerating Rate

Over the past two decades, the melt area on the Greenland ice sheet has increased on average by about 0.7%/year (or about 16% from 1979 to 2002).

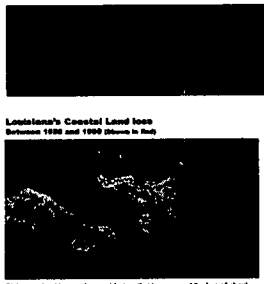
There is preliminary paleoclimatic evidence suggesting that sea level was a few meters higher than at present during the Eemian interglacial 120,000 years ago. There is also evidence that this sea level rise occurred over a few centuries, mainly due to rapid melting of about half of the Greenland Ice Sheet.

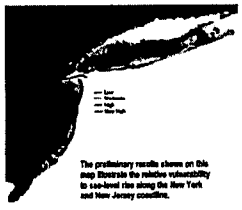




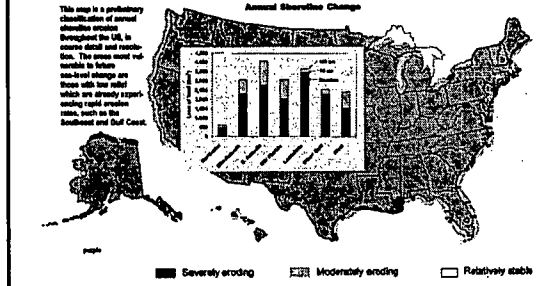
Source: Huff and Steffen, CIRES, University of Colorado

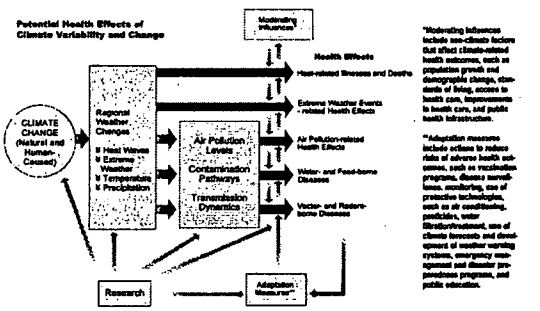
Update: Recent satellite observations of the melt rate are about 3 times as large as the IPCC's projection for the whole 21st century!

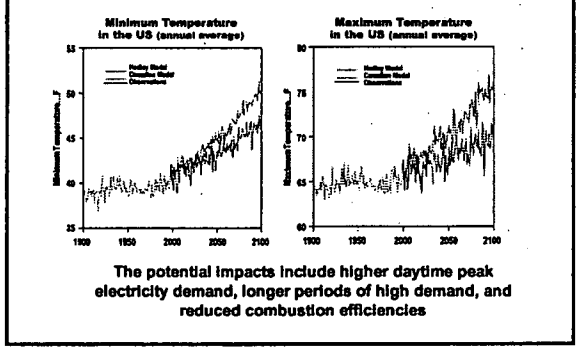




Coastal islands and wetlands are the "shock absorbers" in the event of hurricanes



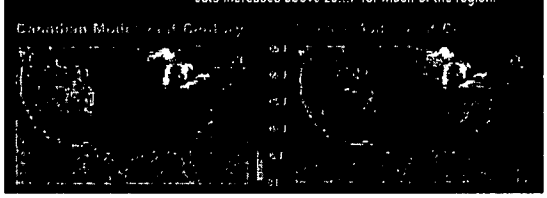


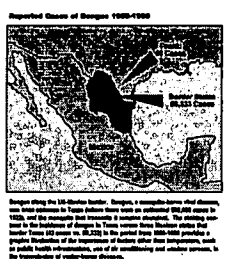


The potential impacts include higher daytime peak electricity demand, longer periods of high demand, and reduced combustion efficiencies

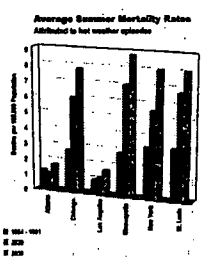
July Heat Index Change

The projected changes in the heat index for the Southeast are the most dramatic in the nation with the Hadley model suggesting increases of 9 to 15...F for the southernmost states, while the Canadian model projects increases above 25...F for much of the region.





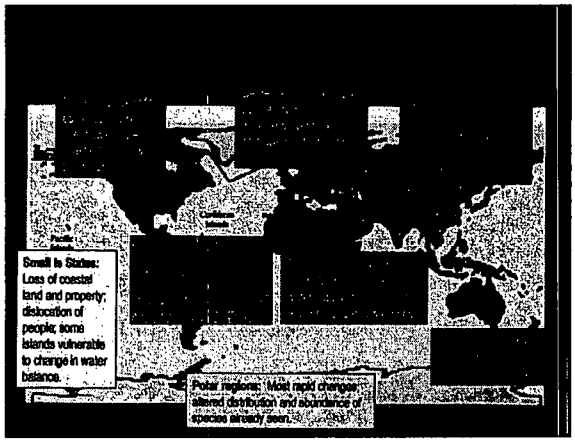
Community design and standards can limit mosquito habitat



Air-conditioning and better housing can limit heat stress

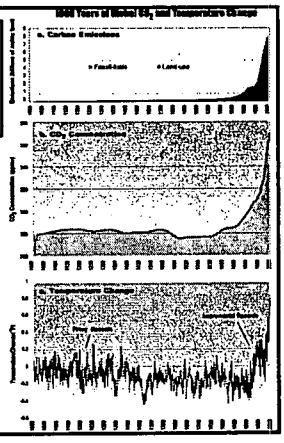
Region	Environmental Consequences	Economic Consequences	Consequences to People
Northeast	Wetland inundation	Reduced wintertime recreation	Rising summertime heat index
Southeast	Loss of coastal ecosystems; changing forests	Increasing productivity of hardwood forests	Increased coastal flooding; longer, hotter summers
Midwest	Higher lake and river temperatures alter fish species	Increasing agricultural productivity	Lowered lake and river levels; hotter summers
Great Plains	Warmer winters allow more invasive species	Increasing agricultural productivity	Worsened climatic extremes in spring/summer
West	Altered ecosystems, and more fire	Rising snowline intensifies water problems	Shift toward warm season recreation; greater fire danger
Northwest	Stress to cold/cool water ecosystems and fish	Earlier winter runoff tightens water supplies	Shift to warm season recreation; coastal erosion

- ***Economic and Market Couplings:*** imported products, export markets, investments, international well-being
- ***Shared Resources and Environments:*** water resources, hydropower, fisheries, migrating species, ocean resources, biodiversity
- ***Human Health:*** disease prevalence and vectors, health of visitors, disease level of countries where visit and do business
- ***International Security and Well-Being:*** pressures for immigration, environmental refugees, levels of international conflict and requirements for peace-keeping, concern for relatives and peoples



The Observations Alone Create a Very Strong Circumstantial Case for a Strong Human Influence

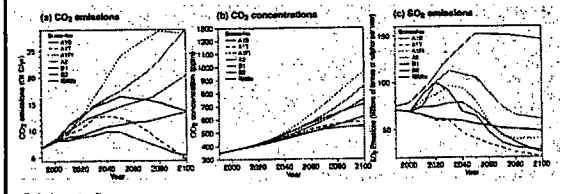
The consistency of reconstructions of the changes in (a) CO_2 emissions, (b) CO_2 concentrations, and (c) surface temperature over the last 1000 years strongly suggest that the 20th century has been significantly warmed by human activities



Because Science is Never Certain, There Will Always be Differing Views

- **Scientific Skepticism:** All scientists are taught to be skeptical, to raise questions, and to investigate alternative hypotheses and explanations
- **IPCC Consensus:** Most active research scientists support the IPCC process as a means of expressing consensus understanding and agree with the overall thrust and nature of the findings, even if disagreeing with some details
- **The Skeptics:** A relatively small number of active scientist and a larger number of formerly active scientists, energy experts, and economists--generally also opposed to governmental interventions of many kinds--who focus primarily on the shortcomings in understanding, and tend to be rather uncritically attracted to alternative hypotheses

To evaluate potential changes in atmospheric composition, 6 storylines were created as possible scenarios for the future



Emissions storylines:

- A1B: Rapid economic growth with balanced set of energy technologies
- A1T: Rapid economic growth with strong emphasis to non-fossil energy technologies
- A1F1: Rapid economic growth with emphasis on fossil fuel energy technologies
- A2: Heterogeneous world with preservation of local identities and fragmented economic growth
- B1: Convergent world economy, moving toward service and information economy and efficient technologies
- B2: Emphasis on local solutions, with continued growth in world population, and emphasis on environmental protection and social equity
- IS92a: Business as usual scenario generated in 1992 and used in IPCC's Second Assessment Report

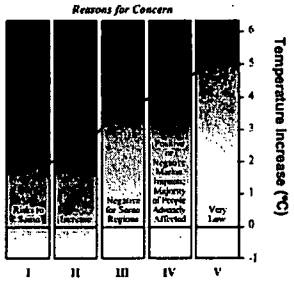
Summary of Impacts by the IPCC--there is not much margin before most systems are significantly impacted

White: neutral or small positive or negative impacts

Yellow: negative impacts for some systems or low risks

Red: negative impacts or risks that are more widespread and/or greater in magnitude

I Risks to Unique and Threatened Systems
II Risks from Extreme Climate Events
III Distribution of Impacts
IV Aggregate Impacts
V Risks from Future Large-Scale Discontinuities



Reasons for concern about projected climate change impacts

Source: IPCC Climate Change 2001: S. Schneider & M. Mastrandrea, PNAS, 102, 15728, 2005.

- ***Adaptation* to ongoing and changes will be required**. Climate change has already begun and will continue for many decades, even with significant cutbacks in emissions. We can either use what scientific information we have to prepare, or we will have to adapt as we go, costly as that may be.
- ***Mitigation* is essential if we are to avoid initiating the rapid onset of very disruptive impacts.** Because of the time to make changes and the inertia of the climate system, aggressive efforts to limit emissions need to begin now, even though the direct benefits of eventually slowing climate change will mainly be experienced by our grandchildren. In the short-term, the indirect benefits of improving energy security, creating jobs in the US, and some reduction in air and water pollution are likely.
- ***Delay* is very likely to only make the transition need to be more rapid, and therefore likely more expensive**. California, for example, projects cost savings by making the transition.

Objective 2 of the UNFCCC calls for:

- **stabilization of the greenhouse gas concentrations in the atmosphere**
- **at a level that would prevent dangerous anthropogenic interference with the climate system.**
- **Such a level should be achieved within a time-frame sufficient**
  - **to allow ecosystems to adapt naturally to climate change,**
  - **to ensure that food production is not threatened, and**
  - **to enable economic development to proceed in a sustainable manner.**

Earth Summit, Rio de Janeiro, 1992

(adopted widely by the world community and approved by the US Senate in 1992)

Future emissions will be the product of four terms:

• The global population	⇦	Rising
• Energy use per person (related to standard of living)	⇦	Rising
• Fraction of energy coming from fossil fuels	⇦	Depends on choice of technology
• Amount of carbon from fossil fuel generation of energy	⇧	Will rise if go to coal, unless sequester

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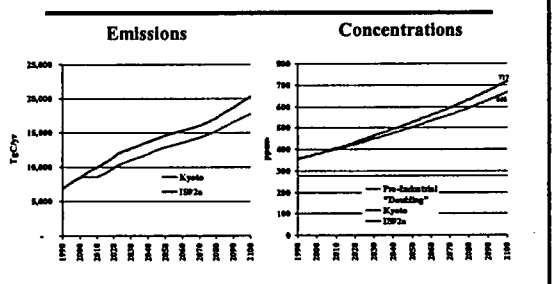
The Kyoto Protocol, Even if Fully Implemented, Would Have Only a Very Modest Effect-- Challenging as It May Be, It Can Only Be a First Step



Battelle Memorial Institute — Pacific Northwest National Laboratory

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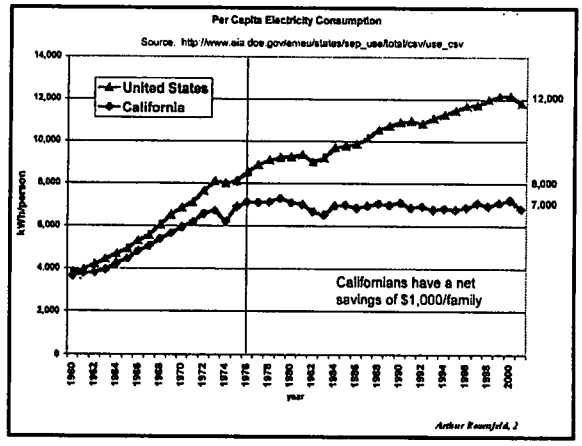
Assuming the world population rises from 6 billion to 10 billion, stabilizing CO_2 implies the following per capita limits for the 21st century (compared to current level of 1 tC/person/yr):

• Current CO_2 level (370 ppmv)	⇦ Near zero
• Double preindustrial (550 ppmv)	⇦ 1 tC/person/yr
• Double 1990s (710 ppmv)	⇦ 2 tC/person/yr
• Unconstrained (>1000 ppmv)	⇦ 3 tC/person/yr
• U.S. usage today	⇦ >5 tC/person/yr

Global average decrement that Kyoto agreement would create is <0.25 tC/person/yr

A Range of Short-term Options are Available to Reduce Greenhouse Gas Emissions

- Improved efficiency (motors, lights, appliances, etc.)
- Insulation and better thermal design of buildings and appliances
- Recycling and reduction of waste generation in manufacturing
- Better electronic controls
- Switching from coal and oil to natural gas so less carbon emitted
- Improving combustion efficiency
- Reducing methane emissions
- Renewables where cost-effective (wind, solar, hydro, biomass)
- Reforestation and reducing deforestation as emissions offsets
- Eliminating CFCs having high Global Warming Potentials
- Lifestyle changes (mass transit, bicycling, carpooling, etc.)
- Others (taxes, parking fees, incentives, etc.)



Getting to Long-term Solutions Appears to be a Very Large Challenge

From a global perspective, it is easy to be discouraged:

- There are many gases to deal with (CO_2, CH_4, etc.)
- Solutions are needed for both transportation and for electric generation
- With fossil fuels supplying 90% of the world's energy, finding a single solution is hard to imagine

Possibilities seem to include:

- Biomass--competes with food and forests for land and nutrients
- Fission--very large numbers required, with consequent environmental issues on a global basis
- Fusion--Appears to be 50 years in the future
- Solar--Requires storage medium (possibly hydrogen)
- Solar power satellites--conceivable, but very visionary
- Ocean kelp farming--massive undertaking
- Geoclimatic engineering (mirrors, aerosols)--important side-effects
- Adaptation starts to appear as an essential option

Taking a Regional Perspective Provides the Basis for some Encouragement

Thinking about solutions on a regional basis:

- Wet tropics: biomass, reforestation, hydropower, etc.
- Dry subtropics: windpower, distributed solar, solar thermal
- Industrialized midlatitudes: efficiency, conservation, natural gas as transition to biomass, solar, wind, nuclear, etc.; dietary changes
- Large developing nations (China, India); efficient coal and other fossil fuels, solar, wind, etc.

While there is a need to think globally, action and solutions are likely most practical if carried out on a local to national scale.
The range of approaches seems to present many opportunities for technology.

(Regional breakdown originally from L. Kulp)

NC Legislative Commission
on Global Climate Change

Business and Climate Change

Truman Semans
Director for Markets & Business Strategy
Pew Center on Global Climate Change

April 4, 2006

Pew's Business Environmental Leadership Council

- 41 large corporations active on climate
- Primarily Fortune 500 multinationals
- Employ nearly 3 million and represent $2+ trillion in market cap
- Most have either large GHG emissions or a large GHG "footprint" through products
- Diverse business interests, but agreement on need for action on climate

41 BELC Companies

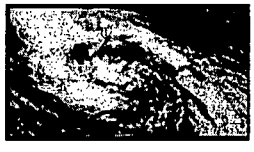
Corporate Strategies that Address Climate

- Reducing GHG emissions
  - Energy efficiency and GHG reduction from operations
  - Broader energy "footprint" of products/services
- Capturing competitive advantage and business opportunity
  - Industry cost leadership
  - Boost demand for existing products/services
  - New products/services
- Constructive external engagement
  - Collaboration with sector and supply chain
  - Disclosure, public awareness, and stakeholder collaboration
  - Proactive involvement in policy

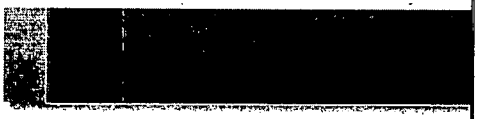
Thank You

For more information visit:

www.pewclimate.org



NC Legislative Commission on Global Climate Change
April 4, 2006
Raleigh, NC



Bill Bailey, Principal Consultant
DuPont
Charlotte, NC

DUPONT
The miracles of science

DuPont Today

- A global science company solving problems in ways that makes people's lives better, safer and easier
- 135 plants and 80 R&D facilities in 70 countries
  - 5 facilities in North Carolina
- Major business segments
  - Agriculture and Nutrition
  - Coatings and Color Technologies
  - Electronics and Communications
  - Performance Materials
  - Safety and Protection

Swimsuit made with DuPont Sorona® bio-based polymer produced in Kinston, NC

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DUPONT

Company Heritage

- Founded in 1802 as a manufacturer of black powder
- Deeply ingrained concern for employee health and safety
- Core Values grew from this concern
  - Safety, health and environmental stewardship
  - Integrity and high ethical standards
  - Fair and respectful treatment of people
- Going forward in our third century...
  - We recognize our operations have global impact
  - Challenge: address issues in a way that makes business sense

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DUPONT

Our Goal: "Sustainable Growth"

- We define "Sustainable Growth" as
  - Increasing shareholder *and* societal value...
  - While decreasing the footprint[1] of our operations...
  - Along the value chains in which we operate
- Sustainable Growth is aligned with our core value of safety, health and environmental stewardship

[1] Footprint = injuries, illnesses, incidents, waste, emissions, and depletable forms of raw materials and energy

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Our View on Global Climate Change

- CFC/Ozone issue in the 1980's helped us understand the implications of environmental issues that are global in scope and decades-to-centuries in duration
- Global climate change is an extension of this experience
- We've studied the science and concluded there is reasonable cause for concern
- We recognize this is a global issue but we also recognize our greenhouse gas (GHG) emissions are significant
- We decided to take responsible action to reduce our emissions footprint and be part of the solution.

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DuPont's "Footprint" Commitment

- In 1999, we committed to achieve the following by 2010
  - Reduce greenhouse gas emissions by 65% versus 1990
  - Hold total energy use flat versus a 1990 baseline
  - Supply 10% of total energy needs from renewable resources at a cost competitive with best fossil-derived alternatives
- Progress is reported annually to public via "DuPont Sustainable Growth Progress Report" and 1605(b) report

http://www2.dupont.com/Social_Commitment/en_US/SHE/usa/us1.html

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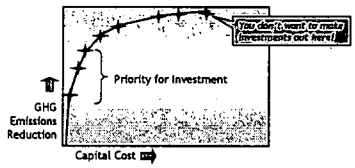
Approach to Greenhouse Gas Goal

- Develop inventory of global emissions and track over time
  - CO_2 and other greenhouse gases (nitrous oxide, HFC-23, etc.)
- Identify emission reduction opportunities
- Implement projects that reduce the most, cost the least



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"Flat" Energy Use Goal

- Our most challenging goal is to keep energy use flat
- If you make more pounds, you must use less energy/pound
- Improving the energy efficiency of existing plants is tough
  - Energy use is dispersed among hundreds of discrete devices
  - Inefficiencies are usually invisible
  - Data required to pinpoint losses is frequently unavailable
  - On-site expertise to make improvements is limited
  - Energy efficiency is not a product quality variable

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Motivating Plants to Use Less Energy

- Our plants must learn how to improve something our customers generally don't care about: energy efficiency
- Rising energy prices and our focus on Sustainable Growth are providing the necessary motivation to work on it
- And we've taken a strategic approach to help them
  - Set annual energy reduction targets at our largest plants
  - Appointed champions to lead site energy efficiency programs
  - Engaged Plant Managers to drive accountability for results
  - Created a "Center of Competency" to share best practices
  - Standardized our improvement methodology (Six Sigma)

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So How Are We Doing vs. Our Goals†?

- Greenhouse gas emissions are down 60% from 1990 levels
- Total energy consumption has decreased 6% while production has increased 41%
  - Over $2 Billion in savings since 1991 vs. "business as usual"
- Over 5% of our total energy is supplied from renewables
  - Largest contributors are landfill gas and wood projects

†Data is for calendar year 2004 and excludes divested Invista® operations.

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And Others Have Recognized Our Work

BusinessWeek online

TOP NEWS | BW MAGAZINE | INVESTING | ASIA | EUROPE | TECHNOLOGY | AUTOS | INNOVATION

DECEMBER 12, 2005 BATTLING CLIMATE CHANGE/Online Extra

Top Companies of the Decade

BusinessWeek, Climate Group, and a panel of judges compiled this ranking [redacted] results relative to company revenues, and management's leadership on environmental issues over the past ten years

	Company	2004 Sales $ Billions	Metric Tons	% Reduction
1	DuPont	$27.5	65 million	72

Reduced energy consumption 7% below 1990 levels, saving more than $2 billion - including at least $10 million a year by using renewable sources

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This Just In...

Ceres

PRESS RELEASES

Contacts:
Peyton Fleming Ceres, 617-247-0700 x 20 | fleming@ceres.org

Read: 2006 Corporate Governance and Climate Change: Making the Connection

BP and DuPont Receive Top Scores in First-Ever Ranking of 100 Global Companies on Climate Change Strategies

March 27, 2006

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Our Products Can Help Others Reduce

- We also provide a broad array of enabling technologies that can help our customers reduce *their* GHG footprint
  - Biofuels and bio-based raw materials like bio-propanediol (PDO) for Sorona® polymer
  - Engineered plastics and composites for lightweight autos
  - Tyvek® housewrap
  - Fuel cells
  - Photovoltaic system components
  - Kevlar® windmill blades

DuPont Tyvek® Housewrap

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In Conclusion

- We believe enough is known about global climate change to provide a basis for concern and warrant prudent action
- We have set aggressive goals to reduce our environmental footprint, including greenhouse gas emissions and energy
- We are making good progress on all of our goals and are on track to meet our 2010 commitments
- Climate change is an environmental *and* economic challenge and a successful strategy must address *both*

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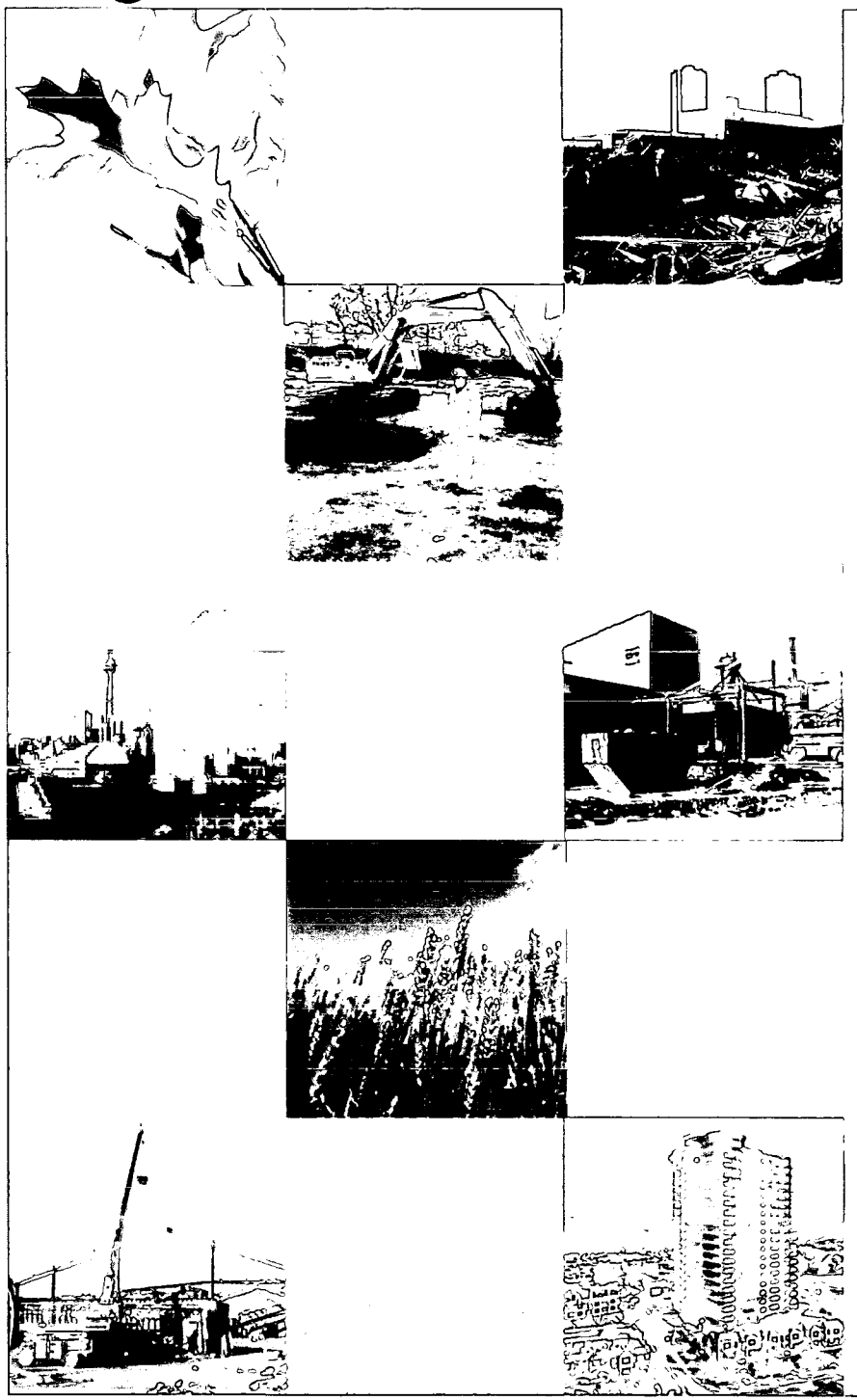
The miracles of science™



CHEROKEE
Investment Partners

PERSPECTIVES ON ENERGY REDUCTION AND ENVIRONMENTAL INNOVATION

North Carolina Legislative Committee on Climate Change

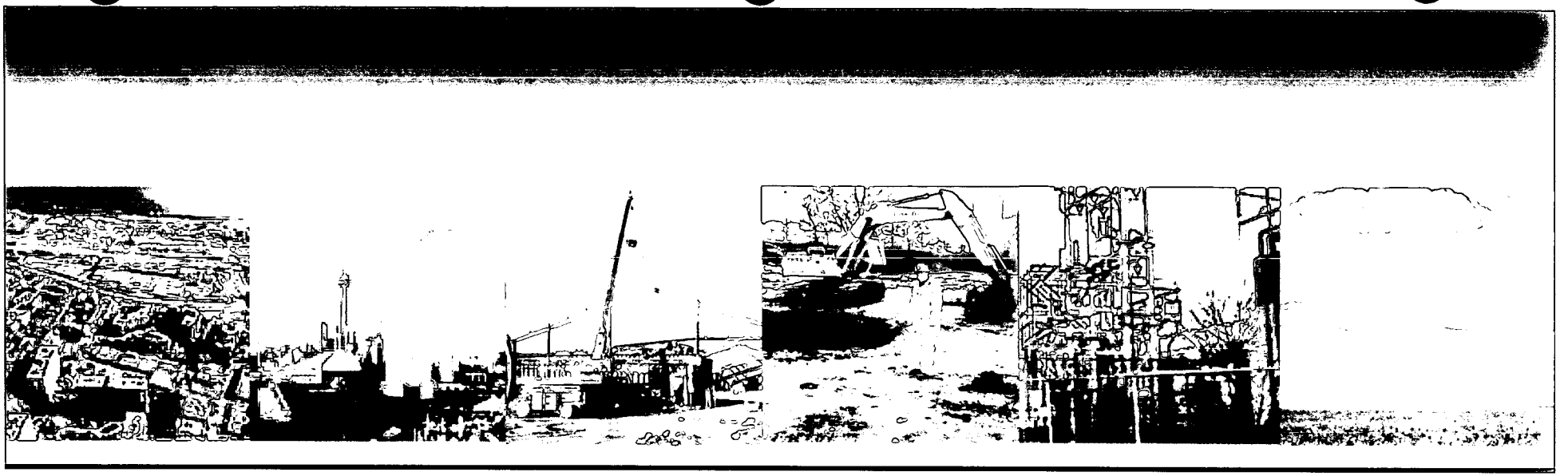
Thomas F. Darden

April 4, 2006

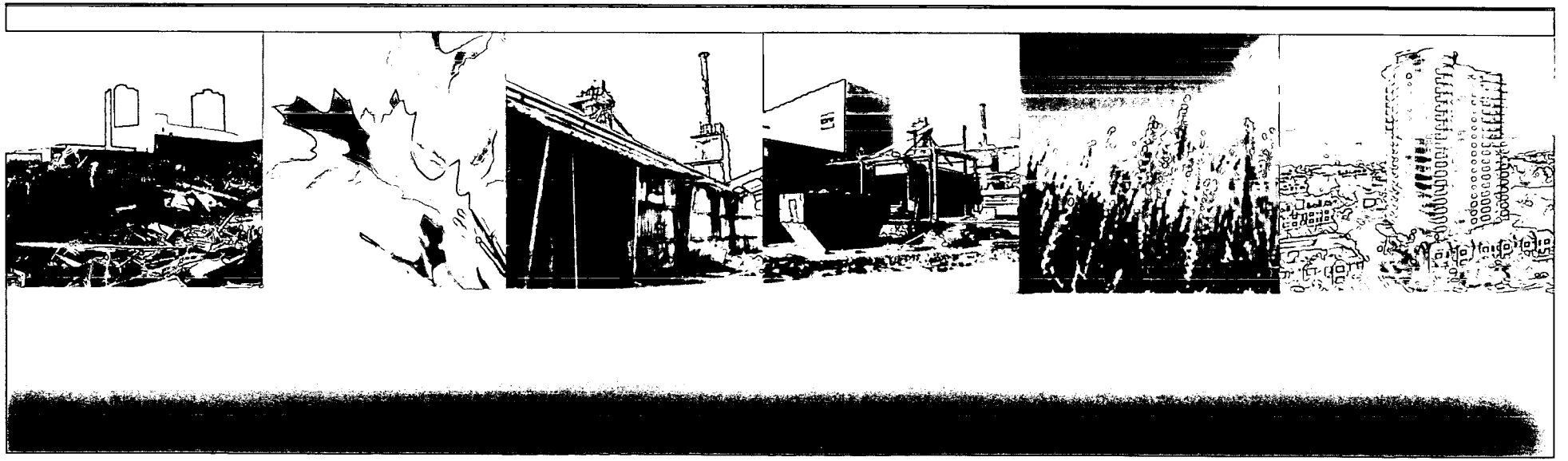
Cherokee Investment Partners, LLC
Corporate Headquarters
702 Oberlin Road
Suite 150
Raleigh, NC 27605
919.743.2500

Presentation Overview

- Introduction to Cherokee
- Representative Transactions
- Sustainability and Responsibility
- Cherokee's Action on Climate Change
- Concluding Remarks
- Contact Information

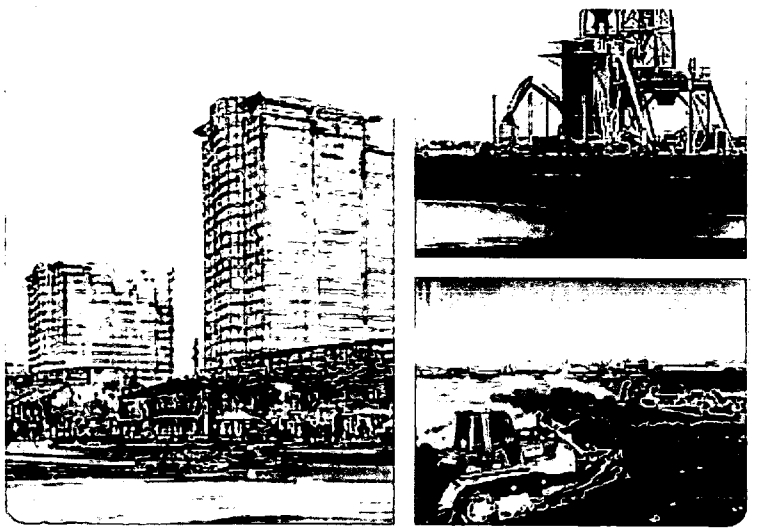


Introduction to Cherokee



History of Cherokee

- Cleanup of contaminated brick sites in the 1980s – learned to handle environmental liability as a principle
- Remediation of contaminated soil from leaking petroleum storage tanks – became the largest remediator of petroleum contamination in the southeastern U.S.
- In 1990, started new business of deliberately buying contaminated brownfield sites as investments
- First institutional capital of $50 million (Fund I) in 1996
- Raised $250 million Fund II in 1998
- Raised $620 million Fund III in 2002
- Cherokee Investment Partners IV - first closing December 2005



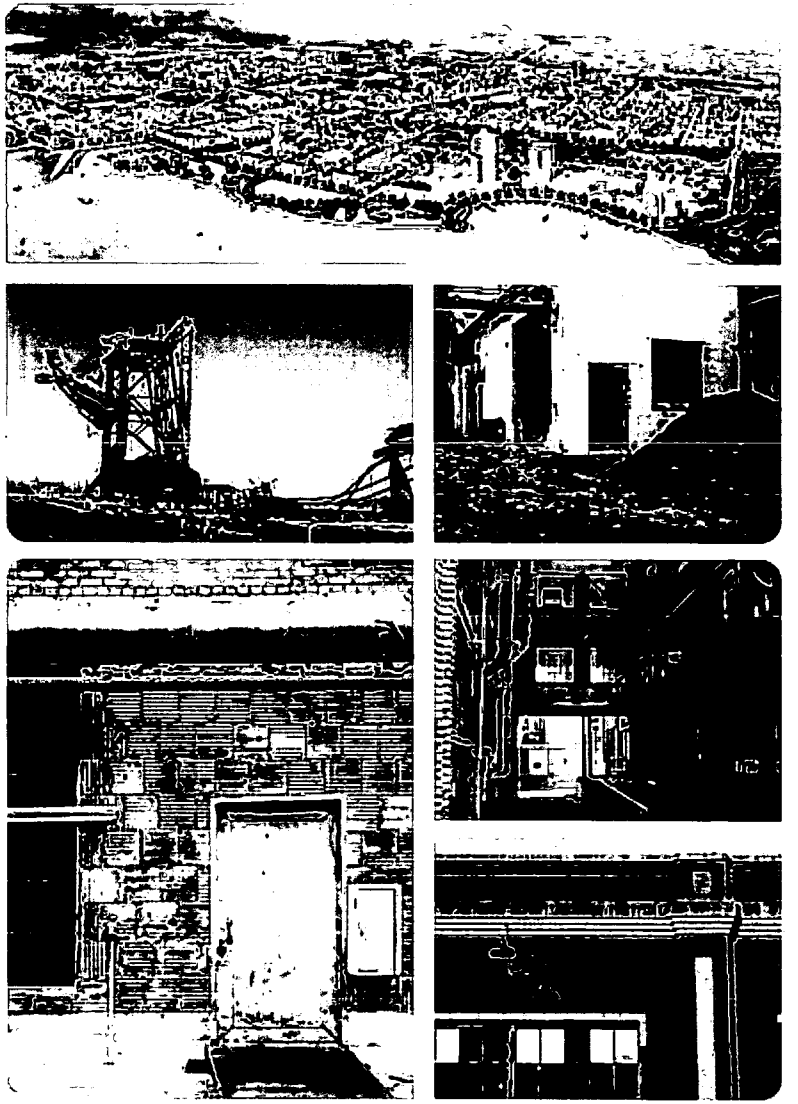
Introduction to Cherokee

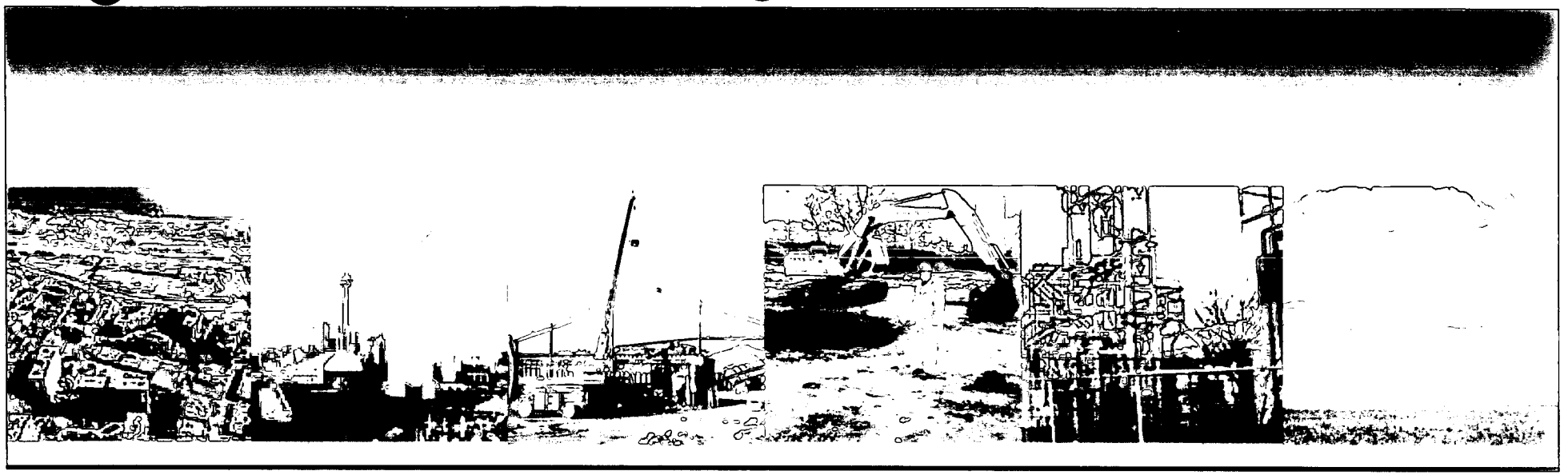
MISSION: ***To acquire environmentally impaired properties, remediate them and return them to productive use. Cherokee embraces a win-win attitude, enabling our partners, our investors, our employees and the communities we improve to share in the benefits of our work restoring brownfields.***

- **Cherokee's investors are large institutional pension funds, university endowments and state funds**
- **Cherokee is the largest redevelopment firm of its kind**
  - **More than $1.4 billion of assets under management**
  - **Acquired more than 520 properties since 1993**
  - **$3 billion in available capital**
  - **More than $250 million will be spent on remediation**
- **Investments encompass a wide variety of property types, sellers, contaminants and regulatory agencies**
- **In all of our transactions, Cherokee has never reverted to an indemnified party to support the costs of remediation or redevelopment**

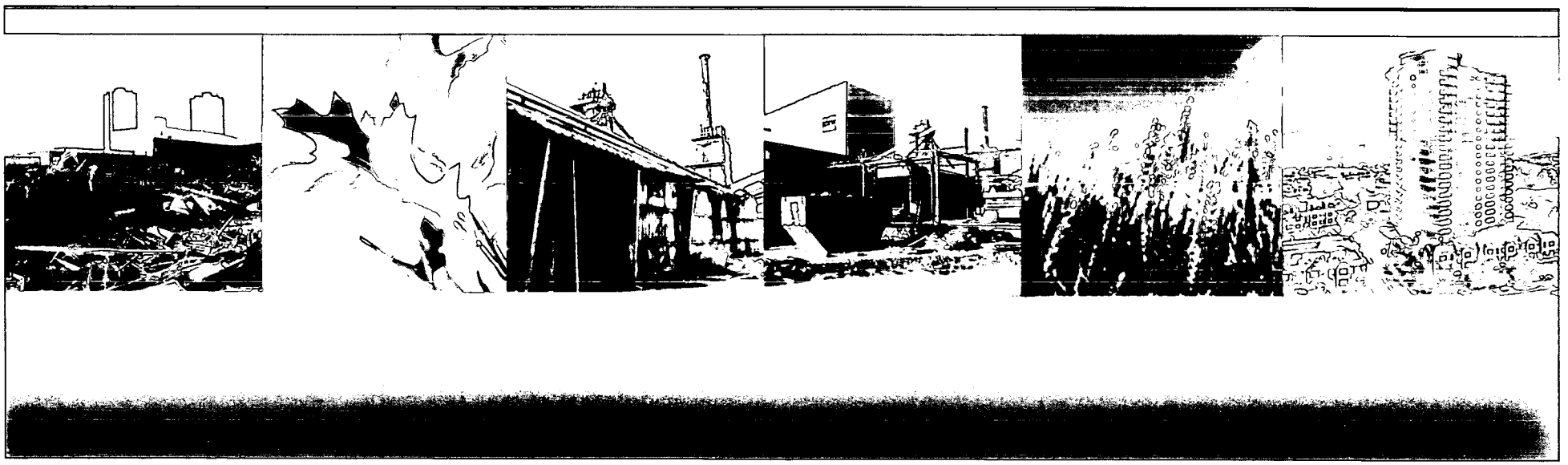
Cherokee Approach

- Commitment to safety, remediation and sustainable development
- Service provider to corporations and local, regional and national governments
- Continuing, active community and stakeholder involvement
- Large pool of discretionary capital
- No financing contingencies
- Use of capital and experience to transfer liability and protect owners
- Effective environmental liability management and insurance





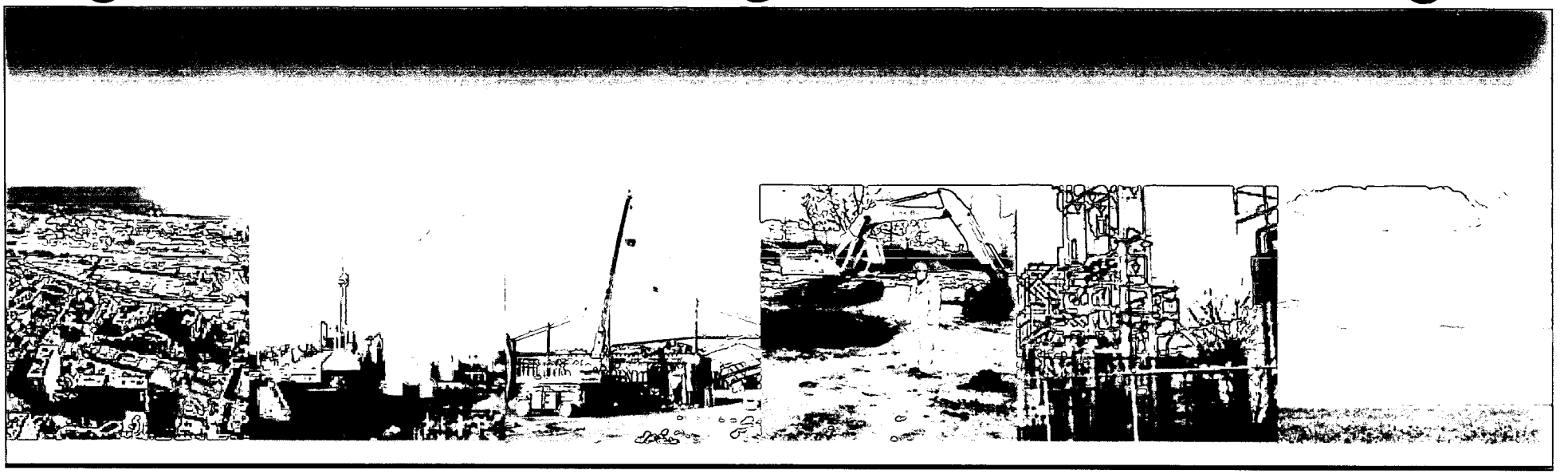
Representative Transactions



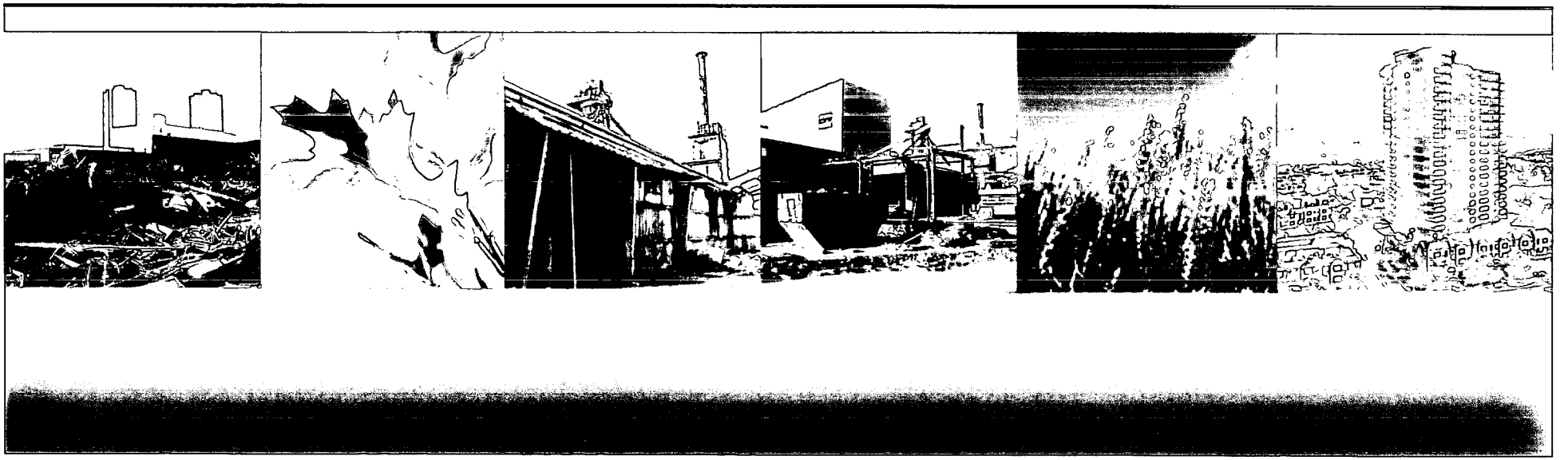
Completed Transactions

Prior owners include:

- **Government entities**
- **Multinational corporations**
- **Financial institutions**
- **Private equity funds**
- **Utilities**
- **Private owners**



Sustainability and Responsibility



Cherokee Responsibility

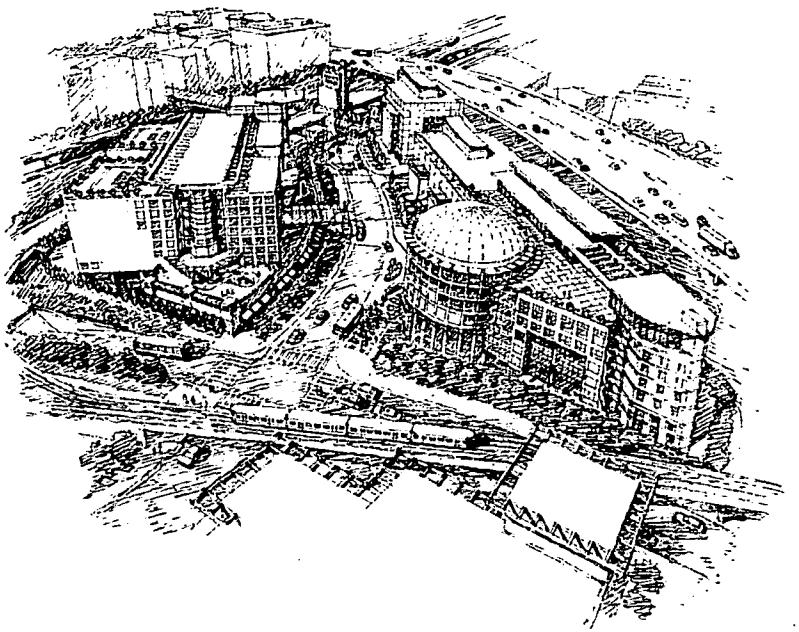
- Our investments have a three-fold outcome: positive economic, social and environmental results
  - Immense impact on environment and property reuse
  - Win-win outcomes for communities and other stakeholders (economic development, jobs, tax revenues, etc.)
- Our responsibility extends beyond real estate
  - We believe community service, compassion and social accountability make us better investors
  - Our nonprofit outreach efforts promote strong local communities and economic development around the world
- We strive to be innovative and a world leader in our performance
  - Smart growth approach to urban planning - mixed use, rail transit, etc.
  - The first (and, we believe, the only) private equity firm with ISO 14001 certification

Sustainable Development

- For Cherokee, sustainable development requires thoughtful consideration of both the environmental and social aspects of our work
- We see competitive advantage in careful land use and environmentally responsive design of the built environment
- Land use
  - Mixed-use, walkable or transit-oriented developments that integrate habitat, scale and aesthetics, stormwater management
- Built environment
  - Innovative, environmentally friendly, energy and water-efficient, community-focused, safe, active, equitable, healthy developments

Cherokee and Sustainability

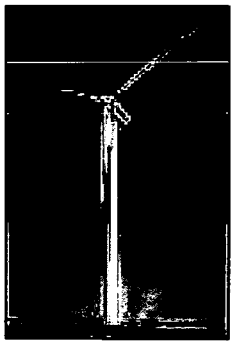
- Business model → small industrial sites to large in-fill brownfield redevelopment
- Application of sustainability principles of smart growth/new urbanism
  - Mixed use
  - Compact neighborhoods with public amenities
  - Open space
  - Transportation alternatives
  - Consideration to aesthetics, a sense of place and history
- Use of progressive planning consultants and architects – William McDonough + Partners, Robert Stern, Shook Kelley and others
- Cherokee balances cost, profitability and community objectives with sustainability



Sustainable Development

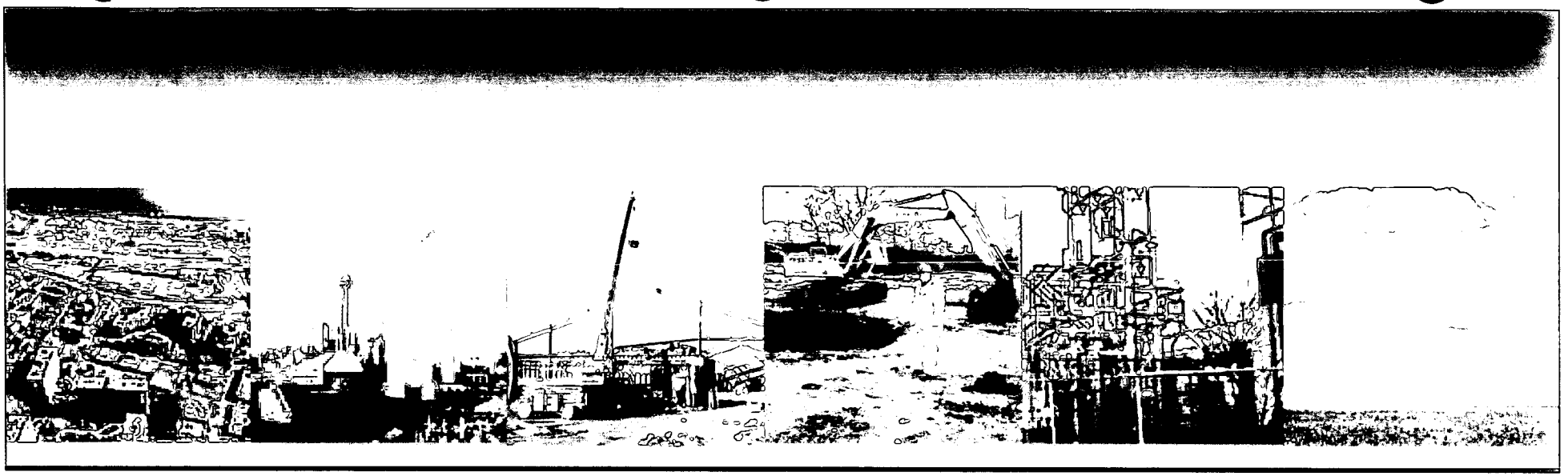
Cherokee's current evolution:

Recycling Land → **Green Building** → **"Off-the-Grid"**

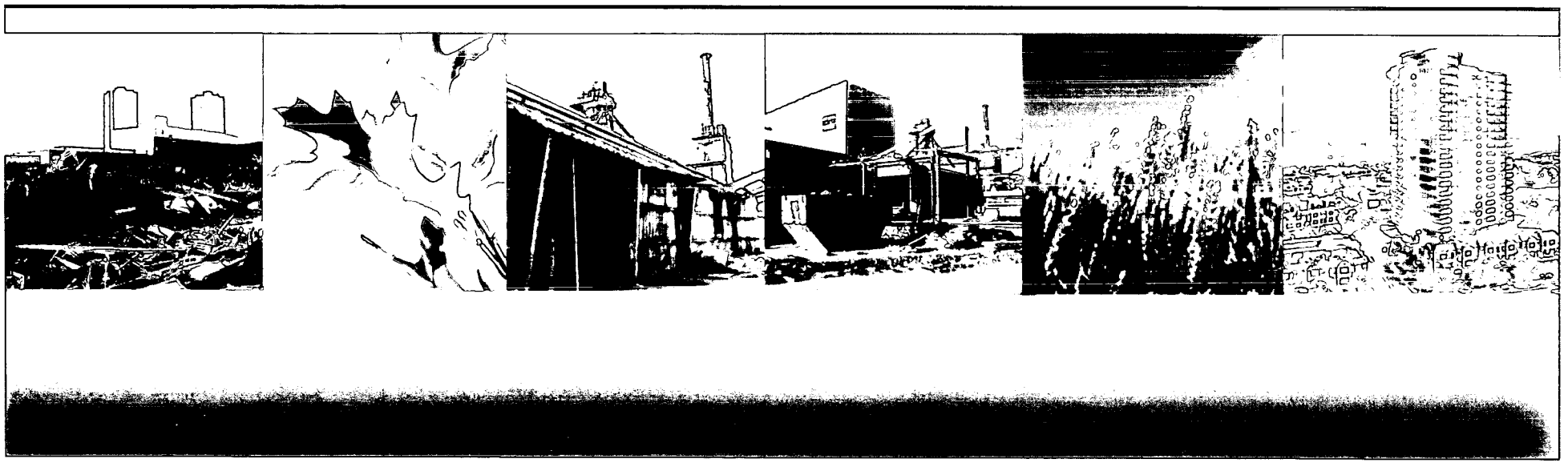


Buildings currently consume:

- 40% of all raw materials consumed by weight globally
- 65% of U.S. electricity consumption
- 138M tons of construction and demolition debris per day
- 30% of all greenhouse emissions



Cherokee's Action on Climate Change



North Carolina Green Power Program

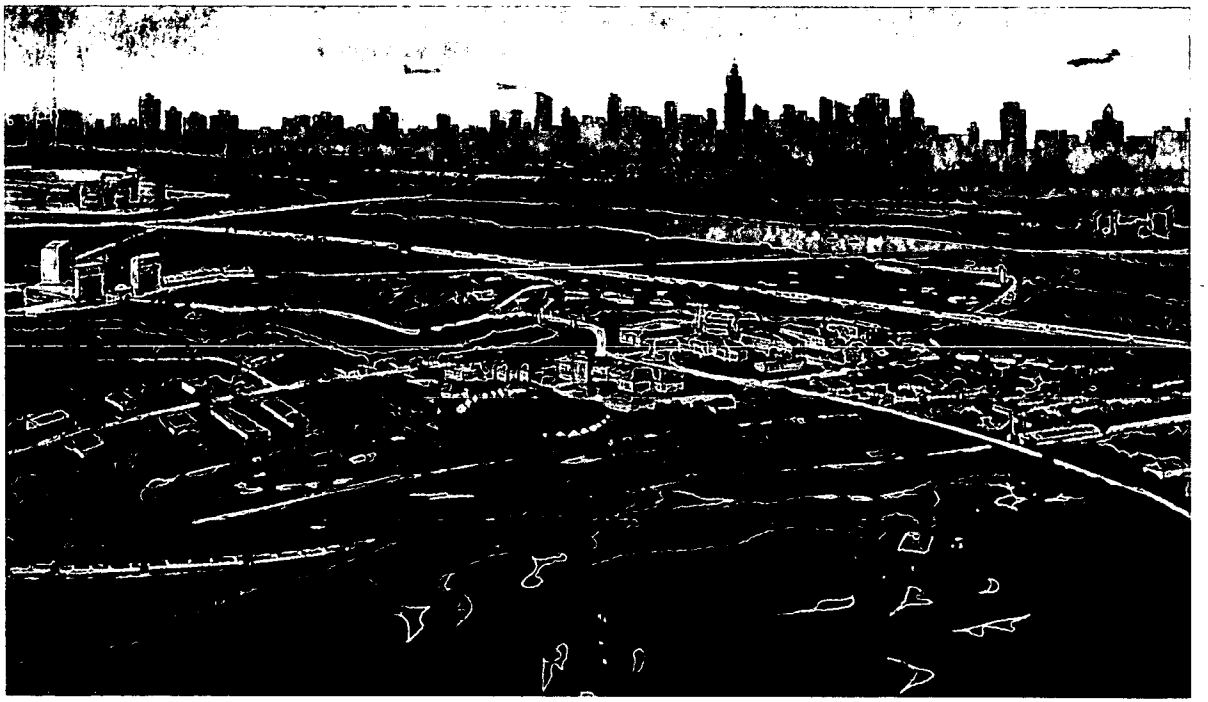
- Cherokee's Raleigh headquarters uses 100% green energy through NC Green Power program.
  - Reduces annual carbon dioxide emissions by 570,000 lbs
  - Equivalent to not driving 700,000 miles per year

NC GreenPower

- Cherokee aims switch its other offices to 100% clean energy in 2006
- Cherokee plans to implement green energy use in its redevelopments

Meadowlands Project

- Located next to mass transit and hopes to reduce automobile traffic to the greatest extent possible
- Renewable energy studies underway: large-scale on-site solar, wind, biomass, combined heat and power, and geothermal energy sources



Methane produced from the landfills on-site will be captured and reused on site.

GreenHome Demonstration Project

- Demonstration green home project
  - NAHB pilot project
- Located here in Raleigh near the Rex Hospital
- Infill location reduces travel time, setting it apart from many green homes
- The home will use ground source heat pumps for its space conditioning needs which will reduce energy for this use by 30-40%

NATIONAL HOMEBUILDER MAINSTREAM

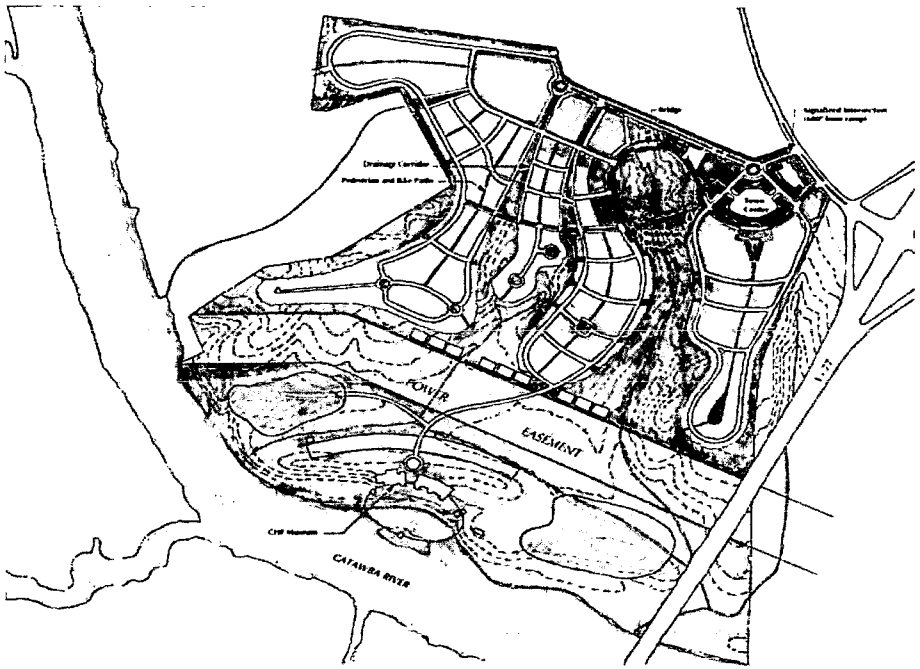
GREENHOME™

GreenHome Demonstration Project

- ~50% less energy than a conventional home
- Solar photovoltaics and solar hot water systems
- Renewable energy credits through NC Green Power to achieve a zero carbon status in its operational energy use

Kanawha

- 350-acre mixed-use development
- The future Museum of Life and the Environment
- William McDonough + Partners
- 50% less energy use in buildings, on-and off-site renewable energy to approach zero carbon status
- Use of locally produced and harvested materials in construction and create on-site food production to reduce carbon emissions from transporting goods.



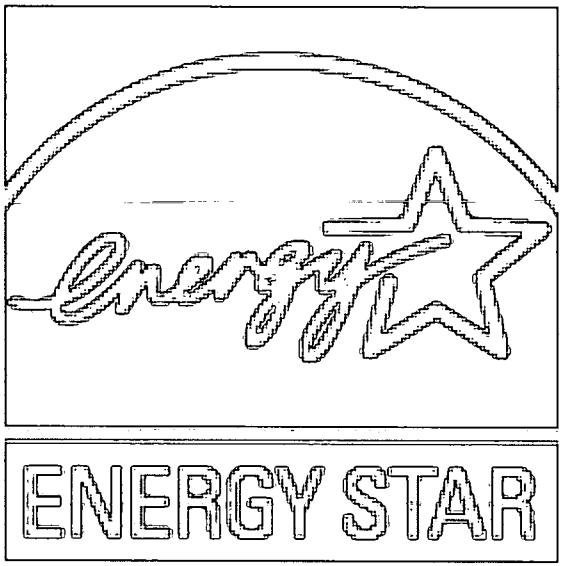
- Connected with a future area greenway linking to another community and bike/walking trails will encourage non-vehicular traffic within the site.

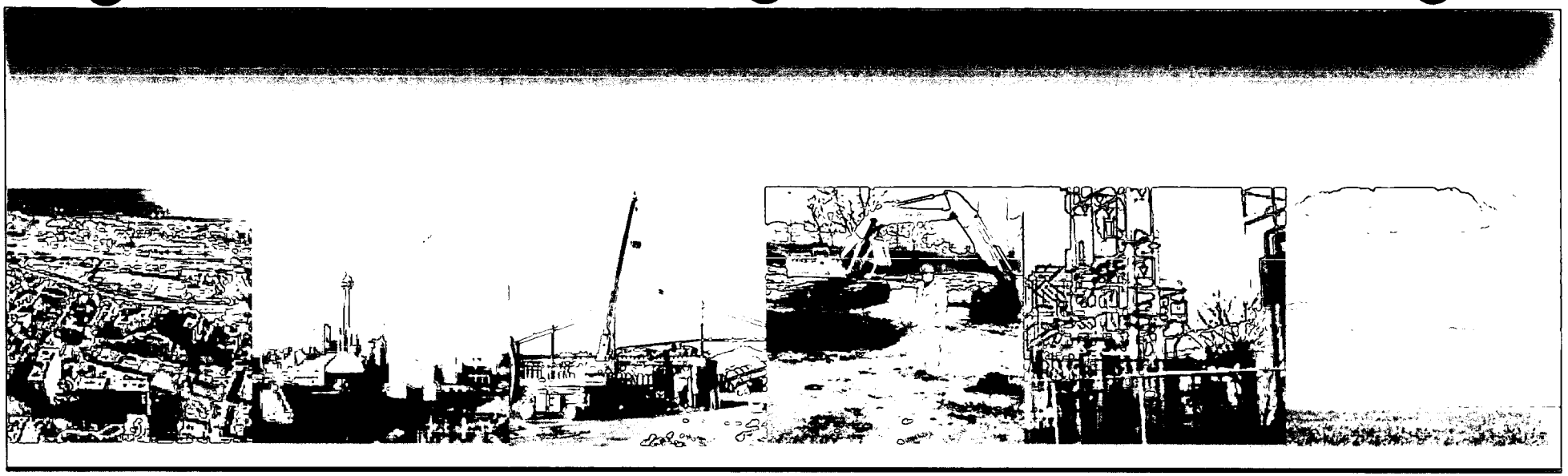
Partnership with Energy Star

- Last year, Energy Star efforts saved enough energy to power 24 million homes and reduce greenhouse gas emissions equal to those from 20 million cars – all while saving $10 billion.

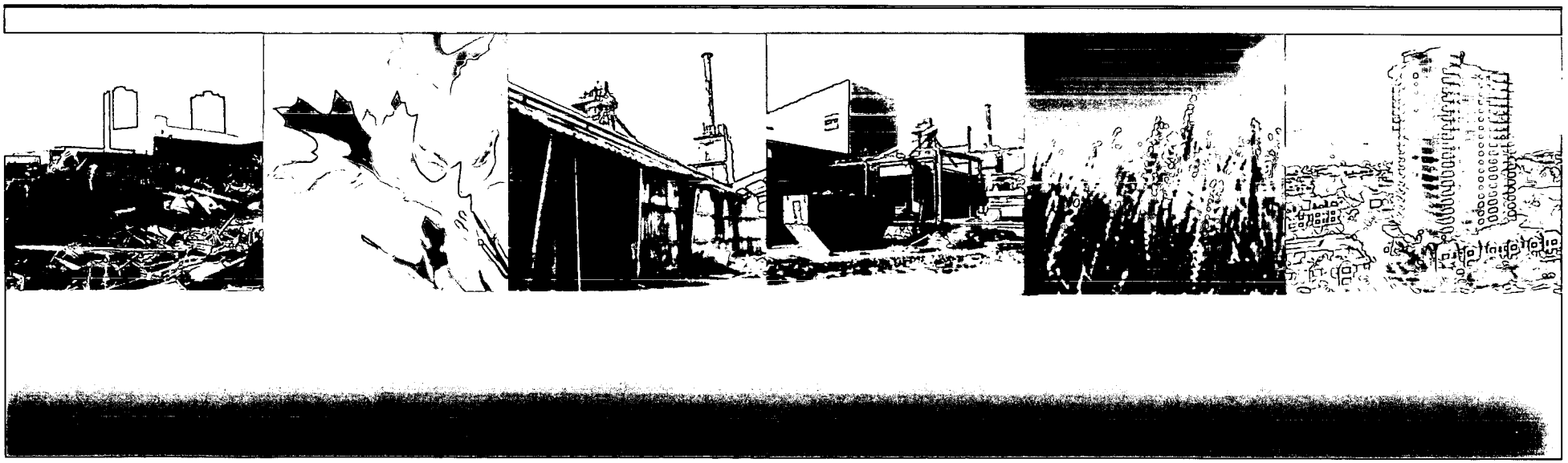
- Cherokee is an official partner of the US EPA-DOE Energy Star Program.

- Cherokee is intent on promoting these kinds of energy- and money-saving designs in its redevelopments.





Conclusions

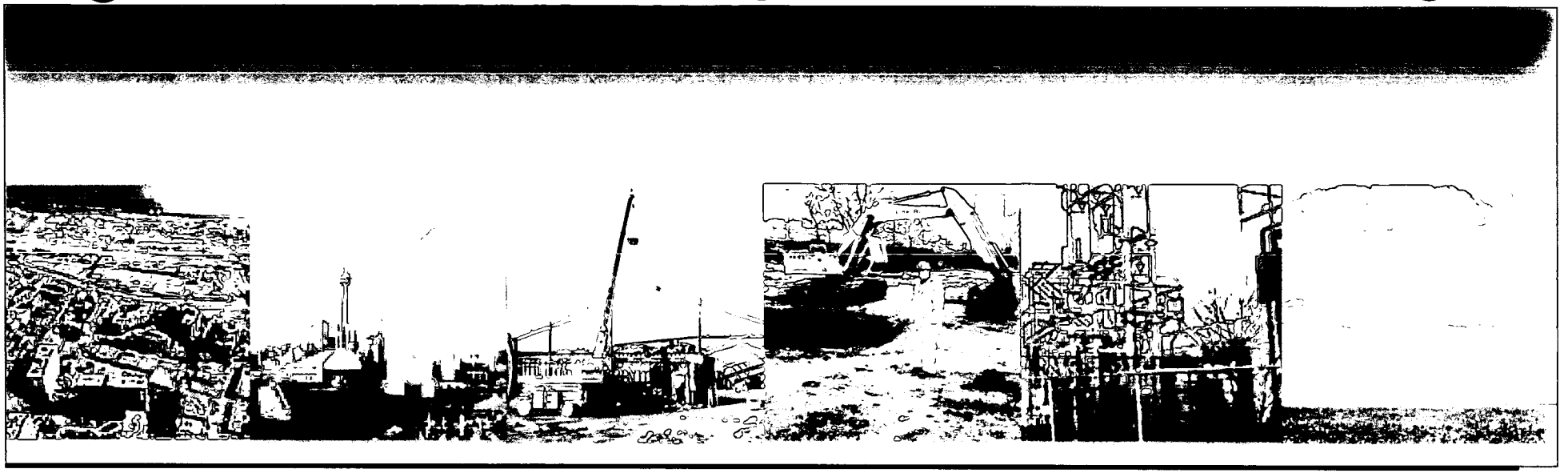


Conclusions

- Investors are becoming increasingly interested
  - Coalition of Environmentally Responsible Economies - institutional investors representing over $1 trillion in assets
  - Carbon Disclosure Project – institutional investors representing over $31 trillion in assets
- Reduced energy use benefits the state economy
  - Millions of dollars leave our state each year in the purchase of out-of-state energy. Reducing total energy used or creating more renewable sources in state would help reduce this siphoning of state dollars out of state.
  - Knowledge-based companies seek locations with cleaner environments
  - Environmental innovations create business opportunities
    - Denmark example

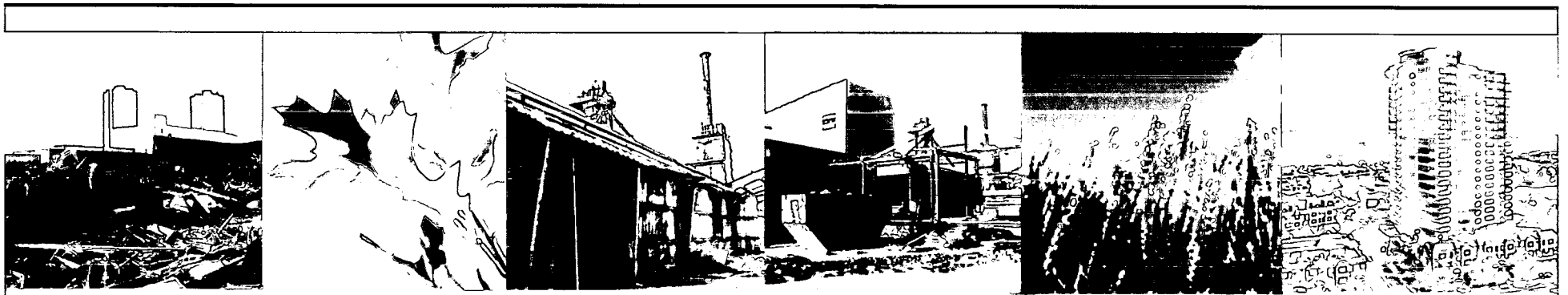
Conclusions

- National security
- Pollution = waste = dollars lost
- Waste = raw material
- Costs vs. Investments in energy reduction initiatives
- Smart growth reduces GHG emissions AND preserves open space
- Uncertainty: Is global warming induced by human activity?
  - If yes =>
    - Avoid more serious climatic repercussions plus those shown below
  - If no =>
    - Reduce operating costs, hedge against future energy price uncertainty, product and brand differentiation, good ROI
- Reducing GHG emissions achieves a number of other air pollution goals
  - Carbon emissions are often linked with nitrogen oxides, sulfur oxides, mercury, particulate matter, and other pollutants of concern. Reducing one often reduces the others, though not necessarily in the same proportion.

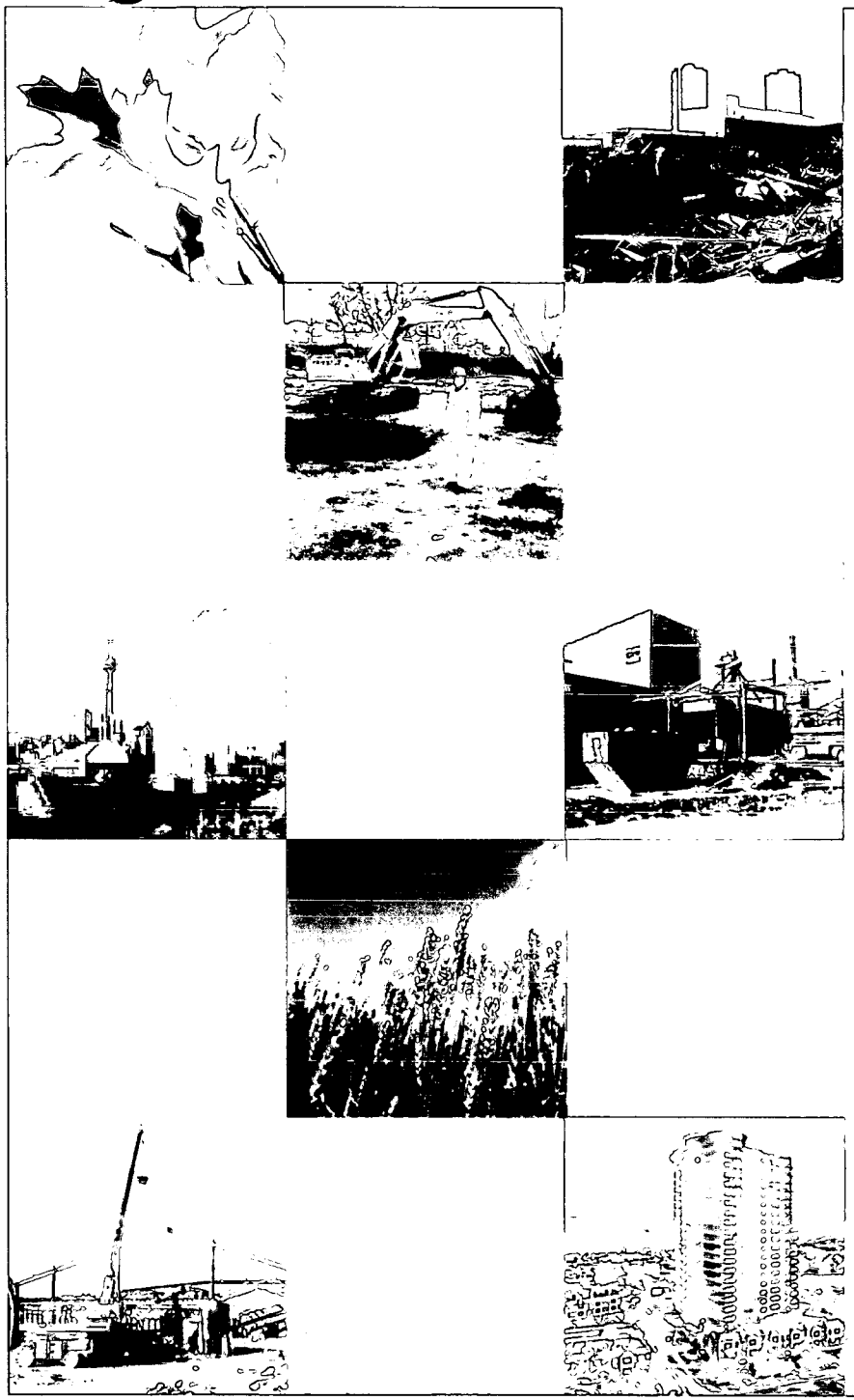


Contact Information

Tom Darden **tdarden@cherokeefund.com** **(919) 743-2506**



www.cherokeefund.com



CHEROKEE
Investment Partners

Raleigh
Corporate Headquarters
702 Oberlin Road
Suite 150
Raleigh, NC 27605
919.743.2500

Denver
4600 S. Ulster Street
Suite 500
Denver, CO 80237
303.689.1460

London
41-43 Maddox Street
London W1S 2PD
United Kingdom
44.20.7629.9993

Northeast
One Meadowlands Plaza
Suite 810
East Rutherford, NJ 07073
201.804.9100

Toronto
141 Adelaide Street West
Suite 220
Toronto, Ontario M5H 3L5
416.364.3389

DRAFT

Minutes
LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

Tuesday 25 April 2006
10:00 a.m.
643 Legislative Office Building

The Legislative Commission on Global Climate Change convened its fourth meeting on Tuesday 25 April 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building with Mr. John Garrou, Co-Chair, presiding. Other members present were: Representative Joe Hackney, Co-Chair, Senator Charlie Albertson, Senator Pittenger, Representative Wilma Sherrill; Representative Alice Underhill, Representative Winkie Wilkins, Ms. Caroline Choi, Dr. Douglas Crawford-Brown, Mr. Walter Clark, Dr. Dolores Eggers, Dr. Edward W. Erickson, Dr. George Everett, Mr. Preston Howard, Dr. Daniel Phaneuf, Mr. Tim Profeta, Dr. Sethu Raman, Dr. Stanley Riggs, Mr. Michael Shore, Mr. Robert Slocum, Dr. Stephen Smith, Mr. James Stephenson, Mr. Tim Toben, Mr. Ivan Urlaub, Dr. Godfrey Uzochukwu. Absent were: Senator Janet Cowell, Representative Becky Carney, Representative Pricey Harrison, Mr. Thomas Cecich, Mr. Barry Eveland, Mr. Robert Glaser, Mr. Michael Nelson, Mr. Mitchell Peele, and Ms. Susan Tompkins.

A copy of the meeting notice for this meeting, a copy of the agenda and the visitor's registration are attached to these minutes as Exhibits A, B, and C.

Mr. Garrou called the meeting to order and welcomed everyone to the fourth meeting of the Commission of Global Climate Change. The co-chair had no introductory remarks so he asked Mr. Givens to come forward.

Mr. Givens thanked Mr. Garrou and hoped that everyone works together to get through two exciting panels of presenters. At the last meeting minutes were distributed for the 3 Feb. meeting and those minutes are available for approval if the co-chairs so desire. They are referred until a later date. The minutes of the second meeting (5 April) will be distributed electronically later today and your help is needed with a few things. If you search the word inaudible and know what goes in that blank, we would appreciate it. In addition to other materials distributed to you, attached to your reminder notice is a transcript from the second meeting that was intended to resolve what was said that was sent to you by the request of the co-chairs. Also, an item from the Wall Street Journal of 11 June of 2001 is submitted by Senator Pittenger (Exhibit D) and a publication titled North Carolina Climate is submitted by Sethu Raman, our State Climatologist (Exhibit E).

We have a morning panel and an afternoon panel. The first panel is on technology, the second panel on economics. Our next meeting will be scheduled after Sessions ends.

Mr. Garrou called on the first speaker, Dr. David Green, Corporate Fellow from the Oak Ridge National Laboratory in Knoxville, TN to talk about the transportation sector.

Dr. Green: Good morning. It certainly is a pleasure to be here. There are a few key points I would like to make in my presentation this morning about transportation. The first one is that very often it's said that little can be done with the transportation sector. I and a colleague at Massachusetts Institute for Technology did a study for the Pew Center on Global Climate Change which I think they are providing a copy (Exhibit F) to you which shows that using a mixture of policy economic measures but also regulatory as other measures that you should be able to reduce greenhouse gas emission from transportation in the United States by 20-25 percent by 2015 and by as much as half by 2030 (Exhibit G), compared to a case in which we don't make active efforts to reduce greenhouse gases. Now I'll be drawing to a large extent from that study about the United States and there are significant differences between what can be accomplished at the national level and what can be accomplished by a single state acting on its own. I'll mention some of those but I hope we will have time for questions to get into others.

The second point I would like to make is there is no one simple policy that accomplishes every thing that can be done in the transportation sector. The transportation sector differs in many respects from the other sectors of the economy. First of all, governments have a very large role in providing and regulating transportation infrastructure, the states especially do. This is not the case, for example, in the industrial sector for the most part. And there are, as I will spend quite a bit of time trying to explain significant market failures in markets for automotive fuel economy. And I'm not talking about the extra-nalities as we say of climate change in greenhouse emissions. I'm talking about an inefficient market for fuel economy and I'll try to explain that. And of course, we all know, and we're feeling right now the fact that there are not sufficient competitive alternatives to petroleum to power our transportation system. We know that well, in spite of having worked on alternative fuels for the past two/three decades. It's important, also that we advance technology. Technology such as hydrogen fuels sells vehicles are not yet ready for the market place. And if we want to get the benefits of those, we have a lot of work to do to improve the technology.

And then there is a strong inter-dependence between the way we build our communities and the amount of transportation we have to do. And that land use decisions are under state and local control for the most part. There are other areas as well in which state and local policy will and should differ. Little bit of background we have not surprisingly the largest transportation system in the world, 5.4 trillion passenger miles of travel. That is to give you a rough measure enough to send everybody in the United States around the world once every year. Three point eight trillion ton miles of freight, the transportation is second to industry in greenhouse gas emissions but the largest emitter of carbon dioxide. And the carbon dioxide emitted from our transportation sector is more than the carbon dioxide emitted by any other country in the world in total except for China. Most of this carbon dioxide comes from highway vehicles, 72% and over half of the carbon dioxide comes from passenger cars and light trucks. This shows that graphically you can see transportation shooting past the industrial sector in carbon dioxide emission just before

the turn of the millennium. As far as what kinds of greenhouse gas emissions comes from transportation, its all about carbon dioxide. There is a little bit of methane that is produced a little bit of nitrous oxide from our catalytic converters mainly that keep the air clean, we need those and some haligenous flora carbons from our air-conditioners but almost all of it, 96 percent is carbon dioxide. So when we talk about transportation, we're talking about CO_2 emissions. The graph illustrates the dominance of light duty vehicles, passenger cars and light trucks and those emissions, heavy vehicles airs in just seconds of the highway mode followed by water, rail and others.

One proposal for reducing carbon emissions that is a useful proposal but not a solution to the big problem is to move people to transit. Of all forms of public transit in the US as this pie chart illustrates, deliver about one percent of passenger miles of travel in the United States. So to have a significant dent on the transportation sectors carbon dioxide emission by increasing public transit, you would have to have an enormous investment in public transit to make a significant dent. That's not to say it's not a useful thing to do, that it can't in the long run have benefits, but it has to be one small piece of a larger strategy. Not only that the differences in energy intensity and carbon emissions across modes of transport are not as great as one might think as the graph shows. Shifting modes of traffic turns out to be on one hand difficult and on the other hand not as productive as you would hope. The single biggest strategy we have had for reducing our oil dependence over the past 30 years and the single biggest strategy we have in the future for reducing carbon emissions from transportation is to increase fuel economy.

First of all, we know that meaningful increases are achievable at low to moderate cost. I've been on two national cabinet panels looking at cooperate average fuel economy standards and the technological potential for increasing fuel economy. Both panels concluded that significant improvements in fuel economy could be made at cost that would be paid for by the fuel savings over the life of the vehicle and it would not call for reductions in the size or the performance of vehicles. This is a big opportunity. Of course, no infrastructure changes are required to do this and there are barriers however. And the key barrier I want to talk about today is the consumer evaluation of fuel economy and their car buying decisions.

There are many ways to implement policies to increase fuel economy. Corporate average fuel economy standards are just one, there are economic instruments that could be used, the National Highway Transportation Administration has just proposed a major reform of the fuel economy standards which I think is well worth looking at and solves many of the objections with respect to fairness of the standards, with respect to possible safety impacts, my own view is that is essentially a red herring. But there are many ways to skim this cat, let's put it that way and one can pick one.

Since 1978 when cooperate average fuel economy standards first took effect, they were passed in 1975, the fuel economy improvements we've made in this country are saving us an enormous amount of gasoline. We would be consuming 50 billion gallons more gasoline every year had we not improved the fuel economy of passenger cars and light trucks, a strategy that we know works. And we know that essentially it was the fuel

economy standards that we largely responsible for bringing about that improvement in light duty vehicle fuel economy. Here you see the standards plotted against the history of new passenger car and light truck fuel economy and they track almost exactly. We also see here that we really haven't improved passenger car or light truck fuel economy in about 20 years and that therefore the shift that we all know about from passenger cars to light trucks has actually resulted in a reduction in fuel economy. This improvement has been estimated by scientific panels and these panels have found that technologies exist if applied to passenger cars and light trucks will significantly reduce fuel consumption within 15 years and obviously greenhouse gas emissions as well. A little bit less potential for smaller passenger cars and larger potential for SUVs and larger light trucks, but these are all cases where the value of the fuel savings over the life of the vehicle exceeds the cost of the fuel economy technology required to improve miles per gallon, with no change in the size, weight or performance of the vehicles. Of course, vehicles have been getting larger and more powerful all the time so we might have to forego some future increases in weight and performance in order to achieve this. These numbers that the National Academy finally came up with do not include the potential impacts of hybrids or clean diesel vehicles which are coming along. Each of which could offer a further 30 to 40 percent improvement in fuel economy.

But technology alone doesn't do the job; we need some policy for a variety of reasons. The Environmental Protection Agency estimates that had the new 2005 light duty vehicles fleet had the same distribution of performance and the same distribution of weight as the 1987 it could have achieved about 24 percent higher fuel economy. That's almost entirely due to the performance increase the weight is just a little bit higher. This graph shows a number of advanced technologies that are on their way that can expand the potential to improve fuel economy at a lower cost than is possible today. There's a constant increasing supply of technology to this vehicle manufacturing sector that allows them to potentially continue to improve fuel economy over time.

Part of the problem here is us the consumers. Economist assumes generally, that consumers will evaluate the full fuel savings of fuel economy improvement over the life of the vehicle which today is about 15 years. Discount that fact to present value and compare that with the cost of improving fuel economy or with a trade off that might have to make against performance or weight. But a recent study by the University of California at Davis in depth interviews of 60 households, their full lifetime history of buying cars and selling cars found no evidence that this rational economic model of behavior exists. Out of the 60 households, only nine stated that they had ever considered fuel economy in buying a vehicle. Only four knew how much they spent each year on fuel and none had made any kind of quantitative comparison of the value of fuel savings over one year verses another. We know from other surveys that 40 percent of US car buyers don't consult any source of fuel economy information, not the window sticker, not the fuel economy guide, not any of the many other sources including our website fueleconomy.gov when they buy a car.

But consumers are not completely irrational, there's a reason why they don't consider fuel economy. This shows data from the National Academy of Sciences study, the red

curve is the cost of increasing fuel economy from a typical passenger car which is about 28 mpg and it shows the value of fuel savings in the solid black line as a discounted present value of fuel savings over the life of the vehicle. Consumers are interested in neither the total cost nor the total savings but what they're interested in is the difference between the two. What do they get out of it, what is the net value and that's plotted in this gray line. The point I would like to make about that is that over a range of about 10 mpg from 31 to 41 mpg there is not more than one or $200 difference in this net value. Never mind the uncertainty that consumers feel about what those EPA fuel economy numbers really mean. The real value is on a par with wheel covers, floor mats and those types of things. Consumers have a lot more important things to think about when they're buying a new car, especially negotiating the price for example. This is not, even for a perfectly rational consumer, going to be very high on the list of things to worry about. However, we know that consumers don't fit that model and manufacturers use a rule of thumb as they've told us in research over the years. Consumers will pay for about three years worth of fuel savings, they believe. If you use that rule, then this gray line shows the net value of fuel economy improvements to consumers. Again, there is a wide range of fuel economy over which there is almost no difference in net value and furthermore there is almost no incentive to improve fuel economy here if you believe this. Manufacturers tell us they believe it, Honda says 50,000 miles of fuel savings, Toyota says four years, some other manufacturers say two years, but on average about three years is what the manufacturers believe. If you believe this, there is no reason to use technology to improve the fuel economy of cars; rather you should put it into performance and other factors.

As we note today, after consumers buy their cars they do realize sometimes that they care about the fuel economy every time they go to the pump. We run the fueleconomy.gov website for the Environmental Protection Agency and the Department of Energy. We know there is tremendous interest on the part of consumers in ways to improve their in use fuel economy. This is an area in which states can have an influence, by speeding and aggressive driving is probably the single most important factor that degrades the fuel economy of vehicles. A driver who likes to pass every one on the road, who likes to weave in and out of lanes, stomp on the accelerator, and consequently using the brake as well, can cost himself 30 to 40 percent in fuel economy. There are other factors that have lesser impact, tire inflation, tune-up and removing excess weight from your car, a variety of tricks that can give you a significant improvement in real world fuel economy. We know consumers are interested in this because they come to our website and try to learn about it.

Another strategy for reducing the carbon emissions from transportation and that is lower carbon fuels. We have a lot of experience in the United States with alternative fuels, vehicles that can run on compressed natural gas or methanol or LPG but not gasoline. Those frankly have not been successful in achieving large market shares. What have worked, is what we call replacement fuels, fuels that can be blended with conventional gasoline or diesel fuel and which have lower carbon content. No change in infrastructure, no change in the vehicles. You have heard the President say we have five million flex fuel vehicles running around on the road today that are capable of using 85 percent

ethanol, 15 percent gasoline. Every gasoline using vehicle on the road is capable of using up to ten percent ethanol. Ethanol from corn reduces carbon emissions on an energy equipment basis by anywhere from 20 to 30 percent. There are still some studies and people going around saying that's not true but recent articles and science demonstrated that those studies are incorrect and there is a small but none trivial reduction in carbon from ethanol made from corn but far better than ethanol made from corn is ethanol made from cellulose which the President also highlight in his State of the Union address and that can reduce carbon emissions on an energy equipment bases by about 90 percent. I don't know the situation in North Carolina well enough to know what the potential here is for using agricultural waste products and dedicated agricultural products to produce cellulosic ethanol, but that would certainly be something that could have a significant impact on greenhouse gas emission if it could be done. This graph shows the relative greenhouse gas emissions from ethanol based on a number of different studies and you can see there some ethanol produced from cellulose has only about 10 percent of the greenhouse emissions of gasoline. Without going into the slide in much detail, the Departments of Energy and Agriculture have estimated that there is really a very substantial potential to increase bio-fuel production in the US.

To make a significant impact on the transportation sector it is not enough to have a single policy, carbon tax, carbon cap and trade system, it simply will not have a huge impact. A $50 a ton carbon tax translates into about $.25 per gallon of gasoline. Things like that would send a tremendous signal to save the utilities sector to switch from coal to something with lower carbon will have only a minimal impact on transportation. You have to have a mixture of policies at the national level and at the state level. I'm sure you have seen other lists as well. It's important to combine everything from consumer information with regulatory strategies, with pricing strategies, with land use and transportation planning strategies all the way down the line.

I just want to reiterate what I said in my first slide that when you put all of these strategies together a few substantial potential to reduce transportation greenhouse gas emissions. We found practical strategies that either pay for themselves in fuel savings or are useful in doing these like reducing traffic congestion or air pollution that could reduce greenhouse gas emissions by up to 50 percent by 2030 and even more is possible with policies that are more expensive. This show a kind of rainbow slide how those policies stack up and you can see that aside from light duty vehicle efficiency improvement there are no strategies that just dominate. It is a number of things that need to be done.

I would like to close in effect by making a few remarks about how state policies differ from the national policy context and I'm sure the people here are well aware of that. Greenhouse gas emission standards such as the California standards simply at the state level for a single state like North Carolina would not have the leverage on manufacturers to persuade them to implement technology that would a national greenhouse gas emissions standard. On the other hand, California alone represents ten percent of the North American vehicle market when you add to that the northeast states and build other states on that. You have about a third or so of the North American vehicle market and no manufacturer can ignore a market that size. It depends not only then on what you do but

what everybody else is doing at the same time. My own belief is that a manufacturer faced with a number of significant states adopting such standards should they stand up in court, as you all know they are being challenged in court, would probably ask for one simple standard that they make for the whole country. States I think also have a key role to play in educating motorist, that's really important both in terms of how they drive, how they maintain their vehicles, but also how they use fuel economy information to select vehicles. States can play and do, such as the state of Minnesota, play an important role in promoting biomass fuels. And states and local governments have the greatest influence when it comes to the transportation system and the transportation infrastructure, land use planning and those factors that accumulatively all put together can have a major effect on transportation demand. I've said many times, a comprehensive approach is essential for the transportation sector. Thank you for your attention if there's time I'll be happy to take any questions.

Mr. Garrou thanked Dr. Greene and called for questions.

Rep. Wilkins asked if we could have Dr. Greene back up about three frames to that multi-colored frame so that we might have a moment to look at it.

Dr. Greene – This comes from the Pew Center study that I mentioned and is explained in detail there.

Dr. Smith had a couple questions about state local policies. Is there any experience with differentiating the local registration to give a sentence for higher fuel economy vehicle sales or lower and pricing for securing your state or local registration, do you have any knowledge of anything like that?

Dr. Greene – There have not been significant policies actually implemented along those lines to my knowledge. There have been a number of studies of policies called peabics in which one picks what I would call a pivot point, that any empty g-value for gallons per mile, above which you pay a penalty. So if you consume more fuel than that per mile you pay a penalty when you buy the vehicle and if you are below that you receive a rebate. Such a system can be designed such that the revenues taken in equal the revenues paid out. This can have a very significant impact on the vehicle fleet fuel economy, however, 90 percent or so of that impact comes from manufacturers implementing technological design changes in the vehicles and only about 10 percent from these studies. We don't have a real world example of the peabic system except the gas guzzler tax. Those can have a very significant impact on fuel economy but most of it comes from changing the design of the vehicle, the actions of manufacturers not the mix-shifting from consumers buying smaller, less powerful, more fuel efficient cars. Studies have been done by Canada for what would happen if the Canadian government implemented a peabic system but the United States did not and you get only about 10 to 15 percent of the potential impact split about half between vehicle changes and consumer mix-shift. One state going alone on this has a difficult problem because the manufacturers may not pay attention. They may not decide to redesign vehicles just for your North Carolina peabic

system. But if a nation as a whole did it, it could have a very significant impact similar to the true economy standards.

We do have a gas guzzler tax many people don't realize that because it applies to so few vehicles, Ferraris etc. That gas guzzler tax essentially persuaded all the manufacturers that those are very high performance high priced vehicles to make sure that those vehicles don't pay any of that tax. We do have some experience with that and the tax was effective and unfortunately applies to only passenger cars and not light trucks. So you're squeezing the passenger cars and essentially and not gas guzzler tax for light trucks.

Dr. Smith: Follow-up question, a little different direction. As far as the ag. fuels you spoke about, what about now that the heavy duty diesel rule is coming in, the opportunity for more higher efficiency diesel vehicles, the diesel is generally a better fuel because of the BTU value and the diesel hybrids getting market penetration in the United States. What are your thoughts about that and then how does the buy diesel play into an opportunity for both increasing fuel economy and also getting a lower carbon fuel into the marketplace?

Dr. Greene: Right there have been tremendous advances in diesel technology made in over the past two decades and mostly in Europe. Modern diesel engines are quieter they are almost as quiet as a gasoline engine and they don't smell like diesels, they don't put out black smoke anymore. They have good acceleration performance because they're all turbo charged and improvements have been made. They are excellent for towing things and those kinds of applications where you need a lot of torque. The problems the diesels have had is meeting the new emissions standards and with the new tier two emissions standards they will need to get into bin five or better. All of the ones sold today are in bin one that's not good enough. They will have to do better. They have two problems, particulate emissions and knox emissions. The particulate emissions problem is solved both from a technical point of view and an economic point of view. Their particulate traps works, they're durable and not too expensive. Now the problem is knox. The solution that the Europeans are going with and that heavy trucks in the US appear to be going with is the selective catalytic reductions system. That requires that you have Eurea underneath the vehicle to act as a reductant. How will that play out? So far the catalytic system and those things don't require any maintenance or any replenishment of fluids on the part of the owner. So far those don't work well enough to meet the tier two standards. They may some day, they're getting better and better, but right now what works is this Eurea basic selective catalytic reductant system and it remains to be seen how consumers will react to that. It's not like you have to do it every time you fill up, maybe every 3,000-4,000 miles, you would need to make sure this tank is filled up. But from the EPA purposes they would want to make sure that it never ever was depleted and you would never run your car without that. Given that I think diesels can be reasonably priced and meet the tier two standards. Under those circumstances my own view is that they can achieve a substantial market share in the US especially for light trucks and larger passenger cars.

Unfortunately, I have a negative view of bio-diesel. It s a fine fuel for a niche market but I don't see it as being a major fuel partly because of cost and partly because of the yield from agricultural land it comes the oils of the plants and you will always have a much smaller yield from that than from say ethanol either made from sugar cane or ethanol made from cellulose where you can use most of the energy from the sunlight that's been stored in the plant. That is my personal view.

Mr. Garrou: Senator Pittenger.

Senator Pittenger: Thank you Mr. Greene. Thank you very much for your presentation. I have two questions one is related to the efficiency of the cars and the correlation between efficiency and the make of the car. What studies have you seen that reflected the impact relative to serious accidents and deaths as a result of the lighter weight vehicles?

Dr. Greene: Right. There is a fairly substantial literature on this. Up until the National Academy report in 2002 almost all of this literature said that decreasing the weight of the vehicles would lead to increased traffic fatality and injuries. I was on the National Academy panel at that time and I looked very carefully at this evidence. In my own mind I came to the conclusion that it was seriously flawed for the application for this problem. It's a very complicated question but basically if I could try and summarize it, it comes down to this. The key argument has to do with fundamental laws of physics and collisions of objects. If an object with greater mass collides with an object of lesser mass, the change in velocity experienced by the object of lesser mass will be injuriously proportional to its weight. In other words, if a small car hits a big truck, the big truck will keep going and the small car will reverse direction. It is well known that the probability of fatality goes up greatly with the change in velocity experienced by the car to the fourth power, a huge factor. So in a collision between two objects there is no doubt that the object with bigger mass will be safer for its occupants than the object with smaller mass. It's no question about that. However, the fuel economy standards apply to both vehicles so the question is now what happens when the weight the mass associates with is reduced. Here the laws of physics say nothing, because it's the relative mass of those vehicles that matters, not the absolute mass. So now this question changes from fundamental laws of physics to how did you design the vehicles, what are the vehicles made of, how do those materials perform under crash conditions and it gets extremely complicated and it's all about the engineering and design and not about fundamental laws of physics anymore.

Looking at the National Highway Traffic Safety Administration study the best study that was available at that time and applying that reasoning, what I discovered was that their model also predicted no change in fatalities and vehicle to vehicle collisions if you took ten percent of the weight out of one vehicle and ten percent of the weight out of the other. Since that time there have been a number of studies that have challenged the view that was prevailing at the time and a number of peer reviewed articles that essentially say that there is no impact of fuel economy on traffic fatalities. One of them is my own study published in the Transportation Research Record in 2004. I think that at the present time

the best understanding of this issue is that from societal prospective taking mass out of vehicles without changing the size of the vehicle would either be neutral with respect to safety or beneficial with respect to safety. There is a major study done by DRI funded by Honda that shows that taking some weight out of vehicles but maintaining their size, material substitution mainly, would be beneficial to safety. Finally, weight reduction is one strategy out of many for increasing fuel economy and reducing greenhouse gas emissions. Although the weights of vehicles were decreased in the late 1970's in response to higher gas prices and fuel economy standards that cars and light trucks sold today combine light duty vehicles weigh more than the cars and light trucks sold in 1975 on average and get significantly better fuel economy about 75 percent better fuel economy.

Senator Pittenger: This may not be the question to ask Dr. Greene but maybe others might know. I read in the paper a couple of months ago that we waived the requirement for emission testing on older cars, 1995 or older, is that correct did any of you all read the same thing? If so why did we do that?

Dr. Greene: Emissions testing from older cars is generally a state requirement rather than a national requirement.

Senator Pittenger: Right, I'm saying that North Carolina waived that.

Dr. Greene: I don't know the answer to that.

Mr. Givens: We made the decision as a state a few years ago to shift technology from tail pipe technology to what's called on board diagnostic. OBD first became available in 1996 model vehicles as time goes on the number of vehicles that are in the fleet for any given year go down so there was a determination made essentially that because at the same time we were expanding from the nine original counties and we're now up to 48 counties where we have vehicle emissions testing. The cost of the analyzers for tail pipes is an order of magnitude higher than the cost of the OBD technology in other words $3,000 maybe for an OBD analyzer verses $30,000 for a tail pipe analyzer. So there's no thought about requiring tail pipe test in the expansion counties because the vehicles that would be available the pre 1996 vehicles were a declining fleet of vehicles. What we really did is say that within the original nine counties we would allow the tail pipe tests to continue for a period of time in order to advertise the investment that inspection stations had made in those expensive analyzers but not require the purchase of new analyzers. That's how we got to where we are.

Mr. Shore: Thank you. So hybrid cars seem to be coming more and more popular in North Carolina and I am curious are they reflected on this graph that's showing up there and can you just talk a little bit about the potential of getting more hybrids on the road as a tool to reduce global warming pollution.

Dr. Greene: Right. No, hybrid vehicle technology is not reflected in here. We use the National Academy of Sciences study for our technology potential for light duty vehicles

that did not include hybrid or diesel. I think hybrid sets a very substantial potential the cost of hybrids keeps coming down. I had the opportunity two years ago to meet with Toyota, Honda, and some others who are making hybrids and hybrid components in Japan and talk with their engineers about their cost targets and where they are going. The conclusion is that hybrid vehicle cost will come down, I think to about half of what they started out. They started out being about $4,000 more expensive for a mid size car then it came down to about $2,000. Now that is well within the range of what a consumer might pay to get a more efficient vehicle. I think the problems that people initially thought might occur with hybrids have been over come. People worried about the battery life, the battery life is certified to 100,000 miles and the manufacturers believe they will last considerable longer than that. I think hybrids do have tremendous potential and the sales of hybrids will grow as more makes and models of hybrids are offered. Of course the tax credit that is now available will help as well.

Mr. Toben: Thank you Mr. Chairman. Dr. Greene the first slide you presented reads using a mix of practical political measures US transportation should be able to cut greenhouse gas emissions by 20 to 25 percent by 2015 and 45 to 50 percent by 2030. At the end of the presentation you spoke to the economic impact, could you just speak to the economic cost where a return associated with these reductions at those levels?

Dr. Greene: Right. This is an extremely important point because many economic studies from the top will come to the conclusion that almost nothing happens in the transportation sector and the reason is because you need to attack the transportation sector from many different angles and different ways. When you do that it can be done very cost effectively. For example the biggest bar you see here is light duty vehicle efficiency. Those improvements over the life of the vehicle are paid for by the fuel savings at, in the case of our study, $1.50 per gallon. The air efficiency improvements are also cost effective the heavy truck efficiency improvements are also cost effective. The low carbon fuel in 2030 is mostly cellulosic ethanol and that requires some technical advance. So if we don't get the advance in technology that we hoped for that may not be economical. The hydrogen requires very significant technological improvements. We are working on it hard but there is no guarantee that's going to work. The carbon cap is simply a $50 a ton of carbon equivalent tax and so that cost whatever that cost. Pricing strategies are shifting the incidence of cost not changing the total cost of travel. For example, the most significant pricing strategy there is taking about 25 percent of the cost of automobile insurance and shifting it to a tax on gasoline. That gives everybody who drives a car a minimal amount of insurance, it makes some of the cost of insurance proportional to how much driving you do but requires everybody to sign up with some insurance company for the rest of that cost and if they belong to a high risk pool or something like that. This doesn't change the cost of travel at all but it does move the incidence around in a way that's beneficial to reducing carbon emissions.

The systems changes and the land use changes are very difficult to say what those cost are because its extremely difficult to quantify what is the cost of making sure that walking and cycling are options in a newly constructed community verses not building any sidewalks or not having any bike paths or anything like that and not constructing the

community in a way that people can walk from one place to another. Those kinds of things the costs are very difficult to quantify and we did make an attempt to do so.

Mr. Clark: Thank you Mr. Chairman. Mr. Greene state governments often have very large motor pools and have a large inventory of vehicles, are you aware of any states around the country that provide good examples of state governments setting a good example by using hybrids or alternative fuel vehicles?

Dr. Greene: I guess off the top of my head I can't say, I'll be happy to get back to you on that. I'm sure there are I'm just not connecting at this point.

Mr. Garrou: Thank you very much Dr. Greene for your presentation. Our next speaker is Dr. Edward Rubin from the Center for Energy and Environmental Studies, the Department of Engineering and Public Policy at Carnegie-Mellon University. Dr. Rubin. Thank you for coming sir.

Dr. Rubin: Thank you Mr. Chairman, it's a real pleasure and honor to be here. Before I get started Mr. Chairman I would like the record to note that I meet the official definition of an expert that being someone who comes here from more 500 miles away. I say that because on this topic and several of the others you certainly as I am sure you know, have many valuable local resource persons who are certainly as knowledgeable as many of us are including two of my best former students who are faculty members at two of your great North Carolina campuses. So with that caveat let me take on the assignment that I was asked to do here which is talk about greenhouse gas reductions from the electric power sector. I want to basically try to touch on three questions, first why focus on the electrical power sector secondly and mostly talk about what options are available to reduce power sector emissions of greenhouse gases and finally what some of the key policy considerations and options might be.

First the why question. The answer is perhaps intuitive but I wanted to start here with two points. I know in past presentations you have had extensive deliberations about climate change and greenhouse gases. You know that carbon dioxide is not the only greenhouse gas but it certainly is the dominant greenhouse gas of concern for climate issues. For the electric power sector it is perhaps unquestionably the major focus, so for simplicity I want to try to focus on this major greenhouse gas of CO_2. The picture before you (Exhibit G) is a sketch showing where CO_2 comes from nationally in the United States allocated across the four major activities that give rise to greenhouse gas emissions. This picture does not include power plants at least not directly, it includes the things that we do. The industrial sector that makes all the things that we like to have is roughly another third and the other two bars residential and commercial are essentially energy used in buildings in which we live and work. The carbons are the sources of the CO_2 emissions. So for transportation it's basically an oil related problem, the blue. For the industrial, residential and commercial sectors the largest share of greenhouse gas emissions comes from that top yellow bar which is the electricity. Electricity is one of those things that are an intermediate energy from the raw resources we use. Here is

where the electric power sector comes in. The electric power sector is responsible for about 42 percent of the greenhouse gas emissions.

One important take home message which applies roughly in North Carolina as well as the US is power plants and transportation together accounts for about three quarters of the problem. So electric power plants are the larger source of carbon dioxide in the US as well as internationally and that is the major focus of it, most of that depends on how electricity is generated. Here is a figure from the most recent projections by the US Energy Information Administration which shows the historical trend of US power generation and their so called reference case scenario out to 2030 the dotted line separates the two. In this country a little more than half of the electricity we use comes from coal. The projections of the reference case scenario which assumes no change in policy over the next 25 years assumes substantially higher increases in that amount. I'm curious how many of you here from the legislature believe there will be no change in policies over the next 30 years. So we could throw this scenario out, unfortunately a lot of people take this as the gospel, this is only if nothing else happens along the way. So you know we can be wrong we don't yet know what the right answer is going to be but if we stick with this reference case scenario essentially its business as usual.

The carbon dioxide implications of this are that we will continue to increase substantially CO_2 emissions nationally. I should also note on the handouts (Appendix G) there was a typo it should be millions shown here not thousands as shown on your hard copy. Here is the picture in North Carolina thanks to some data that Judy Greenwald showed you earlier this year. The plants in North Carolina are even more economically core based, a little over 60 percent as opposed to 50 percent nationally. So again coal fired power plants are a major local consideration as well as the key national consideration. Here is a picture of CO_2 emissions from those power plants in North Carolina according to data that PIA puts out and you can see where it is still currently on an upward trend.

The climate change driver has been with us for close to two decades now. A lot of it goes back to the 1992 so called earth summit where the United Nations spring convention on climate change was agreed to 150 countries around the world including the US. The US agreed to the long term goal of stabilizing in the atmosphere the concentration of greenhouse gases so as to prevent dangerous anthropogenic interference from the climate system. A lot of ambiguity as to what that means but the key message is that any policies aimed at stabilizing in the atmosphere of the concentration of greenhouse gases implies over the long term a drastic reduction in CO_2 emissions. Almost independent of what that target is and the time table for achieving it we understand the physics well enough to know that. Over the long term CO_2 emissions have to come down by 70, 80, and 90 percent of what it might be 50 to 100 years from now. It's a long term drastic change in energy pictures that we're looking at to achieve that stabilization goal. And that has motivated a lot of the concerns that motivated the Kyoto protocol and is motivating a lot of the activities around the world today.

So let me focus on CO_2 problem for the power sector and briefly touch on some of the options that are currently available and or will be available in the near term. There are a

couple of general approaches that apply to many other sectors as well. First, any technologies that reduce the demands for electricity will almost proportionally reduce the emissions from electric power generation. Secondly, improved efficiency in the technologies that are used for power generation as well as for transmission and distribution will reduce the amount of fuels that are needed to provide the electricity we like to have and that will reduce emissions. Thirdly, power generation technologies that use energy sources with either lower carbon levels than currently or zero carbon levels will also by definition lower greenhouse gas emissions. And finally, technologies that might be able to both capture and then store or sequester CO_2 produced at power plants could be a fourth option. Now there is a lot of information and large literature on each of these topics, let me try to say a brief word on each of them and perhaps entertain some questions if there is time.

Options to reduce demand is part of the first thing to look at, Mary will follow and elaborate substantially on this so I will say no more than there is an enormous potential here again to go thru and improve efficiency of the technologies that use electricity and potentially ensure the modest initial changes in consumer demand the way the kinds of things we like to have. All of these things can reduce the demand for electricity and reduce emissions from the electric power sector. The programs that are called demand site management which have had often other objectives and these could be part of the solution depending on the details in the specific systems that these potentially could be less beneficial in terms of reducing greenhouse gas emissions although they could be beneficial in managing electricity. The records on DSM programs in general this was in the 80's and 90's, they clearly had relatively small impact in reducing demand but there are substantial variations from one location to another so these are things that demand a location of a specific analysis.

Options to increase the efficiency of generating electricity - this sketch is simply to remind us that with the technology that we currently use in the US today to produce electricity has an efficiency of roughly 35 percent. That is for every 100 units of energy in the fuels that we burn for use to produce electricity we get about 35 units worth of electricity. Now that electricity has different characteristics it is a lot more valuable in some ways thermodynamically than the energy and the fuels but the efficiency is on the order of 35 percent. So we throw about 65 percent of the energy away at the power plant typically in the form of waste heat that goes into the air or water. The transmission and distribution lines that take the electricity from the large power plants and bring it here typically lose about another 10 percent of that electricity in heating and other loses. So we wind up with a system deficiency well in the low 30's percentages. How can we do a better job? Each of the individual blocks potentially could be improved particularly the electrical power plant which is kind of a part of this. There are technologies in use around the world today that are significantly more efficient than the technologies we have in place in this country and in North Carolina. Today these are technologies that use natural gas in what are called combined cycle plants. There are more efficient technologies for burning coal and there are technologies not for burning coal but for turning it into a coal gasification and then using that clean gas to generate electricity in

much the same way that natural gas would do it in a combined cycle plant some call IGCC plants.

Part of the set of options available to improve the efficiency of electricity use that might involve doing away with the transmission and distribution and putting the power plant closer to where the energy is actually needed is called distributed generation. These are typically smaller facilities that might be in shopping centers or neighborhoods. Many of the technologies that are available to do that are smaller and actually less efficient, some substantially less efficient than the power plants we currently use but others like certain kinds of fuel cells that we have now are on the horizon could be substantially more efficient. Again the opportunities there are sites specific, one of the advantages potentially is that this offers in the right environments the ways to use some of that waste heat for heating and air conditioning and other uses that would otherwise require additional fuels to be burned. So there are potentially substantial improvements in the overall efficiency of using energy and along with potentially significant reductions in greenhouse gas emissions.

Finally, there is also technology available that is starting to come into use to do a better job of managing electric transmission and technologies that can improve efficiency at that end as well. Some of the big players have to do with options for using alternative energy sources that are either zero carbon or low carbon emitters. The two I've highlighted here are natural gas and nuclear power. These are the two options that realistically today probably have at least from a technical point of view the largest capability of serving the large amounts of electricity demand we have. Available today but with more illuminative deployment wind is technology whose cost have been coming down significantly biomass is another option particularly here in North Carolina although again it has its limitations. Geothermal resources are located in various parts of the country again potentially conserve but with more limited details. Things like solar and low head hydro also might serve mixed applications. The cost of solar technologies today is still roughly ten times where it needs to be to be competitive with some of the options shown here. All of these options have various kinds of issues both technical, economic, social, and political and limitations that have to be considered. I believe in your handout you have a copy produced last year by three of my colleagues at Carnegie Mellon that goes into substantial detail on all of these things. A report from the PEW Center and I would recommend strongly a look at that for a lot more detail in these areas.

What I've tried to show here is to put all this together to give you some of the trade offs between producing emissions and what it would cost. What I'm showing here on this graph along the horizontal axis is the rate of CO_2 emissions, tons of CO_2 per megawatt hour of electricity generated. If we continue to build for example the kinds of PC pulverized coal plants that we have already we emit roughly a ton of CO_2 for every megawatt hour of electricity we generate and the total cost of building those plants would be about four or five cents per kilowatt hour or $40 to $50 per megawatt hour including the cost of the whole plant. But if we move to more efficient plants that we have today already we can essentially get a ten to fifteen percent reduction in CO_2 emissions with essentially no increase in cost. IGCC, integrated gasification combined cycle is a

technology with comparable efficiencies but today would have ten to fifteen to potentially twenty year 25 percent higher cost for a number of reasons. The red bar shows natural gas combined cycle plants, here we get two benefits. One because natural gas as a fuel has less carbon in it and secondly, because the combined cycle plants are about 50 percent efficient as opposed to 38 or 40 percent deficient for the coal plants. So overall the natural gas combined cycle plants we can get roughly a 50 percent reduction in CO_2 emissions per megawatt hour relative to the coal plants that we currently have. As I am sure most of you know there has been large increases in the price of natural gas over the last couple of years, so that red bar is being stretched vertically basically reflecting the bottom is basically the price a couple of years ago about $2 a million BTU. At the top I think I stopped at about $6 currently it's about $7 or $8, so if you're betting on the futures of natural gas prices as to what the cost will be. It's in that same range roughly, the zero option from those shown here, nuclear and wind so they are basically non emitters of CO_2 and their costs are somewhat speculative. The best wind systems today are in fact getting quite competitive already competitive with coal plants and less desirable locations wind costs are still high. The cost of nuclear is still hard to note because we haven't built one in 20/25 years and so there is still a bit of uncertainty and that's reflected in this range.

I didn't put biomass on this slide, I perhaps could have and it would have been in that same ball park as wind. This is roughly what we see as we go down in CO_2 emissions we can come down significantly with fossil fuels, coal and natural gas once we go to non emitting fuels - in general the costs are going to go up. Again just a reality check as to where we're starting from. We're starting from a base where over half of the electricity we currently use comes from coal and so there has been an especially important interest in and we have a lot of domestic coal resources that don't require imported fuels. So there has been a lot of interest in can we have our coal without CO_2. That's the segment into the last of those four options that I indicated earlier that the technology called CO_2 capture and storage for sequestration. In the community here the word storage is being used to indicate this technology is close to sequestration that you will hear about a little later which is typically associated with forestry and terrestrial ways of taking CO_2 from the atmosphere. Since the "s" has become the acronym for that.

This is a recognition that fossil fuels would be used extensively for many decades we're heavily reliant on it already. The alternative that I've shown you earlier while very important are not likely to achieve the kind of long term large reductions in CO_2 that would be required to stabilize atmospheric concentrations in which are significant interest to the policy community. So the technology of CO_2 caption storage offers a way to in fact continue to use fossil fuels especially coal in a way that doesn't totally eliminate but substantially reduces by 85/90 percent the CO_2 emissions. So if you think of this as a bridging strategy that might last over several decades to essentially toward the ideal substantial future this has some interest. Particularly interesting is a lot of the large energy models that are used to look at climate change policies in areas indicate that if capture and storage is part of the mix of technology options, part of the portfolio, the overall cost of achieving substantial reduction in CO_2 are substantially lower by 30/40/50 percent sometimes than if you don't have CCS in the mix. So it has gotten a lot of

interest in the last half dozen years. I want to spend a little more time on this since this may be a technology that is less familiar to many of you than some of the others I've shown here. I am going to draw on a recently completed report that I was involved in the International Intergovernmental Panel on Climate Change IPCC completed late last year - a comprehensive report on this technology. This picture shows schematically how you would take various carbonations fuels, fossil fuels but biomass as well bring it to the power generation rather large industrial facilities where CO_2 is generated. Capture that technology and then transport it typically by a pipeline to a storage option and the one I'll focus on here is the geologic storage option we're talking about putting CO_2 into a pipeline and then putting it a mile or two into the ground. The leading candidates because these are the leading sources of CO_2 as well are large fossil fuel power plants we have three types of the large industrial sources. And again let me focus on geologic storage and show you in the next few slides some of the potential applications of this technology. Here is a cartoon that shows how you would do this at a conventional pulverized coal plant today. At the end of that train would be another vessel of CO_2 scrubber after the SO_2 scrubber. This is technology that exist today it's not fiction it's not something that needs development you can go out kick the tires, here are a couple of pictures of this. What doesn't exist today is that technology implemented on large power plants. On the left is a picture of the technology at a smaller power plant in Oklahoma where using the CO_2 is an industrial commodity here they are using it to send next door to a food plant where it goes into some beverages, so when you open your next Coke the fizz that's the CO_2 released. But it's an industrial commodity that has substantial value. The picture on the right is a much larger unit at an industrial facility in Malaysia but it is also treating the flu gas from a plant that burns natural gas. So you see this stuff looks more like petroleum refineries it doesn't look like burners it actually is technology that is widely used and quite familiar to the chemical and petroleum industries.

Here is a cartoon with that other technology I mentioned integrated gasification with combined cycle. When carbon capture comes into the picture this technology has a special interest because the cost of taking the CO_2 out in this option is substantially low and the efficiency is substantially higher than doing it from a conventional coal burning plant. Here is one of the four IGCC plants of the world this one is in Florida, we have another one in Indiana, in this country and the other two are in Europe. This plant doesn't have carbon capture on it but if it did it would look like one of these, again on the left is a coal gasification plant in North Carolina which separates the routinely captured CO_2. Up until a couple of years ago the CO_2 just went into the air. I'll show you in a minute where it's going now. The other picture is a chemical plant which also separates CO_2 to produce hydrogen that it uses to make ammonia and other chemicals. So again, it's technology that's well known and exist at fairly large scales. What do you do with the CO_2 after you get it? The notion is to transport it typically by a pipeline, you compress it to where it becomes kind of a liquid so it's not gas any more and you put it into a pipeline to the storage reservoir. We have thousands of miles of CO_2 pipelines mostly in the western part of this country which have been in operation for many decades taking natural CO_2 out of natural sources in the ground and pumping it substantial distances. Often the CO_2 can lubricate and help get more oil out of the ground. There are many places also in the world now that either have started or about to start on CO_2

geologic storage sites, these circles are three of the larger ones. One of them is nearby here that coal gasification plant in North Dakota that I mentioned a couple of years ago put a CO_2 pipeline at the end of the CO_2 captured. Instead of venting it into the atmosphere they put it in a pipeline and sent it 200 miles north to southern Saskatchewan to an oil field called Rayburn in southern Canada that is depleted and is being used today for enhanced oil recovery and is being closely monitored because that CO_2 is intended to stay in the ground as a geologic sequestration demonstration. So it makes money in the short term in terms of producing oil and long term as a way of storing the CO_2. There are two projects that use similar technologies, the one on the top is the oldest, it looks like an off shore oil rig. It's actually a natural gas processing plant in the North Sea. It's a Norwegian project called Slighter - they extract natural gas from well below the sea bed. That's a little insert on the top there and natural gas has a lot of CO_2 when you produce it. So you simply separate it out and routinely send to the atmosphere. Another way to put a tax on CO_2 emissions ten years ago which was big enough to get stat oil interest and instead of releasing it to the atmosphere they rejected it below the sea bed into a large reservoir and that's a project that's being replaced now for close to ten years about a million ton of CO_2. That's a big project and very closely monitored and you can actually see the CO_2 that are being sequestered and stored and so far things are going along quite well. The lower project is the newest of the three big ones. This is a BP form of the British petroleum, another gas processing plant, this one is in Algeria. If BP is doing this just to get some experience, they think they can make money with this technology and they are one of the leaders in this. They extract the CO_2 and there is a pipeline that takes it several miles away where it's again injected into a very deep reservoir. So this isn't science fiction it's something that is in fact being implemented in many parts of the world today. Over the long term on a large scale as a climate of (inaudible) measure we're talking about fairly large amounts of this stuff but just for calibration we already inject in various parts of the country many wastes and liquids into the ground today. This is a graph put together by one of our former students that simply makes the point that if you took all of the CO_2 emissions from all the power plants in the US, the mass of that CO_2 would be roughly comparable than all the stuff we're currently injecting already. So while it's certainly something on a large scale that would be nontrivial it is comparable to other things that we're doing.

If I put those options back on the graph I showed earlier, they fall in that range so here we can get it in 85 to 90 percent reductions in CO_2 but at higher cost. The costs are wide because it depends on where the plant is and what type of technology and a whole bunch of other factors. One of the key messages in terms of coal burning technologies is that with capture and storage the orange bar the IGCC plants systematically would lower in cost than burning coal. That is one of the reasons that IGCC has been getting a lot of attention in this country even without the CO_2 it has environmental benefits relative to many of the combustion plants that are in operation. So we see a lot of interest in terms of getting this technology into the electric power sectors - the next generation technologies using coal. There are a lot of cultural issues to be overcome in that because the utility industry is used to burning that gasifying expertise in a different industry but there are major projects underway by American Electric Power Southern Company and others to start looking at that technology.

This is a slide that was put together by my colleagues as part of the study that was done by the PEW Center that simply took a quick look and ask is this possible if we use a variety of low carbon or zero carbon sources, is it possible to make a significant dent in CO_2 emissions. They looked at a scenario that looked at a more aggressive building schedule that is looking over the next 50 years at replacing power plants as they retire and then also dealing with new plants we take to supply the increased demand for electricity and concluded that doubling the current construction rate which will be aggressive but not outrageous would allow potentially over a 50 year period all of the CO_2 emissions to be taken out. That will obviously overcome a lot of the other issues associated with the use of these energy sources.

It's getting late and I included so that you will have it to take home and read rather than talk about it here, a number of policy options and considerations your DNR has already done a wonderful job in getting starting laying out some of these options and these are things that I'm sure you are all quite familiar with. You've probably already been briefed on a number of the programs around the world interestingly enough the two largest states in this country are both with Republican governors have programs that are intended to reduce CO_2 emissions. I was involved in some of the California issues last year and there are a number of other states that also as you are looking seriously at this issue. I've left with you also just basically for comment perhaps after today's meeting my blue sky list of various kinds of policy options and handles for introducing reductions to the utility sector. Some of the ones I've talked with perhaps familiar are carbon taxes, cap and trade, there are other ways of working that problem as well.

I was involved in a Pew Center study a couple of years ago looking at the issue of technology and innovation and its role in climate. We rarely do a lot of things that generally go under the (inaudible) policy these are things like R&D expenditure, tax credits, portfolio standards, educational programs. These are basically all carrots no sticks and they have in varying degrees of success being very effective in stimulating innovations that ultimately reduce the cost of technology. So getting started on that path toward lowering future costs through innovation is a key message and something that's strongly encouraged. Think about it, I know this can be done again through incentives. Many of the options that are used at the federal level are also available at the state level and I would urge you to look at it more fully. There is another Pew report that talks about this in detail if you are interested in it.

We've also done work at Carnegie Hall, I'm looking particularly at a class of technologies and environmental technologies, these are things you would not normally do unless there was an environmental reason to do it. What we find is that regulations like the sulfur dioxide regulations we had over a decade ago and nitrogen dioxides more recently, those regulations enclosed by state and federal governments in facts in stimulating innovations that reduce costs and make money for some people. Those are important take home messages because reductions in cost over a couple of decades of 40 to 50 percent are often overlooked in analyses of what some of these options may cost.

My next to closing slide is first with the climate changes and environmental problem that cannot be addressed by voluntary technology policies alone. Regulatory policies that limit greenhouse gas emissions also are needed. Energy policies this is more a national but potentially state can further help and impede progress on reducing greenhouse gas emissions and my own preference is for a combination of these traditional technology policies together with regulatory policies that put caps and time tables on CO_2 emissions productions. It's that combination that we're looking for as a way forward. I took a quick look with the help of one of my colleagues over the weekend at the situation here in North Carolina. It's true nationally but even more true in North Carolina that your fleet of existing power plants is aging. Most of the power plants are generating electricity here from fossil fuels coal in the 35 to 50 year old range. There is a couple down in the 60 well it's not quite a one point analogy. Power plants are not unlike people when you get out toward the tail end of that thing, things don't look as well as they used to when you were younger. Things start breaking down and you have to start worrying about replacement. So I think you have a situation here in North Carolina where quite soon you will have to be worrying about what will replace these plants and those decisions will have very important consequences for greenhouse gas emissions and I would say that you have a lot of time but not a lot of time and you will be in the forefront of states that will be dealing with this issue. Thanks very much for your time.

Mr. Garrou thanked Dr. Rubin and stated he did not want to limit questions but we do need to move quickly so if you would ask your questions fast and if Dr. Rubin would respond briefly that would be good.

Dr. Riggs – You showed a lot of examples of CO_2 sequestration in subsurface. You said they were all successful, is this just a matter of out of site out of mind? You didn't present any data whatsoever that suggest just how successful these things are. Do we really know that this stuff stays there and how much is coming back out?

Dr. Rubin – It's a great question and a key one. This is a question also that we've dealt with extensively in this IPCC report that I recommend to you. The longest experience we have right now is the Red Sea operation at Slighter which has been in operation for ten years, the other one has only been in operation for two years and the BP plant even less. Those have been quite successful there have been no issues of leakage or seepage. Models have been used to predict where things will be going and by and large pay for the crude as we go along but things have been working very well. One of the barriers that still remains to using this technology more widely though is a more uniform and appropriate regulatory regime for these kinds of operations. Right now any injection programs into the ground typically regulated by the state there are some federal classifications. There are programs including one led by World Resources Institute that is looking at trying to develop the larger issues associated with what this EPA is involved in it. So what the geological community reports is that in a world characterized in a well selected site, one with a cap lock that this is likely to be secured. One of the interesting things here unlike other kinds of waste the longer the CO_2 in the ground the longer it's going to stay in the ground. It gets injected as a liquid but it's relatively buoyant but it gets injected into typically a mud, think about it, there's not just this big hole that you can

puncture it. Over time the CO_2 begins to react with the local water so it dissolves which makes it less amenable to escaping over time periods of hundreds of years. And over time period of hundreds to thousands of years it starts to react chemically and eventually turns into limestone and rock. The longer it's in the ground the longer its going to stay in the ground but the key is putting it in a well characterized and well monitored site. That's where a lot of the focus of this work currently is.

Dr. Uzochukwu: Thank you Mr. Speaker. On page 12 of the handout of your presentation second slide Innovation Policies to Mitigate Climate Change you indicated that global climate change is an environmental problem that cannot be addressed by voluntary technology policies alone, why not?

Dr. Rubin: Look at history it just doesn't work. That's the short answer. We've had voluntary CO_2 reductions in place in this country since at least the early 1990's.

Dr. Uzochukwu: But also how aggressively are the power plants upgrading their facilities? Are they doing it just because or is there a sense of urgency to get this done in order to reduce the CO_2?

Dr. Rubin: I don't think CO_2 yet has the sense of urgency that other environmental issues have. It's plain to see that it's faced with all sorts of problems. This is one of many issues on their plate they've been worried a lot about deregulation/re-regulation all sorts of business related issues. They've been worried about sulfur dioxide in the 80's, nitrogen oxides, mercury, there are a lot of near term issues that have the quality of maturing in the regulatory process. As one of my colleagues and I frequently do, if you ask utility CEO's the kind of question I ask you to raise your hand if you think there is not going to be some reduction of requirements on CO_2 emissions over the next ten years, you see very few hands go up. So everybody is expecting it but it doesn't have quite the urgency yet in some cases. Some utilities in some cases it does.

Dr. Smith: Mindful of the time here I was intrigued by the last couple of slides. The mission of this Commission is to consider looking at setting a goal and I gleamed from your slides that potentially setting or what we're doing is debating whether we should set a goal and if we set a goal I gleamed from your slides that you, correct me if I'm wrong, that there are benefits to states or any form of government that sets the bar and lets innovation follow and works with RD to get those technologies. Can you talk a little about how you would envision or what your thoughts are about a state setting a goal and then setting the rules correctly and how that could lead to innovation and also lead to potential economic development for the state.

Dr. Rubin: I think that's the kind of market signal if you will that a lot of people I talked to in not only in the utility industry but in other industries are waiting for. The lack of clarity as to time tables and requirements I think is putting an awful lot of decisions now that soon need to be made. I think once those requirements are in place there's inevitably going to be some moaning from some sectors but again there are a lot of people that are trying to position themselves as BP for example in this situation to take advantage and

move into these markets. One case in point, I think you've already heard California. California last year enclosed the standards such that California doesn't have coal fired power plants in its borders but it allows electricity generated from coal outside of its borders. As of now any load serving entity that wants to sell its electricity to California from coal must meet a CO_2 standard that is equivalent to what a natural gas combined cycle plant would be about half of what current coal plants would be. BP announced recently a project in California that would use its technology to turn petroleum coal into hydrogen to provide electricity to California's market under those situations.

Mr. Urlaub: Thank you and thank you for this very thorough presentation. I had a question, clarification on prices. You have a slide titled Approximate Cost of the Options and I was comparing it also to the Pew Center report that was handed out. Looking at both the time frame in the Pew Center report, for example, it says IGCC with carbon capture available in volume in 15 years, biomass and wind in 10 years, nuclear now. One does that mean advanced nuclear and two, I've looked at DOE cost assumptions and the annual energy outlook above 2005 and they placed advanced nuclear to about just over $2000 per kilowatt overnight capital cost and wind around $1100, biomass like $1400. Could you talk about where is the difference here because your cost chart does not match up with that?

Dr. Rubin: Sure, those numbers are just cited with the capital cost, the cost of constructing those plants dollars per kilowatt. The cost I've shown here are dollars per kilowatt hour or megawatt hour so these are cost basically its called a levelized cost but its basically the cost over full operating life of the plant. So it includes both the capital cost as well as the operating cost over typically 30 years. And part of the variation in those numbers comes about by things like interest rates. What's it going to cost to borrow the money that it will take to build those plants? What will the cost of fuels be? So the levelized cost is not something like an average it's equivalent to a mortgage payment kind of term. So it's the cost of the electricity as opposed to cost of building a plant. I think on that basis those numbers are probably comparable to what you would find in other reports recently. And those are reflective of cost, those numbers were really generated a couple of years ago, so it's probably on the order of 2002 dollars that you're looking at here.

Mr. Urlaub: May I ask a quick follow-up? Uranium, traditionally the understanding has been that Uranium is cheap as a fuel. We've seen it go from less than $10 per pound to close to $40 over $30 at least, is that a trend that you expect to continue and is that reflected in this.

Dr. Rubin: That's hard to know. Those things all obviously depend on how many plants are being built and how much demand there is for these fuels. You don't want to take these numbers to the bank they're simply indications of ranges that are reflective of estimates you can find today for cost. Projecting these costs out into the future is as you know quite flawed with uncertainty and so I would say there are probably a lot of studies you could find that might make those speculations.

Mr. Toben: Thank you Mr. Chairman, just a quick question. On the same chart related to cost the range that you have wind energy I am sure that you are aware that the wind energy cost is a function of the wind resource, the technology, and the location of the plant of the wind farm. In North Carolina we're finding because we have such great wind resource in the mountains and on the coast that the cost per megawatt hour is about $40 up in the mountains and about $70 at the coast. So our range is a little bit narrower and probably a lower bit lower based. On the nuclear side here I understand that you're carrying the entire operating cost out here in terms of that range, are you including the commission cost of the nuclear storage costs long term?

Dr. Rubin: I think those are embedded in a lot of the estimates that I've put there. There was a study done at MIT a couple of years ago that looked at nuclear issues and they came out with a cost somewhere a little shy of around seven cents per kilowatt hour including some of those costs. But to the extent those costs change in the future, one doesn't know. Your point about wind is certainly well taken. The wind still is the intermittency issue and the storage issue and as you start to try to bring more significant amounts of wind into the system you've got to deal with that sometimes because of the intermittency. That means you have to build a natural gas combined cycle plant to handle the times when the wind isn't blowing and worry about transmission and distribution lines if they don't exist. There is a lot of site specific kind of considerations that need to go into the wind. Let me also say a word about biomass, it's an essentially important resource. While it certainly is true that you can use biomass exclusively to generate electricity and combustion gasification, one of the major limitations is being on the size usually very small facilities and while the cost of the facility gets cheaper as you build a larger one, the cost of getting more and more biomass in the facility tends to go in the other direction. The numbers that you find today for a purely biomass based power plant either gasification or combustion would be higher than the fossil fuel ones. But probably the most effective use of biomass certainly in the near term is a supplemental fuel for either combustion or gasification. That is you can feed 10 perhaps 15 percent of the energy with biomass as a supplement to fossil fuels and that can make good economic sense. If you go all the way to carbon capture and storage plants that have some biomass (inaudible) with carbon captured storage you're actually getting a negative emission. The biomass is taking carbon out of the air and then you're putting it back in the ground and that's also something that over the long term could improve the economics of some of these things. Probably not as a stand alone facility at least not from your term but in conjunction with other fuels could make a lot of sense if you've got a lot of biomass issues here.

Senator Pittenger: Thank you Chairman Garrou. Thank you Dr. Rubin. Dr. Rubin you mentioned natural gas and nuclear as alternate sources of energy. We have significant reserves we're told off our continental lateral shelf of natural gas. You mentioned how the sequestration in Norway and other places have been effective with the CO_2. We have companies who are advocating or desiring to see expansion in nuclear energy. Would you be an advocate of regulatory change in a form that would relax the codes and guidelines that restrict nuclear expansion and natural gas expiration?

Dr. Rubin: You're not asking a leading question are you?

Senator Pittenger: No I'm seeing if the opportunity is there for areas that have minimum or no CO_2, you didn't see any oil rigs down during Katrina. I mean there are some opportunities there that could seem to be a logical part of this solution.

Dr. Rubin: I think Senator in all of these cases there are balances that need to be achieved. I don't think I'm in a position to say categorically that we can't have our cake and eat it too in that demand that is. It is not clear to me that you need relaxations in certain areas but again that's perhaps a separate discussion.

Senator Pittenger: But as you advocated CO_2 the restrictions and regulatory there I just wanted to know on the other side you advocated expansion in these other two areas the regulatory change.

Dr. Rubin: I think if they could be expanded in ways that preserve the other things we value, environment and others, we should certainly do it and there is a lot of work going on in those areas. The nuclear issue is particularly prominent these days and has its problems but the nuclear issue is perhaps the most serious. My personal feeling is that until the issues of waste disposal the back end of the system are clearly resolved and issues of proliferation are addressed adequately nuclear is going to continue to be problematic in this country and many others despite advances in the technology and the safety of the nuclear plants. I think there are still a lot of issues that need to be worked through that we are not quite there yet.

Senator Pittenger: France is 78 percent nuclear with regard to electricity is that right?

Dr. Rubin: They show that can be done.

Dr. Everett: Thank you Mr. Chairman. This is a great discussion by the way. In looking at this cost of options on page 9 one of the things that interest me at Duke Energy, we spent, I'm going to say, close to eight billion dollars on gas plants combined cycle we built around the country. Unfortunately none of those are running these days. There is a loop effect here once we convert our electricity to gas generation we burn a lot of that fuel that is useful to other people and so we see this price spike that doesn't show up in these kinds of graphs. I wonder if there is a way to account for those feedbacks once we convert to this other fuel type.

Dr. Rubin: It's clearly a critical issue and it does show up in that graph because before I came here the graph which is stretch this way was kind of down here. So I stretched it to reflect in fact the higher prices that we've seen over the last few years.

Dr. Everett: If we were to convert some of our coal plants to gas we would stretch that curve a lot higher.

Dr. Rubin: There are different voices in terms of what the future of natural gas supplies look like as certainly you know. LNG, we can have more LNG or not it's one of the key ones. I've seen curves from equally prominent experts as I've defined them that show things going both ways so it has that potential and certainly that's one of the key issues with natural gas as whether that would go in the other direction. The other issue is just from a purely balance of trade point of view we are now net importers of natural gas as we are of oil. If you will look at the data that directories for natural gas look very much like the directories for oil did thirty years ago. So we are going down a slope where we will be sending dollars out of the country to buy fuels from other parts of the world, again one of the major reasons for looking back at coal potentially with capture and storage to avoid those kinds of issues.

Ms. Choi: Thank you Mr. Chairman. I am at Progress Energy and we are involved in a study with a couple of other utilities including Duke looking at carbons geological sequestration in the Carolinas and the initial indications look pretty bleak. I am interested in hearing from you what you've seen as far as particularly the North Dakota project, the cost of transporting the CO_2 and the sequestration.

Dr. Rubin: I've tried to get some information on North Carolina resources. At the end of last week things got busy and I thought the DOE folks would have everything I needed because I had heard something to that effect as well. I was not able to get the information as the DOE did not have it as quickly at hand. I did not understand that there were some projects now with Duke University and others to do a characterization and I think until that work is done the answers will not really be known. The cost of transporting CO_2 while not insignificant or not unreasonable, the major cost is at the capture plant. We do modeling of these types of things and have looked at that so you can reasonable afford to transport CO_2 a couple hundred miles at cost typically a couple of dollars a ton of CO_2 is kind of the ball part we're looking at as opposed to ten of dollars per ton for the capture. Costs are typically in the 20 to maybe 40 or $50 a ton. The crude operation the actual cost numbers are not actually public. They are probably in the higher 10 or more. They report the combined cost of transport and storage and so it's hard to know what those are but that's a 200 mile pipe line that was certainly economical enough to do the project.

Mr. Garrou: Thank you very much Dr. Rubin we've had a request that you provide your contact information to the Commission. Would you be willing to do that?

Dr. Rubin: I would be happy to do that. My e-mail if you need it is just Rubin@cmu.edu, that's the easiest way to get to me.

Mr. Garrou: Our next speaker is Dr. Marilyn Brown who is the interim director of the Engineering Science and Technology Division of Oak Ridge National Laboratory in Oak Ridge, Tennessee. Dr. Brown, thank you and welcome.

Dr. Brown: Thank you very much for inviting me to participate in these hearings. You do indeed have a lot of energy research and analyses assets at your fingertips in the great state of North Carolina. And Oak Ridge Laboratory has had the privilege of working

with many of them, Larry Shirley who heads your North Carolina State Energy Office, Bob Koger who heads Advanced Energy we've worked with the NC State University Solar Center here in Raleigh and with Duke University. And in addition on the western side of the state we've had the privilege of working with Max Lennon who heads the Education and Research Center of the Western Carolinas in a project that's been supported by Congressman Charles Taylor to try to transfer some of the technologies from the National Laboratory System into use in the western Carolinas to build jobs and new small businesses around some of the technology advances. It's a pleasure to be here.

I am going to talk about opportunities to reduce greenhouse gas emissions from the built environment. I did want to note that at Oak Ridge National Laboratory we have identified a number of global challenges that we are addressing and you will notice at the top of that chart (Exhibit G) its climate change. That's the first time in all the 24 years I've been at the lab that our lab's strategic planning effort has placed that challenge so prominently. Of course there is also a challenge of meeting the increasing demand for energy and also all of the energy security and global security issues that surround our energy infrastructure. We are attempting to help address those with investments and energy R&D and science and technology education. You've heard all of the various important sectors that need to be addressed and looking at opportunities for reducing greenhouse gas emissions and I'm here to tell you that buildings are the place to look at first. You can slice and dice this pie in many different ways. All together buildings when you total residential, commercial and industrial buildings they count for 43 percent of US carbon dioxide emissions. Now that's not to mean that there are not other ways that you can indirectly reduce the energy requirements of buildings, for instance if we were producing electricity without any CO_2 emissions then that would have an important reducing impact on the role that buildings are playing. Because buildings are the principal consumer of the electricity in this nation, so you can either make buildings more efficient or you can de-carbonize the electric sector. Now obviously that is not a choice you really want to make, we need to do it all because the magnitude of the challenge is so great.

The building sector does use energy in many different ways and it's traditional to look at how homes use energy and how larger offices and industrial buildings use energy. Homes are much more climate responsive and so they consume energy principally for heating and cooling although water heating and other uses are important and there is a massive increase in the plug loads in homes and in offices. When you look at commercial buildings lighting is the most important energy use and because of the heat that is emitted from lighting systems cooling is also extremely important and space heating and all of the office plug loads as well. One of the problems in addressing the opportunities for greater efficiencies in buildings is that decisions in this sector made by so many different stake holders. This diagram shows some of decision makers that influence how buildings are built and occupied. You just take a look at home building in the United States. There are half a million home builders and the top five of them dominate only seven percent of the market. It's not like Detroit where you can get them in one room and talk to them one on one, it's just not that easy.

Now there have been some successes in improving the efficiency with which we use energy in buildings and I've developed this chart for the Pew Center report that I think you all have copies of. If you look at how much energy is used per person over the last two/three decades, it has reduced significantly. If you look at how much energy is used per household or per capita the similar trend is true of energy consumption per square foot of office building, we're doing a much better job. One of the problems is our homes are bigger and expanding our built infrastructure at such a rapid pace. As an example of one of the improvements that has occurred over the past several decades, take a look at how much energy has gone into refrigerator. The standard refrigerator in your home use 75 percent less energy for our household refrigerator today than we did in 1970 approximately the same size 22 or so cubic feet. One of the ways that we've done that is through R&D we've improved compressors, insulation and motors and actually that work was done at Oak Ridge National Laboratory. It's been coupled with appliance standard beginning with the state of California and then moving to federal standards which have racked down the requirements for new appliances manufactured in the US. So we have seen an incredible drop in the energy required to maintain your household refrigerator. I like this chart this is one that was developed by a colleague of mine, Art Rosenfeld, from the California Energy Commission, last year he pulled this together. It shows that had we not improved our household refrigerators it would be like having to build twice as many hydropower dams as are currently in the US. It would be about equivalent to having to have as many power nuclear plants built to meet that demand. It's saved billions of dollars and that's only one appliance. It was the focus of a major R&D and appliance standards program and similar programs could tackle other end uses.

Future energy challenges are going to require that we address these other opportunities. In say 30 years most of the current stock of buildings that exist today will still be standing so we need to retrofit them. The built-in environment is going to grow by 70 percent over the next quarter century or so. So we need to figure out how to build them for long term prosperity and also how to situate them so that we can also consider the implied transportation demands that occur either with choices we make between more sprawls or more urban in filling. We need to figure out how to meet new energy services because we're demanding more and more from our buildings every year. It used to be 25 years ago that only about 20 percent of the homes had air conditioning. Well today it's considered a necessity, almost all new homes do and similar examples are pertinent to other services as well. So the forecast is that if current trends continue, greenhouse gas emissions from buildings are going to increase at about 1.5 percent per year.

There are opportunities to shave that growth rate I think it's quite feasible to imagine a future in which our annual growth for energy for buildings is cut in half to 0.75 percent per year. If you look at buildings today the full compliment of efficiency approaches are not used, you've got less than a quarter of the glass sold for windows today having low (inaudible) that is reflecting heat. We have almost none of them yet with electric chrome principles per properties, these are where you reflect the heat in the summer and you absorb it in the winter. They're a little pricey but just wait a few years and we will see more of those. You have insufficient use of insulation in attics and walls and we don't have reflective roof coatings as we should, that's a cost effective measure for homes and

for offices. We've got sprawling urban landscapes and rarely are considerations of life cycle issues built into our considerations. So how much did it cost to make the materials that are being installed? What are the greenhouse gas implications of the materials that we are using to build our infrastructure?
This is a list of some of the emerging energy technologies that could make a difference. I mention the electric chromic windows, various unconventional water heaters - one of my favorites is being developed in that partnership in the western Carolinas. That's an integrated water heater dehumidifier all in one should hopefully cost no more than the two appliances together and it's a heat pump water heater. Which means it's twice as efficient as a standard resistance electric water heater with thermo electric materials where you take a small temperature differential and convert it into electricity, lots of emerging technologies. And looking out further, scientific discoveries are going to transform how we use energy and the technologies available to us. Today we are developing materials atom by atom, we're manipulating them at the atomic scale. That's the scale at which properties are determined such as melting point, even color. We are also involved in molecular biology and looking at the DNA of living organisms for instance to develop bio-energy plants that can more easily be converted into ethanol or plants that have more oil so that bio-diesel could make a bigger difference.

And finally, we now have paraflow capabilities in our performance computing nationwide. That means billions of calculations per seconds and this means that we can simulate so much of our science. Instead of having to do experiments and relying on theory we can preliminary simulate into solutions. One of the sort of break through technologies that I think we will be seeing more of are net zero energy homes. These are homes that produce as much energy as they require to fuel and power their appliances. I know Steve Smith's been out to Lenoir City where we have a subdivision of Habitant for Humanity homes with five of these with net zero energy homes that TVA has helped to construct with sort of opaque panels. Making up almost the entire difference between what these homes need to consume and what they can produce. The average utility bill for these homes is now 40 cents per day. So it does cost a little more today than you might want to pay, the life cycle payback is still not there but I'm optimistic that within the next 10 to 20 years these could be affordable. We are working also with Clayton Homes. I know that the manufactured housing is a large portion of the market in North Carolina and they are going to try to develop one of these net zero energy manufactured homes to show in their upcoming summer home display.

Another technology which is emerging and very promising is combined heat and power or distributed energy. I think Ed talked a little bit about how power plants could be made so much more efficient if the heat from power production could be put to productive use. Well here we have the possibility of a paragon shift from massive central generation to much smaller and distributed power generators such as fuel cells or micro-turbans, reciprocating engines. Now the advantage is by putting that small power producer right next to your office building it will operate say at say 35 percent efficiency, I'll give some amount of electricity, and we've got one of these at the National Transportation Research Center in Knoxville. Almost all of the waste heat that the micro-turban is producing is going into preheating a hot water system. So that whole system is working at 80 percent

efficiency. The improvements and the reduction in greenhouse gas is significant and that's a new paradigm and we're going to see more of and it's nearly cost competitive today. So if you total all of these technology opportunities and a series of policies that we investigated that are itemized in the Pew report, we believe that you can bring greenhouse gas emissions in the building sector down by the year 2025 to today's levels. Significant reductions are possible and that amounts to a 10 percent overall reduction in the nation's greenhouse gas emissions in 2025 relative to what would be emitted without taking accelerated action.

I did want to spend a minute saying that the Energy Policy Act has been in place simply because of the policies that will be needed to stimulate these investments. In fact Judy Greenwald from the Pew Center on Global Climate Change asked me to say something about the act and then she saw how much I have here she said but that's implying that the job is done. So first I want to say that while there is a lot in this Energy Policy Act and we need to take advantage of it in terms of taxing centers for clean energy options. It's not sufficient to meet the challenges that the nation faces and in particular it doesn't have much in the way of mandatory regulations. So you all know it was the first major energy legislation passed since 1992 and just a few of the provisions that impact building are highlighted in the next few year graphs so there are 12 new residential and five new commercial product standards that are legislated within the Energy Policy Act. Lots of new tax credits and one reason for bringing this to your attention is that you want to be sure that North Carolina gets more than its fair share of these tax incentives. So be sure that your home owners know that they have tax credits up to $500 for qualified energy efficiency improvements like $50 off for an advanced air circulating fan and be sure the builders know that they get $2000 incentive for homes that are 50 percent more efficient and there is a $1000 tax credit for manufacturers of mobile homes that require 30 percent less heating and cooling than the IECC standards and current practice.

Noted here some of the features of homes that might be typical of those built in a hot humid climate like North Carolina that would qualify for these tax credits. And there are tax credits for commercial buildings that are built to higher energy efficiency standards. There are energy efficiency provisions to legislate greater efficiency in the federal sector as well. I wanted to be sure that you knew that there is also activity that requires states to facilitate development of these combined heat and power and distribute generation technologies. And particular states are encouraged to improve the inter-connections standards to enable these distributed power systems to interconnect to the grid.

I have five maps coming up that show how the states are doing in terms of implementing some of the more advanced policies and you will see that in terms of the first two state residential energy codes North Carolina does real well and for commercial energy codes likewise he's adopted EPCA compliance of efficient standard codes. But when you look at supplemental appliance efficiency standards you don't have any. Many states do and here are about ten of them that have implemented their own standards for a ray of different appliances that are not currently regulated by the federal government, you should consider that. These are standards which pay back to the consumer. It's just sort of forcing the market to behave more efficiently. And then there are also standards for

state buildings that I recommend you consider for instance, the possible adoption of lead certification for state buildings that is a leadership and energy and environmental design. Many states are requiring that of their state buildings.

And finally one of my very favorite policy tools is the energy efficiency resource standard. This is a standard that was first pilot tested in Texas about five years ago where the Texas legislature required that its investor on utilities reduce the growth of electric demand in their territories by a certain percentage and they could do it any way they wanted through some system of rebates or incentives and it would have to be monitored and measured. And they have done this and they have reduced their growth by ten percent through incentives that they put in place that have been managed by the utilities. In ways that best meet the economic of those service territories and you can trade too it's a cap and trade kind of set up so it adds even more to the efficiency of this type of policy approach.

This is my last slide in conclusion there are many near term opportunities to bring building practices up to best practices. And the longer term 2025 I see zero energy buildings and some of these integrated energy systems that combine heat and power systems is playing a big role. And of course looking further out we are going to need to consider smart growth concepts and take a much broader integrated approach to the development of our energy infrastructure including the built-in environment. Thank you very much.

Mr. Garrou: Thank you Dr. Brown. Questions for Dr. Brown?

Mr. Shore: This is just a question about low hanging fruit. Our utility commission is considering energy efficiency issues maybe the General Assembly will be thinking about these issues when the session comes in. Do you have a sense of what are the lowest hanging fruits, what are the things that are just a no grainer for North Carolina to be doing to promote energy efficiency in the building sector?

Dr. Brown: I think some of those policies that I just mentioned should be considered. The supplemental state appliance standards, take a look at a recent report by the American Council for an Energy Efficient Economy. I think they looked at something like a dozen different appliances and you would want to consider how big a role they would play in North Carolina like pool heaters. Is it important or not here? I do think that energy efficiency is the fastest, cheapest, cleanest way to go in terms of meeting climate and energy challenges. There is an array of technology so if you want to go down the technology path its all traditional insulation and windows and reflective roofs and there's a lot to be done.

Senator Pittenger: Thank you Chairman Garrou. Thank you very much for your presentation. You mentioned in your presentation advances have been made in technologies for example the refrigerator and other things have really improved. Was that done through government mandates or through the research and development in the private sector and market driven?

Dr. Brown: That is a combination, the requirements for federal standards is that they have to be proven to be acceptable economically to a consumer. That is you can't force an un-economic option upon consumers. So the technologies have to be available and shown to pay back over the lifetime of their existence but what you saw was this combination of research triggering advances and then standards catching up with them and then more research and then stricter standards. It was a really nice companion you ask was it a private R&D or public R&D was that also part of your question?

Senator Pittenger: Actually my question was it driven by the private sector market driven or was it government mandates to require the transition? What are the mandates regarding the efficiencies of refrigerators?

Dr. Brown: Yes a little bit of both. The first mandates were the California appliance standards for refrigerators because they saw that it was an economic proposition for their state consumers and they could prove it in the state court. Then the federal court launched about a 5 million dollar R&D program done with industry and partnership with cost shared efforts with industry and drove up the performance of compressors and insulation and motors. And then the standards in California racked down and then the federal government caught up. California was always a few years ahead of the feds.

Senator Pittenger: I think to clarify if it's ok Mr. Chairman. The standards were related to receiving the R&D they set is that correct?

Dr. Brown: Well not exactly. The research shows that the manufacturers could produce a more efficient refrigerator. The research next improvement and in fact in one case it was a major Georgia compressor manufacturer at the time it was called Columbus Compressor Products, a big company in Georgia. And they started to roll off the assembly line a refrigerator that could perform well and wasn't very much more expensive. So with that on the market the federal government could conclude that every manufacturer could do that. The research has been done and so the mandate then was across all manufacturers for that appliance. I hope that that helps. I can give you more literature.

Dr. Everett: Thank you Mr. Chairman. I'm interested in some information exchange that maybe would be helpful to everybody across the state who is very interested bridging the gap, deciding what do I do next that's out there in the market place that I can select from that is cost effective. So if I wanted to build a zero energy efficient home who do I go to, what's the cost to me as a consumer added on to my anticipated cost in the first place or what kind of appliance do I need to buy, where can I get it. So that for all those people who are eager to step forward and do something we need some tools that I think are just missing.

Dr. Brown: There are some great websites to go to: the Energy Star website that EPA and DOE manage and then there are two associations I direct you to the American Council for an Energy Efficient Economy www.aceee.org has incredible literature and

material on the website and then there is the Alliance to Save Energy in the Pew Center has a lot of reports posted as well.

Dr. Everett: Yes I guess we need some how to make them more user friendly to refer people to a web page probably is not the solution I suspect but I think there are tools out there that just aren't readily available and used and if we had them in a user friendly form we might do better.

Dr. Brown: I think probably the biggest success in terms of communicating recommended projects is the Energy Star Label has great acknowledgement across consumers nationwide. So when you go into Home Depot or Lowes you can find that label or not and that really helps. That's only part that I recognize that doesn't get you all the way to the really premium products that I think we need to move to.

Dr. Urlaub: I had a question for you about who should be carrying out implementation. For example some programs it's most appropriate for electric utilities to carry them out for some its government programs and what not. A lot of your input you pointed out especially with buildings, where do you think with the appropriate institutions that we should be presenting those kinds of programs?

Dr. Brown: Well it used to be in the 90s that the electric utility industry was a great conveyor of demand size management options but then with the restructuring of the industry the incentives were no longer there. So their return on investments a function of sales and there are no longer options for rate based energy efficiency to be implemented by utilities. Now that is a state decision how you manage your utilities. So these energy efficiency resource standards that I mentioned is something that you can put in place in the today restructure environment. I think utilities should play a role. They are in the energy business but the state energy office is also a great place to reach out to state consumers. And so working with them is very useful.

Mr. Toben: Thank you Mr. Chairman. You mentioned California has typically been a few years ahead of some of the other states. And it looks from your chart like they have adopted the residential energy codes, the commercial codes and the appliance energy standards. What is the per capita energy consumption in California verses North Carolina? Do you have that number?

Dr. Brown: Well the BTUs not the dollars but the amount of energy consumed in California per capita is probably less than in North Carolina. It is a lot less than in Tennessee and Tennessee and North Carolina have very similar climates. Were you suggesting that you thought maybe they paid more and consumed more so it was more of an issue?

Mr. Toben: I am more interested in the impact of the standards on consumption rates.

Dr. Brown: California has been able to institute policy such that their electricity consumption has not grown state wide over the past decade or something like that. It has

had a big impact and yet their economy has boomed. So they have really made a big difference and following the rolling blackouts in the summer of 2000 and 2001 that period when they appear to be the crest of this they put in place a big program that's called the 20/20 program. If you could reduce your electricity consumption by 20 percent they would give you an additional 20 percent off your electricity rate. And they showed an impact of something like 10 percent reduction in electricity consumption that next summer which made a very big difference in terms of grid stability and keeping the lights on. So they really have done a lot and made a powerful impact.

Mr. Profeta: Thank you Mr. Chairman. First I would like to second to what George has said about the Commission thinking about the education assimilation because I'll just use myself in having some construction projects. It's not that easy to determine what is capable and clearly if we are going to deal with our missions we are going to have to deal down shore demand. I want to go back to a line of questioning on the economic feasibility test on standard center. If a jurisdiction was to bring in a program that created a market based system that values carbons lowering energy use what affect would that have and what range do these technologies become more economically viable?

Dr. Brown: Well it would certainly lead to the improved attractiveness of these options across the board. Depending on the magnitude of either the cap or the carbon tax, maybe you're asking would this solve the problem, would a price or cap and trade system do it all, probably not.

Mr. Profeta: Would it stimulate more of these technologies and be able to penetrate the market?

Dr. Brown: It would I think David Greene did a nice job explaining how consumers don't really pay that much attention to energy prices so I would hate to be on the record as saying that the price signal would do it alone. Price and necessity of demand for energy show its not very elastic maybe a ten percent reduction for 100 percent increase.

Mr. Profeta: One last follow-up. If the standard or being able to create the standard is it to be shown to pay back economically, would more technology be able to have a stand set for them because they would be now economic?

Dr. Brown: Yes they would indeed.

Dr. Smith: Thank you very much Mr. Chairman. In response to Tim's question my understanding is that on a residential perk applicative consumption of electricity in North Carolina slightly below 1100 kilowatts per hour. I think the national average is about 850 and California is about 580 so I think that gives you a sense that California is probably consuming approximately half on kilowatt hour basis rather than take in BTUs. The other question I have is I think North Carolina is projected to grow electricity demand slightly less than two percent per year going out. In your professional opinion do you believe that that could easily be met with energy efficiency programs to offset growing demands by some of the things you outlined?

Dr. Brown: I've come to sort of rest on feeling comfortable with cutting the gross rate in half. Its professional judgment but I do think certainly that is feasible and California has shown that you can go further.

Mr. Garrou: Thank you very much Dr. Brown for your presentation. Our last speaker before lunch is Dr. Dennis W. Hazel who is not an expert because he is from Raleigh. He is a Professor in the Forestry and Environmental Outreach Program at North Carolina State. Thank you for being here Dr. Hazel.

Dr. Hazel: Thank you and in the spirit of Dr. Brown's presentation and since in fifteen seconds we are supposed to be breaking for lunch I shall attempt to speak efficiently. So it will not be in fifteen seconds. What I would like to do is to cover the range of opportunities represented by the forestry and agricultural sectors and I hope the take home message will be a fairly simple one. If these are large sectors the opportunities are large and that's the good news. There are a couple of words of caution that I would like to leave you with. What I would like to do in the next few minutes is describe why agriculture and forestry are significant sectors to look to and I'm going to give you what I'm going to call a partial laundry list (Exhibit G) of those things that we might do as solutions to global change from both of these sectors. The list largely comes from sort of the sister group that's meeting concurrently, the Climate Action Plan Advisory Group. I'm part of that and I serve on the agricultural and forestry technical work groups. Of course our job is to tease apart the specific options, look at them, weigh them, prioritize them, look at the cost of implementing them and then get back to you. The group that is facilitating our discussions has given us a list of what they call action items that is being done in other states. Those of us on that group are also of course coming to the table with some of our own ideas and I'm going to give you a partial list of those. We have just begun our deliberations. And then there are several things I think are particular opportunities. They're implementable and they are implementable on a large scale in the relatively near future and I'm going to try to focus a little bit of extra attention on that.

Why are these such good sectors to look to? They are large. Forestry is our second largest industry in the state, have over 18 million acres of forest land in North Carolina. Most of it owned by 650 to 700,000 private individuals, a 29 billion dollar a year economy additive of business for North Carolina. Those of you who know Bob Slocum or hear him on the radio, he is our ambassador for forestry in North Carolina and his group is the one group that truly represents all aspects and parts of our forestry community. We think of agriculture as being somewhat in the decline and it is but we still have nine million acres in North Carolina in farms representing 52,000 farms and without some of the net multipliers just last year's net cash payments to farmers was 1.9 billion.

There are four general ways that forestry and agriculture can contribute solutions to the global change issue. The first is reducing emissions from our own sector and the things that we are most concerned about are carbon dioxide which has been talked about a great deal today and I'm sure at previous meetings and also methane and nitrous oxidize. In

the case of nitrous oxidize, that's a product of our fertilizer applications with nitrogen based fertilizers. Second, sort of a general category of solutions is promoting carbon sequestration which you heard about several times this morning. An example would be increasing the land area that we have with plant, crops and forest. Maybe a more viable solution is improving the productivity of the land that we have in agriculture and forestry because the growth rates on every acre that are in agriculture and forestry are directly proportional to the carbon sequestration that takes place. So if we can improve productivity on the lands that we still have in forestry and agriculture then we have some solutions. Another sort of general way of heading for solution action items is substituting farm and forest biomaterials for others. Dr. Brown talked about some efficiencies and things being done in buildings. A 24 hundred square ft. frame house has enough wood in it that has sequestered about 23 ½ tons of carbon dioxide. So when we're using wood products to build for construction instead of some of the other products then we're on a long term basis using a product that has come from carbon sequestration. And then preserving land in farm and forest use, this is a very important one. I said there were a couple of cautions I wanted to add. The first one is that forestry has lost one million acres permanently to non forestry use between 1990 and the last statewide inventory that was done in 2002 represents about five percent of our forest land base. Farm acreage in North Carolina has dropped two percent between 2000 and 2004 and I would like to raise the question and maybe answer it or suggest some answers that address the question can global change solutions from these sectors help retain land in farm and forest and I think maybe the answer is yes.

I'll go through what I call the laundry list of the possible action items and I'll start with agriculture, the first one, protecting farm land from permanent conversions. Ways of getting at that or incentive programs, the use of conservation easements which are becoming more and more popular, continued employment of our use value taxation program in North Carolina. There is some rumblings of things going on that in my opinion will threaten the long term viability of that program. If you don't know what it is, we have a program where if your land is in agriculture or horticulture or forestry and you're actively managing for those commodities and you meet certain criteria in terms of acreage sizes, you can apply for and receive in your county what's called current use or use value property tax or property valuations and receive reduced property taxes. If you're living especially in an urban area it could mean a reduction in your annual property taxes of 90 percent. So it's a significant incentive for land owners to hold on to those current uses.

Another broad category is expanding our soil of carbon storage and this again we're talking about agriculture. There's a range of things that can be done and we'll be looking at them in our group basically designed to keep carbon or promote more carbon deeper into the soil. And loosely put its keeping the fields in production more of the year by having less fields fallow in the summer, using winter wheat as a cover crop. Of course conservation tillage is especially a good one because it maintains a cover on the land that degrades and introduces soil into the soil profile. And then there are crop rotation strategies that also reduce carbon lost.

Animals are emitters of greenhouse gases and there are some things that can be done we think in terms of improving feed efficiency. And then the emissions directly from the land itself and basically we're talking about nutrition strategies that reduce our nitrogen use on the landscape by using what we call precision agriculture where the rates are very much controlled by a map system if you will that controls the rates that are dispensed by the equipment. And it's a very high tech but it's a very cost effective way of approaching nutrient management on farms. Using deep rooted species on field borders happens to be another good strategy because it helps manage the nitrogen and the soil.

Another set of options that we will be looking at in our group are expanding the use of renewable energy directly on farms and expanding the use of farm products for off farm energy production. And there are a lot of things that are out there that are already developed or being developed, newer gas digesters, farm gasifiers, Mike Boyette in our department of Bio.& Ag. Engineering right now is working on a farm based gasifier that uses wood chips and would produce the energy on the farm and provide rate structure was favorable and net metering could produce some electricity for the grid in certain scales. In using bio-diesel in farm equipment, our farmers are agri-businessmen they're smart people, we are not producing bio-diesel in North Carolina but our farmers, especially our soybean farmers know that if they're using bio-diesel in their farm equipment they are setting the example, they're increasing the demand that promotes better prices for soybeans. And we have probably 300 to 350 farmers in North Carolina that are using bio-diesel in their own equipment and you can buy it if you have a diesel vehicle in about 24 or 25 of our counties at commercial service stations. And then a very large opportunity is using our agricultural commodities for feed stocks for off farm energy. Soybeans for bio-diesel, last year in North Carolina I think we had over 1.5 million acres of soybeans, so it's a very large crop. Feed stocks for ethanol production such as sweet potatoes and corn we had just a little under eight hundred thousand acres of corn in North Carolina last year.

And feed stocks for direct combustion and that can include things that you pick up and glean after harvesting so probably one of the bigger needs that's out there and that's our waste products. We are right at the top of the list nationally for the amount of livestock waste that we produce from our poultry and our swine industries. We produce an awful lot of waste, we're getting buildup of phosphorus in our soil across North Carolina and it's a real barrier to increase productivity at some of these sectors in our farm community and yet these particular wastes serve as potential feed stocks for both ethanol production and direct combustion. I'll give you some examples of that in a minute. Some other key action items are developing more efficient routing to get our commodities directly to market and encouraging windmill use on our farms as has already been noted. Those windmill technologies are getting more and more effective. Another really important one is taking our less productive farmlands our more erodible soils and planting them into trees. We get a terrifically increased rate of sequestration when we take farmland and we put into forestry and I've given you some numbers. A managed loblolly pine plantation in North Carolina can sequester over three tons of carbon dioxide a year as compared to typical farm crops which tend to be in the range of several hundred pounds per year.

Another action item that has a lot of interest, I don't know what the potential will be, is some new dedicated crops on our farmland for feed stocks for ethanol specially switch grass, several species of hard woods that grow and can be harvested in just a very few years. One of my concerns there is these tend to be terrifically expensive to establish. For forestry again the key action item is looking at things that reduce our conversion of our forestlands to permanent non-forestry use and better markets through healthy forest industry. Bob Slocomb if you're heard him you've heard this message from him that if we're going to have healthy forest and forest products derived from this almost three quarter of a million private land owners in the state, you've got to have healthy forestry industries and he's absolutely correct. There are some other mechanisms that are basically sort of legal mechanisms including land trust that have purchased land or purchased land rights for use of conservation easements are all incentives that can encourage the land owner to keep land and forest land.

And then some other directive incentive programs and again I'll mention the continued employment of use values. Increased use of residential and urban trees and promoting better health of those trees can be a very important item. We are losing our forest to everything from Wal-Marts to subdivisions but at least within those kinds of context we're encourage the use of shade trees and good management of shade trees. We're still keeping a good carbon sink out there working. We're storing non-forest lands to forest like wetlands, pastures and crop land is another potential action item. And developing improved trees for special uses through genetic and biotechnology in my own department at NC State our biotechnologist right now are engineering an improved variety or several varieties of loblolly pines that will be more efficient when converted to ethanol, so it's another action item, longer term.

Some other key action items are employing better utilization during harvesting. These can be pretty important, we're doing some studies in the group that I'm with now and we've estimated that by not changing what we're doing in our harvesting in terms of going after more acres but simply doing a better job of utilization in terms of getting what we're leaving out on the landscape now, which does degrade and does become carbon dioxide when it's left on the landscape. By going out and getting that through the use of chippers and using it, we've estimated that we can probably pretty easily in North Carolina produce 500/600 megawatts worth of electricity on a sustainable basis by doing nothing but better utilization. Then there are some opportunities in forest management and I described this as removing and easing trees to promote forest health especially thinning. Our number one from a dollar wise point of view problem we have with our forest in North Carolina in terms of pest and disease are the southern pine beetles in roughly half of our stands that are pines. And they especially go after slow going stands that are over stocked – that is too many trees growth rate slows down, sequestration rate slows down and the beetles go after them. And a biomass market for example could open up opportunities to manage for forest health and healthier higher sequestering forest. Just to let you know in the last ten years we've estimated we've lost 60 million dollars of pine timber – southern pine beetles.

Then improved silviculture – many are over stocked stands in North Carolina of about 18 million acres. About nine million of those acres over 50 percent of those are considered to be over stocked. Not only are they less healthy but when the growth rates slow down because that's what happens when you've got too many trees, your sequestration rate slows down. But we don't have markets for a lot of the materials that we need to remove to improve our growth rates. And also renovating the graded stands – the degradation of a lot of our forest especially our hard wood forest has been documented for years and they go all the way back to the administration of Governor Luther Hodges and that's occurred largely because of poor markets below value species. So timber buyers come in and the lower value species get less on the landscape because there's no market for them. The better trees get removed and when two or three cycles of that happens a lot of our landscape ends up in what we call a high graded condition with minimum very low stocking. It may look green, it may look pretty from the road but the growth rates are very, very minimum and that's related directly to carbon sequestration. And going in and renovating those stands or increasing stocking depending on how severely degraded they are can terrifically improve sequestration rates as well as providing potential good cash crop for our forest land owners which is yet one more incentive to encourage them to hang on to forest land. We have the distinction now in North Carolina to officially being the fastest organizing of the 50 states. And we have all over North Carolina subdivisions and individual homes being built in an around the forest which presents a very serious condition from a wildfire risk point of view. The program that has been developed nationally to address that is called Fire Wise, but the same problem exist there as with a lot of other problems that we have in forestry. Its low value material that needs to be removed from the landscape to reduce fire risk and it's that same low value material that we don't have markets for now.

So we've heard the term biomass several times this morning and a biomass market would make the economic opportunity to remove these dangerous fuels better. Salvage opportunities are a big factor in North Carolina. Annually about 426 million cubic feet that's about 16 million tons of wood that's often just left on the landscape, it degrades becomes carbon dioxide, with micro-degradation. Another possible key action item is improving carbon sequestration through nutritional amendments especially including agricultural waste. We have a group of our scientist that are in our air quality group in our department who have done a very good inventory of especially our agricultural waste in North Carolina and they're proposing scenarios where we use them wisely as nutritional supplements on our better soils where we have forests to improve growth rates which again are directly related to harvest sequestration. So that's a good option both for the forestry and agricultural sectors.

The one item that might be the biggest bang for the buck for ag and forestry and this is my opinion, and first of all using biomass for direct production of energy. Steam for heating and chilling – the chilling technology is very good now so you air condition with steam as well as heat electric power generation. I mention that there's also a second term which I'm calling the biomass bio-refinery and I'm asking why these are important. Well we'll go back to Thomas Edison and this is a quote. I would put my money on the sun and soil energy – what a source of power. I hope we don't have to wait until water and

coal run out before we tackle that, amazing thing considering when that was said – so what are the least expensive solar collectors currently available out there, our crops and our forest. They are out there doing the job converting carbon dioxide directly in the sequestered products and making energy. So biomass is important since its all about the carbon cycle and you don't need this re-explained to you today but through photosynthesis we've captured carbon dioxide, we turned it into products that you can create energy, carbon dioxide is released and then recaptured. So it's a recycling process and the estimates are that for forest it tends to be about 90 percent efficient. So that if you take a ton of carbon in the form of wood, make energy with it and then you keep that land in forest about 9/10 of a ton of wood would grow back to replace it. Actually if you think about what I said in terms of improving, using an energy market to improve the growth rates of our degraded forest instead of talking about a carbon neutral recycling procedure we may be talking about a carbon negative and that doesn't include things like geological sequestration, some of those others options you've heard about. It's a significant opportunity - you can make fuels chemical products, electric power or what is biomass. In the interest of time I will not read the definition but it's a lot of different things for agriculture from the crops grown to dedicated crops to agricultural waste. In the forestry when you look at the definition it's basically the things that we are now not using for our traditional forest products. That's what biomass is when it comes from the woods. Things that you can do with it, electric power generations, Craven wood energy in New Bern and Craven County 45 megawatt facility. About 40 percent of their furnace the last time I checked was chips that came directly off of better utilization from the forest. They used municipal waste from the Triangle that's shipped down there for making energy and they also use poultry litter. So the last trip I made down there they were actually producing 52 megawatts that day using poultry litter that's supposed to be a problem.

Heating and chilling for schools is another strong action item that I think we ought to think about in North Carolina. We have three states that are very aggressively going after institutional distributed generation for things like schools. Vermont has got one of the strongest programs. The General Assembly in Vermont has said that they will pay the freight on converting a school to a wood system or they will pay the extra cost because the wood system is a little more expensive for a new system school being built. And they are running entirely on wood chips with new systems that don't produce some of the particulars that some of the older boilers do and they are as automated as an oil or gas fired burner – you push the button and it goes. There are some higher tech options that some cities are trying when in the city themselves they locate a facility that can produce heating and chilling for downtown as well as electricity production.

I did want to especially highlight animal waste. The idea of using hog waste and poultry waste is not a novel idea it's a real opportunity. I've given you some facilities from around the world. I just saw an announcement yesterday that one of the largest energy facilities from biomass in Europe is being planned in Lockerbe and its going to use a lot of poultry litter in that. I did want to point out that there is a lot of existing use of biomass as a carbon nutrient fuel and its being done by forest industry. Our saw mills, our pulp mills and our dry fumes are being fired by wood waste right now and they're

already doing it. One problem is that a lot of them have boiler technology from the 50s and 60s and did produce particulars.

Last couple of things I would like to say is that we do have a lot of options. There are technologies that are emerging for using a wide variety of feed stocks from agriculture and forestry. There a variety of conversions processes for a huge variety of uses. One of the greatest potentials we have in North Carolina and anywhere is what our new department head in my college, Wood and Paper Science, who came from the National Renewal Energy Laboratory last year. He thinks one of the greatest opportunities we have any where are our pulp mills. They already have the infrastructure for procuring and handling wood – they have got technology and lots of other stuff that's in place. With some modifications and a couple of technological miracles that we ought to have achieved within the next five years they can become not only manufacturers of pulp and paper but bio-refineries producing a wide variety of products and especially ethanol. We think that ethanol conversion technologies are getting ready to be pretty good. We are learning how to do that. Many co-benefits of implementing such solutions in these sectors, first of all we are using renewable fuels, carbon neutral fuels, more incentives to keep land and forest and ag, keeping dollars spent for energy here in North Carolina, new jobs in rural areas. I will not read this but Ivan Urlaub with the Sustainable Energy Association, I borrowed a power point slide from him, one of the concerns is using things like biomass is what will it do to our utility rates. Will it go up? I will not attempt to answer that but there is a very real offset in terms of creation of jobs, social and environmental benefits. Some last co-benefits forest health is improved, things that reduce emissions tend to be soil friendly, reducing dependence on foreign energy sources, proved balance of trade and markets for ag and forest waste products.

I'll close with this point – its up to you to decide in this group whether we're going to do something in North Carolina and of course North Carolina is just part of the growth, but there is a cost to our forest communities for not doing something. I heard one of the arguments about not worrying too much about global changes but we've been there before. We've had ice ages we've had tropical climates in this part of the country ok so what, we'll do it again. The thing I would like to point out is that our communities adapted to those changes because those changes took many thousands of years. The kinds of things that we're talking about now are not thousands of years if you believe some of the things that are being published. I'll give you a for instance – the Barrier Forest that we have in North Carolina that we enjoy hiking in, seeing places like Mt. Mitchell, Rome Mountain, Grandfather Mt., Mt. Rogers those Barrier Forest are there because they adapted with the retreat of the glaciers during the ice age. Well a couple of the papers that I think are pretty good that are out are suggesting about a three degree rise by the year 2100 here in North Carolina. Other studies are shown because of things that control bug sect, germination and flowering that in three to four degrees rising temperatures will completely eliminate those communities. So there's one plant community that we could see disappear completely in less than 100 years. That is the price of not doing anything. With that I will entertain questions.

Mr. Garrou: Thank you very much Dr. Hazel.

Dr. Eggers: Thank you Dr. Hazel. There are two things that I didn't see on your laundry list that I am kind of excited about and since you are an expert in the area I wanted your opinion about these. One of those things is some of the research coming out of the Pacific northwest and other places which are going to impregnating chips after logging with mycelium and increased carbon sequestration. Because of that and decreased runoff and sedimentation and improved forest health because of the better fungal community in the soil. So a faster bigger crop coming out of it too. The other thing I didn't see was bio-char and could you comment on how excited you are about either of those?

Dr. Hazel: Both of those questions, I'm not an expert I apologize for correcting you. Both of those are exciting opportunities. I know less about the impregnation. Of course we do things like that already in our seedling production in North Carolina and I've read a little bit about it and it looks very exciting. It is probably something that ought to be added to our action list. The bio-char looks like it has huge potential. They are doing that at the University of Georgia which is the closest place. There are several ways of doing that but one of them that they think is commercially viable down at the University of Georgia is using what's called fisher stroke technology. They're producing a bio-diesel from wood chips and poultry litter and the product is a bio-char that can become a soil amendment and the productivity of the soils is just about unbelievable. But you've immediately got the sequestration potential improved through the bio-char and then you've got long term improved growth rates and the numbers that they're showing in terms of productivity increases are literally staggering. In fact we just had their principal person come up and make a presentation at NC State about a month ago. But yes very good thank you.

Senator Pittenger: Thank you Mr. Chairman. Thank you for your presentation. What has been the percentage change, amount of acreage change in the acreage in forest in our state in the last 40 or 50 years?

Dr. Hazel: We actually probably have more forest and I refer to Bob on this too but we probably have more forest now than certainly we did at the turn of the last century. So it depends on where you draw the line in time but since the soil back era when we had a huge amount of area that was added for forestry it's been a consistent decline. So you're probably talking about 20 percent that we've lost.

Mr. Shore: I'm just struck taking in all four of these presentations together with these diverse sectors of the economy. Opportunity after opportunity I'm just taking that in and I think it bodes well for us on this Commission as we figure out what is North Carolina's role in dealing with this challenge of global warming.

Mr. Garrou: Any other questions. If not thank you very much Dr. Hazel, I've altered my view you are an expert. We will now adjourn for lunch and how much time can we minimally have? We will start back at 1:35.

1:50 After Lunch

Mr. Garrou: Our first presentation this afternoon will be from Brock Nicholson and you've heard from him before and he is going to bring us up to date on what the Climate Action Plan Advisory Group is doing. Brock.

Mr. Nicholson: Thank you Mr. Chairman. I appreciate the opportunity again and I'll be pretty brief on this and I'll turn it over to Dr. Karl Hausker to explain a little bit more about what we're doing in the Climate Action Plan Advisory Group process. I want to report that we have had our first round of TWGC (Technical Work Group Calls) and again they were in the week of April 10 and we are divided up as we said before into these five categories, agricultural and forestry, and after the presentation just before lunch you probably have a little better appreciation of why that's a logical grouping. Energy supply, energy use by residential, commercial and industrial sector where we get into efficiencies that is a big point there; transportation and land use and then cross-cutting. I do want to say that we felt like we had very good cause. We had considerable enthusiasm especially in the energy supply and the ag and forestry. In fact a couple of extra suggestions that were made by participants in the ag and forestry that we particularly look at on farm production of bio-diesel as an option and understand what it might take there. In fact the bio-char topsoil incorporation was another suggestion that was brought up here before lunch but that brought up in our work group that we should include that. And crops that better take up carbon is another suggestion that we had as a starting point. Even though the first call was more of kind of a get together, get used to the process get used to the members and we'll plan to get on with it a little more earnest manner subsequently.

The general schedule that we're following is that we will have two work group calls between our advisory group meetings and we had the first meeting in February. We have our second meeting scheduled on May 23rd but what is listed is the first round of TWGC. Conference calls are actually two calls and each one of the rounds constitutes at least from the current planning that we will have two calls of each work group in between. I think the most important thing to note here is that we plan to finish up this project under the current schedule in the spring to summer period of 2007. And then of course be reporting again to this group along as we move along and I think as time goes on we will report a lot more substantive results of these discussions and work. With the report coming out in the June/July time frame. One of the questions that came up is an interface between the advisory group process where we're looking at mitigation options for actions in this Commission and we do have a considerable number from the Commission here. They are actually on the CAPAG process and we certainly wan to encourage that and in fact we would encourage greater volunteering if you want to be on the CAPAG process for members of this Commission or staff or other recommended individuals that you recommend to participate in this process of really digging into the cost benefits and so forth.

We handed out the catalog of mitigation options last time that we talked about which is a copulation of actions that are being developed, considered and in many cases implemented in other states. And these recommendations come from our September

Clean Smoke Stacks report which was referenced earlier in one of the presentations. That was our report to the legislature in the fall of potential mitigation options. The state energy plan recommendations and a lot of these three sources have considerable overlap. I do have a few for those that might want an extra written copy or otherwise they are available on our website which you can see at the bottom of the page there.

At this point I would like to transition to Dr. Karl Hausker who will share with you a little bit more of the specifics of the process of really considering each of the potential options.

Dr. Hausker: Thank you Brock and good afternoon to everyone. Brock has given a good lead up to my presentation. I am going to try to keep it very brief and help us get back on track timing wise. As I think many of your know the Center for Climate Strategies is a nonprofit group that provides analytic support and facilitation services to states, localities, regions in the area of climate change mitigation. We have a team of experts who have worked at the international levels, national levels and sub-national levels and we're very happy to be providing the service to DNER and to the CAPAG process. The slide you have up (Exhibit H) is just an example of the kind of information that we are going to be providing to the CAPAG. As Brock described for every state we work in we put together a catalog of options that other states are either considering or in some cases have implemented. I think this morning it was called a laundry list. I prefer to call it a catalog. I think the catalog metaphor captures it the best. There are some things in here that may make no sense for North Carolina but I think there are many things in this catalog that may indeed hold interest for North Carolina. In fact some of them are already under way being implemented or have been recommended as part of the state energy plan through some other process. A lot of this stuff will look familiar - some of it may give CAPAG and this Commission some new ideas on what could be implemented to reduce greenhouse gas emissions.

For every option that we put before the CAPAG we put before them some initial information on the potential GHG emission reductions that may come from this option in a high/medium/low kind of category. We put before them a cost per ton for reducing emissions, again its sort of a high/medium/low categorization and then a list of what we call (inaudible) impacts for additional impacts outside of the climate arena that this option might have in terms of air quality, water quality, energy security, economic development, things like that. This initial bundle of information can help the CAPAG screen which options it wants to focus on. We don't do a full blown analysis on an entire catalog of 200 options but in these early months go through a screening process to say what do you want to focus your attention on, what do you think might be best for North Carolina to focus on? Then we will take a subset and often in other states we've found that narrows down to perhaps 40-60 options that then require a very detailed examination and we do this in work groups, supplemented by other experts across the areas of agriculture and forestry, energy supply, energy demand, transportation and land use and then a series of cross-cutting options that don't easily fit in a single category. Then I think it has been described to you before those work groups developed recommendations, developed analytical support for the options and those are fed up into the full meeting of

the CAPAG for their consideration and ultimate recommendation in their final report. That is how we do our work.

The last speaker before lunch gave an excellent presentation on the very options that are available in the agriculture and forestry sectors. Then the speakers before although not in the same format they also were identifying the kind of options that could be undertaken. Dr. Greene was talking about the transport sector, technology, fuels, land use decisions that affect vehicle miles traveled. And the other presenters diagnosing all the different options within building construction and then of course the energy supply sector and how we generate our electricity. No one should ever say that there is only one or two options for dealing with climate change. There are entire portfolios of options you can take in each sector and they can be woven together into a state plan. The kind of plan that we've seen adopted in places like Connecticut, California, Maine and now underway in places like Arizona, New Mexico, and soon in Montana. We are advising a number of these states and we're very happy to be a part of this process too. In the interest of trying to get us back on schedule I'll stop there – our last slide is just to give you Brock and my contact information for questions or spam or very good clips from the daily show. Thank you.

Mr. Garrou: Thank you very much and to remind everybody you are encouraged to participate in this process with DNER and to participate in these task forces as you saw from Brock's slide. Many of you are already doing that. You have before you this afternoon's power point presentation behind a blue folder (Appendix H) and our first speaker this afternoon.

Mr. Shore: Mr. Chair may I ask a question or request on the CAPAG process? Brock one of the major responsibilities that this Commission has is to explore the possibility of global warming pollution reduction targets for North Carolina and I wondered if the CAPAG plans on providing some of the base line analytical information that could enable this group to have an informed debate about goals for global warming pollution? This is a request – this is something that the CAPAG could take on to help us out.

Mr. Nicholson: I think if there are specific questions that the Commission would want us to help answer through technical analysis and consideration by our stake holders, we could certainly do that. But I think we would need to maybe understand the specific questions. If it is an issue of how might we begin to reach a goal if one is suggested that might be one area that we could look at certainly in terms of value or reductions if there is.

Mr. Shore: Yes that exactly. If North Carolina were to have a goal of bringing back global warming emissions to 2005 levels how might that be achieved, what might the cost and benefits be if our goal were to be year 2000 levels of global warming pollution. How might that be achieved and what might the cost and benefits be?

Mr. Nicholson: I would think that would be a work that the CAPAG could certainly help with in terms of the technical information.

Mr. Shore: Thank you.

Mr. Garrou: Any other questions. I didn't mean to cut off the question period. Our next presenter this afternoon is Joseph E. Aldy who is a Fellow with the Resources for the Future and I hope I pronounced your name correctly.

Mr. Aldy: Thank you Mr. Chairman and thank you all for being here. It's a pleasure to be here to be back in North Carolina. I am at Resources for the Future which is a nonpartisan objective research oriented think tank in Washington, DC. We are primarily a group of economists who do research on environmental, energy and resources use and as I've tried to explain to some of my friends we are sort of like an economics department except that we don't have students. Instead of going into a classroom a couple of days a week to teach students we actually try to teach the (inaudible) world as a classroom and try to bring the lessons for our research to bear on ongoing policy debates. So it is a pleasure to try to contribute to your discussion here in North Carolina on what to do to address the issue of global climate change. I should also note about Resources for the Future that climate change is one of the primary areas of research interest with my colleagues. There's a good half dozen or so of us that do work on these issues. And at the end of my slides there is actually a link to our own climate change policy website at RFF and I encourage you to take a look at that and see the different kinds of work that my colleagues and I have been doing on climate change.

In my talk here today I am going to first discuss the primary determinants of mitigation costs and think about what are the kinds of issues one needs to think about to think about how the economy, how individuals, and how firms respond to a climate change policy in order to reduce their emissions of greenhouse gases. Through this discussion and subsequently in the presentation I'll be focusing primarily on carbon dioxide emissions given the prevalence and the economy and given that most of the economic models have focused on carbon dioxide emissions although the principles and concepts apply to all greenhouse gases. Then I'll discuss some of the cause implications of how we design our policy. I think this is very important and can actually provide policy context for a lot of the discussion this morning about technologies and options for reducing emissions by adopting those types of technologies.

Then I'll provide an illustration of some examples (Exhibit I) of cost estimates of various climate policy proposals for the United States to give you a sense of what the economic burden would be of undertaking some policies to move off of our current path increasing greenhouse gas emissions. Then I would like to close with a couple of comments on issues that I think merits further consideration when thinking about the design of policies to reduce greenhouse gas emissions.

When one thinks about the determinants about mitigation cost the first thing we need to think about is a reference of businesses usual emissions scenario. So I'm going to provide some comments on that. I'll talk about the ability to substitute to move from carbon intensive fuels to carbon lean fuels. I'll then talk about some of the substitutions

that is available when we think about energy used in technology and the opportunity for investing and adopting more energy efficient technology. I'll talk briefly about technological change and how this can affect the cost of reducing emissions and then the section where I'll talk about policy design issues.

When we think about a reference case or business as usual scenario this has to be basically the kind of action by which we are going to evaluate any proposed policy. One thing that is important to recognize is that business as usual does not mean no policy it typically means no new policies. So the idea that we have current policies on the books whether its on appliance standards, whether it's some states have renewal portfolio standards that would increase the amount of renewal power in the generating sector. These would all be incorporated and final assessment of what our future might look like if we don't implement any new climate change policies. After our county put us in a policy foundation we did need to get a sense of what the economy is going to do and how its going to grow and is it going to reflect basic fundamental forecast of economic growth and understanding of population growth over the long term. Then it also matters how energy intensive economic outlook will be. This has to do with both the technologies that are used and energy intensive industries but also relates to what we think the structure of the economy how it is going to evolve over time. Will we see more growth and energy intensive manufacturing sectors, will we see more growth and energy in lean sectors such as in high tax or in services. Then it is also important to recognize what we think the carbon intensity of energy use is going to be. This will depend a lot on what kind of fuels we use to power our economy. What's important to recognize when do these forecast of reference, or business as usual or what's often referred to as BAU emission forecast or scenario. It is important to recognize the existing policies and energy prices and innovation all matter. Expectations of energy prices matter. I am going to give you an illustration of the recent increase in energy prices that influence how we do a forecast of long term emissions.

One way is to think about where the future might be as we look at what happened in the past. From this table I provide evidence for North Carolina and for all states of what their emissions growth has been over the last 40 years and last century. This annual growth in carbon dioxide emissions and then it breaks it down by how much of that is comprised of the growth and population, how much more is the growth and income, how much the growth and energy has improved over time and decreased. And then how the carbon per unit of energy has changed over time. So we see here that North Carolina actually experienced a faster growth and carbon dioxide emissions over the last 40 years the last entry then all states did. They reflected at a faster growth rate above population and in income per capita. There is virtually no difference in the improvement and energy efficiency per year. Whereas about a one percent improvement in energy in energy efficiency per year over this period and very small changes in the carbon per unit of energy.

Now I also put in here the second set of rows, focus on 1973-1986. This is to give an illustration of what a high energy price looks like. I think one thing that's important to recognize is that first we see virtually no growth in emissions both for the US as a whole

and for North Carolina. They grew in North Carolina only two-tenths of a percent per year over the 73 to 86 period. What we want to recognize is that is basically negligible growth in North Carolina and the country as a whole more than just because incomes grew slowly, you also saw an increase in the improvement of energy efficiency. So when it shows that there is this potential that when we look at where can we reduce emissions it is not just that you have to grow slowly to reduce emissions. There are these opportunities to improve the energy efficiency of how we use energy to also improve the carbon intensity of energy we use to help reduce emissions even as you see both populations and incomes grow.

Now one thing I noticed that forecast of energy prices can have an impact on where we think the future is going to be when we think about forecasting future emissions. So this figure here shows the last five years of forecast for the nation from the energy administration and their annual energy outlook. Now the 2002-2005 annual energy outlook has very similar forecast for the next 25-30 years. The only difference between them is basically depending on what year you were looking at, whether you counted for the fact that you had slow growth in 2001 and early 2002 because of the short recession we had. What is interesting is they updated significantly the most annual energy outlook which came out about four months ago to account for the much higher prices for both petroleum products and for natural gas. What we see here is a slower growth rate and a diversion from the previous forecast. So we see that by the time you look at 2020-2025 emissions, they are about seven percent lower under our new forecast than they were by previous forecast we made. The good news is that we are actually expected to contribute less to climate change over the coming years. It doesn't mean don't do anything but it also means that if we want to propose a goal to reduce emissions to say current level or 2000 levels or whatever goals people want to imagine, the burden of doing so is going to be lower because there is already some built in in the economy. A slower growth rate because of these higher energy prices than we expect to experience.

When we think about what is the opportunity to substitute to carbon lean fuels obviously the cost of any mitigation cost are going to be lower, the easier it is to substitute you need carbon lean fuels. From the electricity sector and Dr. Rubin went into this in much detail this morning so I will not discuss this too much. Clearly anticipation that one would transition from coal to natural gas and then to renewable and nuclear power and relative cost of will impact a lot on where we are going to see growth in different categories of these fuels.

Transportation - that we have fewer substitutes available for us that substitute from gasoline or diesel to a non-carbon or to a low carbon fuel, there is potential to go to ethanol. But as we heard this morning from Dr. Greene the carbon savings are going to depend a lot on whether the ethanol has original corn based ethanol or whether it's cellulose. You're going to get a much bigger climate bang for your buck at least if you get cellulose to be concentrated with corn. One thing that is clearly important here is when we're talking about the kinds of technologies that use different forms of fuel. The existing capital stock is going to have a big impact on this. The timing is going to really matter because we're talking about investments and technologies that have very long life

lines. So when Duke Power is trying to decide on what power plant they're going to build next they have to have in mind that they want to be running this power plant for a number of decades. That's going to have an impact on what kind of decisions they make having expectations of what future prices are lived what kind of decisions they make. It helps to have not just what the sense of long term is going to be, but are you going to be regulating carbon dioxide just for the next five years or for a long time rising. It also helps to give firms that make these investments some lead time to make decisions. You don't want to impose a regulatory policy tomorrow that would impose really high cost for them to continue to run coal fired power plants. You want to give them time to transition to take advantage of the natural turnover and the capital stock as they invest in new technology to reduce their emissions.

When you think about improving energy efficiency, again I think what is important is recognizing that investment in energy efficients are going to reflect both expectations about prices, this is the one thing that people really respond to, this is a lot of what you have seen about responses to the increase and gasoline prices. I was reading yesterday that more and more people are taking transit in response to the high gasoline prices. We see fewer purchases of SUVs and low fuel economy vehicles in response to the high gasoline prices over the last year and a half. So people clearly respond to prices. Its also important that this was certainly eluded to this morning that there is not enough information in some of these markets and its useful to try to convey more information to consumers and to firms about energy saving opportunities for them to take advantage of some of these energy efficient technologies.

What is important and this is a caveat somewhat was said this morning, consumers care about more than just how much do they spend on fuel when they buy products. If you really cared only about getting from point A to point B with your car you would never spend $50,000 on a gas guzzling SUV. But I think you care more than just can the car get me from point A to point B and try to minimize my cost. There are other attributes to the vehicle that we care about. So it is important to recognize that when we think about what are the opportunities for energy efficiency one can just say if we improve fuel economy and have the pay back in so many years a lot of people are going to buy the car. I actually have to exception with claims that people under value fuel economy in the market as an economist. I am not out here trying to say whether people under value it or over value things in market, I'm trying to interpret their values they reveal in markets. So I want to try to take a diagnostic view on that and don't take the people under value or over value but I want to try to convey to them that with the right price signals to show that yes there are extra analogies such as the impact on climate, local air pollution, congestion, every route applies transportation appropriately that would then create the incentives for them to make investments and more energy efficient technologies.

As an example drawn by a one month old analyses by EIA, the dark blue columns are for the reference case out for the next 25 years. The other two columns reflect two carbon regulation policies so it would actually impose a cap and trade program on the US economy and then by virtue of the permit price would raise the price of electricity. What we see here under these three scenarios the differences and the use of different fuels in

the generation sector. You see where coal decreases significantly in part because it is the most carbon intensive fuel in the generation sector. You see a slight decline in natural gas and if you look at analyses EIA did six-eight years ago, you would actually see natural gas increase. Even though natural gas generates carbon dioxide emissions given how low natural gas prices were six-seven years ago you would have seen much more natural gas going into the electricity generation sector. Now with much higher natural gas prices forecast by EIA you don't see that kind of supply going to the generating sector and that's why you see a slight decline here in power generation. You see a slight uptake in nuclear and a lot of this has to do with where we think both policies and cost of technology is going to be in future with nuclear. But you see especially on the far side a big increase in renewables. You see a big uptake in the higher price, a big increase nearly doubling in renewables from what's forecast over the next 15 years.

The inside figure shows the decline in electricity energy consumption overall so the larger figure shows the switching from a carbon intensive generation fuels to more carbon lean and zero carbon fuels. So you see the fuel switching the insert shows the improvements in energy efficiency. One thing I've shown here is when you thinking about a policy, what can be a cost effective policy, you want to be able to take advantage of both your low cost opportunities for fuel switching and your low cost opportunities for energy efficiency. When we think about technological change its one thing in these models and how we look at the economy is always ongoing technological change even if we don't have changes in energy prices there is still going to be some change in technologies, whether it just turning over into capital stock you can't build a power plant today with the same technology 50 years ago. You can't buy a refrigerator with the same technology you had 20 years ago. You can't buy it and put it in your home today so we have this sort of natural improvement in our technology. But as we think about the impact of policies if you are able to put in a policy that imposes the price on carbon dioxide emissions on greenhouse gas emission that induces additional technological change. You'll see low carbon and zero carbon technologies coming off the shelf and being deployed in the economy. You also see the incentives for more R&D, more innovation if you try to define the next generation technologies that will be low carbon or zero carbon.

Right now we know that we have insufficient R&D, we have it for two reasons. One, if I make carbon dioxide I pay the price of zero for that. That means that I have no incentives to invest in R&D for a lower carbon technology to replace what I currently use. There is also the problem that I cannot fully capture all the benefits of R&D. This is a fundamental problem not just for R&D for efficiency or for the climate issue but all forms of R&D and that is the people who are the innovators can't always capture all the benefits. All the risks associated with it, people will try to mimic the new technology even though we try to protect this with our patent laws there are still opportunities to better try to take advantage of how you create a new knowledge. When we think about appropriately dealing with R&D incentives in the climate context we need to think about both correcting the fact that we aren't pricing the pollution like we should but also think about policies that might try to promote more R&D and address the fact that we are under investing in R&D irrespective of the impact of pollution on the climate.

One other thing to think about R&D isn't going to lower our cost of new technologies in the next two to three years. The payoffs for innovation, especially given the long life times of the capital stock are going to be longer term. But if we think we are going to eventually need to get to very low emissions or even zero emissions economy in the latter half of this century as many scientists and engineers have said in order to meet reasonable long term climate change goals, we need it. So I've undertaken that kind of innovation today creating the incentives for that innovation today in order to have those technologies we will need to invest in in the future.

The cost implications of policy design. I am going to focus on cost effectiveness and be very careful about how I use the word distribution impacts which I think are very important when we think about the political economy of these kinds of issues. A little bit on cost energy and then give some examples many of which I am sure you are familiar with on how we use market based policies to try to achieve environmental goals and cost effective matter. So when we think about cost effectiveness we're really saying here is given an environmental goal, say a level of emissions of greenhouse gases one wants to achieve, a cost effective policy minimizes the total cost of achieving that goal. Now one of the things that is necessary for us to be able to do, that is you want to be able to equate the cost that all the sources of emissions are going to face. So one way in which economists have often advocated for this is through either carbon taxes or through a cap and trade program. That is what a lot of my analyses will focus on.

When we think what are the characteristics of a cost effective policy we typically try to describe it by using the Ws, the where, when and what flexibility. So the idea here for where flexibility you want to be able ideally if you were designing a policy without the context of North Carolina, the US or the world, you would have every source of emissions to cover. The climate doesn't care if a ton of carbon is coming from Raleigh or from Beijing or from Delhi. It has the same climatic impact. So what is important is trying to be able to design into our policies where you are getting the biggest bang for the buck. You want to go after the lowest cost opportunities to reduce emissions.

When we think about when flexibility with timing, we don't have to reduce our emissions to zero tomorrow, we're talking about with the exception of methane, all other greenhouse gases have life times on the order of hundreds to even thousands even some of them tens of thousands of years. So the thing is that when thinking about the climatic impact you want to be able to design a policy that can get the emissions reductions going now but you don't have to have drastic emission reductions in 2006-2008. What you want to do is be able to get on the transition so that you are able to make more substantial reductions. Later we will be able to take advantage of the turnover in capital so I can have lower cost in generating the climate benefits.

The what flexibility means don't just focus on carbon dioxide. I am going to focus on that in my discussion of modeling results to illustrate this but you want to be able to cover as many of the greenhouse gases as possible and you want to be able to cover carbon sinks, the biological carbon sequestration. Again you will be able to take

advantage of low cost opportunities to be able to reduce your total cost of meeting your climate change or your emissions goal.

Economists have been saying this for 40 years now about the benefits of cap and trade or emission taxes in achieving a goal in a cost effective fashion. They incur fewer cost for meeting a given level of emissions then mandating technologies or mandating performance standards.

The distribution impacts, clearly when we think about how we are going to go forward with the climate change policy if an emissions tax or a cap and trade program is implemented its going to raise the price on energy. In fact the modeling houses I'll show will illustrate that. It's going to have a big impact more so on low income households because energy tends to be a bigger share of low income household budgets and so there is a concern that this policy could be regressive. It's also going to have a big impact on energy intensive industries and carbon intensive industries. Whether those who are generating energy or those who use a lot of energy. One thing is how do I address the fact that there are going to be winners and losers by this policy. Do you think about how do you design the policy, one thing that is appealing about both the cap and trade program and an emission tax is the opportunity to use the program to compensate losers. So if one were to have an emissions tax you could simply use the revenues from that tax. Use part of the revenues perhaps to offset the burden based 50s who are an industry that would be adversely affected by the policy. You could use it to help low income households.

I think another thing that is really important when we think about the benefits of emissions tax or if we were to auction off permits in a cap and trade program is that you are able also if you have additional revenues left over, you can use that to offset other taxes. So this is something that economists have been saying for a long time that the problem with the US tax code is that we tax a lot of goods. We don't tax bad we tax capital, we tax labor, these are good, these are important for growth. We don't tax things like pollution. These things are bad. We like less pollution more labor more capital. So if you were to have a policy where you said ok we're going to either impose a cap and trade and auction off the permits or we are going to have an emissions tax and get revenues from the tax we are now able to reduce our payroll tax for our tax on capital and be able to help offset some of the cost of the economy of opposing a climate change policy.

I think one thing that is important is that there has been a good bit of work that is shown that if you were to give away all of the permits that are envisioned under various cap and trade programs, the firms receiving those permits even though they are the ones that have to reduce their emissions, actually could be made better off. There has been several other studies that have shown that their inquiry values will increase in response to this policy. Now this is clearly contrary to our standard notion of the polluter page principle. This is actually a polluter winds principle happening here. Its because there is so much value in these permits that we give away even though we're giving them away for free, we're giving away a scarce asset because we're constraining the number of permits in the

economy. So this has the impact of actually they can buy and sell these permits and they end up basically having something given to them for free, that's a big asset. This is contrary to what we've done in other context, for example when we auctioned off the spectrum to wireless carriers, we didn't give away the spectrum to all of the wireless carriers they actually had to pay for it. The view was the spectrum is part of the public domain and for the wireless carriers to be able to use it they have to pay for the right to do it. In the context of our free allocation though you supposedly would have to pay for those rights to emit carbon dioxide and other greenhouse gases and it could actually benefit them substantially. That is why a lot of people have advocated for hybrids, part auction, part free allocation with so many allocations would be able to offset some of the adverse impacts on the effective firms and industries.

Cost certainty, there has been some concern that the cost are so uncertain with any form of regulatory policy, especially the cap and trade program that we really can't take the risk of adopting a policy and if things turn out to be a lot more expensive than we thought, end up really taking the economy because we implemented this climate change policy. There are a couple of different ways in which people try to address risk when designing climate change policy. One is actually instead of setting a hard cap a quantitative cap on the total emissions of the economy you're going to index your economic growth. You're uncertain about how much the economy is going to grow over time, this way you remove the uncertainty with economic growth by making your quantitative emissions cap a function of that economic growth. This is reflected in the Bush administration's voluntary goal. This is also reflected in some firm's voluntary goals that they've taken on for themselves. Probably because they're like we don't know how much we're going to grow over time, we definitely don't know how much we are going to grow because of mergers or divestures and so during it as a share of output makes more sense to us than a total aggregate quantity of emissions.

Another way to address cost uncertainty is to have a hybrid system that has both attributes of a cap and trade program and an emission tax. So the idea here is that you would assess total number of emissions that you allocated in the economy. You would do an auction or if you're grandfathering, and then you would allow at a predetermined price additional permits to be sold in the market. The firms would go to the government and they could buy as many permits as they want at that price. That effectively serves as a sealing price on the cap and trade program. And one can design this so that its an insurance mechanism. You can say well we expect prices to be say $10 a ton but we're concerned that if prices go over $25 a ton it could have an adverse impact on the economy. So we are going to tell all the regulated firms to sell additional permits at $25 a ton. If we're wrong about cost of emission reductions being much higher than we thought and the price in the market goes up, it will be capped at $25 a ton and these firms could be additional permits. If we're right and the prices never go high, we never trigger this and we end up complying with the original quantitative cap.

Another thing that is important to recognize is that we don't need to have complete and total certainty to take action. Firms make investments all the time in light of uncertainty. Uncertainty about energy prices are more bearable than what we will expect to see under

reasonable climate change policies, they also make decisions all the time of uncertainty in various forms of regulations whether its unconventional air pollutants, whether its economic regulations, whether they restructuring industry or not, all of the uncertainty with the competitive pressures both in other states and in other countries. So decisions get made all the time under uncertainty.

A couple examples on cap and trade as many of you know there is the acid rain experience which has been very successful by reducing carbon dioxide emissions from power plants and in the late 1980s we phased out lead and gasoline through a system that allowed trading among refineries that was very successful. Southern California has also started a trading program to deal with local air pollutants. With emission taxes we have less experience in the US for the most part we've done it primarily to yield solid waste where people pay through what's called unit base pricing. Pay for solid waste collection. I will note that this is part of the debate that Duke Energy has advocated for a carbon tax in lieu of a cap and trade program. This is part of the discussion among those who actively engage on the climate change issue on whether to go with tax or cap and trade in the future for policy.

In Washington especially in the Senate you've seen a lot of action with a variety of bills some of these are books on just the utility sector. These are being called the 4P bills, the four pollutants because they regulate carbon dioxide, sulfur dioxide, nitrogen dioxide, and mercury. There are two bills from the last several years on regulating utility sector emissions. There have also been several proposals to try to address emissions economy wide. Both the McCain/Lieberman bill that came out for the first time three years or so years ago then also last year follow up with the National Commission on Energy Policy by Senator Bingham is sort of advocating for an economy wide program based on their proposals and they're continuing to take comments and ideas for that. There is a lot of action going on thinking about national cap and trade programs.

When we think about the cost estimates there are a lot of models one can look at here and I actually don't want to say that the model results that I am going to be presenting from the energy information administration are the best models. But I think they have the benefit of having been very recently done to reflect the fact that we have new forecast to show much lower forecast emissions in the future. There are some models out there which are going to say that climate change policy is going to be an incredible burden on the economy. There are other models out there that say the economy is actually going to grow faster if we undertake a climate change policy. I have problems with both sets of these analyses but I think some of the assumptions that are being made by those that show very high cost make some assumptions in models that I can get to an (inaudible) aren't really associated with climate change policy per say but actually have a lot to do with how labor markets start reacting to climate change policy. Which I don't think is what we see when we get labor markets to respond to energy price shocks and that is how they get really big cost. My concern with these models that get negative cost for reducing emissions are doing so without fully appropriating all the cost associated with some of the policies they envisioned for reducing emissions.

So instead of going with the EIA model we should be honest it is probably on the conservative end that tend to show more cost and higher energy prices for giving levels of emission reductions than the typical model that's out there.

I'm going to present three cases here, the reference case which is consistent with a figure shown earlier. Then what is called cap and trade 2 and cap and trade 4 and I have these abstract names so if you want to look at the analyses, this is how they named the analyses. These are based on true variations of the National Commission on Energy Policy Proposal. And it shows what different kind of caps look like for the economy. This figure shows what the emission would look like under these three cases. The blue line on top shows the forecast emissions. The cap and trade 2 - the more moderate of the policies shows a slower growth rate but still shows that US emissions of carbon dioxide will continue to grow over the next 25 years. The cap and trade for the more stringent of the policies shows that by a decade from now carbon dioxide emissions will peak under this policy and that by 2025 they will return to current levels and continue to decline in the rest of the forecast period.

Emission scenarios are based on these carbon prices so this is price per ton of carbon dioxide. We are looking at very modest slow growing prices for the cap and trade 2 case and we see an increase in carbon price for the more ambitious case. GDP under these three scenarios – this is not a mistake in the figure, there are actually three lines there. But it shows here that there is very little difference in economic growth under these three scenarios. By the time we get to 2030 the most ambitious policy where we actually see emissions peaking in 2015 and declining and reaching current levels by 2025 and continuing to go down. By 2030 the GDP and the US economy is forecast to be about half of a percentage point lower. It's just half of a percentage point lower than it would be otherwise. This is much smaller than the uncertainty we're trying to forecast GDP out that far certainly but it shows that you can take reasonable climate change policies and see very little change in economic growth. I can use this model and say we're going to go and implement Kyoto when we started today. We're going to give the economy two years to get ready for 1990 minus seven percent. You would see a very big difference in this figure if we were to do that. So this isn't because all this model show very low cost, when it estimated Keota back in 1998 it showed very big cost for the economy. So it is just a function of the stringency of the policy.

To give you some sense of what the policies mean in terms of what you and I care about which is what happens when I fill up with gasoline or pay my utility bills. This figure shows the last 15 years the energy prices for the US and then shows the forecast for under these three scenarios. So we see here for gasoline it's a big increase in gasoline prices over the last three or four years. EIA actually forecast that once we get through this short term peak we should expect to see gasoline prices go down. We would see under these two different climate change policies a slight increase in gasoline prices. I think one thing that is important about this is that we see that the increase in gasoline prices is much less than what we've seen in the run up in the last four years. The increase occurs over a much long period of time so I'm forecasting thru 2020. So we are going to see an increase in gasoline prices over a 15 year period but much lower than the increase in

gasoline prices we've seen in the last three years. Another thing important is if we were to implement a climate change policy we actually know and expect that gasoline prices are going to increase. We could start adjusting and making decisions say what kind of car do I buy because I know gasoline is going to be a little more expensive now because of climate change policy. No one in 2001 could have forecast $75 a barrel oil and $3 a gallon gasoline and made a purchase decision to reflect that. Where now if they had bought that SUV in 2001 they are now paying a lot to fill up their tank, a lot more than they had anticipated. So the important thing to also recognize here is that with the climate change policy people can have expectations they can form that can help them adjust and adapt to the increase in prices expected.

This figures shows that for electricity again the increase is a little more substantial here but it is important to recognize this again forecast over a long period of time is also anticipated and as a growth rate between now and 2020 it is still a much smaller rate of growth in electricity prices than what we have seen over the last several years with a big increase in natural gas prices.

Finally this figure also shows the change in natural gas prices, again the increase under these two scenarios is much less than what we've seen in the natural gas market. A couple of comments I would like to make that merit consideration when thinking about the cost implications of climate change policies, one that I advise and know that you're already hearing this is to think what are other states doing, what can we learn from the other states and how they're designing climate change policies and taking action to address this issue. Second, think about what are some of your non climate change policies, what kind of impact they can have on emissions and then also think if we are going to do this for climate change are there ancillary benefits, are there other things that we value that we can address at the same time when we address climate change.

One as you know, the northeast states are moving forward with the regional greenhouse gas initiative. This puts the cap and trade program on their utility sector emissions. There are some other design issues that I think merit consideration, one is thinking about how stringent a cap to impose, one thing to think about how one allocates the permits across the effective utilities. The other is to think about the offsets. The opportunities that you should go outside the utilities sector to produce emissions. I think one thing that is of concern here is the concern about the emissions leakage. So this is the idea that you have in the northeast, they're putting a cap on the utilities sector emissions. They are already a net importer of electricity and there is a concern that if they make electricity generation more expensive in their home state that just creates the incentive for more generation outside of the region to then be exported into the northeast states. So I think it is one thing that's important to think about and we think about it also when we think about international climate change policy. Some countries take actions and some don't. The Europeans are very concerned about emissions they should give to the US right now because they have regulatory policy and we do not. This is the just taking the international context and applying it to the state level which is of importance.

California as you know has tail pipe standards - nine or ten other states have adopted their tail pipe standards conditioned on surviving the legal challenges. Then also it started to advocate and discuss and propose a number of utility sector policies. I think it is useful to get a sense of what those different types of policies may mean.

As an economists, I think about climate change as an alternate set of policies. I want to think about policies that both reduce my emissions, they reduce the effective climate change but I have to recognize that there is already climate change that is occurring, that has occurred and that will continue to occur. There is already enough emissions in the system that we know, there are some risks of climate change impacts in the future, we need to think how best to adapt to them. While a lot of people who worked on this issue talked about it like a big stretch of developing countries, we saw that low probability of catastrophic impacts that could be associated with something such as levees being breached in Louisiana. So this raise the questions of can we look at how people adapt and develop and rebuild New Orleans given that is in a very vulnerable area two natural disasters and things. How that influences how we want to think about things such as how do we douse our coastal environments for the potential climate change risk in the future.

None climate policies of emissions impacts – more than 20 states have renewable portfolio standards and these will certainly reduce the emissions in future generations in those states. Then there is the biofuels mandate. The Energy Policy Act last year actually mandated renewable fuels in motor gasoline. And again the emissions will depend a lot on whether or not we're using standard corn based ethanol or a more carbon efficient ethanol such as cellulosic. It's important to recognize what you are able to get in terms of emissions reduction and it also lowers your cost of any climate change policy you do want to propose because you've already taken some effort to reduce your emissions.

And finally on ancillary benefits one thing that is important is that if we do reduce our carbon dioxide emissions by reducing our coal consumption, reducing some of our natural gas and petroleum consumption, we're going to reduce emissions of local air pollutants and generate some important public health benefits. The higher gasoline prices that would be expected would help reduce congestion and lower traffic accidents. There is also the benefits of biological carbon sequestration could have in terms of various ecosystem services whether it's water shed protection whether it's habitant per species depending on how one goes about planting the trees and so on. And there are some things in which you can do which include and I put in quotes energy security because energy security means a lot of different things for a lot of different people. What we are talking about is being efficient how we use energy that should help us in that regard.

So to conclude I think when one looks at the economic literature on the cost of mitigating emissions one draws from it that there is no free lunch. It is going to involve real resource costs there is going to be real cost to the economy, to consumers, to firms but it's not like we will have to go back to the 1970s and deal with incredible slow economic growth, recessions, lines to fill up the car and things like that. But there is a middle ground that are the reason policies want to implement that can reduce emissions in a cost

effective manner that are consistent with where we need to be going to address climate change. I think it is important to think about how we design these policies and how do you create the incentives for people to invest in these technologies. I think the recent energy price shock show that reasonable policies are going to have an impact on energy prices but less than what we have been experiencing in recent years. We suggest that we are able to adjust to them and account for them without big impacts to the economy.

And finally I would suggest that we think about where this policy can go where policies can go. In the future total cost matter may be even more important when you think about how you get support for the distributional impacts of the policy.

To conclude my contact information is on the last slide and it also the website for climate change work address. I appreciate your attention and look forward to your questions. Thank you.

Mr. Garrou: Thank you very much Mr. Aldy. Questions?

Mr. Urlaub: I had a question, you showed a couple of scenarios projecting forward like gasoline prices, electricity, natural gas, is it correct for me if I wanted to glean a lesson or principle from your research analysis and presentation, if I walk away and think that if energy firms can come closer to an optimal portfolio mix, if the price in carbon risk which could mean pricing in anything like alternative electric generation options or if there are firms like a manufacturing firm, pricing in some kind of process innovation or product innovations or something like that. Is that generally accurate to take that away from your presentation and is that reflected in your results here.

Mr. Aldy: Well I think what one sees when one gets sort of inside the black box the model and you see what kind of behavior goes on. In these models we sort of have representative firms of different kinds, different sectors, the representative individual we see how they start their behavior. What you will see here is that they do start to change their mix in both how they would dispatch electricity. So you would start seeing where natural gas might be moving into base load and less into peak because it has a much lower carbon content than coal. You would start seeing also changes in where they do their investments in the long term planning horizon. So they start saying well we know that there is not going to be this price on carbon, this now makes nuclear more attractive than going with another coal fired power plant. So I think these are the kinds of things that when you start seeing it you will start seeing a change in the mix that better reflects the cost of generating power from these sources has on the climate. And that is why when economist advocate for cap and trade or an emissions tax what they want to do is price extra rights. But right now we know that that is something that is bad for the climate, it's bad for people and in the long term when we think about these different kinds of impacts climate change will have and no one is paying for that cost they are imposing on the planet and on society in the future. So the idea here is that if we are able to price it correctly and there is a lot of sectors that say what is the right price, one can do a full blown benefit cost analyses and try to come up with that. Before you put on that price you start getting them to change the fuel mix and the technology decisions they

make and they are indeed efficient. So it is not just what am I going to invest in for the next power plant but what do I do in terms of investing say carbon capture and storage which no one would ever want to do if they thought there would never be a price on carbon dioxide. So these are the kinds of things that I think start to influence the kinds of decisions a utility would make as they more forward in response to this kind of policy.

Dr. Eggers: Thank you for your presentation. Just recently one of the economic professors at my university was talking about how, he's a big fan of cap and trade as am I, but really how when we put some kind of safety valve on it we loose a lot of the potential benefits of having a market trading program. So as the economist stand before me and talk with a straight face about putting a safety valve on, I wonder is that really just for political reasons to increase certainty for industry to make it more palatable or is it because you think it is economically the best idea.

Mr. Aldy: Well I think both. So on the political point of that there are a lot of different models out there that will give you a lot of different estimates of prices. So some people who are skeptics of climate change policy will point to that and say prices are all over the map, we don't know what they are going to be. Some of them show that they can really be high cost and we can't take that chance to the economy that is what some will say. So one response on why this idea was first put on the table some eight/nine years ago was to try to address this concern. Now from an economic prospective why it's appealing, I actually don't think it breaks down the kind of market you're trying to create and the reason I say that it depends on what kind of price you have in mind for what you sell these permits at. So as I like to think of it as an insurance mechanism and the idea that we think prices are going to be at this level, say $10 per ton but we don't want it to go above $25 per ton. So that is what we're going to price these additional permits at. So if the market is working very smoothly, cost of investing in these technologies are at or maybe even below what we had originally forecast, we're going to see the market behaving down here. No one is ever going to go to the government and buy these $25 per ton extra permits or extra allowances. If they do I hope their share holders throw them out of their job because that's a very bad business decision when you just go to another firm and buy them at $10 per ton. So it is only when the prices are unexpectedly high when you have these sorts of shocks in the system that one would actually want to be able to have this insurance mechanism.

The other reason I've given the prospective of why it's appealing is that actually if you talk to a lot of economists, they actually prefer a price based approach to a quantity based approach. That is a carbon tax can have more appeal than a cap and trade program. And the reason being is that in the near term the absolute level of emission reductions isn't that critical for the climate. In the next 50 to 100 years how many tons will you net in the atmosphere aren't important but whether they're all being emitted in the next five years or spread out over time doesn't matter as much. So the idea is that there is an incremental benefit of reducing another ton is not that big for climate for any given year. If there is this risk that if I do reduce the amount of emissions that can occur through a cap and trade program that incremental cost may end up being really high by ending up having a really stringent cap. So the idea that you may want to have some of this hybrid

system that allows you to make sure you don't even experience these really cost because the incremental benefit of reducing another ton isn't that high in the near term. That's what the standard economic analysis will say on this. That's why at the end of the day you see more and more economists saying that a cap and trade or carbon tax or hybrid or both. The other thing I would say is that I like them both a lot more than standard commanding control kind of policies where I think you start getting the situation where the cost that different firms face can vary a lot and that means we are spending a lot more money for giving emission reduction than we would if we had either an emissions tax or a cap and trade program.

Senator Pittenger: Thank you Mr. Chairman. I am hesitant to make a statement because I would like to hear from the other four people who I think deserve equal time. You mentioned Duke Energy and I know Exxon too advocated caps. While I am a big supporter of nuclear energy I do think that the reference to that should be noted the fact that the nuclear energy doesn't create CO_2 emissions and it certainly is worth their advantage to say that.

Mr. Aldy: I think it's very true that as utilities come more and more sophisticated about this issue you will see different positions being taken and you see this some in California and partly reflect their current mix and where they think they are going in the future.

Mr. Profeta: Thank you. I will try and be brief. The Senator just mentioned Duke Energy is also in favor of cap and trade and they had a higher 12 percentage factor than any other utility in the nation. So it is not only nuclear as their advocating point. Just a quick question on the modeling data you talked about, the EIA model and how it was maybe being a little more conservative. What is really important in all these models is the assumptions that go in. Can you give any sense of what are the assumptions that go into that EIA model in terms of what price do we see coal gasification coming in and things like that we heard about this morning and is there any sort of tax feedback looped in that model where you would actually have a reduction in revenues and taxes raised as a result in the model in that model.

Mr. Aldy: To be honest this is the most recent version I have and they don't actually present this in their public report. So it's something I would need to go to the EIA modelers and get detail on how they model the tax issue. This is something if one were to read the economic literature for which I wouldn't recommend unless you got insomnia but if you were to read this literature there is a vast literature on basically the tax code and how you implement this thing and the tax effect. So there are different kinds of rules that get used in different models, some of them are this idea that well if we are going to see an increase in these permits being put out there and an increase in energy prices that's going to slow economic growth, that's going to slow the government revenues. One response is you decrease the amount of money that the government has to have to operate the model. You always have to have a balance in the model which also doesn't quite marry the railroad where we don't have balance in what our government is doing with our expense money in Washington. There is that kind of assumption that's being made in the model. All the models assume that you have to increase tax rate on goods to make up

for the fact that you've got slower growth which of course then just makes the economy grow even slower. That I think is very frustrating for me because the whole point of trying to put a cap and trade program on pollution is because it allows you to free up and reduce your taxes on goods like labor and capital and instead some of these models make these assumptions that we're just going to increase taxes on labor and capital. So what you end up seeing is that it is not the energy price that's sort of our first initial effect that's driving the economic cost it's the secondary effects that's based on the assumptions about how the government responds to the taxes and then how people respond to the supply and labor of the economy in response to these higher taxes. All of which you can address if you just want to do tax reform. I can tell you the exact same story if we have a conference on fundamental tax reform. So our issues that are important to think about that are related to climate change but there are smart ways to do it that aren't always captured in all of the models.

Mr. Stephenson: Could your elaborate on the depth of strategies what lessons have been learned from other states and what you think we've learned from Katrina? I assume you are not suggesting that we begin building levees.

Mr. Aldy: No I don't suggest that. One reason is that I realize we're looking at the agenda that it really didn't seem to be anything on adaptation. I think this initiative is getting more and more serious consideration at the international policy level. I think it's a little premature to say what we've learned from Katrina. I think we've learned a lot of the failures but it would be nice to think over the coming years we can learn about some successes on how to address this. I think what is important is that it shows that we are at risk of natural disasters and when we think about in the future with climate change that places whether it's the southern half of Florida, whether it's the Outer Banks that we have areas where we have economic development and economic activity that's very close to sea level or even below sea level in some cases and they will be more and more vulnerable. The idea then is to think of what kinds of actions are being done around in Louisiana. For example one of the things that's been talked about is really trying to regrow and redevelop a lot of the coastal weapons many of which were destroyed that served as a natural buffer and perhaps that's something that can be useful when one thinks about how to restore the Ecko systems in southern Florida and maybe there are some lessons to be learned from that. Right now its more to the question of can we learn from these experiences and recognizing that even a very wealthy developed country, we're going to have to learn to adapt.

Mr. Garrou: Thank you very much Mr. Aldy. We're going to change the order slightly because one of our speakers has to catch an airplane and that speaker is Margo Thorning who is Vice-President and Chief Economists of the American Council for Capital Formation.

Dr. Thorning: Thank you very much. It's a an honor to get to talk to you about some of the work that the American Council for Capital Formation has done on this very important issue and I have to say before starting I agree with a lot of the comments of the previous speakers and I think the difference I may bring to bear is a careful look at what

some of the array of models has shown about the cost of trying to a near term of emission reductions and also what's going on around Europe and how their system is working. So let me just say the American Council for Capital Formation is a non profit bi-partisan think tank in Washington. We also have a think tank in Brussels that is the International Council for Capital Formation and their websites have different sorts of economic analyses on this very important topic. Let's take a look at what some of the previous work has shown about what the cost to the US might be actually trying to reduce emissions. The chart (Exhibit I) I just put up is an array of different modeling from the past five/six years some of which was done during the Clinton administration. Looking at what it would actually cost if the US had ratified the Kyoto protocol and the number on the far left was produced during the Clinton administration by our Department of Energy suggesting that it might reduce the level of GDP by 4.2 percent in 2010 if we actually had implemented the Kyoto target. Various other models that I put up there are by work econometric forecasting by DRI/WEFA after they combined, by the Australian Bureau of Resource Economics, by DRI by Trouser Associates, by Professor Allen Mann at Stanford, the late Professor Mann, rich rituals all show substantial economic cost. Range depending on whether they used a microeconomic model. Which is better designed for measuring the near term short run cost of reducing energy and raising energy prices or general equilibrium model which is better at assessing the cost over a 30 or 40 or 50 year period after all factors of production have had time to change the capital stock. But the reason our Senate voted 95 to 0 to not support a Kyoto type proposal is that our Senate and House had before them these type of results, these modeling results. So they understood that they might not know exactly what the economic impact would be of trying to hit a target at a predetermined date but they knew it would be costly in terms of lower levels of GDP, lower levels of jobs and so forth.

Another set of recent model results looks at what the New England governor's plan would have cost the eleven northeastern states had they adopted it, had they chosen to go it alone. The New England governor's plan envisioned all sectors being included, not just the electric utility sector. They envisioned reducing the emissions in these eleven states to 1990 levels by 2010 then tightening the target so that by 2020 they reduced ten percent below 1990 levels and then they contemplated getting on a path after 2020 to reduce emissions to 85 percent below 1990 levels. Charles Rivers Associates, now called CRA International, modeled the impact of the New England governor's plan and concluded that compared to the baseline which Dr. Aldy talked about, we would see increase in those eleven states of electricity prices compared to the baseline of 35 percent, gasoline prices almost 40 percent and natural gas prices by 111 percent. Those eleven states in 2010 would lose almost 200,000 jobs because of course industry would migrate out of those eleven states. There would be carbon leakage and job leakage and productivity would be less because energy prices would have to rise to force down emissions. Household income would be about $2600 less and federal and state tax receipts would decline and as Dr. Aldy mentioned low income and elderly would bear a disproportionate burden. So this is what accreditable modeling result shows as the impact of states going it alone and so something for North Carolina to consider whether they want to go it alone because clearly there would tend to be carbon leakage. The unfortunate thing is because global emissions are going much faster in China and India.

By the year 2100 it will make no difference to what happens to concentrations of CO_2 in the atmosphere even if North Carolina absolutely shut down and didn't use any carbon. Some other recent results which contrast a little bit with what Dr. Aldy was showing previously this economic analysis of the McCann-Lieberman proposal and the Bingaman proposal was prepared again by Trouser Associates International Energy Modeling firm and the question is how much do less stringent targets, less stringent than the Kyoto protocol, how much do those cost? And clearly again GDP would be impacted approximately one percent less because energy prices under the McCann-Lieberman proposal would rise because that proposal envisioned reducing emission to 2000 levels by 2010 then in 2016 getting on a track to reduce to 1990 levels. We also assume that post 2020 they got on a trajectory to reduce emissions to 85 percent below 1990 levels because that is where IPCC scenarios suggest the development countries may have to go. So the targets will not stay the same they will be ever tightening and in that situation by 2010 GDP would be lower by one percent. Job losses for the US would be almost one million fewer jobs, household consumption would be about $725 less and again federal and state tax receipts decline. In the Bingaman proposal is a less stringent proposal than the McCann-Lieberman. The NCEP plan Dr. Aldy referred to has targets to reduce emissions intensity and those are less tight than the McCann-Lieberman. So the impact while negative is not nearly as great minus 0.2 percent of GDP and 230,000 jobs and smaller impact on household income. In 2020 of course the costs get higher because the targets are tightening. So these proposals are not as painful as the Kyoto protocol but none the less has cost. But when you look at it from a global prospective and try to look at the cost and the benefits because even if all of the countries that took on targets under the Kyoto protocol actually hit their targets, by the year 2100 it makes no difference. So Kyoto and these proposals are not enough in order to make a measurable impact on CO_2 emissions globally.

Another point I would like to raise with you is let's take a look at how European Union is doing with their emission trading system. The latest projections from the European Environmental Agency which we released in November of 2005 show that in fact the Union is not on track to hit their target even with the emission trading system that they put in place in January 2005. They are expected to be four percent above the earth Kyoto target, no eight percent below 1990 levels, so it would be four percent above 1990 levels. Many of the countries like Spain are expected in 2010 to have some strong new measures to be about 28 percent above their emission levels. So at the European Union unless they put in place much higher taxes to force down energy use, they have no prayer of meeting their Kyoto target and their current emission trading system covers 9-12,000 industrial facilities. Of course there are millions and millions of emitters in Europe and they simply don't have the political will to impose taxes on households and on transport. A large source of their emission growth is in transport to get emissions down to their Kyoto target. I believe given the recent evidence that the emission trading system has raised electricity prices substantially in the UK and in places like Germany that probably there is going to be a gradual evolution toward an alternative policy and most likely their attempt to get a target for the second commitment period is domed to fail, I think because they are not making much progress toward their current target. Industry is struggling, growth is only one percent in the EU verses about 3½ percent here, so I think cap and

trade in Europe is probably going to be slowly phased out and hopefully replaced with something that is more productive.

The reason why I think we need to look hard before a state like North Carolina would adopt a cap and trade system is that basically when you cap something you are forcing producers to go to end of pipe near term solutions and you're diverting resources from longer term research and development that could lead to the technologies that will enable us to move away from fossil fuels. Carbon caps really don't provide certainty. We already have uncertainty about energy prices in general. A current government could say we are going to put in place a safety valve of $25 a ton but this current government can't fine future governments. You really don't know whether the cap will hold, whether the targets will be changed because of the realization that energy use and economic growth go hand in hand and when an economy begins to struggle you will find legislators who are interested in their political survival making every effort to generate the kind of climate that will allow industry to growth. So I don't think it is accurate to say that carbon caps provide certainty and will therefore increase investment. I think quite the opposite is true. Also we can't really count on international arrangement, the economists are talking about international proposal with an international trading system so that we can find the lowest cost emissions and then purchase them so we would not have to make even more costly reductions in our already energy efficient economy. But you can't really bind, let's say we bought emission credits in China that were to come due in 25 or 30 years, what if China doesn't make those emission cuts, how are we going to enforce such a regime. I think there is a lot of uncertainty and probably its not very practical to think that we can develop an international trading scheme that would not be just plagued by fraud and abuse.

Well how can we reduce greenhouse gas emissions in a cost effective way? Clearly it is an important issue, not that there aren't many other important environmental and social issues but the guiding principle I think we should focus on is using cost benefit analyses to determine whether an approach, what is the net benefit in terms of environmental benefits, in terms of economic benefits and what does it cost. Bill an esteemed economics professor at Yale University issued a study in December 2005 an NVER research paper that stated the cost to the US of complying with the Kyoto protocol, the present discounted value is 5.5 trillion dollars even when you include all the possible environmental benefits and economic benefits. It's a huge cost and hardly any benefit so based on the preponderance of the research that I've seen I think we need to be looking elsewhere and a different approach to reducing greenhouse gas emissions. You've probably seen this chart before, the greenhouse gas emissions over the next 100 years are the developed country emissions are the ones shown in blue. As you can see the developed country emissions are pretty much flat and declining very slightly over the next 100 years whereas developing countries, India, China, Latin America, Indonesia places like that are growing much more rapidly. So the question is how can we approach the issue of climate change in a way that does some real good and doesn't materially impact US economic growth and global economic growth.

Take a look, I know these numbers are small and you probably can't see them, but as I say you have the slide presentation and it will also be I believe on your website. This chart shows the average life span for selected energy related capital stock and for example toward the middle you have residential, heating and cooling equipment. The average life span there ranges from about 10 to 20 years, so your average air conditioner might last 20 years. Your average truck and bus might last 15 to 30 years. The average piece of manufacturing equipment perhaps 15 to 40 years and of course electric transmission distribution equipment can last anywhere from 25 to 50 years. Power stations up to 50 years, the building stock can last anywhere from 40 to 120 years. So our capital stock tends to be very long life and we need to think of ways to pull through that capital stock more quickly so that we can actually put in place cleaner, less emitting, less energy intensive equipment. One thing we can think about doing and the ACCF has long urged, is to reform the US tax code so that depreciation allowances for these type investments are a lot quicker. One of the startling facts is for example if a US investor puts money in a combined heat and power facility which tends to be more energy efficient, after five years he's only gotten back 29 cents on the dollar in depreciation allowances. He's only been allowed to write off 29 cents on the dollar. In Germany that same investment investor's got 50 cents back and in China the investor's got $1.04 back so many countries have much more favorable tax codes to allow quicker write off which lowers the cost of capital for these types of energy investments. The US has one of the highest cooperate tax rates in the industrial world, 35 percent versus an average of for example 30 percent in the EEU and much lower elsewhere. So when you look at our high tax rate and our slow depreciation, US companies are very disadvantaged and we can take a look and gradually make some changes to the tax code without breaking the budget and perhaps North Carolina might also like to think about improving the investment incentives or improving the tax climate so as to encourage pulling through the capital stock a lot quicker.

Another important thing that I think to address the whole issue of how to reduce global emissions of CO_2 is to take a look at what countries like China and India are doing now in terms of replacing their capital stock versus what the US and a country like Japan is doing. If you take a look at the far left column you can see that China is using about 0.7 million metric tons, their current installed base, to produce a dollar of output. Their new installed base is using about 0.4 million metric tons for every dollar of output. In India a similar situation, they are not really installed bases it's just about as efficient as the Chinese. But if you look at the US we are using about 0.1 million metric tons to produce a dollar of output. In Japan much more energy efficient is using about 0.07. So if we could get into Chinese and Indian factories the kind of equipment that we already have with our current technology or that Japan has or that Germany has or that Australia has for various different production processes, we would see a material slowing in their energy intensity and a gradual reduction in the rate of growth in greenhouse gas emissions as well as other emissions. So the positive approach of trying to transfer the technology to developing countries in the Asian-Pacific partnership as an example of that you probably follow the agreement that was signed in July of last year between China, India, the US, South Korea, Japan, and Australia to focus on economic development and to focus on transferring technology so as to reduce greenhouse gas emissions. That could

be a very positive step forward that will help generate the kind of development and economic growth that will make a difference over time as Professor Aldy discussed. That's important how we do it over time, emission reduction don't have to ratchet down immediately right now. And just to drive home the point of how strong a factor economic growth can be in terms of reducing energy intensity, take a look at these data which we compiled from Energy Information Administration document. As you can see the red bar which is the US, we've reduced our energy intensity by 12.2 percent over the 1997-2003 period so we've reduced our energy intensity much more rapidly than has the EU. Even though the EU has a mandatory required Kyoto target we're doing much better and the reason is we're growing, they're not growing. And we also have population growth. They don't have population growth. We're doing very much better at reducing energy intensity with our 3½ percent growth rate. They are only growing at 0.1 percent on the average and they're not pulling through on their capital stock as fast. The bar over on the far right is the data from 1993-2003 so that's a longer time period. I will correct the slide so you will have the correct numbers, I apologize for that. So the point I'm making is that economic growth can actually be a really strong positive thing to improve environmental quality and let countries continue to grow, continue to prosper and gradually become less and less energy intensive. Of course at the same time we have to continue with research on alternative technologies and ways of slowly moving away from fossil fuels if that is what the science indicates is necessary.

To sum up, I think a state like North Carolina would be good to focus on using cost benefit analyses before you adopt any mandatory policies or further policies to address greenhouse gas emission reduction. I should point out that the state of Maine last May 2005 passed legislation requiring the use of cost benefit analyses for any policies to address climate change. I think it also would be very good to reform the US tax code to speed up depreciation and perhaps also take a look at the tax code in North Carolina. We're moving barriers to developing world access to more energy and cleaner technology by promoting economic growth and economic freedom can be a really positive thing. There is a new study by Dr. David Montgomery and Roger Bate which is on the ICCF global website which shows the countries that tend to have the criteria that indicate they're economically free, like low trade barriers, protection for an electoral property rights, lack of subsidies for domestic industries, low level of corruption. Those countries tend to grow faster and tend to be much less energy intensive.

Furthermore increasing R&D for new technologies is essential. We probably need to be spending more than we are to encourage reductions in energy intensity, developing sequestration through both natural and man made technologies. By the way, carbon sequestration has been used very effectively to enhance oil recovery so I think that it is not clear that we need a cap on carbon to encourage carbon sequestration and some industries have been doing that for some time and hopefully that will continue. Also, plus promoting nuclear power for electricity generation, expanding bilateral cooperation with developing countries which the US has 13 or 14 partnerships with other countries to work on various aspects of climate policy including the science, new technologies and other aspects and then promoting a truly global solution such as the Asian-Pacific partnership. This climate change is a global issue, it's not a local issue and as Dr. Aldy

pointed out it really doesn't do very much good for one small locale to focus on reducing its emission in isolation. We need a global approach and one that will not reduce our economic growth.

I just want to add in 2005 the US actually used less energy than before and that was in response to the higher prices that we're seeing and that was the first time in 20 years we've used less energy when we were in a period of strong economic growth. So I think the fact that energy prices are high and not predicted to go down any time soon for natural gas or for gasoline is going to be a really strong incentive to encourage investment in alternative technologies and energy efficiency. Thanks and I will be glad to answer any questions.

Mr. Garrou: Thank you Dr. Thorning. Questions?

Dr. Smith: I appreciate your comments on technology and certainly technology is going to be a very integral part of how we move forward. But I think policy development is going to be very critical. I am curious, my experience in looking at coal fired power plants and the lives of coal fired power plants is not one where accelerated appreciation or amortization is going to drive them off the market. We're actually seeing a converse because the utility industry has continued to pop up and maintain a lot of the old coal fired power plants. I'm not sure that just changing the tax code for them is going to get them out of the market and that is what has precipitated a lot of the discussion about new source review and other things like that is they came to Congress years ago and said that they were going to have a discrete life and at some point would be rolling the fleet off. But the fleet hasn't rolled off and as a matter of fact you're seeing a lot of the coal fired power plants are actually going beyond what was originally conceived and then now they're making significant investments and retrofitting those plants and keeping them going for the foreseeable future. So I guess it would be helpful for me to understand what examples do you have of the fleet turnover in the coal fired power plants or is there an example of how that would happen? And I have one quick follow up to that.

Dr. Thorning: I think the fact that natural gas prices have risen so much in the last several years has probably encouraged people to go back and retrofit a lot of coal plants that might have been scheduled for retirement and the fact that it's been so difficult if not impossible to build a nuclear power plant in the US over the last 20 years has also perhaps encouraged the extension of life of these coal fired plants. But I think a lot of utilities do have new coal plants on the drawing boards of course because of the change in energy prices and if depreciation could be speeded up so that they could get their cost back faster I think we would find them putting in place much more efficient plants that had a much higher ratio of energy efficiencies. So I think it would certainly make a difference over time, maybe not immediately, but they have to supply their markets and we are going to be needing more energy not less and I think we have estimates of 30 trillion over the next 15/20 years in energy investment here in the US. So anything we can do to encourage people to take the risk to put in place cleaner less emitting technologies whether its coal or other fuel sources should be encouraged.

Dr. Smith: I guess I understand that the new plants to meet new demand but I'm not sure that that's necessarily taking the existing fleet off the market and that's one question. Another quick question I had was on your chart that showed sort of the growth of the developing nations and developed nations if there is an amount of CO_2 loading into the atmosphere that causes the dangerous changes to the environment that many people are concerned about, there is a total amount of that pie that can be done, let's say there 450 or 550 parts per million in the atmosphere. I guess my concern is that the developed countries have already eaten up a significant part of that pie and now we've got the developing nations coming in behind as they grow and they catch up with their standard of living and so it's a little disconcerting that you seem to be implying that there may not be as much responsibility with developed nations to decrease their share to make some head room for the rest of the world to develop. And I'm just curious, did I miss something there or what are your thoughts on that?

Dr. Thorning: I think you have to look at the whole issue and perspective. The developed countries are responsible for the strong economic growth and have pulled through economic growth and developing countries. So when the industrial countries maintain a strong economic base and are able to provide markets for developing countries we're in effect pulling them along with us so you have to think about what near term emission reductions in the industrial countries would do to our ability to be a strong engine of economic growth and most of the studies I've seen including Dr. Aldy mentioned is costly to reduce emissions in the near term. So we want to balance the need to move it forward in terms of being more energy efficient with a desire not to throw the baby out with the bath water and strangle economic growth. The hope and the thought is that as we continue to spend on new technologies and on new research gradually we will be able not only in the developed countries but also in the developing world to consume more and more energy. China for example has 40 nuclear power plants on the drawing boards. Of course they also have 400 coal fired plants on the drawing boards. So I think that it is probably premature with the sciences not well enough understood to know exactly what sort of target would be needed. We still need to do further research on that but the point is, without strong economic growth we will not be able to continue to provide a market and to be a force for positive change.

Mr. Shore: First of all I want to thank you for your last slide. I think the way you presented those government policies that could move us forward in aligning economic growth and reducing global warming pollution is good for us to consider. So I appreciate those thoughts and then I want to try and uncover a little bit of where the truth lies. I know we can cut the data and force them to confess in whatever outcome we want, and so there is a difference in between your presentation and of Dr. Aldy in the economic impact to GMP and yours showed a more significant impact. So I wonder if you can comment, and I think his went out to 2030 and showed a very small impact of capping carbon emissions, he had a $50 per ton level. So could you comment on his presentation and that analyses where that very small effect on GMP and if Dr. Aldy could also then comment on your slides that showed the bars that had the one to five percent impact on GMP that would be great.

Dr. Thorning: Of course I haven't really studied Dr. Aldys' model but just in general the assumptions going as one of the members of the Committee pointed out, assumptions going into the model are very important, the type of model whether it's a macro economic model that's geared to measuring short run frictional cost or whether it's a general equilibrium model or whether it's a bottoms up engineering model but assumes basically that if the technology is there it will be adopted and that the reason it has not been adopted is that there is lack of information or people some how don't know about it. So I really would have to study his results but I presented to you an array of models from different groups, academics, consultants, the government and they all showed either using the two types of macro equilibrium models quite significant cost to near term emission reduction. So obviously the longer you give to reach a target, if you give 20/25 year to reach a relatively easy target that will cost less using anybody's model. I was focusing on trying to explain to you why the Bingaman proposal for example cost less than the McCann-Lieberman and why Kyoto cost much more than either of those two.

Dr. Smith: Dr. Aldy do you have comments on the difference in how the numbers were presented.

Dr. Aldy: No. I think one thing that is important about the model that I used, the results that I presented, I didn't actually do the modeling analyses it was from the Energy Information Administration. I think this is actually useful and contrasting the cost of the stringency of different kinds of policies because the bar figure that Dr. Thorning presented at the beginning the highest cost model results for Kyoto was actually from EIA, their 1998 summer 1998 analyses and they showed on the order of about 3½ to 4 percent decrease in GDP in 2010. All I'm using is the same model but updated to basically late 2005 versions that they just published last month. So it is the same fundamental basics, a lot of the same fundamental assumptions, the big difference is that if you look at implementing Kyoto and how it was modeled in EIA, that was the scenario in which they assumed that all emission reductions to satisfy Kyoto would have to occur within the United States in the energy sector on carbon dioxide emissions exclusively. That analysis you're talking about reducing your emissions about 17 or 18 percent from the current levels over a period of about 10 years. Now the two scenarios that I presented in my presentation showed that with the more stringent case you had emissions reaching current levels peaking in ten years and reaching current levels in about 20 years. So the thing is that it's a very different profile of the emission reductions required under the policy cases that I presented today and then what was assumed in the EIA analysis of the Kyoto protocol from ten years ago. And a lot of the variations you'll see in those economic analysis have to do with how much of Kyoto do you think would be actually achieved domestically, how much can be achieved through taking advantage of international emissions trading and other kinds of mechanisms, clean mechanisms things like that. So there are differences across the models and the kinds of assumptions they make but I think in this case it really illustrates the stringency of your target. I mean do you really want to reduce emissions drastically. I don't think that you are going to be able to get there without imposing substantial cost in the economy. But if you take a recent path of slow down growth, peak in the decline, then you can do so without a big burden to the economy.

Dr. Thorning: Let me point out that there is a new EIA study I'm not sure if it is the same one you're referring to, it comes from Salazar Requested same study. But if you look in the back of this study it points out that a proposal a little bit more stringent than the Bingaman proposal the contrast that the Bingaman type intensity target a little bit tighter than Bingaman with a high technology scenario. The high technology scenario actually increases GDP whereas the Bingaman type proposal reduces GDP and electricity prices actually fall into the high technology scenario and they rise under the Bingaman proposal. So I think it's clear that a focus on encouraging even more than we already do more investment and development of technology which I know North Carolina is well able to do – its likely to lead to less pain and more gain in terms of environmental benefits.

Senator Pittenger: Thank you Mr. Chairman. Dr. Thorning we've had several references today and on previous meetings of what other states are doing particularly today several references to California. What role have they taken and Governor Schwarzenegger in terms of mandates on CO_2 emissions.

Dr. Thorning: Well that's a good question. And I was invited to be on a panel with Governor Schwarzenegger on April 12 out in San Francisco. The climate action group had a symposium to discuss the path forward for California and as you may know the target action team proposed similar targets to Kyoto protocol and they advocated about 43 different mandated measures to reduce greenhouse gases. It was very interesting because there were ten people on the panel and then Governor Schwarzenegger and when the moderator rolled around to the Governor and said well Governor what do you think ought to be done here and Governor Schwarzenegger said in his wonderful Australian accent "well you know I think we had better hold off on putting caps on carbon emissions because we don't want to scare the business community out of California". And of course the audience who had been assembled expecting to hear we're going to go forward and we're going to implement these type caps in the near term just about fell out of their chairs because it was very clear that the Governor had begun to think about what near term caps and high renewable targets might do to the already somewhat difficult business climate in the state of California. So I think they are taking a much more careful approach in term of what sort of policies they are going to adopt on climate change.

Mr. Profeta: Apologies for keeping this going but a lot of people have raised the assumptions question and I wanted to go back to it. Also, I was at the California Climate Action Registry Conference last week where Terry Tamlin who is head of Environmental Policies spoke and did advocate for some caps. Also AB32 which was introduced in California last week that has caps incorporated so I would agree that there is a political process in California that is underway but I think the Commission should do some fact finding about what is going on in California because there's a pretty influential situation.

Dr. Thorning: The Governor was quoted yesterday in the press as saying he thinks we should encourage more energy efficiency and drive more energy efficient cars and there really was no mention of cap and carbon.

Mr. Profeta: OK I will concur to the Commission to do some fact finding. I want to go back to the assumptions since I raised the issue earlier and we got into it a little bit and other than the slide on the Kyoto protocol all the modeling results were presented from Trouser Associates study and I'm wondering if you could answer some of the same questions I had for Dr. Aldy about the assumption that went to that study particularly about the question of what happens with tax revenue and whether taxes should be increased, what is the coverage of the model of other gases besides CO_2 that also contributes to greenhouse gases. What price point in terms of a carbon market, certain technologies, cleaning coal gasification are soon to penetrate the market?

Dr. Thorning: You may have to keep going over those. I'm not sure I got them all down but the first one the question of what happens to revenues. All of the studies I'm aware of assume revenue is recycled. Taxes are not just raised and then the government takes more revenue, they are all recycled. By the way if you take a look at the studies that are on the ICCF Global website on impact on European countries of trying to actually meet Kyoto targets and even tighter targets all that revenue is recycled, so that is a pretty standard assumption. And the price of carbon emissions I think under the EIA estimate was assumed to raise as high as perhaps $350 a ton of carbon and its less for some of these other simulations ranging down to 90 or $100 a ton on carbon.

Mr. Profeta: What price did IGC penetrate? If it were 300 would that seem about right?

Dr. Thorning: I really honestly would have to look that up and get back to you. I'm not certain. I hesitate to answer that. If I can get your contact details I'll try and answer that. But technology is assumed even under the base case forecast, we assume substantial new technology and it's driven through even faster under the carbon cap scenarios.

Mr. Profeta: My apologies I know this is long but the last one is what is the assumptions that there is non CO_2 gases in the .....

Dr. Thorning: Most of the studies only look at CO_2 because that's 85 percent of most of the greenhouse gases so all the studies that I'm aware have just looked at CO_2 not tried to factor in methane and the others. It's just too complicated, it gets too expensive to do the modeling at least for the resources we have. I apologize I've got to go in about three minutes.

Mr. Karl Hausker: If the Chair will allow a question. Just wanted to first of all observe, I just flipped through the executive summary of the California action plan on my left and it confirmed what I thought I remembered when I first read it which is there are no Kyoto style caps in the proposed actions in the California plan. It's a sector by sector portfolio of policies covering all sorts of things. I think that's very important to remember along with the fact that in my experience there is only one group of states that have actually proposed capping their emissions. A group of northeast states have been floating the idea of an emissions cap that would start at the power sector maybe go to the rest of the economy but that is only based on power plants in their states and people who look at that

recognize that that's not going to be particularly binding. My point here is we've had two very excellent presentations on the economics of climate change mitigation however they are very limited relevance to what North Carolina is considering which is looking at a full catalog of options that have tremendous co-benefits across different sectors. The discussion of national or international cap and trade have very limited relevance to what California has proposed, the plan that Connecticut put forward, the plan that Maine put forward, Rhode Island the plans that are being developed in New Mexico and Arizona because they do not contemplate state wide cap and trade. Instead they look at specific policies that create many benefits for the state, air pollution reduction, water pollution reductions, GHG mitigation, economic development, quality of life improvements, that's where we should have our focus and not on economic analyses of national or international cap and trade.

Dr. Thorning: Let me just respond to that. All of the programs that could be contemplated to be mandated if they were truly energy efficient, you wouldn't need to mandate them the market would take care of addressing that. And just one more word on California's plans, they have aspirational targets to reduce greenhouse gas emissions to something like Kyoto levels and they also have a proposal to require 20 percent of all electricity to be produced through natural gas by 2010 or 2015 so they are approaching this with a commanding control approach basically but they do have aspirational targets. But Governor Schwarzenegger seems to be pulling the state back from that type of approach. Thank you very much.

Mr. Garrou: Thank you very much Dr. Thorning. We have decided that we will have one more presentation this afternoon. We don't want to wear everybody out. Our last two speakers have agreed to come back at our next session. So we will hear from Dr. Whitehead this afternoon and then we will hear from the other two speakers at our next meeting. So Dr. John C. Whitehead who is an Associate Professor at the Department of Economics of Appalachian State University, welcome Dr. Whitehead.

Dr. Whitehead: Thank you and while my presentation (Exhibit I) is being pulled up Joe mentioned that he works at an economics department with no students, I work at an economics department with a lot of students and finals week is coming up and so I appreciate this little vacation from that part of my job.

My task is to talk about what might happen, what the cost might be if climate change is not mitigated. First of all, I want to lower expectations I don't have any clear answers and the previous two presentations and the ones this morning did a real good job of laying out what actually might happen on the cost side and with technology. On the benefits side and the opposite of the cost of not doing anything, those are the benefits of mitigation. On the benefits side there is a lot of uncertainty about what might happen and so in my outline here I have a lot of qualifiers, economic uncertainty, a partial list of potential impacts, the evaluation of these potential impacts and if you will bear with me I just want to sketch out a real quick economic model of what might be going on here. First of all this first picture is what we call a damage function and on the vertical axis we have temperature and other physical aspects of global climate change and on the

horizontal axis are the potential damages of those. Right now it is difficult to determine what these might be if we're thinking that temperature increases and temperature leaves a sea level rise. These damages might be the impact on home owners at the beach, it might be an impact on people who like to go to the beach, and if sea level rise erodes the beach and makes it more difficult for the beach to handle storms then home owners and beach goers will respond to that in one way or another. It's difficult to say how that might be so I've drawn three pictures, three lines and each of them imply a different set of behavioral assumptions. Right now there have not been a lot of studies nationally or in North Carolina about what these lines might look like. A lot of what I have to do is guess work here. On top of the damage functions, evaluation functions turning these behavioral responses into dollar and cents estimates that can be compared to the cost estimates that we've heard in the previous two talks. On the horizontal axis here I've gone to damages again, two arrows indicate that the damages might be small and the cost of the damages depend on again a reaction function that might be concave or convex. So those are my apologies for some of the numbers that I'm going to show you. It's a lot of guess work and a lot of piece mill adding up of various types of things.

Potential damages I'm going to talk about are in two main categories – human health and environment and Brian was going to talk about agricultural and forest today and he's been bumped and so you can look forward to that. The evaluation methods I'm going to use, first of all I'll admit that these are back of the envelope calculations the numbers that are plucked from the literature and I applied those to a very rough estimate of what the damages might be, multiplied and then added up. In economics we call this the benefits transfer approach. Back in the old days they called it plain estimates off the shelf. But they are just back of the envelope calculations. The scenario that I'm going to look at is that the magnitude of the damages are estimated as an annual one percent change and the one percent change might be the lowest damage that we might face. These damages can be scaled up in parenthesis. I say down if I've overestimated the damages by simple multiplication assuming that the two lines in the damage function and evaluation function are linear. If you see a one percent change in your handout, if you think that the actual change is ten percent you simply multiply that by ten percent to get an idea of the magnitude of what those numbers might be. All the numbers that you will see are in 2005 dollars.

In terms of human health there are more sectors in the economy or four types of damages that I'm going to consider. Heat related deaths, storm related deaths, non-melanoma skin cancers and drinking water and there are other human health related impacts that could be considered. They are not considered simply because I either ran out of time or was not familiar enough with the literature to find those estimates quickly. In terms of heat related deaths, again the scenario is there should be a one percent increase in heat related deaths. The numbers that I'm using is first of all an estimate of the total deaths in North Carolina from heat. Over 24/25 years is 161, one percent of the annual heat related deaths almost seven per year so one percent change of that is 0.671. There's the potential damage for one percent increase in heat related deaths in North Carolina. Now the value that's going to be attached to that is known as the value of a statistical life and here's another mistake in the slide on emission that $4.54 should be millions. That's millions of

dollars. The value of a statistical life, non economists are very used to talking about this, we have no problem, the non economists may get queasy about it and for good reason. It may be a little more iffy to talk about the value of statistical life but we think that economists in general think that its important to at least get a handle of what this number might be otherwise decisions are made that might impact lives and those decisions might use an implicit value of life that ranges anywhere from as low as $100,000 to as high as a good portion of annual GDP. So what we're trying to do here is just get a handle on what statistical life might be. Not to say that everyone's life is worth 4.5 million dollars. The idea is that people everyday reveal something about the willingness to accept greater risk, risk of death. You cross the street when you shouldn't, when cars might be coming down, you drive recklessly. These behaviors reveal that risk taking behavior is an economic behavior. The idea with this value-statistical life is that some people take more risky jobs and the compensation for that is a higher wage and you can use that behavior and those numbers to get a handle on what this number might be so this 4.54 million is a summary of a bunch of studies like this that look at people's behavior towards risk taking; so just a simple multiplication of this one percent change in heat related deaths and the value-statistical life, at least the annual damages of about $300,000.

Storm related deaths - again the scenario is a one percent change in storm related deaths. The value-statistical life 4.54 million again, the hurricane death estimate here is from the past ten years from the National Hurricane Center's website of freshwater, inland, perk related deaths in North Carolina. So the number there of one percent increase is 0.91 for deaths, the search and rescue estimate, the idea is that if climate change increases the number of storms, the coast guard has more problems to respond to in the ocean and has more trouble saving lives. Of one percent increase of fewer lives saved in North Carolina is 1.74 adding those together, multiplied by 4.54 gives us a damage estimate of 8.31 million.

Now the skin cancer estimate is the only dollar value where I'm not following the state of methodology. This is from a study that was published about 15 years ago and in reading the study I was having a hard time pulling out that one percent estimate so just looking at the numbers from that study and I've scaled it down to North Carolina. This was a national study and the idea is that to reduce the risk of a non-melanoma skin cancer people would use more sun screen. If you use more sun screen that cost money and that money to defend yourself from an environmental threat could be used for something more fun like a movie ticket or a round of golf. So in that sense this is a cost of the increased risk of the skin cancer. Scaling that down to North Carolina highlighted here is the 25 million dollar estimate in 2010, I just went with the lowest number they had here to be conservative.

Drinking water – the global climate change could lead to salt water problems in coastal areas and other contaminations of drinking water. So the scenario here is that North Carolina households experience the drinking water contamination episode for one week and this is one percent of North Carolina households. So in 3.1 million households each one percent change in that number is 31,000 households might experience a drinking water contamination episode. Again the defensive expenditures methodology is used to

attach a dollar value to this, the idea is that if your drinking water has problems in your home then you go to the grocery store and buy several gallons of bottled water to avoid the contaminated drinking water. From a literature view that I conducted about ten years ago the average defensive expenditures is about $6.50, just a simple multiplication of households times the damage and we've got 200,000 dollars annual damages in North Carolina. Again let me emphasize that the numbers I've just run through the sectors of the behaviors that we talked about is only a partial list of some of the things that might happen, they were the ones that being time constrained that I was able to pull out relative quickly.

Turning to environment - I want to talk about wetlands, tourism, commercial fishing, hurricanes, biodiversity and again there are some other things that could be included in this list that I'm not including. Sea level rise and other aspects of climate change could impact coastal wetlands in North Carolina. Again the scenario is a one percent change in coastal wetland acreage. The estimate of coastal wetland acreage that I have is from the US Geological Survey - 5.42 million acres, a one percent change, one percent loss of coastal wetlands would be 54.2 thousand and the value per acre here is from studies that might look at the effect of coastal wetlands on property values. The idea of wetlands provides storm protection and provides water, wildlife habitant, water quality improvements and this does increase coastal property values. The estimate of value per acre is about $70 and this is from a study that looked at a large number of these coastal wetland evaluations studies. So multiply the one percent change again times the value per acre gives us damages of about 3.8 million.

There are many types of coastal tourism in North Carolina. The type I'm focusing on is just beach trips. The scenario is that beach erosion causes reduction in beach days and again the magnitude of the damages is one percent change in the number of beach days in North Carolina. According to the National Survey of Recreation and Environment, the survey conducted in 2000 there were 28 million beach days enjoyed in North Carolina so one percent change there would be 280,000 fewer beach days. Then the value per day that I'm using is from a study that was just recently published in Marine Resource Economics by some researchers at East Carolina. The conceptual idea is that people are willing to pay to go to the beach and if the cost of a beach day increases, they might choose to pursue some other activity and so the cost of cost increase that might lead to another activity is about $23 from their study. So multiply 23 times 280,000 gives me damages of about six million per year.

Commercial fishing – The idea here is that global climate change might lead to more storms, reducing commercial fishing and economic activity warmer temperatures might lead to stock changes and so considering a one percent change in the dockside value for the expense or value of commercial catch leads to a damage estimate. The annual excess or value of finfish in North Carolina, which is Flounder, Spot and other commercial fish is about 45 million dollars. The annual excessive value of shellfish that's our shrimp and crabs is about 71 million dollars. A one percent change in those add up to about one million dollars each year.

There is a lot of debate about the impact of climate change on hurricanes and again I'm trying to avoid all of that by just applying the one percent rule. So at the National Hurricane Center I looked at the damages inflicted in North Carolina for the past ten years from hurricanes, the annual average hurricane damage is 360 million and a one percent change in that is 3.6 million. I should say that the National Hurricane Center typically takes their damage estimate and doubles it to reflect insured losses and uninsured losses and I'm not doubling this number. For most of these estimates I'm trying to remain as conservative as possible. So 3.6 million dollars are the damages for hurricanes.

Biodiversity – The scenario I'm looking at here is an increase in the probability of extinction for coastal threatened and endangered species. These numbers are from a study that I conducted about 15 years ago and the idea is that habitant loss and other impacts of climate change leads to this increase in extinction risk. So looking at the North Carolina population in scaling the numbers I had way back when down by one percent gives me a cost for each individual in North Carolina of 42 cents for this biodiversity loss. Again scaling it down by survey response rate of 35 percent and then taking a product of all of, that gives me a damage estimate of 1.26 million dollars.

There are still some other things that could be included in this list that I'm not including because I ran out of time or I wasn't as familiar with the literature as I could have been. So to summarize these impacts – the health impacts mostly are from the skin cancer benefits. The estimate that I departed from the one percent methodology, the second biggest category are the storm related deaths, and then little slivers of heat related deaths and the drinking water benefits. In terms of environmental impacts the losses to the tourism industry are large when lands and hurricanes are the next largest and then biodiversity and commercial fishing are about pie size wedges.

The total impacts of each one percent change in North Carolina in millions of 2005 dollars are for health, about 34 million dollars and to the environment about 17 million dollars. Let me again say that these are the impacts of each one percent change and if we think that the total impact of some magnitude of climate change in North Carolina would impact the economy at the rate of five percent, a simple extrapolation of this number by multiplying by five would be the best estimate that I would have today. To put this in context the 50 some million dollars of annual valuation of those damages is about 0.2 percent of state personal income and dividing that by the number of households in North Carolina that's about 16 dollars. Now if we think that most of these damages occur in eastern North Carolina and on the coast then the dollars per household should be increased by a scale of five to ten depending on how far away from the coast the damages are. The bottom of the slide is my email address and website in case you would like to contact me with any questions.

Mr. Garrou: Thank you Dr. Whitehead. Questions?

Dr. Riggs: Sea level doesn't work alone it works in concert with the storm dynamics and the history of storms over the last half decade five/ten years has been one of increasing

frequency and intensity. If we just take the last few years and the records of Ivan and Wilma, Rita and Katrina we're looking at 50 billion dollar storms and I think your numbers are off by one or two orders of magnitude. These events are not local events these are events that have impact large regions, not just states but the whole country and a part of the country. If we just look at the Noah data, the billion dollar climate disaster map that they just came out with, North Carolina is one of the three states that's painted black on here with 21 to 25 number of events between 1980 and 2005. I think that your numbers are very misleading, if a Katrina or Rita or Ivan were to come across North Carolina coast today, we're looking at a massive disaster that's orders of magnitude bigger than what you're talking about.

Dr. Whitehead: Yes, that's why I've tried to emphasize that these numbers are for each one percent change and so as soon as I get better information like you've just given me about what the magnitude of the physical impacts might be then I have a multiple to attach to that one percent to get a better estimate and so it's real important and let me emphasize that again. These numbers for each one percent change in these sectors – this is not the bottom line estimate of the cost of doing nothing – the bottom line of the estimate of the benefits of mitigating climate change. This is a number that give us something to multiply by if there are larger magnitudes of impacts as Stan points out.

Dr. Eggers: Thank you for this. I think this is a valuable start on a way to think about this. I think at this time it's not substantial useful because it is very limited and you're just beginning in your approach and I think anybody who might say ok a dollar and twenty five cents per household per month probably some things are missing. So I am going to suggest a few things that are missing, crop loss, so we've got a lot of people who say CO_2 will increase the rate of plant growth but there is also data that it will increase several types of diseases that plants get so we have crop loss in the net and I've got some data on that if you would like. Also infectious disease like malaria and (inaudible) fever so that's also health related and cost of control of disease vectors like mosquitoes; so not just direct cost but also cost of applying more pesticides and house related illnesses as a result of that which is harder to get a handle on. Certainly a lot of it is non-monetizable like biodiversity. Also decreasing ecosystem services as a result of storms which we really should be talking about billions, with sequestration alone in the United States is estimated back of the envelope to be worth 60 billion dollars a year so losing ecosystem services is major. Pollination is estimated to be worth 40 billion dollars a year, pollination services not from European honey bees from native bees of various sorts. So that would be something to take a look at. All the different ecosystem services that you would find like in the natural step for business are somewhere else listed. Also I think it's important to think about psychological effects, stress effects and we can map those into money, you know one of the first times that was effectively done I think was with a joint study between Duke University and Chapel Hill where they looked at the health effects of living near hog farms down east. They were able to statistically significantly quantify negative impacts on people's psychological well being on their mental health. And that maps into productivity and also increased costs of medicine and just frankly decreased quality of life in ways that are very important so I applaud you for looking for an easy knob to turn on climate change and I would encourage you to just really round

this out and be qualitatively honest in your assessment about a lot of non-monetized effects.

Dr. Whitehead: Yes I was right with you until you used the word honest. I'm trying to be very honest here and …

Dr. Eggers: I didn't mean to imply that you weren't – in terms of omitted things.

Dr. Whitehead: Healthy it meets my lists – the others that was in gray that showed up on the printout so I recognize that this list of impacts that I have is not complete. It's just items of others that could be a number of things there. I appreciate your comment I think you're right and to emphasize that in terms of agriculture I think Brian and my talks are companion pieces and it's a shame that he's not coming right after me to present his estimates right after mine so I think a lesson from today to take home is not that here's the benefits of mitigation in the previous two talks of the costs and I'm going to compare these two numbers. That's not it – the idea that I'm trying to present is that this is a way of thinking about what the benefits might be and this is the way economists thinks about these things and these benefits on the cost of an action are all over the place and some of the things might be things we haven't thought too much about. We need to consider all of these things, monetize them, find the actual damage magnitude like Stan points out and then add those things up and then compare them to the cost.

Ms. Choi: Could you just comment real quickly on how adaptation would play into this model in some of the things that Dr. Eggers talked about. I guess we are currently adapting anyway to some of the changes in our environment. We spray for bugs those kinds of things, how does that adaptation play into your model?

Dr. Whitehead: In terms of the sea level rise and tourism cost and homes at the beach one of the decisions that society might have to face is whether to retreat from the beach or to harden the beach so both of those decisions have cost and benefits. Both of those decisions represent adaptation to sea level rise.

Ms. Choi: Are they reflected in this model this cost?

Dr. Whitehead: No this is again one of the others that's not included here. Yet none of these adaptations or changes in behavior are well quantified in what I'm doing, its a very rough cut of one percent change, no more no less.

Dr. Everett: I wonder if not being an economist these kinds of things scare me, but I wonder if there are any benefits that we would see in any of these categories that you've outlined here. For instance, tourism, I might go to the beach if it was warmer in April than it is today. Commercial fishing or sport fishing is it better in Florida than it is in North Carolina? Biodiversity – is there more biodiversity in certain arenas as it warms? So I think there is a missing piece to this whole discussion about some benefits to coal related deaths versus heat related deaths and the same is true through this whole presentation. I wonder if anybody looks at that other piece of the pie.

Dr. Whitehead: Considering that the one percent change I'm looking at would be a one percent net change and if there are other benefits of warming then that might lead to a scaling down of the one percent. Again it's a question for a scientist who is not an economist to determine what those things might be. And it's tough for an economist to deal with those sort of issues.

Dr. Riggs: The answer to your questions is yes. As the barrier islands collapse the fishing is going to get awesome and the pollution is going to away, Pamlico Bay will be a very clean water body, there are some benefits but the cost is going to be astronomic.

Dr. Whitehead: Yes and I presume that most of those wetlands were created when these rivers basins drown as sea level rose.

Mr. Garrou: Thank you very much Dr. Whitehead. That concludes our presentations for today. To remind you all we are going to have to take a hiatus. We have no ability to meet because we don't have a facility and we don't have a staff while the legislature is in session. So we will have to wait until, one would hope, early fall. George is going to talk to us about that.

George Givens: This Commission is about predicting what will happen when and what the consequences will be so I am about to make a few predictions for your benefit about reliability and so doing can be gauged by my best ability to figure out just exactly how much material we could cover at any given meeting. In other words like all predictions it comes with some caveats. This is the last meeting that's scheduled it will not be possible to schedule another meeting until after the session adjourns. We note within just a few minutes it will begin and we know within just a few months of when it will end. If I had to guess I would guess that this Commission will not meet before August and more likely in September. On behalf of the co-chairs I will continue to welcome input as to how we ought to proceed when we resume. I reiterate what was said before the Division of Air Quality is anxious for the involvement of those of you who are able to participate in this CAPAG process during this time. As I told you on the first meeting and as you are aware this Commission is currently scheduled to expire on 01/11/2006. This Commission does not have the authority to go to the General Assembly directly, however, my sister commission or the commission which I'm also counseling, the Environmental Review Commission, does have that authority and it is my intention to take to them a recommendation that this Commission be extended into the 2007-2008 (inaudible) of the General Assembly with the interim and final reporting dates which we're still discussing with the co-chairs. I have little doubt that the ERC will recommend that to the 2006 regular session and I assume that the 2006 regular session will be amenable to that extension. Probably it will be packaged in with other items and just move forward I hope without controversy.

Mr. Garrou: Thank you. Mr. Nicholson.

Mr. Nicholson: Thank you Mr. Chairman I just wanted to quickly reiterate the comment George just made about continuing to seek interest from members or staff or recommended individuals and I think a particular comment is we were very impressed with the presentations today. I think they did lay a foundation for us and for the Commission members on the potential for measures in North Carolina that have economic benefit in their own right. Not necessarily as an offset to damage from sea level rises just as has been explained but I think there is a very large list of potential measures you heard quite a number of them today especially lined out in agricultural and forestry presentation and hopefully that will stimulate some thoughts and you will make some suggestion to us on other specific measures that you want us to look at. So we significantly invite you to do that in the near term and we'll definitely put them on the list to look at. We look forward to both your participation and suggestions. Thanks.

Mr. Garrou: Other comments or anything else, if not we are adjourned. Thank you very much for your patience.

Meeting adjourned at 4:19 p.m.

Respectfully submitted,

John Garrou Co-Chair	Thelma T. Utley Committee Clerk

LIST OF EXHIBITS

EXHIBIT A	**Meeting Notice**
EXHIBIT B	**Meeting Agenda**
EXHIBIT C	**Visitor's Registration**
EXHIBIT D	**Handout provided by Senator Pittenger to Commission members from the Wall Street Journal – Scientists' Report Doesn't Support the Kyoto Treaty**
EXHIBIT E	**Handout provided by Dr. Sethu Raman – A Newsletter of the State Climate Office of North Carolina**
EXHIBIT F	**Solutions – The U.S. Electric Power Sector and Climate Change Mitigation Book from the Pew Center on Global Climate Change**
EXHIBIT G	**Legislative Commission on Global Climate Change Presentations Dr. David L. Greene Dr. Edward S. Rubin Dr. Marilyn A. Brown Dr. Dennis W. Hazel**
EXHIBIT H	**North Carolina Climate Action Plan Advisory Group – CAPAG Report to Legislative Commission on Global Climate Change**
EXHIBIT I	**Legislative Commission on Global Climate Change Presentations Dr. Joseph E. Aldy Dr. Margo Thorning Dr. John C. Whitehead**

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

GENERAL ASSEMBLY OF NORTH CAROLINA

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

State Legislative Building
Raleigh, North Carolina

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27715

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

TIMOTHY R. DODGE
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

10 April 2006

TO: Members of the Legislative Commission on Global Climate Change
Interested Parties

FROM: George F. Givens, Commission Counsel

RE: **Reminder of Meeting**
Schedule of Future Meetings
Commission Website
Additional Information

COMMISSION MEETING:

The Legislative Commission on Global Climate Change will meet at 10:00 a.m. on Tuesday 25 April 2006 in Room 643 of the Legislative Office Building.

Tentative agenda items for the 25 April meeting include the following:

1. Discussion of technology options and solutions by sector related to global climate change.

2. Discussion of the economic implications of climate policy.

3. Update on activities of the Department of Environment and Natural Resources and the Climate Action Plan Advisory Group.

4. Other matters related to the powers and duties of the Commission.

SCHEDULE OF FUTURE MEETINGS:

The 2006 Regular Session of the General Assembly is scheduled to begin at 12:00 noon on Wednesday 9 May 2006. The Commission currently has no plans to meet during Session, but will resume meeting following adjournment of the 2006 Session of the General Assembly.

COMMISSION WEBSITE:

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

http://www.ncleg.net/committees/legislativecomm_/default.htm.

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

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

TIMOTHY R. DODGE
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

AGENDA

10:00 a.m. Tuesday 25 April 2006
Room 643 Legislative Office Building

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

2. Introductory remarks by Cochairs
   John. L. W. Garrou
   Representative Joe Hackney

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

4. Discussion of the technology options related to global climate change by sector
   Transportation sector
   David L. Greene, Corporate Fellow
   Oak Ridge National Laboratory
   Knoxville, Tennessee

   Electricity sector
   Edward S. Rubin, Director
   Center for Energy and Environmental Studies, Department of Engineering and Public Policy, Carnegie Mellon University
   Pittsburgh, Pennsylvania

   Construction and building sector
   Marilyn A. Brown, Interim Director
   Engineering Science and Technology Division, Oak Ridge National Laboratory
   Oak Ridge, Tennessee

   Forestry and agriculture sector
   Dennis W. Hazel, Professor
   Forestry and Environmental Outreach Program, North Carolina State University
   Raleigh, North Carolina

LUNCH BREAK *– Estimated for 12:30 p.m. to 1:00 p.m.*

5. Update on activities of the Department of Environment and Natural Resources (DENR) and the Climate Action Plan Advisory Group (CAPAG)

   Brock M. Nicholson, Deputy Director
   Division of Air Quality, DENR

   Karl Hausker, Senior Advisor
   Center for Climate Strategies
   Harrisburg, Pennsylvania

6. Discussion of the economic implications of climate change policy

   The costs of climate policy options

   Joseph E. Aldy, Fellow
   Resources for the Future
   Washington, D.C.

   The costs of inaction

   John C. Whitehead, Associate Professor
   Department of Economics, Appalachian State University
   Boone, North Carolina

   Economic implications for forestry and agriculture

   Brian C. Murray, Director for Economic Analysis
   Nicholas Institute for Environmental Policy Solutions, Duke University
   Durham, North Carolina

   Economic questions regarding climate change

   Margo Thorning, Vice President and Chief Economist
   American Council for Capital Formation
   Washington, D.C.

   Costs and benefits of climate policy options

   Karl Hausker, Senior Advisor
   Center for Climate Strategies
   Harrisburg, Pennsylvania

7. Commission discussion and announcements

8. Adjourn

SCHEDULE OF FUTURE MEETINGS:

The 2006 Regular Session is scheduled to begin at 12:00 noon on Tuesday 9 May 2006. The Commission will resume a schedule of regular meetings following adjournment of the 2006 Session of the General Assembly.

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LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE
Speaker Biographical Sketches -- 25 April 2006 Meeting

Technology Options Panel

Marilyn A. Brown, Ph.D., is the Interim Director of the Engineering Science and Technology Division at the Oak Ridge National Laboratory (ORNL). Prior to coming to ORNL, she was a tenured Associate Professor in the Department of Geography at the University of Illinois, Urbana-Champaign. Dr. Brown has a Ph.D. in Geography from The Ohio State University, a Masters Degree in Resource Planning from the University of Massachusetts, and is a Certified Energy Manager. During her 22 years at ORNL, Dr. Brown has researched the impacts of policies and programs aimed at accelerating the development and deployment of sustainable energy technologies. She has led several energy technology and policy scenario studies and is a national leader in the analysis and interpretation of energy futures in the United States. She has authored more than 140 publications and has been an expert witness in hearings before committees of both the U.S. House of Representatives and the U. S. Senate. Dr. Brown serves on the boards of directors of the American Council for an Energy-Efficient Economy and the Alliance to Save Energy, and on the editorial boards of several journals.

David L. Greene, Ph.D., is a Corporate Fellow at the Oak Ridge National Laboratory (ORNL) and has spent 25 years researching transportation energy and policy issues. Dr. Greene received a B.A. from Columbia University in 1971, an M.A. from the University of Oregon in 1973, and a Ph.D. in Geography and Environmental Engineering from The Johns Hopkins University in 1978. He has published more than two hundred professional publications, including three books (*Transportation and Energy*, *Transportation and Global Climate Change*, and *The Full Costs and Benefits of Transportation*), and is the recipient of four "best paper" awards from scientific societies. Dr. Greene has been active in the Transportation Research Board and National Research Council for over 25 years, serving on numerous standing and ad hoc committees dealing with energy and environmental research. In recognition of his service to the National Academy of Science and National Research Council, Dr. Greene has been designated a lifetime National Associate of the National Academies.

Dennis W. Hazel, Ph.D., is an Assistant Professor and Extension Specialist in the Department of Forestry and Environmental Resources in the College of Natural Resources at North Carolina State University (NCSU). His focus areas include forest health, forest productivity, and Christmas tree production. His degrees are in forestry, experimental statistics, and wildlife biology. Prior to coming to Extension in 2003, he held several research positions at NCSU where his research included wildlife habitat and biology, silviculture, forest ecology, and water quality in agricultural and forested settings.

Edward S. Rubin, Ph.D., is the Alumni Professor of Environmental Engineering and Science at Carnegie Mellon University (CMU), with joint appointments in the Department of Engineering & Public Policy, and the Department of Mechanical Engineering. He holds a B.E. in mechanical engineering from the City College of New York, and an M.S. and Ph.D. from Stanford University. Prof. Rubin's teaching and research are in the areas of energy utilization, environmental control, and technology-policy interactions, with a particular focus on issues related to coal utilization. He is the author of over 200 technical papers and reports, plus a textbook on, "Introduction to Engineering and the Environment" (McGraw-Hill). At CMU, Dr. Rubin was the founding director the Environmental Institute and the Center for Energy and Environmental Studies. He serves on technical and advisory committees to the U.S. Department of Energy, the National Academies, and the Intergovernmental Panel on Climate Change, and also as a consultant to public and private organizations with interests in energy and the environment.

Economics Panel

Joseph E. Aldy, Ph.D., is a Fellow at Resources for the Future, a non-profit, non-partisan organization that conducts independent research on environmental, energy, and resource issues. In 2005, he completed his Ph.D. in economics at Harvard University where his research focused on climate change policy, mortality risk valuation, and the benefits of energy subsidies to low-income households. Prior to attending Harvard, Aldy served as Senior Advisor for the Global Environment and Senior Economist for the Environment at the President's Council of Economic Advisers (CEA), where he was responsible for climate change policy and other environmental issues. He served as lead author of the Clinton Administration's July 1998 report "The Kyoto Protocol and the President's Policies to Address Climate Change: Administration Economic Analysis" and the CEA September 1999 report "The Economics of Greenhouse Gas Emissions Abatement in China, A Preliminary Assessment." He wrote articles on energy and environmental issues for the Weekly Economic Briefing of the President and drafted the Chair's testimonies on climate change policy for Congressional hearings. Aldy participated in bi-lateral and multi-lateral conferences and meetings on climate change policy in Argentina, Bolivia, China, France, Germany, Kazakhstan, Korea, Israel, Mexico, and Uzbekistan as well as at COP-4, COP-5, the Organization for Economic Cooperation and Development (OECD), and the International Energy Agency. He received a Master of Environmental Management degree from the Nicholas School of the Environment and a Bachelor of Arts degree from Duke University.

Karl Hausker, Ph.D., is a co-founder of the Center for Climate Strategies (www.climatestrategies.us) where he provides overall management and leads work related to transportation and land use. He is also a Principal at the Global Environment and Technology Foundation (www.getf.org) and has co-chaired the Mayors' Asia Pacific Environmental Summit since its inception in 1999 (www.environmentalsummit.com). From 2000 to 2003, he was a Managing Consultant with the PA Consulting Group (www.paconsulting.com) where his projects included strategic advice to corporations on

climate change and capacity-building projects related to climate change for United States Agency for Economic Development (USAID). During 1999, he was a Senior Visiting Fellow at the Tata Energy Research Institute (TERI) in New Delhi where his project included capacity-building related to the Clean Development Mechanism. From 1995 to 1998, he directed environmental projects at the Center for Strategic and International Studies (CSIS) in Washington D.C. He directed the Enterprise for the Environment (a consensus-building project on U.S. domestic environmental policy chaired by Bill Ruckelshaus), Climate Change Roundtables, and Sustainable Development Roundtables. He remains an Adjunct Fellow at TERI and CSIS.

From 1993 to 1995, Dr. Hausker served as the Deputy Assistant Administrator in the Office of Policy, Planning and Evaluation, U.S. Environmental Protection Agency where he led the Agency's climate programs. From 1987 through 1992, Dr. Hausker was the Chief Economist for the U.S. Senate Committee on Energy and Natural Resources, helping staff committee hearings on climate change. Prior to joining the Committee, Dr. Hausker was an Associate at Putnam, Hayes and Bartlett, an economic and management consulting firm, where he specialized in electric utility regulatory issues. He has also worked for the U.S. Department of Energy and the California Public Utilities Commission. Dr. Hausker received a B.A. in Economics from Cornell University, and an M.P.P and Ph.D. in Public Policy from the University of California at Berkeley.

Brian C. Murray Ph.D., joined the Nicholas Institute for Environmental Policy Solutions at Duke University in March 2006 as Director for Economic Analysis. Before that, he was Director of the Center for Regulatory Economics and Policy Research at RTI International. He specializes in developing and applying economic models to analyze environmental and natural resource policies, programs, and regulations. He is a widely recognized expert in the integration of economic and biophysical models to assess greenhouse gas mitigation strategies in agriculture, land use change, and forestry. In pollution control, he has examined the economic effects of traditional command-based regulatory strategies and more market-oriented approaches such as emissions fees. Dr. Murray's work has been published extensively in professional journals, edited book volumes, and commissioned reports. He has been invited as a co-author of several national and international assessments of forest resources, especially related to climate change. He received his Ph.D in resource economics from Duke in 1992.

Margo Thorning, Ph.D., is senior vice president and chief economist with the American Council for Capital Formation (ACCF) and director of research for its public policy think tank. Dr. Thorning also serves as the managing director of the International Council for Capital Formation (ICCF) (www.iccfglobal.org), a new think tank incorporated in Brussels. The ICCF is an affiliate of the ACCF.

Dr. Thorning is an internationally recognized expert on tax, environmental, and competitiveness issues. She writes and lectures on tax and economic policy, is frequently quoted in publications such as the *Financial Times, Suddeutsche Zeitung, New York Times*,

and *Wall Street Journal*, and has appeared internationally on public affairs news programs. In North America, Dr. Thorning has testified as an expert witness on capital formation and environmental issues before various U.S. congressional committees, including the Senate Environment and Public Works Committee, the Senate Energy and Natural Resources Committee, the Joint Economic Committee, the Senate Governmental Affairs Committee, the House Ways and Means Committee, the House Commerce Committee, and the House Committee on Government Reform.

Dr. Thorning is coeditor of numerous books on tax and environmental policy, including "The Kyoto Commitments: Can Nations Meet Them With the Help of Technology?" and "The U.S. Savings Challenge: Policy Options for Productivity and Growth." (See www.accf.org for complete list of publications). Previously, Dr. Thorning served at the U.S. Department of Energy, the U.S. Department of Commerce, and the Federal Trade Commission. Dr. Thorning received a B.A. from Texas Christian University, an M.A. in economics from the University of Texas, and a Ph.D. in economics from the University of Georgia.

John C. Whitehead, Ph.D., is an Associate Professor in the Department of Economics at Appalachian State University. He received his PhD in economics from the University of Kentucky in 1990. He previously held faculty appointments at East Carolina University and the University of North Carolina at Wilmington. His research has been funded by the National Marine Fisheries Service, the National Oceanic and Atmospheric Administration, the U.S. Environmental Protection Agency, and other government agencies. He currently serves on the Editorial Council of the Journal of Environmental Economics and Management, the Scientific and Statistical Committee of the South Atlantic Fisheries Management Council and is president of the Socioeconomics Section of the American Fisheries Society. Previously, he served on the Board of Directors of the Association of Environmental and Resource Economists.

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Name of Committee — **Date**

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Jack Floyd	Public Staff - Utilities Commission
James McLawhorn	" "
Tom Lam	" "
Ben Turner	" "
Sharon Miller	CUCA
Teri Gray	League of Women Voters
Kathy Hawkins	Progress Energy
Alice Loyd	NC Council of Churches/IPH
MARK GINSBERG	GLOBAL WARMING INITIATIVES
James Southerland	NCDENR DAQ
Heather Hawkins	NCDENR DAQ

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Amy MacDonald	Environmental Defense Southern Alliance for Clean Energy
Amy Simes	DENR
Kim Garnett	NC-DAQ
Charlo Davis	NC - DAQ
Patrick Butler	NC DAQ
James Haven	Global Warming Initiatives
Leigh Tulloss	Global Warming Initiatives
Steve Wall	DENR
Dan Bakson	BGA

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NAME	FIRM OR AGENCY AND ADDRESS
Wade Rawlins	The News & Observer
Anne Thaxton	NC Council of Churches
Ulla Reeves	So Alliance for Clean Energy
JAMES SIMON	NC ELECTRIC MEMBERSHIP CORP.
Steve Woodson	NC Farm Bureau
[illegible]	NC AFC
Andrew Meehan	NCAEC
Amy Fullhart	Hunton & Wms
ROGER SHEATS	Global Warming Initiatives
SHARON STROUD	State Energy Office
PATRICK BUFFKIN	AMEA ASSOC.

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[illegible]	Capitol Group
Julie Luck	FOX8 WGHP
[illegible]	NCFB
R. Contato	JLF
Guillermo Peño	JLF
Mago Thorning	ACCF
Carter Payne	Edmisten & Webb
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Graham Long	Sen. Pittenger's Office
Brock Nicholson	N.C. DENR / DAQ
Karl Hausker	Center for Climate Strategies
Ed RUBIN	Carnegie Mellon University <rubin@cmu.edu>
Judi Greenwald	Pew Center on Global Climate Change
Marilyn Brown	Oak Ridge National Lab
David Greene	" "
Dennis Hazel	NC State University
Joe Aldy	Resources for the Future
John Whitehead	Appalachian State University
BRIAN MURRAY	NICHOLAS INSTITUTE, DUKE U.

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John Goodman	Allen Associates
Nancy Thompson	MCIC
Denise Choy	Environmental Defense
Jo Ann Norris	Public School Forum
John Mottyl	Gov office
[illegible]	[illegible]
Bob Hazel	Climate Action Advisory Gp.
Elizabeth Ouzts	Environment North Carolina
Stephen Halstead	Council of Churches
Larry Shirley	State Energy Office
Susan Tidemon	Durham Friends Meeting

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OSBIHAT

June 11, 2001

COMMENTARY

READERS RESPOND

Scientists' Report Doesn't Support the Kyoto Treaty

By Richard S. Lindzen. Mr. Lindzen, a professor of meteorology at MIT, was a member of the National Academy of Sciences panel on climate change.

Last week the National Academy of Sciences released a report on climate change, prepared in response to a request from the White House, that was depicted in the press as an implicit endorsement of the Kyoto Protocol. CNN's Michelle Mitchell was typical of the coverage when she declared that the report represented "a unanimous decision that global warming is real, is getting worse, and is due to man. There is no wiggle room."

As one of 11 scientists who prepared the report, I can state that this is simply untrue. For starters, the NAS never asks that all participants agree to all elements of a report, but rather that the report represent the span of views. This the full report did, making clear that there is no consensus, unanimous or otherwise, about long-term climate trends and what causes them.

As usual, far too much public attention was paid to the hastily prepared summary rather than to the body of the report. The summary began with a zinger -- that greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise, etc., before following with the necessary qualifications. For example, the full text noted that 20 years was too short a period for estimating long-term trends, but the summary forgot to mention this.

Our primary conclusion was that despite some knowledge and agreement, the science is by no means settled. We are quite confident (1) that global mean temperature is about 0.5 degrees Celsius higher than it was a century ago; (2) that atmospheric levels of carbon dioxide have risen over the past two centuries; and (3) that carbon dioxide is a

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greenhouse gas whose increase is likely to warm the earth (one of many, the most important being water vapor and clouds).

Spec

But -- and I cannot stress this enough -- we are not in a position to confidently attribute past climate change to carbon dioxide or to forecast what the climate will be in the future. That is to say, contrary to media impressions, agreement with the three basic statements tells us almost nothing relevant to policy discussions.

One reason for this uncertainty is that, as the report states, the climate is always changing; change is the norm. Two centuries ago, much of the Northern Hemisphere was emerging from a little ice age. A millennium ago, during the Middle Ages, the same region was in a warm period. Thirty years ago, we were concerned with global cooling.

Distinguishing the small recent changes in global mean temperature from the natural variability, which is unknown, is not a trivial task. All attempts so far make the assumption that existing computer climate models simulate natural variability, but I doubt that anyone really believes this assumption.

We simply do not know what relation, if any, exists between global climate changes and water vapor, clouds, storms, hurricanes, and other factors, including regional climate changes, which are generally much larger than global changes and not correlated with them. Nor do we know how to predict changes in greenhouse gases. This is because we cannot forecast economic and technological change over the next century, and also because there are many man-made substances whose properties and levels are not well known, but which could be comparable in importance to carbon dioxide.

What we do is know that a doubling of carbon dioxide by itself would produce only a modest temperature increase of one degree Celsius. Larger projected increases depend on "amplification" of the carbon dioxide by more important, but poorly modeled, greenhouse gases, clouds and water vapor.

The press has frequently tied the existence of climate change to a need for Kyoto. The NAS panel did not address this question. My own view, consistent with the panel's work, is that the Kyoto Protocol would not result in a substantial reduction in global warming. Given the difficulties in significantly limiting levels of atmospheric carbon dioxide, a more effective policy might well focus on other greenhouse substances whose potential for reducing global warming in a short time may be greater.

The panel was finally asked to evaluate the work of the United Nations' Intergovernmental Panel on Climate Change, focusing on the Summary for Policymakers, the only part ever read or quoted. The Summary for Policymakers, which is seen as endorsing Kyoto, is commonly presented as the consensus of thousands of the world's foremost climate scientists. Within the confines of professional courtesy, the NAS panel essentially concluded that the IPCC's Summary for Policymakers does not provide suitable guidance for the U.S.

government.

The full IPCC report is an admirable description of research activities in climate science, but it is not specifically directed at policy. The Summary for Policymakers is, but it is also a very different document. It represents a consensus of government representatives (many of whom are also their nations' Kyoto representatives), rather than of scientists. The resulting document has a strong tendency to disguise uncertainty, and conjures up some scary scenarios for which there is no evidence.

Science, in the public arena, is commonly used as a source of authority with which to bludgeon political opponents and propagandize uninformed citizens. This is what has been done with both the reports of the IPCC and the NAS. It is a reprehensible practice that corrodes our ability to make rational decisions. A fairer view of the science will show that there is still a vast amount of uncertainty -- far more than advocates of Kyoto would like to acknowledge -- and that the NAS report has hardly ended the debate. Nor was it meant to.

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North Carolina Climate

A Newsletter of the State Climate Office of North Carolina
A Public Service Center for Climate-Environment Interaction
http://www.nc-climate.ncsu.edu

SPRING 2006

In This Issue

NC Climate Change	1
Utilization of the MPE Website by NCDOT	1
From the State Climatologist	2
NC Water Resource Database to Provide Real-time Water Information	2
New ECONet station	3
CCMS Interns Help Study Climate Changes in NC	3
Decision Support for Peanut Growers	4
Quality Control of Surface Weather Observations	4
Drought Threatens NC Again, Summer Outlook not Hopeful	6
Recent Climatological Conditions	7
Summer Climate Outlook	7
Recent Activities and Visitors	8

Guest Contributor...

Bob Holman, NCDOT Environmental Operations Engineer

A Multi-sensor Precipitation Estimate (MPE) Website was developed by the State Climate Office for the North Carolina Department of Transportation's (NCDOT) Highway Stormwater Program. This effort is in response to a general requirement in the North Carolina Stormwater NPDES Permit for rainfall monitoring. We are concerned with maintaining erosion control best management practices after a 1/2 inch or greater rainfall event. The monitoring of these rainfall events can easily be handled at large road construction sites with rain gages that staff and contractors can check daily because of the number of individuals on-site. However, with smaller construction projects, such as secondary road box culvert replacement, staff and contractors would not be on-site daily. Therefore checking rain gages would become a logistical problem with the large number of small active projects across the State.

Continued on Page 4 as "NCDOT"...

North Carolina Climate Change

By Ashley Frazier, Staff Meteorologist

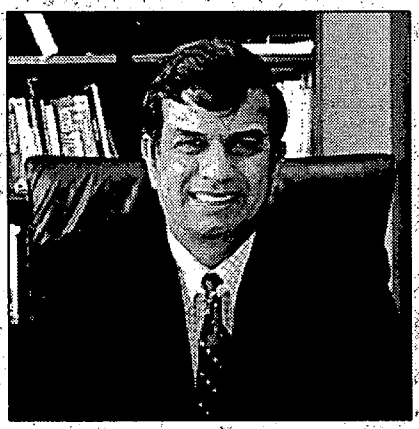
"How has North Carolina's climate changed over the past 100 years?"

Global warming has been a big topic of debate over the past decade. Has human activity, specifically the production of carbon dioxide, contributed to the rise in temperatures over the past century? Or is the earth's recent warming simply a part of a natural cycle? With so much hype involving this global warming controversy, we're left with one inevitable question: how has North Carolina's climate changed over the past 100 years?

To research this issue, temperature as well as precipitation data were used from nine National Weather Service Cooperative stations across the state. These stations are part of the U.S. Historical Climate Network, as they have relatively complete datasets, and fairly extensive periods of record (of the order of 100 years). In addition, they were chosen to represent the three main climate regions of North Carolina: mountains, piedmont, and coast.

One of the most noteworthy temperature trends was seen in the coastal station, Elizabeth City, which showed an overall increase in temperatures of about 3.17 degrees Fahrenheit from 1911 through 2002. (See graph 1 on page 5) In fact, temperatures seemed to increase significantly across the board in the coastal and piedmont regions. However, the mountain stations showed only slightly increasing, and some even decreasing trends.

The greatest precipitation change was observed at the piedmont station in Chapel Hill. From 1893 through 2002, this station showed a decrease in precipitation of about 4.1 inches. (See graph 2 on page 5). *Continued on page 5 as "Climate Change"...*



From the State Climatologist

In this newsletter, we provide information on many research and outreach projects in progress at the SCO. They include NC climate variation, current drought conditions in the state, update on weather-based crop management tool development, deployment of a new ECONet station at NC A&T university, Greensboro, water resources data base, MPE (multisensor precipitation estimate) data base, and data quality control. We continued the CCMS (Centennial School Middle School) internship program for the fourth year. Four students, Brad Stackhouse and Alex Vail of 7th grade and Rob Collis and Melissa Gregory of 8th grade participated. Several graduate students in the SCO expect to graduate this spring and summer. They are Matthew Simpson and Ryan Boyles with Ph.D. and Matthew Borkowski with M.S. degree. Undergraduate students Kate Horgan, Michael Diaz, Brandon Inge, Jenna Schlobohm, and Jared Vander Duim worked in the SCO this semester.

We welcome Douglas Hoell Jr., Director, NC Emergency Management Division to the SCO Advisory Committee. The annual board meeting is scheduled for May 19, 2006.

It has been a great experience working with my young colleagues and (30 undergraduate and 20 graduate) students in the State Climate Office of NC for the past 10 years. Their enthusiasm for public service and tireless work are the reasons that made this State Climate Office to become one of the best in the nation.

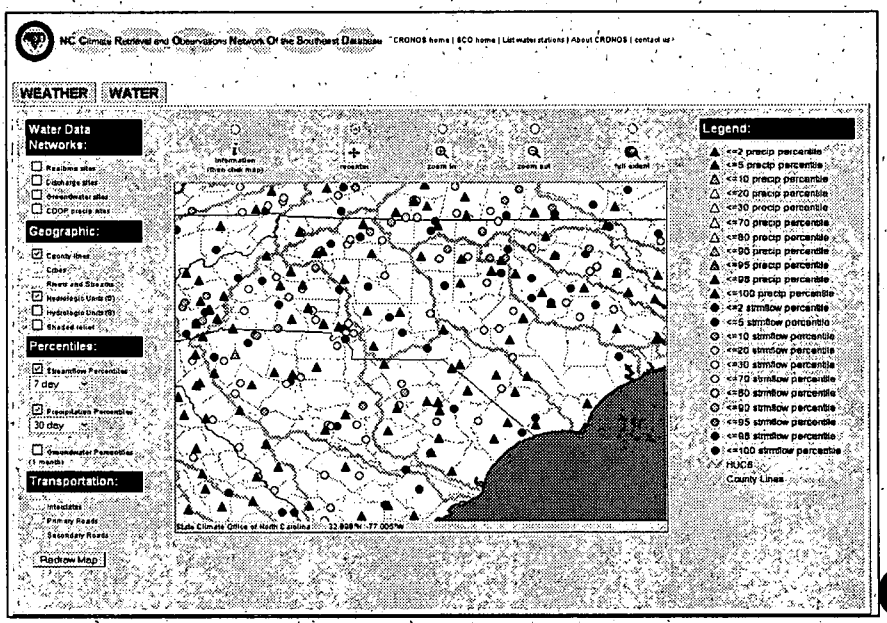
At the service of North Carolina,

Sethu Raman
State Climatologist

NC Water Resource Database to Provide Real-time Water Information

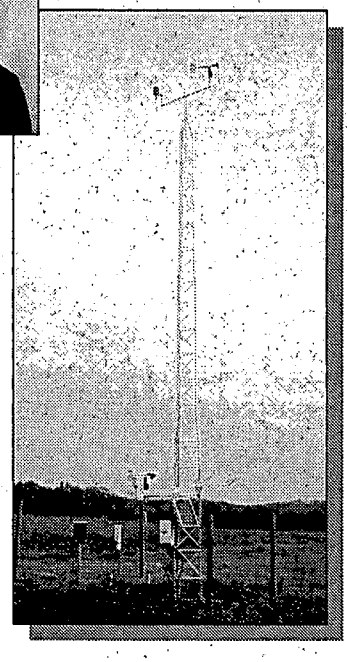
By Ryan Boyles, Associate State Climatologist

The State Climate Office is working on a test release of a new water resource database. Supported by the NC DENR Division of Water Resources, this web-based database provides interactive mapping and data lookup of water resource information over the Carolinas using data from the US Geological Survey, the DENR Division of Water Resources, the US Army Corps of Engineers, and others. The database combines historical and real-time stream flow, groundwater, reservoir, and precipitation observations into a common, intuitive interface. This tool will be publicly available to provide users with current and historical data as well as drought and flood monitoring capabilities. The SCO expects a preliminary release of the web-enabled database in late May.

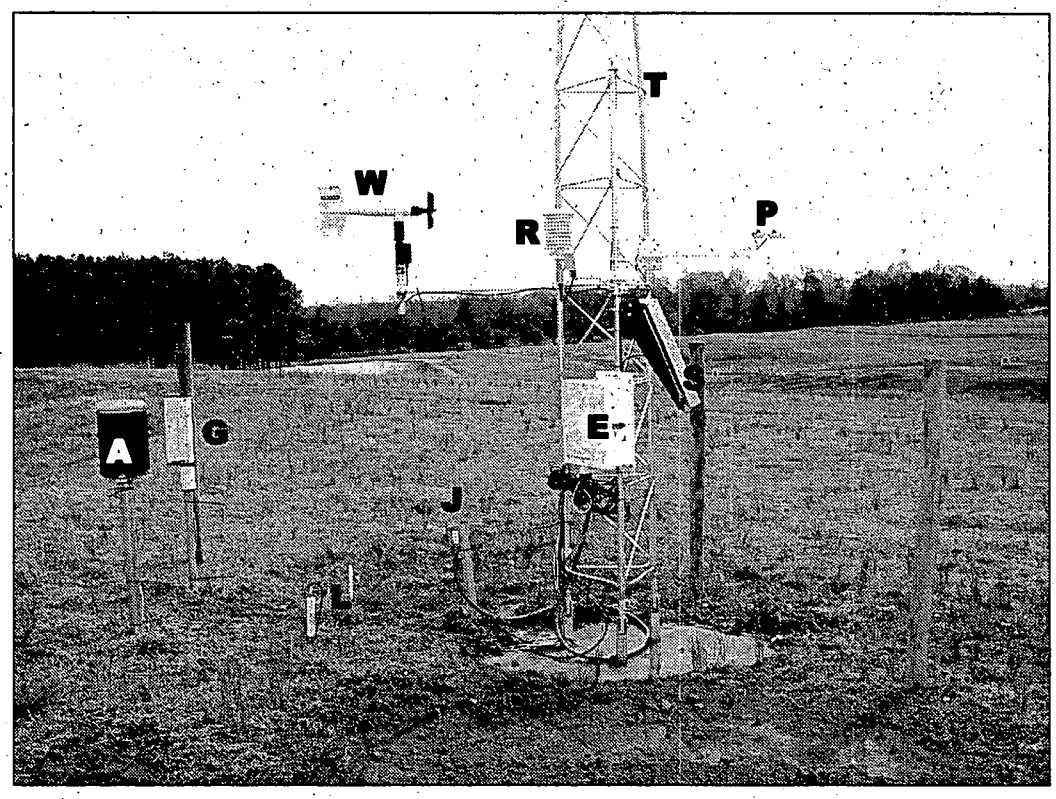


New ECONet Station

By Ameenula Syed, Instrumentation Meteorologist / ECONet Manager



A new station has been added to the Environmental and Climate Observing Network (ECONet). The new station was deployed in Greensboro, NC, at North Carolina A&T University. Data from this new station is available online via the NC CRONOS Database, including multi-level soil moisture and temperature. Shown to the right is the new station. A schematic of the tower components is shown below.



A – all season rain gauge
T – tower section
P – PAR & SR
S – solar panel
E – electronics enclosure
R – 2 meter temperature and RH (also at 10 meters)
W – 2 meter winds (also at 10 meters)
G – ET gauge
J – phone jack
L – soil moisture and temperature profilers at six levels

NC A&T station (Greensboro, NC) – http://www.nc-climate.ncsu.edu/cronos/index.php?station=NCAT

Centennial Campus Middle School Interns help study climate changes in NC

As part of our 4 year collaboration with Centennial Campus Middle School, the State Climate Office once again hosted four students as part of our mission to support education. Rob Collis (8th grade), Brad Stackhouse (7th grade), Alex Vail (7th grade), and Melissa Gregory (8th grade) worked with SCO staff during the 2005-2006 academic year to learn more about changes in temperature and precipitation patterns over NC during the past 100 years. Through their research, they concluded that minimum temperatures had generally increased and that precipitation had increased in some areas. Alex Vail and Melissa Gregory won a First Place award in the CCMS Science Fair, with Rob and Brad as a close runner-up. Details of their studies are available under the Education section of the SCO website.

Pictured above: CCMS students from left to right are Brad Stackhouse (7th grade), Rob Collis (8th grade), Alex Vail (7th grade), and Melissa Gregory (8th grade).

...continued from "NCDOT" on page 1:

The NCDOT Roadside Environmental Field Operations Engineers will utilize the new website daily. These engineers monitor all NCDOT's erosion control devices to ensure they are constructed and maintained properly during the life of a road project. The website will help them schedule which sites need visiting based on automated email messages alerting them to recent rainfall events. In addition, the Resident Engineers will use this website to direct staff and contractors to construction sites that need visiting after a 1/2 inch rainfall event to determine if the erosion control practices are still functioning properly. The website can also be used by the Resident Engineer to check the forecast for a certain construction site and determine if additional erosion control measures are needed before a predicted heavy rainfall event occurs.

NCDOT will utilize the MPE Website to: review past rainfall amounts over a certain period of time in order to resolve weather related delay claims by contractors; monitor multiple sites on very large projects that are several miles long; follow large weather fronts in order to prepare the construction site for adverse weather conditions that are forecasted; track rainfall data in remote locations where staff is not continuously on-site; and alert water quality monitoring crews and researchers of rainfall amounts at certain project locations. The website also serves as a means of obtaining and keeping accurate rainfall data, as well as a means of receiving email alerts when a particular site has reached a pre-defined rainfall threshold.

Decision Support for Peanut Growers

By Mark Brooks, Environmental Meteorologist

The primary mission of the State Climate Office is Extension, and one objective is to assist other extension scientists by integrating climate data into agricultural and environmental models. Last year, the SCO worked with faculty to develop automated, daily peanut disease advisories. These advisories were then e-mailed to county extension agents and other interested parties. The peanut advisories use data from the ECONet (a weather monitoring network maintained by the SCO) combined with weather modeling capabilities. In May, we will again start disseminating daily peanut disease advisories.

Disease prevention is an integral part of any crop management. Appropriately timed chemical applications can mitigate yield losses by preventing disease onset, but should only be used when environmental conditions favor disease development. Over-application can exacerbate non-target problems.

The State Climate Office remains committed to developing decision support tools for crop management. We plan to launch a comprehensive agricultural website later this spring. Other crops, such as turf grass, will be highlighted as part of the agricultural weather site.

Quality Control of Surface Weather Observations

By Aaron Sims, Environmental Meteorologist

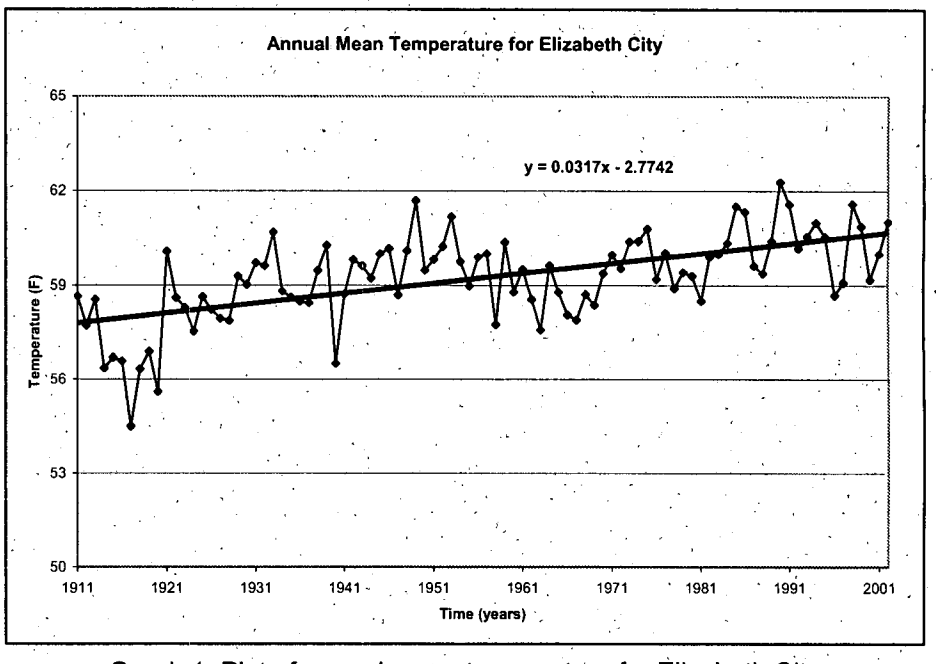
The SCO is employing a multi-faceted approach for developing new and improved quality assurance and quality control (QAQC) procedures for ECONet data and the NC CRONOS database. These techniques will improve monitoring of input data streams and the flagging of suspect data. We plan to implement a new data-range checking algorithm based on the climatology of each station this Spring. Other procedures to follow include a "buddy check", comparing a station's parameters to conditions of other nearby stations, and temporal checks, to show temporal consistency for multiple parameters at each station. Also, a new interactive trouble ticket system being developed will alert, log, and archive routine station service and maintenance procedures as well as address sensor malfunctions and replacement protocols.

Continued from "NC Climate Change" on page 1:

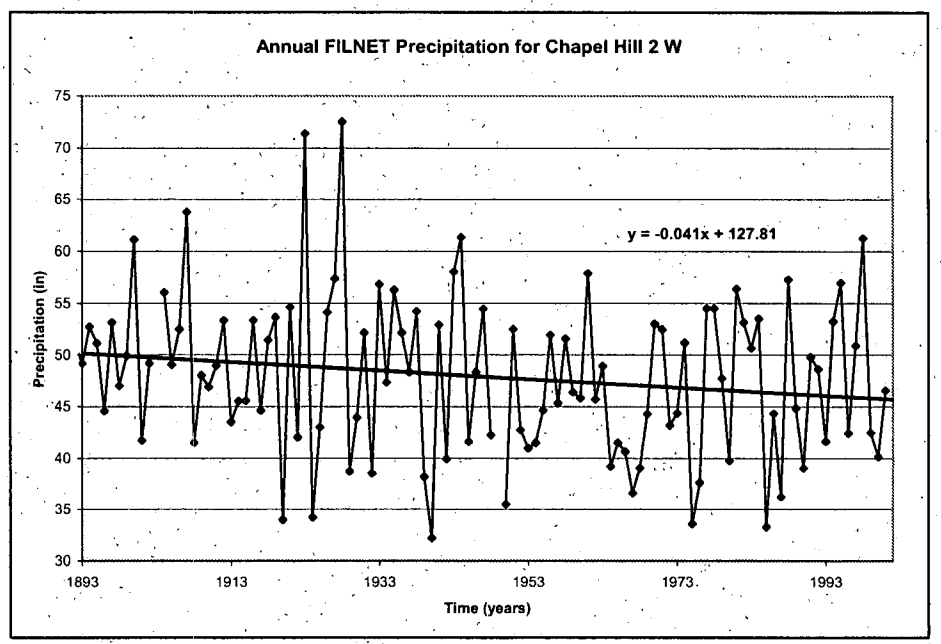
Annual rainfall amounts for the other piedmont stations also decreased, with the largest decreases seen in central and north central NC. Coastal stations also exhibited this precipitation decrease. However, mountain precipitation seemed to increase over each station's period of record.

These results suggest the coastal and piedmont regions of North Carolina are warming and drying out, while the mountain region is becoming cooler and wetter. However, more analysis is needed to determine if these observed trends accurately depict overall climate change in NC, or simply show local climate changes. Increasing station density in North Carolina is one way to further monitor atmospheric conditions, and get a better idea of weather and climate changes across the state. The North Carolina Environment and Climate Observing Network (NC ECONet) in its full development will help to establish such station density by providing at least one station in each county across NC.

In addition to the standard observations of temperature, precipitation, and wind, NC ECONet sites provide unique measurements of soil temperature, soil moisture, solar radiation, and evapo-transpiration. Such parameters often result in small scale changes at the surface, which in turn can affect weather at larger scales. Thus, a state-of-the-art network like the NC ECONet is critical to fully understand any climate changes North Carolina may or may not be facing.



Graph 1. Plot of annual mean temperature for Elizabeth City



Graph 2. Plot of annual precipitation for Chapel Hill 2 W

For more information about this project on North Carolina climate, contact the State Climate Office:

Phone: 919-515-3056 or 877-718-5544 (toll free)
E-mail: sco@climate.ncsu.edu

State Climate Office of North Carolina
Suite 240, Research III Building
1005 Capability Drive
Centennial Campus, Box 7236
NC State University
Raleigh, NC 27695-7236

Drought Threatens NC Again
Summer Outlook not Hopeful
By Ryan Boyles, Associate State Climatologist

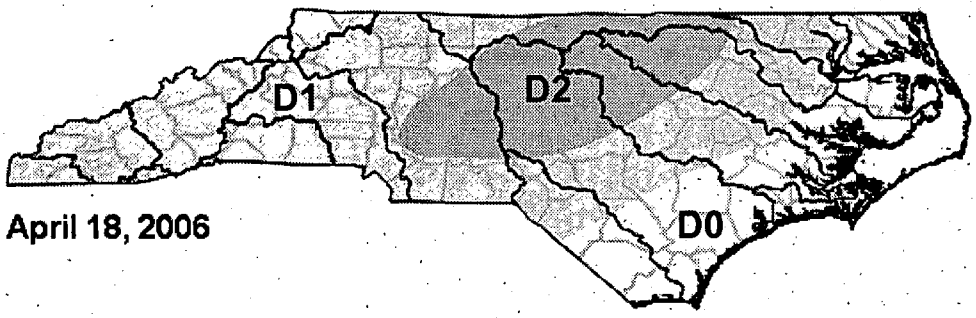
> *"...conditions across the state have been near record dry conditions for this time of year."*

With a dry winter and record low rainfalls during the spring, North Carolina is once again faced with drought conditions. Parts of central NC experienced drought during the late summer and fall of 2005. With cooler temperatures and regular winter rainfalls, conditions moderated during December. However, the upper Neuse River basin did not experience all the needed rainfall, and stayed in moderate drought through the winter.

Since February, conditions across the state have been near record dry conditions for this time of year. Forest and brush fires have occurred at a much higher rate than normal, and water resources have decreased. Streamflow and groundwater levels have dropped during the spring – a time when we normally expect conditions to be at their highest levels for the year. Water inflows to Jordan and Falls Reservoirs approached near record lows in March 2006. Reservoirs are near normal levels for this time of year due to control efforts by the Army Corps of Engineers and other reservoir managers. Water supply managers are gearing up now to conserve as much water as possible to extend water supplies through the summer.

The outlook for summer precipitation is not hopeful. Guidance from the National Weather Service's Climate Prediction Center suggests equal chances that the southeastern US could be dry over the next 2-3 months. Without regular and substantial rainfall, central North Carolina could experience water supply problems this summer. Water supply conditions in the summer of 2006 could become as bad, or worse, than those experienced in 2002. An active tropical storm season is predicted with 17 named storms forecasted, and NC may experience higher precipitation amounts associated with tropical storms in the late summer and autumn – hopefully without damaging winds and floods. Although the tropical storm season of 2005 was the most active on record, storms generally did not affect NC and did not bring much rainfall to central parts of the state.

The NC Drought Management Advisory Council has called on all water users in affected areas to monitor water supplies closely, to review their Water Shortage Response Plans, and implement the Plans if necessary. As a member of the Drought Management Advisory Council, the State Climate Office will continue to monitor conditions across North Carolina using the best tools available.



April 18, 2006

Drought Classifications
D0 - Abnormally Dry
D1 - Moderate Drought
D2 - Severe Drought
D3 - Extreme Drought
D4 - Exceptional Drought

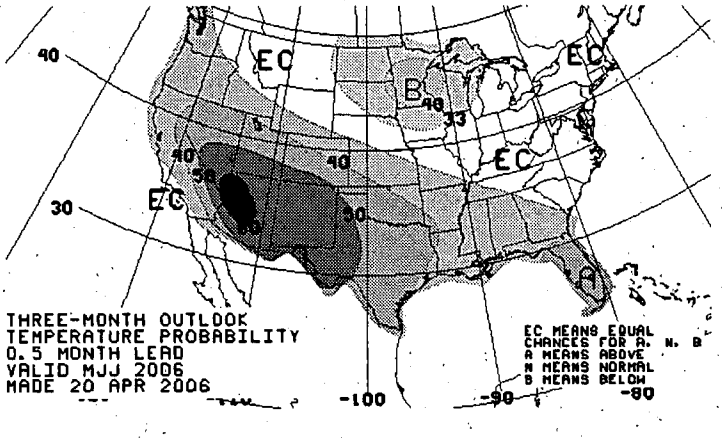
Recent Climatological Conditions (Jan 1 — Mar 31, 2006)

Station	Average Daily Mean Temperature (F)	Departure from Normal of Daily Mean Temperature (F)	Total Precipitation Reported (in)	Departure from Normal Precipitation (in)	Percent of Normal Precipitation
Asheville Airport	43.3	2.9	7.04	-5.44	56
Charlotte Airport	47.5	0.9	5.72	-6.22	48
Chapel Hill	46.2	3.2	6.52	-5.99	52
Clayton	45.3	1.4	4.86	-7.18	40
Concord	47.5	3.1	5.25	-6.97	43
Elizabeth City	46.3	0.3	4.64	-7.71	38
Fayetteville	48.0	1.9	4.73	-7.24	40
Greensboro Airport	46.9	4.1	4.87	-5.62	46
Hickory Airport	46.6	2.8	6.12	-6.90	47
Kinston	47.9	2.3	7.76	-4.36	64
Lincolnton	46.9	2.2	6.25	-6.67	48
Morganton	44.9	3.0	5.14	-8.28	38
Mount Mitchell	29.9	0.9	12.88	-7.46	63
New Bern Airport	49.1	1.0	6.27	-6.79	48
Raleigh/Durham Airport	47.7	3.2	4.97	-6.55	43
Waynesville	40.8	2.0	9.12	-5.28	63
Wilmington Airport	50.8	0.8	6.51	-5.89	53

Summer Climate Outlook

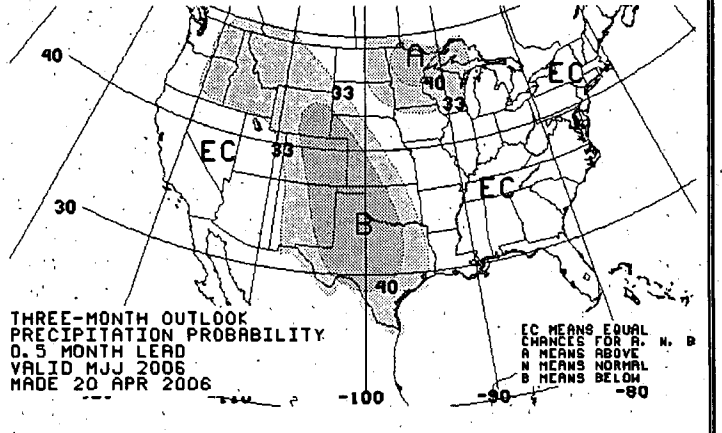
Provided by National Oceanic and Atmospheric Administration's Climate Prediction Center

TEMPERATURE



May 2006 – July 2006 Temperature Outlook

PRECIPITATION



May 2006 – July 2006 Precipitation Outlook

A = Probability of Above Normal Conditions
B =Probability of Below-Normal Conditions
EC = Equal Chances of Above-, Below-, and Near-Normal Conditions

The oceanic and atmospheric indicators in the tropical Pacific remain consistent with weakening La Niña conditions. The temperature outlook for this summer calls for warmer than normal conditions across the South. The precipitation outlook suggests equal chances of wetter-than, drier-than, or near-median for North Carolina this summer. This outlook is from the Climate Prediction Center and is based on a multi-model ensemble as well as various statistical tools.

SELECT ACTIVITIES

- Presentation to Wake Tech Community College, September 27, 2005, Raleigh, Ryan Boyles
- Drought Management Advisory Council Meeting, October 5, 2005, Raleigh, Ryan Boyles
- Presentation on Severe Weather and Emergencies to Chatham County, October 15, 2005, Goldston, NC, Ryan Boyles
- "Thunderous Technology" program for Pines of Carolina Girl Scout Council, October 5, 2005, Raleigh, Ryan Boyles, Ashley Frazier, Kate Horgan, and Suzanne Schwab
- Presentation on Smoke Plume Modeling, NC Forest Service Fire Partners, November 10, 2005, New Bern, NC, Ryan Boyles
- ECONet site survey, December 7, 2005, Anson and Richmond Counties, Ryan Boyles and Ameenulla Syed
- ECONet site survey, January 19, 2006, NC A&T SU Research Farm, Ryan Boyles, Aaron Sims, and Ameenulla Syed
- SCO/NWS Cooperative Observer modernization planning meeting, January 26, 2006, Raleigh
- AMS Annual Meeting, January 29 – February 3, 2006, Atlanta, GA, Ryan Boyles, Mark Brooks, and Sethu Raman
- International Conference on Mesoscale Processes, February 13-17, New Delhi, India, Sethu Raman
- Seminar to National Institute of Ocean Technology, February, 23, 2006, Chennai, India, Sethu Raman
- Legislative Commission on Global Climate Change, March 7, April 4, April 25, 2006, Sethu Raman
- Interview on Lightning, WTVD-TV, March 9, 2006, Ryan Boyles
- Seminar to NCSU Department of Horticulture Science, March 13, 2006, Mark Brooks, Sethu Raman
- Seminar to NCSU Department of Crop Science, March 16, 2006, Mark Brooks
- Wind site survey, Grandfather Mountain, Linville, NC, March 23, 2006, Ryan Boyles
- Seminar Department of Mathematics, NCSU, March 31, 2006, Sethu Raman
- Seminar to Marine Sciences Program, UNC-CH, April, 5, 2006, Chapel Hill, Sethu Raman

VISITORS

- Girl Scout Troop from Alamance County, October 27, 2006
- NC DataStreme / WES program, December 3, 2006
- Jamie Rhome, National Hurricane Center, February 24, 2006
- Dr. Charles Peacock and Dr. Art B., NCSU Department of Crop Science, March 30, 2006
- Professor Jerry Whitten, NCSU, April 12, 2006
- Professor M.P. Singh, Director, Ansel Institute of Technology, India, April 12, 2006
- Dr. Lane Tredway, NCSU Department of Crop Science, April 21, 2006

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State Climate Office of North Carolina
College of Physical and Mathematical Sciences
1005 Capability Drive, Centennial Campus
Suite 240, Research III Building
Box 7236, North Carolina State University
Raleigh, NC 27695-7236

Voice: 919-515-3056
Fax: 919-515-1441
Email: sco@climate.ncsu.edu
WWW: http://www.nc-climate.ncsu.edu/

Dr. Sethu Raman

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE
Presentation Handouts - 25 April 2006

Agenda Item #4: *Discussion of the technology options related to global climate change by sector*

Transportation sector

David L. Greene, Corporate Fellow
Oak Ridge National Laboratory
Knoxville, Tennessee

Electricity sector

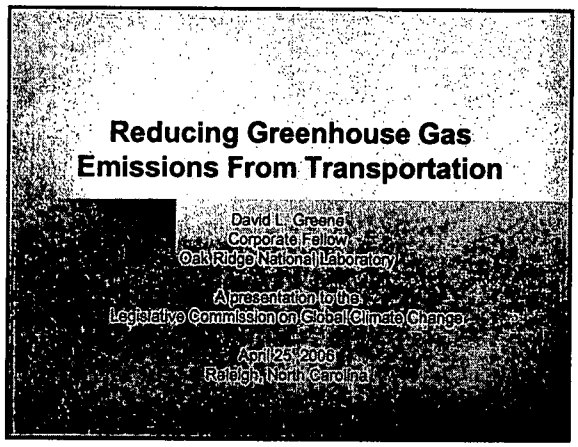
Edward S. Rubin, Director
Center for Energy and Environmental Studies, Department of Engineering and Public Policy, Carnegie Mellon University
Pittsburgh, Pennsylvania

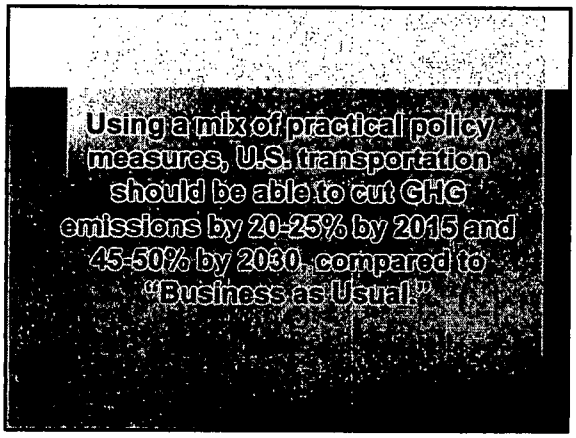
Construction and building sector

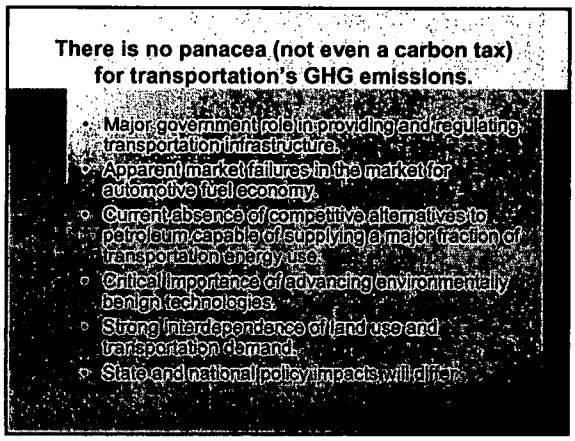
Marilyn A. Brown, Interim Director
Engineering Science and Technology Division, Oak Ridge National Laboratory
Oak Ridge, Tennessee

Forestry and agriculture sector

Dennis W. Hazel, Professor
Forestry and Environmental Outreach Program, North Carolina State University
Raleigh, North Carolina


Reducing Greenhouse Gas Emissions From Transportation
David L. Greene
Corporate Fellow
Oak Ridge National Laboratory
A presentation to the
Legislative Commission on Global Climate Change
April 25, 2006
Raleigh, North Carolina

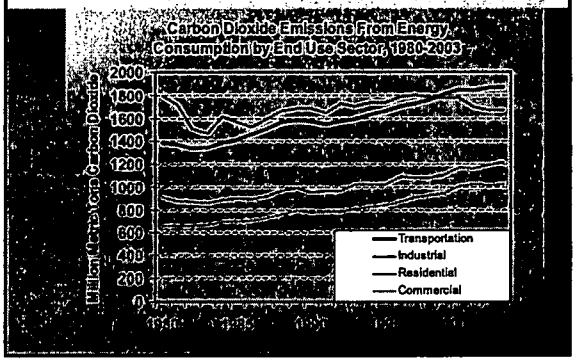

Using a mix of practical policy measures, U.S. transportation should be able to cut GHG emissions by 20-25% by 2015 and 45-50% by 2030, compared to "Business as Usual."


There is no panacea (not even a carbon tax) for transportation's GHG emissions.
Major government role in providing and regulating transportation infrastructure.
Apparent market failures in the market for automotive fuel economy.
Current absence of competitive alternatives to petroleum capable of supplying a major fraction of transportation energy use.
Critical importance of advancing environmentally benign technologies.
Strong interdependence of land use and transportation demand.
State and national policy impacts will differ.

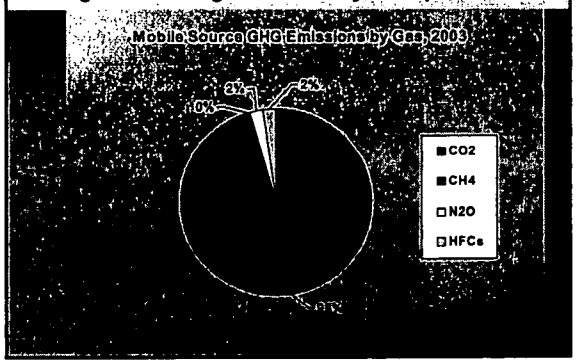
The U.S. transportation system is the world's largest.

- 5.4 trillion passenger-miles 3.8 trillion ton-miles of freight per year
- Second to industry in U.S. GHG emissions, but growing faster
- Largest source of CO_2
- More than any nation in the world's total CO_2 emissions, except China
- 72% from highway vehicles, over half from cars and light trucks

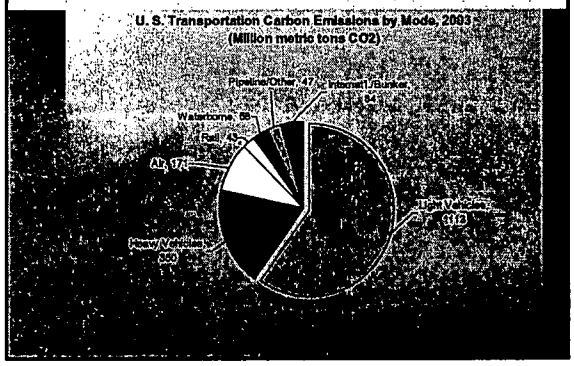
Among the energy end use sectors, transportation is the largest emitter of CO_2



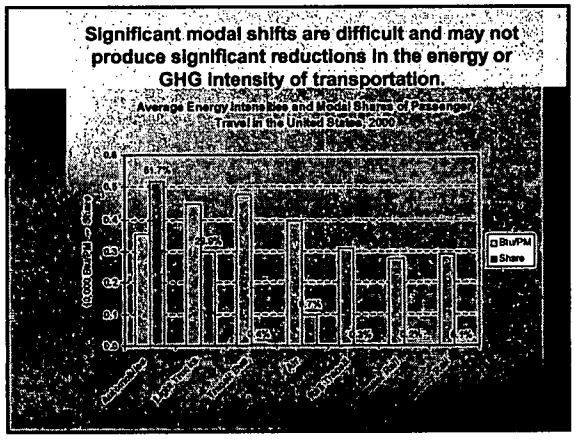
Carbon dioxide is by far the most important greenhouse gas emitted by transportation.



Highway vehicles, especially passenger cars and light trucks, account for most transportation GHG emissions.



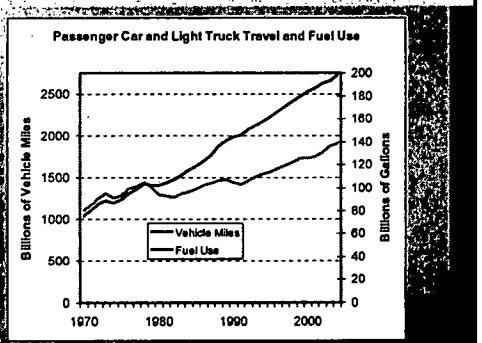
Significant modal shifts are difficult and may not produce significant reductions in the energy or GHG intensity of transportation.



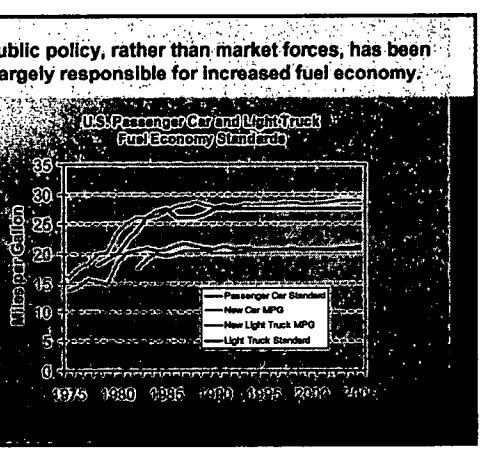
Increasing fuel economy can make the largest single contribution.

- Meaningful increases achievable at low to moderate costs
- No infrastructure changes required
- Main barriers:
  - goals sought are public not private benefits (GHGs, oil dependence)
  - consumers may undervalue fuel economy
  - Powerful interests oppose meaningful policies
- No shortage of effective policies: feebates, standards, carbon cap and trade, etc.

Fuel economy increases since 1978 are saving more than 50 billion gallons of gasoline every year.



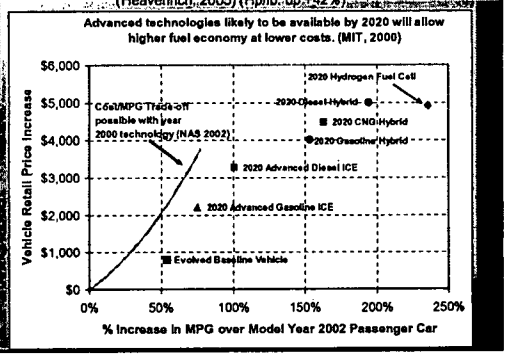
Public policy, rather than market forces, has been largely responsible for increased fuel economy.



The near-term (circa 2015) potential for GHG reduction from NEW vehicles via fuel economy improvements has been estimated by the NRC (2002) and others.

- "Technologies exist that, if applied to passenger cars and light trucks, would significantly reduce fuel consumption within 15 years."
  - Passenger cars 12% (subcompacts) to 27% (large cars)
  - Light trucks 25% (small SUV) to 42% (large SUV)
  - Present value of fuel savings > vehicle price increase
  - No change in size, weight or performance
  - Does not include hybrids or clean diesels, each offering 30-40% increases.
  - Further market penetration of hybrids and clean diesels through 2012 and beyond could boost fleet average fuel economy by an additional 10% or more. (Greene, Schafer, McManus, 2004)

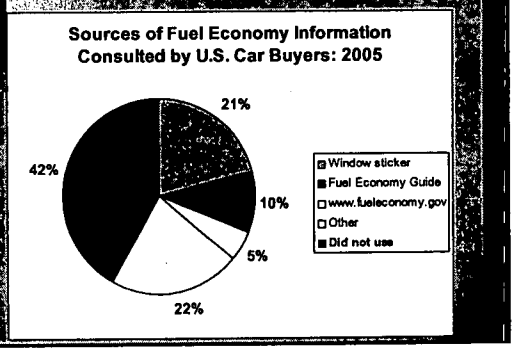
Technology alone is not enough:
"EPA estimates that had the new 2005 light-duty vehicle fleet had the same distribution of performance and the same distribution of weight as in 1987, it could have achieved about 24 percent higher fuel economy." (Heavenrich, 2005) (Hp/lb. up +42%)



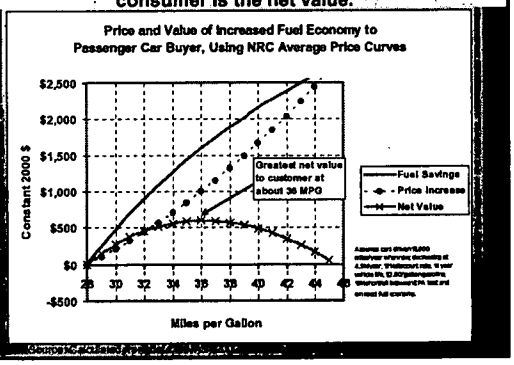
There is substantial potential to improve consumers' decision-making about fuel economy.

- In-depth interviews of 60 California households vehicle acquisition histories found ***no evidence*** of economically rational decision-making about fuel economy. (Turrentine & Kurani, 2004)
  - Out of 60 households (125 vehicle transactions) 9 stated that they compared the fuel economy of vehicles when choosing a vehicle.
  - 4 households knew their annual fuel costs.
  - None had made any kind of quantitative assessment of the value of fuel savings.

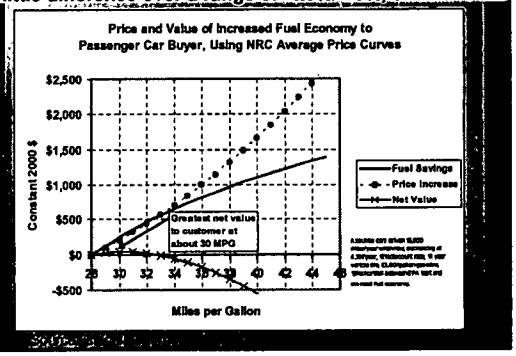
4 out of 10 U.S. car buyers did not consult any source of fuel economy information.



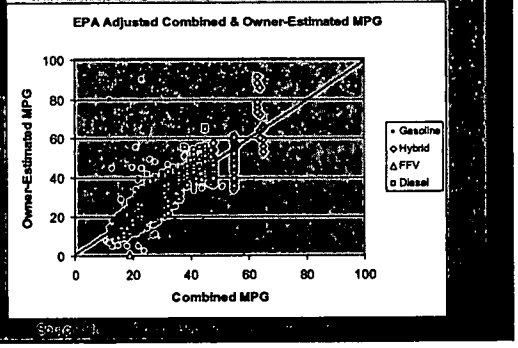
Fuel economy can be traded off against cost, performance or weight. What matters to the consumer is the net value.



But manufacturers assert that consumers are willing to pay for 3-years worth of fuel savings: still little difference over a range of +20%/-10%, or so.

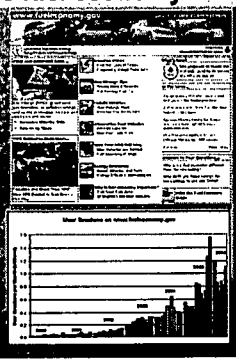


Official fuel economy estimates appear to be unbiased but inaccurate, adding uncertainty. Can we do better?



There is substantial consumer interest in improving in-use fuel economy.

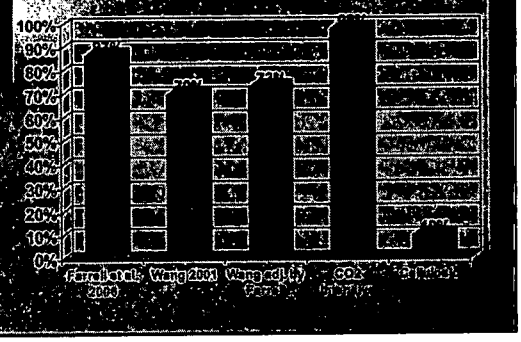
- Speeding and aggressive driving: up to 30% in highway driving
- Proper tire inflation (3%), tune-up (4%), correct grade of oil (1-2%).
- Remove excess weight: 1-2%/100 lbs.
- Trip planning, avoiding idling, and more.
- www.fueleconomy.gov
- High level of media and consumer interest.



The greatest near-term potential for low-carbon alternative fuels is as replacement fuels.

- Replacement fuels (e.g., ethanol) are compatible with vehicles and refueling infrastructure.
- Cellulosic ethanol needed for near zero fuel cycle GHG emissions & lower cost.
- Tax subsidies effective
- CO_2 reduction:
  - ≅ 3% by 2015 (10% ethanol from corn)
  - ≅ 10% by 2030 (10% ethanol from cellulose)

A recent study in Science (Farrell et al., 2006) updating published estimates of ethanol's CO2 reduction potential and putting them on a consistent basis found a range of reduction from 2% to 30% depending on the process.



The U.S. Departments of Energy and Agriculture have estimated that biofuels could replace up to 30% of U.S. petroleum use.

- 1.3 billion dry tons of sustainably produced biomass
- 370 million dry tons from forest lands, including 120 million of logging and other residues
- 1 billion tons from agricultural lands
  - 445 million tons of crop residues
  - 377 million tons of perennial crops
  - 87 million tons of animal manures and other residues
- Perlack et al., "Biomass as a Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Supply", 2005.

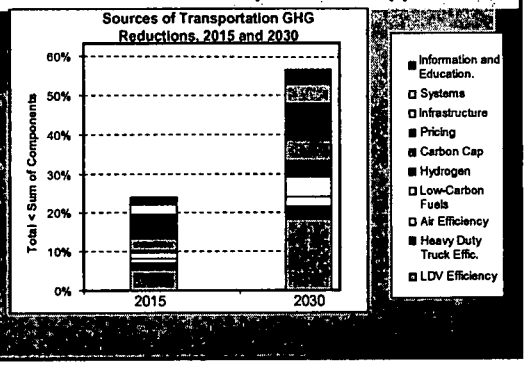
A comprehensive GHG strategy for transportation should address system efficiency, infrastructure, and land use.

- Some external costs of motor vehicle travel could be internalized via policies that do not increase total costs (8-12% reduction), e.g. "pay-at-the-pump" insurance.
- Opportunities for transit and intermodal investments to increase system efficiency may exist.
- Operational efficiency improvements, e.g. reducing diesel truck idling, can make significant contributions.
- Improved consumer information could raise consumer awareness and improve market efficiency.
- Managed growth policies might reduce travel by 10% in the long run with no loss in mobility.
- Comprehensive "smart growth" policies could reduce vehicle travel by 25% (eg, Ewing et al., "Growing Cooler: The Evidence on Urban Sprawl and Global Warming", 2007).

As the Pew Center's study demonstrated, there is substantial, practical potential to reduce transportation GHG emissions.

- For 2015 assumed:
  - Proven energy efficiency technologies & fuels
  - Value of fuel saved = vehicle price increase
  - No change in vehicle size or performance
  - Carbon cap and trade to internalize external GHG costs
- For 2030 added:
  - Likely technological progress
  - Continuation or moderate extension of 2015 policies
- Greater reductions are possible with more effort, cost or technological success

Major reductions in transportation GHG emissions call for a comprehensive approach.



A comprehensive strategy could yield dramatic results.

Emissions Source	Example Policies	2006 Carbon Emissions (mmtC)	Potential reduction in 2015 (%)	Potential reduction in 2030 (%)	Emissions Weighted % GHG Reduction 2015	Emissions Weighted % GHG Reduction 2030
Research, Development & Demonstration						
Passenger Car Efficiency	PNGV, FreedomCar	1061	11%	38%	7%	23%
Heavy Truck Efficiency	21st Century Truck	294	11%	34%	2%	4%
Aircraft Energy Efficiency	NASA EEE, Aerospace Tech.	186	11%	27%	1%	3%
Low-carbon fuels	Biofuels	100	50%	100%	3%	6%
New Vehicle Efficiency or GHG Emission Policies						
Passenger Car and LT Truck	CAFE, Voluntary, Feebates	1061	11%	38%	6%	21%
Heavy Truck	Voluntary Standards	294	11%	22%	2%	4%
Commercial Aircraft	Voluntary BMPG Standards	186	11%	20%	1%	3%
Replacement & Alternative Fuels						
Low-Carbon Replacement Fuels	Ethanol tax credits	100	30%	100%	2%	6%
Hydrogen Fuel	Hydrogen-Fuel Cell Partnerships	1061	1%	6%	1%	4%
Fiscal Policies						
Low-carbon fuel subsidy	Federal Tax exemption for bio-ethanol	100	30%	100%	2%	6%
Carbon Tax		1792	3%	6%	3%	6%
Versatilization		1365	6%	12%	6%	9%
Behavioral						
Land Use & Infrastructure	Urban Design, Planning	903	6%	10%	3%	6%
Systems Efficiency	Rideshare, transit promotion	265	2%	6%	0%	1%
Climate Change Education		1792	1%	2%	1%	2%
Fuel Economy Information	Driver training, www.fueleconomy.gov	1061	1%	2%	1%	1%
TOTAL		1792			23%	50%

Clearly, state policies will have different impacts from federal policies.

- Impacts of GHG emission standards will depend on leverage and control of leakage.
- States can play a key role in educating motorists.
- States can play an important role in promoting biomass fuels.
- States and local governments have the greater influence over system efficiency, land use, transportation planning and regional development.
- A comprehensive approach is essential for significant reductions in transportation GHG emissions.

THANK YOU.

Greenhouse Gas Reduction Options for the Electric Power Sector

Edward S. Rubin
Department of Engineering and Public Policy
Carnegie Mellon University
Pittsburgh, Pennsylvania

Presentation to the
North Carolina Legislative Commission on Global Climate Change
Raleigh, North Carolina
April 25, 2006

Outline of Talk

- Why focus on the electric power sector?
- What options are available to reduce power sector GHG emissions?
- What are some of the key policy options and considerations?

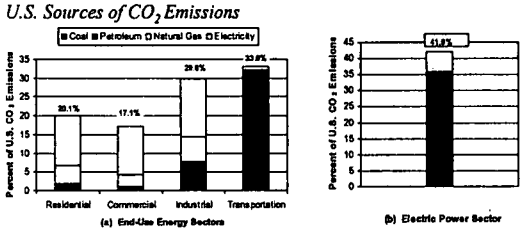
E.S. Rubin, Carnegie Mellon

Why focus on the electric power sector ?

E.S. Rubin, Carnegie Mellon

CO_2 from Fuel Combustion is the Dominant Greenhouse Gas

U.S. Sources of CO_2 Emissions

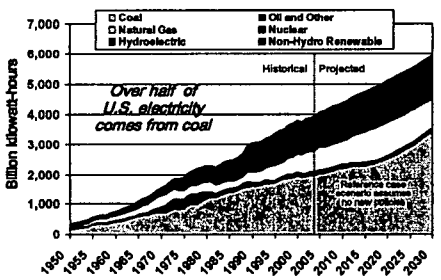


Electric power plants are the largest source of U.S. emissions of carbon dioxide

E.S. Rubin, Carnegie Mellon

U.S. Electricity Generation by Fuel

(1950–2004 with EIA Reference Case projections to 2030)



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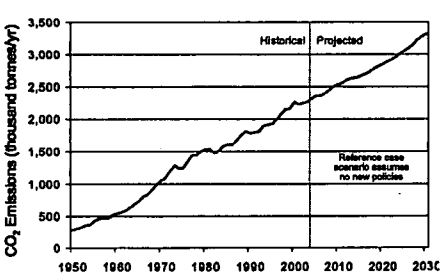
U.S. Power Sector CO_2 Emissions

(1950–2004 with EIA Reference Case projections to 2030)



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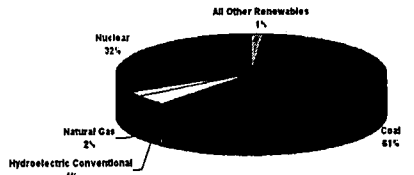
Fuel Sources for Power Plants in North Carolina

In-state Generation

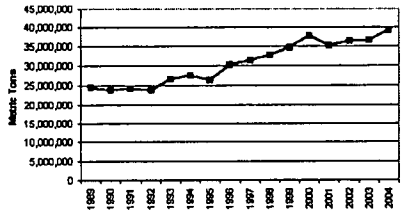


Source: Pew Climate Center, 2006

In-state consumption uses less coal and more nuclear

E.S. Rubin, Carnegie Mellon

CO_2 Emissions from Power Plants in North Carolina



Source: EIA/DOE, 2005

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The Climate Change Driver

- 1992 U.N. Framework Convention on Climate Change called for "stabilization of greenhouse gas concentrations in the atmospheric at a level that would prevent dangerous anthropogenic interference with the climate system"
- This implies a long-term need to drastically reduce CO_2 emissions, *no matter what target is selected for stabilization*

E.S. Rubin, Carnegie Mellon

What options are available to reduce CO_2 emissions from the electric power sector?

E.S. Rubin, Carnegie Mellon

General Approaches to Reduce Power Sector CO_2 Emissions

- Technologies that reduce demand for electricity
- More efficient technologies for power generation, transmission and distribution
- Power generation technologies using alternative energy sources with lower or no GHG emissions
- Technologies to capture and store (sequester) CO_2 produced at power plants

... a brief word about each ...

E.S. Rubin, Carnegie Mellon

Options to Reduce Demand

- Other speakers on today's panel will elaborate on the potential to reduce demand for electricity via improved building designs and more efficient end-use technologies; GHG emissions are reduced roughly proportionally (assuming all else constant)
- Demand-side management (DSM) programs employing changes in pricing and/or technology to meter and control customer loads may (or may not) further reduce GHG emissions; system-specific studies are required
  - Past DSM programs had generally small impacts and relatively high costs, but results varied widely by region and company

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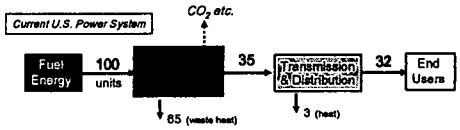
Options to Increase Efficiency



- More efficient power generation technologies are available today, including
  - Natural gas-fired combined cycle plants (NGCC)
  - Supercritical pulverized coal plants (SCPC)
  - Integrated gasification combined cycle plants (IGCC)

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Options to Increase Efficiency *(2)*

- Smaller-scale distributed generation (DG) can reduce needs for transmission and distribution and facilitate greater use of co-generation (combined heat and power) to significantly improve overall system efficiency
  - Technologies include internal combustion engines, micro-turbines, fuel cells
  - Applications must consider local energy demands air quality impacts, and other factors
  - CO_2 impacts will depend on fuel mix and system efficiency
- Micro-grids and improved grid technologies (power electronics, superconductors, etc.) can further enhance overall system efficiency

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Options for Alternate Energy Sources
(with low or zero carbon)

- Available today, with potentially wide deployment
  - Natural gas
  - Nuclear
- Available today, with more limited deployment
  - Wind
  - Biomass
  - Geothermal
- Also available for niche applications
  - Low-head hydro
  - Solar photovoltaics

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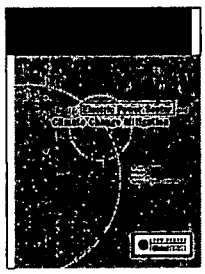
All of the options above have issues and limitations that must be considered

- Several of my Carnegie Mellon colleagues recently produced a report for the Pew Center on Climate Change that addresses the full range of issues and options related to climate change mitigation and the U.S. electric power sector
- Available at: www.pewclimate.org



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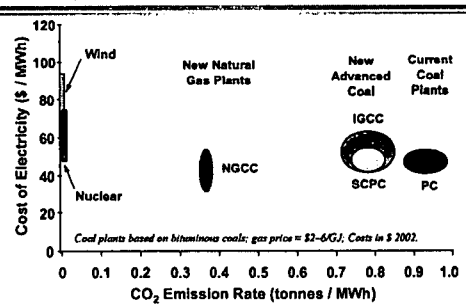
Approximate Cost of Options



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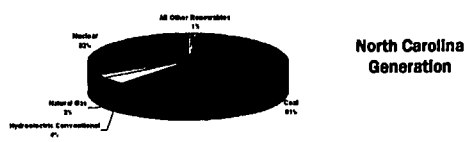
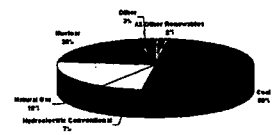
Reminder: Currently, We make most electricity from coal



North Carolina Generation

Source: Pew Climate Center, 2006



United States Generation

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Options for CO_2 Capture and Storage

- Fossil fuels will continue to be used extensively for many decades to come—alternatives are not likely to achieve large CO_2 reductions in time frames of policy interest
- CCS offers a way to allow fossil fuels (especially coal) to be used with little or no CO_2 emissions—a potential bridging strategy
- Energy models indicate that the availability of CCS in a portfolio of options can significantly lower the cost of mitigating climate change

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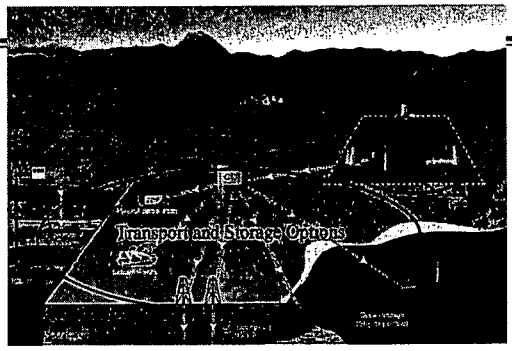
CO_2 Capture and Storage Systems



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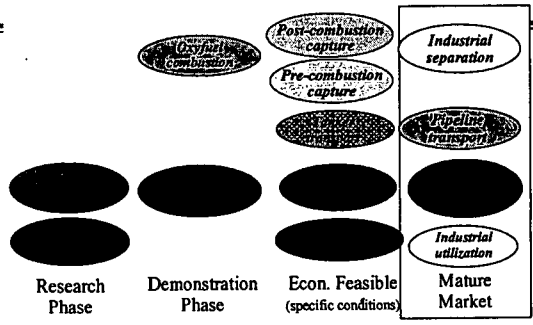
Maturity of CCS Technologies



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Leading Candidates for CCS

- Fossil fuel power plants
  - Integrated coal gasification combined cycle
  - Advanced pulverized coal combustion
  - Natural gas combined cycle
- Other large industrial sources of CO_2
- Focus on geological storage

This option is relatively new and less familiar to many policymakers. The next few slides show some potential applications to power plants as the largest source of CO_2

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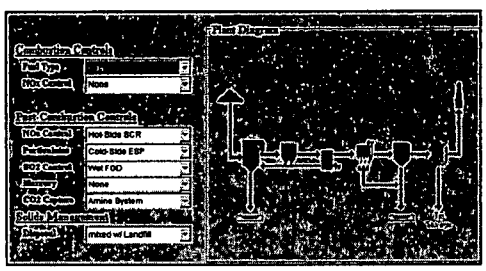
PC Plant with CO_2 Capture



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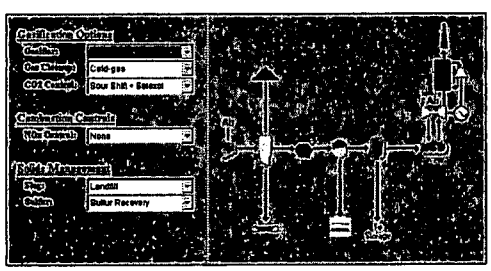
IGCC Plant with CO_2 Capture



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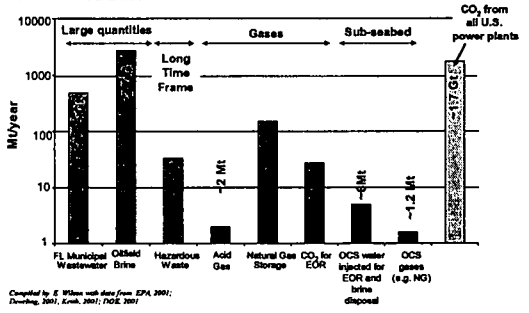
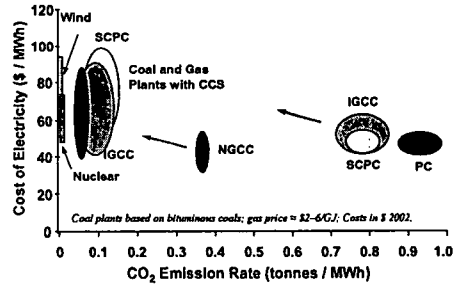
Current U.S. fluid injections exceed the mass of all CO_2 from U.S. power plants



Approximate Cost of Options
(including power plants with CCS)



Cost of CO_2 Avoided
(Based on Current Technology)

(2002 US$ per tonne CO_2 avoided)

Power Plant System	Natural Gas Combined Cycle Plant	Pulverized Coal Plant	Integrated Gasification Combined Cycle Plant
Same plant with CCS (deep aquifer storage)	40–90	30–70	15–55
Same plant with CCS (EOR storage)	20–70	10–45	(-5)–30

Source: IPCC, 2005

Analyses indicate that CCS can begin to play a significant role at carbon prices at or above roughly $100/tC ($27/tCO$_2$)

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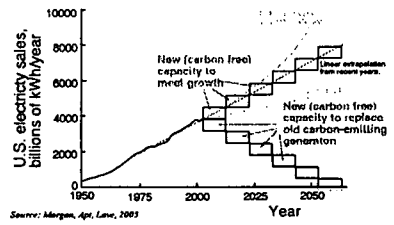
Using carbon free technologies…

…and doubling current construction rates, the Pew Center report concludes it should be possible to essentially eliminate CO_2 emissions from the U.S. power sector in about 50 years.



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Policy options and considerations

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Examples of Policy Opportunities for the Electric Power Sector

Near-term recommendations from 2005 DENR report:

- Cleaner coal and renewable energy capacity
- Mandatory GHG reporting
- Energy efficiency
- Center of low-carbon technology development
- Work with other states in the Southeast

Longer-term recommendations:

- Public Benefit Fund
- Renewable Portfolio Standard

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Some Examples of Current Policies to Reduce GHG Emissions

- European Union Emission Trading System *(C/T)*
- Kyoto Protocol *(C/T, JI, CDM)*
- Northeast Regional Greenhouse Gas Initiative *(C/T)*
- California Climate Action Policy Proposals *(C/T)*
- California GHG Performance Standard for Power Plants
- Energy Policy Act of 2005 *(incentives)*

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Other Potential Policy Options to Reduce Power Sector GHG Emissions

- Incentives to Reduce GHG Emissions
- Carbon Tax
- Cap and Trade System
- Performance Standards for CO_2 Sources
- Technology Standards for CO_2 Sources
- Portfolio Standards for Power Retailers
- "Capture Ready" Design Requirements
- "Feebate" System for Existing Power Plants
- Combinations of the Above

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"Technology Policy" Options

Direct Government Funding of Research and Development (R&D)

- R&D contracts with private firms
- R&D grants and contracts with universities
- Intramural R&D conducted at gov't laboratories
- R&D contracts with consortia (2 or more of the actors above)

Direct or Indirect Support for Commercialization and Production; Indirect Support for Development

- 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
- Demonstration projects

Support for Learning and Diffusion of Knowledge and Technology

- Education and training
- Codification and transfer of knowledge
- Technical standard-setting (non-regulatory)
- Technology and/or industrial extension services
- Publicity and consumer information

- ***These policies influence different phases of the innovation process***
- ***Provide incentives for technological change & innovation***
- ***Many of these options are available to state governments***

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Conclusions from Case Studies of Environmental Technology Innovation

- The stringency of emission reduction requirements is a major factor in both *stimulating* and *directing* innovations and deployment of cleaner technologies
- The cost of achieving a given level of emissions reduction tends to fall with increasing technology deployment and sustained R&D
- The firms that innovate tend to capture large market share of environmental technology
- No strong empirical basis for comparing alternative environmental policy instruments

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Innovation Policies to Mitigate Climate Change

- Global climate change is an environmental problem that cannot be addressed by voluntary technology policies alone — *regulatory policies that limit GHG emissions* also are needed
- *Energy policies* can further help—or impede—progress and innovations that reduce GHG emissions
- A *combination* of traditional technology policies and regulatory policies that limit GHG emissions can most effectively foster innovations favored or required by markets in a carbon-constrained world

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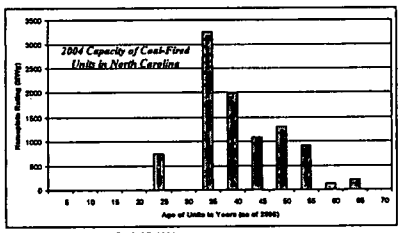
North Carolina Power Plants are Aging … little time to waste

- Current fleet of CO_2-emitting power plants is 35–55 years old; decisions about replacement capacity will have a major impact on future GHG emissions



Source: Based on data from EIA/DOE, 2006

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Towards a Climate-Friendly Built Environment

Presented to:
Legislative Commission on Global Climate Change

Presented by:
Dr. Marilyn A. Brown, Interim Director
Engineering Science and Technology Division
Oak Ridge National Laboratory

April 25, 2006

Much of the material for this talk is drawn from: *Towards a Climate-Friendly Built Environment*, Sponsored by the Pew Center on Global Climate Change (June, 2005) (http://www.pewclimate.org/global-warming-in-depth/all_reports/buildings/index.cfm)

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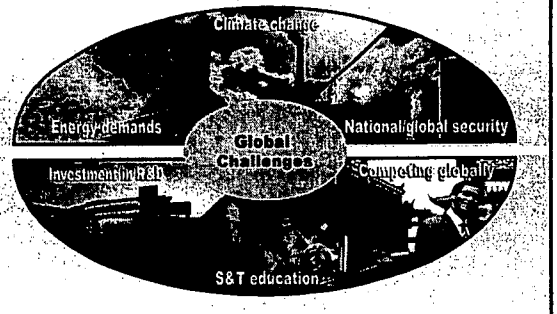
U. S. DEPARTMENT OF ENERGY

Three Closely Linked Global Challenges Call for a Broad Response



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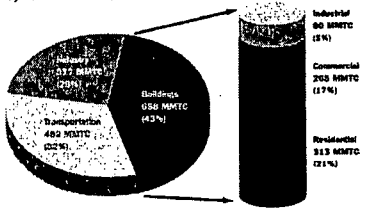
≈ 43% of US CO_2 Emissions are from the Energy Required by Buildings

Figure 1

CO_2 Emissions From Fossil Fuel Combustion by End-Use Sector, 2002



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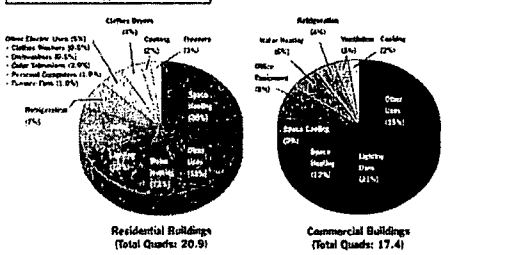
Diverse Sector, Diverse Uses

Figure 5

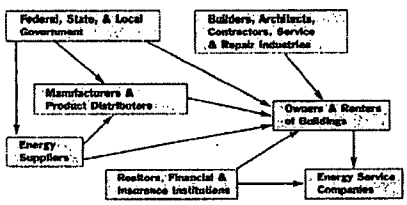
Primary Energy Consumption in Residential and Commercial Buildings, 2002



The Fragmented Building Industry Inhibits Innovation and Change

Figure 6

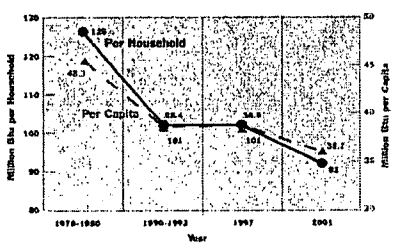
Multiple Stakeholders and Decision-makers in the Building Sector



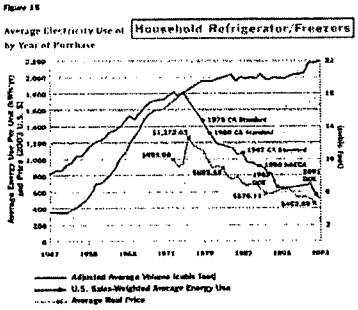
Past Success in Reducing GHGs from the Buildings Sector

Figure 2

Declining Energy Consumption per Household



Household Refrigerator Illustrates Potential for Improved Efficiency



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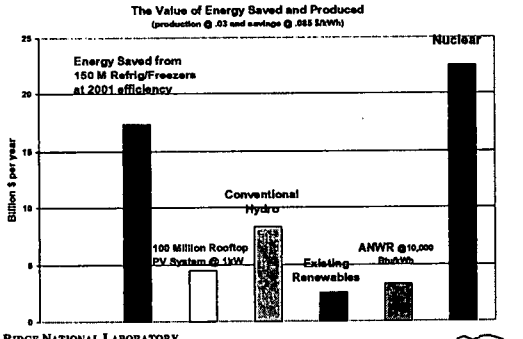
Value of Energy Saved & Produced



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Source: Art Rosenfeld, 2005

Future Energy Challenges Require Eliminating More Energy Waste

- In the U.S. over the next 30 years:
  - Most of the current stock of buildings will still be occupied
  - The built environment will grow by 70%
  - New energy services in buildings will continue to expand
  - GHG emissions from buildings are expected to increase ~ 1.5% per year

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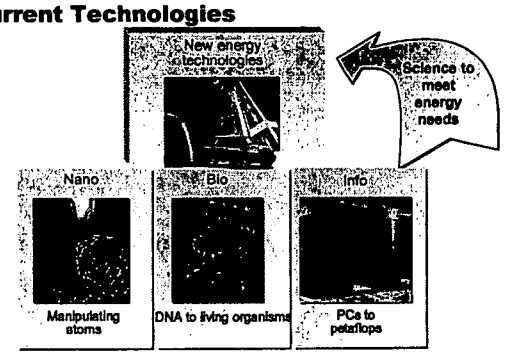
Opportunities for Improvement are Great

- The full complement of cost-effective climate-friendly technologies are rarely used
- Renewable energy only a small fraction of energy used on-site
- Sprawling urban landscape has spawned ever-longer trips
- Life cycle issues suggest the need for an integrated approach

Emerging Energy Technologies Could Make a Difference

- Sealing methods that address unseen air leaks
- Electrochromic windows
- Unconventional water heaters (solar, heat pumps, tankless...)
- Inexpensive nanocomposite materials for solar energy
- Thermoelectric materials that transform heat into electricity
- Abundant sensors dispersed to continuously optimize operations
- Solid state lighting
- Selective water sorbent technologies for geothermal heat pumps
- 80-90% efficient integrated energy systems

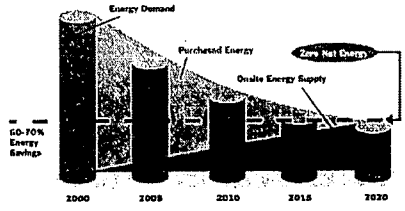
New Scientific Discoveries Can Transform Current Technologies



"Net Zero Energy" Homes Show Promise

Figure 9

The Pathway to **Net Zero Energy Homes**



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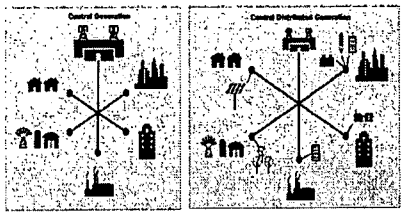
Climate-Friendly Distributed Energy is Promising Paradigm Shift

Figure 10

The Transition to **Distributed Energy Resources**



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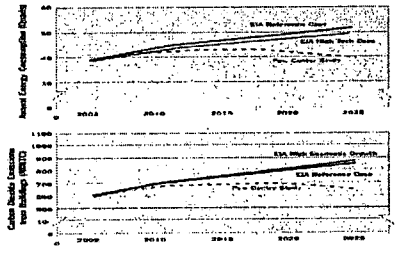
The Potential for Reduced Emissions

Figure 15

Scenarios of U.S. **Energy Use and Carbon Emissions**



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Energy Policy Act of 2005 is Stimulating Clean Energy Investments

- First major energy legislation since 1992 EPACT
- Signed into law on August 8, 2005, following four years of debate
- Overall goal of the Act is to provide incentives and remove obstacles in order to:
  - Create and grow next generation of power plants, fuels, and infrastructure
  - Prepare the nation to meet the energy needs of the future

http:www.ne.doe.gov/EPAct2005/hr6_textconfrept.pdf

Energy Efficiency Provisions Include New Appliance Standards

- Legislates new efficiency standards on 12 residential and 5 commercial products
- Reauthorizes Energy Star program & divides program between EPA and DOE
- Increases authorization for Weatherization and Low Income Home Energy Assistance Programs

Tax Credits for Existing Homes

- Consumers can receive a credit of up to 30% of the cost, or up to $2,000, for installing solar-powered hot-water systems used exclusively for purposes other than heating swimming pools and hot tubs.
- Consumers can receive tax credits up to a total of $500 on the amount they spend on qualified energy efficiency improvements to their home including:
  - 10% of expenditures to improve the building envelope (The credit for new windows is limited to $200.)
  - $50 for an advanced main air circulating fan
  - $150 for a highly efficiency furnace or boiler
  - $300 credit for a highly efficient central air conditioner, heat pump or water heater

New Home Tax Credits

Business Tax Credit for homes sold by the builder or manufacturer from 01/01/06 to 12/31/07:

- Site Built Home:
  - $2000 for homes 50% less heating and cooling energy than IECC code 2004 supplement (1/5 from envelop improvement)
- For HUD Code Manufactured Homes:
  - $1000 for Energy Star homes or homes using 30% less heating and cooling than IECC 2004 Stds. (1/3 from envelope)

Tax Credit Strategies for Hot Humid Climate*

	House 1**	House 2**
• Walls	R-19 2x6	R-19 2x6
• Ceiling	R-60	R-40
• Reduced infiltration	typical	tight
• Air conditioner	SEER 15	SEER 13
• Furnace	AFUE 92.5	AFUE 80
• Ducts	inside	inside
• Estimated cost	$1,635	$1,112

* Two story 2500 ft sq house slab on grade with 18% window to floor ratio.

** These are representative strategies. Builders must conduct their own analysis to determine the changes to their homes to qualify for the tax credit.

Tax Credits for Commercial Buildings

- A deduction up to $1.80/sq. ft. to owners or tenants of new or existing commercial buildings that save 50% of heating, cooling, water heating, and interior lighting energy cost of a building that meets ASHRAE Standard 90.1-2001
- Partial deductions of up to $.60 per sq. ft. can be taken for comparable reductions from any one of three building systems
- For government-owned buildings, the deduction may be taken by the building or system designer

EE Activity is Legislated for Federal Sector

102: Annual energy reduction goal of 2% from FY 2006 – FY 2015. Reporting baseline changed from 1985 to 2003

105: Reauthorizes ESPCs through September 30, 2016

109: Buildings to be designed to 30% below ASHRAE standard or International Energy Conservation Code unless proven to be not life-cycle cost-effective

203: Renewable electricity consumption by the Federal government can not be less than:

- 3 percent in FY 2007 – FY 2009
- 5 percent in FY 2010 – FY 2012
- 7.5 percent in 2013 and thereafter

204: Establishes a photovoltaic energy commercialization program in Federal buildings

Install 20,000 solar energy systems in Federal buildings by 2010

Lots of Additional EE Activity is Legislated

106: Authorizes voluntary industrial energy-efficiency agreements and establishes an Advanced Building Efficiency Testbed program ($6M/year)

132 & 134: Directs DOE to create an Energy Efficiency Public Education program and public awareness campaign

139: DOE to conduct a study of utility-run state and regional demand-side management programs

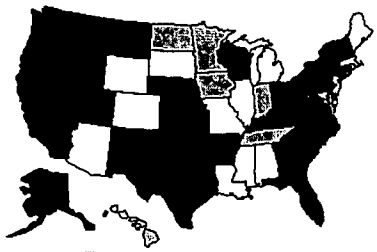
154: Requires HUD to develop EE strategy for public housing

Requires states to facilitate development of combined heat and power and distributed generation technologies

More Energy Efficiency Policies are Needed

1. State Residential Energy Codes
2. State Commercial Energy Codes
3. State Appliance Efficiency Standards
4. Green Building Standards for State Buildings
5. State Energy Efficiency Resource Standards

States with Residential Energy Codes



1998 IECC or Later (EPCA Compliant)

1997 IECC or Earlier (Not EPCA Compliant)

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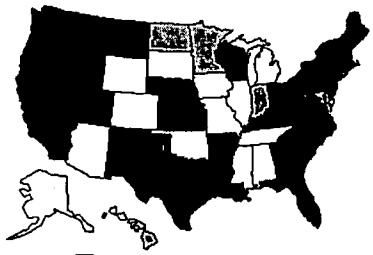
States with Commercial Energy Codes



1999 ASHRAE or Later (EPCA Compliant)

1998 ASHRAE or Earlier (Not EPCA Compliant)

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States with Appliance Efficiency Standards

Energy Efficiency Standards for Household and Commercial Appliances (beyond Federal standards)

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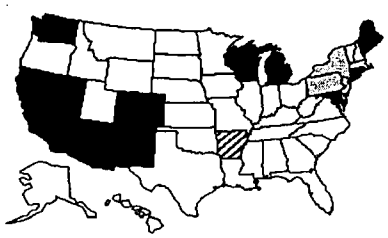
Green Building Standards for State Buildings



- LEED Certification Required for State Buildings and/or State-Funded Buildings
- LEED Certification Recommended for State Buildings and/or State-Funded Buildings
- Green Globes Certification Required or Recommended for State Buildings and/or State-Funded Buildings

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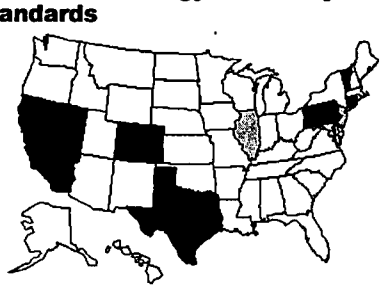
States with Energy Efficiency Resource Standards



- Completed EERS
- Pending EERS

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Conclusions

- Near term:
  - Bring current building practices up to level of best practices
  - GHG reduction potential resides mostly with the existing building stock
- By 2025 and beyond:
  - Zero-energy buildings, climate-friendly designs, and smart growth practices
- An integrated and expansive approach is needed that:
  - Coordinates across technical and policy solutions
  - Integrates engineering approaches with architectural design
  - Considers design decisions within the realities of building operation
  - Integrates green building with smart-growth concepts

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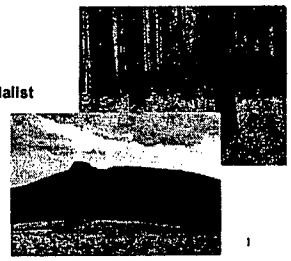
Solution Opportunities Regarding Global Change from the Agricultural and Forestry Sectors



Dennis Hazel, Ph.D., C.F.
Extension Forestry Specialist

North Carolina
Cooperative Extension Service
NORTH CAROLINA STATE UNIVERSITY
COLLEGE OF AGRICULTURE AND LIFE SCIENCE

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Objectives

- Describe why "agriculture" & "forestry" are significant sectors to look to for global change solutions
- Provide a partial "laundry list" of some action items to be considered by the Climate Action Plan Advisory Group
- Discuss several action items in more detail that have promise for significant benefit

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Opportunities are Enormous Because the Industries Are Large

- Forestry is the state's second largest industry
  - 18.3 million acres in NC (2002)
  - 78% owned by 650,000+ individuals
  - Economic benefit to NC of $29+ billion
- Agriculture still very significant
  - 9 million acres in NC (2004)
  - 52,000 farms
  - Net farm income $1.9+ billion

4/24/2006 3

Four General Ways for Agriculture and Forestry to Contribute Solutions

- REDUCE EMISSIONS
  - CO_2 which constitutes most greenhouse gasses
  - CH_4 (methane)
  - N_2O
- PROMOTE CARBON SEQUESTRATION (capturing carbon from the atmosphere with live plants and storing it long term)
  - e.g. increase land area with plant crops and forests
  - Improve productivity (growth rates and health) of our crops and forests

4/24/2006 4

Four Ways - Continued

- SUBSTITUTE FARM AND FOREST BIOMATERIALS FOR OTHERS
  - Use and produce biofuels instead of burning fossil fuels
  - Use wood in place of other materials
- PRESERVE LAND IN FARM AND FOREST USE

4/24/2006 5

However, a note of caution must be added!!!!

- Forestry lost one million acres to non-forest use between 1990 and 2002 (5%).
- Farm acreage in NC dropped 2+% between 2000 and 2004.
- However, could global change solutions from these sectors help retain land in farm and forest?

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Possible Key Actions – Agriculture*

- Protect farmland from permanent conversion
  - Incentives
  - Conservation easements
  - Continued employment of use value taxation
  - BETTER MARKETS so that farming is more profitable
- Expand soil carbon storage
  - Conservation tillage
  - Less summer fallow fields
  - Increasing use of winter cover crops
  - Reduction of C loss through improved crop management

4/24/2006 *Items from a partial list being considered by Climate Action Plan Advisory Group 7

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Possible Key Actions – Agriculture

- Improve feed efficiency
  - Reduces methane emissions
- Reduce emissions from land
  - Use improved nutrient management including precision agriculture and manure management
  - Use deep rooted species on field borders (helps manage soil N)

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Possible Key Actions – Agriculture

- Expand use of renewable energy on-farms and expand the use of farm products as feedstocks for off-farm energy production
  - Manure digesters
  - Farm gassifiers
  - Using biodiesel in farm equipment
  - Feedstocks for biodiesel
  - Feedstocks for ethanol production
  - Feedstocks for direct combustion

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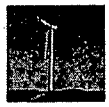
Possible Key Actions – Agriculture

- Develop more efficient farm to market routing of farm products (results in reduced transportation use)

North Carolina Farm Fresh



- Encourage windmill use on farms

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Possible Key Actions – Agriculture

- Plant erodible or no-longer used cropland to trees (very large potential gain in carbon sequestration! 3.2 tons per acre per year for managed pine plantations vs. about 100 pounds a year for some crops)

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Possible Key Actions – Agriculture

- Establish dedicated biofuel crops such as switchgrass or hybrid close-grown trees

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Possible Key Actions – Forestry

- Reduce conversion to non-forest use
  - BETTER MARKETS through healthy forest industry!
  - Land trusts
  - Conservation easements
  - Incentives (tax, cost-sharing, others)
  - Continued employment of use value taxation

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Possible Key Actions – Forestry

- Increase use of residential and urban trees and promote better management of them
- Restore non-forest lands to forests (wetlands, pastures, cropland)
- Develop improved trees for special uses through genetic and biotechnology

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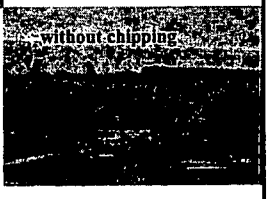
Possible Key Actions – Forestry

Employ Better Utilization During Harvesting

- Higher yields during logging
- Lower site prep & planting cost



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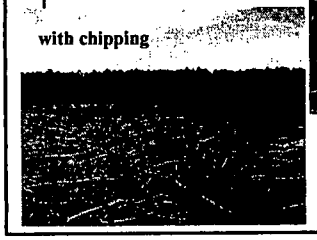

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Possible Key Actions – Forestry

4/24/200 16

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Possible Key Actions – Forestry

4/24/2006 17

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Possible Key Actions – Forestry

Wildfire Risk Management/Firewise

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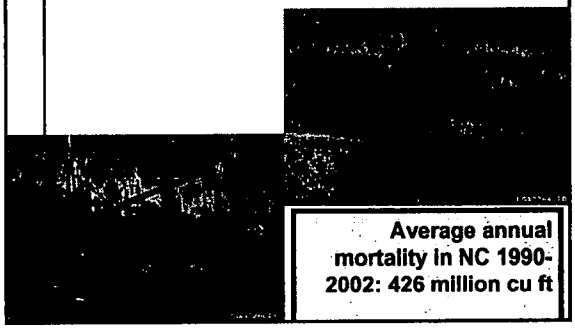
Possible Key Actions – Forestry
Salvage



Average annual mortality in NC 1990-2002: 426 million cu ft

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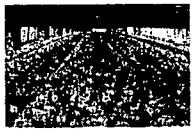
Possible Key Action - Forestry



- Improve carbon sequestration through nutritional amendments including ag wastes

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What Items Might Be the Biggest Bang for the Buck for Ag & Forestry?

1. Using "biomass" for direct production of energy
   - Steam for heating and chilling
   - Electric power generation
2. The Biomass-Based Biorefinery

WHY ARE THESE SO IMPORTANT?

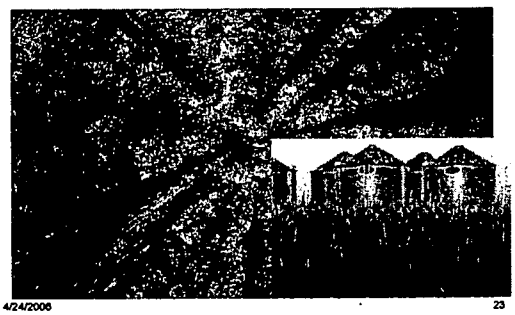
4/24/2006 21

Thomas Edison (1847-1931)

"I'd put my *money* on the sun and solar energy. What a source of power! I hope we don't have to wait 'til oil and coal run out before we tackle that."

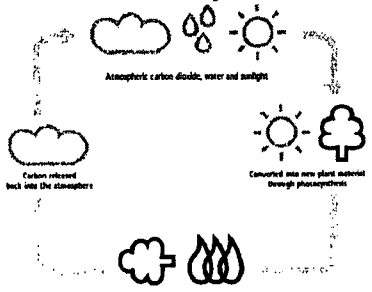
4/24/2006 22

So what's are the least expensive solar collectors currently available?



4/24/2006 23

Biomass – It's All about the Carbon Cycle



4/24/2006 24

Graph from Susan LeVan

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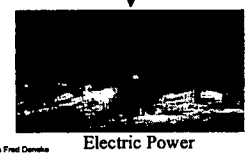
Biomass. It's a Significant and Realizable Opportunity

Chemical Products

Fuels



Electric Power

4/24/2006 25

Graphic borrowed from Fred Denske

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Agricultural Biomass

- Agriculture biomass includes crop, animal, and processing residues (straw, corn stover, sugarcane, animal manure, orchard prunings, hulls, shells, pits, seeds, and waste water from food processing operations
- Dedicated agriculture crops such as corn, sorghum, switchgrass, etc.
- Rapid fiber forest crops such as silage alder, hybrid poplar, sycamore, and willow

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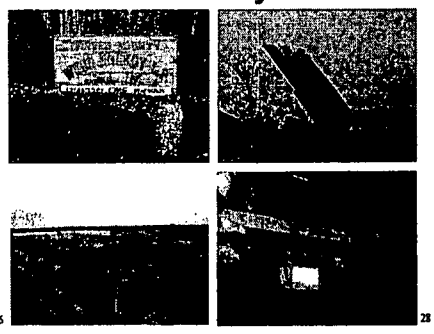
Forest Biomass

- Forest biomass includes harvesting and thinning residues, and thinnings from hazardous fuel reduction, habitat improvement, and other ecosystem restoration projects
  - **Trees & woody plants, including limbs, tops, needles, leaves, and other woody parts**
  - **Grown in a forest, woodland, or rangeland**
  - **Products of forest management, restoration, & hazardous fuel reduction treatments**
  - **For energy, it will not include higher value traditional forest products including sawtimber, chip ' saw, veneer poles, and pilings**

4/24/2006 27

Electricity



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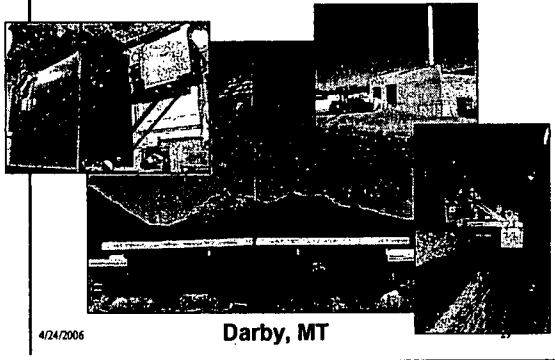
Heating & Chilling *(Fuels for Schools)*



Darby, MT

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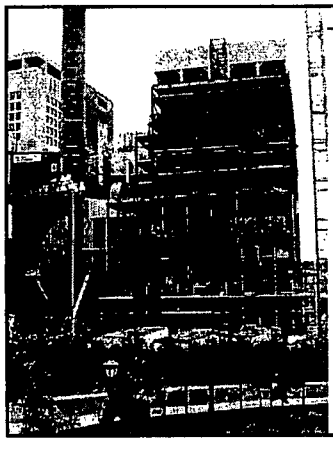
Combinations (District Energy *St. Paul, MN)*



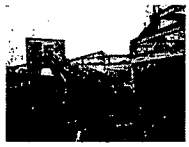
- Urban wood waste
- Daytime
  - Heating & cooling to downtown
  - Electricity to grid
- Night
  - Cooling downtown
  - Uses electricity

30

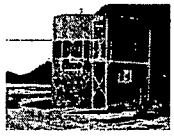
Animal Wastes Products for Electricity and Liquid Fuels

Electricity, Poultry Litter - Minnesota

Electricity, Poultry Litter - Scotland



Electricity, Poultry Litter – New Bern

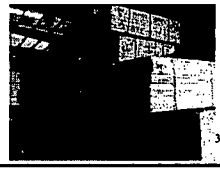


Ag Bio-diesel

4/24/2006 31

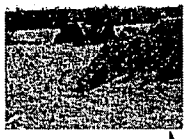
THERE IS EXISTING USE IN NC Residues and Wood Wastes

- Maybe 225+ plants with 300+ boilers
- Sawmills
- Furniture plants
- Dry kilns
- Co-generators
- Brick plants
- Many long-term users of renewable



4/24/2006 32

The new industrial biorefinery



Biomass Feedstock

- Trees
- Grasses
- Agricultural Crops
- Agricultural Residues
- Animal Wastes
- Municipal Solid Waste

Conversion Processes

- Enzymatic Fermentation
- Gas/liquid Fermentation
- Acid Hydrolysis/Fermentation
- Gasification
- Combustion
- Co-firing

USES

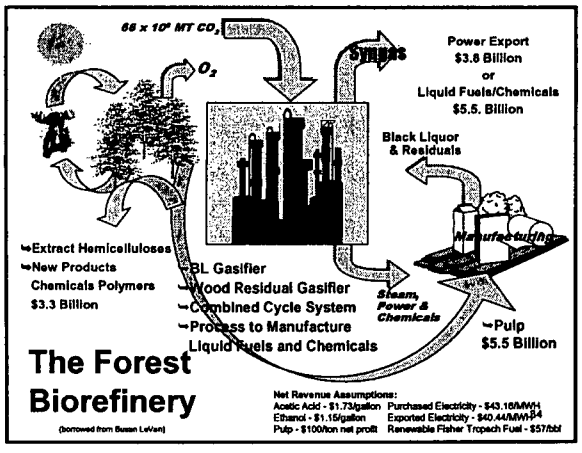
Fuels:
- Ethanol
- Renewable Diesel

Power:
- Electricity
- Heat

Chemicals:
- Plastics
- Solvents
- Chemical Intermediates
- Chemicals
- Adhesives
- Furfural
- Fatty acids
- Acetic Acid
- Carbon black
- Paints
- Dyes, Pigments, and Ink
- Detergents
- Etc.

Food and Feed

4/24/2006 33



NC STATE

Many Cobenefits of Implementing Solutions in Ag & Forestry Sectors

- Using renewable fuels
- Using carbon-neutral fuels
- More incentives to keep land in farms and forest
- Keeping $$$ spent for energy in North Carolina
- New jobs in rural areas

4/24/2006 35

Potential Benefits to NC of an RPS*

- Economic (net gain) Benefits
  - Lower rate impact than new nuclear + coal!
  - 3,000+ net jobs per year
  - $1.5 billion more in wages through 2017
  - $2.7 billion increase in Gross State Product
  - Keeps more $'s circulating in NC economy
- Social Benefits
  - Creates local wealth statewide; close to the land
  - Strengthens rural counties
- Environmental Benefits
  - Helps resolve hog and poultry waste/pollution issues
  - Improves air and water quality
  - Reduces NC's CO_2 emissions by several million metric tons

4/24/2006 * Ivan Urlaub, NC Sustainable Energy Association 36

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Co-Benefits - Continued

- Forest health is improved
- Strategies to reduce emissions are generally soil friendly
- Reduced dependence on foreign energy sources
- Improved national balance of trade
- Markets for ag and forestry waste products

4/24/2006 37

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There Can Be a Price to Waiting: Example Spruce/Fir Plant Community in NC Mountains

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Summary

- Agriculture and forestry have solutions to offer – with help!
- Terrific traditional and new partners exists to help identify and implement solutions
- Many, many co-benefits of turning to agriculture and forestry
- As Snuffy Smith said years ago: "Times a wastin'!"

4/24/2006 39

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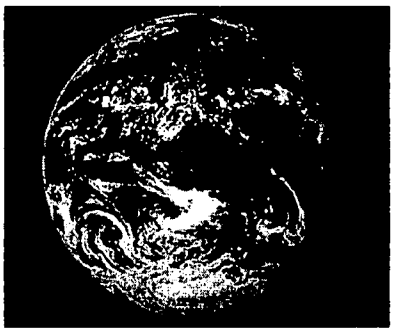
QUESTIONS?



North Carolina
Climate Action Plan Advisory Group

CAPAG Report to Legislative Commission on Global Climate Change

April 25, 2006

ncdenr
North Carolina Department of Environment and Natural Resources

CCS
CENTER FOR CLIMATE STRATEGIES

First Round of TWG Calls

- Week of April 10, 2006
- Five Technical Work Groups (TWGs)
  - Agriculture and Forestry (Ag&For)
  - Energy Supply (ES)
  - Energy Use by Residential, Commercial and Industrial Sources (RCI)
  - Transportation and Land Use (TLU)
  - Cross Cutting (CC)
- Good First Calls – Considerable Enthusiasm – e.g. Ag&For

Current CAPAG Schedule

DATE	MEETING
1st CAPAG meeting	February 2006
1st Round TWG conference calls	April, May 2006
2nd CAPAG meeting	May 2006
2nd Round TWG conference calls	June, July 2006
3rd CAPAG meeting	July 2006
3rd Round TWG conference calls	August, September 2006
4th CAPAG meeting	September 2006
4th Round TWG conference calls	October, November 2006
5th CAPAG meeting	November 2006
5th Round TWG conference calls	December, January 2007
6th CAPAG meeting	February 2007
6th Round TWG conference calls	March, April 2007
Public Report review	May, 2007
Final DENR/DAQ Report Due	CAPAG Meeting #1 June 2007

Commission Members on the CAPAG and TWGs

- Thomas Cecich
  - *Pharmaceutical Consultant*
- Caroline Choi
  - *Progress Energy*
- George Everett
  - *Duke Power*
- Preston Howard
  - Manufacturers & Chemical Industry Council
- Mitch Peele
  - *North Carolina Farm Bureau*
- Michael Shore
  - *Environmental Defense*
- Steven Smith
  - *Southern Alliance for Clean Energy*
- Jim Stephenson
  - *NC Coastal Federation*
- Tim Toben
  - *Carolina Clean Energy*
- Ivan Urlaub
  - *NC Sustainable Energy*

Invitation to Participate in TWGs

- LCGCC Members
  - Themselves
  - Staff
- Recommend Individuals

Catalog of Mitigation Options

- Handed Out at Last Commission Meeting
- Compilation of:
  - Actions developed and implemented in other States
  - Recommendations from Clean Smokestacks Act Report to Legislature in September 2005
  - State Energy Plan Recommendations
- Additional Copies Available today

Sample of Draft Potential State GHG Actions - Agriculture

Option No.	Climate Mitigation Option	Priority for Analysis	Potential GHG Emissions Reduction	Potential Cost or Cost Savings	Ancillary Impacts, Feasibility Considerations	Notes
AFW-1	AGRICULTURE – PRODUCTION OF FUELS AND ELECTRICITY					
1.1	Manure Digesters/Other Waste Energy Utilization**					
1.2	Biodiesel Production (incentives for feedstocks and production plants)					
1.3	Biomass Feedstocks for Electricity or Steam Production**					
1.4	Ethanol Production					

Contact Information

- **Brock Nicholson, P.E**
  - Deputy Director, Division of Air Quality
  - 919-715-0587
  - brock.nicholson@ncmail.net
  - www.ncair,org
- **Karl Hausker, PhD**
  - 202-412-5972
  - Karl.Hausker@comcast.net
  - www.climatestrategies.us
- **www.ncclimatechange.us**

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE
Presentation Handouts - 25 April 2006

Agenda Item #6: *Discussion of the economic implications of climate change policy*

The costs of climate policy options
Joseph E. Aldy, Fellow
Resources for the Future
Washington, D.C.

The costs of inaction
John C. Whitehead, Associate Professor
Department of Economics, Appalachian State University
Boone, North Carolina

Economic implications for forestry and agriculture
Brian C. Murray, Director for Economic Analysis
Nicholas Institute for Environmental Policy Solutions, Duke University
Durham, North Carolina

Economic questions regarding climate change
Margo Thorning, Vice President and Chief Economist
American Council for Capital Formation
Washington, D.C.

Attached you will also find a copy of testimony given by Dr. Thorning on April 5, 2006, to the U.S. Senate Committee on Commerce, Science and Transportation, Subcommittee on Global Climate Change and Impacts

Costs and benefits of climate policy options *(No handouts)*
Karl Hausker, Senior Advisor
Center for Climate Strategies
Harrisburg, Pennsylvania

Economic Costs of Mitigating Greenhouse Gas Emissions

Joseph E. Aldy

Presentation for the

North Carolina Legislative Commission on Global Climate Change

April 25, 2006

Economic Costs of Mitigating Greenhouse Gas Emissions

- Determinants of Mitigation Costs
- Cost Implications of Policy Design
- Cost Estimates of Climate Policy Proposals
- Further Issues Meriting Consideration
- Conclusions

April 06

Determinants of Mitigation Costs

- Reference/business-as-usual emissions
- Substitution to carbon-lean fuels
- Improving the efficiency of energy consumption
- Technological change
- Policy design

April 06

Reference/Business-As-Usual Emissions

- Forecast a "no new policies" or counterfactual emissions profile
- Reflects changes over time in:
  - economic growth
  - population growth
  - energy intensity of economic output
  - carbon intensity of energy use
- Existing policies, energy prices, innovation matter
- Past can illustrate opportunities for the future

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NC and All States' CO_2 Annual Growth Rate Decompositions

Sample	Carbon Dioxide	Population	Income per capita	Energy per unit income	Carbon per unit energy
North Carolina, 1960-1999	0.026	0.013	0.027	-0.012	-0.00084
All States, 1960-1999	0.020	0.011	0.021	-0.012	-0.00091
North Carolina, 1973-1986	0.0022	0.012	0.017	-0.014	-0.013
All States, 1973-1986	0.00023	0.011	0.012	-0.020	-0.0029

Source: Aldy, J.E. 2006. Energy and Carbon Dynamics at Advanced Stages of Development: An Analysis of the U.S. States, 1960-1999. RFF Discussion Paper 06-13, www.rff.org/Documents/RFF-DP-06-13.pdf

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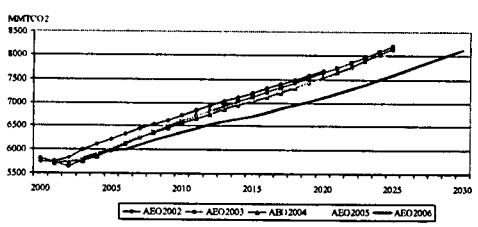
U.S. Reference Emissions through 2030



Source: Annual Energy Outlook 2002, 2003, 2004, 2005, 2006, Energy Information Administration, www.eia.doe.gov

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April 06

Substitution to Carbon-Lean Fuels

- Costs will be lower the easier it is to switch to low-carbon energy
- Electricity: switch from coal to gas to renewables and nuclear
- Transportation: few substitutes for petroleum
- Prices and existing capital stock matter
- Time matters: lead time and regulatory horizon

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Improving the Efficiency of Energy Consumption

- Investments in energy efficiency reflect prices and information
- Consumers care about more than just energy expenditures associated with products they buy
- Prices and existing capital stock matter
- Time matters: lead time and regulatory horizon

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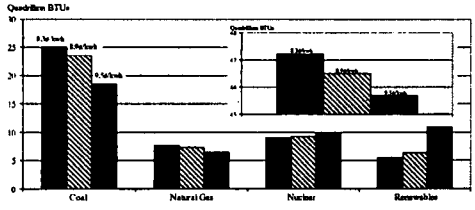
April 06

2020 Electricity Generation, Reference and Two Cap and Trade Policies



Source: Constructed from EIA. 2006. Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals.

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Technological Change

- Ongoing technological change at current prices, policies
- Policy-induced technological change
  - increases diffusion of on-the-shelf technologies
  - increases R&D expenditures
- Insufficient R&D
  - firms cannot capture all of their innovations' benefits
  - limited incentives for climate-friendly R&D
- Payoffs from innovation may be in more distant future because of long capital stock lifetimes

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April 06

Cost Implications of Policy Design

- Cost-effectiveness
- Distributional impacts
- Cost certainty
- Examples of market-based environmental policies

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Cost-Effectiveness

- Cost-effective implementation minimizes the total cost of achieving a given emissions reduction
- "Where" flexibility: broad geographic coverage
- "When" flexibility: timing
- "What" flexibility: cover sources and sinks
- Cap-and-trade and emissions taxes more cost-effective than technology mandates or performance standards

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Distributional Impacts

- Increasing energy prices adversely impacts low-income households
- Energy-intensive industries and carbon-intensive energy producers adversely impacted
- Allocation of permits can create winners/losers
  - 100% free allocation could make firms better off
  - Hybrid free allocation/auction proposed by some
  - Auction/tax revenues could be used to offset impacts

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Cost Certainty

- Uncertainty about costs could limit political support and hinder capital investment
- Index emissions caps to economic growth
  - Bush Administration 2002 voluntary goal
  - Some firms have voluntary indexed emissions goals
- Hybrid cap-and-trade program with a safety valve
  - quantitative emissions cap with the option for firms to buy more permits at a predetermined price
  - insurance against unexpectedly high costs

April 06

Examples of Market-Based Environmental Policies

- Cap-and-Trade
  - Acid Rain Program for sulfur dioxide emissions
  - Lead phase-out from gasoline
  - EU Trading System for carbon dioxide emissions
  - RECLAIM – southern California local air pollutants
- Emissions Taxes
  - Limited experience in U.S.
  - Unit-based pricing of solid waste collection

April 06

Cost Estimates of Climate Policy Proposals

- Brief description of climate change policy proposals
- Estimates of energy price increases and economic costs
- Comparison of policy impacts with recent increases in energy prices

April 06

Climate Change Policy Proposals

- Utility Sector Proposals ("4P" Bills)
  - Carper
  - Jeffords
- Economy-Wide Proposals
  - McCain-Lieberman
  - Bingaman/NCEP
- Recent Proposals

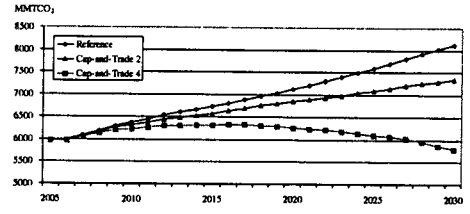
April 06

Cost Estimates

- Based on recent economic modeling work by Energy Information Administration
  - important to account for new lower forecast in reference emissions (effects of higher energy prices)
- Three cases: (1) reference; (2) cap-and-trade 2; (3) cap-and-trade 4
- Results on emissions, GDP profiles, energy prices

April 06

Carbon Dioxide Emissions, 2005-2030



Source: Constructed from EIA. 2006. Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals.

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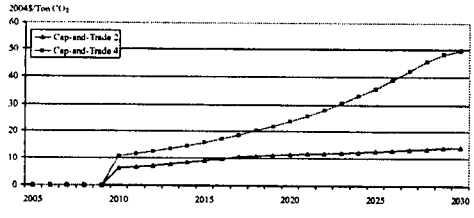
Carbon Dioxide Permit Prices, 2005-2030



Source: Constructed from EIA. 2006. Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals.

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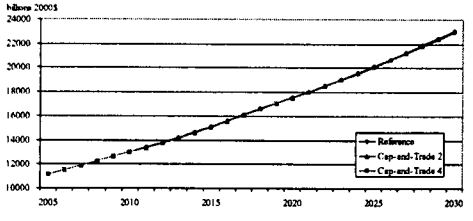
Gross Domestic Product, 2005-2030



Source: Constructed from EIA. 2006. Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals.

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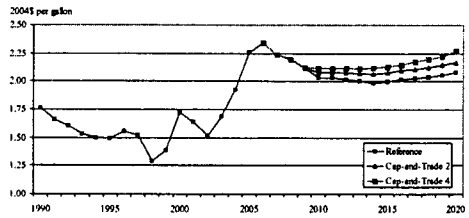
Gasoline Prices Under Reference and Two Climate Policy Cases, 1990-2020



Source: Constructed from EIA. 2006. Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals and EIA's Monthly Energy Review price series at www.eia.doe.gov/emeu/mer/prices.html.

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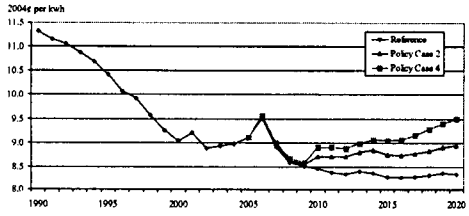
Electricity Prices Under Reference and Two Climate Policy Cases, 1990-2020



Source: Constructed from EIA. 2006. Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals and EIA's Monthly Energy Review price series at www.eia.doe.gov/emeu/mer/prices.html.

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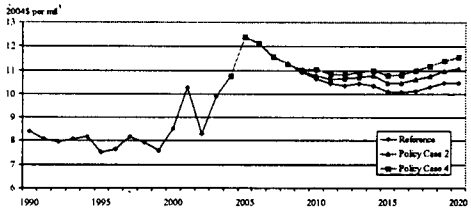
Natural Gas Prices Under Reference and Two Climate Policy Cases, 1990-2020



Source: Constructed from EIA. 2006. Energy Market Impacts of Alternative Greenhouse Gas Intensity Reduction Goals and EIA's Monthly Energy Review price series at www.eia.doe.gov/emeu/mer/prices.html.

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Further Issues Meriting Consideration

- What can be learned from other states' climate policy actions
- Non-climate policies with emissions impacts
- Ancillary benefits of greenhouse gas mitigation

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What Can Be Learned from Other States

- Northeast states moving forward under RGGI
  - cap-and-trade on utility sector emissions
  - design issues: stringency of cap, allocation, offsets
  - possible concern: emissions leakage
- California climate change policies
  - tailpipe standards
  - utility sector policies
- Adaptation
  - Lessons from Katrina?

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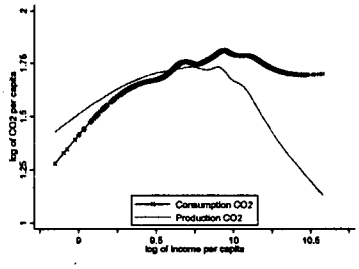
The Effects of Interstate Electricity Trade on Carbon Dioxide Emissions



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Non-Climate Policies with Emissions Impacts

- Renewable Portfolio Standards
  - 20+ states mandate a share of electricity generation from renewable sources
- Biofuels mandate
  - 2005 Energy Policy Act: requires a minimum renewable fuels content in motor gasoline
  - emissions depend on ethanol production technology
- Can affect forecast emissions and incremental cost of carbon dioxide mitigation policies

Ancillary Benefits

- Reductions in local air pollutants associated with fossil fuel combustion
- Higher gasoline prices would reduce traffic congestion, reduce accidents
- Biological carbon sequestration activities could yield other ecosystem benefits
- Consistent with some views of "energy security"

Conclusions

- Climate change policy involves real resource costs (no free lunch), but it does not require a return to the 1970s
- Well-designed, cost-effective policies can send price signals that spur technology diffusion and development and lower emissions
- Recent energy price shocks larger than 15-year out energy price increases under some proposals
- Distributional impacts may present challenges

Contact Information

Joseph E. Aldy
Fellow
Resources for the Future
1616 P Street NW
Washington, DC 20036
aldy@rff.org
202-328-5091
www.rff.org/Aldy.cfm

RFF Research on Climate Change Policy:
www.weathervane.rff.org

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Economic Implications of Not Taking Action to Address Climate Change

John C. Whitehead
Department of Economics
Appalachian State University
Boone, NC

NC Legislative Commission on Global Climate Change
Raleigh, NC | April 25, 2006

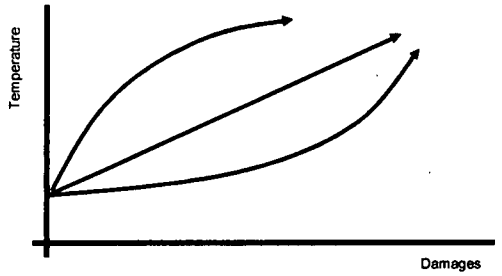
Appalachian

Outline

- Economic uncertainty
- Partial list of potential impacts
- Valuation of potential damages

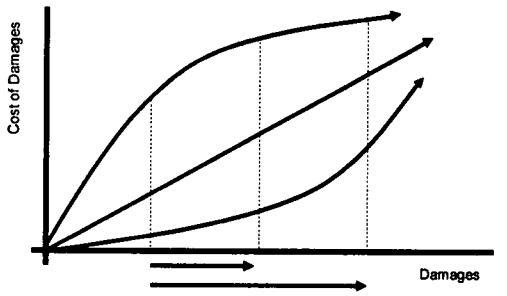
Appalachian

Damage Function



Appalachian

Valuation Function



Appalachian

Potential Damages

1. Human Health
2. Environment
3. Agriculture
4. Forests

Appalachian

Valuation Methods

- Back of the envelope calculations (i.e., benefit transfer)
- In response to the economic uncertainty, the magnitude of damages are estimated as an annual 1% change
- Damages can be scaled up (or down) by multiplication [assuming linear damage functions] (e.g., 10% = 1% × 10)
- 2005 dollars

Appalachian

Human Health

- Heat-related deaths
- Storm-related deaths
- Non-melanoma skin cancer
- Drinking water
- Others

Appalachian

Heat-related deaths

- Scenario: increase in annual heat-related deaths

Total deaths (1977-2001)	161
Annual deaths	6.71
Each 1% change	.0671
Value of statistical life	$4.54
Damages	$304,634

Sources: Mirabelli and Richardson, AJPH, 2005; Blomquist, REH, 2003

Appalachian

Storm-related deaths

- Scenario: each 1% change in storm-related deaths
- VSL = $4.54 million

Hurricane	0.091 (more deaths)
USCG search and rescue	1.74 (fewer lives saved)
Damages	$8.31 million

Sources: NHC; USCG; Blomquist, REH, 2003; Dumas and Whitehead, ASU, 2005

Appalachian

Non-melanoma skin cancer

- Scenario: annual "defensive expenditures" required to offset increases in UV-b
- 8.5 million NC residents
- 72% white

Year	Damages (millions)
2010	$25
2020	$53
2030	$96
2040	$155
2050	$250

Source: Murdoch and Thayer, JEEM, 1990

Appalachian

Drinking Water

- Scenario: NC households experience a drinking water contamination episode for 1 week

Households	3.1 million
Each 1% change	31,000 households
Defensive expenditures	$6.5
Damages	$201,140

Source: Whitehead and Van Houtven, ECU, 1997

Appalachian

Environment

- Wetlands
- Tourism
- Commercial fishing
- Hurricanes
- Biodiversity
- Others

Appalachian

Wetlands Loss

- Scenario: coastal wetland loss due to sea level rise

Coastal wetlands	5.42 million acres
Each 1% change	54.2 thousand
Value per acre	$70
Damages	$3.79 million

Sources: USGS; Woodward and Wui, EE, 2001

Appalachian

Tourism

- Scenario: beach erosion causes a reduction in beach days

NC Beach Days	28 million
Each 1% change	280,000
Value per day	$23
Damages	$6.44 million

Sources: NSRE 2000; Bin, et al., MRE, 2005

Appalachian

Commercial Fishing

- Scenario: loss of commercial fishing dockside value

Annual ex-vessel finfish value	$44,486,485
Each 1% change	$444,865
Annual ex-vessel shellfish value	$71,138,977
Each 1% change	$711,390
Damages	$1.16 million

Source: Dumas and Whitehead, ASU, 2005

Appalachian

Hurricanes

- Scenario: increase in economic damages due to hurricanes

Annual average hurricane damages	$360 million
Each 1% change	$3.6 million

Source: NHC

Appalachian

Biodiversity

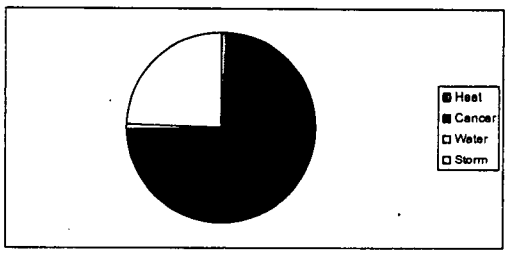
- Scenario: increase in the probability of extinction for coastal threatened and endangered species

NC population	8.5 million
Cost of each 1% increase in probability	$0.42
Survey response rate	35%
Damages	$1.26 million

Source: Whitehead, MRE, 1993

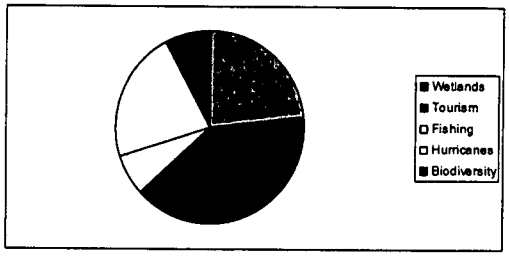
Appalachian

Health Impacts: Summary



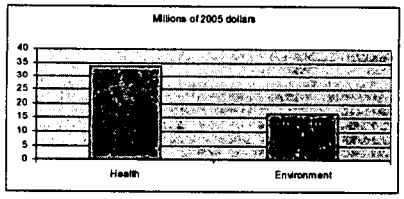
Appalachian

Environment Impacts: Summary



Appalachian

Total impacts of each 1% change



- 0.02% of state personal income
- $16 per household

e-mail: whiteheadjc@appstate.edu
website: http://www.appstate.edu/~whiteheadjc

Appalachian

Nicholas Institute for Environmental Policy Solutions

Potential Climate Change Mitigation Opportunities in Forestry and Agriculture for North Carolina

Brian C. Murray
Director for Economic Analysis
Nicholas Institute for Environmental Policy Solutions
Duke University

Presented at
North Carolina Legislative Commission on Climate Change
Raleigh, NC
April 25, 2006

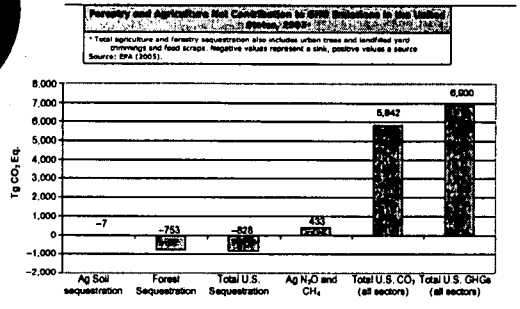
Overview

- Climate Change Influence on Forestry and Agriculture
- Forestry and Agriculture as Mitigation "Offsets"
- Economic concepts of mitigation
- Costs of Mitigation
  - National estimates
  - Regional estimates
  - Inferences for North Carolina
- Ancillary effects: co-benefits and co-costs
- Conclusions

Climate change can influence forestry and agriculture in 3 ways

1. Impacts (Biophysical)
   - Level and Variability of
     - Temperature
     - Precipitation
   - CO2 fertilization
2. Adaptation
   - Changes in technology and practices may be needed to adapt to changing climate
3. Mitigation
   - Raise costs of energy-intensive inputs
   - Opportunity for farmers/forest owners to provide mitigation offsets to other sector

Forestry and Agriculture National GHG Balance



Sector is a net sink, nationally

Agricultural Non-CO_2 Emissions by Source, 2003 (Tg CO_2 Eq.)

Table 3-2:

Emission Source	CH_4	N_2O	Total Non-CO_2
Agricultural soil management		253.5	253.5
Enteric fermentation	115.0		115.0
Manure management	39.1	17.5	56.6
Rice cultivation	6.9		6.9
Field burning of agricultural residues	0.8	0.4	1.2
Total emissions from agriculture	161.8	271.5	433.2

Source: EPA (2005).

Policy Context: Forestry and Agriculture as Mitigation "Offsets"

- **GHG emissions caps** usually envisioned for certain sectors – e.g., energy, transportation, manufacturing,...
- But emission sources within the GHG constrained sectors could be allowed to purchase ***offset credits*** from outsiders as an alternative to continued (more expensive) reductions w/in sector
- **Forestry and Agriculture** often viewed as outside the system and a possible source of offset credits, esp carbon sequestration
- **Key Economic Issues**
  - How cost effective are they?
  - How to ensure that you get what you pay for?
  - What else do you get when you pay for the carbon – i.e., co-effects (co-benefits and co-costs)

Offset Project Implementation Issues:
Getting what you pay for (an emission ***offset***)

- **Permanence**
  - Carbon sinks can be reversed through harvesting or natural disturbance (see below)
- **Additionality**
  - Confining credits to reductions that would not otherwise have occurred
  - Requires a baseline
- **Leakage**
  - Accounting for emissions that are simply relocated outside an offset project's boundaries
- Accounting adjustments can be made for all of these
  - Protocols are being developed internationally, nationally, regionally

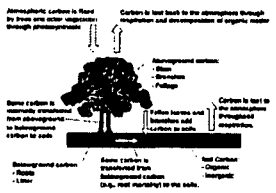
Current examples of forestry and agriculture offset programs

- **International: Kyoto Protocol: Projects**
  - Clean Development Mechanism
  - Activities Implemented Jointly (AIJ)
- **Domestic**
  - Proposed mandatory GHG caps
    - McCain-Lieberman - for/ag offsets (<15%)
    - Feinstein- unlimited role
    - NCEP (Bingaman-Domenici)
  - Voluntary:
    - 1605(b) program
    - Chicago Climate Exchange
- **Region and state initiatives**
  - Oregon utility sector offets
  - RGGI (Northeastern states)
  - California GHG proposals
  - Renewable portfolio standards (~ 24 states)
  - Many other initiatives being discussed

Mitigation Options in Forestry and Agriculture: Sequestration, Emissions Reduction and Biofuels

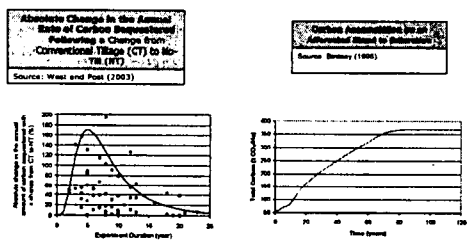
	Strategy	Mitigation Activities	Target GHG
Sequestration	Afforestation	Convert agricultural lands to forest	CO_2
	Forest management	Lengthen timber harvest rotation Increase forest management intensity Forest preservation Avoid deforestation	CO_2
	Agricultural soil carbon sequestration	Crop tillage change Crop mix change Crop fertilization change Grassland conversion	CO_2
Emissions reduction	Fossil fuel mitigation from crop production	Crop tillage change Crop mix change Crop input change Irrigated/dry land mix change	CO2
	Agricultural CH4 and N2O mitigation	Crop tillage change Crop mix change Crop input change Irrigated/dry land mix change Biotic fermentation control Livestock herd size change Livestock system change Manure management Rice acreage change	CH4 N2O
Biofuels	Biofuel offsets	Produce crops for biofuel use	CO_2

Sequestration: Carbon fixing process in trees

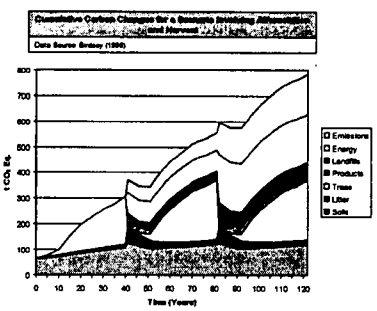


Source: US EPA http://www.epa.gov/sequestration/local_scale.html

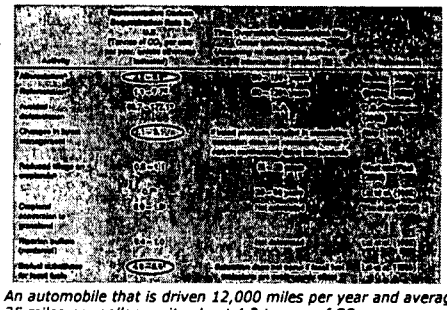
Carbon "Saturation": Attainment of a new equilibrium



Added complexity: Harvest cycles, storage in products and landfills, use in energy, emissions



Representative (US) Carbon Sequestration Rates and Saturation Periods



An automobile that is driven 12,000 miles per year and averages 25 miles per gallon emits about 4.3 tonnes of CO_2 per year.

Economic Principles

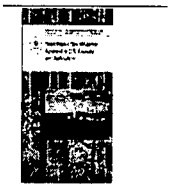
- **Benefits of mitigation in forestry and agriculture**
  - General: reduced threat of climate change
  - Forest/Ag offset: reduced overall cost of complying with GHG constraints
  - Income supplement for farmers and forest owners
- **Costs of mitigation**
  - Assume that current practices are optimizing for something other than carbon (e.g., crops, timber)
  - New practices to optimize on carbon have opportunity costs for other outputs
  - Carbon supply function: How much can be sequestered at what cost per ton

Determinants of mitigation offset supply

- **Practice 1 (High emitting)**
  - Net income = $100/ac/yr
- **Practice 2 (Low emitting)**
  - Net income = $80/ac/yr
  - Sequesters (or reduces emissions) = 1 ton CO_2/yr
- Will adopt Practice 2 (mitigate) if paid at least $20/ton CO_2

National Forestry and Agricultural GHG Mitigation Report

- Funding Source: EPA
- Objectives
  - ✓ Identify mitigation options in forestry and ag
  - ✓ Estimate potential
    - Biophysical
    - Economic
    - Competitive
  - ✓ Examine policy design issues (quantity vs price, activity targeting, per acre vs per ton)
    - Address key policy implementation issues
      - Permanence
      - Leakage
    - Assess environmental co-effects (water quality, biodiversity)
- Collaborators: within RTI, Texas A&M, Ohio State, EPA
- Published 12/05. Posted at http://www.epa.gov/sequestratio n/greenhouse_gas.html



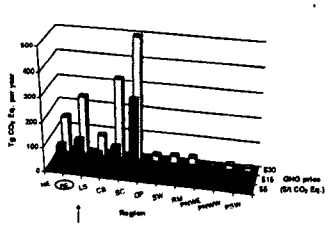
National GHG Mitigation Totals by Key Activity:

Annualized Averages, 2010–2110

	GHG Price ($/ ton CO_2)				
Activity	$1	$5	$15	$30	$50
Afforestation	0.0	2.3	137.3	434.8	813.4
Forest management	24.8	105.1	219.1	514.2	964.8
Agricultural soil carbon sequestration	62.0	122.7	168.0	182.4	130.6
Forest fuel mitigation from crop production	20.5	31.9	53.1	77.6	95.7
Agricultural CH_4 and N_2O mitigation	9.4	15.2	32.0	166.8	310.2
Biofuel offsets	0.0	0.1	57.2	274.6	590.9
All Activities	116.8	277.3	666.7	1,430.4	2105.4

Potential is not uniform across regions

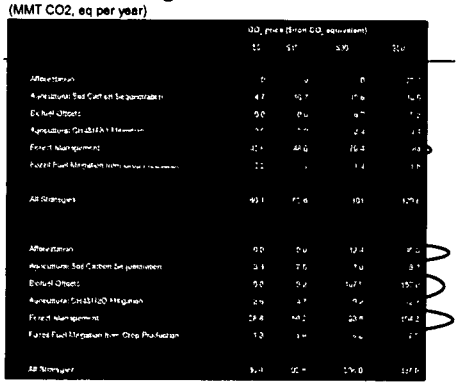
Total Forest and Agriculture GHG Mitigation by Region
Quantities are T_g CO_2 Eq. per year net emissions reduction below baseline, annualized over the time period 2010-2110.



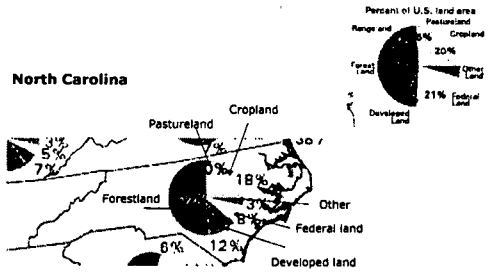
Opportunities primarily in the eastern US

Southeast Regional Totals

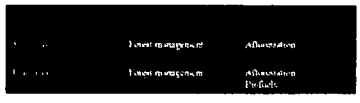
(MMT CO2, eq per year)



North Carolina Land Use Shares



North Carolina Opportunities



Issue: Forest management can be difficult to measure, monitor, and compare to baseline

Effect of Carbon Price on Forest Management and Timber Returns: Southeastern Planted Pine

Effect of Carbon Price on Stand-level returns for a planted pine stand in the Southeastern US

	Carbon Price ($/ ton carbon eq)					
	$0	$10	$20	$30	$40	$50
Optimal timber rotation (yrs)	29	28	26	24	23	21
Forest land value ($/ac)	$570	$708	$924	$1,168	$1,439	$1,754
Forest annual return ($/ac/yr)	$28.81	$34.68	$41.16	$47.70	$54.75	$61.66

Source: Murray, B.C. 2003. "Carbon Values, Reforestation, and Forestry Activities under the Kyoto Protocol" Mitigation and Adaptation Strategies for Global Change

Biofuels

Source: Ongoing work by Bruce McCarl, Texas A&M

- Biofuels are currently not significant economic alternative to fossil fuels without subsidy
- Economic tipping points

CO2 price = $10/ton
- Biodiesel from corn and soybeans starts to become economic

CO2 price = $30/ton,
- Electricity generation from switchgrass, hybrid poplar, and willow (large potential)
- Cellulosic ethanol

CO2 price = $100/ton
- Ethanol from grains

- Issue: infrastructure for using large amounts of biofuels not yet there

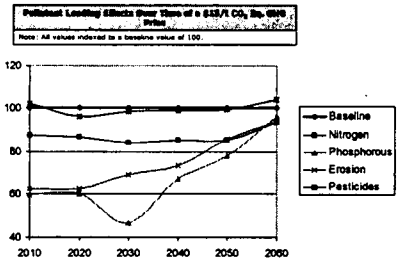
A Note on Manure Management

- Livestock manure management (primarily hogs) produces about 1.7 million tons/yr of CO_2 eq GHGs (source: Ctr for Climate Strategies)
  - ~ half of state's total Ag emissions
  - ~ 1% of all NC emission sources
- Mitigation options include covered lagoons and digesters to trap methane and (possibly) generate electricity
- Economic estimates of mitigation costs vary widely
  - Engineering studies show range of mitigation costs from +$40/ton to negative, depending on
    - Equipment costs
    - Operating costs
    - Recovery factors
    - Electricity prices
    - Other factors
- More rigorous work needs to be done to identify situations where hog farmers could benefit from adoption
- For NC, must take Smithfield/Attorney General agreement into account

GHG Mitigation and Water Quality Co-benefits

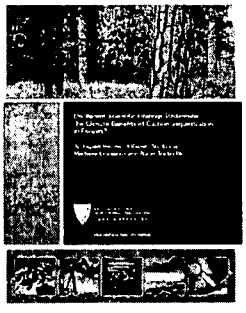
Changes in land use and crop management to sequester carbon and reduce GHG emissions can reduce erosion, nutrient runoff, and pesticide use to the benefit of water quality

Reduced Agicultural runoff under GHG pricing



Work by RTI, Texas A&M, and EPA found that thise reduced runoff led to appreciable improvements in water quality nationally (Pattanayek et al, 2005, Climatic Change).

Do Recent Findings Undermine the Value of Forest Carbon Sequestration? Not really

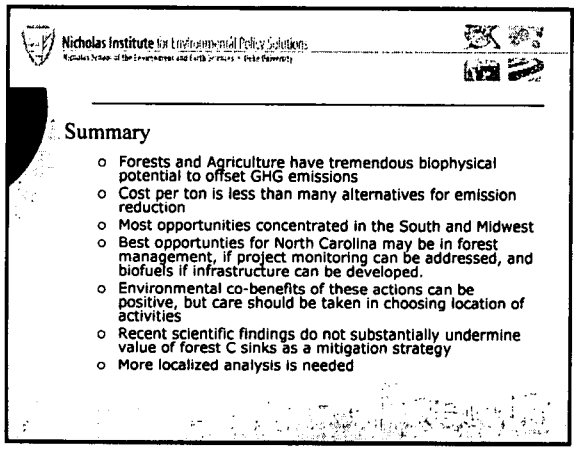


Recent Concerns

Water stresses from plantations
R.B. Jackson, E.G. Jobbagy, R. Avissar, S.B. Roy, D.J. Barrett, C.W. Cook, K.A. Farley, D.C. le Maitre, B.A. McCarl, and B.C. Murray. Dec 2005. Trading water for carbon with biological carbon sequestration. Science. 310:1944-1947.

Methane emissions from plants/trees
Keppler, J.T.G. Hamilton, M.Bras, and T. Rockmann. Jan 2006. Methane emissions from terrestrial plants under aerobic conditions. Nature. 439:187-191.

General findings
- Water stress issue calls for intelligent location of plantations
- Methane emissions from plantations are quantitatively insubstantial in terms of global warming potential


Nicholas Institute for Environmental Policy Solutions
Summary
Forests and Agriculture have tremendous biophysical potential to offset GHG emissions
Cost per ton is less than many alternatives for emission reduction
Most opportunities concentrated in the South and Midwest
Best opportunties for North Carolina may be in forest management, if project monitoring can be addressed, and biofuels if infrastructure can be developed.
Environmental co-benefits of these actions can be positive, but care should be taken in choosing location of activities
Recent scientific findings do not substantially undermine value of forest C sinks as a mitigation strategy
More localized analysis is needed

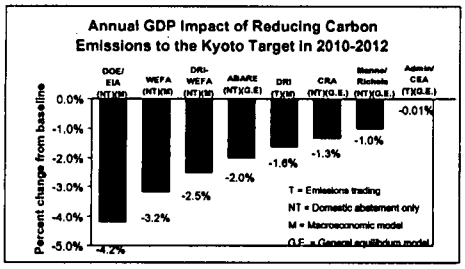
Future Directions in Climate Change Policy: Cost Effective Strategies for North Carolina, the U.S. and the World

Prepared for:
Legislative Commission on Global Climate Change
General Assembly of North Carolina
Raleigh, North Carolina
April 25, 2006

By: Dr. Margo Thorning, Ph.D.
Senior Vice President and
Chief Economist
American Council for Capital Formation

Washington, D.C.
www.accf.org
Tel: 202-293-5811
Mthorning@accf.org

Impact of the Kyoto Protocol on the U.S. Economy: Various Model Estimates



Source: Testimony by Margo Thorning for California Climate Summit, April 11, 2006

Impact of the New England Governors / East Canadian Premier's Agreement on Eleven Northeast States

	2010	2020
▪ Energy Prices Rise		
– Household electricity	35%	39%
– Gasoline	39%	44%
– Natural gas for industry	111%	119%
▪ Job Losses	192,000	218,000
▪ Household Income Falls	$2,600	$3,000

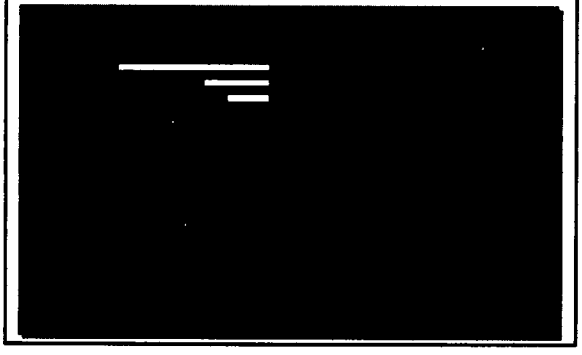
▪ State and Federal Tax receipts decline by $29 billion.
▪ Low income and elderly bear large burden

Economic Impact of McCain / Lieberman and the Bingaman Proposal on the United States

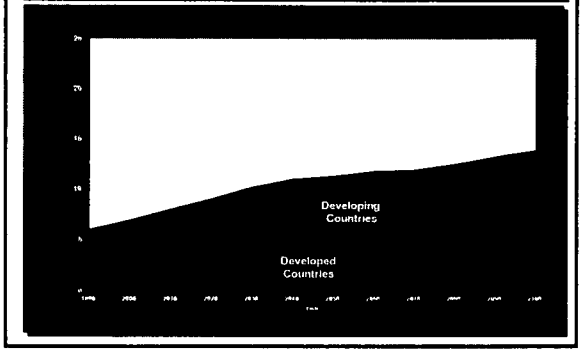
	2010		2020	
	McCain/ Lieberman	Bingaman	McCain/ Lieberman	Bingaman
GDP Falls	-1.0	-0.2	-1.9	-0.4
Job Losses	-840,000	-230,000	-1,306,000	-326,000
Household Consumption Falls	-$725	-$147	-$800	-$164

- State and Federal Tax receipts Decline
- Low Income and Elderly Bear Large Burden Due to Higher Energy Costs

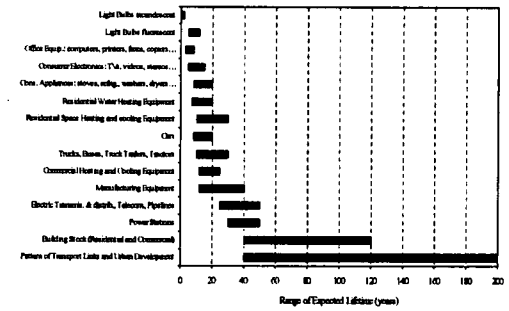
Greenhouse Gas Emissions in the European Union Projected to Exceed Kyoto Targets in 2010



Developed and Developing Countries Carbon Emissions Projections

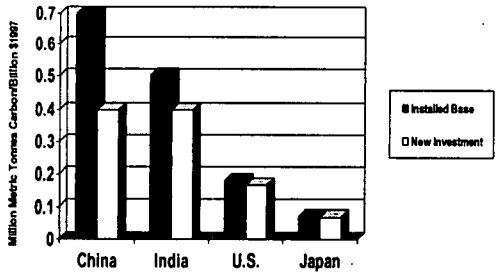


Average Life Spans for Selected Energy-Related Capital Stock

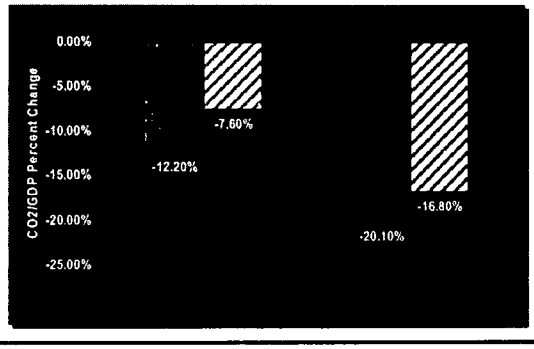


Impact of New Technologies on Carbon Emissions

(Greenhouse Gas Emissions Per Dollar Output)



Comparison of EU and US Energy Intensity Reduction 1991-2003



Practical Strategies to Address Economic Growth and Climate Change Policy

- Use cost / benefit analysis before adopting policies
- Reform U.S. tax code to accelerate depreciation allowances
- Remove barriers to developing world's access to more energy and cleaner technology by promoting economic freedom and market reforms
- Increase R&D for new technologies to reduce energy intensity
- Develop sequestration through both natural and man-made technologies
- Promote nuclear power for electricity
- Expand bilateral cooperation with developing countries
- Promote a truly global solution such as the new Asia Pacific Partnership on Development with its focus on economic growth and technology transfer

The Impact of Voluntary Measures and the Asia Pacific Partnership for Reducing Greenhouse Gas Emissions
by
Dr. Margo Thorning, Managing Director
International Council for Capital Formation*
Before the
Committee on Commerce, Science and Transportation Subcommittee on Global Climate Change and Impacts
April 5, 2006

Introduction

Mr. Chairman and Members of the Subcommittee, I appreciate the opportunity to submit this statement for the record. The International Council for Capital Formation is a Brussels- based think tank whose goal is to promote market based solutions cost-benefit analysis to address economic and environmental issues. The ICCF is an affiliate of the Washington-based American Council for Capital Formation. We appreciate the opportunity to comment on the goals of the Asia Pacific Partnership on Clean Development and Climate and positive impact that voluntary programs (in contrast to mandatory programs) can have in reducing greenhouse gas emissions.

Pros and Cons of Mandatory Approaches to GHG reduction

Although there are numerous supporters of mandatory US programs to reduce GHGs in the US it is useful to examine the record of our allies in the EU in reaching their Kyoto Protocol targets before making such a committment.

- **Emission Trading in the EU:** As UK Prime Minister Tony Blair noted in a speech last week, "I think first of all I should say that Britain is one of the very few countries in the world that will meet its Kyoto targets." The main reasons for the UK being one of the few countries able to meet it's Kyoto target are: 1) that it switched from coal to natural gas power for electricity generation and 2) DuPont closed a facility that emitted large quantities of GHGs. Other EU countries are not so fortunate and incur significant costs if they try to meet their Kyoto targets. The ETS requires approximately 12,000 large industrial emitters and utilities to reduce CO2 emissions (or purchase the right to emit CO2) in accordance with their country's Kyoto Protocol targets.

  The approach to emissions reductions embodied in the EU's sectoral approach has failed to make much of a dent in EU emission growth, but has the potential to

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* For more information about the ICCF or for copies of this testimony, please contact the ICCF, 1750 K Street, N.W., Suite 400, Washington, D.C. 20006-2302; telephone: 202.293.5811; fax: 202.785.8165; e-mail: mthorning@iccfglobal.org; website: www.iccfglobal.org. or our Brussels office, Park Leopold, Rue Wiertz 50/28, B-1050 Brussels, Belgium; telephone: +32.2.401.68.44; fax: +32.2.401.68.68; e-mail: mthorning@iccfglobal.org; website: www.iccfglobal.org.

make a significant impact on the economies of countries trying to meet their targets. As noted in a recent report by the UK's EEF, an association of engineers and manufacturers, part of the 34% increase in UK electricity prices in 2005 was due to the ETS. The price of the right to emit a ton of carbon reached unexpectedly high levels in 2005, reaching $36 per ton of CO2 ($120 per ton of carbon). Similarly, German climatologist Dr. Gerd Weber states that the ETS has placed additional costs through higher electricity prices on a number of energy intensive companies located in Germany, making production in the EU uncompetitive versus production from outside the EU. Several companies have announced that they will shift production to non-Kyoto countries, taking with them thousands of jobs. Norsk Hydro Aluminum, a Fortune 500 energy and aluminum supplier, closed several production sites in northern Germany because of higher costs related to emissions trading/electricity prices, Dr. Weber notes.. The latest data from the European Environmental Agency shows that the "EU 15" is expected to be 4% above their emissions target in 2010 instead of 8% below 1990 levels as required under the Kyoto Protocol(see figure 1).. There now appears to be a rift within Europe on climate change policy as Italy and some German industrialists express growing concerns with the impact of the ETS on electricity prices, production costs and competitiveness. The EU's slow economic growth rate (about 1% annually) and high unemployment (about 10%) will only be exacerbated by their ETS.

It seems very unlikely that EU governments will actually enforce their Kyoto targets because the cost, in terms of reduced GDP and employment, would be political suicide. If the EU actually wanted to reduce its emissions to the Kyoto Protocol target, it would have to use an economy-wide approach and cover all sectors, including transportation and households. Recent macroeconomic analyses of Germany, Spain, UK and Italy by the International Council for Capital Formation show that an economy-wide ETS designed to meet the Kyoto targets would reduce these countries' GDP levels and employment significantly in 2010 (see http://www.iccfglobal.org/pdf/Country-reports-overview.pdf).

Reducing GHGs: Alternative Approaches

- **Mandatory "Upstream" and "downstream" regulatory approaches:** Trying to reduce US emissions through a cap and trade system applied at either "upstream" or "downstream" is likely to have serious consequences for the US economy, including reduced GDP and increased unemployment rates. For example, various economic models show that the imposition of the Kyoto Protocol would reduce US GDP levels by 1 to 4.2% annually by 2010 (see Figure 2 at http://www.accf.org/pdf/oregontestimonyfinal.pdf). Less stringent emission reduction targets such as those in the McCain Lieberman and Bingamin proposals also have negative consequences for the U.S. economy (See table 1). While the upstream approach is perhaps easier to monitor and enforce because far fewer emitters would be in the system, it suffers from the fact that final consumers won't see much of a direct impact of the energy tax (or permit price) on their energy and fuel bills because those also include the cost of delivering the energy

to consumers.. On the other hand, if a business owner (say a paint manufacturer) who owns equipment that emits CO2 has to submit an emission allowance for each ton emitted, he will be able to make a careful cost-benefit analysis of when it makes economic sense to replace his capital equipment or make other production related decisions. An obvious question is, if a "downstream" system for reducing CO2 emissions is impractical because of the millions of small emitting sources, and an "upstream" system results in only attenuated decision making on emissions, how efficient would a cap and trade system be in providing emission decision makers with a realistic incentive to efficiently and significantly reduce emissions?

- **Mandatory Caps on Emissions will not Drive Innovation:** First, caps on emissions are not likely to promote new technology development because caps will force industry to divert resources to near-term, "end of pipe" solutions rather than promote spending for long-term technology innovations that will enable us to reduce GHGs and increase energy efficiency. An ETS will send exactly the wrong signals to investors because it will create uncertainty about the return on new investment. A mandatory cap would be seen by U.S. investors as just the "first step" in a likely series of more stringent targets as policymakers strive to reduce developed country to trajectories suggested by IPCC scenarios. Investors know that a "safety-valve" price of carbon (designed to create a sense of confidence about future energy costs) can easily be changed. Such uncertainty means that the hurdle rate, which new investments must meet, will be higher (thus less investment will occur) and they will be less willing to invest in the US. In addition, investors realize that if a mandatory emission reduction program were established in the US, they would be disadvantaged vis-à-vi European companies because the relationship between regulators and business in the EU tends to be more flexible and accommodating than in the U.,S. Now is the time to provide incentives for companies to voluntarily undertake additional carbon dioxide intensity reducing investments, not promote a system that raises the risk of any investment in our economy.

  Second, caps on US emission growth are unlikely to succeed unless all the relevant markets exist (in both developed and developing countries) and operate effectively. All the important actions by the private sector have to be motivated by price expectations far in the future. Creating that motivation requires that emission trading establish not only current but future prices, and create a confident expectation that those prices will be high enough to justify the current R&D and investment expenditures required to make a difference. This requires that clear, enforceable property rights in emissions be defined far into the future so that emission rates for 2030, for example, can be traded today in confidence that they will be valid and enforceable on that future date. The international framework for climate policy that has been created under the UNFCCC and the Kyoto Protocol cannot create that confidence for investors because sovereign nations have different needs and values. Therefore, it seems likely that the ETS system which the EU has implemented will fail to spread to other parts of the

world and will eventually be replaced with a more practical approach to climate change policy.

Third, a fixed cap on emissions inevitably collides with US population growth. The EU-15 countries are having difficulty meeting their Kyoto targets and they have negligible population growth. In sharp contrast, US population is projected to grow more than 20% over 2002 2025 according to the EIA. More people means more mouths to feed, more houses to warm, more factories to run-all of which require more energy and at least some additional GHG emissions.

Voluntary Approaches to Emission Reduction

- **The Role of Economic Growth and Technology in GHG reduction**

  Many proponents of the cap and trade system fail to realize that economic growth can have a positive impact on GHG emission reductions. For example, the US, with its voluntary approach to emission reductions, has cut its energy intensity by 12.2% over the 1997-2003 period compared to only 7.6% in the EU with its mandatory approach(see figure 2). Technology development and deployment offers the most efficient and effective way to reduce GHG emissions and a strong economy tends to pull through capital investment faster. Given the extremely long lives of much of the capital stock, the voluntary approach will allow emissions intensity to be reduced in a cost effective way (see figure 3). There are only two ways to reduce CO2 emissions from fossil fuel use -- use less fossil fuel or develop technologies to use energy more efficiently, to capture emissions or to substitute for fossil energy. There is an abundance of economic literature demonstrating the relationship between energy use and economic growth, as well as the negative impacts of curtailing energy use. Long-term, new technologies offer the most promise for affecting GHG emission rates and atmospheric concentration levels. In fact, a new analysis by DOE/EIA (AEO 2006) shows that their High Tech scenario reduces emissions more than does a mandatory reduction in GHG intensity (see table 2) and has a positive impact on GDP levels and reduces electricity prices.

- **Tax Reform Could Reduce Growth of US GHG Emissions**

  Stimulating the development of various high technology programs can be accelerated through government programs as well as by encouraging private sector investment. Improving the tax treatment of new investment through faster depreciation, investment tax credits, making permanent the 15% tax rate on dividends and capital gains received by individuals are positive steps that reduce the cost of capital for investment. ACCF research shows that US companies receive only 29 cents after 5 years through depreciation allowances on each dollar of investment in a combined heat and power facility while a company in China gets $1.04 back and a Brazilian company gets 50 cents. Thus, slow capital cost recovery in the US Federal tax code places domestic companies at a disadvantage compared to our trading partners and slows the development and installation of new energy efficient technology.

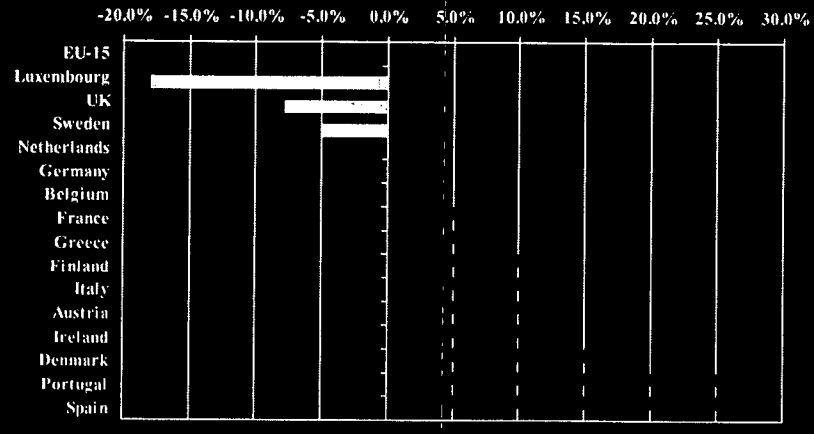
Conclusions: Energy use and economic growth go hand in hand, so helping the developing world improve access to cleaner, more abundant energy should be our focus. Near-term GHG emission reductions in the developed countries should not take priority over maintaining the strong economic growth necessary to keeping the U.S. one of the key engines for global economic growth. Establishing a mandatory cap and trade system in the US would impede, not promote, US progress in reducing emissions intensity. US climate change policies should continue to strive to reduce energy intensity as the capital stock is replaced over the business cycle and to develop new, cost-effective technologies for alternative energy production and conservation and encourage the spread of economic freedom in the developing world. This approach is likely to be much more productive than having the US adopt an ETS and thereby sacrifice economic well-being and job growth with little or no long-term impact on global GHG emissions.

Several provisions of the 2005 Energy Bill should have a positive impact on climate change. The new Asia-Pacific Partnership for Clean Development and Climate can also play a key role in transferring new technology to developing countries and help provide the practical assistance that is needed for a global approach to emission reduction.

Table 2: Comparison of EIA High Tech Scenario with "Salazar Request" Cap and Trade Scenarios

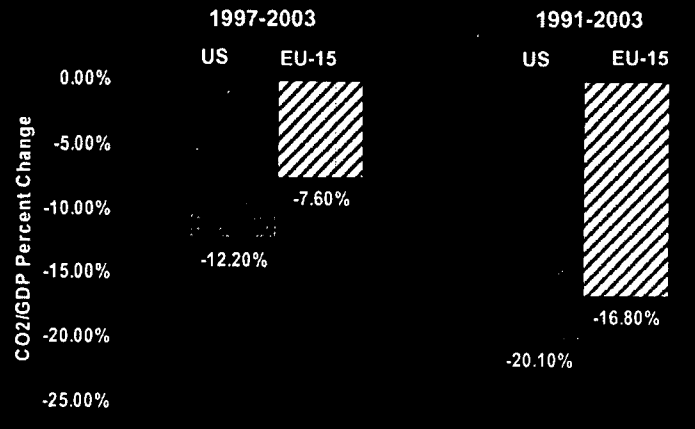
	2010	2020	2030
CO2 Emissions From Energy (Million Mt CO2)			
AEO2006 Reference Case	6,364	7,119	8,114
AEO2006 Integrated High Technology	6,253	6,734	7,421
EIA/Salazar Cap-Trade 2	NA	6,843	7,333
Change From Reference Case			
AEO2006 Integrated High Technology	(111)	(385)	(693)
EIA/Salazar Cap-Trade 2		(276)	(781)
Real GDP (billion 2000 Dollars)			
AEO2006 Reference Case	13,043	17,541	23,112
AEO2006 Integrated High Technology	13,056	17,580	23,152
EIA/Salazar Cap-Trade 2	NA	17,522	23,077
Change From Reference Case			
AEO2006 Integrated High Technology	13	39	40
EIA/Salazar Cap-Trade 2		(19)	(35)
% Change from Reference Case			
AEO2006 Integrated High Technology	0.1%	0.2%	0.2%
EIA/Salazar Cap-Trade 2		-0.1%	-0.2%
Electricity Prices (Average all users - cents per kwh)			
AEO2006 Reference Case	7.3	7.25	7.51
AEO2006 Integrated High Technology	7.2	7.03	7.33
EIA/Salazar Cap-Trade 2	NA	7.89	8.48
Change From Reference Case			
AEO2006 Integrated High Technology	(0.1)	(0.2)	(0.2)
EIA/Salazar Cap-Trade 2		0.6	1.0
% Change from Reference Case			
AEO2006 Integrated High Technology	-1.4%	-3.0%	-2.4%
EIA/Salazar Cap-Trade 2		8.8%	12.9%

Figure 1: Greenhouse Gas Emissions in the European Union Projected to Exceed Kyoto Targets in 2010



Source: European Environmental Agency, November 29, 2005

Figure 2: Comparison of EU and US Energy Intensity Reduction 1991-2003



Data: EIA International Energy Annual 2003

Figure 3: Average Life Spans for Selected Energy-Related Capital Stock

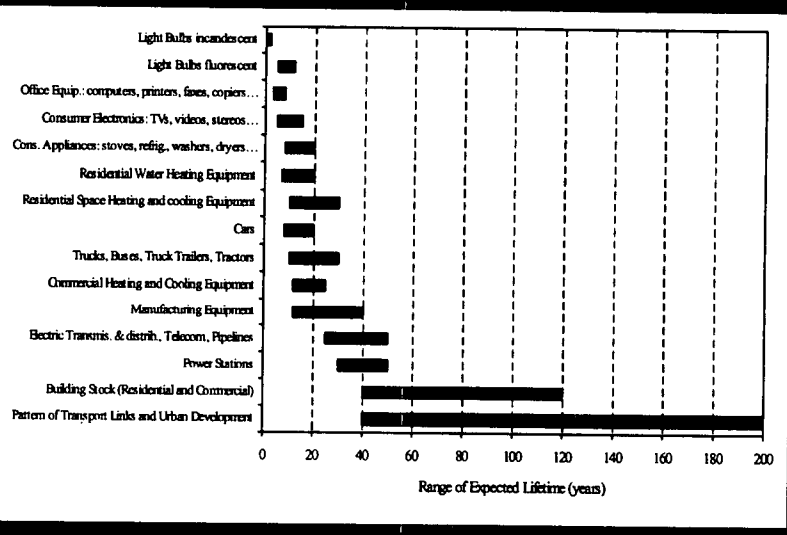


Table 1: Economic Impact of McCain / Lieberman and the Bingaman Proposal on the United States

	2010		2020	
	McCain/ Lieberman	Bingaman	McCain/ Lieberman	Bingaman
GDP Falls	-1.0	-0.2	-1.9	-0.4
Job Losses	-840,000	-230,000	-1,306,000	-326,000
Household Consumption Falls	-$725	-$147	-$800	-$164

- State and Federal Tax receipts Decline
- Low Income and Elderly Bear Large Burden Due to Higher Energy Costs

(THIS IS A DRAFT)
Minutes

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

Monday 27 November 2006
10:00 a.m.
Room 643 Legislative Office Building

The Legislative Commission on Global Climate Change convened Monday, November 27, 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building with Mr. John Garrou, Co-Chair, presiding. Other members present were: Representative Joe Hackney, Co-Chair, Senator Charlie Albertson, Representative Pricey Harrison; Representative Alice Underhill; Representative Winkie Wilkins, Dr. Ryan Boyles, Mr. , Mr. Walter Clark, Dr. Dolores Eggers, Dr. Edward Erickson, Dr. George Everett, Mr. Preston Howard, Mr. Michael Nelson, Dr. Daniel Phaneuf, Dr. Stanley Riggs, Mr. Michael Shore, Mr. Robert Slocum, Dr. Stephen Smith, Mr. James Stephenson, Mr. Tim Toben, Mr. Ivan Urlaub, Ms. Susan Tompkins, and Ms. VickyWill.

A copy of the meeting notice for this meeting, a copy of the agenda and the visitor's registration are attached to these minutes as **Exhibits A, B, and C**.

Mr. Garrou called the meeting to order and welcomed everyone to the meeting of the Commission of Global Climate Change. He and Representative Hackney agreed to waive introductory remarks so he called on George Givens to talk about our agenda for today.

Mr. Givens thanked the co-chair, greeted the members and visitors and gave a few brief remarks. He reminded the members to sign their reimbursements and send them forward and the visitors to sign the log in the back. Dr. Erickson has handed out two items for inclusion in the record and for your review and consideration. A memo to the Commission dated the 22nd and a paper called The Energy's Future: A Perspective (**Exhibits D and E**). Two additional meetings have been scheduled: Monday, December 11th in this room and then Friday, January 12th to consider what to do about the meeting schedule for the early part of 2007 session.

Mr. Givens received a lot of good feedback from the last meeting about the opportunity afforded to members of the Commission to interact and to discuss and so he hopes the several presentations to be heard today will prompt some discussion and you will find Item 8 to be useful and interesting.

Mr. Garrou called on Brock Nicholson to give his report on the CAPAG standards and developments among those subcommittees.

Mr. Nicholson thanked the chairman and reported on the meeting that was held following the previous meeting of the Commission on October 3rd. Copies of the slides

were passed out to members (**Exhibit F**). Their last meeting was held at N.C. State on October 12th and this meeting was primarily to complete the definition of items that we've identified for priority study and they had a follow-up call to that meeting on November 13th because there was a lot of material to go over. They have had numerous technical work group calls and even a meeting since that date also. The meetings were very well attended and very productive. The primary objectives of the CAPAG meeting and the follow-up technical calls were to continue to define the options so that the analyses by the consultant could move forward and the committee is at that point.

Mr. Nicholson focused on the adaptation and that Dr. Riggs expressed interest in our last Commission meeting in October and he took that interest back and so did George Givens when he talked to the workgroup, CAPAG on October 12th. At that meeting and subsequent workgroup meeting it was clearly acknowledged that that is an item that we could move forward in the near term in terms of making a recommendation. We had an understanding that the thrust of that recommendation would be to recommend the development of a task force or a study commission to look specifically into what sectors should be covered under such a study and a plan that the study commission or task force needs to be made up of appropriate representatives from various sectors certainly public safety, emergency management, public health, agriculture persons are necessary because of the wide ranging interest that such a plan should cover. He envisioned the recommendation developing is two-fold, one to charge such a group with understanding studying what items needs to be included in such an effort and then to develop such a plan itself and envisioning that it's very much akin to some of the work that the Emergency Management even does now. But some of the other sections that one might even think about is communication, for example, or infrastructure of various types of infrastructure that we have in this state. And if it is to be effective and we can certainly use some more science advice on this, but to the extent that climate change effects severity or frequency of storms then you might think well maybe that adaptation plan didn't run for the long term, long term look but it is also a near term look. I think we are going to suggest that it be that broader view.

The schedule and next steps certainly is to do the analyses that we have talked about with these higher priority items now that we are having them more specifically defined and that includes cost and the benefits to include jobs created in the various sectors. We think there are going to be significant economic advantages to the state in a number of sectors where we're promoting new industry and it does have job implications that are positive. The next CAPAG meeting is scheduled for January 24, 2007 and we will have the initial reports on the analyses at that meeting. Hopefully we will have some before that meeting.

The other item we've talked about is the possibility of extending the CAPAG effort to better coordinate with the extension of this Commission's schedule and while we haven't done that yet but we feel that it is important to support the effort and what analyses this Commission would like to see from the CAPAG effort. That's the short report and questions are welcomed.

Dr. Riggs: I'm glad to see that you've considered the adaptations in your meetings. It's not clear to me what the difference between your group and this group is with respect to going forward. Are we going to have a duplication of effort here, is there some sort of a tie between us?

Mr. Nicholson: I think it's the tie between us that really is important. I view that our CAPAG effort will consider maybe the sectors to be looked at but then recommend an approach such as I've outlined. Certainly our recommendations on sectors is not complete so it would be a recommendation to this body and to the administration in terms of the need of such a process. We don't see that CAPAG itself would be the one developing the adaptation plan or that there would be more other study or analyses in the traditional way that we're looking at these other mitigation options in terms of costs and benefits but that we would make our recommendation and submit to this Commission.

Mr. Garrou: So is it the case that the CAPAG process would end first quarter of next year but the committee would stand by in case we ask it to do further things?

Mr. Nicholson: I think what we have in mind in terms of other recommendations is that we'll continue some work and either do more in-depth analyses maybe reacting to request of this body and then potentially even looking at what we call a second tier of some of the mitigation options that we've kind of put in a category of second tier which was maybe beyond what we could actually work on in this time frame. But extending the CAPAG process a certain amount anyway, this doesn't make a lot of sense to cut it off and disband it when this body is going and we could be of some help particularly with the last of our cost-cutting items to assist with the issue of looking at the impacts of various goals in terms of greenhouse gas reduction.

Mr. Smith: Brock your thoughts on CAPAG's process and the potential for some input in the interim report for this group, what is your current thinking on that, I know that there is obviously a meeting coming up in January where there will be additional work done, but what's your current thinking?

Mr. Nicholson: Well we have talked about the need to focus on that and I think that is one thing we will do in our upcoming work groups. I hesitate to just give my thoughts on it because we want it to be the product of the effort of the process but I think some likely candidates for consideration by the CAPAG in the work groups will be those major standards that the state takes on. Something that the Legislature will maybe deal with in the next term that might involve less give and take with a lot of stake holders outside some of the government agencies. That will be one fault we will pursue with the work groups.

Mr. Clark: Brock thank you very much for that. For those of us who have been interested in adaptation for a long time and sort of came to this Commission for that as an interest, we appreciate looking at your beginning to focus on that and I appreciate Dr. Riggs' letter that he wrote to the Commission which outlines some of the coastal concerns very clearly. In the group that you are going to consider, I know you had

several listed up there, but I think one of the important ones is certainly the Coastal Resources Commission. They are looking at a lot of things right now currently that would have some implications and relationships with sea level rise and some adaptations issues that we're discussing now. If our chairmen may perhaps in the future we might invite Dr. Courtney Hackney who is chair of that Commission to come and speak to us about some of the adaptation like issues that they are considering. I know one of them is the practice of hardening the estuarine shore line which we currently allow in North Carolina which a lot of people see as an issue with habitant declined with rising sea level and a lost of fringe marsh land. So perhaps we could explore some of those issues with the Commission, I know they are really going to be considering some issues within the next year so I consider it very timely that we have a dialogue with them.

Mr. Shore: The adaptation issues - I wonder if we could communicate to them and then they could have dialogue among themselves and then the chair bring discussion back to this group and if that's a good idea how would we convey that to them?

Mr. Garrou: We could certainly do that at the staff level here. Mr. Givens and others could do that. I see no reason not to.

Mr. Givens: I think Commissioner Clark's suggestion is good but let me say also that we're working on an adaptation agenda item with Mr. Stephenson and others. We've had some discussion about whether we will try to do that in December or January but within the next two meetings we will have, and I think Dr. Riggs is involved with that too, an agenda item for this Commission to look at those issues and perhaps adding Chairman Hackney of the CRC would be a good suggestion.

Rep. Hackney: Brock do you anticipate that in extending or amplifying the work of CAPAG that there will be legislative recommendations with respect to that issue to the process or is it entirely in your view something that can be handled within the Executive Branch?

Mr. Nicholson: My understanding is I think we can handle it within the Executive Branch.

Rep. Hackney: So you would not anticipate that a recommendation to this Commission for legislative actions say at one of our January meetings would involve CAPAG?

Mr. Nicholson: Maybe I mis-understood the question but I believe recommendations could come from CAPAG with the understanding of where we are in the CAPAG process.

Rep. Hackney: No I mean recommendations about CAPAG. Do you need money, what do you need to continue your work?

Mr. Nicholson: That might be a need now that you've mentioned it.

Rep. Hackney: Sorry I brought it up. Second you have quite appropriately focused in your remarks on the various significant economic development opportunities that we are presented with on this issue. Can you amplify a little bit about that and talk about what work CAPAG is doing in that direction?

Mr. Nicholson: Certainly, that is one of the areas that we think is very important to identify and put some quantification to in terms of what economic benefit may be to the state to include but not just limited to job opportunities in some of these new thrust of industry. So that is something we intend to and hope to quantify. One of the thoughts that we've also had is that part of the process in the original schedule might not have allowed as much in-depth analyses in this area that we would like to see so that might be one of the several areas that we could enhance by having an extension of the process also.

Rep. Hackney: I would certainly encourage you in that direction. I think one of the things that has become apparent to me in sitting here through our meetings is the great opportunity for economic development in these opportunities that are presented. And the more that we can identify them and the more that the Legislature can support those and we spend a lot of money on economic development and jobs and members of the House and Senate support that almost universally. And I think when you find those win-win situations, that's something we can go ahead and move on.

Mr. Nicholson: And I think we've already identified but not done as much study as we need to do. Certainly in the agriculture and forest products area are the tremendous opportunities to use the bio-waste, bio-fuels that we have quite a resource here in this state and we could in some respects revitalize some of our good products industry in terms of promoting better management, proper management, maybe different management all across the whole spectrum of that industry to promote greater growing of trees as well as the appropriate maybe even greater harvesting and use of wood products.

Dr. Smith: Brock it is my understanding that both the state of Arizona and New Mexico have recently completed somewhat very similar processes to this and that particularly in the case with Arizona, I think there was some very significant economic development opportunities that came through. I'm just wondering if it wouldn't make sense at a future meeting to at least summarize some of the work that has taken place in some of these other states because I do believe there are some parallels that are appropriate and I think states can learn from each other and there are a couple that are a couple of steps further down the road and some of that analyses I think was pretty encouraging that they came out with. I take it that would not be that difficult to share with this group and summarize it.

Mr. Nicholson: I think that's right. I haven't studied the Arizona report as much as perhaps I need to but I do have the same understanding that what they ended up with were very significant both reductions and greenhouse gases and economic opportunities. As the Commission knows the same consultants that are helping us with our work in fact helped Arizona with that project also so I think we can definitely do that.

Mr. Garrou: I guess two points about that, the California legislation that just passed global warming legislation was supported strongly by Sicilian Valley because they saw it as an economic development issue. And the new governor of Massachusetts ran part of his platform on the economic opportunities for global warming mitigation for Massachusetts. So a lot of people figured this out.

Mr. Givens: I think there may have been one point at one legislative meeting when we asked representatives of the executive branch if they needed more money and they said no but that's lost in the mist of time. I would have expected you to say yes but at any rate Chairman Hackney raises an interesting question about report on what the CAPAG itself needs on a related matter or more directly, it has been my understanding that we've had a lot of conversation about low hanging fruit in terms of recommendations coming forward from the CAPAG to this group for recommendation as legislation to the 2007 session. Are we on track for that - is that going to happen?

Mr. Nicholson: George we certainly are looking at that, one of our considerations is one of sequencing here in timing in terms of when our analysis is done. One of the reasons I mentioned perhaps an area of potential low hanging fruit or options for the state is that perhaps we might be able to get through that a little quicker than some of the others. But I would want to have these discussions within our work groups in CAPAG specifically before we actually come forward with recommendations there. Adaptation – I think we did have sufficient discussion that we have a broad interest in moving it forward as a recommendation for the near term.

Mr. Shore: Brock if I could request that the CAPAG at its January meeting be very intentional on taking up this issue, set aside some time to identify which might be the low hanging fruits and you just mentioned a few that could be put forward to this Commission for its consideration and perhaps set the stage for legislation.

Mr. Nicholson: We will.

Mr. Garrou: Thank you Mr. Nicholson. Our next presenter is Franz T. Litz, who is the Climate Change Policy Coordinator with the New York State Department of Environmental Conservation. Welcome.

Mr. Litz: My name is Franz Litz, I am the Climate Change Policy Coordinator for the NY State Dept. of Environmental Conservation and I am here with great pleasure to talk with you today right after the holiday weekend. I want to thank the Commission for the invitation to have me here and hope that what I have to say will be interesting to you. Before I start I do want to commend you for just the fact that this Commission exists and that you're having these conversations. Last night in my hotel room I searched through your previous meeting agendas and presentations and it's very clear to me that you're approaching this in a very thoughtful measured way and something that we could have and could use in New York but we have no such commission of this sort. You really deserve a lot of credit for undertaking this process. I don't want to leave without mentioning the leadership that North Carolina exhibited through the North Carolina

Clean Smoke Stack Act and now through the CAPAG process that Brock is leading and his staff at DAQ. It's really remarkable and again a very thoughtful measured process that I think will withstand the model for other states as they undertake similar initiatives. Congratulations and great work!

I want to just clarify where I sit in our organization. I am the senior most bureaucrat, I'm a lawyer and bureaucrat, two strikes against me. Senior most bureaucrat in the environmental agency working on climate issues which means I'm not a political appointee, but somebody who has chosen this role. As a career measure I'm really showing my poor judgment before I even get to the substance of my talk. But I say this because I want you to know that I am a staff level representative and I will talk about things that other states are doing but one rule that we've established very early on in our Northeast process is that no one state will speak for another state. We can speak about the other state and we each speak about each other usually positively I hope. All of my remarks are either personal or represent a New York view and not necessarily a view of the other states.

I am climate scientist – I am not a scientist as I mentioned I've trained as a lawyer and I work primarily in the policy area but I struggle with the science as many of you who are on this Commission who aren't scientist struggle with the science and I look for ways to reduce the science to map this body of complex science down to nuggets that we can use to make policy decisions on. I think it boils down to these words up here, these six words: we know enough to act now. It doesn't mean there are no uncertainties, there are uncertainties, there will always be uncertainties if we wait to act until after all uncertainty is left from this screen it will be the day after the event, because we will not know. We will not know for sure what will happen until it happens. As a non-scientist I look for proxies. I found in going from conference to conference and talking from scientist to scientist, you get a slightly different take from each scientist. And so I listen to bodies of scientists like the National Academy of Sciences, like the Union of Geophysical Scientists, you name it, every scientific union that's taken on this issue, and look for proxies, I look to them for these little nuggets that help in policy making. Probably foremost in that is the joint statement from the National Academies of Science that was issued in June 2005, these are eleven science academies from eleven industrialized countries including the US and they issued a statement that the scientific understanding is not sufficiently clear to take action. We know enough to act now in other words. I find these issues of science an uncertainty very fascinating. I was watching on C-SPAN the science subcommittee in DC and the president of the National Academy was testifying and he testified that the scientific certainty around climate science in his opinion is far greater than the scientific certainty around cigarettes causing cancer. I've been trying to get a copy of that transcript because I think for those of us trying to wrestle with the uncertainty and focus on risk and what measured responses are appropriate in the face of that risk, those kinds of context placing comments are important.

I was struck by the remarks and some of the questions to Brock just now understanding that this date with climate impact is really at just the very beginning. Especially when you're talking about how it impacts a particular state or area of the state. We were

fortunate to get a study that was issued earlier this month and we have no claim or credit for it, none of the states in the northeast. This was done by a group of 40 independent scientists bought together by the Union of Concerned Scientists and they took the global science and they brought it down to a regional scale. This is the kind of study and it is not the first of its kind, there was one done for the Great Lakes region, one for California, one for the Gulf Coast, so we were the fourth to benefit and you really ought to push them to do one for the southeast because it is helpful. Not to overstate the merit of this study but the point I would like to leave you with is that we could benefit from more study that takes place closer to the ground so that we can get a better understanding about how climate change is going to affect all of our states and constituencies. Only then will we have the political backing that we need to really take steps toward solving the problem. This is a diagram (**Exhibit G**) from that study that shows two different paths, one with a lower emissions path and one with a higher emissions path, selected from the various models that have been run internationally and they show quite a difference in the climate changes that would occur if we take a lower emissions path versus a higher emissions path. The point here is that the steps we take to address our emissions pathway will have a significant impact on climate change even while recognizing that the climate is already changing. So we are working now with a climate that's changing and those of you who made comments about a better understanding are right on it and I know we in New York are really just starting to grasp that issue as well.

For some of the potential impacts that have been identified and yours will probably be slightly different here in North Carolina than the impacts out in the west. They're looking at potential long term droughts which will have serious impacts on their way of life in the west. We're understand those impacts will be important and perhaps not surprisingly in our country the businesses were the first to pick up on this, not politicians and not bureaucrats. This is a couple years old cover of Business Week. This is this year's cover from Time, businesses and normal everyday people are starting to read these issues. The economists recently, just more than a month ago, came out with this article where they essentially said in their editorial, we know enough about the science to act now; interestingly they also said not only do we know enough to act now, but the cost some of those dramatic estimates about how much it is going to cost are just as looney as some of the domes sayers projections, so they are basically saying we need to go to the middle on this issue. I'm a member of the Advisory Board to the Climate Group which is an international group focused on highlighting climate change actions and they issue every year a carbon down profit which focuses on businesses which have taken this mission and actually improved their bottom line while reducing their carbon emissions.

This is an economic issue and we shouldn't be surprised that businesses have been the first to figure this out. New York spent 55 billion on energy in 2005. Most of those dollars left our state. Two years earlier we spent 38 billion dollars on energy. When we talk about changing that dependence and moving toward policies that promote renewable energy and low emitting electricity generation we are quivering over a very small amount of dollars. I like to think of the state climate policies falling into four baskets, one is to reduce energy consumption, the next is to promote non-carbon emitting energy, de-

carbonized fossil fuel energy, and last increase sequestration in carbon sinks, moving in the forestry area, moving in the agricultural area.

Most of us have undertaken climate action plan maybe with the exception of Connecticut, none of them were as well carried out as what you're doing here with the CAPAG. Other states will learn from that process. We have in most of the northeast states renewable portfolio standards and we're seeing all kinds of development as a result of these RPS's. In parts of New York State we are now seeing hundreds of billion dollar projects going in wind projects, bio-fuel projects that are simulating areas of our state that really badly need that stimulus and the tax base for these local governments. Those have been very positive in their economic impact and we hope in their environmental impact. Greenhouse tailpipe standards, all of these things I know you have on the CAPAG docket you've been picking up in some form or another.

RGGI – Regional Greenhouse Gas Initiative

RGGI will be the nation's first mandatory cap and trade program for carbon dioxide. It covers only power plants and there are a number of reasons for that. One is as you have good data from your power plants, so do we and that's the function of the Federal Clean Air Act requiring that some of those emissions be monitored and reported. So we had a very good sense of where the base lines were for those sources and it seemed like a logical place to start. The governor sent invitations to 11 other governors and of the nine that responded positively six were Republican and three were Democrats. This is really not a partisan issue in the northeast as it is in much of other parts of the world. We had a three year design process so again this wasn't something we did overnight. I was the chair of the working group that bought the states together and was chair over the course of three years. We had initially hoped to get it done in two years. Back in December 2005 we reached an agreement with seven of the states, we lost two, we hope to get them both back and expect to (Massachusetts and Rhode Island). The Massachusetts governor elect said he will sign RGGI as one of his first things next year so we will have Massachusetts back early next year. Maryland has legislation that brings them on board. So we will be back up to nine states next year and we hope to have Rhode Island and Pennsylvania which will bring us up to the original 11.

What does this mean and what do you really expect to accomplish as a group of states? This is a global issue. Just to give some quantitative sense, the region at a glance is about 40 million people which is before we add Massachusetts and Maryland, that 13 percent of the US population. If we were considered a country, we would be the 11th largest emitter in the world. Our economy represents 15 percent of the US economy or 1.8 trillion dollars so that gives you a sense of the economic breadth. And when we start them talking about linking this effort with other state efforts like perhaps what you're doing here in North Carolina, what they're doing out west and New Mexico, Arizona, and California then you start really adding mass to your effort and not only do you point the way for the federal government but you also just make your actions more meaningful than just going it alone as one state.

Essentially in a cap and trade program you have a source space. So you figure out which sources are covered and you say as of a certain date that source must have a permit for every ton of emissions that comes out of its smoke stack. Then the government or the regional authority determines the total emissions that will be coming out of those sources and establishes a cap, issues permits one per ton up to the limit of the cap, distributes them in some way. Each source at the end of each compliance period has an emissions account, it then looks at its allowance account, it spends those allowances or it goes out on the market and buys allowances to cover it. What happens is that sources that can cost effectively reduce their emissions will do so, those for whom it is cheaper to buy allowances on the open market will go and buy them. Then the carbon context because we don't have a commercially available scrubber technology, we have added this concept of offsets but project based offsets where you allow the sources to purchase certified reductions outside of the covered sectors and they can use those credits interchangeably with allowances. What do we plan to do? RGGI does not purport to seek to solve the problem, it's a first step. That is why for the first five years we have a stabilization target which caps emissions at current levels and then we reduce by ten percent over the following four years. Stabilizing emissions accomplishes more than that ten percent reduction because without the program emissions it would go up 25 percent in this sector based on our moderate business as usual projections. By capping emissions just at current levels we would be avoiding a 25 percent increasing by reducing them ten percent we will end up 35 percent below business as usual.

Some interesting things about the RGGI cap and trade program other than its multistate, there are a couple of things that we had to do differently this time around. One is allowance allocations in many cases will be sold instead of handed out to generators and this is due in large part to the fact that our electricity markets are not deregulated and the regulators no longer have control over the rates that are charged by the generators. New York will be proposing this week of 100 percent allowance of options for our RGGI cap and trade program. Vermont will do the same, it sounds like New Jersey will also do the same. So this is different than previous cap and trade programs where the allowances were largely handed out to generators based on past emissions.

One very important thing and this is something that the Europeans experience with their cap and trade program, biomass and bio-fuel can be used as a control method. Now it is not a typical control method like a scrubber on a stack but if you allow your sources to coal fire biomass using carbon neutral fuels, you can give them a control method. I know you're 61 percent coal here in terms of your generation in North Carolina. If you allowed those coal fired generators to burn biomass on a coal fired basis and did not require them to convert those emissions with allowances you're effectively giving them a control path that is a win-win. That's what we have in RGGI and that's what they have in Europe for their trading program and they're finding that the generators are using that pathway very quickly and after the first year in Europe they saw a large increase in biomass coal firing. We picked five initial types of offsets and we would like to expand those types. You can earn those reduction credits by going out and proving reductions, accomplishing reductions through natural gas, propane or heating oil efficiency. You can convert land

to forest and prove a reduction, you do land fill gas capturing combustion and this for the smaller sub and SPS for performance standard landfills.

Methane capture from animal operations – we've gotten a lot of interest from our farms in New York and Delaware (mostly New York) where we've had a lot of interest in that offset type. We chose that one because we were going first to the electric sector and we thought we ought to find offset categories that likewise benefit the electric sector. What we've established in the program is that offsets are increasingly allowed in the program based on the cost of the allowance. So if the cost of the program ends up being higher than we anticipated, then we allow more offsets in to reduce that price pressure. We call it an offset release style and that includes if the price gets higher than $10 we can bring in credits from the outside. Our objective there was to see investment in our region primarily and in the country because these credits can be generated anywhere including North Carolina.

So what does this accomplish? A few slides ago I showed this that there are really basically four baskets for reducing carbons. A well designed cap and trade program will hit every single one of those baskets. The carbon price will reduce energy consumption at generators and to some degree at the consumer end. It will promote non-carbon emitting energy because nuclear generators and renewable generators who have no compliance obligation under the program are better off than they were without the program. We've already seen since the proposal of RGGI pilot projects in our state that are aimed at scrubbing carbon from the emission train and using some very innovative technologies one of which is an algae scrubber, which actually yields bio-diesel at the end. And of course through offsets you bring in the carbon sinks elements. So a well designed cap and trade program really hits all four bases and it does it using market to drive innovation. It doesn't say the government is not out there picking the winners by and largely putting a price on carbon you allow the market to then pick the winners. You let innovation take its course. One thing as we stand here today many of us are hoping for that innovation that we don't even know about yet. That innovation that some savvy entrepreneur in the Research Triangle, or up at MIT in Cambridge or you name it, Silicon Valley where there is just billion of dollars of investment being made, that break-through that is yet to come forth.

So that is the carbon market and what we're trying to do is expand that market whether through linking to other states or other markets or having other states join us in RGGI. The governor of California came to New York about a month ago and signaled his interest in joining or linking RGGI and we're currently in discussions with them on that subject but I threw up these numbers just to give you a sense of what happens as you start to add states working together. With California we're a quarter of the US population, we would be the third largest economy behind the rest of the US and Japan. We would be 15 percent of the US emissions and the sixth largest emitter. So if it makes sense for some of these large industrial countries to act on this problem, it makes sense for a group of states to act on this problem. I would encourage you through your leadership to bring in a group of southeast states in a program and then later we could talk about linking up to the northeast and to the west, but my only request is to do the analyses and figure out

whether it makes sense for you to do that. I think you will find a much most cost effective program to add as many states as possible.

The next steps on RGGI - we are currently implementing RGGI, we're proposing our role making this week. Other states are on similar paths in the northeast. Early next year we will be bringing Maryland and Massachusetts on board and the launch date is January 1, 2009. Pennsylvania - we have hope for, they've been on a path toward more and more action on climate change, much like North Carolina, and we're hoping since they were one of the original responders to the invitation that they will eventually jump on. We're looking for ways to increase this multistate cooperation because it makes sense and whether that is harmonizing our RPS standards or working on an energy efficiency portfolio standard, we don't know where the next step will take us but we would like to build on this state cooperation that has been slow but has been fruitful so far.

Incidentally I understand you're looking at environmental portfolio standards which already combines the RPS and the energy efficiency portfolio standard and that makes good sense and I wish we had thought about that.

Just in summary – we know enough about the science to take some actions and those actions make a lot of sense in terms of improving our economic posture relative to the energy that we consume. We would rather buy our energy from inside our borders than spend those dollars outside and also be at the mercy of those fluctuating fuel markets. The states that are acting are also prospering, in the northeast our biggest area of growth is in renewable energy development, renewable energy technologies. These policies have immediate economic benefits not to mention the long term economic benefit that comes from relying on energy that you can produce yourself.

Regional and multi-state cooperation really makes a whole sense. We would look forward to any avenues of potential cooperation with North Carolina. We applaud you for the Commission's efforts, the CAPAG's efforts and wish you well on this. Thank you.

Mr. Garrou: Thank you Mr. Litz.

Dr. Eggers: Thank you so much for coming down Franz and thank you for also mentioning algae because I love to talk about that to anybody who will listen. It might get us out of this mess. Another thing I think is not getting enough attention is the possibility of building our soils and in North Carolina sequestration is always the last on the list. But sequestration I think should be considered a very high priority opportunity and we have a tremendous opportunity here in re-building our soils which we need to do anyways and a tremendous amount of carbon could be sequestered that way, but I didn't see that on your list in terms of offsets. Could you talk about opportunities there under RGGI?

Mr. Litz: Sure – conservation tillage is on our next short list of offsets. The way we've approached it is the design standard up front so that a project proponent could look at the

standards and know what kind of project would yield credit. That's a very front loading time consuming process because you have to establish the standards up front. But once you're set the standards you then have the regulatory agency in a position where it just needs to go down and check a bunch of boxes before it issues the credit. We're moving toward other types of offsets and conservation tillage is high on the list, forest preservation is one that we've had a lot of interest in. We do need to focus more on sequestration, at most conferences it doesn't even get mentioned.

Dr. Eggers: Just a follow-up on soil – what can North Carolina be doing right now to prepare ourselves to participate in getting to this market quickly?

Mr. Litz: In order to do offset credits in North Carolina that would be redeemable in RGGI we need a cooperating agency in North Carolina. That would probably be Brock's agency and that agency would just agree to do random spot checks on projects as they go into effect. We need someone to stand in our shoes because we have no jurisdiction in North Carolina. Probably early next year we will be able to start hammering out those MOUs that will bring in cooperating offset states. That's the way to get the benefits of the carbon program in those non-sector areas.

Representative Harrison: Of the states in RGGI do all of them have renewable portfolio standards and if not are they on their way?

Mr. Litz: All except for New Hampshire and Maine and it's on their dockets for the next legislative session in both of those states.

Representative Harrison: How about the clean cars?

Mr. Litz: That is every state except New Hampshire I believe has the lower emission vehicle because Rhode Island came on, Pennsylvania is now looking to do it, Maryland just announced their intention to do it. New Hampshire and Maine are actually seeing a lot of renewable generation because the RPSs in Massachusetts and Connecticut will allow the credits to come from those states. So in some ways they have been benefiting from the RPS without actually having one in their state. They are paying for it because they are part of the same power ball.

Mr. Toben: Wonderful presentation. You mentioned in these offsets natural gas, propane and heating oil efficiency as one of the categories, can you say a little bit more about how that works, how you set that up and measure that and qualify for credits.

Mr. Litz: Sure – one thing in energy efficiency we have up to date, governments investing in energy efficiency whether its through system benefit charge or by mandating that utilities invest in energy efficiency. We have had some success with that and a lot of failure too. What we were trying to do with this offset and what you would do with your EPS or energy efficiency portfolio standard would be to attempt to inject market forces into this mix and have entrepreneurs go out and actually generate these projects. We have energy efficiency providers which right now say in New York City would go and

sign up a building and say I will retrofit your oil boiler make it state of the art natural gas, give you smart thermostats and the like in your building. And they say to the building owner, we will pay for all of that but we will recoup our cost over time through your bill savings. We wanted to spur that a little more and make more of those projects economically feasible. Primarily the credits are going to these energy service companies that are acting as sort of an intermediary between the end user and the state. We're the buyer of the credit and they're both generating a return on the energy savings and the credits are being sold to supplement that.

Senator Albertson: Its great interest to hear you talk about the jobs that's being created around renewable energy in your area. Is that one or two sources or is it a variety of sources? Can you talk to us a little bit more about that?

Mr. Litz: Sure – I can do the written study that was done by the Univ. of Massachusetts a Professor by the name of David Levy that looked into job growth in various areas across the economy that concluded that job growth was highest in these clean energy technology fields. That's what I was basing that statement on.

Mr. Shore: Thank you for your presentation, I have two questions first just looking at how you constructed the program with the coal firing of biomass and bio-fuels as a control method and also some of that ag. and forestry offsets, do you have an estimate of the magnitude of the benefits to those sectors of the ag. and forestry sectors just to give us some sense of what might be possible here in North Carolina and then my second question is about how you in New York embarked on this coordination with the neighboring states, how did that process start and any guidance for us in addition to your points about analyses that could be helpful as we think about this.

Mr. Litz: I have to point you to our website we have some quantifications that were done in the offset context - I will say that what we've done so far doesn't amount to enough because we only have the Landa Forest and we have the ag. methane and there are lots of other categories of conservation tillage that could be added to expand the opportunities and we intend to do that. I'll point you to the information but I think you'll be a little disappointed with it up front but then you have to bear in mind that there's a lot of room for expansion and we're just getting started.

Mr. Shore: In terms of how this began and it really goes to the point of analyses, the governor established a task force in 2001 that wasn't a legislative commission it was an agency and state co-commission, more like CAPAG but not as well organized version of CAPAG and one of the analyses that was conducted as part of that task force was a regional cap and trade versus the state only cap and trade and the differences were quite striking in terms of both the benefits and the cost, that's why I say do the analyses and see whether it makes sense.

Mr. Litz: Well the governor was prepared to do a state only cap and trade. We have one which is sort of a pre-care cap and trade program but before he did that he wanted to see whether there would be takers and in New England you had this band of governors that

had agreed to work on climate action plan so the ground was pretty fertile for growing this kind of a regional initiative plus the previous operation we had together. In terms of reaching out to the rest of the southeast, I would have to do some brain storming with you about what to do but I could do analyses, probably the best way to win people over, show that it cheaper and more cost effective, focus on the benefits that you can reap. Of course in the short term there are going to be cost and some of these benefits are more long term in nature that if you can rely on locally generated energy those are benefits that are in some cases intangible.

Representative Hackney: What were the three obstacles to your implementation of a cap and trade system?

Mr. Litz: The biggest obstacle was that each state was a sovereign state and used to making its own decisions and it's still the biggest obstacle. Walking that fine line and you probably heard it a little bit with my comment about we don't speak for others but we'll speak about them. Figuring out how to communicate in those ways and trying not to step on others toes is a big part of it because governors get elected and they want domain over their state and they don't like to answer to other governors and I would say that is one of the biggest challenges coordinating a bunch of sovereigns. The fact that when it comes time to implement it you each have separate legal structures, so right now we have to go back to every RGGI state and put it on the books separately unlike the national government where they can just put in on one set of books and it would apply to everybody, there is no regional authority so that's a problem. I guess the other issue I would say is that its very time consuming, there are a lot of different interest at the table, a lot of different stake holders, some of whom have very good channels in their individual state and not necessarily in the other states, so you have a lot of competing.

Representative Hackney: What sort of buy in did you get from the utilities?

Mr. Litz: We have a website (www.RGGI.org) and from the beginning I would say there was a general sense that this was coming and it wasn't really a question about whether it would happen. We got a lot of constructive input from our stake holder process. In the end we had support from some utilities the nuclear generators were supportive almost straight through, because this is a win for them, renewable generators likewise. Most companies have a mixed portfolio they have some nuclear, some renewable and some fossil so the perspectives ran the gamut. ES Corporation and NRG were less positive but they were very constructive.

Representative Hackney: Should I assume that the more coal oriented utilities the less positive?

Mr. Litz: I would say that probably to the extent that nuclear was very positive, coal was at the other extreme, yes it's the most carbon intensive generation. But I would also say NRG is the company that's doing a pilot project for the algae scrubber in one of their western New York coal plants and they will be taking the carbon from the exhaust stream generating algae and actually making a profit off the diesel fuel. I say that by way of

illustrating that while they were the most weary coming in, they are also poised to capitalize on the opportunity.

Mr. Urlaub: Thank you very much for your presentation you've answered a lot of questions for me personally. You illustrated for us RGGI and California combined being very sizeable, the third largest world economy, how soon do you see just RGGI and California combined having an impact on the rest of the country doing offset projects or some how participating in or doing projects for RGGI in California and specifically if you could speak to new power plants throughout the southeast region and coal and nuclear are the two leading proposals right now, if an IGCC plant was built in the southeast would that somehow qualify as an offset project if there was a way to sequester the carbon in the southeast?

Mr. Litz: Not currently, I'll answer your last question first. There is no offset for other combustion sources that are not covered by the cap but that wasn't on the list. The concern there was that if you get some of the benefit of that reduction without having to be under a cap then when will they ever be under a cap. I think states will always have a rule on this issue particularly in certain areas, renewable portfolio standards doesn't make sense to implement an RPS on a national level. We've always regulated energy on the state level and probably will remain that way so renewable portfolio standards must have been the bigger investor in energy efficiency, California being the lead in terms of its investment and energy efficiency. I don't see that turning into a federal exercise, I may be wrong so I think there will always be state rules and those are two examples where I think the states will always be relevant. On the cap and trade front we are already seeing what the new Congress movement toward a federal cap and trade system that I am a little less certain about. That RGGI may be obsolete in five years there may be a federal program that preempts it in which case it makes our joint effort with California no longer necessary and that's perfectly fine with us. Everyone at the table has always said we would rather have a federal program but we also recognize our role as a laboratory of democracy where we can try some things and we'll probably make some mistakes that the feds can learn from and we'll have some successes that they can likewise take and make part of their program.

Representative Wilkins: It appears that your region has had a bit of southward movement I was wondering if there has been any interaction with your neighbors to the north?

Mr. Litz: Are you referring to the diagram or are you talking about the population pattern?

Representative Wilkins: Canadian.

Mr. Litz: Canada – yes in fact north of the New England states have a long standing relationship with the eastern Canadian products such a Quebec and Maritimes. We in New York have a relationship that is primarily with Ontario. The fact that Canada is a Keota signatory has hampered their movement toward cooperating with us because any

reduction that they would get from us would not be valid to meet their Keota obligation. But now that the new government has really sort of said he's not going to worry about Keota and he's pushing it to the side but he's going to do X,Y, and Z anyway, we have had renewed interest from them. That's just about the extent of it not really any serious discussions or figuring out how we would connect the two programs.

Dr. Smith: Couple of questions. I'm just curious about the base line - it seems to me that given this flurry of activity identifying a good solid baseline that you can trend off of. It's got to be really critical early on in the process can you talk a little about that because it seems to be that as we begin to look at linking up across multi-states, across regions that have a common set as much as possible.

Mr. Litz: This speaks to Brock's and the CAPAG's crosscutting issues with the inventory registry and the reporting. You are right you cannot overstate the importance of getting good numbers in your inventory. I wish we were better about it, our inventory is in a dark room in Albany somewhere and I don't have good access to it and it's not well updated. You have to get your numbers, figure out the way to do it, there are plenty of common protocols that you can use, there's a lot of assistance in coming up with those numbers.

Dr. Smith: In a follow up question, I followed this from a distance but the way you did the auction with the allowances could you talk a little more about that, my understanding is that was very innovative and it was a little controversial at first but its played out quite well and it created a dedicated pot of potential money to really go in and do some strategic work on efficiency and renewables and others like that.

Mr. Litz: That's absolutely right it is probably the chief innovation in the program. We will be selling the allowances and that will generate a pot of cash. The reason we are doing that is we have a deregulated electricity market and it became very clear to us that if we give the allowances away the generators are still going to charge for those allowances. Its kind of like if you give the generators a year's supply of fuel to run their plants and then you ask yourself the question, well are they then going to fit in a zero cost, are they going to provide the electricity for free to consumers, the answer is no of course because they can take that fuel and sell it to their competitor. The opportunity cost of burning the fuel leads them to put the cost into their price. The same thing is true for a commodity like an emissions allowance. So it's kind of counter-intuitive but if you give that allowance to the generator you're not lowering the cost of the program at all it stays the same and the benefit of that allowance goes in the pocket for the shareholders of the generator and the consumer pays for it either way. So we should charge for the allowance and let the consumer get the benefit of what the consumer is paying for and that does result in a pot of money that can be used to help sustain the program where we in New York intend to use it for energy efficiency investments to attempt to capture some of that low hanging fruit.

Dr. Smith: Pardon my lack of understanding completely but would that be limited only to a deregulated market or could that allowance selling allegation be appropriate to apply in a regular market?

Mr. Litz: This is really states specific so I think you would have to do the analyses for North Carolina to figure out how the market works. Theoretically, my answer would depend on whether the cost gets passed on to the consumer whether or not the generator pays if the consumer is paying for it either way, then the consumer better get their benefit for it otherwise you're just lining the pockets of the wrong entities. But if you're able to control that to keep from passing on the cost through regulatory bodies the argument is much less compelling.

Mr. Garrou: I assume that each state in the compact has a different regulatory balance for its utilities so how did you deal with that?

Mr. Litz: We are all deregulated with one exception and that's New Hampshire and we generally designed around the majority of the states. The auction provision is so broad New Hampshire has a lot of leeway so we can actually benefit those regulated sources.

Mr. : Two questions about slide 25 – the first board is implement of RGGI, could you explain what that means specifically and #2 what reservations have Rhode Island and Pennsylvania raised as to why they are not willing to participate at this time?

Mr. Litz: Implement RGGI in most of the states means a rule making through the Environmental Agency so we have a model set of regulations which we put together and other states have conformed that model to their state's guidelines and they have to propose it to their state procedures. In two cases New Hampshire and Maine that will go through the legislature, in New Hampshire that will go full fledged to the legislature and in Maine they have this kind of legislative review process where the legislature can grab a rule making and hold hearings on the rule making as part of the rule making process and that sometimes leads to counter legislative measures. Rhode Island followed Massachusetts because they're the small neighbor to the south. Once you get Massachusetts in the mix Rhode Island pays for the program without getting any of the benefits so very clearly they are going to want some of the allowances so that they can recoup some of the benefit of the program and not just have their consumers pay for it. Pennsylvania just hadn't done much thinking about this issue they had a new administration when this first came about and they were new and still getting used to things in Harrisburg and they had other things higher on their agenda. They wanted to do an RPS first which they've done, they wanted a clean coal initiative which they've done but now I think in terms of going down their priority list we're closer to the top and I'm just guessing.

Dr. Everett: If you break that 55 billion dollars now what does that look like.

Mr. Litz: I have no idea. These are just numbers that I got through our Governor's office.

Dr. Everett: Do you have any sense in terms of your energy needs growth what it's likely to be met by in terms of new generation.

Mr. Litz: Sure – we have a fairly diverse portfolio now which is about 25 percent gas, 25 percent coal, 30 percent nuclear the rest mostly renewables and some oil. In general we have a NGCP plant being proposed in New York which the governor is supporting very heavily. I don't see anything non IGCC coming in on the coal side in New York and the natural gas and we have a big boom in renewables right now.

Dr. Everett: Let me just ask one other question – I don't know which slide it is I can't read the number but the figure that looked at summers and upstate New York, I assume the presumption was that's not a good thing is that the presumption? And I wondered if you looked at upstate winters?

Mr. Litz: I'm from upstate and still live there. Yes we did and the winters are dramatically impacted, the number of days of snow cover have decreased already quite significantly and the biggest significance is talking about the changes we've already had and talking about the changes as if it's your back yard and it is my back yard. There will always be people that see figures like this and they say yea it will be like living in North Carolina instead of upstate New York. What's hidden in the simplicity of this chart is the problems that you can reek in any system for example if some plants bloom earlier before the insects actually mature, you're disturbing that balance you don't end up with the pollination that's just one small example. Not everything in nature would be able to adapt as quickly to the change as other things in nature. Humans might be the best to adapt to the change and then you have all the other organisms.

Dr. Everett: Really the connection I was trying to see if it exist at all in your energy use where the 55 billion dollars goes you wonder what course in the pack is used in current energy consumptions whether that change in upstate New York in the winter time has the impact on that energy consumption.

Mr. Litz: I know in terms of our carbon inventory that's about 30 percent of our inventory so it could be a significant portion heating and cooling of buildings so you're right it's hard to know. These are the areas where we need more adaptation analyses if the temperatures are going up how is that going to affect the way we actually respond to this program. Do we really want to push boiler replacement? Boiler replacements might not get a verified winter and end up being two months long and didn't even run the new boilers that might be a bad investment.

Mr. Givens: With regard to this study you said what had been done to the northeast and recognize that we have done for the southeast that did the study?

Mr. Litz: It was 40 independent scientists that were self funded in their work. One of the things I'm trying to do in New York is get state funding for that kind of research. All you need to do is get a climate science pool of money and then that money would go to

researchers at your universities. It would be coordinated by someone within the state but it could be done with a relatively small staff. You could support your university scholars that way and ensure that the results are objective. My concern about that study is that it really wasn't done for decision making purposes so you have to take it with a grain of salt. That's why we need more of this research and it should be primary in government funding.

Mr. Givens: Do you know who paid for it?

Mr. Litz: The scientists themselves were not paid at all out of the grant that allowed the coordination by UCS. They had to come up with the money from their universities and in some cases their university departments supported their work on this study.

Mr. Givens: Is there in fact an interstate compact associated with RGGI or what's the interstate brain work?

Mr. Litz: There is no compact per say, we have a memorandum of understanding which is not binding. One of the provisions of the memorandum of understanding says that any state can decide to back out after 30 days. There are no enforcement provisions so New York cannot enforce it on Massachusetts. They recognize our missions permit and we recognize theirs if they do something to anger us we stop recognizing their permit, that's really our only recourse.

Mr. Givens: So in essence it's a good faith hand shake.

Mr. Litz: Yes.

Mr. Givens: Is their some potential for purchase of credits outside your region that are non-combustion credits I've had some understanding that perhaps North Carolina could generate and sell credits even though we weren't part of the program.

Mr. Litz: Yes indeed you can. Once you establish a cooperating agency relationship and that would probably be Brock's agency, then projects can originate here in North Carolina after that point.

Dr. Smith: Where does combined heating power fit in to this scenario here and how advanced was New England in going after that low hanging fruit and how much has this played into being a player?

Mr. Litz: I get a lot of grief from the CHP people because this program is focused primarily on emissions and a lot of times a CHP installation will actually increase efficiency but also increase emissions and so it's very hard to give credit for a CHP installation. The answer is we have other ways of encouraging CHP, we have a bunch of regulatory reforms underway, a decoupling proceeding that will put energy efficiency on level footing with new generation, stand-by grids you can generate your own electricity on site but then you need as a backup being able to hook to the grid and typically the

utility will charge a great deal for that stand-by credibility to have the grid power standing by and that makes the CHP less attractive.

Dr. Smith: I guess I don't understand how it would increase the emissions because my understanding is that a lot of the CHP is actually capturing waste energy and converting it to use for work whereas it is basically going up the stack as waste heat.

Mr. Litz: If it doesn't increase emissions then they're eligible under the fossil fuel but in may cases what they're doing is they're taking both their electricity requirement and their space heating requirement and they're replacing their current ways of meeting that demand with the CHP unit. Now that may actually increase their fossil emissions relative to heating and electrifying the facility on site whereas previously the electricity portion was emitted somewhere off on the grid now they're emitting that portion on site. One thing Connecticut did in their renewable portfolio standard, they have a CHP component and an energy efficiency component.

Mr. Garrou: Our next presenter is Mr. Kurt S. Creamer, Biomass Program Manager at North Carolina Solar Center and Animal and Poultry and Waste Management Center at North Carolina State University

Mr. Creamer: Good morning and thank you for allowing me to come and talk to you today about bio-fuels. I will start out with a little background on the major bio-fuels that have potential here in North Carolina and most other places as well, that would be ethanol, bio-diesel and I am also going to talk about fuels from animal waste. This is a slide (**EXHIBIT H**) about the benefits of bio-fuels that are well documented particularly in economic development that becomes obvious if you're producing these bio-fuels in state it generates jobs at the actual fuel production plants and of course that has an economic multiplier effect. It approves our energy security, in nearly all cases reduces regulated tail pipe emissions reduction and it also reduces greenhouse gas emissions. There are three ways to produce ethanol from feed stocks, the most simple is producing it directly from sugar crops and by sugar crops I'm talking about sugar cane, sugar beets and sweet sorghum. Sugar cane doesn't have much potential here in North Carolina. Sugar beets and sweet sorghum are an option but most studies have found that the cost of producing ethanol from sugar crops is higher than producing it from corn.

You may have heard a lot about Brazil recently as we wrap up our ethanol production here and their ethanol is produced from sugar cane and they are able to do this in an economical way and one of the tricks they use to do that is they burn the residue the left over stalks and cane from the sugar production process and that goes into boilers to generate the heat necessary for the ethanol production process. There is a significant amount of heat required for that process. In our country ethanol is primarily produced from corn and 97 percent of our ethanol is produced from corn and it's estimated for the year 2006 that up to 20 percent of our corn crop will go into ethanol production. This is a standard process that involves cooking the corn and breaking it down with enzymes that breaks down the starch in individual sugars. You ferment those sugars with yeast and then you distill out the ethanol. There are over 80 plants here in the US that are using this

technology and it's of course as you would expect primarily focused on the mid west. There are no plants on the eastern seaboard at the moment.

You've probably heard a lot lately about producing ethanol from cellulose and cellulose like its cousin starch is just made from individual sugar molecules. It's just there in a long chain but the issue for cellulose is they are connected differently. Chemically they're connected differently and they are also protected by two other substances, hemi-cellulose and linoncellulosic. All that together makes it more substantially difficult to break down cellulose as compared to starch. Once you accomplish that you just ferment the sugars and the back end of the production plant looks a lot like the back end of a corn to ethanol plant. One opportunity is a stepping stone toward cellulosic ethanol is you build a corn ethanol plant and then you put on the required pre-processing on the front end of that plant down the road when it becomes more economical.

US ethanol production is just sky rocketing due to a number of factors. A lot of it has to do with banning of MTB, we are in for another record year in 2006 we have over four billion gallons now in ethanol production. We use in this country about 146 billion gallons of gasoline a year. Here in North Carolina it's over four and a half billion gallons per year. We do use some ethanol here in the state, the Motor Fleet Management does use over 200,000 gallons of ethanol in the form of E85 which 85 percent ethanol, 15 percent gasoline and also another 700,000 thousand gallons of E10. You can find E10 at commercial gas stations including Crown and a chain out in western North Carolina called Hot Spot. There are also ten service stations, maybe up to 12 now that sell E85 directly and these are scattered around the state including one here in the Triangle. All told we use about five million gallons of ethanol in the state.

We have had and have had for a number of years some proposed ethanol plants for NC. You hear a lot of press releases you also have a lot of ground breakings but ground breakings are somewhat separate from the actual shovel going into the ground. The three that I'm most aware of is the Agri-Ethanol Products in Aurora, NC they talk about 54 million gallons per year plant wrapping up to 108 million gallons per year in Phase II. DFI Group has been around for a number of years looking at a site in Jamesville in Martin County and there is also a group out of Chapel Hill looking at a site in Hoke County.

This is a slide that I put together for a group that I'm involved with and that's the group that was eluded to earlier, it's a bio-fuels strategy group created out of the Energy Independence Act. This act created a group to prepare a bio-fuels strategy for North Carolina and the group is led by the Rural Center, the NC Biotechnology Center, NC State University and NC A&T University and each of those entities has a different need that goes on to this strategy group and then a number of others are invited acting as an advisory role. I put this slide together because I was curious about what is the potential looking at various scenarios of displacing gasoline in NC. So the big chunk there for our current gasoline usage would be that whole pie basically, but now I look at ways to that you might displace gasoline usage and first of course you would look at corn. What I did there I took our entire corn crop and proposed that it be used for ethanol production and

that amounts to about three and a half percent of our gasoline usage. That is the maximum you could displace from using our entire corn crop for ethanol.

Another crop we're working with at the University is Hulless Barley it can be grown in the winter so it doesn't interfere with corn production. It can work into a corn rotation and if you replace all the wheat in NC with Hulless Barley you get another 0.8 percent. Going down the list if you use all of our agricultural residues - corn, silver and sweet straw that's another 1½ percent, then you get into the big ones because the resources that we have in abundance are woody biomass resources. My best estimate based on research done at NC State suggest that by using that forest residue to produce ethanol you could displace almost ten percent of gasoline consumption in this state.

Then I looked at another scenario just more out of curiosity than immediate reality and that is using pulp wood for ethanol production. What some people may not realize is that the front end of a pulp and paper mill also looks very much like the front end of a cellulosic ethanol plant that is going to utilize woody biomass as a feedstock. If for whatever reason the pulp and paper industry should collapse here in NC then the amount of pulp wood available for ethanol production would allow us to displace about seven percent or so of gasoline consumption. I looked at a couple of scenarios we have these lands of federal program called Conservation Reserve Program, the thought there was to utilize these lands for growing a perennial crop that would have minimal environmental impact such as switchgrass and then use that switchgrass to produce ethanol. And finally look at the opportunity we have on a spray field, these are the spray fields associated with hog lagoons in the state and there is another potential opportunity to grow energy crops such as switchgrass on the spray fields and have some impact on gasoline consumption.

I am going to jump over to bio-diesel and as many of you know now that bio-diesel is produced by a chemical reaction between the methanol and some source of oil and fat. As an example, you can take 100 pounds of Canola oil, ten pounds of methanol that produces roughly 100 pounds of bio-diesel and you're left with the by-product glycerin. The potential feedstocks we have here in NC for bio-diesel production include waste vegetable oil and soy oil. We can grow Canola in the state, there are other oil seeds available, peanuts, cotton seed, and also we have several large rendering operations in the state and the animal fats from those rendering operations makes very good bio-diesel. It's often used in a blend, commercially it's used in a blend of 20 percent bio-diesel and 80 percent petroleum diesel and has a number of properties that make it nice to handle. Actually as chemical processes go it's pretty straight forward, you are mixing the source of oil or fat with methanol. There is a catalyst involved that's very simple catalyst sodium hydroxide or potassium hydroxide. After the reaction the bio-diesel and the glycerin separate into two layers, you drain off the glycerin layer and you're left with the raw bio-diesel that you then further process a little bit through a washing operation to get out some of the other contaminants.

Bio-diesel production is also ramping very rapidly in the US and a lot of this is centered around our soybean producing regions. There is a long way to go as you can see from this graph you don't have a higher percentage offset from bio-diesel as you do ethanol.

We produced about 75 million gallons for 2005 but our consumption of diesel is 40 billion gallons so we have a long way to go with bio-diesel. In our state the true leader in bio-diesel consumption was our own Department of Transportation - they still use bio-diesel - have had a very minimal or no problems with it. Use roughly one million gallons per year of B100 or pure bio-diesel a lot of it is to state agencies and municipal entities so they are non-taxed entities, and then we have a number of private stations that now offer bio-diesel. Like the ethanol situation we have had a number of proposed bio-diesel plants, the first one there Piedmont Bio-fuels the one million gallons per year facility had their grand opening and they are very close to commercial production. The Grain Growers Coop is proposing a 30 million gallon per year in Mt. Olive. They have concluded their investment drive and are in very good shape from a finance perspective which should allow things to move forward much more quickly. We have a plant in the western part of the state, a new plant in Lenior County and another plant in Autryville that is coming on line.

For the same bio-strategy group I did the exact same sort of scenario looking at how much petroleum diesel we could displace in the state. The first option would be soybeans is the most obvious so this assumes that we took the entire soybean acreage in the state and produced bio-diesel from that soil and you get to about 4.7 displacement with that. Again we're looking at a crop at NC State called Canola it's a relative of grape seed and it produces a lot of oil per acre, two or three times more than soy but can be grown in conjunction with soy in place of wheat in a corn-soy-canola rotation. So if you replace all the wheat in NC with Canola you could offset another 4.3 percent of our diesel use then you start looking at some of these other sources, peanut, cotton, corn oil, lard from pig fat, poultry fat, used vegetable oil and of course tallow we don't have much of a beef industry here so that's a very small impact.

Because I am with the Animal Waste, Poultry Management Center at State I want to talk a little bit about the unique opportunity we have with hogs in the state. Many of you know we have roughly ten million hogs in the state concentrated in the eastern region and they present us with a unique issue with their waste and if you look at the opportunity they're taking both hog waste and poultry litter and generating electricity from them. These are my estimates of how much power you can generate from hog waste-poultry litter-dairy cow waste and also poultry layer waste using different technologies. In the case of hog waste that would be an animal digestion or bio-gas technology and in the case of poultry litter would be a combustion or gasification. The ideal part about utilizing hog waste in this way is it gives you a double benefit because methane is a very potent greenhouse gas. By covering lagoons or using some other technology to capture the methane generated you're eliminating that source of greenhouse gases and then you also get a double benefit because if you use it for generating electricity you are also displacing some fossil fuels.

I want to talk about some of the programs we are conducting at NC State and elsewhere to look at potential feedstocks for bio-fuels. We have right now and we just got a second year of funding from the Gold Leaf Foundation a grant to look at energy crops for NC. We focused on five crops, canola for bio-diesel production, switchgrass which could be

for ethanol production, it could be for coal firing, it could be for combustion and gasification those latter to generate electricity. We are also looking at hulless barley - this would be in a starch based ethanol plant. We are looking at Coastal Bermudagrass and that's of interest because that's the grass that is now grown on lagoon spray fields because of its tremendous nutrient uptake potential. But also since it's a low value hay you can certainly imagine the scenario where it could also be utilized as an energy crop and then our big resource, our woody biomass. Why are we focusing on these particular crops – well for the case of canola it could produce two or three times as much oil per acre as soybeans but it does not have to replace soybean production. You can follow canola with soybeans if the next winter is fallow and then the following spring is corn. You can work it into an existing rotation where it essentially just replaces wheat in that rotation. It has similar agricultural inputs to wheat but we are projecting from some work we do with our Ag and Resources Economics Department at NC State that you can actually get a better return for canola than for wheat.

Again hulless barley - we are looking at that it would also be the exact same scenario so you can't replace all the wheat with both hulless barley and canola you've got to pick and chose here. But the idea is the same it would replace wheat in that same corn-hulless barley-soy rotation. It uses a lot less energy to produce than wheat and therefore makes the energy balance I'm going to talk about much better for this crop than as compared to corn.

Switchgrass it once was a native grass to NC you can produce in a minimum five tons of biomass per acre which translates into about 400 gallons of ethanol per acre. What's especially attractive about switchgrass is it is a perennial so that it can help control soil erosion and can be managed in such a way even with biomass harvest to provide a habitat for wild life.

On behalf of the State Energy Office the NC Solar Center was asked to organize the NC Biomass Council and our mission is to promote economic development and reduction in greenhouse gas emissions and promote energy security through utilization of biomass in the state. We have a very good group - a mixture of industries - state government and university representatives and we are working on a road map for NC for biomass utilization and that includes biomass for both power production and biomass for bio-fuel production, we are feeding into the other groups that I eluded to earlier the Strategic Bio-fuels Initiative, feeding our recommendations into their recommendation process.

We have already done some of our work on the road map and have come up with some recommendations. These are recommendations from individual biomass council members they don't reflect an official list of biomass council recommendations. You can see a number I selected from a group of 24 that we're going to be reviewing at our next meeting but some of these are excellent suggestions for furthering the use of biomass in our state. There are a couple of really excellent federal programs that promote the use of renewable energy and I think it will be a real boom to NC to offer state matching funds to help promote and provide some funding for some of these up front cost related to these programs. One of those programs was created in the 2002 farm bill called the

Renewable Energy and Energy Efficiency Program. It's eligible to farmers and rural small businesses. Renewable energy projects are eligible for grants up to 25 percent of the cost of the projects, they can get another 25 percent in the form of a loan, it could go for a 50 percent loan too but the maximum federal funding is 50 percent. But what they don't pay for is some of the up front cost like feasibility studies so there are not too many farmers that are willing to risk the kind of money you would need to sink into a feasibility study in order to move forward with the project.

I want to talk a little bit about the legislative end incentive scenario in NC. There was a bill passed recently to help promote the production and distribution of bio-fuels in the state it allows for 25 percent tax credit for the capital cost associated with constructing a bio-fuel production facility. Also there is another 15 percent tax credit available for the distribution of the bio-fuels. In other words this would be for instance if you needed a separate tank for dispensing E85, you would be eligible for this tax credit. Also last year there was a special budget provision that was passed that seeks to require the state to utilize 20 percent of bio-fuels or reduction in fossil fuels of 20 percent. There is a plan being put together for this program and agencies need to report on this program to the State Energy Office. There are also a couple of good grant programs in the state to further the use of bio-fuels and other alternative fuels. The Solar Center is managing a project that received two million dollars from the NCDOT coupled with matching funds from the State Energy Office and the Division of Air Quality to fund the program to actually fund projects related to the reduction of fossil fuels and the emphasis is on emission reduction so it's only eligible for certain counties in the state. The incremental cost of alternative fuel vehicles, the incremental cost of refueling and construction, infrastructure and also for idle reduction technologies and diesel particulate traps, all of these technologies are eligible for reimbursement under the program. There is the mobile source emission reduction grants program that have gone on for a number of years that have funded a bunch of great projects to increase the use of alternative fuels.

I want to talk about the climate change impact of bio-fuels. The energy balance of a bio-fuel is to define as the amount of energy inherent in the fuels divided by the amount of energy required to produce the fuel and when I say the required energy to produce that fuel I'm talking about the fossil fuel energy necessary to produce that fuel. In this sense by this definition a high number is good so for instance in Brazil they get nine units of energy inherent in the fuel itself if you burn the fuel while only putting one unit of energy in as fossil fuel. The reason they can have such a high ratio is the fact that they are utilizing the residue of the sugar cane to generate steam to help drive some of the processes involved in producing ethanol. Those energy consuming activities in producing ethanol primarily the matching process and the distillation process are big energy consumers. If you can provide some sort of alternative fuel for those processes your energy ratio looks much better and you may have read about a project in Texas where they are actually going to be using methane from animal waste to utilize in an ethanol plant for producing ethanol. There is a lot of debate on these ratios among government scientists for corn ethanol that is about 1.2-1. Cellulose ethanol looks better because production of ethanol from cellulose as a by-product leaves over a product of this lignon by-product that can be burned and used to generate steam for the actual distillation

step in the process. So cellulosic ethanol looks attractive, soy bio-diesel has a good ratio because this is not primarily a thermal process. A lot of it has to do with mechanically squeezing the oil out of the soybeans. What people often forget is in order to get gasoline to your retail gas station you also have to put fossil fuels for the extraction and distribution of that gasoline to get it to your retail station. So the ratios for gasoline and diesel are actually less than one. This has a direct correlation to the greenhouse gas reduction. The higher this ratio the better the greenhouse gas reduction is for that bio-fuel. This is what this next slide demonstrates when you're using switchgrass or popular or looking at other cellulosic fuels because of that higher energy ratio you are getting a very high reduction in the emission of greenhouse gases from the utilization of those fuels. This all relates to the fact that switchgrass is getting its energy from the sun the only fossil fuel you have to put into it is for some of the processing. So it's utilizing CO_2 from the atmosphere when that burns of course that CO_2 goes right back to the atmosphere in a cycle.

Way soils also look attractive, sugarcane, sugar beet especially as the practice in Brazil look good, vegetable oils are very attractive. Starches not quite so good and again that has to do with the amount of coal or natural gas that has to be utilized to process the corn and the ethanol.

That is the end of my talk and I will be happy to entertain any questions that you have.

Mr. Garrou: Thank you Mr. Creamer. Questions?

Dr. Riggs: In your calculations you assume that we would convert all of our wheat production into canola and so forth, is it wise to think in terms of total conversion, don't we have a food production problem that we have to cut off or limit and is it not more realistic to think in terms of some fraction rather than the total production of those various products?

Mr. Creamer: Absolutely, I think for practical purposes you would definitely be looking at some fraction. My interest was as an engineer this is just my nature to start from the maximum and then back off from that. So I want to look at the absolute maximum potential that you would have and then move backwards from there.

Dr. Riggs: What in your opinion is the realistic figure? I realize it is different for each of those crops but are we looking at 50 percent or 25 percent?

Mr. Creamer: I think 50 percent from wheat would be very realistic now we have to have a very good year for wheat this year but that's an abnormally, wheat is off and some of the statistics on the NCDA website bears this out. It's often just used as a ground cover the revenues are so marginal from it in some cases its just plowed under. We think that canola has a real opportunity to be economically more attractive here than wheat – that's why out of all the energy crops we're looking at we're particularly interested in the canola because it seems to have the most attractive economic return in the short term which of course is what (inaudible) mission is to have impact in the short term.

Dr. Riggs: As a resource geologists I've been involved with fossil fuels most of my life and one of the questions that I've been dealing with for 40 years is the question with the ability to use organic products as a replacement and for decades it was always the question that it takes more energy to produce that than you get out the end plus the problem of feeding the world. Now we're the bread basket country of the world not just NC but the whole US system and in thinking in terms of the use of organic matter here it seems to me, and I would like your opinion on this, that we have to balance not just NC or US for food production but global food production particularly with growing populations and it is part of a bigger problem, I think my question and I would like your opinion on how we approach that?

Mr. Creamer: Well it is a question certainly beyond my capacity to answer especially in the short term. I guess my own feeling is I have a certain amount of trust that the market will shape some of that out. That as these prices for these commodities start to rise and we have seen that with corn, that you will start to see shift toward that crop and we will grow a lot more corn so I think there will be some adjustment by the market place to produce more of these crops and we have idle crop land in this country that can be utilized as well. I can't tell you how it will shake out but I think we have a lot of potential for adjustment in the crops grown without affecting food supply.

Representative Wilkins: Thank you Mr. Chair – a couple of things if I may. One is I would like to know what is included in your definition of forest residue?

Mr. Creamer: The primary components of forest residue are a harvest residue so these would be the parts of the tree that are currently left in the forest when you're harvesting timber or even pulp wood. So it tends to be upper portions of the tree - limbs, branches, etc. that cannot be economically used in the forest products industry. The second is the calling processes that occur in timber stands early on in the production of tree crops.

Representative Wilkins: Thank you Mr. Chair. Way over in the presentation under the grant programs I think you mentioned 24 counties, are they the counties that we know as non-attainment counties?

Mr. Creamer: Brock can probably answer this question better than me they are the ones that are eligible for congestion mitigation air quality grants. This is past through money from the federal government that targets certain counties that can get c-max funding, am I somewhat on target there?

Mr. Nicholson: That is correct.

Dr. Smith: How many crushing facilities are located in North Carolina now and how much of an issue is that?

Mr. Creamer: It's a big issue and as part of that grant, we obviously don't have any of the grant funding itself and the funding to site a crushing plant or even perform a

creditable feasibility study, so it's a huge issue and there are two very large crushing plants in NC. There is one in Raleigh and there is one in Fayetteville and they are both Cargill Plants, it's the kind of tonnage that is going to be a long time before we ever produce that much canola. So to get those folks interested in a canola crushing plant is going to be somewhat difficult. We have to find some sort of stepping stone to match a crushing plant with the size of canola acreage that we're likely to be able to grow in the next few years. So there is a third crushing plant, a much smaller plant, in Warsaw and we're trying to intrigue them into crushing canola and then selling the oil. This would be an expeller only not using the solvent base extraction process but expeller crushing technology to extract the oil and then sell it as a premium in restaurant applications. As you may know the canola oil has lower saturated fats than any oil. So there are some real health benefits associated with canola oil.

Dr. Smith: And I assume that a crushing facility that handles soybeans can or cannot handle ....

Mr. Creamer: Well it's an interesting question. It could with some modifications and probably some additional equipment. It certainly would be better than starting from scratch but you cannot just switch feed stocks it would not be that simple. And part of that is because with canola you have to mechanically expel the oil first. The seeds are so full of oil (40 percent oil) that you have to mechanically expel the oil first and then if you want to get the rest of the oil then you go to a solvent extraction. Whereas the large crushing plants in Raleigh and Fayetteville are both solvent extraction plants have no mechanical expelling ability.

Dr. Smith: Had there been studies that identify the potential added revenue to rural communities and to farmers, you have food and fiber obviously has been the focus but now that you bring energy crops in, I think we are all sensitive to the food impacts and I know that some of the livestock producers are sensitive to even the feed being impacted at some level. My understanding is that again significant land is discouraged from going into rotation there is a conservation easement land that can be used, particularly the thing like switchgrass because there is ecological benefits of having them. And then there is an active debate with the upcoming federal farm bill about trying to undercut some of the subsidies and the fact that in the international market there is ongoing competition about who can get federal subsidies. I am curious about whether your group or are you aware of any group that has done any of this sort of revenue generating to rural communities that is potentially here from bringing on a whole new market to bring on some of these crops for the energy sector and is there any analyses that gives any round figures for that?

Mr. Creamer: It is one of those things I am sure it is out there somewhere. I have not focused on it because our own project is much more limited in scope where we're looking at it specifically from the farmers' standpoint and from the next step in the chain, the processing standpoint or the fuel production plant. We don't really have the resources that you would need to do a full economic study. The things I see are sort of back of the envelope sort of calculations like the National Bio-diesel Board would put out or the Ethanol Vehicle Col. or the other ethanol groups would put out that say how many

employees there will be at an ethanol plant and how many extra jobs that will create in a community and those kind of studies. But I am certainly not an expert on objective detail studies on the specific rural development impacts.

Mr. Shore: Thank you for an excellent and very clear presentation. I feel smarter on this issue than I was half an hour ago. I have two requests and a question. The requests are is this something that maybe you've done to some extent or may as you do your additional analyses it could be incorporated. It would be helpful to know if doing the things that you suggested in the presentation with some reasonable scenario say 50 percent of the wheat converted to these other resources and so on, what would be the carbon reduction potential for NC, I am curious how those numbers add up to other things that NC might do? That's one request and the second one is given various potential values of carbon in the carbon marketplace using RGGIs' going price or what we might expect the going rate to be if federal caps were put in place what would be the potential revenue for the NC agricultural community from selling carbon credits? I would be interested to see that if you have any information on those and my question is as we think about the 2007 legislative session you have some draft recommendations that you shared with us could you share where you are in the process and do you think that your groups that you're involved with might have recommendations for consideration in 2007?

Mr. Creamer: Absolutely – I can certainly speak for the Biomass Council and since I sit on the Advisory Board I can at least let you know what the schedule is there. Now with the Bio-fuels Strategy Initiative their whole target is the 2007 legislative session so they are going to deliver their set of recommendations, like I said, we're trying to provide input for that session so they will have at least a draft if not a final document ready in January. Their first draft document is going to come out in December and then they will be moving on to a final draft in mid January. They want to have impact on the legislative session and our own NC Biomass Council we are doing the exact same thing it will be a little broader in that it will include bio-fuels and bio-power what we call generating electricity from biomass. We are also targeting the legislative session so we want to have our recommendations out there since some of them could be legislatively introduced.

Mr. Shore: If you would obviously share those draft recommendation with this Commission and any comments on those data request that I made, are those reasonable?

Mr. Creamer: Yes I think they are reasonable and I think that they could be something that we could... you know I don't know the full ramifications I don't want to promise, we do have an ag resource economist on board, I don't want to make any promises because I am not sure exactly how much effort I am asking for but it certainly is something that he could be looking at.

Dr. Eggers: Thank you also for coming. I know that Germany relies primarily on rape seed or canola if you will for their bio-diesel production and Germany is one of the leading or perhaps the leading country right now in micro-algae research and I was curious when I saw your name and what you were talking about, whether you would be

talking about micro-algae. So I have a request as well and that is that we get some information on production because I know that rape seed oil and I pulling this from memory and I'm just going to get the orders of magnitude right but rape seed oil is something like 147 gallons per acre per year in terms of production. Micro-algae and this is based on data that the Germans agree with and it's coming out of MIT and NERO in Colorado, it is 5,000 to 15,000 gallons a year so you're nodding your head as if you agree. So I would love to perhaps hear more about the potential for NC and I also deeply share Stan Riggs concern about food production issues. Micro-algae offers some really innovative opportunities for example, growing it in tanks where we are also growing Tilapias to increase protein resources or growing it above crops instead of using shade netting using micro-algae between insulating layers in greenhouse for example which there is research going on in the desert southwest on that in the US. So there is a great potential opportunity here and I would love to see more information about how we can use it.

Mr. Creamer: Unfortunately a lot of the work that was done on algae production for bio-diesels specifically was done at the National Renewable Energy Lab in the 1990's and then that program was just cut dead and the level of research that is going on today I think hails in comparison to that research effort. So all of us that are interested in this topic and our interest is exactly because of what you say because we feel like we're just messing around with these land base crops if you could truly produce 5,000 gallons of oil per acre with algae but it's really going to take some effort. I don't consider it real near term solution to some of our problems but I certainly think it is one that is worth looking into because of some of that potential that folks see out there. I think it is very attractive and I will continue to look at that. We have proposed projects and everything we do is dependent on getting funding from the government or other sources and we have actually proposed some projects. There is a researcher at Clemson who has worked out a whole algae production system and we want to tie it into energy production and unfortunately that work wasn't funded but we're still very interested in trying to find projects in that area. You can't ignore that kind of potential.

Representative Harrison: Thank you Mr. Chair and thank you for your presentation. I want to follow up on the energy money available from the farm bill. I am wondering are we losing any because we don't have a state program in place or matching funding in place like we are with the farm and preservation money from the federal government and has anybody been getting any access to that money and is it a finite source of money?

Mr. Creamer: It is a finite source – the program over the last few years have been funded at the national level for about 21 million dollars. Environmental defense and some other groups are advocating a major increase in that funding and the next farm bill something along like the order of $150 million dollars and I think that is actually been well received by some of the folks in Congress. So I think there is an opportunity here to greatly increase the federal funding which would make even more urgent the idea of having some state matching money and yes I do think we have lost some projects because we didn't have any way of getting farmers over this hump of preparing feasibility studies, looking at specific projects and one thing I think the university and perhaps some other

groups could provide is some objective analyses of some of the projects that are being proposed. Our most successful model for the program was where we had a vendor and this vendor supplied solar thermal systems and he took the initiative and contacted some dairy farmers because they have hot water needs, helped them with the applications and what we did we actually had a small pot of funds from the State Energy Office to independently verify that the system was actually going to work as proposed by the vendor. I think it gave great comfort to the dairy farmer to see that there was somebody doing an objective analyses of what he was proposing and enable them to go forward. It's a very difficult thing to find folk that are interested in renewable energy projects, there is no list out there. There is no easy way to contact people that might be interested in a renewable energy project. You almost have to wait for them to come to you. Did that answer the question?

Senator Albertson: This is a most interesting subject. I am sure some of you know that the last session we passed this legislation that has asked a group of people to come back and help us develop a strategic bio-fuel plan for our state, NC State, A&T and Rural Center, Biotechnology Center, I think all of you also know that we are a corn deficit state so I don't think we can plan on getting much of the north's production from corn in North Carolina but I do sincerely believe that switchgrass, our forest products and animal waste offers a great potential for us to produce a lot of energy and keep some of those 15 billion dollars that we send outside of the state that we use to purchase energy and keep it here in North Carolina at the same time create some jobs and we'll do some things to help the rural areas of our state. So I am really looking forward to that and your presentation this morning was great and I thank you for it.

Representative Hackney: I want to thank you for a good presentation as well and to note for your next version of slides that there is a bio-diesel tax credit also.

Mr. Creamer: At the state level?

Representative Hackney: Yes.

Dr. Smith: I have a procedural question. At what point is it possible that this group, if there is general consensus, might write a letter of support or encourage our federal delegation to look at some things that may .... what Representative Harrison said I think is exactly right that 9006 or this energy renewal money that the federal government is looking at expanding a number of folks are advocating for I think it has tremendous potential for North Carolina. North Carolina if I am correct has a higher percentage of elected representatives on the House Ag Committee than just about any other state and I think it may be very timely for there to be some general level of support saying that this is something that could significantly benefit the ag community in North Carolina as well as aid the work that we're struggling with here. So it might be something to contemplate and at some point maybe we can talk about whether there is a procedure or methodology that we can use to communicate because I think it is going to take interaction government all levels and that includes state and federal and this is something with the upcoming

farm bill reauthorization that is going to be moving very quickly over the coming months it might be very timely to think about.

Mr. Garrou: Good point good suggestion.

Mr. Urlaub: Thank you for your presentation. I noticed that the State Energy Office came up a lot in one way or another involved in a lot of these projects and you've highlighted a couple of gaps in funding or resources available to get us down this path of exploring bio-fuels adequately. Is more funding for the State Energy Office so that they can expand this support an appropriate solution or something that can help us get down this path further for bio-fuels?

Mr. Creamer: Yes I think absolutely that the State Energy Office is an excellent coordinating body for these efforts just because they have no vested interest and have a long history and very good staff. So I think it would be very beneficial and my understanding of their funding situation is that they are getting on programmatic funds the very funds that organizations like mine depend on to conduct these kind of programs.

Dr. Eggerson: That was an excellent presentation. I am curious about the slide where you look at potential power generation from animal waste and that adds up to 203 megawatts, I believe. Do you know off hand what the installed capacity is in North Carolina in terms of megawatts for electrical generators?

Mr. Creamer: Well it is sole capacity I think is about 21 gigawatts is roughly what the installed capacity is – someone in the room may know better than me. My understanding is that we are still somewhat below capacity so if you figure out the average annual rate it is something like 14 gigawatts or something like that, so the animal waste clearly isn't going to take us to a huge dent in that electricity generation. What I think is important about the animal waste is it's the whole idea of killing two birds with one stone because you're dealing with a significant environmental problem and you're getting a little generation out of it and you're also capturing the methane, so maybe it's a triple benefit.

Dr. Eggerson: It's more of a supplement than a replacement I wasn't trying to down play it but for years I've been very interested in biogas and aerobic digestive systems but I just wanted to get it in perspective.

Mr. Garrou: Thank you very much Mr. Creamer for your presentation it was very informative. Our final presentation comes from one of our members, Tim Toben and he is going to talk to us about two reports that he will describe.

Mr. Toben: Good afternoon. I have been asked by Mr. Givens and the chairs to report on two studies that came out between the last Commission meeting and today's meeting. There is a lot of material that's published daily about climate change and its impacts and sometimes it is difficult to sort through all of that. These two reports are significant, one is an international report that was produced out of Great Britain it was altered by Sir

Nicholas Stern who is Head of Government Economic Services and I think he is a former Chief Economist with the World Bank. The second report is a Rand Cooperation Report on the impact in the energy price mix if the United States went to a 25 percent renewable mix by the year 2025. So my role here today is to just give you some highlights of these two studies and I believe you will get a summary of these and what I am going to do is list some of the major points from these studies. This Stern review again Sir Nicholas Stern was widely reported in the rural media about three weeks ago, it was described as the first major contribution to the global warming debate by an economist, I think there have been many, but this one dealt with the full global impact of climate change. It also used a slightly different analytic and modeling technique, techniques which were sort of a hybrid between biological modeling techniques and economic modeling techniques similar to those that are used by insurance companies and re-insurance companies and in fact some of the probabilities that were generated from these are consistent with the probabilities defining risk for all sorts of loss calculations for the insurers.

The primary data input for the Stern review came from the Hadley Center in the UK, the Energy Forum, the US Climate Change Science Program and the Inter-government Medal Panel on Climate Change third assessment. The fourth assessment has not been released yet as I understand it so they were using the third assessment data. The model described in the report and it's available online if you would like to download a copy of the report. The full report is 700 pages, there are two good summaries, one that is an executive summary and one that is about a 25 page highlight but the model is described in detail in the appendix of this report. So if you have specific questions about that I would refer you there. The forecast that we have provided would have been more conservative of the range, damage estimates due to global warming were actually much higher when you added in the amplifying feedback, for example the perma-frost melting in the Artic region. If you added those in and the consequence release of giga tons of methane from perma-frost then the numbers were much higher. So while they may seem to be very high as we go through this, the range was actually quite a bit higher. CO_2 in this study is expressed as CO_2 equivalent to encompass the total warming effect of all of the greenhouse gases in Keota on carbon, methane, etc. By this definition the current level of greenhouse gases is 430 parts per million today versus the pre-industrial level of 280 parts per million.

The broad conclusions again are pretty dramatic but optimistic in some respect. There is still time to avoid (these are quotes from Stern) the worst impacts of climate change if we act now and act internationally. The overall conclusion was that for every $1 invested we can save at least $5 in damage cost. Governments, business and individuals need to work together to respond to the challenge. A very clear emphasis on policy at the state and national government levels worldwide essential to achieve stabilization, they have stabilization targets that we look at, the task would deem to be urgent. Delaying action will take us into dangerous territory, the benefit of strong early action far out weigh the cost of non-acting. The business as usual cost for climate change were redeemed to be high, the overview of the literature suggest that the basic elements of modern life for people around the world would be compromised, access to water, food production, human health and melting glaciers could cause water shortages of 4, 1 and 6 of the

world's populations. Crop yields would decline particularly in Africa they showed some peaks in areas like Scandinavia for several years but then a decline after that but generally crop yields would decline. More extreme weather patterns would result in severe floods and drought. Hundreds of millions of people would suffer hunger, water shortages and coastal flooding and it was concluded that all countries would be affected with the poorest countries earliest and obviously there are some countries already being affected particularly near Africa. The estimate was that the impact after 2035 would potentially be two hundred million climate refugees moving out of those drought and flood stricken areas. Without action, overall cost is equivalent to loosing five percent of global GDP. This was not including the carbon sink breakdown which could result in a cost rise of 20 percent of global GDP each year after 2035. The mitigation costs were found to be far lower. The cost of lowering GHG emissions to reduce the worst of these impacts was estimated to be limited to one percent of global GDP. The current global GDP is roughly 35 trillion dollars so the implication would be about $350 billion dollars in cost annually and I think interestingly to Senator Albertson's point, there are going to be winners and losers in this whole investment strategy. Those states and countries that get into the investment and deployment mode earliest obviously are going to be the beneficiary; these are not going to be gains that are going to be distributed sort of randomly across the globe. So I think that's where the opportunities for North Carolina to editorialize a little bit may be of interest.

Policy and investment over the next ten to 20 years will have a profound impact on the climate in the second half of the century and obviously on economies of the world thereafter. Again prompt and strong action was recommended and to put this in perspective, a five percent decline in global GDP would be equivalent to the combination of the impacts of the great depression and the world wars of the last century.

The report concludes with what they consider to be a pro-growth strategy, lack of action to reduce emissions would result in double the concentrations in GHG by 2035 versus the pre-industrial level. They have found that a cost to each ton of carbon equivalent to $85, the estimate without action is a temperature rise two degrees centigrade or roughly three and one-half degrees Fahrenheit by 2035. Most des-concerning was that there was a fifty percent change based on these models of temperature rise of five degrees centigrade under a business as usual case, which is equivalent to an average temperature from the light last ice age until today. Emergency training scheme strategies have demonstrated numerous opportunities to cut emissions for less than $25 per ton because we saw from the data in the first presentation today and then again the benefits of actions to shift the world into a low carbon path could be in the order of 2.5 trillion dollars. So 350 billion dollars invested, 2.5 billion dollars, again these are big numbers, gross numbers, but numbers that clearly give us some direction.

Cap and anthropogenic climate change is pro-good strategy ignoring it would undermine economic roads. One percent cost of GDP is not something that is going to dramatically disrupt our economy. Five percent decline in GDP which would be accumulative over time would indeed have a major impact. To stabilize the energy levels emissions we need to stabilize the next 20 years and fall between one percent and three percent

thereafter. There are three critical policy elements that seem to be coming up consistently that were emphasized in this report. Certainly carbon pricing was a key one, taxation, emissions trading or regulations so that people are faced with the full cost of carbon impacts. The goal is a common global carbon price across countries and sectors obviously that will take years. Technology policy to drive the development and large scale deployment of low carbon and high efficiency products, promotion of energy efficiency, removal of barriers to energy efficiency and information to education for state industry and individuals about what they can do to respond to climate. There are chapters on each of these policy initiatives and I would direct you to those but some of the highlights are as far as emissions trading goes. There was an interesting developing link between the emissions trading schemes like California and RGGI have done around the world, the conclusion with the strong markets and wealthy to drive low carbon development.

As far as technology cooperation – informal and formal trade agreements would be used to detect effectiveness of investment and innovation globally, support of R&D should double. They looked at total R&D on energy globally and concluded that those investments should double and deployment of low carbon technology should increase five fold. International cooperation of product standard would also aid in energy efficiency deployment. Two other areas of focus were actions to reduce de-forestations, loss of natural forest, forest contribute more to global emission than the entire transportation sector. Curbing de-forestation is a highly cost effective way to reduce emissions, again a carbon sink strategy.

Adaptation – the poorest countries are the most vulnerable to climate change. Climate change has to be fully integrated to development policies so that they are set aside for adapting to the changes that are ahead. International funding should support regional information on climate change impact and also for a new crop variety that are resilient to drought and flood. There are some recent policy successes in the country that are not signatory to the Keota protocols. China's eleventh five year plan contains a very ambitious goal to reduce energy intensity of their industrial outputs by 20 percent from this year to 2011. USDA investment in R&D clearly has been significant but the real focus in the US and the accommodation there was states are taking the lead through policy initiatives like RGGI and the California initiatives and deployment of renewable energy and through the use of emissions trading. In India there is increased emphasis on renewable energy and energy efficiency, so even in those countries that have not been signatory to Keota there has been progress.

The conclusion that was reported in the media from Prime Minister Tony Blair was that the Stern review showed that the scientific evidence of global warming was overwhelming and its consequences if we fail to act were literally disastrous. But the disaster also is not set to happen in some science fiction future many years ahead but in our lifetime.

The second report was from the Rand Corporation, their Environment Energy and Economic Program. Basically what they did was they set a target of 25 percent

renewable in the energy mix by the year 2025 and then they did 1500 mathematical analyses varying the cost of each of the different fossil fuels of the non-renewables and each of the renewables. And rather than sort of prescribe an outcome they let the model basically settle around this range. I'm going to read you something here that sort of summarizes where we are in the country today. In March of 2006 in his address at the Brushing Institution Senator Richard Luber, Republican of Indiana summed up the history in political dynamics of renewable energy in the US by observing that for decades the energy debate has pitted so called pro oil realists against idealist and advocates of alternative energy. The battle between the idealist and the realist has been waged largely on the grounds of cost and competitiveness and they are battled that the idealist have tepidly lost. As Luber noted the realist have prevailed by pointing out that renewable energy makes up a tiny share of energy consumed and that the dependence on oil is a choice of the market place. The reining consensus among policy makers and the public is that renewable energy is appealing but unaffordable. Is this really so? Despite this consensus or perhaps because of it, there has been relative little systematic analyses of the possible impact on total energy expenditures of expanding the issue of renewable energy reinforces like solar, wind, geothermal and biomass. A series of national and international developments has forced a reappraisal of fossil fuels and some of those developments are here under market conditions. The rising oil and natural gas prices the war in Iraq and the threat of global warming has stimulated a new look at the economics of fossil fuels and renewable energy. For example, in the last 20 years renewable technology prices have declined 57 percent and for wind energy from 40 cents per kilowatt hour to 46 cents per kilowatt hour which compares to four to five and one-half cents per kilowatt hour for a new coal generation.

In his 2006 Kennedy Union address, President Bush set a goal of replacing 75 percent of oil imports from the Middle East by 2025. Now we saw this morning from Kurt's presentation how difficult that would be to do from strictly bio-fuels but I think you see how the conditions have changed over the last two decades. The methodology for this study again was to use the energy demand and supply rejections from the US Energy Information Administration. They ran 1500 analyses, they varied future cost and rates of technology change for fossil fuels and renewable energy. Analyses illustrated the range of uncertainties around future energy cost and these were missing from some of the best guesses from previous models from EIA. They didn't presuppose any most likely scenario. Their conclusion was that renewable energy at this 25 percent level actually lowered total energy expenditures in virtually all cases in which current energy price and cost trends continue. The conclusion was renewable energy can produce 25 percent of US electric power in ten percent of motor vehicle fuels by 2025 at no additional cost to this economy so long as renewable technology can continue to improve at least 20 percent over that 20 year timeframe. The National Renewable Energy Lab predicts that it will decline by 45 percent, remember that it declined 57 percent over the last 20 years and NREL predicts 45 percent decline over the next 20 years, so the baseline here is that technology would have to improve in terms of costs improvement by 20 percent over the next 20 years. And secondly, oil prices would not exceed the EIA projections of $54 per barrel by 2025, so their projection out to that end point is that oil will be trading roughly in that $54 per barrel range. If renewable technology improves relative to fossil fuel

technology by 50 percent so if we exceed that, that 45 percent expectation will come close to that NRL prediction, the net energy savings could be about 30 billion dollars annually. And they concluded that meeting the interim goals at lower costs on the way to 2525 that is ten percent by 2015, 20 percent by 2020 is feasible since less expansion of the renewable resource is required. We currently have some renewable resources - the cheapest renewable resources are going to be the ones that are exploited first. The best win resource, the best solar site and then they will decline in terms of their choice after that.

There is also some significant national security in climate change implications, Rand found that 2525 would cut petroleum consumption by 2.5 million barrels a day by 2025 and that's about ten percent of projected US consumption in 2025. It would also eliminate one giga ton of CO_2 emissions which is about one-seventh of our projected CO_2 emissions every year at little or no additional cost. This would result in obviously a 50 percent reduction in US contributions to global warming and two-thirds reduction of our projected growth in emissions. So effectively we would achieve a 2004 emissions rate by 2025 with this deployment. There is still enormous renewable challenges as there are with fossil fuels as well, their intermittency issues with wind and with solar, there are transmission issues most of these projects are cited in rural areas, there are interconnection issues, there are supply issues and there are environmental concerns related to these large projects. Again the benefits are significant, reduction in greenhouse gases, the jobs and the economic growth in some of the rural communities, reduction in local air pollution, there was also a kind of interesting phenomenon which was downward pressure that was placed on fossil fuel prices. This more diverse energy portfolio could actually be a hedge against price (inaudible) particularly for natural gas. In Texas they have already seen some benefits from that.

The last slide here - 2025 alternative energy reference case – their best case scenario was when they looked at all the outputs. Wind would comprise 50 percent of renewables capacity which would be 14 percent of total electricity capacity in 2025. Twenty-five percent biomass would contribute to auto fuel and would recommend it be co-fired with coal. Twenty percent solar PV and five percent hydro-electric again these are the percentages of the 25 percent renewable mix. There would be increased reliance on alternative energy which would lead to these lower prices for fossil fuels, it was predicted oil prices were four percent lower, natural gas prices were six percent lower and coal prices were 16 percent lower again as a function of demand. Electricity prices under all scenarios would be higher in 2025 the estimate was that electricity prices for the consumer would be roughly 16 percent higher in 2025. These are the conclusions of the study and again I'm basically doing a review at this point and I'll try to answer questions but would refer you to the studies which are available on line.

Mr. Garrou: Thanks Tim I have a question. Just on this last slide – if fuel prices are lower and renewables are economically neutral, why do electricity prices go up 16 percent?

Mr. Toben: I think these are fossil fuels and I know that nuclear was not taken into account but was considered in the mix so it could be that.

Dr. Eggers: At the beginning when you were talking about the Stern report you were saying that $1 invested basically will offset $5 in damage, over what time period is that?

Mr. Toben: All of these forecast were based on the down turns occurring sort of post 2035 so the five percent disruption in the economy or the five percent loss in global GDP was five percent per year and it was forecasted out basically based on that model. The one percent cost was basically a cost to avoid the five percent decline.

Dr. Eggers: I think a question some people might have is well if we spend that one percent now are we going to actually save anything in the short term?

Mr. Toben: The other metric fear that the one percent investment which was at this point 350 billion dollars per year could yield up to 2.5 trillion dollars in return. So there was that ratio. The estimate that we would have to stabilize the price per million of carbon equivalent over the next 20 years and drop by one to three percent in the out years there after in order to realize the gains beyond that.

Representative Harrison: Thank Mr. Chair and thank you Tim for the presentation. If you could clarify for me, I don't really understand the (inaudible) as well as co-firing the biomass with coal. This burning the biomass releases carbon emissions - could you just clarify what that means exactly.

Mr. Toben: Yes there was a little bit of a mention of that today. Basically the idea that the coal is a non-renewable resource so when you release the carbon into the atmosphere from coal there is nothing to uptake that carbon on the back end when you're using biomass which is a renewable resource when you're cutting timber and using that in coal plants basically through co-firing you are also replacing that resource with new forest crops that uptake that same amount of carbon. So there is a net zero carbon impact for biomass relative to coal. So you would use this facility .... have I categorized that right?

Mr. Shore: Are you familiar with some of the proposals that have been floated in North Carolina for renewable portfolio standard in terms of what percentage we could get from renewables cost effectively in our state and how those relate to the numbers that you showed in these presentations?

Mr. Toben: I've been in meetings where some of those issues have been discussed and it looks to me like the goals that are being talked about are consistent with the outcomes that are looking at no net energy cost related to a national program. So ten percent by 2015, 20 percent by 2020 and 25 percent by 2025 I think were the numbers that were reported here. It will be very interesting to see the results from the Utilities Commission's RPS study to see if their findings are consistent with these Rand Corporation findings about cost impacts of renewables as a portion of the energy portfolio in the state.

Mr. Givens: Let me say with regard to the Utilities Commission study – that study will be released on 13th of December when the ERC meets. I call the attention of all of you particularly of the non-legislator members who may be interested. The ERC will meet beginning at 9:30 in Room 544 and that report will be on the agenda and what they plan to do is issue a draft report and then take comment. They are not going to change the report based on the comment but they are going to add the comment to the end of the report as they publish the final version which will be available in January. The original projection was 1 December and that's been moved to the ERC meeting on 13 December.

Mr. Garrou: Thank you very much Tim that was a good presentation well summarized. We are now at the point in our agenda where we open the floor for discussion and any announcements here. Do you have any before we go forward George?

Mr. Givens: Reminded committee of next meeting on December 11, 2006 in this room.

Mr. Erickson: I would like to call the Commission's attention to the lead story in this morning's Wall Street Journal – Power Surge After Decades of Solar Pioneer See Spark in Sales it's a thoroughly detailed story there are not a lot of numbers in it but I am sure there are numbers behind it somewhere. It's very interesting with regard to commercially viable solar power.

Mr. Garrou: Dr. Smith would you be willing to give us an e-mail with suggestions about how we might communicate with the congressional committees you suggested earlier?

Dr. Smith: Yes I would be happy to do that we've given some thought to that and we would be happy to share that information.

Mr. Shore: We are meeting in mid December and then have a meeting scheduled for January, we have the requirement to have an interim report in January, I think and then presumably we will break for the long session. Just how do we see things unfolding over the next couple of months?

Mr. Givens: That's a matter under discussion among us up here as to what we're going to do about that. We are very conscientious about that.

Mr. Garrou: We will have the report that we are required to have we just haven't decided how we are going to get it done.

Representative Hackney: I would like for us to have a good report for the January session and to that end I want to encourage everybody and I think they have been doing this anyway, but I just want to add an encouragement to it. There is so much opportunity for, George calls it low hanging fruit, and some people call it win-wins and sometimes there are triple wins and so forth, there is a lot of opportunity for doing good things which are both efficient and smart and also contribute to the direction of this Commission. So I

want to encourage everybody to send in those ideas and suggestions, there are a lot of opportunities in forestry, lot of opportunities for the utilities, particularly with efficiencies so I hope that we will have some of that from CAPAG and we will have the biomass recommendations coming. We have a lot of recommendations to sort of field and look at I think and I am excited about the prospect for a good report for the session and we'll have some time I'm confident at the end of January to put all of these on the table and let the Commission chew on them and come up with the best ones to recommend.

Dr. Smith: I assume this is a given but maybe I didn't catch it but given that the RPS study has been delayed to a couple days past our next meeting are we requesting that there be a briefing for that or has it been a request to brief on in the January meeting on that particular .....

Mr. Givens: I've talked to staff at the Utilities Commission about that it's a timing question both as to when they are going to receive this comment that they're asking for and put that together and then what they are budgeted for in terms of access to their consultants. Their initial obligation is to report to ERC and they will do that and then I'm going to see what they can do about briefing us. I have to save some room in that budget for briefing of legislative committees once the session starts.

Meeting adjourned at 1:15 p.m.

_____
Mr. John Garrou
Presiding Co-Chair

_____
Representative Joe Hackney
Co-Chair

_____
Thelma T. Utley, Committee Clerk

LIST OF EXHIBITS

EXHIBIT A	**Meeting Notice**
EXHIBIT B	**Meeting Agenda**
EXHIBIT C	**Visitor's Registration**
EXHIBIT D	**Letter from Ed Erickson to NC Legislative Study Commission on Global Climate Change**
EXHIBIT E	**The Energy Future: A Perspective – Dr. Edward W. Erickson**
EXHIBIT F	**Report on Climate Action Plan Advisory Group (CAPAG) Activities – Brock M. Nicholson**
EXHIBIT G	**RGGI – Regional Greenhouse Gas Initiative: States Stepping Up to Address Climate Change – Franz Litz**
EXHIBIT H	**Biofuels in North Carolina – Kurt Creamer**
EXHIBIT I	**25 Percent Renewables by 2025 is Achievable and Affordable – Tim Toben**
EXHIBIT J	**Stern Review: The Economics of Climate Change**

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER R. F. MUNDT
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

General Assembly of North Carolina

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

State Legislative Building
Raleigh, North Carolina

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

8 November 2006

TO: Members of the Legislative Commission on Global Climate Change
Interested Parties

FROM: George F. Givens, Commission Counsel

RE: **Notice of Meetings**

COMMISSION MEETINGS:

The Legislative Commission on Global Climate Change will meet at 10:00 a.m. on the following dates in Room 643 of the Legislative Office Building:

Monday 27 November 2006
Monday 11 December 2006
Friday 12 January 2007

The purpose of these meetings is to continue the work of the Commission in the performance of its powers and duties as set out in Section 5 of S.L. 2005-442.

OTHER 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

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

JENNIFER R.F. MUNDT
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

AGENDA

10:00 a.m. Monday 27 November
Room 643 Legislative Office Building

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

2. Introductory remarks by Cochairs
   John. L. W. Garrou
   Representative Joe Hackney

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

4. Update on activities of the Climate Action Plan Advisory Group (CAPAG) 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
   Brock M. Nicholson, Deputy Director
   Division of Air Quality, Department of Environment and Natural Resources

5. Discussion of the Northeast Regional Greenhouse Gas Initiative (RGGI)
   Franz T. Litz, Climate Change Policy Coordinator
   New York State Department of Environmental Conservation

6. Discussion of the options for production and use of biofuels in North Carolina
   Kurt S. Creamer, P.E., Biomass Program Manager
   North Carolina Solar Center and Animal and Poultry Waste Management Center,
   North Carolina State University

7. Overview of recent reports on the economic impacts of climate change
   Stern Review Report on the Economics of Climate Change
   Her Majesty's Treasury, United Kingdom

   Impacts on U.S. Energy Expenditures of Increasing Renewable Energy Use
   RAND Corporation
   Tim Toben, Member
   Legislative Commission on Global Climate Change and
   Chief Executive Officer of Carolina Green Energy Corporation

8. Commission discussion and announcements

9. Adjourn

SCHEDULE OF FUTURE MEETINGS:

Below is the schedule of meetings of the Legislative Commission on Global Climate Change prior to the convening of the 2007 Regular Session.

Commission Meeting	Location
10:00 a.m. Monday 11 December 2006	643 Legislative Office Building
10:00 a.m. Friday 12 January 2007	643 Legislative Office Building

COMMISSION WEBSITE:

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

http://www.ncleg.net/committees/legislativecomm_/default.htm.

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.

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — November 27, 2006

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Patrick Buffkin	ALLEY ASSOCIATES, INC.
Sara Nienow	NC Dept. of Commerce
Sharon Strand	State Energy Office
Page Blackwelder	Hunton & Williams
Thomas Lam	Public Staff - Utilities Comm.
James McLawhorn	" "
Jack Floyd	" "
John McKay	Gov Office
Alice Loyd	NC Council of Churches/Interfaith Power & Light
Janice Godfrey	NCDENR
Kim Garnett	NC-DAD

Exhibit B

Exhibit C

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — November 27, 2006

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Charles Davis	Division of Air Quality NCDENR
Heather Hawkins	Division of Air Quality
Jim Southerland	" " " "
Deatrice Williams	CUCA
Amy MacDonald	SACE / Env. Defense
Christa Wagner	NC Sierra Club
Molly Diggins	Sierra Club
Mary Moon	BBA
R. Paul Wilms	NCHBA
Elizabeth Oates	Environment North Carolina

North Carolina State University is a land-grant university and a constituent institution of The University of North Carolina

College of Management

NC STATE UNIVERSITY

Department of Economics
Campus Box 8110
Raleigh, NC 27695-8110

919.515.3274 (phone)
919.515.7873 (fax)

TO: NC Legislative Study Commission on Global Climate Change
FROM: Ed Erickson
DATE: November 22, 2006 EWE
SUBJECT: The Energy Future: A Perspective

"The Energy Future: A Perspective" is a contribution to a book that my colleague, Mike Walden, is doing for Praeger. The book will be coming out in 2007. The contributions to the book are intended for general readers and written in nontechnical language. Praeger wants each chapter to be about 5,000 words, so my ability to expand upon some of the ideas in this essay was limited. Pages 21-25 of the attached contain three sidebars that the publisher will locate alongside the text. In this manuscript version of the essay, I have simply attached the sidebars serially at the end of the text.

The principal themes of the essay are that f nergy supplies are the overwhelmingly predominate workhorse of the v onomy. This has been true for centuries and is well illustrated by our quarter century. For both total world energy consumption and U il fuels supplied over 70% of increased use of energy from ower supplied most of the rest of the increas urces of energy (hydro, geothermal, solar, wi worldwide and less than 3% for th

The predominance of that there are not cost-effec usage. This is particularly tru tor.

The corollary of this observa on fossil fuels usage, or aggressive mandated ado will impose severe economic costs and efficiency losses nd general economies, of the U.S. and the world.

I hope that this perspective will be relevant an ie NC Legislative Study Commission on Global Climate Change as we go t with our deliberations.

The Energy Future: A Perspective

Dr. Edward W. Erickson
Professor of Economics Emeritus
NC State University

Introduction

This is a "good news; bad news" essay. Since the 19th century, there has been regular and periodic concern that fossil fuel supplies will be inadequate to support and maintain the world's energy dependent economy and society. In England, a classic example of this concern was William Stanley Jevons' The Coal Question published in 1865.

In the 20th century, the most prominent advocate of impending trouble was the well-respected geologist and geophysicist, M. King Hubbert, who predicted in 1956 that U.S. crude oil production would peak between 1965 and 1970. U.S. crude oil production did in fact peak in 1971. Hubbert further predicted in 1974 that global crude oil production would peak in 1995. World oil production has not yet peaked.

In the 21st century, there continues widespread concern and support for Hubbert's perception and contention that the fossil fuel era would be of very short duration. Although Hubbert considered all fossil fuels, his major focus was oil. Hubbert's Malthusian theme underlies Matthew Simmon's Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy and Kenneth Deffeyes' Beyond Oil: The View from Hubbert's Peak. Simmons argues that Saudi Arabian oil production may have already peaked and now be in decline. Saudi Arabia is the largest supplier of

crude oil exports to the world market. Deffeyes argues that total world oil production, if it has not already peaked, will peak in a few years.

The first "good news" is that this essay argues that world oil production has not yet peaked and may continue at current, or higher, levels for the foreseeable future - - decades or more. The second "good news" is that even if Hubbert, Simmons, Deffeyes and others are correct, there are apt to be cost effective fossil fuel substitutes for oil that allow continued economic growth and improvement in living standards for the population of the world. There is no question that the fossil fuel content of the geology of the earth is finite. But that physical constraint may not be so binding as many appear to believe.

What is the bad news? The "bad news" is that just as the world is now predominantly a fossil fuel economy, the world is likely to continue to be a predominantly fossil fuel economy for at least the balance of the 21st century.

Use of fossil fuels emits green house gases. The 1997 Kyoto Protocol amended the international treaty on climate change to assign mandatory targets for the reduction of green house gas emissions. If there are adequate fossil fuel resources to maintain or increase our global fossil fuel consumption, then there will be inexorable tension between maintaining and improving our energy dependent standard of living for the growing population of the world on the one hand, and curbing green house gas emissions on the other.

"Inexorable tension" is a polite way of saying a political catfight. And this is an international political catfight that may take decades to resolve.

The Centrality of Oil

The primary energy used by the world economy comes in a variety forms: petroleum (crude oil), natural gas, coal, hydro, geothermal, solar, wind, biomass and nuclear. Electricity is a derived form of energy that can be generated by any of the primary energy sources. Many energy sources have multiple uses. For example, wind can power turbines to generate electricity or propel sailing ships. Solar can generate electricity photovoltaically or directly provide space heating. Natural gas can be used for space heating and cooling or to generate electricity. Coal can be used for transportation (locomotives and steamships), space heating or electricity generation. The variety of energy sources compete with each other in the energy market which determines which source is the most cost effective and technically efficient alternative for each specific use.

There is, however, only one energy source that broadly competes with all other energy sources in all uses. This is petroleum. This use competitive centrality of petroleum, in addition to petroleum's predominance as the largest single source of energy for the world economy, is why so much attention is focused on world crude oil supplies. Because of petroleum's worldwide competitive interconnectedness to the markets for all other sources of energy, when the world oil market sneezes, each of the markets for other types of energy at least sniffles.

The Flow of Oil

The standard way that energy economists think about the amount of oil produced and consumed is in barrels per day. There is a good reason for this. Oil is always on

the move. It flows in drill pipes from underground geological formations to the surface of the earth. There it is temporarily deposited in lease tanks before beginning another journey by pipeline to a refinery. A refinery is a vast network of pipes, pressure vessels and storage tanks through which oil flows as it is converted from crude oil to refined products such as gasoline, jet fuel, and heating oil.

Refined products leave the refinery and move to market through pipelines. Sometimes crude oil and refined products also move great distances around the world by ocean tanker. Since time is money, there are large economic incentives to minimize the amount of time oil temporarily spends in storage tanks along its route from geological formation to refined product customer.

The United States uses about 20 million barrels of oil a day. How much is that? An oil barrel is 42 gallons, so 20 million barrels a day equals 840 million gallons per day. Well, in terms that are intuitively understandable, how much is that?

Visualize a reddish orange and yellow one gallon size gas can used to fill a lawn mower. Start at the Miami City limits and line up 42 of these one gallon cans across the northbound lane of the interstate highway from Miami to Chicago. Repeat that line-up of cans across the interstate all the way to Chicago until the northbound lane is full of gas cans. That is 840 million gallons of oil.

Now, today, blink your eyes and all the oil cans disappear - - i.e., the oil is consumed. Now, tomorrow, blink your eyes again and all 840 million oil cans - - full of oil - - reappear. The vast production network of wells, pipelines, tankers and refineries replaces yesterday's consumption with today's new production.

This is a logistic miracle. It happens everyday, day-in and day-out, 365 days a year. It happens not only in the United States, but all over the world. And world production and consumption is 85 million barrels of oil a day.

The planning and implementation imperatives that this daily feat of logistics imposes upon the oil industry is the practical reason why industry operators commonly measure production and consumption in millions of barrels a day. Oil, of course, is not the only source of energy. So it is useful to have a measure of energy that allows comparison across the various types of energy. That measure is the British thermal unit, or Btu. Production and consumption statistics are also kept on an annual basis. But beneath the annual numbers, energy is moving in a ceaseless hourly and daily flow.

The Patterns of Energy Consumption

The world used 444.3 quadrillion Btus of energy in 2004. A Btu, or British thermal unit, is the heat equal to 1/180 of the heat required to raise the temperature of one pound of water from a temperature of 32 F to 212 F at a constant pressure of one atmosphere. An atmosphere is the air pressure at sea level. A quadrillion is a million billion or 10^{15}. This is a tremendous amount of energy. A shorthand expression for a quadrillion Btus is a "quad".

On a worldwide basis, Table 1 shows the types and amounts of each type of energy consumed in 1980 and 2004 and the increases in energy consumption over the 1980-2004 interval. Table 2 shows the relative percentage shares of each type of energy for 1980 and 2004 and the 1980-2004 increase.

In each year, petroleum was the largest single source of energy (Table 1). Petroleum accounted for 46.6% of total world energy consumption in 1980 and 38.7% in 2004 (Table 2). Petroleum, however, was not the largest increment to world energy supplies over the 1980-2004 interval. Although petroleum supplied 22.4% of the 163.1 quad increase of 2004 consumption relative to 1980 consumption, natural gas (30.3%) and coal (27.2%) supplied larger shares of the increment in production (Table 2).

In 1980, as shown in Table 2, the three fossil fuels (petroleum, natural gas and coal) supplied 90.8% of all worldwide energy consumption. In 2004, the share of fossil fuels in total consumption was 86.7%. Fossil fuels accounted for 79.8% of the 58.0% increase in world energy consumption between 1980 and 2004.

On a worldwide basis, as shown in Table 2, renewable sources of energy (hydro, geothermal, wind, solar and biomass) accounted for 6.5% of total energy consumption in 1980 and 7.1% in 2004. Renewables accounted for 8.0% of the increase in world energy consumption between 1980 and 2004.

Renewables, however, had strong growth over the 1980-2004 interval. (See Table 1.) The relative contribution to total world energy consumption made by the combination of geothermal, solar, wind and biomass increased by 680%, from 0.5 quads to 3.9 quads. Hydro grew 53.6%, from 17.9 quads to 27.5 quads. Overall, total renewable production and consumption grew by 70.7%, from 18.4 quads to 31.4 quads. This compares to 51.0% growth for total fossil fuels, from 255.2 quads to 385.4 quads.

Table 1

World Consumption of Energy by Type of Energy, 1980 and 2004

Type of Energy	Quadrillion Btu Consumed 1980	2004	Increase	Percent Increase (%)
Petroleum	131.0	167.5	36.5	27.9
Natural Gas	54.0	103.4	49.4	91.5
Coal	70.2	114.5	44.3	63.1
Total Fossil	**255.2**	**385.4**	**130.2**	**51.0**
Hydro	17.9	27.5	9.6	53.6
Geothermal, solar, wind, and biomass	0.5	3.9	3.4	680.0
Total Renewable	**18.4**	**31.4**	**13.0**	**70.7**
Nuclear	7.6	27.5	19.9	361.8
World Total	**281.2**	**444.3**	**163.1**	**58.0**

Detail may not add to totals because of rounding.

Source: U.S. Energy Information Administration, Monthly Energy Review, August, 2006, Table 1.3

Table 2

Relative Contributions of Various Types of Energy to Total World Energy Consumption, 1980, 2004 and 1980-2004 Increase

Type of Energy	Percent Contribution to Total World Consumption		
	1980	2004	1980-2004 Increase
		(%)	
Petroleum	46.6	38.7	22.4
Natural Gas	19.2	23.3	30.3
Coal	25.0	25.8	27.2
Total Fossil	**90.8**	**86.7**	**79.8**
Hydro	6.4	6.2	5.9
Geothermal, solar, wind and biomass	0.2	1.0	2.1
Total Renewable	**6.5**	**7.1**	**8.0**
Nuclear	2.7	6.2	12.2
World Total	**100.0**	**100.0**	**100.0**

Detail may not add to totals because of rounding.

Source: Table 1

Nuclear power increased by 361.8% between 1980 and 2004, from 7.6 quads to 27.5 quads. Over the quarter century spanning 1980 through 2004, the fastest growing sources of world energy consumption were nonhydro renewables and nuclear. Nevertheless, fossil fuels accounted for nearly 80% of the total growth in energy consumption over that same period.

Tables 3 and 4 mirror Tables 1 and 2, but the focus is the United States. Between 1980 and 2005, U.S. energy consumption increased 27.5%, from 78.3 quads to 99.8 quads (Table 3). Data are available for 2005 for the U.S. Individual totals are available for hydro, biomass, geothermal, solar and wind. Fossil fuels supplied 89.4% of U.S. 1980 energy consumption and 85.9% in 2005 (Table 4) Fossil Fuels also supplied 73.0% of the 21.5 quad increase in U.S. energy consumption over the 1980-2005 intervals (Tables 3 and 4).

Between 1980 and 2005, U.S. total renewable energy consumption increased 0.6 quads, or 10.9%. This net increase reflects a 0.8 quad increase for the combination of biomass, geothermal, solar and wind that is partially offset by a 0.2 quad decrease in U.S. hydro power. In general, although the use of hydro power increased on a worldwide basis and decreased in the U.S., the pattern of U.S. energy consumption is similar to the pattern for the world. Over the 1980-2004/5 quarter century, both the U.S. and the world increased total energy consumption. For both the U.S. and the world, by far the principal source of total energy consumption was fossil fuel. In relative terms, fossil fuels lost a few percentage points of market share. But for both the U.S. and the world, increased fossil fuel consumption accounted for over 70% of the total increase in energy consumption. Use of nuclear power increased in both absolute and relative

Table 3

U.S. Consumption of Energy by Type of Energy, 1980 and 2005

Type of Energy	Quadriillion Btu Consumed 1980	2005	Increase	Percent Increase (%)
Petroleum	34.2	40.4	6.2	18.1
Natural Gas	20.4	22.5	2.1	10.3
Coal	15.4	22.8	7.4	48.1
Total Fossil	**70.0**	**85.7**	**15.7**	**22.4**
Hydro	2.9	2.7	-0.2	-6.9
Biomass	2.5	2.8	0.3	12.0
Geothermal	0.1	0.4	0.3	300.0
Solar	NA	0.1	0.1	NA
Wind	NA	0.1	0.1	NA
Total Renewable	**5.5**	**6.1**	**0.6**	**10.9**
Nuclear	2.7	8.1	5.4	200.0
U.S. Total	**78.3**	**99.8**	**21.5**	**27.5**

Detail may not add to totals because of rounding.

Source: U.S. Energy Administration, Monthly Energy Review, August, 2006, Table 1.8

Table 4

Relative Contributions of Various Types of Energy to Total U.S. Energy Consumption, 1980, 2005 and 1980-2005 Increase

Type of Energy	Percent Contribution to Total U.S. Consumption		
	1980	2005	1980-2005 Increase
		(%)	
Petroleum	43.7	40.5	28.8
Natural Gas	26.1	22.5	9.8
Coal	19.7	22.8	34.4
Total Fossil	**89.4**	**85.9**	**73.0**
Hydro	3.7	2.7	-0.9
Biomass	3.2	2.8	1.4
Geothermal	0.1	0.4	1.4
Solar	NA	0.1	0.5
Wind	NA	0.1	0.5
Total Renewable	**7.0**	**6.1**	**2.8**
Nuclear	3.4	8.1	25.1
U.S. Total	**100.0**	**100.0**	**100.0**

Detail may not add to totals because of rounding.

Source: Table 3

terms in the U.S. and worldwide. With the exception of hydro power outside the U.S., renewable sources made relatively modest contributions to either absolute or relative energy consumption in the U.S. and on a worldwide basis.

Oil Production: The Intensive Margin

Economists have long considered two general approaches to increasing or maintaining the production of output: the intensive margin of production and the extensive margin of production. Think of a tomato farmer. If the farmer wants to increase production, one way to accomplish this is by getting more output from her existing fields. This can be achieved by installing irrigation, applying fertilizer, hiring more labor to pick and cultivate more carefully, and applying pesticides and herbicides, etc. These production enhancement techniques are all examples of expanding output at the internal margin of production.

There is also an external margin of production - - an alternative way the farmer could expand production. She could plant, cultivate and harvest additional fields of tomatoes. She could manage the new fields in exactly the same way that she managed her original fields. If she were to follow this approach, the farmer would be expanding output at the external margin of production. Not surprisingly, if there are economic incentives to expand the output of some commodity, there are production responses at both the internal and external margins of production.

Terms of art in the oil and gas industry are "resource" and "proved reserves." Resources exist in nature. Proved reserves are an artifact of man. Resources are the total global endowment of fossil fuels that nature has bestowed upon us. Resources

exist whether they have been discovered or not. Proved reserves are the portion of a discovered resource that is recoverable (or producible) under existing technological and economic conditions.

In order to better understand how the concept of the internal margin applies to oil production, it is necessary to review a little petroleum geology. Oil does not occur in huge underground lakes or pools. What is often called a "pool" of oil actually appears to the naked eye to be solid rock. The oil is contained in the microscopic pore spaces between the tiny grains of sand that make up the rock. Porous rock that contains oil is called "reservoir rock". The reservoir rock of the Prudhoe Bay oil field on the North Slope of Alaska could be cut into thin slabs, polished up and used as the facing on a bank building. Passers-by would be none the wiser.

Geologists speak of source rock, reservoir rock and cap rock. Source rock is the progenitor of fossil fuels. Eons ago in geologic time, plant and animal life lived and died and was deposited as organic material in sedimentary basins. The earth's crust moved and buckled and bent and folded over upon itself. This process rolled organic sedimentary material deep underground where, in the due course of geologic time, heat and pressure converted the organic sediments to fossil fuels - -petroleum, natural gas and coal.

Fossil fuels are solar fuels. The energy they contain derives from the energy of the sun. It is just that the production process which created them is much more roundabout - - millions of years more roundabout - - than the process that uses the energy of the sun to warm a solar water heater.

Oil formed in the source rock is pushed by underground pressures through various strata of permeable rock until it is trapped against a layer of impermeable rock- - the cap rock. The pressure pushing the oil into the ultimate strata of reservoir rock is often water driven by a subterranean aquifer. If no cap rock stops its pressure driven journey, the oil escapes to the surface of the earth- - on land or under the oceans. These are natural oil spills. One of the largest known deposits of oil in the world- - the Athabasca Tar Sands in Alberta, Canada- -is such a natural oil spill.

Nature abhors a vacuum. Nature also abhors a partial vacuum. Oil in a strata of reservoir rock is under great pressure, trapped between a water drive and the impermeable cap rock. It requires tremendous pressure to force oil to flow through solid rock from the source rock to the cap rock. When a well pierces the cap rock and enters the reservoir rock, a partial vacuum is created. The great pressure differential between atmospheric pressure at the surface of the earth and the underground reservoir pressure causes the oil to flow to the well bore and then up through the well casing to the wellhead at the surface.

In the 19th century and the first half of the 20th century, successful oil wells were often allowed to erupt as gushers and temporarily spew a fountain of oil from the drilling derrick. This is no longer the case. Reservoir pressure is precious and managed carefully. As natural reservoir pressure dissipates, less and less oil is forced through the reservoir rock to the well bore and daily production declines.

Not all the oil in place in a reservoir is produced. In the earliest days of the oil industry after Col. Edwin Drake drilled his discovery well in 1859 near Titusville, Pa., as little as 10% of the oil in place was produced before the natural reservoir pressure was

exhausted and primary oil production ceased to flow. To offset the loss of production as primary output slowed, secondary production techniques were developed and employed.

There are many different kinds of secondary production technology. The classic secondary production technique is the walking beam pump that resembles a mechanized saw horse bobbing up and down. Others include drilling injection wells and pumping water, natural gas or carbon dioxide into the reservoir to maintain pressure. Secondary recovery shades into tertiary recovery such as injecting steam to make heavy oil flow more freely or injecting surfactant detergents to maintain reservoir pressure and to wash oil out of tight pore spaces and help it to flow to the well bore. From the inception of production, modern reservoir engineering now uses whatever techniques are cost effective to maintain reservoir pressure, improve flow and increase ultimate recovery of oil in place. The result has been a significant increase in the percent oil in place that is recovered through production. In the 20th century, 10% recovery became 30% recovery. Now it is often possible to achieve 50% or higher ultimate recovery of the oil in place. Higher prices for oil make application of expensive existing enhanced recovery technologies more cost effective and also encourage development of new technologies.

A large fraction of the oil ever discovered from 1859 to 2006 remains unrecovered and in place in known reservoirs. At historical and current prices with historical and current technologies, it has not been cost effective to produce it. Most of the oil in place that has not qualified to be designated as proved reserves will likely never be recovered and produced. But if petroleum becomes more scarce relative to

our desire to benefit from its use, its price (adjusted for inflation) will rise, perhaps dramatically. If, or when, that occurs, there will be a variety of responses, interactions and consequences. One of these responses will be at the intensive margins of production. New discoveries will be developed more intensively and old oil fields will be intensively reworked.

Fossil Fuel Production: The Extensive Margin

The fossil fuels are all hydrocarbons. Petroleum is the most widely used fossil fuel with the largest market share of any energy source because transportation is such an important use. Liquid transportation fuels - - gasoline, jet fuel diesel - - are easier, more convenient and less costly to store, transport, distribute and use than solid or gaseous fuels. However, the resource base for petroleum is smaller than that for coal or natural gas. In Basin and Range, John McPhee observed that in nature the occurrence of oil relative to natural gas is analogous to the occurrence of statesmen relative to politicians in public life. Coal exceeds natural gas.

Engineers and scientists can convert the hydrocarbons in coal into liquid fuels. The Fischer –Tropsche process (named for two German chemists) is the best known technology. It was used by Germany in World War II and by South Africa during the apartheid embargo. Natural gas also can be converted to liquid fuel using a variation of the backend of the Fischer-Tropsch process. Exxon-Mobil is building a big gas-to-liquids (GTL) plant in West Africa. Qatar is building a very large GTL plant in the Persian Gulf to facilitate marketing of its substantial natural gas reserves. The output of a GTL plant is equivalent to environmentally friendly diesel fuel. We are on the cusp of

extending the commercial production of liquid hydrocarbon fuels to natural gas. Higher oil prices will extend the commercial horizon to coal-based liquid hydrocarbon fuels.

The recent exploration activity focused upon the Lower Tertiary geologic formation in the deepwater Gulf of Mexico is another illustration of the relevance of the extensive margin. Two-thirds of the surface of the earth is covered by water. There has been considerable exploration for and production of oil and natural gas on the great deltas of the shallow near-shore OCS. - - the North Sea, the Bright of Benin, the Gulf of Mexico, the South China Sea, etc. Exploration and production in water depths up to 10,000 feet and at geologic horizons 25,000 feet beneath the ocean floor is now possible.

Vast new areas about which we now know relatively little have become accessible. Attractive prospects will not be limited to just the near-to-shore relatively shallow waters bordering the continents. New deep-water geologic horizons lie before us. A great adventure will continue. If the last 50 years of history in the Gulf of Mexico are a tell-tale, the technological limits will not long remain at 10,000 feet of water depth and 25,000 feet beneath the ocean floor. For liquid hydrocarbon fuels, Hubbert's peak lies before us - - perhaps a long way before us.

Price Volatility

Following World War II, oil prices were quite stable for a number of reasons. Prices spiked in the early middle 1970's following the Arab oil embargo. Prices spiked again at the end of the 1970's and in the early 1980's coincident with the Iranian revolution. In the early 1990's, the first Gulf War was accompanied by another spike in

prices. In 2006, due to supply dislocations in Alaska, Venezuela, Nigeria and Iraq, prices spiked again and reached nearly $80 a barrel. We can learn a number of things from these price spikes.

First, short-run demand for and supply of oil are quite inflexible. Small dislocations on either side of the market can cause big swings in price. Second, volatility is a two–way street. What goes up often comes down. The price bust in the mid 1980's and the soft markets of the late 1990's and early 2000's illustrate such turn-arounds. The big downward slide of prices from the 2006 highs punctuates the message. Third, economic recessions are often attributed to oil price spikes, but we should be cautious about these inferences. In every instance, oil price spikes were accompanied by restrictive monetary policies applied by the U.S. Federal Reserve - - sometimes draconian restrictions. Fourth, there is upward pressure upon prices due to increasing demand for energy from the growing economies of India and China. This is good news. The world is a much better place with billions of Indians and Chinese participating in dynamic economies that are demanding more energy than it would be were these countries failed societies with stagnant demands

There is a further general lesson in our experience of price volatility. Prices fluctuate, we adapt. The original Honda Civic and the SUV are classic examples of our response to higher and lower prices. In an important sense, $75 oil and three dollar gasoline are a bargain. In terms of what oil (and, potentially, other liquid hydrocarbon fuels) do for us, and what we would have to give up without them, there are no readily available cost effective substitutes.

In Europe, high fuel taxes cause gasoline prices to be greater than five dollars a gallon. But even at these prices, motor vehicle use in London has to be restricted in order to reduce congestion. As an hypothetical example, consider the effects of five dollar a gallon gasoline in the U.S. If five dollar a gallon gasoline occurred because of long-run higher crude oil prices, this would be equivalent to a price of $125 a barrel for crude oil. Such prices would cause a lot of pain, but after adjusting and adapting, it is unlikely the economy would suffer long-run collapse. Supply-side initiatives at all dimensions of the intensive and extensive margins, however, would be undertaken with incredible creativity and vigor. Demand-side responses would also be significant. In the short-run, modern, high-tech versions of the original Honda Civic would be widely adopted. In the long-run, land-use patterns and building design and construction would change.

Conclusions

Fossil fuels are the workhorse of the world energy economy. Nuclear power is making a growing contribution to electricity generation. Outside the U.S., new hydro facilities have also contributed to increased energy consumption. Nonhydro renewable energy use has grown rapidly from a small base. But these nonhydro renewable sources make a very modest contribution toward meeting increased energy demands or total energy use. It is likely that supplies of fossil fuel resources will be ample to meet growing energy demands for the foreseeable future.

Consumption of fossil fuels generates carbon dioxide. Many environmentalists believe that the greenhouse effect of increased atmospheric concentrations of carbon

dioxide is the principal cause of global warming. In The Skeptical Environmentalist, Bjorn Lomberg expresses reservations about the extent of environmental degradation due to human activities and the tightness of the linkage between carbon dioxide concentrations and global warming.

Nevertheless, serious people consider the links between human activity, fossil fuel use, increased carbon dioxide concentrations and global warming to be very tight and regard the situation to be very serious. This is a big problem.

Modern societies and the global economy are built on fossil fuel use. There are now no cost-effective substitutes for fossil fuels. Reducing carbon dioxide emissions significantly will require dramatic changes in the way we organize our activities and live our lives. Many people, especially skeptics, will not make these sacrifices happily. If the skeptics are correct, we will incur great costs for few, if any, benefits. The resolution of these questions will become an increasingly important item on our global political agenda.

Sidebar 1

Technology Creates Resources

When I was a young graduate student in the early 1960s, I traveled through Louisiana, Texas and Oklahoma interviewing oil company exploration executives for background for my Ph.D. dissertation. One interview still vividly stands out in my mind. Jim Finley was the exploration vice-president for a consortium of major oil companies that was pioneering drilling on the outer continental shelf (OCS) in the Gulf of Mexico. He very graciously spent most of an afternoon with me answering my (often naïve) questions and explaining Gulf of Mexico OCS oil exploration and production to me.

Offshore oil production in the Gulf of Mexico actually began in the 1930s. In shallow water near to the shore, large wooden platforms were built on wooden pilings and drillings rigs and production facilities operated from these platforms. The platforms were connected to each other and to the shore by a network of docks and walkways.

After World War II, steel platform technology began to advance. This was complemented by advances in drillship and drilling barge technologies and advances in undersea pipeline laying techniques and technology. But, compared to current industry offshore operations, exploration and production were still limited to relatively shallow water. I recall the pride, animation and sense of adventure with which Jim Finley told me about what could then be accomplished with 1960s technology. Steel platforms could be set in 100 feet of water! Using directional drilling, drillbits could be turned (or "whipstocked") so that wells could be completed in water that was 300 feet deep. A deep well was a completion into a reservoir that lay 10,000 feet under the floor of the Gulf.

In 2006, the Jack field in the deep waters of the central Gulf of Mexico was flow tested. The discovery well was drilled in 6,000 feet of water. The producing formation lies 25,000 feet under the floor of the Gulf of Mexico. The Jack field is part of a larger formation that is estimated to contain 9-15 billion barrels of oil, a 50 percent increase in U.S. proved reserves. The seismic and geophysical technologies that allowed identification of the Jack prospect and the drilling and production technologies that allow development of the field are amazing. As late as the last quarter of the 20th century, the Jack field might as well have been on Mars. For all practical purposes, the oil resources of the Jack field did not exist. New technologies create new resources.

Sidebar 2

Can Ethanol Replace Gasoline?

Ethanol is a type of ethyl alcohol. Ethanol has been used as an additive for gasoline to oxygenate the fuel in order to reduce emissions and pollution. For this purpose, a common blend of ethanol and ordinary gasoline is a fuel called E15. E15 is 85% petroleum based gasoline and 15% ethanol. An alternative much more ethanol intensive blend is E85. E85 is 85% ethanol and 15% gasoline.

The U.S. automobile industry produces many cars that are ethanol capable and can run on either 100% gasoline or fuels such as E15 or E85. Use of E15 ethanol is a replacement for the chemical MTBE for purposes of oxygenation. Use of E85 ethanol is primarily a replacement for gasoline itself. Ethanol contains only about 80% as many Btus of energy per gallon as does gasoline.

In the U.S., most ethanol is made from corn. There are biofuels other than ethanol and biological feedstocks other than corn. The cultivation of alternative biofuel feedstocks - - switchgrass for example - - is apt to be less energy intensive than the cultivation of corn. But corn is currently a major U.S. crop. Conversion of corn to ethanol is a market tested technology. So, for illustrative purposes, the focus here is upon corn-based ethanol.

The U.S. corn harvest averages about 11 billion bushels of corn per year. The principal use of corn is for animal feed. Between 1.5 and four billion bushels of corn are exported for this purpose. There are about 81 million acres of cropland planted for U.S. corn production. For the last decade, the average price of corn has been about $2.00

per bushel, although in 2006 corn was $2.50 per bushel. A bushel of corn is 60 pounds of corn.

The U.S. uses 144 billion gallons of gasoline per year. The conversion process of corn into ethanol yields slightly more than 2.7 gallons of ethanol per bushel of corn. If the entire 11 billion bushel current U.S. corn crop were converted into ethanol, about 20% of U.S. gasoline use could be replaced by ethanol.

There would be many major consequences of such a program. Consider just two. First, U.S. demand for imported oil would be reduced. Second, the U.S. price of corn would increase dramatically. We would pay for the program at both the gas pump and the grocery store. There is a place for ethanol, but that is likely to be a niche market as a substitute for MTBE rather than a broad market as a major replacement for gasoline.

Sidebar 3

Price Controls Do Not Work

In the 1970's, in response to a sharp increase in crude oil and refined products prices associated with the Arab oil embargo following the 1973 Arab-Israeli war, there were U.S. price controls upon crude oil and refined products. The result was an economic mess. There were long gasoline lines. There was social and political turmoil. Why did this happen? What went wrong?

When price controls are effective, they make the price of a product lower than it would otherwise be. Lets focus on gasoline. Some drivers will not be able to buy all of the gasoline they wish to buy at the lower, controlled price. This is a shortage. It is hard to predict when and where shortages will hit. This causes drivers to try and keep their gas tanks "topped off" and fuller than they would normally be. This makes the shortages worse.

In response to shortages, regulators imposed a system of allocations. The allocations interfere with the logistical miracle that transports crude oil to refineries, produces the appropriate varieties and amounts of refined products, and then gets those refined products to where they are demanded when they are needed.

Price controls and allocations cause this finely tuned and constantly adjusting supply chain to get out of kilter. The shortages cumulate and snowball. The first intervention thus requires a second to fix it. The second requires a third; the third requires a fourth; and so on.

The end result is a monumentally snarled-up supply chain and egregious economic inefficiencies.

RESUME

Dr. Edward W. Erickson, Ph.D.
NCSU Box 8110, Raleigh, NC 27695-8110
ed_erickson@ncsu.edu
919-513-2876 - office
919-828-4572 - home
919-515-7873 - fax

Dr. Ed Erickson is Professor Emeritus of Economics at North Carolina State University. Dr. Erickson joined the NC State faculty in 1965.

Dr. Erickson has taught a variety of graduate and undergraduate economics courses and has also taught in interdisciplinary teams. He has been Director of the Center for Economics and Business Studies, Coordinator of International Programs and Chair of the University Research Committee. Dr. Erickson has served as a member of the University Committee on Courses and Curricula and also on the University Research Operations Council.

Dr. Erickson earned his Ph.D. from Vanderbilt University and his B.A. from Penn State. His principal area of research is energy economics.

Dr. Erickson serves on the board of directors of Tax Analysts. He was a founding member of the board in 1970. Tax Analysts is a Washington based public interest organization that promotes transparency and efficiency in the tax code. Tax Analysts has 200 employees and a budget of over $20 million per year.

Dr. Erickson serves as a member of the North Carolina Legislative Commission on Global Climate Change. Dr. Erickson has served on the Brookings Institution Panel on Economic Activity and worked with Resources for the Future. He is widely published in scholarly journals and books. Dr. Erickson has testified before Congress more than a dozen times.

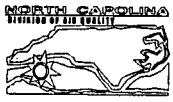
Dr. Erickson is a member of the boards of directors of the North Carolina Beaches, Inlets and Waterways Association and the Bogue Banks Beach Preservation Association. He is President of the Beacon's Reach Master Association. Dr. Ed Erickson is a member of the Coastal Federation. As President of the Beacon's Reach Master Association, Dr. Erickson has been an active initiator of public beach access in Pine Knoll Shores.

Ed Erickson is married to Ann Bright Erickson, his wife of 48 years. Ann and Ed have three children and three grandchildren. They live in Raleigh at 221 West Park Drive.

Report on Climate Action Plan Advisory Group (CAPAG) Activities

Legislative Commission on Global Climate Change (LCGCC)

November 27, 2006



Brock M. Nicholson, P.E.
Deputy Director
Division of Air Quality

CAPAG Activity Update

- Last CAPAG meeting held at NCSU – October 12
  - Follow up call – November 13
- Numerous Technical Work Group calls since
- Objectives
  - To complete the "Definition" of the priority mitigation options prior to cost and benefit analysis
  - Begin to consider recommendations
- Adaptation
  - Interest of LCGCC at October 3 meeting
  - Interest of TWG and CAPAG as an early recommendation
- Considerations for Adaptation
  - Task force or study commission
  - Identify sectors for inclusion in plan
  - Coordination with Public Safety, Emergency Management, Public Health, Agriculture, etc. necessary
  - Develop State plan

CAPAG Schedule / Next Steps

- Analysis underway for selected mitigation options
  - Costs
  - Benefits, including jobs created
- Next CAPAG meeting – Jan 24, '07
  - Initial reports on analyses
  - Final development of and approval on initial recommendations
- Consideration of extending CAPAG schedule to coordinate with and support LCGCC work

Questions?

References

- *www.ncair.org*
- *www.ncclimatechange.us*
- *Brock.Nicholson@ncmail.net*
  919-715-0587

RGGI

Regional Greenhouse Gas Initiative: States Stepping Up to Address Climate Change

Franz Litz
Climate Change Policy Coordinator
New York State Department of Environmental Conservation

Overview

RGGI

- A Policymaker's Perspective on Climate Science
- Understanding What is at Stake
- Brief Snapshot of Climate Change Policies of Northeast States
- Regional Greenhouse Gas Initiative
- Takeaways

2

Climate Science

We know enough to act now

RGGI

Joint National Academies of Science Statement
June 2005

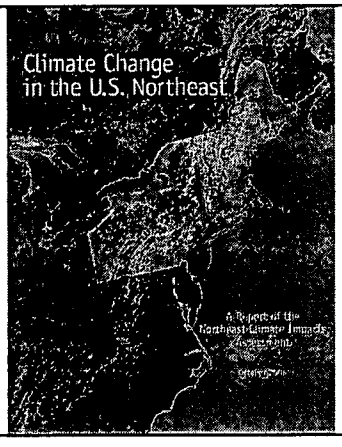
"The scientific understanding of climate change is now sufficiently clear to justify nations taking prompt action."

RGGI

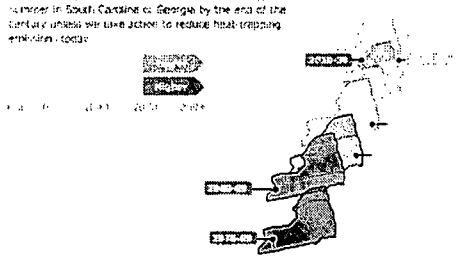
Climate Impacts

Understanding What's at Stake

RGGI

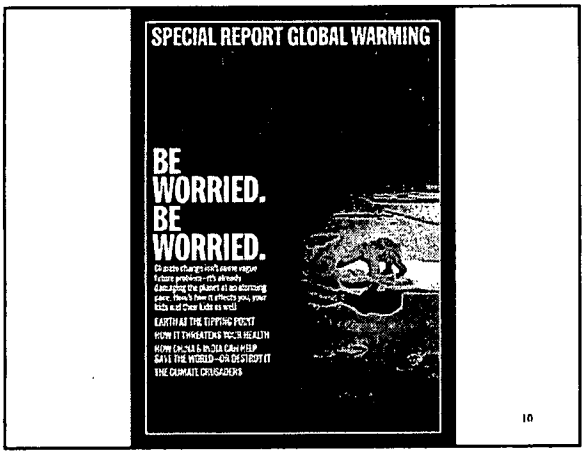


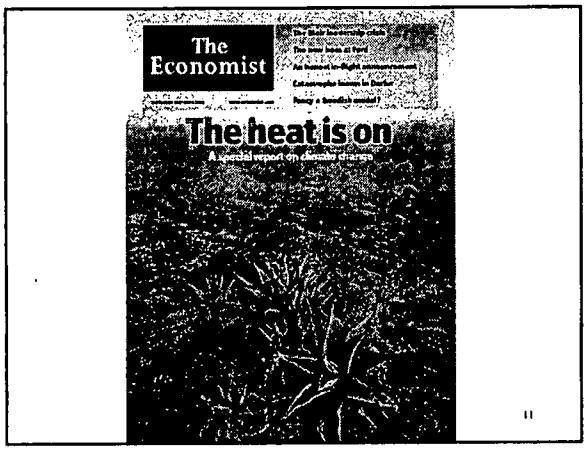
Summers in Upstate New York

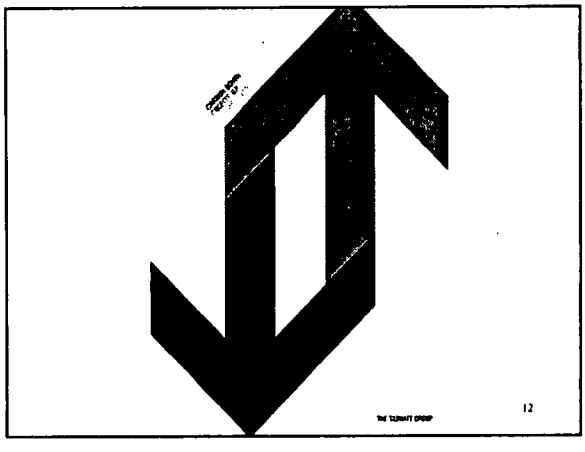


Potential Impacts

- Extreme weather events—heat, storms
- More precipitation in fewer events—floods & infrastructure
- Sea level rise and storm surges
- Agricultural disruptions—droughts, changes in growing seasons
- Unpredictable changes in ecological systems

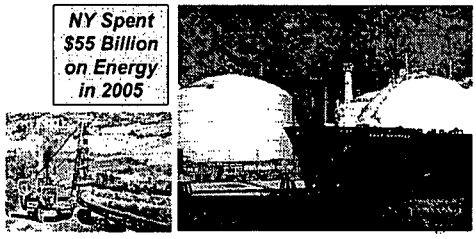

SPECIAL REPORT GLOBAL WARMING
BE WORRIED. BE WORRIED.
EARTH AT THE TIPPING POINT
HOW IT THREATENS YOUR HEALTH
SAVE THE WORLD—OR DESTROY IT
THE CLIMATE CRUSADERS
10


The Economist
The heat is on
11


12

New York's Oil & Gas Consumption Means Billions Leave the State Each Year

NY Spent $55 Billion on Energy in 2005



State Climate Policies

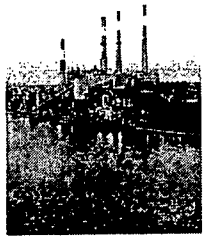
Climate and Energy Policy Options

- Reduce Energy Consumption
- Promote Non-Carbon-Emitting Energy
- De-Carbonize Fossil Fuel Energy
- Increase Sequestration in Carbon "Sinks"

RGGI States on Climate

- State Climate Action Plans with Reduction Targets
- Significant Renewable Portfolio Standards
- Significant Energy Efficiency Programs
- Greenhouse Gas Tailpipe Standards (CA LEV)
- Track Record of Successful Cooperation
  - NE Governors' Climate Pact; Ozone Transport Commission on NOx & VOCs

Regional Greenhouse Gas Initiative



The Nation's First Mandatory Cap-and-Trade Program for Carbon Dioxide

Launch Date: Jan. 1, 2009

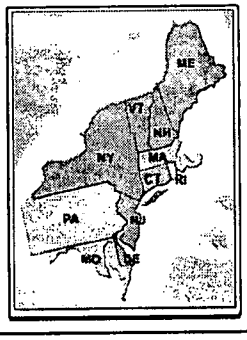
RGGI

RGGI Regional Greenhouse Gas Initiative

An initiative of the Northeast & Mid-Atlantic States of the U.S.

Background

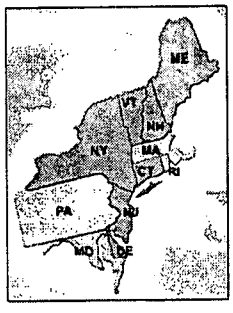
- April 2003 Invitation
- 3 Year Design Process
- December 2005 Memorandum of Understanding (7 States)
- Model Rule Complete
- MD & MA to Join



The Region at a Glance

- *39.4 million people— (13% of US Population)*
- *11th largest emitter in the world*
- *$1.8 trillion economy (15% of U.S.)*

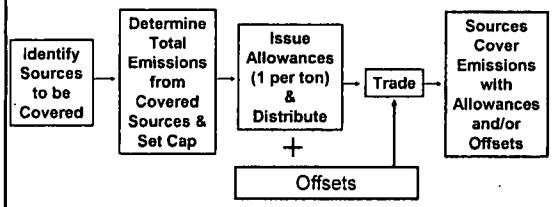
RGGI



RGGI Regional Greenhouse Gas Initiative

An initiative of the Northeast & Mid-Atlantic States of the U.S.

Designing RGGI: A Cap-and-Trade Program



19

Reduction Requirements

- Stabilize emissions at current levels through 2014;
- then reduce by 10% by 2019
- ~13% below 1990 levels
- ~35% below business as usual

RGGI

RGGI Innovations

- Allowance Allocations:
  - 25% or more of the allowances will be set-aside for Auction for Consumer Benefit and/or Strategic Energy Purpose
  - Many States—like New York—will go higher than 25%
- Firing Biomass/Biofuel a "control" method
- Offsets

RGGI

Key Program Features

- Offsets "Valve"
- Offsets—5 Initial Types:
  - Natural Gas, Propane, Heating Oil Efficiency;
  - Land to Forest;
  - Landfill Gas Capture & Combustion;
  - Methane Capture from Animal Operations
  - SF_6 Leak Prevention;
- International Credits from EU or CDM allowed if allowance price is $10 ormore

22

Market Drives Innovation

- Carbon price will promote:
  - reduction in fossil fuel consumption
  - non-emitting renewable energy
  - development of abatement technologies
  - innovation yet unknown

RGGI

RGGI + California

- MOU among RGGI States Welcomes Participation by Additional States
- RGGI + California =
  - 24% of U.S. Population
  - 28% of U.S. Economy
  - 3rd Largest World Economy
  - 15% of U.S. Emissions
  - 6th Largest Emitter Worldwide

RGGI

RGGI Next Steps

- Implement RGGI
- Bring Maryland & Massachusetts On
- Add Additional States—RI, PA?
- Link with West Coast—CA, OR, WA, AZ, NM?
- Next Area of Multistate Cooperation: Harmonize RPSs? Energy Efficiency Portfolio Standard?

25

Summary

- We Know Enough About the Science to Act Now
- There is Too Much at Stake Not to Act
- Good Energy & Economic Reasons to Act Now
- States are Acting and Prospering
- Regional and Multi-State Cooperation Makes Sense

26

Franz Litz
Climate Change Policy Coordinator
NY Dept. of Environmental Conservation
ftlitz@gw.dec.state.ny.us

27

NC State University
North Carolina Solar Center

Biofuels in North Carolina

Presented to the Legislative Commission on Global Climate Change

November 27, 2006

Kurt Creamer, P.E.
Biomass Program Manager, NC Solar Center
Research Associate, Animal & Poultry Waste Management Center
kurt_creamer@ncsu.edu
919-515-4092

WASTE MANAGEMENT PROGRAMS

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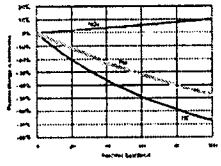
Benefits of Biofuels

- Economic development if produce biofuels in-state
- Energy security
- Regulated tailpipe emission reductions
- Greenhouse gas emission reductions

Biodiesel emissions relative to diesel emissions



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Ethanol from Sugar (sugarcane, sugarbeets, sweet sorghum)

- Can be fermented directly into ethanol
- In US, cost of producing ethanol from sugar crops higher than from corn
- Brazil's produces ethanol from sugarcane at the equivalent of $25 a barrel and energy efficiencies up to 9:1.

Estimated ethanol production costs

Feedstock	Total Costs*	Processing Costs*
Corn (wet milling/dry milling)	$1.82/gal	$0.82/gal
Raw Sugar cane	2.49	0.82
Raw Sugar beets	3.35	0.77
Molasses**	1.37	0.38
Raw sugar**	3.48	0.38
Refined sugar**	3.87	0.34

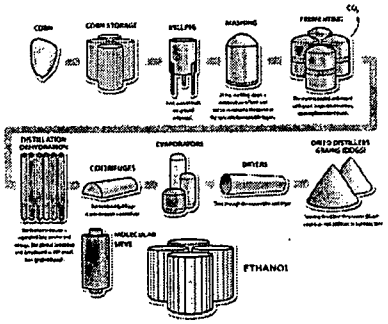
*Per gallon **Excludes transportation costs

WASTE MANAGEMENT PROGRAMS

Animal and Poultry Waste Management Center

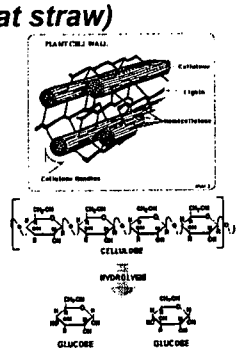
Ethanol from Starch (corn, sweetpotatoes, barley)

- 97% of ethanol in U.S is made from corn
- 20% of this year's corn crop will go to ethanol production



Ethanol from Cellulose (switchgrass, woodchips, corn stover, wheat straw)

- Like starch, cellulose is just a chain of glucose (sugar) molecules
- But cellulose is more difficult to hydrolyze than starch
- Once hydrolyzed, the glucose is fermented (like any other sugar source) into ethanol



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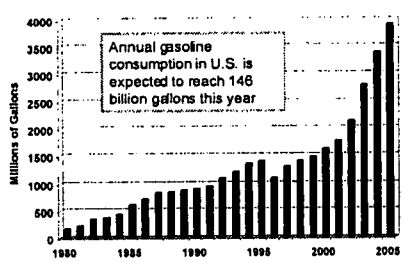
U.S. Ethanol Production



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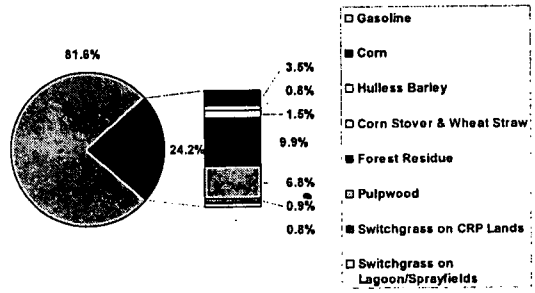
NC Ethanol Usage

- State of North Carolina, Department of Administration, Motor Fleet Management uses approximately 200,000 gallons of E85 and 700,000 gallons of E10
- Found in all three grades of gasoline at Crown stations (E10)
- 10 service stations in NC carry E85 in Shelby, Charlotte, Statesville, Durham, Hickory, Southern Pines & Pinehurst

Proposed NC Ethanol Plants

- Agri-Ethanol Products, Aurora (54 MGY in Phase I, 108 MGY in Phase II)
- DFI Group, Jamesville
- Clean Burn Fuels LLC, Hoke County

NC Gasoline Displacement Scenario



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North Carolina Solar Center

What is Biodiesel?

- Biodiesel is produced by a chemical reaction between methanol (or ethanol) and an oil or fat.
- 100 lb canola oil + 10 lb methanol
  - → 100 lb biodiesel + 10 lb glycerin
- Potential feedstocks are waste vegetable oil, soy oil, canola oil, other oilseeds, animal fats
- Often used in blend with petroleum diesel (B20, which contains 20% biodiesel)
- Good lubricity, non-toxic, high flash point, lower emissions

WASTE MANAGEMENT PROGRAMS

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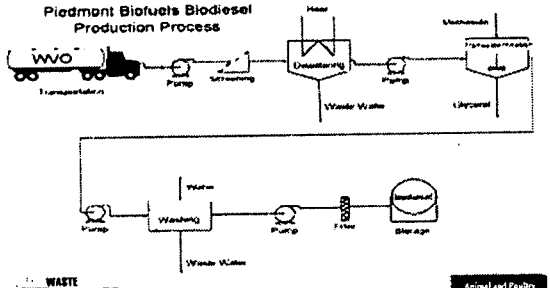
Biodiesel Production



WASTE MANAGEMENT PROGRAMS

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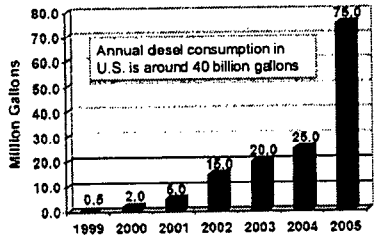
Estimated U.S. Biodiesel Production



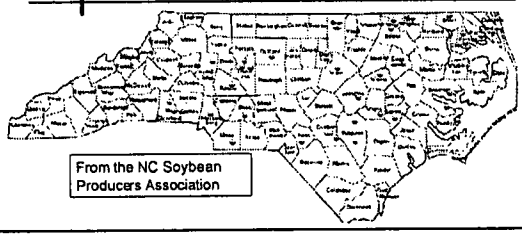
WASTE MANAGEMENT PROGRAMS

Animal and Poultry Waste Management Center

NC Biodiesel Usage, 2005

Major Users Include: NC Department of Transportation (DOT), NC Zoo, Camp Lejuene Marine Corps Base, RDU International Airport, Pitt County Memorial Hospital, Durham & Gaston County Schools, UNC-CH, Duke, and NC State, over a dozen municipalities

NC BIODIESEL DEALERS



From the NC Soybean Producers Association

NC State University North Carolina Solar Center

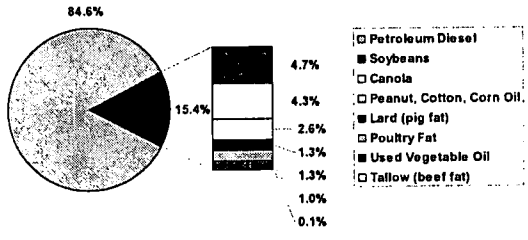
Proposed NC Biodiesel Plants

- Piedmont Biofuels, Pittsboro, 1 MGY
- Grain Growers Coop, Mt. Olive, 30 MGY
- Blue Ridge Biofuels, Asheville, 2 MGY
- Foothills Bio-Energies LLC, Lenoir County, 5 MGY
- Specialty Filter, Autryville, 1 MGY

WASTE MANAGEMENT PROGRAMS

Animal and Poultry Waste Management Center

NC Petroleum Diesel Displacement Scenario



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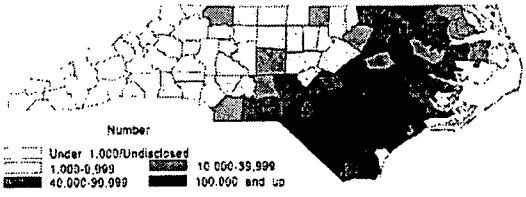
Hogs and Pigs: Numbers on Farm, December 1, 2003



WASTE MANAGEMENT PROGRAMS

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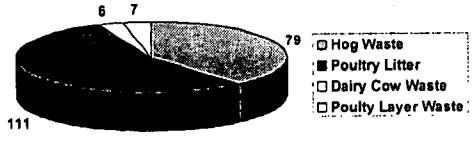
Potential Power Generation from Animal Wastes (MW)



WASTE MANAGEMENT PROGRAMS

Animal and Poultry Waste Management Center

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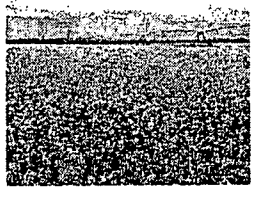
Energy Crops for NC Program

- Evaluate agronomics, economics, processing capacity for:
  - Canola
  - Switchgrass
  - Hulless Barley
  - Coastal bermudagrass
  - Woody biomass

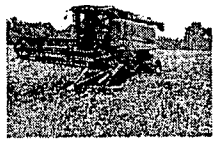


WASTE MANAGEMENT PROGRAMS

Animal and Poultry Waste Management Center

Why Canola in NC?

- Produces 2-3 times as much oil per acre as soybeans
- Can be grown as a winter cover crop in a corn-canola-soybean rotation in place of wheat
- Has virtually the same agricultural inputs as winter wheat and can generate more farm revenue.



Why Hulless Barley in NC?

- Produces similar starch and ethanol yields as corn.
- Can be grown as a winter cover crop in a corn-barley-soybean rotation in place of wheat.
- Uses around 25% of the energy to produce compared to corn, achieving a higher energy balance.

Why Switchgrass in NC?

- Perennial grass once native to the southeast.
- Produces an average of 5 tons of biomass per acre, potentially yielding over 400 gallons of ethanol per acre.
- Because it is a perennial, it controls soil erosion and provides habitat for wildlife.

NC State University
North Carolina Solar Center

NC Biomass Council
State Energy Office

- Mission: To promote **economic development**, a **reduction in greenhouse gas and other emissions**, and **energy security** through the utilization of biomass, including both bioproducts and bioenergy, in the State of North Carolina.
- Made up of members from Industry, State Government and Academia

WASTE MANAGEMENT PROGRAMS

Animal and Poultry Waste Management Center

NC State University
North Carolina Solar Center

Recommendations from NC Biomass Council Members

- Finance preprocessing facilities necessary for bioenergy production, such as regional oilseed crushing facilities.
- Fund an in-state pilot plant that converts lignocellulosic biomass to ethanol on a pre-commercial scale.
- Provide a tax credit to biofuel distributors that is equal to the state motor fuels tax.
- Create an in-state lab that will conduct efficient and inexpensive ASTM standard testing for all biodiesel producers.
- Offer state matching funds to leverage federal funds awarded in programs such as USDA's Renewable Energy and Energy Efficiency Program

WASTE MANAGEMENT PROGRAMS

NC Biomass Council
State Energy Office

Animal and Poultry Waste Management Center

NC State University
North Carolina Solar Center

2002 Farm Bill, Title IX, USDA Renewable Energy and Energy Efficiency Program

- Created by the U.S. Department of Agriculture to assist farmers, ranchers and rural small businesses with energy projects.
- Provides grants and loan guarantees for renewable energy and energy efficiency projects. Grant requests cannot exceed 25% of project costs, and total grant and loan must be less than 50% of project costs.
- The minimum request for renewable energy projects is $2500 and the maximum is $500,000.

WASTE MANAGEMENT PROGRAMS

Animal and Poultry Waste Management Center

Renewable Fuel Tax Credits (H1636) (North Carolina)

- Production/Processing. – a facility for producing renewable fuel is allowed a tax credit equal to twenty-five percent (25%) of the cost of constructing and equipping the facility
- Distribution. – a commercial facility for dispensing renewable fuel is allowed a credit equal to fifteen percent (15%) of the cost of construction and installation, including pumps, storage tanks, and related equipment.

2005 Special Budget Provision Section 19.5

- Requires state fleet to achieve a 20% reduction or displacement of current petroleum use by 2010
- Will spur use of alternative fuels, synthetic lubricants and efficient vehicles
- Effects all state agencies, universities and community colleges that have state owned vehicles (any fleet over 10 motor vehicles)
- Agencies must report annually by September 1st to Dept. of Administration (State Energy Office)

Grant Programs

Clean Fuel Advanced Technology Project (NC Solar Center)

- $2M project funded by NCDOT, State Energy Office and Division of Air Quality
- Project components include:
  - 3 year education and outreach efforts
  - grants for emission reduction projects in 24 eligible counties.
  - funds for incremental cost of AFVs, refueling infrastructure, idle reduction technologies, diesel retrofits
- First call for projects expected out in Sept- Awards expected in December

Mobile Source Emission Reduction Grants (Division of Air Quality)

- Purpose: to achieve actual reductions from on- and off- road mobile source related emissions in North Carolina
- Applications http://daq.state.nc.us/motor/ms_grants/
- Annual grant deadline December 31, Award announcements March following year

NC State University
North Carolina Solar Center

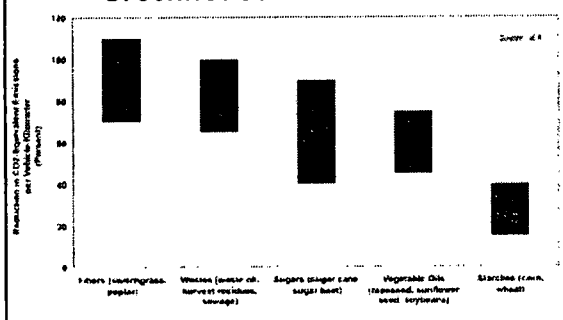
Energy Balance of Biofuels

- Sugar Cane Ethanol (Brazil) → 9 : 1
- Corn Ethanol (U.S.) → 1.2 : 1
- Biomass (cellulose) ethanol → 5 : 1
- Soy Biodiesel → 3.2 : 1
- Gasoline → .74 : 1
- Diesel → .83 : 1

WASTE MANAGEMENT PROGRAMS

Animal and Poultry Waste Management Center

Potential Reductions in Greenhouse Gas Emissions



From "Global Potential and Implications for Sustainable Agriculture and Energy in the 21st Century" Worldwatch Institute, 2006

NC State University
North Carolina Solar Center

Questions?

WASTE MANAGEMENT PROGRAMS

Animal and Poultry Waste Management Center

25x'25
AMERICA'S ENERGY FUTURE

25 Percent Renewables by 2025 is Achievable and Affordable

A new study by the RAND Corporation finds that producing 25% of America's electric power and vehicle fuel from renewable sources by 2025 could be achieved with no increase or even a decline in the nation's total energy bill – assuming continued technology improvement for renewables relative to nonrenewable technologies, and no significant decline in oil prices.

Summary of Key Findings

- 25x'25 is ... onomy, as long as renewable tec... technologies, continues to imp... and long-term oil prices do not ... f the Energy Information Adm...
  - ... gy has improved by 57%, ... Laboratory (NREL).
  - ... y is projected to improve
- This sc... l coal as fossil fuels are displace... olar and biomass. The RAND a... les future could reduce oil prices ... es by 16%.
- **The repo... gy is shown in the simulations to lower tota... ...ures in virtually all cases in which current energy pri... ...and technology cost trends continue."**
- If renewable technology improves by 50% relative to nonrenewables, the maximum degree of improvement simulated by RAND, then net energy costs are nearly $30 billion lower in a 25x'25 future.
- Oil consumption falls by 2.5 million barrels per day. This is 10% of U.S. projected consumption in 2025.

Tim Tolken
Exhibit I
Stern
Rand 2

- 25x'25 results in a 1 billion ton reduction in carbon dioxide emissions – a 15% reduction in the total projected U.S. contribution to global warming and two-thirds of the projected growth in emissions. This reduction is obtained at no additional cost under the conditions noted above. Through achieving 25x'25, the electricity sector returns to 2004 emissions by 2025.

- Meeting intermediate goals on the way to 25x'25 – 10x'15 and 20x'20 – is even more likely to reduce energy expenditures, since the more modest interim goals require less use of more expansive renewable sources. **According to the RAND study, "These findings suggest that while cost savings from renewable energy will not materialize overnight, they also won't take a couple of decades to achieve."**

About the Study

- The RAND analysis simulated 1,500 scenarios, taking into account a wide range of possible assumptions about two key factors:

  - ☐ Fossil fuel technology and prices.
  - ☐ Renewable energy technology and prices.

  The wide range of scenarios was considered in order to incorporate a variety of perspectives on the future of renewables without taking any position on which scenarios might be more likely.

- Each run of the simulation began with the energy characteristics for the U.S. in 2005, and then proceeded in 5-year increments through 2025. This allowed for intermediate findings, as well as for comparisons between a current "business as usual" track and a new portfolio of U.S. energy production.

About 25x'25

- 25x'25 is a renewable energy initiative backed by more than 300 organizations and individuals, including most of the nation's leading farm groups, with a common interest in making America's energy future more secure, affordable and environmentally sustainable. This 25x'25 Alliance supports a national goal for renewable energy: 25 percent of America's energy by 2025.

About the Energy Future Coalition

- The Energy Future Coalition is a bipartisan public policy initiative supported by foundations. It works with business, labor, and environmental groups to identify energy policy options with broad political support addressing three principal concerns:
  - ☐ Oil dependence.
  - ☐ Climate change.
  - ☐ Access of the world's poor to modern energy services.

###

Summary of Conclusions

There is still time to avoid the worst impacts of climate change, if we take strong action now.

The scientific evidence is now overwhelming: climate change is a serious global threat, and it demands an urgent global response.

This Review has assessed a wide range of evidence on the impacts of climate change and on the economic costs, and has used a number of different techniques to assess costs and risks. From all of these perspectives, the evidence gathered by the Review leads to a simple conclusion: the benefits of strong and early action far outweigh the economic costs of not acting.

Climate change will affect the basic elements of life for people around the world – access to water, food production, health, and the environment. Hundreds of millions of people could suffer hunger, water shortages and coastal flooding as the world warms.

Using the results from formal economic models, the Review estimates that if we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more.

In contrast, the costs of action – reducing greenhouse gas emissions to avoid the worst impacts of climate change – can be limited to around 1% of global GDP each year.

The investment that takes place in the next 10-20 years will have a profound effect on the climate in the second half of this century and in the next. Our actions now and over the coming decades could create risks of major disruption to economic and social activity, on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century. And it will be difficult or impossible to reverse these changes.

So prompt and strong action is clearly warranted. Because climate change is a global problem, the response to it must be international. It must be based on a shared vision of long-term goals and agreement on frameworks that will accelerate action over the next decade, and it must build on mutually reinforcing approaches at national, regional and international level.

Climate change could have very serious impacts on growth and development.

If no action is taken to reduce emissions, the concentration of greenhouse gases in the atmosphere could reach double its pre-industrial level as early as 2035, virtually committing us to a global average temperature rise of over 2°C. In the longer term, there would be more than a 50% chance that the temperature rise would exceed 5°C. This rise would be very dangerous indeed; it is equivalent to the change in average temperatures from the last ice age to today. Such a radical change in the physical geography of the world must lead to major changes in the human geography – where people live and how they live their lives.

Even at more moderate levels of warming, all the evidence – from detailed studies of regional and sectoral impacts of changing weather patterns through to economic

models of the global effects – shows that climate change will have serious impacts on world output, on human life and on the environment.

All countries will be affected. The most vulnerable – the poorest countries and populations – will suffer earliest and most, even though they have contributed least to the causes of climate change. The costs of extreme weather, including floods, droughts and storms, are already rising, including for rich countries.

Adaptation to climate change – that is, taking steps to build resilience and minimise costs – is essential. It is no longer possible to prevent the climate change that will take place over the next two to three decades, but it is still possible to protect our societies and economies from its impacts to some extent – for example, by providing better information, improved planning and more climate-resilient crops and infrastructure. Adaptation will cost tens of billions of dollars a year in developing countries alone, and will put still further pressure on already scarce resources. Adaptation efforts, particularly in developing countries, should be accelerated.

The costs of stabilising the climate are significant but manageable; delay would be dangerous and much more costly.

The risks of the worst impacts of climate change can be substantially reduced if greenhouse gas levels in the atmosphere can be stabilised between 450 and 550ppm CO_2 equivalent (CO_2e). The current level is 430ppm CO_2e today, and it is rising at more than 2ppm each year. Stabilisation in this range would require emissions to be at least 25% below current levels by 2050, and perhaps much more.

Ultimately, stabilisation – at whatever level – requires that annual emissions be brought down to more than 80% below current levels.

This is a major challenge, but sustained long-term action can achieve it at costs that are low in comparison to the risks of inaction. Central estimates of the annual costs of achieving stabilisation between 500 and 550ppm CO_2e are around 1% of global GDP, if we start to take strong action now.

Costs could be even lower than that if there are major gains in efficiency, or if the strong co-benefits, for example from reduced air pollution, are measured. Costs will be higher if innovation in low-carbon technologies is slower than expected, or if policy-makers fail to make the most of economic instruments that allow emissions to be reduced whenever, wherever and however it is cheapest to do so.

It would already be very difficult and costly to aim to stabilise at 450ppm CO_2e. If we delay, the opportunity to stabilise at 500-550ppm CO_2e may slip away.

Action on climate change is required across all countries, and it need not cap the aspirations for growth of rich or poor countries.

The costs of taking action are not evenly distributed across sectors or around the world. Even if the rich world takes on responsibility for absolute cuts in emissions of 60-80% by 2050, developing countries must take significant action too. But developing countries should not be required to bear the full costs of this action alone, and they will not have to. Carbon markets in rich countries are already beginning to deliver flows of finance to support low-carbon development, including through the Clean Development Mechanism. A transformation of these flows is now required to support action on the scale required.

Action on climate change will also create significant business opportunities, as new markets are created in low-carbon energy technologies and other low-carbon goods and services. These markets could grow to be worth hundreds of billions of dollars each year, and employment in these sectors will expand accordingly.

The world does not need to choose between averting climate change and promoting growth and development. Changes in energy technologies and in the structure of economies have created opportunities to decouple growth from greenhouse gas emissions. Indeed, ignoring climate change will eventually damage economic growth.

Tackling climate change is the pro-growth strategy for the longer term, and it can be done in a way that does not cap the aspirations for growth of rich or poor countries.

A range of options exists to cut emissions; strong, deliberate policy action is required to motivate their take-up.

Emissions can be cut through increased energy efficiency, changes in demand, and through adoption of clean power, heat and transport technologies. The power sector around the world would need to be at least 60% decarbonised by 2050 for atmospheric concentrations to stabilise at or below 550ppm CO_2e, and deep emissions cuts will also be required in the transport sector.

Even with very strong expansion of the use of renewable energy and other low-carbon energy sources, fossil fuels could still make up over half of global energy supply in 2050. Coal will continue to be important in the energy mix around the world, including in fast-growing economies. Extensive carbon capture and storage will be necessary to allow the continued use of fossil fuels without damage to the atmosphere.

Cuts in non-energy emissions, such as those resulting from deforestation and from agricultural and industrial processes, are also essential.

With strong, deliberate policy choices, it is possible to reduce emissions in both developed and developing economies on the scale necessary for stabilisation in the required range while continuing to grow.

Climate change is the greatest market failure the world has ever seen, and it interacts with other market imperfections. Three elements of policy are required for an effective global response. The first is the pricing of carbon, implemented through tax, trading or regulation. The second is policy to support innovation and the deployment of low-carbon technologies. And the third is action to remove barriers to energy efficiency, and to inform, educate and persuade individuals about what they can do to respond to climate change.

Climate change demands an international response, based on a shared understanding of long-term goals and agreement on frameworks for action.

Many countries and regions are taking action already: the EU, California and China are among those with the most ambitious policies that will reduce greenhouse gas emissions. The UN Framework Convention on Climate Change and the Kyoto Protocol provide a basis for international co-operation, along with a range of partnerships and other approaches. But more ambitious action is now required around the world.

Countries facing diverse circumstances will use different approaches to make their contribution to tackling climate change. But action by individual countries is not enough. Each country, however large, is just a part of the problem. It is essential to create a shared international vision of long-term goals, and to build the international frameworks that will help each country to play its part in meeting these common goals.

Key elements of future international frameworks should include:

- *Emissions trading:* Expanding and linking the growing number of emissions trading schemes around the world is a powerful way to promote cost-effective reductions in emissions and to bring forward action in developing countries: strong targets in rich countries could drive flows amounting to tens of billions of dollars each year to support the transition to low-carbon development paths.

- *Technology cooperation:* Informal co-ordination as well as formal agreements can boost the effectiveness of investments in innovation around the world. Globally, support for energy R&D should at least double, and support for the deployment of new low-carbon technologies should increase up to five-fold. International co-operation on product standards is a powerful way to boost energy efficiency.

- *Action to reduce deforestation:* The loss of natural forests around the world contributes more to global emissions each year than the transport sector. Curbing deforestation is a highly cost-effective way to reduce emissions; large-scale international pilot programmes to explore the best ways to do this could get underway very quickly.

- *Adaptation:* The poorest countries are most vulnerable to climate change. It is essential that climate change be fully integrated into development policy, and that rich countries honour their pledges to increase support through overseas development assistance. International funding should also support improved regional information on climate change impacts, and research into new crop varieties that will be more resilient to drought and flood.

DRAFT

Global Climate Change Commission Meeting
Friday, 12 January 2007
Room 643 LOB

The Legislative Commission on Global Climate Change convened Friday, 12 January 2007 at 10:00 a.m. in Room 643 of the Legislative Office Building with Mr. John Garrou, Co-Chair, presiding. Other members present were: Representative Joe Hackney, Co-Chair, Representative Pricey Harrison; Representative Alice Underhill; Representative Winkie Wilkins, Senator Janet Cowell, Senator Robert Pittenger, Dr. Ryan Boyles, Mr. Tom Cecich, Mr. Walter Clark, Dr. Douglas Crawford-Brown, Dr. Dolores Eggers, Dr. Edward Erickson, Mr. Barry Eveland, Dr. George Everett, Mr. Preston Howard, Mr. Michael Nelson, Mr. Mitchell Peele, Dr. Daniel Phaneuf, Mr. Tim Profeta, Dr. Stanley Riggs, Mr. Robert Slocum, Dr. Stephen Smith, Mr. Tim Toben, Mr. Ivan Urlaub, Ms. Susan Tompkins, Ms. Vicky Will and Dr. Godfrey Uzochukwu.

A copy of the meeting notice for this meeting, a copy of the agenda and the visitor's registration are attached to these minutes as **Exhibits A, B, and C**.

Mr. Garrou called the meeting to order at 10:12 am and stated that we have a very full agenda and would like to get started. The co-chair is not here and I wanted to take a minute to congratulate him on being nominated by his caucus to lead the House so I hope everybody will remember that I did that if he comes in. I think that's very exciting and a real honor to Representative Hackney. We ask George to give us his report and explain the agenda items.

Mr. Givens – Good morning and welcome to another meeting of the Legislative Commission on Global Climate Change. There are two items that I want to call to your attention, there is a document that looks like this and captioned, There is a Better Way that was distributed by Ms. Tompkins a member of the Commission, you should all have a copy of that (**Exhibit D**). There is a document that has been reported to the Commission from the Division of Air Quality captioned Air Report on the Study of Cost Benefits for Reducing Emissions of Oxidizes and Nitrogen Particulate Matter in Greenhouse Gases for Motor Vehicles. This is a follow-up to me and don't look for copies because you don't have them. It's a follow-up of information that was submitted to the Environmental Review Commission. We are going to make it available as fairly voluminous and we will make a hard copy for anybody who requested and we will post it to the web presumably this afternoon but I want to save a tree or two by not distributing it wholesale. With regards to today's agenda, today agenda is as useful as it is quite ambitious. I guarantee you we will run behind, how much behind is in your hands. I would encourage you to ask judicious questions and engage in susink discussion. We need to finish up around 3 or 3:30 and it will be a stress to do that. The agenda is more or less self explanatory but it leads to a couple of other things that I need to tell you. The first subject item is agenda item 4 which is a five part presentation on the effects of global climate change as they relate to coastal adaptation, the next item is the report of study of the renewable energy portfolio

standard that was done at the request of the Environmental Review Commission by the Utilities Commission through a contract arrangement and a state voters advisory group. We have optimistically scheduled that to occur before lunch. I hope you will help us meet that goal but that may not actually happen. Commissioner Kerr and Mr. Watson are ready to do that either way.

We also expect a further report from the CAPAG group and what we are going to do as this relates to how we are going to proceed for the rest of this present series of meetings and how we are going to create a report. The plan is as follows: we will hear from the CAPAG group an extensive discussion of the recommendations that they are intending to consider at their next meeting and its subsequent meetings with particular emphasis on what has usually been described as win-win-win or low hanging fruit or that sort of thing. That's for the purpose of putting those ideas out there - not for the purpose of taking action on them today but getting them all out. In addition to that in response to Chairman Hackney's invitation at the last meeting, we received four sets of proposed recommendations for inclusion in the interim report. Those have been duplicated and will be distributed to you. Some of them have already been sent out by e-mail. They will be distributed to you and posted to the web, the folks who prepared those, one represents three of you, and the other three were prepared by individuals. We would give those as much discussion time as time fits.

So the way forward is this: this Commission has one more meeting which is tentatively but I think you can rely fairly confident we will meet on the scheduling of that for Thursday 22 of February. The thought process goes like this – you will have hopefully by the end of the day an opportunity to give some thought and discussion to all the proposals that have currently been received or are out there. The co-chairs have asked that any other members of the Commission who wishes to submit proposals for inclusion in the written report do so by the 31st of January as sort of an ending date on that so that those proposals can be distributed and considered well in advance of the meeting on the 22nd. I caution you that what Mr. Peterson and the CAPAG group are working on at the moment are matters that the CAPAG folks have not actually taken action on, they are proposals not recommendations. Mr. Peterson and I have had a lot of discussion about this and I have talked to both co-chairs about this and what we hope is that discussion in this Commission today would inform the discussion of the next meeting of the full CAPAG which is on Wednesday 24th of January that happens to coincide with the first day of General Assembly Session. The CAPAG will take whatever action it choses and that information will come back to us on the 22nd as a third point of reference for consideration of what goes in our interim report to the Legislature. Also on the 22nd we are working on planning a reception, this is at the request and invitation of the British Counsel General of Atlanta. There will be visiting members of the British Parliament who will hopefully be able to observe at least part of the meeting on the 22nd and they plan to invite all of us to a reception in the late afternoon or early evening as an opportunity to meet and greet. I understand that these particular MPs are the ones who are particularly interested in global climate change matters. So that's the basic plan and I don't anticipate that this Commission will meet again during the session we will presumably resume our work towards a final report once the 2007 Legislative session adjourns.

In terms of getting a report together the elements of the report as I see it are (inaudible) which is easier to authorize legislation and membership for the Commission and that sort of thing. Then there is the matter of the proceedings of the Commission, that a synopsis of the minutes, that is being worked on with some outside assistance and I hope that we will have those proceedings available for distribution early in February. I don't envision really much debate about those because they are supposed to be a straight forward summary of what we have done. There may be of course corrections or there may be additions that you want us to rectify and we will certainly be open to that.

Mr. Peterson and his group will take the recommendations that are agreed by the Commission on the 22nd and do whatever needs to be done to get them in good form for inclusion in the report and that will be the report. Mr. Peterson is currently looking at the four submissions we've received to see how they work with the CAPAG things. That's not to say that the things that you all submit have to be part of what the CAPAG is doing but he's looking for similar or duplicative things so that we consolidate consideration of those matters. So that's our plan for how to produce and report what we hope is that we continue to communicate with you by e-mail in February in advance of the 22nd so you will have a pretty good idea of what we're going to be looking at. I regard the 22nd of February as the decision day. I remind you that the way legislative committees work is that the co-chairs control the agenda as has been the case for all of our meetings. They will get to say to review all packages of recommendations to determine which ones ought to be considered – no doubt with advice of counsel and many of you. So that's the plan I'll be happy to answer any questions. Thank you Mr. Chairman.

Mr. Garrou – Any questions for George? Our first speaker is S. Jeffress Williams, he is a Coastal Marine Geologist with the U.S. Geological Survey/Woods Hole Science Center, Woods Hole, MA. Thank you very much Mr. Williams for coming down here to visit with us and giving us your presentation.

Mr. Williams – Good morning – it is a pleasure to come and give my presentation. The slides will show (**Exhibit E**) some of the recent research ongoing by USGS as well as in partnership with a number of academic institutions and state institutions in North Carolina. The topic of my talk is "Coastal Vulnerability to Erosion, Storm Hazards and Potential Future Sea-Level Rise" and the real take home message that I would like to leave is that there is a great deal of high quality creditable scientific information on what's happening at the coast and what's likely to happen at the coast. And I think as planners and managers in North Carolina plan for the future I would encourage them to use the sciences available. We have a number of outstanding coastal scientists in North Carolina that have published and presented a lot of really excellent material on what's happening along the North Carolina coast and I think that in the long term that scientific information needs to be an integral part in any of the findings that goes on.

There's been an explosion of research in the climate change in the last decade. We know a whole lot more now than what we knew ten years ago. There are two quotes dealing with climate change and one is from the Union of Concerned Scientist changes consistent with

global warming are already on the way across the north east. They are focused with the north east but I think the same can be said about the mid-Atlantic region including NC. Another came out of the UK this fall the scientific evidence is now overwhelming, climate change presents very serious global risk and it demands the urgent global response. This was the Stern report and this came out of the UK government that that certainly is not known for being too radical. So I think if they take it seriously we should take it seriously as well. North Carolina and other coastal states faced upper coastal hazards that are listed here. Catastrophic storms certainly, not so much this year or last year but certainly in the historic past and recent past North Carolina has suffered tremendously from coastal storms. Coastal erosion both short term and long term erosion, global sea level rise certainly the focus of this Commission that I'll talk about. Land subsidence that's related to sea level rise and when you talk about sea level rise you talk about relative sea level rise that is the combination of the oceans coming up, the seas coming up and the land going down. That certainly pertains to NC as well. I include global and regional climate change, earthquake, tsunamis, landslides, volcanic activity, not too much of an issue for NC. I think all of you are aware that the coast line is a highly dynamic area and it's one of the most dynamic regions around the US. It's the intersection between the ocean and the land. And I've just listed some of the primary agents that drive this coastal change, some of the natural regions as well as the anthropogenic. Obviously the type of geology that you have at the coast line is very important whether or not you have hard rocky coast or low lying Barrier Islands those like you have in much of NC. The type of geomothology relative sea level hasn't changed and I'll certainly talk more about the major storms and tropical storms and extra tropical storms are very important and driving local change. And talk more on the routine coastal process from day to day of the way the wind and the tidal currents and so forth. Sediment budgets - what we mean by sediment by sediment budgets is much like your checkbook and that is the sand coming to the coast, sand leaving the coast and how the sand moves along the coast. And it's the sediment budget that's very important to (inaudible) not as close as undergoing secretion, its stable or undergoing erosion just a volume of sand that is available along the coast.

This last and certainly the last 50 years recent human activities have probably done more to alter coastal processes along much of the coast maybe not so much in NC as other parts of the coast and many of the natural conditions. Sort of the unanticipated consequences of some of the coastal (inaudible) structures navigation channels in some places and river modifications. Certainly for the Gulf of Mexico and the west coast this is important, oil and gas extraction not such a big issue for NC but certainly for other parts. I actually like the term climate variability more than climate change – climate change is such a politically charged statement that I think climate variability is just the uncertainty of what's going to happen. It's probably a more appropriate term than climate change. The map on the left is showing long term annual shore line change around the United States based on the map that USGS has done. It doesn't show up real well but the red areas are areas that are severely eroded. The yellow areas are moderate erosion. By severely erosion we are talking about in excess of a meter in excess of about three feet per year on average. Moderate erosion would be one to three feet, the green areas would be relatively stable. Some years may be eroding other years it would be relatively stable.

NC has lots of red and lots of yellows and that's no surprise that much of your shore line is under going long term erosion for a variety of purposes. So about 85 percent of the US shore line is undergoing long term erosion, so the erosion problem that you have here in NC is not unique but it's happening throughout much of the US, and the USGS has projects underway to document and quantify these changes taking place. Of course at the same time we've had an explosion of coastal population this is a figure from the newspapers a couple years ago in NC as you are well aware there's been some in excess of about a 50 percent increase in coastal population. People moving to the coast either from upward areas, people retiring from the middle part of the country and moving to the coast, it's no great surprise NC is a very nice place to live particularly in the coastal zone. But it's this clash between what's happening at the coast, the dynamic coast and people moving to the coast, the infrastructure along the coast that presents the problems.

The last decade have been a very unusual decade in the historic record and even to some degree in the geologic records and certainly the last several years have been fairly unusual. This is just a summary of 2005which in all the historic record 2005 is a record hurricane season. The hurricane season runs from June through November, in 2005 we had 27 name storms, 15 hurricanes, three of which were category five hurricanes. At the end of August Hurricane Katrina of course had a tremendous impact for all south of the south of Louisiana, these are just some of the specifics about the storm, just a huge very powerful storm. That was followed the third week in September by Hurricane Rita, 165 mile per hour wind, 15 foot storm surge about half the storm surge that Hurricane Katrina had. Katrina had on the order of 30 to 33 feet of storm surge, higher storm surge than were reported. Hurricane Wilma in October and this storm season actually brought on the cold weather until January 2006, it was a very unusual year. Two thousand and six (2006), this was just reported the last week or so, was the warmest year in recorded history. What does this protend for 2007? The only reason that we had a fairly quite hurricane season in 2006 was because of the start of El Nino which really suppresses hurricane activity but certainly the Gulf of Mexico and the Caribbean was very warm and if we didn't have El Nino we very likely could have had a repeat of what we had in 2005. So the question is would the oceans warming on the order of a degree or more if El Nino dies down as projected to do what are we going to have in 2007? So I think there is no doubt the scientific consensus that the fact climate variability, climate change is happening. The issue is how much of that is due to natural variability we certainly know that there are cycles to many things but it certainly seems like the climate warming of the atmosphere, climate warming of the oceans is just exasperating some of those natural cycles.

Talk a little bit about the effects of the sea level rise. I've listed a lot of them here from loss of coastal habitat and natural resources increased erosion, loss of recreational resources and certainly this is important for NC. Salt water intrusion - if you have fresh water wells in the coastal zone and you raised sea level you have more incursion of sea level which can bring about salt water intrusion. Elevated storm surge elevations for frequent coastal inundation all of this leads to increased risk to urban infrastructure and ultimately a greater risk to human safety. We note from the geologic records that sea level has been buried considerably this is a graph showing the present sea level right here. The modern sea level and how sea level has changed from back to 160,000 years ago. So here we are at the

present time 160,000 years ago. One hundred sixty thousand years ago sea level was down here, probably about 400 feet below where it is at the present time and it came out about 120,000 years ago and was actually five meters or about 30 feet higher than where it is at the present time. The thought was that all the ice in green would have melted at this time and put that water into the ocean and sea level was actually higher than where it is at the present time. As the climate cools, sea level drops as the climate warms up a bit it came up, so you have these fluctuations in sea level positions. This is just a graph showing the location of sea level. During the last glaciation about 20,000 years ago sea level was back down to about 400 feet below the present time as the climate warms. This is steam up here, this is a very smooth curve certainly it wasn't very straight and continuous like this but this was in general. Twenty thousand years ago -400 feet so the shoreline at that time would have been out at the edge of the continential shelf, hundreds of kilometers off shore and as the climate warms and the glaciers melt and it put more water in the oceans it came up. And it came up to around the present position probably on the order of about 5,000 years ago and since that time it's been slowly rising but certainly not rising as quickly as it did up to that point.

The take home message here is that all of this is, of course, due to natural variability in the climate system. It's the system of glaciers building, glaciers melting the climate warming, so all of this we know they are natural cycles we control, the question is what's going to happen in the future? How much of the natural cycles are going to persist in the future and how much are they going to be exasperated by greenhouse gases and climate warmth. To prove the fact that sea level is continuing to rise is shown by tide gauges. We have two tide gauges closest to NC, one is up here in Hampton Beach at the mouth of Cheseapeake Bay and one is down here at Wilmington, NC. The squiggly graphs are the sea level positions from about 1940 to the present time. For both of these and you can see lots of variability so there are lots of factors that control sea level rise. If you do a statistical regression through these data you can see this sort of yellow line here that comes up from 1930s to the present time. And this suggest that over this period of time sea levels up here at the Hampton Beach have been coming up in about 0.17 inches per year about 17 inches per century, fairly rapid. If you look at the gauge data from Wilmington it suggest that it's coming up about eight inches per century. The difference here is that this is not an ideally placed gauge it's up in the river and there are other influences on it. The other thing is that this area is probably subsided and the land is going down even more rapidly than the area down here in NC. But regardless, the message here is that there are two levels (inaudible) to the NC coast that rises probably in the order of about 18 inches per century and the question is what's going to happen to our beaches?

Ok what contributes to a global sea level rise the one we call an eustatic line. A little over a third is just thermal expansion as you warm the atmosphere the atmosphere then warms the ocean. When you warm water which warms the ocean the upper mixing area expands it so probably in excess of a third of sea level rise that we're seeing is through the thermal expansion. Another third has to do with the wastage of glaciers. You've probably read the papers that places like Alaska, Glacier National Park were very rapidly loosing their glaciers because they are melting such that probably all the glaciers will be gone in Glacier National Park within the next 50 years, so some may say that a third of the sea level rise is

due to glaciers. About a quarter is due to the melting of Greenland and this is where it really gets complex as to try to figure out the budget of ice on Greenland and particularly in Antartic. In Greenland recent evidence through the last year, year and a half suggest that Greenland is melting much more rapidly than what has been normally forecasted. A lot of the melting is taking place along the preiferial Greenland. They're actually building ice and snow in the interior so there is an adding of ice and snow in the interior to the very rapid melting on the exterior and the melting on the exterior is adding water to the ocean that contributes to sea level rise. When this figure was put together there was a real questions mark and in some degree it still is. This is a lot of very troubling information that has come out in the last six months suggesting that ice shells around Antarctica for desengerating and breaking up much more rapidly than what we anticipated. And of course the ice shells that are melted when they break up don't actually contribute to sea level rise because that's (inaudible). That's like an ice cube in a glass, if you have an ice cube in a glass and it melts, it doesn't raise the level at all. What's happening in Antarctica is that deserves attention and that as these ice shells break up they potentially can stay water or on shore glaciers because one per glacier start to move and they start to break up and they are moved to the ocean then they can certainly contribute to the sea level rise.

What's the potential for man made ice to sea level rise? I just listed them here – Antarctica by far has the most ice that contributes to the sea level rise. It has something in excess of 90 percent of all of the glacier ice that can contribute to sea level rise. If you melt all of that you would raise sea level over 70 gators 200 feet. Greenland contributes about eight percent if you melt all of Greenland you would raise sea level on the order of 20 feet and that graph that I showed of sea level in the past would (inaudible) at the present time that's thought to be the result of the melting of Greenland. Mountain glaciers and other sources like in Alaska as well as other places are relatively small probably only about one percent of the glacier life and that would raise the sea level on order of a foot or two. Those are the potential sources. We've heard a lot about the buildup of CO_2 it is one of the principle gases – this is a well known part of carbon dioxide in the past thousand years. Here is 1,000 years here is the present time and as you can see that from 1,000 years ago up to the 1800s up to the start of the industrial revolution. Carbon dioxide in the atmosphere and we know this from an analyses used for price cores in Antarctica. Carbon dioxide is fairly steady as we burn more and more fossil fuels. Carbon dioxide went up and you can see it has a steep increase. The plot here is global temperature – global average temperature in the last 1,000 years and you can see lots of squiggle and ups and downs here in the little ice age in the medieval warm period. Then when you get up here at the start of the 20^{th} century you can see the temperatures going up so there is almost a one for one correspondence between the buildup of CO_2 in the atmosphere due to the burning of fossil fuels and an increase in temperature.

The question is what's likely to happen in the future? This is a graphic base from the Intergovernmental Annual and Coastal Climate Change that was published in 2001 and it just shows the global mean temperature here from 1850 to 2000 and based on the number of numeric computer models these are different scenarios. If you just have sort of a steady stage this is what the temperature is likely to do, it's likely to go up about another degree during the next century. These are the different model runs that we did up here. These are

very high scenario that is likely to happen. These are just average reports what is going to actually happen is going to be highly variable. Some areas are going to warm considerably and we already see that in the colder regions. You probably read in the papers about the break up of ice in the Antarctic the warming up there was in the order of four and five degrees. It varied in other parts in the order of one degree. Even in Massachusetts where I am it has been a really warm winter so far – it's a little deceiving to talk about climate (inaudible) that's highly variable some areas are going to be wetter other areas dryer, there are just lots of things that could be affected. It is truly encouraging to see states like NC take a leadership role, certainly there hasn't been much leadership coming out of Washington and I encourage states like NC to take the leadership role, recognizing that this is an important issue.

Let's summarize on the current projected sea level rise, we know from the tide gauge records that over the past 100 years or so sea level has risen on average of about eight inches. The result of this is contributions from further expansion of the ocean as well as melting from glaciers. Some of the computer models suggest that over the next few years sea level could rise with the estimate of about one-half meter, about two feet. What does this mean for NC? What it means is that sea level is likely to double over the next century and this is just a graph that again is from the IPCC showing the different model runs for what to expect in sea level rise. I might mention too that the IPCC has a report that came out in 2001 and it should be forthcoming later in the year. We'll talk about what USGS is doing in the area of coastal research. USGS is the research artery of the Department of Interior they have national programs and one of the research areas is the coastal change strategy. We are mainly charged with doing the studies in concert with our colleagues at the universities and state agencies that are needed to predict coastal changes and using this information to try and predict (inaudible). The idea being that this information can be used by planners, managers to reduce the risk of social hazards.

A number of years ago we undertook a quantitative assessment of coastal water vulnerability and this is a map and all of this is up on the USGS website. We came up with coastal vulnerability index a relative folder builder in coastal area the future still wide. And this is the map on a national scale with NC you can see lots of (inaudible). But this is based on some of the qualitative analyses of six different geologic and oceanography there is. This is just one example of the coastal vulnerability study that we did as a part of the study for the National Seashore, this happens to be for shoreline change. The red here indicate various high vulnerability going down to the blues so you can see that this on the outer coast, lots of red and browns and yellows in some cases very high vulnerability to the future on the line. This is the overall CPI index again this is up on the website these are the different variables that we measured but you can certainly get a sense from the bright hot colors that applies to the bar and is extremely vulnerable to a number of hazards including (inaudible). One of the other studies that are underway is developing a numerical model and understanding the evolution and what to expect with potential sea level rise. This work has not been published yet so I will stress that this is preliminary and it is based on the modeling work. We find that the NC barrier, the sea level rise, is the most important factor determining erosion or migration rates. The sediments are fine it is important but it's kind of secondary and this has implications I think to be encouraged. The second bullet suggest

that these are modeling that we've done. We've been able to replicate pretty well how the coast has behaved with the past 8500 years. The idea is that if you can get a model to replicate what we think is happening, what we know through the geologic records is happening, and you run that forward then you can have confidence in what it tells you for the future. What it tells us is that if we have a 0.9 meter rise in sea level, this is sort of the upper end of what the IPCC has forecast for the next 100 years. The model suggest that NC barriers might migrate up to three times more than what they have been based on the last 100 years. This last one suggest that if you pick the sea level rise rates that are well above the IPCC predictions and this is some of the information that was put out recently, if we have really wide spread melting or freezing, if we have a breakup in Antarctic ice sheets we could actually get sea level rise rates above this 0.9 meters. If you do that then the model suggests that the Outer Banks become vulnerable to a system wide what we call threshold (inaudible). This really supports some of the work that Professor Riggs and others have done and suggested that in the past as you get a very fine rate of sea level rise you can get that threshold to collapse. I think the modeling would suggest that this is possible in the future to get (inaudible) sea level to rise.

One other study is a cooperative study with USGS is now underway with a number of players here in NC, at East Carolina, NC Geological Survey as well as (inaudible) University of Delaware and Pennsylvania and that is going to last several years. We've undertaken the study to understand how the NC coastal system develop in the processes that are driving the coastal change at the present time. I listed some of the objectives here they are the projects that have been very successful and we've have excellent collaboration between federal and state scientists, academia and state surveys. We mentioned one other thing and that is that we are involved in writing reports for US Climate Change Science Program and this is the website that USGS has the lead with EPA and Noah. This is something I'm undertaking the way to report on the current state of knowledge, the science of sea level rise, the factors that influence coastal change, and also the various methods involved with better ways to predict future coastal change.

This is a map that is just getting started. We had the first meeting of this group in Washington and it will probably go on about a year and a half and this is something that I think is important for ideas to summarize the state of knowledge about climate change in regard to sea level rise. It will not be definite we will put uncertainties in this report as well because we don't know everything, there are a lot of uncertainties and I think we know a great deal more now than what we did ten years ago or even five years ago.

Let me just go ahead and conclude – I've listed four bullets here that I think the take home message is:

1. Sea level rise we know is a primary driver of coastal change and is rising. Future rates of coastal erosion and inundation no double will increase.
2. Climate change is warming the oceans. 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. Melting on Greenland and Antarctic could

further accelerate this rate. So I think 18 inches is probably a good number to plan for and you need to stay turned to see what's going to happen.

3. Warming ocean temperatures seem to be increasing the hurricane intensity. This is on top of the natural cycle of hurricane activity that we know about. There seems to be 25 year cycles to hurricanes with a cycle now we've probably been in it for ten years so we probably have another 15 years to go. Certainly 2005 is very active for the east coast and NC was spared from much of that certainly prior to that you had a number of major storms and climate warming is just going its natural cycle.

So all those are good links that climate warming and hurricane intensity related to hurricane frequency is still scientifically uncertain, there is still a lot of research that needs to be done on that.

The last thing I'll leave you with is:

4. Science should guide coastal management and policy adaptation to climate change.

Mr. Garrou – Thank you Mr. Williams. What I would like to suggest is to finish the presentations under this heading before we ask questions. Our next speaker is Debra Hernandez who is the President of Hernandez and Company and she is going to give us a report on the National Academy of Sciences report.

Ms. Hernandez – Thank you Mr. Chairman it is a pleasure to be here. As your chairman just noted my name is Debra Hernandez. I am a coastal engineer and policy handler, I currently work for myself. I am here on behalf of the National Academy of Science which recently produced a report on Mitigating Erosion along Sheltered Coasts and what is being handed out (**Exhibit F**) the slicker paper is a report prepared by the National Academy and you are also getting a handout of my presentation (**Exhibit G**). First I am going to describe the presentation contents of the reports and then discuss in more detail the major findings and recommendations it contains. I would say that the report itself is not only an issue of climate change it does address some of the likely impacts of rising sea level and that you are going to see erosion of your sheltered shorelines that were just mentioned by the previous speaker.

The purpose of this study was to examine the impact of shoreline management of a sheltered environment. The sponsors of the study are the Environmental Protection Agency, US Army Corps of Engineers, Cooperative Institute for Coastal and Estuarine Environmental Technology and NOAA Coastal Services Center. The purpose of the study 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 of nearby coastal resources. The study will provide framework for collaboration between different levels of owners to aid in making decisions regarding the most appropriate alternatives for shoreline protection. First, what engineering approaches and land management/planning measures are available to protect sheltered coastlines from erosion or inundation? Second, what information is needed to determine where and when these measures are reliable and effective both from an engineering and a habitat

perspective? Thirdly, what are the likely impacts of various shoreline protection practices? And lastly, probably more relative to this Commission, given the current trends in erosion and acceleration of relative sea-level rise, how can design criteria, and the various technologies that are available and land use plans be implemented to protect both the environment and property over the long term? It a nine member committee and supported by the Academy staff Susan Roberts, Study Director.

The report is organized into five major sections: the first is understanding erosion on sheltered coasts, identify various methods and options for addressing erosion. The third talks about mitigating erosion on sheltered shorelines and its particular focus on a trade-off that has to be made. No matter what you do to help protect shorelines from erosion there is going to be impacts to mitigating coastal resources ecosystem and those have to be sound. Fourthly, the existing decision-making process on sheltered coasts is for shoreline protection. And last the report posted for new management approach. I think what you will find as I go through this that it is a lot of common sense. I know you all have done a lot here in NC.

First what am I talking about – what is a sheltered coast – primarily your bays, harbors and estuaries. What's the problem – you all know that there are many people moving to our coastal regions and lastly landowners typically work to harden their shoreline and bays of erosion problems. If this report does anything, I think just raising awareness that is a particular aspect of it. The three major categories of the shoreline are beaches and dunes, mudflats and vegetated communities and unconsolidated bluffs.

Let me take the next few minutes to walk you through the eight major findings and recommendations that are included in this report. The findings are four categories: Information Needs; Erosion Mitigation and Permitting; Cumulative Effects; and Shoreline Management Planning. The information needs the primary finding its scope and accessibility of information on causes of erosion and overall patterns of erosion, accretion and inundation in the broader region is insufficient in most areas to support the kind of planning and management that is necessary. So the committee recommended that federal agencies (USACE, EPA, USGS and NOAA) collaborate with local entities such as counties and states to develop target studies that facilitate more effective decision making that it is looking at the whole system as opposed to what is happening at an individual site.

These studies should identify trade offs in ecosystem services that are associated with the different options to managing the shoreline. Second, the study should document the processes and hazard information is available to a particular area including mapping erosion zones and rates. And then lastly, we need to develop better models to predict how shoreline features are going to respond to various sea level rise in areas, etc.

The next series of findings is in the category of erosion mitigation and permitting. There are three major findings. The first – compared to open coasts is a much greater variety of techniques available to address erosion because these systems are subject to lower energy impact, there are a lot more alternatives to mitigating relations. There are new technologies that are being developed and they require rigorous process testing and evaluation to

determine their effectiveness and environmental impacts. And third, the current permitting system discourages the use of alternatives.

The recommendations under this same category erosion mitigation and permitting – first the major federal permitting agencies (EPA, USACE, and NOAA) should initiate a national policy dialogue. Secondly, the dialogue should be used to develop guidelines for mitigating erosion on sheltered coasts and give deference to ecologically beneficial measures and ensure consistency of decision making across regions. The regulatory preference for permitting bulkheads and similar structures should be changed to favor one that is more ecologically beneficial and then states and federal regulatory programs should establish a technical assistance.

The next set of findings and recommendations for cumulative effects are take a look at the cumulative impact of the loss of many small parcels will at some point alter the properties, composition and functioning of the ecosystem. The recommendation is that shoreline management plans should be developed to account for potential cumulative effects of shoreline hardening. And that by anticipation of the problem you can better manage it.

The last category of findings and recommendations is under the shoreline management planning category. First, many factors in addition to sediment budgets must be considered in the developing regional plans. We have to also look at the socio-economic factors as well as the environmental processes affecting the shoreline. Secondly, regional shoreline management plans could be implemented under the auspices of the federal Coastal Zone Management Act. The third finding category is that there is a good model with the US Corps of Engineers Regional Sediment Management program that can be evaluated to address the problems in NC.

The recommendations of the committee is regional shoreline management plans should be developed to address erosion on sheltered shorelines, they should be comprehensive, they should be pro-active to avoid the unintended losses. You should have a plan – a shared vision for the future of the shoreline, one solution will not work for the entire coast. Analyze the sediment budgets and other effects of existing shoreline management activities. You need to include in the plan mechanisms for turning the vision into reality and to implement the plan. And lastly, enhance performance evaluation and monitoring requirements.

The final two recommendations under the shoreline management planning heading are the information obtained from various monitoring programs and should be incorporated into subsequent planning activities. Use adaptive management strategies to consistently evaluate and refine regional plans. And lastly, each of the regional shoreline management plans should describe the physical and hydrodynamic settings you should include information on method of structure. All of this should be made available in a GIS format ideally and the plan should describe what options are most suitable for the environment and processes that are applicable for a particular area.

So in summary information on shoreline changes is insufficient for sheltered coast. Decision makers and this is landowners, contractors, and state and federal authorities are generally unaware of some of the alternative erosion mitigation strategies and their effectiveness. Individual decisions lead to cumulative impacts. All mitigation measures affect ecosystem. Local pro-active shoreline management plans could prevent unintended consequences of site-by-site permitting. And then lastly, permitting systems need to be changed so that they can promote mitigation alternatives that are more protective of the ecosystem and the natural resources in your area. So as I've said much of this is common sense. The report is not out in print yet it is available for downloading from the website. I have a publication if anyone is interested. That's my presentation.

Mr. Garrou – Thank you very much Ms. Hernendez. If you would be so kind as to hang around for a while until the last presenter is finished for questions. Our next speaker is Douglas Rader who is the Principal Scientist for Oceans and Estuaries Environmental Defense and he is going to relay some of what is referred to as NC specifics. Mr. Rader.

Mr. Rader – Thank you Mr. Chairman and members of the Commission. My job is to bring the important messages that you have heard this morning home to NC. I've been looking around the audience and it looks like a personal trip through the past. People I've worked with for almost 30 years on trying to take the things that we have here that are special and make them be around for our children and their children. Before I began I do want to acknowledge certain people that have made a big difference in my thinking about this and that have been active collaborators over the last year in thinking about NC's coast and what warming seas rising sea level means for our special place. Dr. Sam Pearsall is here he made a big difference in my thinking. You all know Dr. Riggs but in addition Pete Peterson, Pat Halpin and Jennifer Phelan made a big difference to the way we think about these things.

I am going to do three things exactly this morning. First, to give you an affirmative on why our coast is a more special place than anyone really recognizes. But then second of all I am going to give you a painted picture about what the implication are for this special place based on the science in this area. And then third give you some science based quality recommendations on where we might go from here. I don't think I have to argue to you that we have a world class predator at risk. World class fisheries, world class forest, world class (inaudible). And of course most important is world class people, culture, heritage, based on natural resources extending centuries into the past all of these extending centuries into the future. By the way the picture on the right (**Exhibit H**) is a copy I am of a black and white photograph from 1905 of the river here in the Albemarle Sound where single pulls of (inaudible) could capture over 100,000 fish in the western Albemarle Sound at that time. But in addition to being special to us this place is special to the entire northern Atlantic, large green ecosystem and that is because of where we are located in an underlying geomorphology in the way the critters over the millennium have adapted to this place. On the left you will see a picture of the world through the eyes of cool water fish and citrus spawn and things migrating to the north. And to them this is the place where they have wintering cabins or spawning cabins or fish going all the way to the bay. The bluer colors on the map the more ecological importance it is as in massive conjunction off

the north side coast. And if the estuaries had been colored it would be a bright shinning blue-purple. The picture on the right locates NC at the north of the warm spawn. As eastern North America is seen through the eyes of reef pictures and things like that where fish spawn and our estuaries could (inaudible) as far as the Gulf of Mexico.

If you look at this special place and keep it apart what you find is a truly unbelievable natural valley accruing at this meeting of the cool waters and the warm waters. I am going to focus for a moment on Albemarle and Pamlico Sounds because it is one of the world's great unsung predators. Currently delineated by the Barrier Islands to the east and since 1917 with no inlet north of Cape Hatterus forming a largely fresh water or (inaudible) barely salty, a system in the Albemarle Sound a graphic water for (inaudible) system in the middle. Total swan and nursery areas of old time for (inaudible) associated with the fresher waters for wasters and things associated with the more brackish waters. And in between a massive, massive low lying wetland system also surrounding by nursery areas for marine and estuarine lands but also on the land had to catch the migratory birds that nest upon the (inaudible).

If you look at this place Albemarle and Pamlico Sounds and their tributaries the lineages of heritage in fisheries are acute. The Stripped Bass on the left have recovered after being over-fished since the 70s and 80s. Now there's been absolutely peace settling in an in creditable valuable natural resource that a lot of people are highly dependent on, but then also the Shads and Herrings that were in fact the founding fish. Not only for George Washington and Company that over wintering before finally vesting the British but also bring calmness overland to Jamestown into northeastern NC in the middle late 1600. That was the water that made this place work for calmness or be it certain people life. In addition to these fisheries highly dependent on working rivers, the marsh themselves provide key nurseries for fish spawn far from here. This is an aerial picture on the left and the tidal reef primary nursery area, the first place that sea spawn, shrimps and crabs and many other fish unsettle as (inaudible) growth toward juvenile and adulthood. But engine productions are much of the picture in the western Atlantic.

This area has a trendier of the third kind of keys in corporate marine habitant in the salty waters themselves. The salt marsh and shell fish bans in submerged plant beds that are important history grounds in their own life and also key feeding grounds for oceanic fish of all types. Not to focus only on the fish, if you get in between the nurseries and you find a wonderland of natural resource values, world class rural class farmland part wood swamps sustaining both local and migratory populations of all kinds of critters, world renown in the (inaudible) system and beyond. They are also uniquely in this area a massive area of low lying non-life pairings, non-river side swamps bathed in deep organic soils each as deep as 12-14 feet. Kind of massive, massive carbon and also if under very wetland systems that (inaudible) water flows that protect the nurseries and pollution of all types including airborne pollution. Again it also provides habitat for large highly mobile (inaudible) entire migratory birds. Together an absolute treasure rarely regarded as such outside the sport club region. This is a threat to this associating the warm world driving seas are acute. The one you've heard much about rex over land play is only the tip of this iceberg. On the left you see a figure one of Dr. Riggs' recent contributions so everything in blue lower than 20

feet above current sea level and that's vulnerable the same kind as over land play change each day world wide sea level rise to current levels before. The same that happened back about 160,000 years ago. The figure on the right shows the areas that are in blue that will be flooded with lower levels. They start at 700 miles and go up to closer than 1500 square miles that with that expected sea level rises on the order of one to roughly three feet. That's much of this natural treasurer that will be directly flooded by rising sea level.

I probably should say that this shoreline the living process is natural as you've heard. If you look at thecenter of the last curve this area has been subjected to natural large scale long term variability of (inaudible) and this alters the shorelines. The way the system is zooming and the way it responds naturally to such as the last upgrading over land migration of shoreline communities. And what happens is that potential upslope migration, up basing migration is directly (inaudible). That's why people like me care so much about bulk heads and estuarine. But in addition to overland play the rest of the iceberg looks roughly like this (1) these globalized lands have been ditched and drained since George Washington since the 1790s. Everything here in blue is a ditch or a sound but that does not show the field double digits, there is a strange network in place in all of these ghastly low lying lands where natural spring channels can be put into channelized form. That's Pocosin Swamp also one of Dr. Riggs' pictures where the (inaudible) stream area and cut up into mile and a half mile blocks with major channels in blue field ditches connecting just about the entire land scene. Ways to get water off of marginal wetlands in order to use it for the surfaces but also entry points for water moving upstream and the salty waters moving upstream.

Drainage networks also lower the water tables that cause its peat to oxidize liberating large amounts of carbon currently stored in demorganic soils. A piece of the property played and I think it was vastly undervalued and a huge financial opportunity in NC to invest in stock loss for currently sequestered carbon and peat. They offer flow patterns, they allow for salt water movement up canal but also through ground and altered soil structure. They offer vegetation and (inaudible) habitat and therefore human potentials for both for recreational purposes and also for money making purposes for forestry and for agriculture. (2) The rest of the ice burden is storminess not just hurricanes but extra-tropical cyclones. You all remember Floyd and Dennis on the right the rainfall amounts I know are fresh on your mind, Hurricane Isabel on the left and the massive recession of slopes and blusts that occur associate and (inaudible). Again Dr. Riggs thank you so much for your pictures. North Carolina is storm central and this is just counting hurricanes with 46 hitting our coast in the last 150 years. If you count nor'easters and extra tropical cyclones this is per death of storminess. In fact Dr. (inaudible) at a recent symposium added with this equation the fact that most of the big storms that made the northern Atlantic arrived off our coast. We are also the generator, both the receipient and the generator of much of the massive non-tropical storm activity in this part of the world. And so are the bulldozers of the coast the models of simple overland flood simply can't at this point count for the time that has been driving effects that I personally think and that if it's due to (inaudible) swamp the effects of direct overland warmup.

This is a figure from 1974 that was about when I started working on this and Dr. Riggs has been here for ten years showing where the Roanoke River channels have been earth

geologically. You look at it and you will notice (inaudible) right now is a highly looked upon Barrier Island and the task is probably to the future is an Albemarle Sound with the Roanoke River going due east through this (inaudible) northern Barrier Island. The point is that non-linear threshold of sets of variety of scales are in our future period. There will be (inaudible) the lack of innocence in the north since 1817 and is pure artifact of things that have happened here and whether you believe the exact prescription that Dr. Riggs' has laid out and perhaps particular short term future of maps of inlets to the north or the longer term future moving more toward that has a much more dramatic impact or not there are dramatic changes in our coastal future period.

Understanding the implications of these gets complicated because it is not just flooding. It's not that flooding causes it to be lost flooding in enclosed land is different. So understanding this in terms of equalized cascades induced by plaque appearance is key to the (inaudible) success. The forest, new inland alters communities, swamps and marshes. Those shoreline pipe, alter habitat value, alter human and usage patterns and it's not just a simple linear attack that cascade attacks across the complex system. The truth in NC is that we have massively altered many of the basic glaciers and the disciples that maintain our coast. The water balances on the land, the nitrogen balances that have been preferred far more than the carbon budget and also the carbon budget. Thinking back on the future especially in the north, with a (inaudible) moderately sailing Albemarle Sound makes you wonder about nutrient sensitivity. Not just in the shoreline but in Albemarle Sound and therefore the assumptions that we have made about the pipe flows off the Roanoke protecting that system against nitrification being eroded when we take sea level into account. The real point is that all of our status quo thinking needs to be adjusted taking into account what science tells us about our changing future. We know that this last (inaudible) in use that more frequent big storms may also be accompanied by gulf (inaudible) prime times and that rainfall patterns will change probably but not with higher peaks and lower averages. That means altered water availability both for humans and (inaudible) needs will need alterations in that assembly from acids from waste that be consumed in our rivers already stretched to the breaking point and these increasing competitions for water and for (inaudible).

Changing warming world also means changing temperature patterns, it means altered forest, altered crop potential, altered natural vegetative communities and it also means altered fisheries. Most people don't realize that right now Gray triggerfish, the fish on the right has largely replaced Black Sea Bass. It's the main shell fish of the south and there are definitely changes underway. You may have heard about tropical fish in the summer and that is that it is absolutely happening and once its direct response now is that the patterns that are vigorous, it's hard to say but changes are underway. And of course there are implications and another thing you probably haven't heard about is that NC has four reefs. You probably have heard that most scientist believe that within 50 years with the world's coral reefs may largely be gone as we know them. The fact that basic biochemical capacity to make calcium carbonates (inaudible) may be gone in most of the world's oceans you may have no idea that is a direct implication for us. Because (inaudible) spinning south of Florida are roughly 20,000 square nautical miles of deep water coral reefs a world class deep water coral resource. We are just beginning to look at them the scientific community

with great vision from Steve Ross at UNC Wilmington and others are just beginning to understand what's there. They profounding findings are that many of those reefs are already in trouble that there are dead corals associated with many of them. The picture on the right shows roughly 500 ft tall coral reefs mound system those are the type that occurs. It gives the ocean's current conveyor system really breaks down the way some people believe because all their annuals, all of the greenry are adapted directly to buying those terms as both water and then unvegetative.

Finally the iceberg looks like a different (inaudible) feature the things not yet understood not necessarily fully (inaudible) into our (inaudible) ecosystems having some unpredictable effect. You may have seen these if you've gone visiting in the Pacific this is a Pacific red line, these got established in the middle and late 90s in the southeast coast and they're now spread broadly all up and down the east coast they are gracious predicators on everything else on the reef. I am not claiming that they are here because of global warming but those are interesting things to think about how the introduction of individual species we don't yet understand from massively (inaudible).

Let me complete with a huge specific recommendation:

1. We need a comprehensive and integrated climate action plan
2. We should leverage all existing environmental plans along the way. We have an unbelievable set of tools in our tool box and our General Assembly has shown great courage and great foresight in requiring coastal habitat protection plans and collaborating (inaudible) expert program just beginning to revise its (inaudible) plan. Just great planning instruments here to use, every single one of them should factors in the best (inaudible) science as prescriptions for short and long term management. Some specifics that should be included are: flow targets for all rivers including re-operation or removal of dams necessary to achieve those. Identification of drainage system divisions and particular access points are very critical in translating sea level rise (inaudible). There should be a (inaudible) on the insulation of new public and (inaudible) license infrastructure in the flood prone and surge prone areas - makes no sense to funnel money into these areas. We should remediate mistakes we've made in the past. We rarely do that we usually fix things fast or as soon as we can. We should move forward with tools in hand to balance the entire biogeochemical cycles. We should use neutrals the new (inaudible) for balance to begin meeting not just carbon emissions goals but also nitrogen goals. Remember nitrogen oxides are the major greenhouse gases above water and habitant.

We should invest in restoring oyster reefs not just for oyster reefs but also to buffer shorelines and decreasing energy. We should adopt policy in the for sale stage to upslope natural movement of shoreline in response to rising seas. And the last two things that the no brainer is we should be investing more in research and monitoring that will allow us to predict impacts. The federal government is beginning to establish jobs with USGS and lining us up with great thinkers, great universities it's time to get ahead of this (inaudible). What you probably haven't thought about is that with innovation comes change (inaudible) in NC submerged lands are public. So doing a transition blooming of existing private lands turned into public lands there is no reason that smart governments anticipating that change

can't politically (inaudible) programs that facilitates those with private losses and that help (inaudible) along the way.

In closing, this picture of the sun setting of Albemarle Sound suggest dire straight ahead and there are serous changes coming but the Osprey to me is perhaps the better model and that is it is under recovering researgents exemplified by that animal that push for implimatic coast line. People place their time and attention and resources to better achieve for that species but there is no reason that we today thinking about NC coastal future can't make commitments now and make investments now to help ease this transition along the way toward a future that humans appreciate and that the national system can (inaudible). Thank you.

Mr. Garrou – Thank you very much Dr. Rader. Our final presentation in this block of the coastal development will come from Courtney Hackney who is Chair of the Coastal Resources Commission as well as Walter Clark who is the Coastal Community and Policy Specialist for North Carolina State. Thank you.

Mr. Hackney – Thank you and I can't tell you how thrilled I was to hear that our General Assembly had the foresight to begin thinking about something that you've heard about a lot. I have two hats that I wear, one is I am a research scientist and my basic area of interest is studying how coastal wetland and coastal businesses respond to (inaudible). But I happy to sit back and (inaudible) right now and my primary goal today is to study a little about how the state of NC (inaudible) has adapted or has not adapted in terms of policies. Now I wasn't sure how much you heard before I got up to speak about the science of sea level rise from the other presentations but clearly they have given you information you need to make what I am going to tell you more clear. But I think that there are some points that are worth repeating.

The first thing I want to reiterate is that there are a number of components in sea level rise and these have direct relationships to coastal policy, as you've already heard sea level rise is more complicated than just water coming in. Also want to emphasize that the ocean is not flat and I'm going to reference Key West a couple of times for two reasons: (1) I'm from there, my family settled there much like Outer Bankers a couple of centuries ago so I got to experience sea level rise from a personal standpoint. I've also had the opportunity to see how the government is affected. This tidal gauge is a gauge (**Exhibit I**) from Key West, FL and you see how much the locations of it goes up and down, and that you've already heard from our previous speakers, but then it smoothes out fairly clearly and we had a nice living relationship in terms of sea level rise. The primary concerns that we have had historically in NC that relates to sea level rise is the coastal erosion and you've heard those people talk the fact that NC has a very high rate in the coastal zone. We have totally been dealing with from a policy standpoint far longer than anything else and one of the things that have been happening that has had a great effect on the NC coast is a change in (inaudible) and the way (inaudible) travel. So there is a down side to it – it used to be when a major storm was (inaudible) close to the coast close to the ocean. These are issues that are going to continue because of building on the coast. We also adopted years ago a strategy that could really help us and that has been to have set backs. Initially, apparently

we decided that everyone who got an urge to live on the beach should be able to pay that mortgage before the house slide into the ocean and some of you remember the mortgages for 29 years for some reason. So we basically have a policy of ten year erosion rate and setting a new house back 30 years worth of erosion and so those built in the 80s when we had a big building explosion now are getting very close to the subject. That was we had this policy of stepping back, but as you have gathered openly you can only step back so far. This has worked reasonably well and I will tell you that there is an awful lot of pressure right now to allow for change of policy and at some point in time there are going to be a lot of houses sliding into the ocean and we will be spending a lot of money on beach erosion .

We have a fairly consistent policy of allowing beach nourishment this is not without environmental costs and as those of you who (inaudible) know we can also profit (inaudible). When you stand on Wrightsville Beach and you're standing on the sand most people have the idea that what they're standing on is sand that has slipped out of the ocean and that is not true what you're really standing on is a little bit of sand and a lot of water underneath. So when you start looking for sand and re-nourishment sand especially at a certain quality certain consistency (inaudible). What is happening is a difference between the (inaudible) there aren't big pools of sand out there in general that can be used and so one would think of it as rising up nourishment (inaudible) is the fact that we do not have sand. There is a lot of sand in the NC coast and that's a long way from most of the places where we need the sand.

General Assembly wisely decided two years ago that we were not allowed to (inaudible) beaches. Permission was decided years ago but I will tell you that the last couple of years there is a fight over whether we put sea gulls on the beaches. Sea gulls protect (inaudible) they eliminate destroyed beaches. So we no longer have no policies about any parts structure along the beach there are few exceptions to the storm structures and take into consideration (inaudible) and so forth. We do allow sand bags I would like to tell you that this is an issue that isn't easy to solve. Sand bagging is the only temporary feature we've spent probably one-third on dealing with sand bag issues. They build the temporary features to save peoples' houses and everyone realize they worked ok for the storms but no one could save the house. So we've had a very difficult time managing sand bags and we continue to have difficult times. Big storms eliminate this problem because they focus on sand bags. Sand bags have a limited life span and we prohibit them after a certain amount of time. We have wisely figured out how we can eliminate certain kinds of storm damage and you understand the sea level rise that creepy sloping knowing it's swallowed up by sea level rise. We have plenty of time to (inaudible) we don't have time to move quickly when we have a storm. The storm is built on top of the sea level rise that has been going on for a long time. We have good evidence good sound evidence to show the berm protect (inaudible) and so in the special projects that produce the nourishment on Wrightsville Beach and Kure Beach the plotting designs show berms and those berms are very very successful in stopping storm damage in recent storms. We are often sacrificing those berms, they will be building them back afterwards but they do work well. Local zoning, many communities, beach communities are aware of the danger of both (inaudible). There are building policies that everything from high boots are tied on and structural aspects who will allow buildings to be replaced. It's generally local but you have to understand the

local governments are under pressure to keep their tax base up so therefore the system pulls them in two different directions, one of the things that has largely been outside of or doesn't even have any control of which has been reasonable consistent for a long time is federal insurance. The federally subsidized insurance program has allowed a lot of people to live on the beach and have flood insurance. For many many years there were very few changes to that policy but after the major hurricanes starting in 96 in which those of you who were here remember NC was like the bulls eye of the Atlantic we just got a paddling time after time. We begin to see interest in the (inaudible) changing the way in which they designated flood zones and the way in which they were going to manage the program. This process at the federal level has been pushed very hard by the storms in Florida and now Katrina and Rita are just exasperating federal moves to make some changes and the federal moves effect how we operate on the coast because it affects how people get insurance or whether they can live there remains to be seen how all this is going unfold.

This may seem like a strange side, I'm back to Key West, but I want you to see something. This is a family home of my family, this is sea level rise down at the bottom. I took down all the hurricanes those little dots are hurricane surges there are two hurricanes that this US has had exactly the same surge height. One of those hurricanes came in 59 - my family's home had water up to the top step but it didn't come in. The same exact surge in 2006 from Hurricane Wilma flooded my family's home, 2005 five inches of water. We never had storm damage or water in the house and all it takes is an inch. So sea level rise didn't cause that flooding the fact that the ozone had gone up is why that house flooded. Now I'm telling you this because we have few (inaudible) in NC where we think about the ocean but remember there is a back slide on these Barrier Islands too. The water comes up in the front we deal with wave damages and storm surges in the front, but that water level is also coming out of the back of the island as well and every year the water gets a little higher with exactly the same storm surge. So this is something that ultimately is going to be able to protect our coast.

I would glad that the other speakers suggested or discussed the fact that we have more to sea level rise than just what's going on in the ocean because NC is truly being affected. In some places greatly affected by what's going on deeper down in the ocean or deep down in the earth. I can tell you that some of these factors are important in various places including NC and they are making our sea level or which we call relative sea level change different than the amount of water coming out of the ocean. Now the (inaudible) to the ones that we've spent a good deal of time studying particularly in Louisiana and if you don't think this is important let me just tell you that the city of New Orleans was flooded largely because of shallow sediments. The levees that were built around the city of New Orleans were built with certain pipes initially when the storm hit, hitting those was a foot and a half lower than what it was built to and still looked the same it was still the same height from the outside of the levee but the whole (inaudible) had dropped because the (inaudible) would be watering they're settling, they're consolidating so the whole Louisiana area is settling and changing making up the sea level shoreline faster than most of the world. We have some of this but our problems are a little more immediate and close to the surface.

You heard Doug Rader mention that we have large areas of peat, large areas of wetland that can (inaudible) lots of organic soils. One of the things that we haven't understood very well is one of the things missing from our understanding of what happens to coasts and it is especially important to NC. Most of coastal NC's sediments and that keeps us up to sea level rise has accumulated and keep up with sea level rise that is why all the areas between Albemarle and past the sounds where we have 14 feet of peat of wetlands and again sun can make us stay up. So from our aerial view it looks like land hasn't changed, it's staying up to sea level rise. Along our coastal rivers we have sediments coming in that allow the swamps to keep up the sea level rise. In the coastal marshes storms bring sediment you pickup at sea level rise. Historically our wetlands have made what they needed in terms of adding sediment to the coastal sea level rise. There is another process that's going on here and some greater nations is not going to bring it home because this is super important for our management of the coast. Organic materials disappears from bacteria consuming and there is also opposites present that first half but no opposites and that's what most weapons are like, they process very slowly so they accumulate. So that 14 ft of peat that hasn't been put back when it flooded could not be there it would be 14 ft lower behind the Outer Banks where all that peat land is. But this (inaudible) process is driven very very fast when we have salt water intrusion and I cannot emphasize that enough. This is my sign (inaudible) all I am going to say is that the process is very complex it is something we don't know much about but when you start having salt water come into these (inaudible) the rate at which sea level rise is changing dramatically. One place in Cape Fear River is where we have been working for years – one place in ten years has dropped surface elevation six inches. So that is a six inch rise in sea level at that location in less than ten years. We watched this happen and the only thing that changed was salt water coming in, salt water intrusion.

You're heard rainfall changes and all the possibilities that are global climate change – we had a record drought in 2001-2002 we had salt water all the way up to Castle Haynes that has never happened before so are seeing salt here in areas more salt water bring more sulfate (inaudible) to disappear. I am not going to go into all the fun stuff that's in here but this is another map showing the Outer Banks showing NC's coast but what I've got outlined in red here are all the areas that are under meter and a half in elevation and virtually all of these are pure organic soils. If you were to move to the Outer Banks and that salt water come in there you would be loosing surface probably at a rate of half a foot every ten years at least.

Now from a management standpoint, just think about all the things that go in those coastal areas. Notice down below we have a lot of that kind of habitat too – we have roads that we have to figure out how to rebuild and get through and we have subdivisions that are in parts of those areas that will need infrastructure. So from a long life standpoint this is going to be a big problem even if sea level doesn't come up it recently have salt water (inaudible) in these kinds of places. Now the year coastal (inaudible) is one where I will confess we have had a difficult time making rules that in my opinion were going to have long term capability.

You're heard the National Academy report where basically they are saying this is something that we need to deal with. There are major problems and from a policy standpoint I will tell you that the biggest problem in dealing with the inland water and inland inlets is that they are different. It's very difficult fashioning rules and regulations that are different from place to place. We've done that on the coast by looking at coastal roads and saying ok (inaudible) but in the coastal cabin each part of the shoreline is subject to different problems, different erosion problems and probably difficult solutions. You've also heard that one of the difficulties is getting local (inaudible) use to seeing something different happening. Everyone knows what a bulkhead is – everyone knows somebody that knows how to build them – it is easy to find somebody to build a bulkhead. It's actually difficult to find someone that knows how to use some of these other potential solutions. We even have a difficult time getting some of our federal and state agencies to buy into these other solutions. The ones that we've looked at, off shore flooring, basically would be (inaudible) off shore to rock to protect the marsh that they cause marsh to build. We have our different missions that have different responsibilities and the agencies that carry out those rules and responsibilities and it's often difficult to measure all of them.

One other thing that may turn out to be extremely important is the fact that the feds are soon pulling away from regulations weapons. They have been doing it for some time and some of the new Supreme Court cases may make the oversight according to the EPA more difficult for them to use, so some of those fresh weapons that we simply started getting innovative with salt waters will be a channel that probably shouldn't be there in salt water channels. We are going to have a hard time controlling some of that (inaudible) as in the past. We usually just rely on the feds – we're going to have to think about what we need in terms of regulating those weapons. We do regulate coastal weapons we cannot actively specific case and water coastal weapons (inaudible). We have required certain species and plants (inaudible) work pretty well but when we get away from that edge it doesn't work very well alone so this is something we are going to have to think about.

Infrastructure – I've got this in here because one of the things roads do when they go to large areas of weapons mechanical and (inaudible) they become dams, we may want to use those to control fresh water and keep salt water out. But we may also want to make sure there are places where the fresh water can get out. These are some of the things that we need to be thinking about as we design and build infrastructure. I also recognize that the sea level is rising and that plan is falling we are going to have to think about how do we build those roads so that they don't do what the roads in Louisiana did.

Land Use Plans – All of the newer coastal policies particularly if you have any long term background on what happened along the coast and what nature does. One way we can start strategically thinking about how we manage the coast and demanding (inaudible) we want more roads. So they have the power but I will tell you and you're going hear from Walter in just a second that very few have decided to do that. Any real weapons to sea level rise other than raising of the (inaudible) I can't think of ever reading one integrating sea level rise and what that is going to do in terms of (inaudible) in the future into their (inaudible). Furthermore we don't have any ability in terms of regulatory environment to force local governments to follow their (inaudible). The only way we have any control over them is if

they require a channel turning and we will not turn in anything just highlight the language that much of those areas where they (inaudible) are truly limited. So we have some concepts that are very clear and good it could be abandoned through the developer once they develop some area that is marshland. It's unfortunate that that's the story here of what's happened and it is still happening today.

Public Awareness – Walter this is probably a good time for you to share a little of your knowledge on the public awareness side of it.

Mr. Clark: Several years ago I did a study and we looked at all of the (inaudible) on the coast and we were looking at those plants to see if (inaudible) talk seriously about sea level rise and climate change. And surprisingly even though there is language in the (inaudible) guidelines that those weapons aren't supposed to do that we find almost no language in the plan where they had. I think we need to get more on board but the importance of this still I imagine if you look at the (inaudible) today you could find (inaudible) adequacy in having a grip on sea level rise and climate change.

Hazard Notification – Courtney wanted to give me a minute to talk about this because he knows it is a subject that is near and dear to me. There will be a brochure coming around **(Exhibit J)** in just a minute that I offered years ago along with Spencer Rogers one of my colleagues at Sea Grant called Questions and Answers on: Purchasing Coastal Real Estate in North Carolina. The idea was that it would be a good start letting people who are buying property along the coast know what they are buying and have some barriers. The problem with this is (inaudible) that it is not mandatory – it is voluntary. For quite some time now people have been concerned about the fact that there are people who are buying property on the coast who may not be aware of some of the hazards that they might encounter. Along the coast as Courtney stated there is a long standing policy to let our shore lines move. This is basically a (inaudible) situation we have set backs for from new construction basically that is to keep property out of harm's way especially from the roads and coastal storms for as long as possible. A lot of the setbacks that we put in place years ago are hurting the 30 times erosion and setbacks are now probably being caught up with. Another way that we have basically managed because we know no targeting policy on the shoreline that is very different from the ocean shoreline where we do have hardening. The only exception being is according to the government, arbitrary sand bags and said properties until other solutions can be derived due to the moving of property in these various projects can be indicated.

Sand bags are a one shot deal for property so when they get installed or removed the owner or subsequent owner has (inaudible) to do that again. For new construction a developer under the counter rules must sign something called the Ocean Hazard Notice acknowledging this associated with building in the environmental coastal area. However for some with real estate transfers after the property is built, no notice is required. And since most properties transfers on our ocean coast lines are usually resale there are re-buyers who may be unaware of the special risk associated with buying these properties. These risk include a living shoreline often called in (inaudible) terms the Walter (inaudible) rate that the erosion often protruded into sea level rise. Another risk includes the fact that

the property can't be protected from erosion except by temporary sand bags or a re-nourishment project. And third, the sand bag may have been already used and can't be used again and finally the recent headline shows all property on the ocean front is coming under control because of the higher risk associated with it.

For many years it's been an effort to establish a full notice required of erosion from property today, these efforts have not proceeded. Given the current situation with rising sea levels and the potential for more intense storms, I believe we have an obligation and I think a lot of people will agree with me to look at this issue again of hazard and education to buyers. Notice can be accomplished in several ways – the most direct and perhaps the most effective way would be notice from the company deregulations. I believe some people in the General Assembly may be familiar with that option – I think that is some legislation that has been cleared in the past. But other options could include adding warning to the current real estate closing (inaudible) required from seller to buyer. Another would be if the property is handled by a realtor you could require distribution (inaudible) similar suggest updated. That would have to be signed by prospective buyers much like the dual agency brochure that a buyer gets once he hires a realtor. That way the buyer has acknowledged the receipt from the commission, read it, begin to (inaudible) that is the normally positive discretion that the realtor is involved. It really doesn't imply the realtor might have property by (inaudible) other situation.

There is really an educational opportunity here with the full disclosure and having notification. I think it's on the path – I think it is time to revisit that and figure out how we are going to revisit it maybe require some type of legislative action or may require some action from the real estate commission in NC. I'll turn it back to Courtney.

Mr. Hackney: One of the key points that needs to be made is that despite everything that you see in the news, everything that your children have learned and their grandchildren have learned in school about sea level rise, the idea that the ocean is coming up does not seem to demonstrate into government procedures. It's a local level assessment. In fact I would argue that the thing that has the most success at making our citizens along the coast aware of sea level rise and coastal form has been the insurance industry. That's why I've got it back in here again – I will guarantee you when you get your notice if you live on the coast this year assuming you can get insurance, when you get that notice of the cost, it's going to suddenly make you think about why is my cost going up or maybe it's because we keep getting washed away. That being said I also want to mention disasters – wind disasters occur frequently there are a number of things that happened. First of all getting everyone back under view of public safety but then often there is a period of soul searching where those servants should re-think why did you ever put that road there, why did we ever let that subdivision go in. The last six months to a year when (inaudible) goes away but that moment in time there are opportunities at the local and state level to do things that we should have been doing all along and we would probably like to do.

There are a number of other issues that are involved that either the policies that we adopt simply don't affect but they do affect the coast that are important to think about. Local ones you've heard already in the dams trap sediment. Cape Fear River basins has three

dams – they trap virtually all heavy particles coming down the river. We've looked at the sediments along Cape Fear River and essentially in the swamps those sediments are simply not getting there and so our swamps are grounding out because the sediments aren't coming down. Our engineers are clearly interested in trying to think about basin sediment management because they have to get rid of sediment but they also recognize the places like Wilmington and coast itself in eastern NC have been cut off in the sand forest have used it come down Cape Fear River. We certainly don't have as much sand as we would if those dams weren't there. What's particularly sad is that everyone wants to dam the island – that's everyone that seems to have anything to do with environment included but they are still there. So dam trap sediments is a particular problem also local (inaudible) very much seem to spend some time realizing that if sea level comes up the ability simply makes the work decrease, business is especially important where you have areas that have been settled for a long period of time that has septic tanks going back 100 years or more and suddenly they don't drain as well. This is one of the key things that happen when sea level rises.

The insurance industry is like that, it is certainly driving an awful lot of thinking on how we are going to handle it and my guess is this is going to come back some day in a very important way. But at some point in time the huge population growth on the coast is going to look for somebody to insure them. It is very clear that local and state and federal insurance companies that are not sold (inaudible) they are trying to back away from the coast and what is going to ultimately happen is that they are going ask the state government to increase their exposure. The federal government is pulling away and so this is going to be something that the General Assembly is going to have on the store steps in a very near future. You are going to be hearing from your constituents on this I guarantee you because we're hearing about it.

Cumulative Impacts – You've heard earlier about cumulative impacts – one little cup doesn't do much for the thousands needed there. It isn't just the impact of 1,000 cups it is also the effect that our policy end up being directed by the number of people there and the number of things that are happening. I'll guarantee you that if we only had ten families living on Cape Hatteras we would not be discussing putting in a multi-billion dollar cost way on Ocracoke Island because it would not be cost effective. So when you get thousands of families over there then the solution ends up being very expensive and you don't have a whole lot of choice particularly when it comes to forms of safety.

Is it really a hurricane or something that happens very frequently in NC – we have largely looked at hurricane and the aftermath from safety and health standpoint. Try to get people back on track fast as we can we also have all sorts of emergency rules we work on to allow people to rebuild where it seems to make sense. Wish I could tell you that everyone of those have been good but they've all been oriented to assumed safety and human health is another one included. Unfortunately when we go back and we start reconstructing shoreline, typically the first move is to get everything back the way it was. So when we build roads on Hatteras Island where they were to begin with (inaudible). It's a bad place to have an island basically that is what happened salt water places get washed away. So we've gone back and we do things very quickly we don't have any sort of deliberate course to handle the aftermath. We should have policies that say after the storm we are going to

implement these decision making promises so that we don't repeat the same dumb things we've done before. We like to think we've used some of that but the truth is we in CRC and you in the General Assembly and local governments are driven by a notion that it has to be when we have a big bad storm.

I want to show you that this – notice the watering pattern this is not a storm, this is not a hurricane this is (inaudible) this is a house being rebuilt on the left hand of Dalton Island they are about 80 to 90 of these houses washed away and they are all being rebuilt now because the local government with money from the federal government rebuilt all of the infrastructure out there. But you shouldn't go back and do the same dumb thing again and that is what we tend to do over and over again after the storm. We would like to think that we get smarter and we do step back some degree but we need a plan for the big one so that we don't make the same mistake. Those plans by the way need to include someway in which you help the local people who want to get back. That is one of the difficulties and a major step that we have – we have too many people needing so much that the divisions are just overwhelming and we don't have time to do any sort of changing the (inaudible) in this shift that rings natural.

If you need more information please contact me at the University but I would like for you to make this a policy too.

Mr. Garrou: I'm counting on the fact that you may have forgotten some of the questions you were going to ask earlier speakers because we are running behind so if you could exercise restraints I would appreciate it.

Rep. Harrison: Thanks to all of those wonderful presentations. (Inaudible) … we have debated about why (inaudible) …. I'm wondering if you all could have a say on how do you suppose (inaudible).

Mr. Hackney: I think generally we would like to see the public understand the rich (inaudible) when they buy coastal property. I can honestly say that does not happen no matter what realty (inaudible) there are a lot of people who end up in places and claim they have no idea that ban those places (inaudible). I think the key for us is going to have a hazardous disclosure any place any time there is some sort of special permit. So any where along the coast where you have erosion as a factor that would come into play and that includes estuarine shoreline. We never discussed that because we know how difficult it is to deal with that during estuarine discussions but we have coastal erosion there too and one of the things that it does is that it eliminates the (inaudible). So right now we let people put up bulkheads. The erosion still goes on with bulkheads so I would like to see those stations where anything that requires a permit (inaudible).

Rep. Harrison: Thank you. I was just wondering if (inaudible).

Mr. Hackney: Are you thinking of (inaudible) in terms of sea level rise taking land. I don't think anybody in NC has a clue how much is incurred in a Cape Fear Basin. It is at least 200,000 that change hands with private and public (inaudible) at least probably in the

last ten years. Although the swamps along the Cape Fear River are technically public land there is a good (inaudible) but 100 years ago they were all way above the tide so we have no policy right now we don't even assert to restriction in terms of (inaudible) and so forth. I think there needs to be some thought given to the role in easements some day perhaps to compensate the individual that used to own the land. I don't know how you would do that but this is no small concern, this is big. And if the Outer Banks breaks up a little more and those tides come you are going to have exactly the same thing, large areas of the peninsula between Albemarle and Pamlico Sound.

Rep. Harrison: I want to follow up on what seems to be a personal (inaudible) and I don't really understand the process. Could you elaborate some?

Mr. Williams: I'm sorry what was the question?

Rep. Harrison: You had talked (inaudible) fresh hold (inaudible) ...

Mr. Williams: Yes what we did was use this computer model and put in the possibility of a very rapid (inaudible) and that would suggest that the (inaudible) of the Outer Banks is accessible under what we call special (inaudible). It really supports some of the work that Professor Riggs and others have done documenting that in the past when we've had natural accelerations of sea level that on the Outer Banks more inlets have opened more of the Barrier Islands have (inaudible) rapidly and become submerged. In our modeling suggest that in fact that is a reality we have certainly accelerated in sea level rise.

Mr. Hackney: I'll just follow that up with an analogy that I use with my students because it is a good one. Most of the time we think of change leading to something else and it's a slow process one change to the other change. In many cases the way with the natural rule of thumb is not (inaudible) you turn that little (inaudible) down and nothing happens and all of a sudden the lights go out and that is what we see in terms of some of the biological communities along the coast particularly the swamps and wetlands. It looks flush from the air but nothing has changed but when you look at them (inaudible) what we are seeing is fundamentally they could begin to change dramatically and if you're interested in (inaudible) we looked at how much carbon flushes out of the system when you start adding salt water. It goes up as much as 700 percent. So this is no small thing, this has all sort of implications not just the surface rate but this enormous store of parking is suddenly in the atmosphere and what happens is everyone calls me and say watch the storms side down here. They just crossed that point the threshold where suddenly everything all changed and now (inaudible) on the biological side.

Mr. Everett: I wonder if we can go back to one of Dr. Williams' slides on sea level. I guess the thing that puzzles me about this whole issue is at some point on your graph on sea level there was no Albemarle Sound in fact there was no Outer Banks at all. And so we are in the situation where we are looking at it and figuring out a prospective of these very valuable resources we need to protect or maybe we don't I'm not sure. Some people would argue to keep it the way it is others would say let it change but clearly it has changed and will change. So the big difference is the public probably doesn't understand and I am not

sure I have seen the information that helps me to understand it better. How different is the change based on what we think mankind is doing versus the natural change?

Mr. Williams: That's a good point – you know if you get the difference in timing as scientists and geologists we are very comfortable with thinking and talking long term, whereas to the average citizen 30 years in a mortgage is a long time. So that is part of the difficulty. But the graph that I showed shows that 20,000 years ago sea level was 120 meters which was 400 ft lower than where it is at the present time. So you're actually right at that time the whole continental shelf was exposed, the shoreline at that time was out at the edge of the continental shelf (inaudible) that places the animals where as well as early man we were probably roaming out of the continental shelf. As the climate warms sea level came up regardless to where we are at the present time that same record shows that 120,000 years ago sea level was probably 20 ft higher than where we are at the present time and so at that time there was no Outer Banks they were under water and much of the NC coastal plain was in fact submerged. I think the reality of it is that we are probably headed toward that 120,000 year sea level scenario once again, that's the issue. But you are absolutely right if you're looking to dodge the past there has been wide variations in climate, wide variations in what the sea level has done in some cases those changes have been very slow. Many things have been very rapid, there is recent evidence of in fact very rapid climate changes in the past due apparently to natural conditions. We don't know exactly why that happens but there is evidence in decades or centuries of changes of several degrees in global temperature which drives all sorts of changes. So I think what we are looking at is human induced changes on top of a lot of that natural variability. And so it is wrong to think that climate change is all due to humans it is not we have documented science records a lots of variability from climate change. What we're looking at is humans exasperating the changes that are taking place.

Dr. Smith: This is also for Dr. Williams. The variabilities that happen over long stretches of time obviously historically there was never any commendation to level with. We had the investments along the coast line that we have so we have these stipulations and my concern is that the projections particularly with some of the new signs that's coming out about Greenland, I was wondering if you could comment more about that because I know in the IPCC report many people are now concerned about the over conservative projections. The rate of the melting in Greenland and back down to developing science about the actual dynamics of glaciers and their beginnings and a lot of science has never really been understood before but it is just now getting a proper focus. In fact now that we are seeing significant earthquakes on Greenland at levels that have never been seen before because of some of these shifts, can you talk a little more about that as far as the sort of non linear way that Greenland could begin to be treating significantly to and how that type of impact is as far as the types of rates could happen?

Mr. Williams: Yes in my judgment the IPCC 2001 report is probably the best summary that we have on what to expect. That same group has been deliberating since then as was mentioned they're coming up with a report in 2007 and I think you are right. That is my assumption too, there are similar conclusions they are coming up with in the new report. I think you're probably overly conservative and don't factor in some of the recent findings

that we are finding on Greenland and Antarctica. Part of the problem is that they have been deliberating for five or six years and then had this report in preparation. The report has to go through a very extensive review process and so a lot of information that has come out on Greenland and particularly in Antarctica has just come out in the last six months or the last nine months or so and a lot of that has not really properly gotten incorporated into the new IPCC report and I think it should. And it very well could be that the report is going to be delayed because I think others have made that point, but really they ought to incorporate it to absolute latest science. But of course the challenge is whenever you write a report there is always new information coming out – you have to draw the line to say – we need to get the report out and be done with it. But I really am concerned that the new IPCC report is going to be overly conservative in some of the numbers when they come out. Primarily because of the light on (inaudible) that is being done in Greenland showing the various green of ice lost in the melting up there and the fact that so much of the ice water is (inaudible) in Antarctica has been shown to be (inaudible). Not that it is directly contributed to sea level rise but it ultimately leads to instabilities that materializes and can lead to very significant sea level rise. The one graph that I showed suggest that Antarctica contains 90 percent of ice that leads to sea level rise so it is very important that we understand the dynamics of both Greenland and Antarctica because it has huge implications of what might happen in the near future for global sea level rise.

Dr. Riggs: I have a question for Ms. Hernendez. In your presentation the feeling I got was that you dealt with the shorter term and how to mitigate shoreline erosion in the estuary dealing with not just our structures but some new technologies that essentially slowed down or stop. I would like to know from you what the National Academy of Sciences is doing in dealing with the long term where we have to deal the low lying lands where we have to deal with the evolutionary movement migration of the ecosystem of the slopes. How do we back off of some of this coastal erosion which in our estuaries is happening at 100 ft per year. In response to individual storms, we already have a tremendous amount (inaudible) of Albemarle-Pamlico systems because that says eventually has small ocean out there and the energy oils are very high and there is absolutely the same erosion rates that we have on the ocean and it is all storm driven. The ecosystems have to move before they can manage this system and (inaudible) what Dr. Radar has presented as an evolutionary development on our coastal ecosystems to protect the fisheries – how does the environment deal with it?

Ms. Hernendez: The Academy committee that took this on didn't specifically differentiate short term versus long term techniques, leaving the focus on the report on what is that function and I think that message is the communities have to decide how they want their shorelines to look and they can only do that by first documenting and analyzing what the problems are, what the rates of erosion are, and what potential options are available to mitigate the erosion and it's a matter of trade off. That's another important point – you might need in some areas to acknowledge that there is nothing that can be done but let nature take its course and ask those to relocate. In other places where the erosion has been un-significant in their solutions of some sort or more likely options that the Academy didn't advocate one solution for (inaudible). It does advocate (inaudible) proactive and if

you consider various options for decisions made just be happen stance with individual property owners making small decisions in coastal communities.

Dr. Riggs: Did your organization even address this question of long term erosion if you just present this as short term event then in NC what we have is an up hill battle because people will keep going back to your report and if you don't even acknowledge the longer term process going on here, the public is going to refer to this as a major contribution to our science as to the status of things. This is a very important document.

Ms. Hernendez: There are sections of the report that address the design life of various solutions and that is as close as this report comes.

LUNCH

Mr. Garrou: Our next presentation is coming from James Kerr, Commissioner of the Study Commission and Sam Watson, Staff Attorney and they will report on the Renewable Energy Portfolio Standards.

Mr. Kerr: Thank you Mr. Chairman and members of the Commission. I am one of the currently six members of the Utilities Commission and I appreciate on behalf of my colleague the opportunity to talk to you all about a few things that we have going on. I think the agenda speaks to me recently completed a study of a renewable portfolio standard of which we over saw the completion of at the request of ERC and which we presented to ERC several weeks ago. And at the request of counsel for this Commission we were actually (inaudible) for just a few minutes we will do that. This came up before and we have our staff attorney Sam Watson along he actually handled that. In the course of discussing coming over here today it occurred to me and I mentioned this to counsel and to the committee and Dr. Smith and I talked about this, we've got a number of issues going on at this Commission that are probably atoned with you all. So one thing I thought I would do and Mr. Givens perhaps it would not be a bad idea if we try to first of all, run through renewable portfolio standard study and try to give you some idea of the various dockets we have going on currently at the Commission. I was struck this morning by the significant and in some ways so philosophical scientific discussions that you all were having before lunch and we did similar stuff and it should impact what we do. In fact we were charged with a different job that's day to day that will actually implement policy. But the issues are beginning to creep into a number of dockets because at George's suggestion I'm going to run through these fairly quickly and we can come back. We work for the Legislature for you all and we can come back and provide you with more information and we can come back at a number of times.

So first and foremost is probably the NC green power program that we are assisting in developing and continue to have oversight responsibility of. That is a voluntary renewable energy support program that we began working on that back in 2001. Currently there are 9,000 subscribers supporting over twenty million kilowatts hours of renewable energy. My stats (**Exhibit K**) tell me that the amount of renewable energy that that would equate to the amount of coal consumed annually to produce this equivalent amount of energy would be

16 billion plus pounds. The approximate amount of carbon dioxide annually offset by the generation of renewable energy would be greater than 22 million pounds. Here is a (**Exhibit L**) sweeter docket on (inaudible) small generator interconnections and implementation of the federal (inaudible) 2005 wherein we have given more people to try to make it easier. The smaller renewable restriction generation through interconnect to the system to take advantage of some of the opportunities presented by renewable generations. Again in our (inaudible) docket the small generator only connects to the purple standard portion of the renewable policy act and we have seen with people on (inaudible) and people in the sustainable energy association and I think we made some good progress but my sympathy is with the community while not completely satisfied with all aspects of what we have done across these three dockets. We have moved along and removed (inaudible) prior barriers to the interconnection of renewable resources on to the grid even though ability to take a gain about the four votes of residential and smaller multiple applications. And integrated before planning area we are seeing the main issues that have arrived at our peak process of the same need for new base coat generating and it's going to be the extent of these alternative sources of generation demand type demands with concentration and efficiency maybe up to displace some of the proceeding for new generation. That is an annual innovative resource planning process that the Utilities are required to conduct because of an increase in level of activity through some of the renewable conservations and (inaudible) energy entities that members we have identified several fundamental issues that have been raised in this discussion about some of these issues on who have taken those issues and moved them into a generic proceeding on energy efficiency. Looking at the number of issues surrounding the man size management on energy efficiency, one thing I would say is what we are seeing is more active involvement from alternative sorts of interest in these kinds of dockets and hopefully being responsive throughout and we're certainly plowing in to some of these issues whether it be conservation, renewable energy and others in a manner that is different than we were subject to four or five years ago.

And finally there are two dockets – these are kind of both meat and potatoes type of things that we've been involved in, some of the issues you all are probably interested in that seem to be arising. First is that Duke Energy has started a request for us to deal with cost associated with their exploration of nuclear generation. That is a little bit out of the ordinary. I need to be careful not to comment any on the substance of the matter but essentially it is a bit of an unusual request under our prior practice in and under our statue. We try to do different to say only at a point and time whether or not we believe that the pursuit of nuclear generation and the efforts they got to undertake to at least retain that as an option are appropriate for improving and within the (inaudible) regardless of whether they help keep the building into a plan. Again I want to be more careful about the comment and the substance of it and I try to characterize what is going on to the extent that it is helpful to you all. It is an unusual power and I think everyone will admit that it is not the typical approach that has been taken in the past. We are pleased that a couple of our businesses bought to us we are pleased to deal with things that people (inaudible) but it is a docket you would like about climate change and environmental concerns. And then I think the other one that bears interest is the flip side of certification/application due to the carbon application to build two polarized coal units outside Shelby in the (inaudible) community. And in fact I was in Charlotte Tuesday night for a charity lane at a public hearing down

there. That didn't pick up with the press but certainly a lot of the concepts was the alternatives provided by energy efficiency renewables versus (inaudible) and I would commend all of those documents and I haven't bored you with the documents but I wanted you to know that we are seeing a lot of the issues that are relative to you. We are seeing in our day to day efforts and we are available for any thing you want us to do or provide to the Commission more detail about that or being as helpful as we can in your understanding of how we are dealing with those matters.

Let me move on to renewable portfolio standards study and I have spoken to this group before about this since some of the members of our advisory group are actually a part of this group. Let me review the process and tell you a little about what this is. We were asked by the ERC if we would oversee and pay for the conduct of study, find anything and consult and take a look at the potential cost and benefits to the state of various scenarios involved on renewable portfolio standards. We agreed to do that to lay out a plan and a procedure that we thought was fair for everyone involved and that we would end up with the best product at the end of the day. There are two important parts to that plan. One was to go out and find a (inaudible) that had the extra piece, we didn't actually have access to the actual piece to do the kind of work that we could be proud of , but also that would be useful to those such as this Commission might be interested and we think we found that with the (inaudible) Association out of Boston. The second prong of our approach is the RPS Advisory Committee. Based on other experiences we have had we understood that is not going to be very productive for us to go into driving power. Most of the consulting we do in studies that no one in the community had seen before and we understood that the study would be benefited by and the dialogue would be benefited. By then the end result would be benefited by getting the various groups and that these are willing to help with consultants. So that's what we did and we had several representatives of the various environmental interests, various forces of state government as well as the low serving entities. Dr. Erickson is one of the smart people that we've considered on the subject matter involved and they've worked with the consultants throughout and provided background information with new graphs. I don't mean to say that all of the members of the Advisory Committee support these conclusions 100 percent but what I will say is that they were involved in the process and the results are tempered by their involvement throughout. We thank them for their involvement and it is the kind of thing that you all would look at in the report as others. I think you also have confidence that this wasn't something that was done and dumped into the community but rather the community was involved in and had the opportunity to influence along the way as ideas within the committee.

So that is what we did, we have presented the study to the Environmental Review Committee. We are presenting it here – we have a relationship with the consultants where they are available. Financially we are looking on extending your contract. On giving the notice we got we could not have them down here today but we certainly could bring them back if there is some interest. The other thing, the report itself does not earn you a copy but the full report is available in our website which is www.ncsuc.net. One other part of the process, we have posted documents on our website and solicited comments from interested parties, the comments are due January 19th. The comments will complete the study that we

had in the Advisory Committee involved. With that by way of background I will see if there are questions but it would be a disservice if I tried to walk through each stage of the study. I will let Sam Watson do that.

Mr. Watson: I will try to be very brief while they are passing out copies. We put in RSP solicited bids and eventually we trapped it with campus to do the report and what we intended to do was arrive at an objective view of the issues related to potential RPS in NC. And so they looked at potential cost and benefits and the way we went about the study is that we looked at five percent RPS scenario, a ten percent RPS scenario and those would mean increasing the amount of energy produced by the renewable resources, five to ten percent over and above the four or five percent we already had. So these are all new renewable resources and again the five percent and ten percent are being ramped up over ten years evenly. The half percent of one percent of ten years we looked at each case and three different groups of resources. The first group would include those resources that are currently eligible as marine resources under NC green power program. In the first group we excluded the western end because of the rigid law and complications associated with sighting wind in the mountains. But it included things like biomass, small (inaudible) soil and wind and the wind in eastern NC. The second group of resources was all that plus western wind, development of new hybrid resources. And then finally we looked at a group of resources which included all of that and the potential for using energy efficiency to offset 25 percent of that RPS mandate. So if in the tenth year you are looking at ten percent RPS mandate the utilities could supply two and one-half percent of that 25 percent of the ten percent scenario through energy efficiency programs. The key findings that were found when they studied this were first that NC passed emission resources to meet this five percent requirement, the new renewable generation. So using the additional biomass land fill methane, animal waste, coal firing utility plants from wind resources we could have generated an additional five percent of the energy requirement in NC for new and renewable resources.

Secondly, they found to be difficult to meet a ten percent RPS requirement solely with new renewable resources located in NC. The last key finding that they had was that if you allow the utility to expend money on energy efficiency and give that equivalency towards renewable energy up to 25 percent that the state would be able to achieve the ten percent RPS and end up reducing the consumer overall electricity bills. So there is a lot of detail in study I've given you in the handout there is a lot of detail of these slides. I know we are already winding and are way behind and so I think the best thing at this point is perhaps to just see if you have specific questions. But that was the general interest of the report and the report comes in two volumes and they are both available.

Mr. Garrou: Questions?

Dr. Crawford-Brown: What are the issues of the RPS and the percentages that are being talked about? The different percentage is how you're factoring in the per capita growth of energy consumption. So for example, if you lose towards ten percent renewable that doesn't do any good for our task for reducing carbon dioxide emissions if everybody gets per capita and doubles their energy consumption. So how does that figure in, does the ten

percent always just mean whatever if the environment (inaudible) is being consumed in NC in the future, ten percent of that has to be from renewable or is it all bench marked to current end levels of energy consumption?

Mr. Watson: I'll be glad to answer that. First the purpose of the study the consultants modeled the future energy forecast as is, they took the (inaudible) resource plans that were filed by the utilities and used those energy forecast for modeling and for the ten percent requirement. Once you got into the third scenario that included energy efficiency then there was some reduction of the future low based on and equivalent to reduction per energy efficiency measures. The second part of your question I believe is the different General Assembly sides that we are seeing along these lines, those are the kind of implementation measures and the kind of additional policy measures that may want to be addressed. But for the purposes of the RPS we are ten percentages just now. You look back and what was the sale, was it ten percent was they compliant with the mandate.

Mr. Slocum: Did I understand correctly that in your definition of renewable and this is based on the existing green power study of renewable?

Mr. Watson: There were three different sorts of levels of what were eligible resources at least for persons in this study. Again what we're trying to do was to work with the consultant, work with stakeholders in NC to come up with a group of resources to make sense for NC. Clearly you can alter in your implementation to favor certain resources over others. But the reason why we began with the NC green power resources was because of the (inaudible) stakeholders the process we went through in trying to define what was acceptable resources for the purpose of the NC Green Power Program. It was considerable give and take working with the Utilities and the environmentalist and developing what was that group of resources. What eligible resources are bringing renewable. So that seems to be a good starting point since we had already gone to the stakeholder process in deriving that.

Mr. Slocum: The reason I ask is my understanding of the existing green power portfolio is that it's fairly restrictive on what can be counted from the standpoint of wood resources that can qualify as green power and the fact of the bases that it really limits the contribution that might be available from biomass from wood.

Mr. Watson: I support my answer again that those are the types of implementation and details where if the Legislature goes to adopt and RPS program. They might go into what are the available resources. I remember those discussions at the time about what wood is allowed and then there was a lot of disagreement as to it but it was a lot of concern over if you allow certain kinds of wood as well as certain kinds of practices an environmentalist would oppose to. I am not sure what all goes into it but I do recall there is a limit on the types of wood that is being burned.

Mr. Kerr: One of the things that struck me about the study and how it might be useful really if people (inaudible) we started with what we had already talked and come to a general agreement on through our (inaudible). But what we now have is a (inaudible) and I

think that many policy makers started to lose, if you know how the beaches were (inaudible) to one another, I think one of the interesting things you look to deep levels of (inaudible) until you get some sense of the relative relationship between cost of various resources between the level of which you might try to bring them on line. And then too you really go astray for those relationships. The (inaudible) is designed to be perfect in any way or definitive but I think we now have a framework and we also have a sculptures to have the modeling done so we could pump more wood into the model or we could do more western wind. We had policy makers suggest different changes, I think we are much further than we were ten months ago being able (inaudible) to the kinds of questions that you ask.

Dr. Smith: A couple of things, having been one of those who was in that battle a few years ago, I would remind folks that a number of us, I can't speak for all of the environmental community, but I think much of the distinction made between the premium pricing associated with the green (inaudible) the NC Green Power Program solution asking for people to pay extra versus an across the board requirement which is a renewable portfolio standard and the fact that many of us felt that some of the restrictions in the green power program would not necessarily transfer over to an RPS. I am not speaking for all members, but our organization certainly draws that distinction and I think we take a broader definition of the use of what resources in a mandate that is required for an RPS. And so if you use it more restrictive in this study and I think this is probably more of an economic opportunity and more economically favorable to the centers of NC to take this broader definition because I think more resources would be available. The second follow up question I had was didn't this study look at some of the economic benefits of flow from things like the pollution reduction, emissions and how those actually could be added to the economic benefit and then more importantly was there any analyses of the harming benefits associated with renewable portfolio standards which would be most applicable to our discussion. My understanding is we're looking at this in the CAPAG and this could be a very significant benefit to moving the needle on reducing carbon emission and I'm just wondering would that factor in the study of (inaudible) or would it be to bring up that in a sharper understanding of both.

Mr. Watson: The answer to the first questions – it is not a good omen to economic benefits of reduced emissions. It did go into economic benefits associated with RPS in terms of your mandating the construction of x amount of (inaudible). So there were only potential jobs created none of them offset the utility plants that wouldn't be built. Also it was suggested that there might be property tax benefits to (inaudible) but not to economic benefits to increase emissions. The second part of the questions – there is some discussion in terms of carbon equivalencies in terms of the change in the emissions from the utility portfolio versus the portfolio of resources that would go into making up a five percentage of the RPS. That would decrease emission and result in certain kinds of carbon (inaudible).

Dr. Smith: Just to clarify – so is it my understanding then that theoretically some additional (inaudible) members could withhold probably the utility companies from the (inaudible) reduction and when it comes down to (inaudible) carbon so this would be added

to tune (inaudible). What it looks like is it's hard for this scenario to push induction benefits we've added.

Mr. Watson: They were not addressed in this report.

Mr. Kerr: I think it is calculated farther in particular at this time. The counter production is what some units of production which is (inaudible) consultants and most of fewer (inaudible) who would get a sense of that. So then when you start bobbling what Congress or anyone else might do with the carbon policy and how to price that out meaning that you and others have argued in building a coal plant and came out of it. So I think the same thing would be similarly as difficult as to whether you should go (inaudible) or not. It is difficult to try to spread an economic benefit in a situation like this. So I think in one of these new projects we will keep some level of certainty to what were comparable in having models and some of the things that are suggested, I think are battles.

Dr. Smith: (Inaudible) so there are very clear (inaudible) for that right now and then we would assume that, again we don't know for sure, it is very likely to be additional monetary .....(inaudible).

Mr. Kerr: I agree with your thesis but it is not part of (inaudible).

Senator Cowell: How do you make assumptions about the ratio between renewable energy and energy conservation and energy conservation seems like it's less expensive but yet you have it as a smaller incentive of the overall package and I am also curious about the assumption that you made on what energy efficiencies are capturable.

Mr. Watson: Certainly, when we originally begin applying them it was looking at renewable energy portfolio standards which it offset and it is more (inaudible) is requiring the low (inaudible) to generate a certain percentage of the sale through renewable resources. But through the last research and some of the interests that are from the environmental community we looked and saw that a few other states had given credit for energy (inaudible) and how much of a reduction to this money spent towards energy efficiency accomplished and given equally with energy produced by renewable energy resources. And so we improved an (inaudible) line at 25 percent of the RPS mandate since the real focus of the report was not to do energy efficiency studies but to be responsive to the request for what would be the potential policy on this, a real energy portfolio standard. As far as your second question, the second volume in this study is the energy efficiency part of it and one of the things we would try to continue to make clear is that the energy efficiency report is not a standard on energy efficiency. So it doesn't contain energy efficiency potential with what the utilities are doing to provide (inaudible) it compares the energy efficiency of current to renewable energy alternatives that would have to be secured to satisfy the RPS standards.

Dr. Eggers: Under key findings at one point it says if these additional resources can be developed at a 3.6 percent estimated rate increase at most by the 10^{th} year and is that the 3.6 percent rate increase of what, it sounds just like this three feet mandate.

Mr. Watson: That is from this chart which shows what the rate in fact would be if developing ten percent RPS implement and ten percent RPS. And here you see the three different resource moves that are sliding and that's where you get to if you include the expanded plus the energy efficiency it would result in a 0.4 percent rate increase. If you only allowed the resources currently under NC Green Power Program you could have as high as the 3.6 percent rate impact. Then as you see it says as soon as the average lift rates (inaudible) hours 2017. The study was done assuming the ten year random period in 2007 and 2008 and 2017 one of the caveats was you may want to push that off a little bit but this corresponded with the ten year (inaudible). But what this basically says is that if you only allowed the NC Green Power, and that is where in counseling terms if it could be developed, because the preceding was in you can't get the ten percent with only instate renewable resources. And that is why there is a caveat of if they could be developed and there is also a sign here one of the things they did, they first looked at all technical potential of how much renewable energy could be condoned but then they reduced that to lower the practical potential. How much was really economic, how much do they really think will ultimately be desired.

Dr. Eggers: What would be the... is this the anticipated rating path in 2013 of (inaudible) instead of the way you look at conventional energy package.

Mr. Watson: Yes all of these are comparing the utility portfolio that they planned to install to meet their forecasted low (inaudible) versus what resources would be in place to meet the same demands that will also satisfy the five percent (inaudible) portfolio standard. So this appears to be what the overall cost of satisfying those two portfolios with the different groups of resources.

Mr. Kerr: We anticipate and we'll do our job and collectively meet the demands (inaudible) use to be in the Legislature or to (inaudible) to where that percentage of meeting that job as it comes from (inaudible) portfolio standard. And I really do want to write the script between where we would be.

Dr. Eggers: I want to thank you very much for doing that kind of thing. In soil and mountain water is one of the most economically efficient things that we can do from a user end point but it wouldn't really be confident of the renewable portfolio when using a scenario like this. And so I would just encourage everybody to look at this report as part of the possibilities but in NC understand that there is a lot more renewable energy that we can use to meet our energies that would be a suite of economically viable solutions. Does that make sense what I just said?

Mr. Watson: The solar form was addressed in the 1950s it was looked at as an energy efficiency measure and evaluated.

Mr. Urlaub: Thank you and thank you for coming – I know this was short notice. Can we talk about slide 17 and 19 real quick? In 17 can you explain to us what total incremental cost/savings over 20 years is?

Mr. Watson: Sure this goes back to that question about what would be the cost of meeting the forecast in ten years under the utilities what their plan is and in order to build and operate for generations the utilities portfolio 9,000 MW so the next value of 20 years or 15 billion dollars. So what this slide represents is if instead of building generations of base load energy repeat generations that the utilities has currently planned to meet the next ten years. What would be the cost of meeting that demand using the alternative RPS (inaudible) and so each of these are relative to that utility portfolio difference in the increase and so what it shows is that it will be an incremental cost to go with an RPS in each of the cases unless we included energy efficiency and in that case it would actually cause an increase in the total cost versus the value of (inaudible).

Mr. Kerr: Can I follow up? That is primarily because you are with an energy efficiency measure and you are reducing the demand so you are avoiding (inaudible) more extensive resources offset by (inaudible).

Mr. Watson: And if you look back at those at the raising tax line you will see that there is in the ten percent a positive link impact. So, on a portfolio (inaudible) it would actually cost more unless you had implemented the energy efficiency (inaudible) and you're using that energy and so that therefore your bill would actually be lower.

Mr. Urlaub: A quick question – so theoretically if you increase either the RPS target to have to (inaudible) the efficiency I just think a greater share of the scenario three tenths percent RPS and energy efficiency make that very important energy efficiency. We could generally send up a lower rate and then the energy efficiency is a lower cost than the renewable.

Mr. Watson: I only say that because it is offsetting the demand.

Mr. Urlaub: These are the self-setting demands. And then the cost assumptions going in for coal what we've seen is that the one proposal so far on coal powered plants the cost estimate (inaudible) 2.2 billions to three billions. It was my impression on (inaudible) necessarily capture how the changing environment of our planned capital policy and rising fuel costs is going on. Do you think that the three billion dollar price tag is it closer to two – what do you think we actually (inaudible) in our process?

Mr. Watson: The idea was (inaudible) and the number of the assumptions used in the study was actually somewhere between that two billion and three billion number. We saw the input from the stakeholders but the consultants looked at what their experience and what they knew from (inaudible) were being developed and these were only in the (inaudible) area and they come up with the assumption on cost. And so that was the singular cost control that was used in assuming in the model was higher than the two billion dollar process because of the Duke plant but not as high as the three billion dollar plan. And you're right because of the timing situation we didn't go back and (inaudible) of the study and say whatever changes you used over two or three months when we finished the study.

Mr. Kerr: And that was for the sake of putting back the kind of relationship (inaudible). People come in to us for different resource cost abilities, when we earn more and we should be more responsible in terms of cost sharing. One other thing you will hear a lot and I think this group is probably been called to 20 some odd states through the portfolio standard and that's a true statement. But I think if you peeled that statement back a little bit no statement is (inaudible) but we need to read and (inaudible) what valuable, what resources, what cost structures, and what I would commend to you is that I think we are a lot further from the seeing NC's unique prospective on how this type of policy would affect the state. Before we started this and Ivan you've been there since the beginning, we were somewhat less to extrapolate from the experiences in other places and so I would suggest that you use this as a tool not necessarily as a definitive answer and again we are available as consultants and will continue to polish up the findings.

Mr. Garrou: I have a question for Commissioner Kerr. It has nothing to do with the RPS. You mentioned a docket which you were considering have we gotten to reduce some areas on private sources concerning energy (inaudible), could you tell us a little more about that what you're doing and where you are?

Mr. Kerr: I'm glad I've got my staff attorney to help me keep it straight but I think the fundamental issue (inaudible) of the various questions and I think when you talk about through the portfolio standards you're talking about significant fundamental policy directions (inaudible) companies as to how they meet demand. (Inaudible) and continue this personal decision of what choices and investments they will make in their home in efficiency and things like solar panels and so forth. So a little bit in the middle of that is the opportunity to interconnect to the system and being the Green Power has provided a price premium for folks who want to make those investments. To help pay for those investments they sell excess generations from back home to the grid. There are some obstacles in doing that which is how small generators interconnect to the grids and so this was a series to these two dockets perhaps a third where we had gone through and worked with those small generators as well as the hundreds and operators of the grid for the low servicing entities progress through Dominion, NC. Powers of any coop to try to simplify the rules and the standards for interconnecting and (inaudible) it is one complex machine that was ever connected. Someone who is interconnected to that grid may have the potential to be benign but they also have the potential to be anything but benign. So there are issues of pliability, issues of viability, and reliability. I don't know which one I said first but there are a series of issues when you take something that you're doing disconnected from the grid to seek to bring that activity into the same grid that serves this building and the rest of our state or even other states. So I hope I have not made a too general range but the idea was for us to work with those interested parties to make it simple and less expensive or efficient for people who wanted to take some of those steps in their personal lives to participate on the grid in ways that could be advantageous to them in terms of settle (inaudible) to NC Green Power.

Mr. Garrou: So you're in the midst of that?

Mr. Kerr: Well John I'm going to be careful because some of this might be on the heel. But as a practical matter I think we have adopted a net metering standard, we have adopted a standard a small generator interconnection which is 20 residential salt commercial. The thing that is pending Mr. Chairman is in the Federal Energy Policy Act. Congress asked states to look at whether or not they had sufficiently dealt with both net metering and interconnections rules. I mean the idea was this is important for the reasons we discussed – make sure you've done what you ought to do. We believe we have, we put that out to comment and a variety of parties have responded as you might guess with these things. Some things we've done more than enough, some things we haven't done enough. So that is a continuing issue to see what else might be done and there is, I think, the practical answer would be we've covered them all and I have the numbers over there. But we've basically done residential and pretty small commercial (inaudible) up to 100 coops and there has been an approach to us probably the significant suggestion is that there is probably two to 20 MW which is still not (inaudible) but is some rapid cover on (inaudible) I'm tempted to say park raiders solar project but I mean you know some where commercially significant efforts would fall into that.

Mr. Watson: That's the question how much further do we go in applying those tools.

Mr. Kerr: One of the mis-understandings is that it doesn't mean that the utilities are obligated to anything customer generation of any size. The question is how much (inaudible) is given on a case by case basis the specific application. So what we have done is streamline our process for extremely small. Of course these are all being put out on distribution lines that people, owners and businesses and not on the (inaudible) system which is designed to carry large generations. And so you have to look at the impact to the individual distribution circuit and substations when you get a large and more complex (inaudible).

Mr. Garrou: Thank you. Mr. Givens.

Mr. Givens: Just a couple of comments Mr. Chairman. First of all if any member of the Commission wants a hard copy of the four reports sent can get that. We made an executive decision to try to conserve some resources and direct you to the website in those cases. Secondly, as noted on several pages this was added at the last minute. This is the results of over play on my part and nothing more or less I realize that we are and I apologize to the different (inaudible) and the last minute discussion and our appreciation. I would say in general, (inaudible) as long as I've been here it has been my experience to (inaudible) Commission its staff and public staff are among the most responsive and flexible agencies in state government in responding to request from over here. I only put that on record because then Brock's made (inaudible). So I ordered my (inaudible) out front the first of those is that some of you may have missed kind of appropriate (inaudible) committee and this is cause to (inaudible) the various dockets from the (inaudible) merit docket and I think those are of particular importance. I note those are the developments I've asked from you (inaudible) arriving in (inaudible) from at least we can do that for almost half of the United States (inaudible). I'm not his but since we're under oath.

Mr. Garrou: Thank you very much George.. Our next agenda item is to hear from Brock Nicholson, Deputy Director of DNER, Tom Peterson, Executive Director of the Center for Climate Strategy. Dave Ross was here earlier and maybe he'll come back in (inaudible).

Mr. Nicholson: Thank you Mr. Chairman and members of the Commission. Tom Peterson and I will present to you and all the current progress in the CAPAG process. I want to thank you for the opportunity. I must say we feel very comfortable we've had a very good effort here, very significant effort. Thank you my stakeholders who are on this Commission, thank you again for that and even if the Commission wasn't directly (inaudible) and draft material. So again thank you very much. A couple of points I want to emphasize here that what we will share is preliminary information on the first round of recommendations that will come through CAPAG. Today we're giving a kind of preview of the work that's been done and some of the results, but again let me emphasize maintaining the integrity of the CAPAG but these are three scopes in many of these cases, three decisions of the CAPAG and recommendations of what we have proposed for the 24th of January meeting. Again emphasizing the results of these mitigation options are preliminary several were in the process of being quantified (inaudible) of CAPAG. Design analyses may be modified by the CAPAG at the last and subsequent meetings so even the specifications of the recommendations may change the results of deliberations or any considerations by the CAPAG.

I think there is an overall summary that we are beginning to understand that we are trying to (inaudible) and in some cases the numbers are very encouraging. Any comments or advice from this Commission certainly will be welcomed today and I might note that the discussion this morning and the presentations I think will give us a lot of good input to our issue on adaptation in terms of the study. Today's meeting is to review the draft CAPAG mitigation options, (**Exhibit M**) the summary list of draft options and initial results. Detailed draft mitigation options templates are available at our website which is www.ncclimatechange.us if you want to go there and take a look. Beginning on the vote CAPAG voting process on final recommendations there is sort of another way in a sense and we're working pretty hard, in fact just yesterday we had a number of things that are underway and that will be forwarded at the January 24th meeting. So again your feedback would be very helpful. The next meeting we will have first round of approval by CAPAG on individual mitigation options. Additional CAPAG meetings will continue in the spring and part of the process is identifying agreement, structuring further development of options with barriers as we go on and adjust as we receive advice from the Commissioners.

Mr. Peterson: At the request of the Commissioners we have been asked to pull together some information (**Exhibit N**) for a report on the progress of the CAPAG as a way to (inaudible) we're expecting by the time we get the others in place here based on the works of the CAPAG much of which will be in place at the next meeting of CAPAG. We will have fairly substantial report available to include a summary and initial results of analysis showing (inaudible). Descriptions, policy design and other mitigation options and we will also have information that shows the (inaudible) of recommendations being finalized by CAPAG. You can expect that document to include about five or six pages for those of you who are on the CAPAG you might want to set aside a little bit of meeting time during the

next meeting. And that information the Commission wants will be on the website after the meeting on the 24th. We have three additional meetings scheduled for early May and July to finalize recommendation which is optional in terms of whether we have additional meetings. During that period of time as we the Legislative Commission identifies the recommendations of the CAPAG that are adverse or may need additional work could be (inaudible) issues but it is certainly possible that we can configure the process to work with those sorts of issues that are in support of the Commission. Certainly DENR is also available with technical assistance with permission as you contemplate the mitigation options that you might want to work on as well. So we've got a sort of process in place in the infrastructure assistance. To give you a better view of where things stand right now we have 52 draft potential litigation options that will be reviewed by the CAPAG at the next meeting. You can see a break down scattered across the five technical work groups. Just a quick reminder of how this all got started, we started with 251 that were on the list of existing actions that's been undertaken in NC and other states. The CAPAG added several more pushing that list over 300 and that includes a process of identifying the most promising options (inaudible) and that's where we are today. This has been a highly participatory process just a reminder this is a process of self determination where the CAPAG members and technical work groups are identifying the options that (inaudible) the proposals that will be for policy design. So again this is a very highly participatory project and we appreciate the time that folks have been devoting to this. Just to give you a heads up in terms of what to look for in the details of the report and the details of the background material with the CAPAG being that each and everyone of these 52 options have templates separate with (inaudible) that have been jointly developed by the groups and these are a list of all the living draft and it will become the final report. The living draft exercise and formed the recommendations and writing them up and it could have a number of different categories including a simple description of the option and the details understanding of the specific policies of the environment (inaudible) participants to study on. An indication of the sorts of implication mechanisms that are envisioned in terms of actually how this might be done and understanding our articulation of existing programs and policies that are in place the business as usual pace if you will. A specification the times that we have mass productions, where it was just carbon whether it was black carbon dioxide will be clearer and importantly we have a series of capitalizations on the potential CAPAG producing these options introducing emissions and foster (inaudible) becomes (inaudible) and so in each of these simplex we will have fairly explicit rendering of the design implementation analyses solutions to these options that will be backed up by other materials and should be in a spreadsheet on size and etc. But the thing is to make sure we are sharing our work and the technical side of this is part of process of doing so.

The other day we also found implication on the amount of support within the CAPAG for each of these options so as Brock indicated we will be going through a billing procedure. We have been able in each of these meetings to get from one stage in the process to the next. The next stage is on January 24th will be put the 52 policy groups and identify those options that do not have any objections. We expect there will be extensive discussion and there may be modifications on some of the options when we get to that stage and certainly we will enjoy complete extensive first go round on January 24th but the remainder will be discussed when we come back in early May. Just to plot the case out we might expect to

just have an extensive discussion on the renewable portfolio standards and one particular piece of what we call policy design coverage for participants when we get to the eligibility issues. And the (inaudible) resources issue comes up frequently and that is one of the many things that we expect to be an item of discussion that deals with the modification of that particular policy design variability and renewing some of the objections that we should have a chance to respond to that proposal. A key point that I would like everybody to understand is these options have not been reviewed. They don't come up just once they come up almost (inaudible) and back to the drawing board for modifications as needed. If we don't have consensus on a particular option we want to note very explicitly that the barriers are there but there's a disagreement why some obey some technical terms so they can be understood. So if there are various points of view (inaudible) as one of the options.

They have come a step further in the whole business of taking things back to the drawing board and working them out and coming up with alternative design proposals to get past barriers of series of bonds and letters. Everyone of these options that the group has already been working on crafting and can continue to craft to their satisfaction to get around the areas that might arise. So for instance with a particular proposal such as the renewable energy portfolio standard and energy proposal have been described, it has a set of goals which are letters of action, time periods, participants, etc. Those are certainly things that the CAPAG could modify to try to deal with any objection. Another important set of letters that you can adjust with (inaudible) is that all the areas gets a mandatory with (inaudible) standard is that the (inaudible) program etc. The bottom line is that the wider the case is in terms of exactly how any given option could be implemented and this is up to the CAPAG group and if some of these methods don't work there are other methods so we expect in many cases part of the process is solving a conflict. We would like to go ahead and get this done in addition to taking the right level of action as some would put it. It is also very important that the analysis measures be consistent with the agreement expectations of the group. Sometimes the barrier consensus are assembled and that's in disagreement of cost figures and in disagreement with a particular assumption. (Inaudible) in methodology says we end the policy (inaudible) their detail that each of the components of the analyses and if there are sticking points there certainly would be an opportunity to go back and look at alternative approaches there. Our experience has been that that's critical as opposed to satisfying this building process to get (inaudible) when we move on in terms of quality action.

With that I have a series of plotted slides that summarize the list of recommendations of CAPAG and I'll give a brief walk through. There are many members of the Commission who are on the CAPAG groups and are quite familiar with these. These are listed in the handout (**Exhibit M**) that we sent around, color coded on the front page with a listing of tables on the pages that follow that. What I would like to do is first just help you understand what's in these tables so that they are not a foreign language as you try to understand and then we can walk through and get a bird's eye view of each of them. But if you look first at the Table 1 which is color coded in orange and it is Residential Commercial and Industrial Technical Work Group, this is a work group that deals essentially with stationary energy demands and process issues. Now the table that has 11 different options (inaudible) 1-11 that are each of the 7-52 (inaudible) but there are similar

meanings for each of them in the second column and then results and analyses and just (inaudible) of the results that we have today should be considered preliminary and these results will be firmed up by the January 24th meeting. They will be adjusted as we go forward but the very first two columns are estimates of the greenhouse gas reduction potential for a particular option so (inaudible) outside management programs. The estimate of greenhouse gas production for 2010 is 6.5 and the climate's carbon dioxide level in 2020 is about 28 in mega tons. The next column which is the 2007-20 is just accumulative reductions out to year 2020 from the start of our program. Just to complete that in the next column and that present value calculation of the implementing cost or cost savings of the option and that is a dollar bill figure and that's a cumulative figure that runs from the start of the program which is 2007 out to 2020. That number does not include a modified benefit for reduction of greenhouse gas and I think no discussion about whether at some point can and should be some dollar value and what it cost emissions. You do not assume any dollar value while this is strictly the cost of cost savings associated with implementing the option. The next column which is cost effectiveness and you look at the cost associated with (inaudible). And the final column to be determined will be the result of the final (inaudible) from the CAPAG just to give you orientation of the table. I see we have some questions on this.

Mr. Erickson: Could you explain what the negative sign say for this -$5,890 in cost?

Mr. Peterson: Those are costs savings as opposed to cost. Negative costs are equal to cost savings and you will see a lot of them when you go through these documents.

Mr. Erickson: Thank you that's what I guessed but I wasn't sure.

Senator Cowell: Who is the fiscal analyst that worked on this?

Mr. Peterson: Well it is a combination of our team – some are on the 800 line right now if we need to talk to them about this. We have (inaudible) that work with us, we have (inaudible) so we have 15 to 18 folks playing that role but really the other fiscal analyst are members of the CAPAG who actually work more for the coops (inaudible) functions are we are using methodologies that are (inaudible) guideline.

Mr. Garrou: Any other questions?

Mr. Peterson: Just to give you a heads up also if you go to end of the table there are a couple of rows at the bottom. The first one is the sectors total after adjusting for overlaps. You take the eleventh item here that precedes this particular batch – though those are this column that we are showing now is what we call (inaudible) analyses. If you had this particular analysis and didn't do anything else, this is the estimate coming out of this process of what you would get out of it and how much of a cost you would save. In all likelihood these would be implemented jointly if the case of all 52 options being implemented. We have lots of potential interaction between the options and various interactions. We didn't express interest in commercial and industrial but with other groups as well so there is a lot of double carrying or interaction. We haven't gone through the

process yet of backing out the double carrying interaction, but it would be substantial. So for instance, if an energy efficiency program is put in place it would reduce the man hours in the future as a mean of the impact of the renewable programs that would allocate some percentage of coal solar power to renewable and would be less than it would be if that was done without an energy efficiency program. People go through a process of integrating all of that and we will have them some bottom line numbers that will tell you the cumulative or integrated impact with doing all of this together.

And that would be the first line, the second line is something we call adjustments or reductions from recent actions. When we started this process in February of last year we ran an emissions forecast reference case that was based on whatever you want to call them that assumed the missing plan of action would in some cases most likely be actions in the future. It was a best guess that was a part of the rules about the future was going to look like absent action from the CAPAG. But along the way things happen and it warrants this portfolio standard variability passed along the way before the conclusion of the process where something else can be done. We had to slow that out because of recent action and we show you how much has already resulted because of the consequence of that.

Then the very bottom line is what happens when you put all of that together and we show total results of the CAPAG actions along with the recent actions (inaudible) and all the amenities (inaudible). Sorry for boring you with the details but these numbers happen to be enormously confusing. Anything else I can do to help in terms of what we are going to be presenting. I should also note that the question came up from Dr. Smith regarding non carbon benefits as to where the American dollar bill figures and we haven't had any dollar benefit information which is certainly the cost of cost savings and its limitations. But in the policy template on the case by case basis there will be notation description that read the analyses on the side benefits (inaudible) the same thing. So there is carbon dioxide benefit and that is something we would be interested in, its important not to miss them but these are not co-benefits.

So then we normally do this – for most of you who will be with us on the 24th we've already gotten a taste for this as we've gone through the process is that we walk through each of the options with various amount of time and our key will get us through each of these line items and get what I call a federal express version or a thumb nail description of each of these options. Then we will then go through a round of clarifying questions from the group so that folks can one by one understand the details, understand the numbers etc. After we clear clarifying questions we will get back to the rules one by one and we will check the various proceedings and if there are no objections, we will pour over that particular option as a final recommendation. If there are objections we will have an extensive session to understand why this objection and what proposals might exist and the kinds of alternatives that might work around that. It's very common that on the plot you can work a lot of that out so that will be put in the parking lot and come back before the next meeting. So it will be the full walk through, those are detailed discussions that are painted substantially by caffeine and sugar and it will be a long day. I guess I'll seek the guidance of the chair here in terms of how much detail you want to go into here on each of these sheets of options.

Mr. Garrou: Well I don't think we have time today to outline each of these in detail on the other hand these are the things that we will also need to consider fairly shortly. So I think we need to know in broad form what you proposed.

Mr. Peterson: It's probably also (inaudible) on the relationship between these and the suggestions that will be responsive to a question I believe his name is the last commissioner we had (inaudible) suggestions on various names with low hanging fruit, win-win and various others.

Mr. Garrou: Keep in mind that this is an interim report we're looking at so (inaudible) follow me through I guess it will be fairly easy to implement the fairly obvious.

Mr. Peterson: So what I would say in response to that would be two things (1) on January 24th we will identify what we call early consensus options. Options that are reviewed and if there are no objections from this floor with a final recommendation and that in all likelihood will include things that could be done very rapidly with minimal amount of effort and perhaps other things that will take more time. But if there is no disagreement we simply underline what needs to be done. Subsequent to that there could be some sorting in terms of timing and also which of those need legislative activity which is our main object. So you will have clarification in the batch there. And of course we will meet that procedure at the following meeting so we come back and have another discussion. But they will be split out in that manner to give you guidance in terms of which ones you want.

I've seen a series of inputs since the last Legislative Commission meeting with respect as to what some of those items might be in response to the request for win-win, so a lot has improved. My general take without having gotten every last detail is that they are highly consistent in that there is tremendous overlap with the draft options that are under consideration by CAPAG. They all look very good and I think one of the things of the CAPAGs process would be in the news by the time we see each other again. That should give you some understanding of how the CAPAG feels about that particular set and whether they are without objection and we will be able to provide you with that clarification. If there are suggestions that are not from the models related to CAPAG, provided we have sufficient capacity to look at some new options, that's something certainly we will be willing to do. Take some new things that aren't there back to the group for their consideration. Some of the members have submitted their proposal and might be able to comment on them.

So the big picture on this sector is that this is where energy efficiency and conservation programs for heat power, heat, electric heat and (inaudible) are found physically. This is where we have industrial process emissions in terms like these for synthetic acids. It is a combination of these, the lion's share if you will refer to page 2 of the handout of the reductions. This entire step comes from the very first one which is the man side of managing programs. In fact if you look through the tables and you look at the whole picture, I would suggest that you look at the 2020 columns where they have fast reductions. It gives you the quickest read on the scale with potentially no reductions associated with

each of these, you will see that this is what we call a big ticket item. In fact this is one of the biggest ticket items in our entire batch.

In terms of the other programs I think most of these are relatively self explanatory but if there is anything that I can do or folks on the team or other members of the group who are working with me can do to provide clarification, I would be happy to, particularly questions about any of the items on the list.

Mr. Garrou: This would be the time to ask those questions.

Mr. Urlaub: Thank you RCI-3 Energy Efficiency Requirements for Government Buildings – could you give a couple sentences on what that might include?

Mr. Peterson: David, could you just a little background on RCI-3 if you can tell the group we're with the Legislative Commission here and we're doing the federal express walk through on these and a little bit of clarifying questions if you could give them some background on RCI-3.

David Vonhempler: Ok RCI-3 is energy efficiency requirements for government buildings and the key to RCI-3 is that new government buildings will be required to meet a certain height or the higher their code standard for energy efficiency. There will be some effort to improve the efficiency of the existing government buildings. I can go into my files and look up some more detail information for you if you guys would like.

Mr. Peterson: That will do.

Mr. Toben: I am curious as to how you and then I guess most ultimately we are going to define low hanging fruit and I look at RCI-1 which looks like it got an enormous sort of absolute potential and so I would imagine that would qualify as sort of budding and pre treating your orchard that seems like a wealth of opportunity. And then I looked down at RCI-5 which has a relatively lower absolute potential but its cost effectiveness per ton $C0_2$ equivalency is higher. So how do you propose that we prioritize beyond the sort of ease of the (inaudible) senses issue? How do we prioritize these issues are they based on what the overall (inaudible) options could be or are they served on a case by case efficiency?

Mr. Peterson: David I have a question for the chair?

Mr. Garrou: Unless yours is a question from me to you.

Mr. Toben: It seems it is going to start with you because of the recommendations coming out of the CAPAG.

Mr. Peterson: The priorities if you will are already preset in terms of poor efficient criteria. The group can be used in determining what the "ifs" priorities are. So when we established close (inaudible) and analyses the decision criteria that were used were four-fold. (1) was greenhouse gas production potential; (2) the cost of cost savings; (3) co-

benefits, co-policy, extra-analogies if you will; and (4) (inaudible) building considerations. Those four guide us to what the group has been able to use to make determinations about priorities of what should, what could be in climate action plan which is a combined portfolio of actions. Subsequent to that in terms of the implementation of what the recommendations are either legislatively or administratively. There are a series of ways in which that is typically prioritized and have to do with how much time it takes to move to adoption. I think the other key thing that comes into play comes into cases where there is a state line (inaudible) for total emissions reduction like (inaudible) time. And the question that arises then is the cumulative impact and the final set of recommendations reach the goal or not and if it surpasses the goal. The additional question is whether a margin or safety is required to be able to (inaudible) limitation barrier or potential if the emissions forecast might turn out to be greater than normal and it has to be (inaudible) and that gives guidance in terms of how important it is to implement the full range of recommendations versus some big (inaudible).

Mr. Givens: A big factor in my opinion of what I was called in line to do is (inaudible) the idea that there can be broad consensus of subjects that can actually be accomplished (inaudible) note some are not globally listed and I realize that's what the difference in planning and in terms of carbon and that's a real (inaudible). While I've got the floor I'm going to ask all of you who are submitting recommendations or plan to submit them to add a couple of columns to your review. And these are for our benefit to identify the agency or agencies that we are understandably responsible for the implementation of stated proposal. If you know, if you don't know we just have to find out if you can help us by identifying them. Secondly, we need for you to distinguish the ones that you believe are a part of this legislation have proposed and maybe somehow we accomplished the agency policy of (inaudible) action someway. And then I urge you to be conservative in this sense that a milligram might be a legislative mandate whenever you consent to adopt rules but you've got to consider the possibility that the legislature is going ahead and act. An act of substance yields (inaudible) of rule making or rather the ability to rule making process if you (inaudible) and need help to be able to consider. Beyond that consent for me to these has been done elsewhere and we are somewhat have prepared the brass language of sometimes between the 22nd of February. I and the folks sitting behind me are (inaudible) trying to make these realities in a sense of (inaudible) something policy building and (inaudible) and this is going to be tough to do. So all the help we can get with that additional information will be a big help.

Mr. Garrou: I guess I would mention one thing about that low hanging fruit and this is a personal view I have not expressed to the cochair and that is all these things that we can present to the Legislature that will enable them to take action (inaudible) for that you reach me with questions where the climate change is an issue that NC should address. In other words there ought to be (inaudible) benefits. Again that is personal.

Mr. Peterson: With respect to the criteria of bringing things forward at this time have both consensus automatically what you get out of the January 24th meeting is the first batch of things within the view of CAPAG. With respect to the last question that there may be a precious view of the adoptions that are structured to be solely for climate purposes but I

would put the number at 95 percent plus that are actually done for other uses. Typically if there was a significant carbon benefit associated with that and by adjusting these to maximize that carbon benefit that is really what the group is interested in doing.

Mr. Nicholson: Actually I was going to step up and note what Tom just said in terms of the consensus items likely to be in that group early on but since it is a group I think that is ok. The other thing in terms of (inaudible) that we still intend to do and might be part of the extended contractual effort on our part is also look at it from an economic benefit where we can (inaudible) jobs benefit some of these actions. Because they really will be grand opportunities with new industry or past existing industry in terms of (inaudible).

Dr. Riggs: You think those reach to your five years right now or is this …?

Mr. Peterson: I think we (inaudible) clarifying questions for whatever period of time the state of NC grants us.

Mr. Garrou: So the answer is not …

Dr. Riggs: When I sent the table why would I ask the question?

Mr. Peterson: If the questions with the same test would want with any of the tables.

Dr. Smith: So perhaps we can check and see what the requirements are on this first batch table.

Mr. Peterson: Table 2 recall the energy supply technical work group and this is typically the (inaudible) renewable energy for heat and power resides in terms of the options. Same table, this is on page 4 of the handout, you can see a couple of options are still under preparation we expect those results to be available by the 24th and most of these are self explanatory in terms of title. I'll be happy to respond to any questions.

Dr. Smith: This is a clarifying question to me. The environmental portfolio standard which I think it is the mirror of the more or less (inaudible) and then given what the GES study and this in your opinion how closely are they on each other. I know at one point we had asked the group to review the final product and I'm just wondering if there is a sense that ES-2 is closely in parallel to what is being submitted by the Utilities Commission.

Mr. Peterson: Let me respond to this – the general impression based on the conversation these are very close but I think others may know the details and we do have just so you know in terms of (inaudible) figures that we offer the current draft 20 percent by 2020 starting in 2008 and then only 10 percent renewable generation by 2017. I don't know if there are some comments here on eligibility criteria but I don't know to what extent they deal with the questions that came up later.

Mr. Nicholson: In summary its (inaudible) more aggressive than the (inaudible).

Dr. Smith: But it should agree following the economic benefit?

Ms. Will: I believe its also (inaudible) amounts with the residential- commercial-industrial we've read about.

Mr. Toben: Exactly, the EPS in this case is actually a two-thirds energy efficiency portion of the 20 percent and a one-third renewable portion as is currently being figured. So roughly it is about 7.5 percent renewables which is consistent with the (inaudible) study and about two-thirds or 12.5 percent energy efficiency to make up the total of 20.

Mr. Peterson: Transportation and land use there are a number of blank spaces in this spreadsheet right now on page 5. This is in progress and we will see these blanks filled up by the middle of next week. A couple of them have been filled in already. I'll be happy to respond to any of the particulars on these.

Rep. Harrison: Thank you I just want to clarify that (inaudible).

Mr. Profetea: Was Pricey's question on and I apologize for (inaudible) earlier but I don't ant to ask one by one questions. But is there any documents laying around that we can look at (inaudible) California report what level is (inaudible).

Mr. Peterson: That's on the website for the CAPAG process each of the five technical work groups and we already got the recent documents that we call (inaudible) and templates. So in California the template standard we don't know all of the details and then we will have them do the updating following version of that by the middle of next week. We will give background readings for the CAPAG meeting on the 24th and then the update of all of that will be in the form of an energy report for the Commission when we meet again in February.

Mr. Profetea: So when is it best for you to pass along to the Commission that document to take us through and (inaudible) and can the Commission see this formula prepared next week or do you want to wait until you get (inaudible) this process and report it to the Commission. How is that going to work?

Mr. Peterson: You can see the background documents – these are living graphs (inaudible) agreement modification for (inaudible) so we've got 256 pages of background material that you can look at. The next slice of that will be next Wednesday and it will be spread before the CAPAG meeting. They are right there now so there is no reason to wait in terms of background research but they will be updated as we get new analyses and the results of the discussions.

Mr. Profetea: One more question – in terms of these data and I have a lot of reading material, is there any part that can be a doctrine that is more like 20 pages that has ES-6 California standard (inaudible), ES-7 that level alone (inaudible).

Mr. Peterson: We have an executive summary for the final report and also we do summaries and its much like we are going to speak out today but I would say if you want to get the flip (inaudible) version of any of these when you go the policy template the first two boxes are the ones that you can reach quickly and tell you pretty much most of what you want. One is the conceptual lay description of policy for California tailpipe standard that will hopefully say that in English. The second part is about policy design which is with timing how soon you get started may have to do with when and what level and who has to do it.

Mr. Nicholson: Let me make one quick comment on the tailpipe standards. As you may know our only choice there is the California standard and the federal law we have here. Of course standards are still subject to the human flaw suits plus California is yet to get the waiver of (inaudible).

Dr. Eggers: Speaking of fruit, organic agricultural again the study apparently might sequester twice as much carbon as no till, so (inaudible) the soil carbon management – what do we need to do to encourage increasing organic production fall under that or just specifically something else.

Mr. Peterson: I would like to introduce Steve Rowe as the leader of our estuarine waste and he can answer that question.

Mr. Rowe: In the eastern shore answers that we consider organic farming as a separate option when we went to their farmers association it was a fairly popular option of any group but just kind of in that second tier of priorities. There is a write-in that there have been studies showing a larger increase in soil carbon sequestration through organic methods but then there is also a lot of other issues as they relate to organic farming that need to be taken into consideration. So when you consider that separately so that we can look a little more specifically overall as organic farming and what the overall greenhouse gas benefits are.

Dr. Eggers: But it sounds like it gets proper rest now so we (inaudible) is that right?

Mr. Nicholson: It sounded more (inaudible) than privacy crops.

Dr. Eggers: So what does this soil private management mean?

Mr. Nicholson: This could mean in addition to things like no till agriculture and other methods that could be applied whether it's reducing fallow fields in summer or increasing winter cover crops, using bio-chard or really a host of other techniques to increase soil (inaudible).

Dr. Eggers: So it's just got so much potential that it might be worth trying (inaudible).

Mr. Rowe: Seeing that if the group wanted to include organic practices as one of the techniques .....

Mr. Nicholson: We just had a meeting yesterday with the rest of the group and one of the members brought forward another proposed policy specifically on organic farming wanting that incorporated into our initial list of priorities here and the thought of the group was that they really felt that we needed to concentrate on what we have got on the table right now and get that finished and then start to look at other things. So which I guess organic would be one.

Mr. Peterson: I think we may be asking procedural questions – is there going to be an opportunity to expand on that and assuming we can expand to do the analyses of the association and that we would want the CAPAG then to let us know which of these items that were on the second tier list of each of these categories might be of interest in putting on the four of (inaudible) so again assuming we can have the extra capacity because we as Steve said we have a full plate here.

Mr. Nicholson: I have one quick comment – in a sense its on the list we are not going to totally remove it – its just not on the first priority list but we will reserve the fact that it was suggested (inaudible).

Mr. Peterson: The list is 307 such yes that will be a party (inaudible) and the list can be updated. It's not unusual for organic farming practices to be one other than the soil (inaudible) so that can take up a big chunk of the discussion.

Mr. Toben: I would just reiterate Dr. Eggers request that it be reconsidered as part of the coastal interim plan and that if there is new data that's available that might not have been available when we were sorting through the options there but if it seems to logically to have been there, request for reconsideration on that.

Mr. Peterson: We go to Table 5.

Dr. Riggs: Are there any numbers on this table?

Mr. Nicholson: In view of the group that these are not quantifiable so the data that we have and information that we have on the templates is going to be descriptive and relatively detail in terms of referring or conformance of the implication programs.

Dr. Riggs: Still bothers me that coastal communication problems associated with this which are very different from everything in this whole set of tables here falls underneath one category called adaptation. I have several questions, first of all when you think that the coastal issues that were presented this morning represent a very major part of this full program. And I think there ought to be other ways to obtain a sense of the seven issues documented underneath that but that's one statement. The other statement is that the question do we submit our recommendations to you to go in this data that category CC5. You submitted recommendations or preliminary set of recommendations represents the beginning point for this Commission and it's really very different than what you're dealing with here. It does fall under CC-5 but I'm not sure, I'm very confused as to how this is

going to forward and how we need to feel. It seems to me that strategy elevated into a separate thing of our own. I know I'm putting fuel on comments when we type this thing up that can from Jim Stephenson who is on this TWG. But explain to me how we are supposed to go forward with all of this and what we need to do to get this up and to a major category by itself. It can't get lost, this is too important for the state of NC to let it get lost down in the bottom or some table at the far end of it.

Mr. Nicholson: I think first of all as I said before, when you've had similar comment earlier that certainly in the order it doesn't signify priority by any means and I mentioned in a previous meeting that we think adaptation is one that would be a grand candidate for early consensus and I think based on the discussions that we've had those of the last CAPAG meeting and others, I believe we are there and we will verify that on the 24th for sure. And the nature of that we're thinking about of the adaptation recommendation has sort of a teeth and bones in it. One of which is to initially identify those concerned areas or issue areas or subject areas that ought to be accomplished by the state adaptation plan. Many of which were reviewed this morning so I think that is a key part. I don't see the CAPAG itself will follow that plan. But that's a very key part of the recommendation that main part of the step where we would recommend priorities to the blue ribbon commission or task force or whatever it might be to in fact tackle the issue. A second thing of course is identifying the scientific issues and similar areas or all of the initiatives that ought to be involved in such to help them set a plan of agencies and various stakeholders. What kind of research you will be doing in the future regarding marine interest or agriculture under adaptation plan. So I think we are very much on the same wave length for this and I would hope that they would try to help the CAPAG come to a consensus on the 24th. It goes without saying that the CAPAG process has been enormously helpful to us and will be and I anticipate but we have an entirely different mandate and we can do what we want.

Dr. Riggs: So have you got a set of our recommendations?

Mr. Peterson: The recommendation that you can actually see on the website is as Brock said is recommendation the long form of (inaudible) while taking action the biggest group has gas emissions in NC station development along with the state climate change adaptation plan that was approved etc. showed a panel of (inaudible) commission etc. should have a (inaudible).

Dr. Riggs: So what we'll do in this Commission is raise this to a higher level?

Mr. Garrou: If that is the wish of the Commission which I suspect that it might be.

Mr. Profeta: Mr. Chair can I ask you the following question for Professor Riggs. Steve Crawford's own recommendation of this Commission which I think is what you're asking Tom about. If Tom had your recommendations what is the process by which this Commission takes the CAPAG output, takes its own internal recommendations that have also been submitted and comes up with what it wants the Commission to include in its internal report. What is that process? I think that's mirrored because of the

recommendations to Tom or to George or all the Commissioners or how basically to proceed.

Mr. Givens: Here are my thoughts – first of all the more time you spend on this the larger the global climate change issue (inaudible) with the large adaptation which is a subset of that (inaudible) that's a whole major area inquiry in itself (inaudible) adaptation part. With regard to the process, I spent some time taking to both co-chairs and I think what we envisioned trying to do in terms of an interim report and I don't want you to lose site of this, is those things that we think we can get done in the near term, very, very privately win-win-win, low hanging fruit, that's what we're looking at in terms of an annual report for this 2007 session. The process (inaudible). I have followed the full recommendation of the folks who represent (inaudible) to Mr. Peterson with the request that he look at them and see how it can help with CAPAG and as I said this morning, not that they have to be synopsis of (inaudible) CAPAG not that we can't have additional views but this is a report on the efficiency point of view. This Commission can consider anything that deals with (inaudible) and if the terms haven't been (inaudible) I solicit today for the last time and as we said this morning we expect to have all that in terms of (inaudible) by the 31st. Now as a practical matter it will be up to the co-chairs, this is a legislative commission, although the legislators (inaudible) and it is required of the chairs of the legislative commission to decide on issues that they are involved in and that process will occur on the 31st or so and the 22nd. (Inaudible) the best we can. I made an earlier suggestion (inaudible) to let you know that (inaudible) of reality and more specifically the closed committee that will more likely be (inaudible). (Inaudible) where we are right now, we will see or completing the long (inaudible) on the next long interim and what we can get ready for in 2008. It's my personal view and I emphasize personal view, that we gain a title change in a year or two years we (inaudible) in the year two. They will have to be (inaudible) currently scheduled like this commission with many of the issues which I think the spirit that we first of all have a (inaudible). When we start talking about insurances (inaudible) we are not going to separate between now and the 22nd of February in 2007 or 2008 probably not in 2009. So what we are trying to do is make progress, meanwhile I believe that nationally and internationally the kind we proposed currently is (inaudible) on this issue and I think we will seem more considerate after the (inaudible).

Mr. Garrou: I would just saying and I had a conversation with Chairman Hackney at lunch and it is not our intention to dwindle this down in three proposals and this sort of wrestling and give another chance to talk about the brass roots. It's likely that every thing that bottles up between now and the next meeting will be presented for action.

Mr. Profeta: If I could just follow up. I want to know what to do next. So if we (inaudible) the source of two sets of possible internal report recommendations we are going to have those that are coming out of CAPAG as the consensus matters that Tom and Brock have identified, (inaudible) we have recommendations proper phone commission to commissioners. We have two policy recommendations, will they be distributed, sometimes I wish we could get them all to work in the path and if we distribute so that I can see them before the 31st and then the agenda for February we will walk through these and say this is something the Commission wants to be important or not.

Mr. Garrou: We try to be helpful to you in terms of what the benefits and disadvantages are and particularly as they relate to the wrestling.

Mr. Givens: We will distribute those that we have received thus far as soon as we can get to next week. We will not wait until the 31st. Have all the ones distributed to the mailing list I would caution you those of you opposed to the notices that list is as good as the last time we sent it. We revise it all the time, you send it to me and I'll send it to everyone in a package. We are going to cut that process off on the 31st. We are going to do the best that we can and I'll ask Mr. Peterson in effect is requiring to have the consultants of CAPAG our assistant in terms of dealing with the recommendations. We are going to try to get them into a unified package so that we can get those out as best we can before the 22nd. The 22nd will be sole for decisions and there will not be presentations. So all the time will be available for deliberations and action, I don't what all the time means yet, because I don't have their times, starting on the 24th along with CAPAG, the Legislature is in session and everybody's job, work or a part of this shifts including I and all of my colleagues. But we are going to do what we can as we (inaudible) 2007 session. (Inaudible), if you want the Legislature to deal with something, then you have to do it in legislative terms which (inaudible) and good ideas to legislators.

Mr. Profeta: I apologize for being such a nuisance but this is very helpful.

Mr. Nicholson: I might add and I don't want to present this as if it is being processed by any means, we certainly want CAPAG to be a supporting and process to the legislature. But I think we have a duty within the CAPAG process to develop these recommendations or options as completely as we can and I would request that you do support the ideas and suggestions and specifications and what have you to CAPAG recommendations. If it develops in parallel or in addition to this body and the legislature I think that's fine but as you said we've been able to support that process and I think that's great. However in my mind I feel like we are still due a final report that has the recommendation regarding each of these subject areas. Some of which we are really fortunate that we have had some legislative activity particularly whether it's required for our report.

Mr. Givens: Whatever is bloom and you've got it in a study (inaudible) legislative procedure I'll probably anticipate on how do we advance on this one (inaudible). There is something called biller (inaudible) and it was put out in June and (inaudible). There are many deadlines for rules designated by the study commission – don't worry about that, leave that to us.

Mr. Garrou: I think unless there are other questions.

Mr. Peterson: I just wanted to provide some clarification on the method by which we might be able to incorporate feedback from the group. Certainly in every single one (inaudible) as well as the CAPAG meetings we offer an opportunity for public input. We consider input from the Commission itself to be very important (inaudible). (Inaudible) back out to everybody we are going to get on the crosswalk here just to double check and

see which of them are not already under consideration. I'm not sure that there are any that are not already under consideration but the short story is take advantage of that opportunity to satisfy working with DENRs suggestions that you have and they can be raised at some point for the rest of you to consider. Just the proposal on hog waste is my understanding from Steven that we have newer management option in place there now.

Mr. Garrou: Thank you very much. I received a call from Ms. Tompkins earlier today and she will speak.

Ms. Tompkins: Thank you sir. I have a few comments just while we are talking about (inaudible) date and near dates. I wanted to just tell the Commission and legislators that on Wednesday night in Charlotte our State Utility Commission held a plummet hearing. Almost 300 people attended on a committing of two coal fired power plants for there billion dollars and since that 50 miles from Charlotte they are going to net ten million tons per year of global warming pollutants. The Utility Commission will decide January 18th or is it the 19th whether Duke Energy can build these fossil fuel plants even though the December 18th date is that close. The capital report on December 18th a six month study that we've heard about from Mr. (inaudible) and Mr. Watson found that renewable and efficiency can provide the same power for half a billion dollars less over 20 years and its necessity is subset. These plants will not only be a major polluter in a region with the worst air quality but a huge promoter of climate change. And it just seems to me that here is a state regulated monopoly on the verge of building a major contributor to mandate coal or climate change right under our nose before we even draft our report. And it also seems that there is no reason for the Utility Commission to rush to judgment now over this unknown contributor to global warming. One of the functions of our report is not just to energize the Legislature but to energize the public. A simple way to do this would be to make the connection between pollution, air pollution which will give us a stronger leg under our table to support legislation. We can have a win-win by getting the public attention on the performance of climate change if we connect to air pollution, whether on (inaudible). It's critical that we address in our report this matter. The question is how much of our effort will be undermined if we do fail flipside, how many (inaudible) and recommendations will it take to eliminate eleven million tons of global warming pollutants. Thank you.

Mr. Garrou: Our last agenda item or reports or recommendations that we've received from several of you we are now at 3:30 we talked about this, I would propose that we receive these recommendations not get full presentations this afternoon but receive them and include them in the report. As we said before that is acceptable to those who have presented them including the document from Dr. Erickson who is giving us one today as part of your materials.

Mr. Givens: For those of you that want a hard copy, we have hard copies of the four we received and we also have Dr. Erickson's handout that you received. We have five documents total and all of these are, there is another from Dr. Eggers (**Exhibit Q**) and Michael Shore (**Exhibit R**) send it to us electronically.

Dr. Eggers: Some of your suggestions about including some columns with additional information, what I will do is resubmit mine to you electronically before the 31st per those recommendations for changes.

Mr. Givens: That would be appreciated from all of those who submitted recommendations.

Dr. Smith: That is fine a number of us submitted something so I assumed that when you pulled that back modifies appropriate to meet your request and then we resubmit so I think we like the hold our until the 31st.

Mr. Givens: I would appreciate that – that's to encourage me I tried looking at that we would have enormous difficulties that we going to have a very hard job as it is we thank you for being willing to do that.

Mr. Garrou: Are there any other questions or discussion.

Dr. Smith: We are adjourning very quickly and a number of us have been kicking around the concept of a letter or something in the report on energy and I have some one-one conversations with members of the Commission that I'm mentioned to Bob Slocum and we continue to deliberate on that. I guess the idea may be that we come back with something that could be incorporated into the interim report possibly a request so that it would necessarily limited even a report based on other things other than just the sort of legislature making recommendation on some other activities that the Commissioners would recommend to other members or other bodies of NC comparable.

Mr. Garrou: We certainly are not limited to recommendations of the Legislature. We address of course (inaudible).

Mr. Givens: Let me say on that it is our intention not to and sometimes it been alleged that I don't, I don't know whether that true or not, and as you come in here on the 22nd that you haven't seen before so my intention was that anything that you see on the 22nd I will assume (inaudible).

Mr. Garrou: On the 21st.

Mr. Givens: Well that may be. We'll leave it at that but let's say if you get it any sooner then we'll hear (inaudible) and then don't hold me to it.

Mr. Garrou: If we are running out of questions or any other discussion we will adjourn and thank you very much.

Meeting Adjourned

Respectfully submitted,

John Garrou, Co-Chair

Joe Hackney, Co-Chair

Thelma T. Utley
Committee Clerk

APPENDIX A

Exhibit A	**Agenda**
Exhibit B	**Attendance**
Exhibit C	**Visitor Registration Sheets**
Exhibit D	**There is a better way – Ms. Susan Tompkins**
Exhibit E	**Coastal Vulnerability to Erosion, Storm Hazards and Potential Future Sea-Level Rise – S. Jeffress Williams**
Exhibit F	**Mitigating Shore Erosion on Sheltered Coasts – Debra Hernandez**
Exhibit G	**Mitigating Erosion Along Sheltered Coasts – Debra Hernandez**
Exhibit H	**Implications of Changing Climate and Rising Seas for Coastal North Carolina – Douglas N. Rader**
Exhibit I	**Sea Level Rise in North Carolina – Courtney Hackney**
Exhibit J	**Questions and Answers on Purchasing Coastal Real Estate in North Carolina – Walter Clark**
Exhibit K	**Renewable Portfolio Standard – Commissioner James Kerr, II**
Exhibit L	**Beach Replenishment and the Impact of Global Warming and Sea Level Rise**
Exhibit M	**North Carolina Climate Action Plan Advisory Group – Brock Nicholson and Tom Peterson**
Exhibit N	**North Carolina Climate Action Plan Advisory Group**
Exhibit O	**Preliminary Recommendations for Mitigating he Consequences of Climate Change Within North Carolina – Stanley Riggs, James Stephenson and Walter Clark**
Exhibit P	**Recommendation Proposal to N.C. Commission on Global Climate Change: Use of a Carbon Fund to Convert Lagoon-and-Sprayfield Systems on Hog Farms – Tom Profeta**
Exhibit Q	**Draft ideas for discussion – Dee Eggers**

Exhibit R **Win-Win Policy Measures to Combat Global Warming – Michael Shore**

General Assembly of North Carolina

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

State Legislative Building
Raleigh, North Carolina

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

GENIE CLARK
COMMISSION CLERK
1117 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-7850
FAX: (919) 754-3264

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER R.F. MUNDT
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

AGENDA

10:00 a.m. Friday 12 January 2007
Room 643 Legislative Office Building

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

2. Introductory remarks by Cochairs
   John. L. W. Garrou
   Representative Joe Hackney

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

4. Discussion of the effects of global climate change as they relate to coastal adaptation

   Discussion of coastal vulnerability to erosion, storm hazards, and potential sea-level rise
   S. Jeffress Williams, Coastal Marine Geologist
   United States Geological Survey, Woods Hole Science Center

   Presentation of the National Academy of Sciences report *Mitigating Shore Erosion along Sheltered Coasts*
   Debra Hernandez, President
   Hernandez and Company

   Discussion of the projected impacts of global climate change on coastal ecosystems in North Carolina
   Douglas N. Rader, Principal Scientist for Oceans and Estuaries
   Environmental Defense

Discussion of the implications of sea level rise for coastal development policy
Courtney T. Hackney, Chair
Coastal Resources Commission

Walter Clark, Coastal Community and Policy Specialist
North Carolina Sea Grant

5. 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
James Y. Kerr II, Commissioner
North Carolina Utilities Commission

Sam Watson, Staff Attorney
North Carolina Utilities Commission

LUNCH – Estimated for 12:30 p.m. to 1:15p.m.

6. Update on and discussion of activities and possible recommendations of the Climate Action Plan Advisory Group (CAPAG)
Brock M. Nicholson, Deputy Director
Division of Air Quality, Department of Environment and Natural Resources

Tom Peterson, Executive Director
The Center for Climate Strategies

7. Proposed recommendations for inclusion in the Interim Report from members of the Commission

Stanley R. Riggs, James H. Stephenson, and Walter Clark
Dolores "Dee" Eggers
Timothy Profeta
Michael Shore

8. Commission discussion and announcements

9. Adjourn

NEXT MEETING:

The Legislative Commission on Global Climate Change will meet on Thursday 22 February 2007 in Room 643 of the Legislative Office Building, at a time to be announced.

COMMISSION WEBSITE:

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

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

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.

ATTENDANCE

Committee: **LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE**

2007

DATES	01/12/07																
MEMBERS																	
Mr. John Garrou, Co-Chair	✓																
Rep. Joe Hackney, Co-Chair	✓																
Sen. Charlie Albertson																	
Sen. Janet Cowell	✓																
Sen. Robert Pittenger	✓																
Rep. Becky Carney																	
Rep. Pricey Harrison	✓																
Rep. Wilma Sherrill																	
Rep. Alice Underhill	✓																
Rep. Winkie Wilkins	✓																
Mr. Walter Clark	✓																
Dr. Dolores Eggers	✓																
Dr. Edward W. Erickson	✓																
Mr. Tim Toben	✓																
Mr. Ivan Urlaub	✓																
Mr. Thomas Cecich	✓																
Mr. Robert J. Glaser																	
Ms. Susan Tompkins	✓																
STAFF																	
George Givens, Comm. Counsel	✓																
Jeffrey Hudson, Asst. Counsel	✓																
Jennifer McGinnis, Asst. Counsel	✓																
Susan Iddings, Asst. Counsel	✓																
Tim Dodge, Research Analyst																	
Mary Watson, Comm. Assistant																	
Thelma Utley, Comm. Assistant	✓																

Committee: **LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE**

2007

DATES	01/12/07																
MEMBERS	✓																
Ms. Vicky K. Will	✓																
Dr. Douglas Crawford-Brown	✓																
Mr. Barry Eveland	✓																
Mr. George Everett	✓																
Mr. Preston Howard	✓																
Mr. Michael Nelson	✓																
Mr. Mitchell Peele	✓																
Dr. Daniel Phaneuf	✓																
Mr. Tim Profeta	✓																
Dr. Ryan Boyles	✓																
Dr. Stanley Riggs	✓																
Mr. Michael Shore																	
Mr. Robert Slocum	✓																
Dr. Stephen Smith	✓																
Mr. James Stephenson																	
Dr. Godfrey Uzochuksu	✓																
Lewis Ebert																	
George F. Givens	✓																
Jeff W. Hudson	✓																
Jennifer L. McGinnis	✓																
Susan Iddings	✓																
Jennifer R. Mundt	✓																
Jessica M. Dicapua	✓																

House Pages

GLOBAL CLIMATE CHG

Name Of Committee: _____ Date: 1/12/07

1. Name: _____

   County: _____

   Sponsor: _____

2. Name: _____

   County: _____

   Sponsor: _____

3. Name: _____

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   Sponsor: _____

4. Name: _____

   County: _____

   Sponsor: _____

5. Name: _____

   County: _____

   Sponsor: _____

HOUSE Sgt-At-Arms

1. Name: MARVIN LEE
2. Name: MARTHA PARRISH
3. Name: EARL COTER
4. Name: _____
5. Name: _____

SENATE

Leslie Wright
Ronald Spann
Charles MARSALIS
Charles Harper

VISITOR REGISTRATION SHEET

Global Climate Change — 1-12-07

Name of Committee — Date

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
James Southerland	NCDAQ - 1641 Mail Service Center Raleigh, NC 27699-1641
Heather Hawkins	NCDAQ - 225 Green St Suite 714 Fayetteville NC 28301
Leslie Kleczek	Nicholas Institute, Duke University
Maximilian Merrill	NCDA+CS
DWAYNE E. PORTER	BELLEN INSTITUTE, UN. OF S. CAROLINA
JOEL C. RAUPE	Office of the Minority Leader, NC House
TAD BOGGS	NCDENR
JOHN TROY	NC WRC
Lisa Riegel	NHTP
Patrick Buffkin	NMRS

VISITOR REGISTRATION SHEET

Global Climate Change — 1-12-07

Name of Committee — Date

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Charlie Carter	Troutman Sanders LLP
Paul Sherman	NC Farm Bureau
Patrick Buffkin	NMFS
James Mauney	MD+A
Becki Gray	John Locke Foundation
Harry S. Simmons	NC Beach, Inlet & Waterway Assoc
Christa Wagner	NC Sierra Club
Denise Choy	Environmental Defense

VISITOR REGISTRATION SHEET

Global Climate Change — 1-17-07

Name of Committee — Date

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Sam Pearsall	The Nature Conservancy 4705 University Dr. # 290 Durham, NC 27707
David Knight	TNC
Jill Holman	N.C. Wildlife Federation Duke University
Sharon Straud	State Energy Office
C W Hoffman	N.C. Geological Survey 1620 MSC Raleigh 27699
Kelly Jones	Hunton & Williams PO Box 109 Raleigh, NC 27602
JUNE SMALL	NCEMC 3400 SUMNER BLVD RALEIGH 27616
LINDA RIMER	US EPA
Jane Preyer	Environmental Defense
Rose Cunningham	
Lola Obembe	NCGA House Staff

VISITOR REGISTRATION SHEET

Global Climate Change — 1-12-07

Name of Committee — Date

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Tracy Leatherberry	NCGA House Staff
Harrison Gilbert	NCGA House Staff
Seth Wells	NCGA House Staff
Jeff Owen	NCGA House Staff
Jess MacDonald	Fiscal Research
Tan Ngo	Fiscal Research - Senate
Teri Gray	League of Women Voters
T. Lam	Public Staff - NCUC
Jack Floyd	Public Staff - NCUC
John Poteat	NCADA
Curtis Hayes	NC Farm Bureau

VISITOR REGISTRATION SHEET

Global Climate Change — 1-12-07

Name of Committee — Date

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
CAROLINE HOWE	LT. GOVS OFFICE
Sam Watts	NCUC

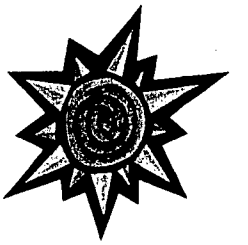
VISITOR REGISTRATION SHEET

Global Climate Change — 1-12-07

Name of Committee — Date

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Libby Smith	Commerce - esmith@nccommerce.com
Amy MacDonald	Env. Defense / So. Alliance for Clean Energy
James DeRosa	Global Warming Initiatives
James Haven	" " "
Dan Crawford	ElectriCities of NC
Jeanne Bonds	ElectriCities of NC
Janice Godfrey	NCDENR
Mike Abraczinskas	NCDENR - DAQ
Will Culpepper	Moore · Van Allen, PLLC
Deatrice Williams	CUCA
Kathy Kaufman	NCDENR-DAQ



There is a better way.

Duke has not seriously addressed alternative ways to meet our energy needs. Yet plenty of evidence shows that energy efficiency programs and renewable, clean energy could eliminate the need for these plants and at the same time stimulate economic development, create jobs, and save ratepayers money!

- A study by the NC Utilities Commission shows that NC can generate significant amounts of electricity from **renewable, clean energy sources** such as wind and hydroelectric power. Over 20 states and D.C. have passed renewable portfolio standards ("RPS") that require utilities to get a certain percentage of electricity from clean, renewable sources.
- Appalachian State University calculates that energy-efficiency programs could **save NC $3 billion per year** and support over **150,000 jobs** at an annual salary of $42,000. The Cliffside expansion would cost $3 billion and provide less than 100 long-term jobs.
- Electric Power Research Institute (the electric power industry's own think tank) says that energy efficiency could reduce usage by 27-44%, eliminating the need for new coal-fired plants!

USE YOUR VOICE FOR A CLEAN ENERGY FUTURE

Duke has not demonstrated a clear need for this facility or explored other options:

- Experts testified that Duke has not shown a need for so much new base load power and that Duke's 10-year plan did not adequately explore other ways to meet new demand, such as energy efficiency and renewable energy.

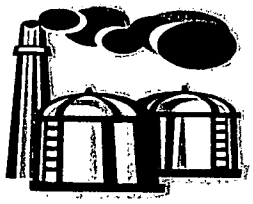
The Utilities Commission should require Duke to pursue the least-cost option of providing power, which also happens to be the option that creates many more jobs:

- The real cost of power plants -- which utilities are permitted to pass on to ratepayers, plus a profit margin -- would rise significantly in carbon-regulated system. Congress is already considering enacting a carbon tax to address global warming, and Duke should be required to factor in the possible costs of such regulation.
- Coal costs are predicted to rise as supplies of other fossil fuels and easily-mined coal in the Appalachians diminish. Duke has not adequately considered rising coal costs.
- No coal is extracted in North Carolina, so Duke will buy all the coal from out of state – sending hundreds of millions of dollars out of our state revenue stream annually.

The NCUC is charged with regulating monopoly utilities in the public interest:

- Coal-fired power plants are not in the public interest, especially given the available alternatives that cost the same or less but don't cause haze, smog, asthma, heart and lung disease, mercury poisoning of our children, or global warming pollution.

For more information: Carolinas Clean Air Coalition (704) 342-9161
director@clean-air-coalition.org



DUKE ENERGY WANTS US TO PAY $3 BILLION FOR A COAL PLANT 50 MILES WEST OF CHARLOTTE

- Duke Energy has proposed building one of the nation's largest coal plants at its CLIFFSIDE site, directly upwind of Charlotte.
- Comparable-sized facilities typically burn over 5 million tons of coal a year and emit huge amounts of **GLOBAL WARMING POLLUTION** and mercury, a toxic heavy metal.
- The plant would further pollute Charlotte's air, which is already out of compliance with federal air quality standards because of dangerous ozone pollution, risking the loss of hundreds of millions in federal highway funds.
- Because initial cost estimates jumped from $2 billion to $3 billion, the NC Utilities Commission has offered the public another chance to comment on this "investment" which will be paid for by us, the ratepayers.

EXPANDING CLIFFSIDE will lock North Carolina into a dirty energy future – 50 more years of blasting away the tops of Appalachian Mountains and pumping out 11[illegible] million tons of global warming pollution each year.

You Can Make A Difference.

ATTEND THE PUBLIC HEARING IN CHARLOTTE
JANUARY 10, 7:00 PM
Main Library, downstairs
310 N. Tryon Street

*** *PRESS CONFERENCE* Outside at 6 pm**

Carpooling encouraged; if you need transportation, call (704) 342-9161

Parking at 7th Street Station (Reid's); $5.00

Please attend the public hearing, or write the NCUC with your thoughts:

NC Utilities Commission
Re: Docket E7, Sub 790 (Cliffside)
4325 Mail Service Center
Raleigh, NC 27699-4325

12 January 2007

Presentation to the North Carolina Legislative Commission on Global Climate Change

Coastal Vulnerability to Erosion, Storm Hazards and Potential Future Sea-level Rise

S. Jeffress Williams (jwilliams@usgs.gov), Coastal Marine Geologist, U.S. Geological Survey/Woods Hole Science Center, Woods Hole, MA

A major emphasis of research in coastal sciences is targeted at understanding how coastal landforms and nearshore regions are likely to change in response to global sea-level rise over the next century. Research over the last 50 years has formulated a conceptual framework regarding the primary factors and processes that drive shoreline change and coastal evolution. Nonetheless, current techniques and models used to make coastal-change assessments such as inundation modeling, historical shoreline-change analysis, and equilibrium-profile modeling do not accurately reflect the current scientific understanding of coastal change due to relative sea-level rise. While research illuminates the complexity of coastal behavior and the inadequacy of current models to predict such complexity, our ability to predict long-range impacts of sea-level rise to inform coastal managers, policymakers, and planners remains limited.

An abundant body of scientific information shows that global climate throughout Earth's history is highly variable with complex natural driving forces. Scientific consensus, however, is that the rapid build-up of greenhouse gases from fossil fuel burning since the 1880s has increased earth surface and atmospheric temperatures and is primarily responsible for the wide spread environmental changes being documented. Climate-change assessments (e.g., IPCC 2001) for the next century suggest global sea-level will rise between 0.2 and 0.88 m with a central estimate near 0.5 m, more than 2 times the rise over the past century. The majority of the predicted future rise will be due to thermal expansion of warming ocean water and the addition of melt water from land-based glaciers and ice sheets in response to climate warming. Recent research continues to support these projections. In addition, consensus is strengthening that the rate of sea-level rise may accelerate in the decades ahead due to climatic factors that are more robust than predicted and processes (e.g., Greenland melting, Antarctic ice-shelf breakup) that have not been considered until very recently.

As part of an effort to evaluate the physical impacts of future sea-level rise on the United States coastline, the U.S. Geological Survey has completed the Coastal Vulnerability Index study of 25 National Park Service coastal parks. In addition, the U.S. Geological Survey, as part of the U.S. Climate Change Science Program (http://www.climatescience.gov/), is performing a review the state-of-the-science regarding potential future coastal changes associated with sea-level rise. The goal is to identify gaps in knowledge that must be addressed to improve our ability to model and forecast these potential changes. Existing scientific approaches to predicting coastal change due to sea-level rise are widely debated and the ambiguity resulting from this lack of consensus leads to an oversimplification of potential coastal hazards and a wide disparity in public awareness of coastal risks and vulnerabilities to sea-level rise and coastal change.

SHELTERED COASTS AND EROSION

Sheltered coasts are shorelines that face smaller bodies of water in contrast to open ocean beaches. These smaller water bodies are typically calmer with less wave energy. Lower energy conditions foster habitats and ecological communities, such as marshes and mud flats, typically not found on open coasts. The unique characteristics of sheltered coasts affect the potential technological approaches and the consequences of actions taken to stem erosion and land loss from sea level rise.

Erosion is caused by (1) winds; (2) waves, currents, and tides that transport shoreline sediments; and (3) weathering processes that destabilize landforms such as bluffs and cliffs. Although natural processes contribute to erosion, the rate may be accelerated by human activities such as construction of dams upstream of estuaries or installation of groins and seawalls that alter the magnitude and direction of sediment transport. Inundation can also increase because the ground sinks when sediments settle and compact or subsurface resources, such as groundwater and petroleum, are withdrawn. Other human activities that increase erosion include dredge and fill operations, wetland drainage, boat traffic, and channel dredging.

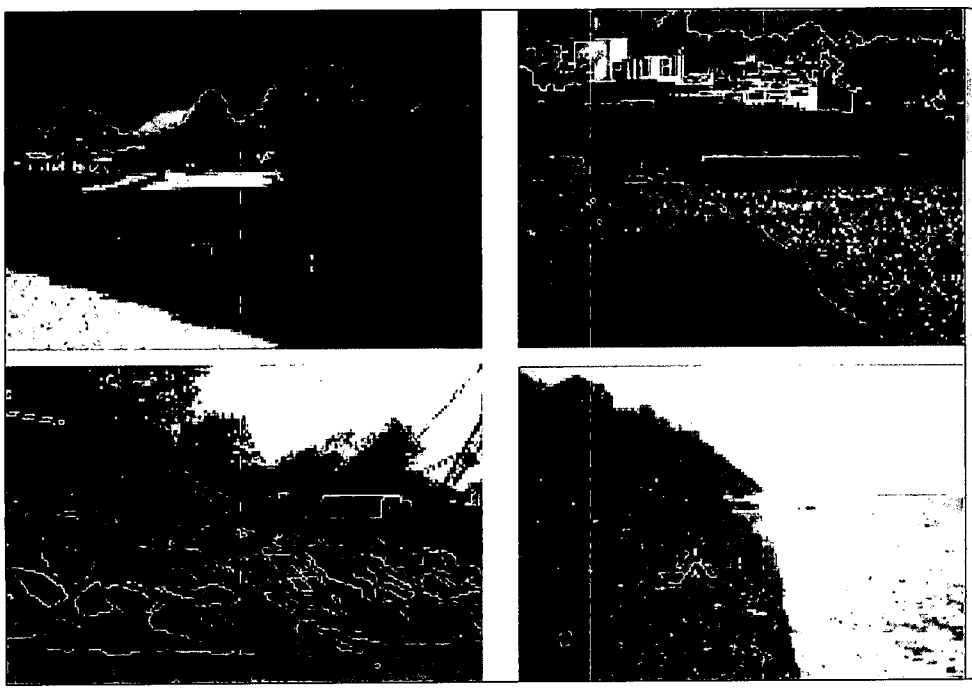
Sea level rise will exacerbate the loss of waterfront property and increase vulnerability to inundation hazards. It changes the location of the coast line, moving it landward and exposing new areas and landforms to erosion. Additionally, sea level rise is chronic and progressive, requiring a response that is correspondingly progressive.

CURRENT APPROACHES TO PROTECTING AGAINST EROSION

The pressure to develop and stabilize shorelines in sheltered coastal areas is increasing because coastal populations are growing. More people desire waterfront homes and coastal property values have risen. There are several types of mitigation measures to stabilize shorelines. The most common response is "hold the line" strategies that harden the shoreline with structures such as bulkheads and revetments. There are alternatives, such as constructed marsh fringes, that are designed to preserve more natural shorelines. The selection of the type of response to prevent or offset land loss depends on understanding local causes of erosion or inundation.

A shift away from the hold the line approach has been slow, in part because there is a greater familiarity with these methods than with alternative approaches such as constructing a marsh fringe or using vegetation to stabilize a bluff. Contractors are more likely to recommend structures such as bulkheads because they have experience with the technology and know the design specifications and expected performance. Landowners often assume that a hard, barrier-type structure will be required to prevent loss of property and protect buildings. In many regions, government regulations may unintentionally encourage shoreline armoring because it is simpler and faster to obtain the required permit(s).

However, there are indirect costs associated with mitigation options that armor the shoreline. Many of these costs are borne by the public rather than the



The photos show different methods of shoreline hardening along the coast of Long Island, Long Island Sound. Wood bulkhead (upper left); concrete seawall (upper right); stone revetment (lower left) and gabion seawall (lower right). Problems that can arise with these methods include loss of sand that nourishes downdrift beaches,over-steepened shorefaces, and loss of habitat and recreational access. Source: Tanski (2005).

REPORT IN BRIEF

October 2006

Mitigating Shore Erosion on Sheltered Coasts

Much like ocean beaches, sheltered coastal areas experience land loss from erosion and sea level rise. The many bulkheads and other structures built to protect coastal properties in those areas cause changes to the coastal environment that threaten landscapes, public access, recreational opportunities, natural habitats, and fish populations. A new management approach is needed that takes into account all available erosion prevention alternatives and their attendant costs, benefits, and impacts. The regulatory preference for permitting bulkheads and similar structures should be changed to favor more ecologically beneficial solutions.

Erosion is a natural phenomenon that threatens properties built on coastal shores. Although open coasts have been the focus of most studies on erosion and technologies for stabilizing the shoreline, sheltered coastal areas, such as those found in bays and estuaries, also suffer land loss from erosion and high waters. For example, the Maryland Geological Survey estimated that Maryland lost as much as 20 acres of land on the western shore of Chesapeake Bay in the wake of Tropical Storm Isabel, causing $84,000,000 in damages to shoreline structures.

Photo courtesy VIMS photo archive

Landowners frequently respond to the threat of erosion by armoring the shoreline with bulkheads and other structures. Although the armoring of a few properties has little impact, the proliferation of structures along a shoreline can inadvertently change coastal environments and ecosystems. Managers and decision makers have been challenged to balance the trade-offs between protection of property and potential loss of landscapes, public access, recreational opportunities, natural habitats, and reduced populations of fish and other marine species that depend on these habitats.

At the request of the U.S. Environmental Protection Agency (EPA), the U.S. Army Corps of Engineers (USACE), and the Cooperative Institute for Coastal and Estuarine Environmental Technology, this report examines the impacts of shoreline management on sheltered coastal environments and strategies to minimize potential negative impacts to adjacent or nearby coastal resources. Overcoming the obstacles associated with the existing management framework will require a number of societal and institutional changes. The report recommends development of a new shoreline management framework to help decision makers evaluate the spectrum of available approaches to shoreline erosion problems in the context of the environmental setting. The new framework would include assessment of the physical and ecological properties of the shoreline and the potential cumulative impacts.

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landowner. For example, installation of a groin to trap sand can affect neighboring beaches and bulkheads may lead to loss of fronting beaches along with attendant public access and scenic amenities. When marshes are affected, highly diverse and productive plant and animal communities may be lost along with the vital ecosystem services they provide—nursery, areas for important fish stocks, removal of excess nutrients from land runoff, feeding areas for migratory birds, and sediment stabilization.

A NEW SHORELINE MANAGEMENT FRAMEWORK

Changing the current practice of armoring sheltered coasts will require a change in the shoreline management framework. Decision makers should appreciate the costs and benefits of the spectrum of potential solutions to shoreline erosion problems, including potential cumulative impacts on shoreline features, habitats, and other amenities. The management framework should encourage approaches that minimize habitat loss and enhance natural habitats in environments where such methods offer effective stabilization. Overcoming the obstacles associated with the current regulatory environment will require a number of societal and institutional changes in the following areas:

Improving Knowledge of Sheltered Shoreline Processes and Ecological Services

Overall, less is known about physical process of sheltered coastal systems than of open coasts. In most areas, the scope and accessibility of information regarding the causes of erosion at specific sites and the overall patterns of erosion, accretion, and inundation in the broader region (estuary, lagoon, littoral cell) is insufficient to support the development of an integrated plan for managing shore erosion. The report recommends that federal agencies (e.g., USACE, EPA, USGS, and NOAA), state agencies, and coastal counties and communities support targeted studies of sheltered coast dynamics to provide an informed basis for selecting erosion mitigation options that consider the characteristics of the broader coastal system rather than simply addressing immediate problems at individual sites.

Improving Awareness of the Choices Available for Erosion Mitigation

Many decision-makers, particularly homeowners but also some state and federal regulators, are not sufficiently informed about the mitigation options available to them or the short and long term impacts of their choices. Decision makers need assessments of new techniques and materials designed to mitigate shore erosion. The report recommends that major federal agencies involved in permitting activities (EPA, USACE, and NOAA) initiate a national policy dialogue that can be used to develop guidelines for mitigating erosion on sheltered coasts. As part of this dialogue, the agencies should develop publications that contain objective information about erosion mitigation techniques, including descriptions of the conditions under which each option would be effective.

Considering Cumulative Consequences of Erosion Mitigation Approaches

Cumulative impacts refer to the combined effects on legal, social, ecological, and physical systems. From a legal or regulatory standpoint, issuing permits may set a precedent, potentially facilitating the approval process for future requests for similarly situated structures. From an ecological standpoint, the cumulative impact of the loss of many small parcels will at some point alter the properties, composition,

Planting vegetation offers an alternative for reducing erosion at some sites. Top photo shows a pre-project shoreline on Wye Island in Queen Anne's County, Maryland. Marsh grass was planted on sand fill and short, stone groins were placed. Middle photo is three months after installation. Bottom photo is six years after installation. Source: Hardaway and Byrne (1999).

and values of the ecosystem. In addition, the economic, recreational, and esthetic properties of the shoreline will be altered, with potential loss of public use, access and scenic values. These cumulative effects are rarely assessed and hence are generally unknown, but an understanding of them is necessary to prevent an underestimation of the impacts of individual projects. The report recommends that cumulative effects be assessed in shoreline management plans, and that a precautionary approach be taken if there is insufficient information to determine cumulative effects.

Altering the Permitting System

The current permitting system fosters a reactive response to the problem of erosion on sheltered coasts. Decision-making is usually parcel-by-parcel and based on relatively little environmental information. The path of least resistance drives choices through a rigid decision-making process, with inadequate attention to the cumulative effects of individual decisions. The state and federal agencies (EPA, USACE, and NOAA) need to convene a working group to evaluate the decision-making process used for issuing permits for erosion mitigation structures to revise the criteria for sheltered coasts, including consideration of potential cumulative impacts. In many jurisdictions, obtaining a permit for bulkheads and similar structures is simple and fast relative to alternative measures. The report recommends changing the regulatory system to make it easier to get a permit to install shore stabilization alternatives that maintain natural shoreline features.

Improving Shoreline Management Planning

Creating a more proactive "regional approach" to shoreline management could address some of the unintended consequences of reactive permit decisions. The term "regional" is used in this report to reflect an area of shoreline that is defined by functional physical or ecological parameters such as littoral cells, or the scale of processes that affect sediment transport. Several examples of regional planning already exist for shorelines: the USACE Regional Sediment Management (RSM) program, EPA's National Estuary Program, and some special area management plans approved by state coastal management programs. This report provides a list of findings and recommendations about the strengths and weaknesses of these programs and how they could be used to address erosion mitigation on sheltered coasts.

CONCLUSION

Until the government regulatory framework addresses the regional scale of the processes controlling sediment transport, stabilization of individual sites will often include structures that damage adjacent areas and create a domino effect of coastal armoring. The dimensions of the regulatory framework should match the scale of the processes that contribute to shore erosion.

Currently there is no national mandate to document erosion processes on sheltered coasts or develop regional scale plans. No federal agency has been assigned to provide that scale of planning, although some states have become more proactive in shoreline management. Hence, implementation of a regional plan will require a new commitment for coordination among local, state, and federal programs, including a regional general permit.

Committee on Mitigating Shore Erosion Along Sheltered Coasts: Jeff Benoit (*Chair*), SRA International, Arlington, Virginia; **C. Scott Hardaway**, Jr., College of William and Mary, Virginia Institute of Marine Science, Gloucester Point; **Debra Hernandez**, Hernandez and Company, Isle of Palms, South Carolina; **Robert Holman**, Oregon State University, College of Oceanic Atmospheric Sciences, Corvallis; **Evamaria Koch**, University of Maryland, Center for Environmental Science, Horn Point Laboratory, Cambridge; **Neil McLellan**, Shiner Moseley and Associates, Houston, Texas; **Susan Peterson**, Teal Partners, Rochester, Massachusetts; **Denise Reed**, University of New Orleans, Department of Geology and Geophysics, New Orleans, Louisiana; **Daniel Suman**, University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, Florida; **Susan Roberts**, (*Study Director*), National Research Council.

This report brief was prepared by the National Research Council based on the committee's report. For more information, contact the Ocean Studies Board at (202) 334-2714 or visit http://dels.nas.edu/osb. Copies of *Mitigating Shore Erosion on Sheltered Coasts* are available from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; www.nap.edu.

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Mitigating Erosion Along Sheltered Coasts

A report of the National Academies

Debra Hernandez, P.E.
President, Hernandez and Company

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Statement of Task

The study will examine the impacts of shoreline management on sheltered coastal environments (e.g. estuaries, bays, lagoons, mud flats, deltaic coasts) and identify conventional and alternative strategies to minimize potential negative impacts to adjacent or nearby coastal resources. The study will provide a framework for collaboration between different levels of government, conservancies, and property owners to aid in making decisions regarding the most appropriate alternatives for shoreline protection.

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3

Statement of Task (condensed)

- What engineering approaches and land management/ planning measures are available to protect sheltered coastlines from erosion or inundation?
- What information (and time frame for monitoring) is needed to determine where and when these measures are reliable and effective both from an engineering and a habitat perspective?
- What are the likely individual and cumulative impacts of shoreline protection practices?
- Given current trends in erosion and acceleration of relative sea-level rise, how can design criteria, the mix of technologies employed, and land use plans be implemented for protecting the environment and property over the long term?

THE NATIONAL ACADEMIES

4

Committee

JEFF BENOIT, *Chair*, SRA International, Arlington, Virginia
C. SCOTT HARDAWAY, JR., College of William and Mary, Virginia Institute of Marine Science, Gloucester Point
DEBRA HERNANDEZ, Hernandez and Company, Isle of Palms, South Carolina
ROBERT HOLMAN, Oregon State University, College of Oceanic Atmospheric Sciences, Corvallis
EVAMARIA KOCH, University of Maryland, Center for Environmental Science, Horn Point Laboratory, Cambridge
NEIL MCLELLAN, Shiner Moseley and Assodates, Houston, Texas
SUSAN PETERSON, Teal Partners, Rochester, Massachusetts
DENISE REED, University of New Orleans, Department of Gedogy and Geophysics, New Orleans, Louisiana
DANIEL SUMAN, University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, Florida

Staff
SUSAN ROBERTS, Study Director
AMANDA BABSON, Christine Mirzayan Science and Technology Policy Fellow
SARAH CAPOTE, Senior Program Assistant

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Report Organization

- Understanding Erosion On Sheltered Coasts
- Methods For Addressing Erosion
- Mitigating Eroding Sheltered Shorelines: A Trade-off In Ecosystem Services
- The Existing Decision-making Process For Shoreline Protection On Sheltered Coasts
- A New Management Approach For Sheltered Shorelines

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What *Is* A Sheltered Coast?

- Typically bays, harbors, and estuaries
- Generally smaller bodies of water with limited fetch and water depth
- Protected from the full force of ocean energy by an island, peninsula, or reef
- Irregular "compartmentalized" shoreline compared to linear open coasts
- High diversity of resources and conditions, unique habitats, ecologically productive
- Same processes as on open coasts, but the scale is greatly reduced

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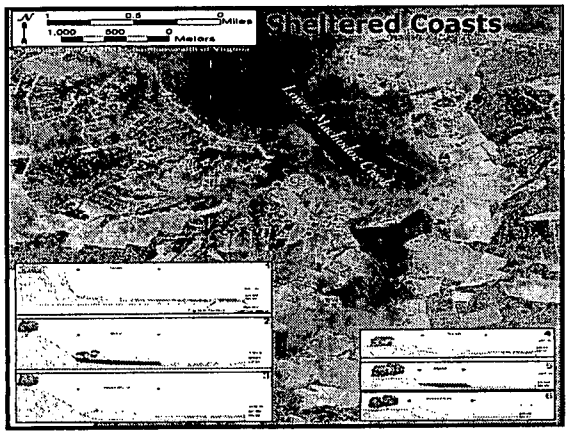
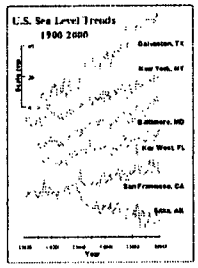


The Problem

- Sheltered c oasts are sites of increasing development, with many people moving to the coast
- Sheltered c oasts are vulnerable to chronic land loss from erosion and sea level rise
- Land owners typically select hardening technologies such as bulkheads, revetments, and groins to prevent land loss although "softer" alternatives are available.



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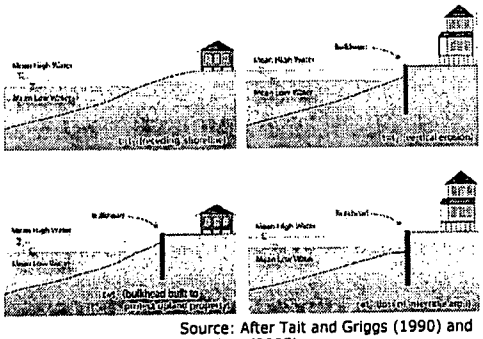
Beach Loss after Installation of Bulkhead



Source: After Tait and Griggs (1990) and Douglass (2005)

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Geomorphic Settings

Three major categories:

- Beaches and dunes
- Mudflats and vegetated communities (marsh, macroalgae, sea grasses, etc.)
- Unconsolidated bluffs

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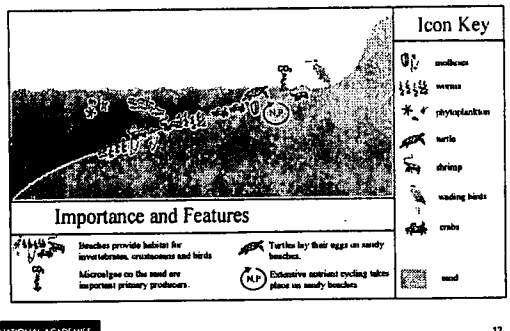
Ecosystem Services - Beaches



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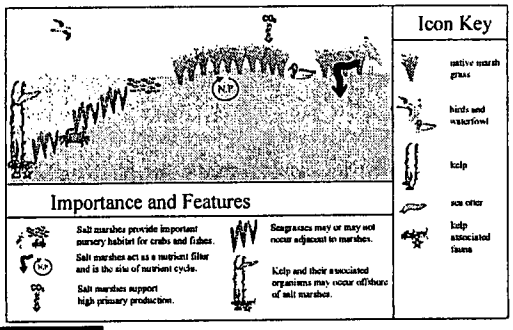
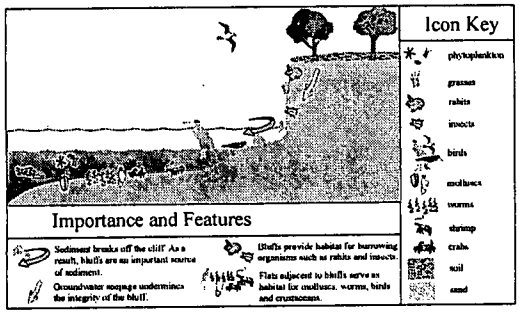
Ecosystem Services - Marshes



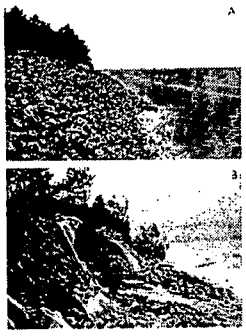
Ecosystem Services - Bluffs



Strategies for Addressing Erosion

- Harden
- Vegetate
- Trap and/or add sand
- Manage Land Uses
- Combination of one or more

Design Criteria



Top: Stone revetment built with only one layer of undersized armor stone on too steep a slope.

Bottom: failure after a modest storm event.

Source: Hardaway and Byrne, 1999

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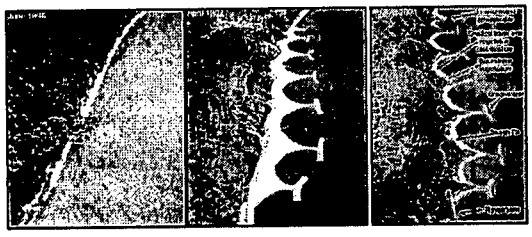
Combination Approaches



Shore protection system utilizing primarily headland breakwaters and beach fill with wetland vegetation,bank grading with upland vegetation, and an interfacing low-crested breakwater and revetment

Source: Hardaway and Byrne, 1999

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Findings and Recommendations

- **Information Needs**
- **Erosion Mitigation and Permitting**
- **Cumulative Effects**
- **Shoreline Management Planning**

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INFORMATION NEEDS

FINDING:
Scope and accessibility of information on causes of erosion and overall patterns of erosion, accretion, and inundation in the broader region (estuary, lagoon, littoral cell) is insufficient in most areas to support the development of an integrated plan for managing shore erosion.

RECOMMENDATION:
Federal agencies (e.g., USACE, EPA, USGS, and NOAA), state agencies, and coastal counties and communities should support targeted studies to facilitate decision making based on the coastal system rather than individual sites.

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INFORMATION NEEDS

These studies should:

- Identify trade offs in ecosystem services associated with various mitigation measures,
- Quantify the costs and benefits of non-structural erosion control techniques,
- Document system-wide process and hazard information, including mapping of erosion zones and rates. This information needs to be presented in non-technical formats such as summary maps that can be readily understood by decision-makers.
- Develop models to predict the evolution of coastal features under various scenarios.

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EROSION MITIGATION AND PERMITTING

FINDINGS:

- Compared to open coasts, a greater variety of techniques are available to address erosion in sheltered areas
- New techniques (or structural materials) require a rigorous process of testing and evaluation to determine their effectiveness and evaluate their environmental impacts
- The current permitting system discourages the use of alternatives to shoreline hardening

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EROSION MITIGATION AND PERMITTING

RECOMMENDATIONS:

- The major federal permitting agencies (EPA, USACE, and NOAA) should initiate a national policydialogue on sheltered coasts to bring decision-makers together to share information on the potential use of different erosion mitigation approaches.
- The national dialogue should be used to develop guidelines for mitigating erosion on sheltered coasts that give deference to ecologically beneficial measures and ensure consistency of decision-making across regions.
- The regulatory preference for permitting bulkheads and similar structures should be changed to favor more ecologically beneficial solutions that provide shore protection.
- State and federal regulatory programs should establish a technical assistance function to provide advice on permitting issues and information on types of erosion mitigation approaches and their effectiveness under various site conditions.

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CUMULATIVE EFFECTS

FINDING:

- The cumulative impact of the loss of many small parcels will at some point alter the properties, composition, and functioning of the ecosystem. In addition, the economic, recreational, and esthetic properties of the shoreline will change with potential loss of public use, access, and scenic values. Cumulative effects of shoreline hardening projects are rarely assessed and hence are generally undocumented.

RECOMMENDATION:

- Shoreline management plans should be developed to account for potential cumulative effects of shoreline hardening. Anticipation of the problem allows prioritization of projects to areas unsuited to non-structural alternatives or sites where structures are predicted to have less impact. In the absence of information, a precautionary approach should be taken.

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SHORELINE MANAGEMENT PLANNING

FINDINGS:

- Many factors in addition to sediment budgets must be considered in the development of regional shoreline management plans including socio-economic factors (e.g., ownership of the shoreline, waterfront property values, beach access for recreational boating and fishing) and a broad range of ecological issues.
- Regional shoreline management plans could be implemented under the auspices of the federal Coastal Zone Management Act (CZMA), Section 309 - Special Area Management Plans, to ensure that federal permitting actions are consistent with the plan.
- The USACE Regional Sediment Management program provides a model for regional planning that matches the scale of planning effort to the scale of the processes and impacts.

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SHORELINE MANAGEMENT PLANNING

RECOMMENDATIONS:

- Regional shoreline management plans (based on estuary, bay, or littoral cell) should be developed by local, state, and federal partners to address erosion on sheltered shorelines in a comprehensive, proactive manner and to avoid the unintended loss of recreational, aesthetic, economic, and ecological values of sheltered coastal areas.
- The essential elements of a regional shoreline management plan should include:
  - a shared vision for the future shoreline of the water body through stakeholder collaboration,
  - analysis of regional sediment budgets and the cumulative effects of existing shoreline management activities,
  - the mechanism for turning the vision into reality through consistent permitting provisions,
  - implementation, and
  - performance evaluation and monitoring requirements.

SHORELINE MANAGEMENT PLANNING

RECOMMENDATIONS:

- Information obtained from monitoring programs should be incorporated in subsequent planning activities. Adaptive management strategies should be used to consistently evaluate and refine regional plans.
- Each regional shoreline management plan should describe the physical and hydrodynamic settings, including the location and type of existing shoreline structures in a GIS format. The plan should describe the available mitigation options and discuss the applicability, relative cost and benefit, and effectiveness of each option.

In Summary

- Information on shoreline change is insufficient for sheltered coasts
- Decision makers (landowners, contractors, local and state authorities) are generally unaware of alternative erosion mitigation strategies and their effectiveness
- Individual decisions lead to cumulative impacts
- All mitigation measures affect ecosystem services
- Local, proactive shoreline management plans could prevent unintended consequences of site-by-site permitting
- Permitting systems should promote mitigation approaches that maintain more natural shorelines

ENVIRONMENTAL DEFENSE

Implications of Changing Climate and Rising Seas for Coastal North Carolina

Testimony to the Legislative Commission on Global Climate Change

Douglas N. Rader, Ph.D.

Principal Scientist for Oceans and Estuaries

ENVIRONMENTAL DEFENSE

12 January 2007

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Special "Thanks" to:

- Dr. Sam Pearsall (Chief Scientist, NC Nature Conservancy)
- Dr. Stan Riggs (East Carolina University)
- Dr. Pat Halpin (Duke University)
- Dr. Jennifer Phelan (NC State University)
- Dr. Pete Peterson (Univ. of North Carolina)

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ENVIRONMENTAL DEFENSE

Overview

- Primer on North Carolina coastal ecosystems vulnerable to global warming and rising seas
- Predicted impacts of warming and rising seas
- Recommendations

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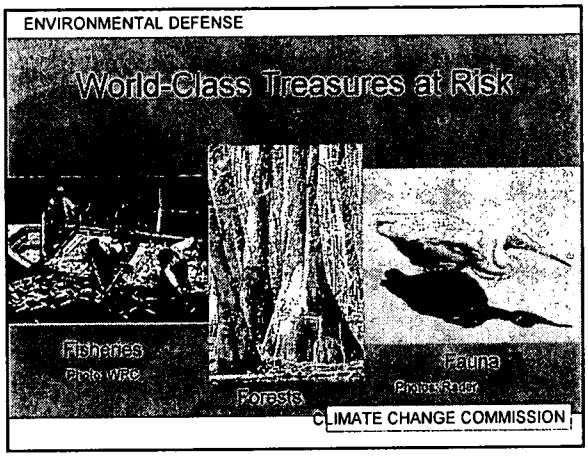
ENVIRONMENTAL DEFENSE
World-Class Treasures at Risk
Fisheries
Photo: WRC
Forests
Fauna
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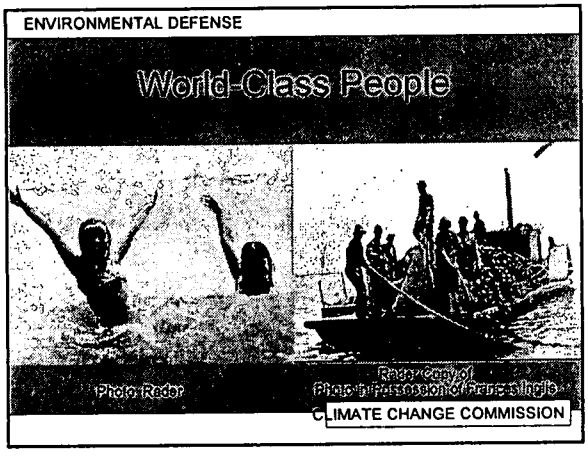
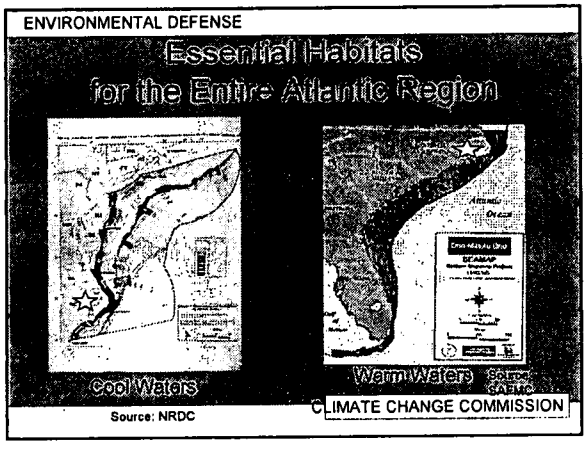
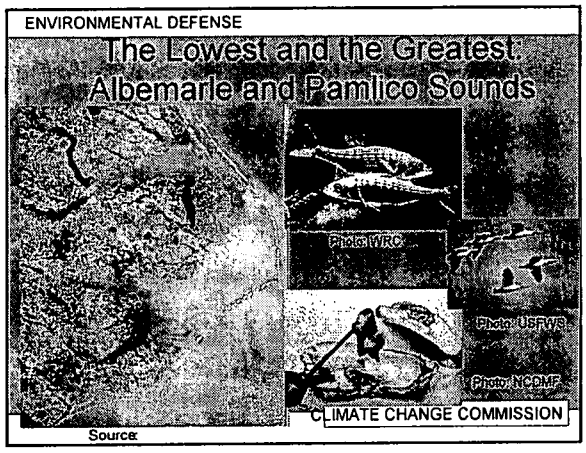
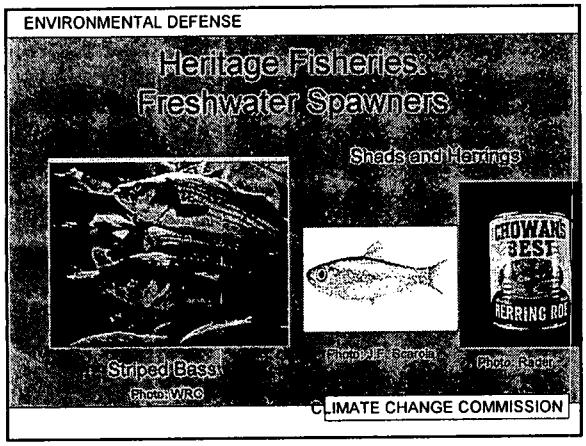

ENVIRONMENTAL DEFENSE
World-Class People
Photo: Reuter
CLIMATE CHANGE COMMISSION


ENVIRONMENTAL DEFENSE
Essential Habitats
for the Entire Atlantic Region
Cool Waters
Warm Waters
CLIMATE CHANGE COMMISSION
Source: NRDC


ENVIRONMENTAL DEFENSE
The Lowest and the Greatest: Albemarle and Pamlico Sounds
Photo: WRC
Photo: USFWS
Photo: NCDMF
CLIMATE CHANGE COMMISSION
Source:


ENVIRONMENTAL DEFENSE
Heritage Fisheries: Freshwater Spawners
Shads and Herrings
CHOWAN'S BEST
HERRING ROE
Striped Bass
Photo: WRC
Photo: J.F. Bacon
Photo: Radar
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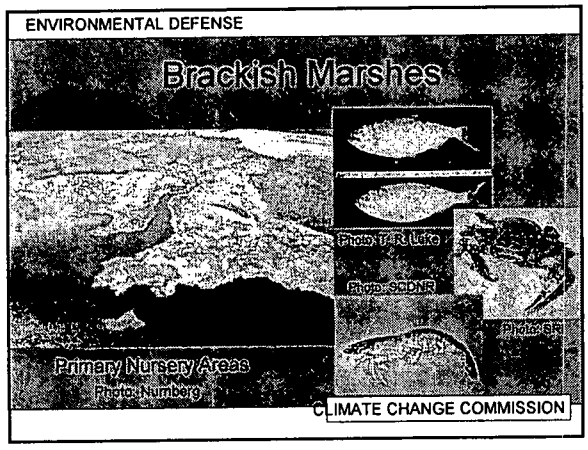
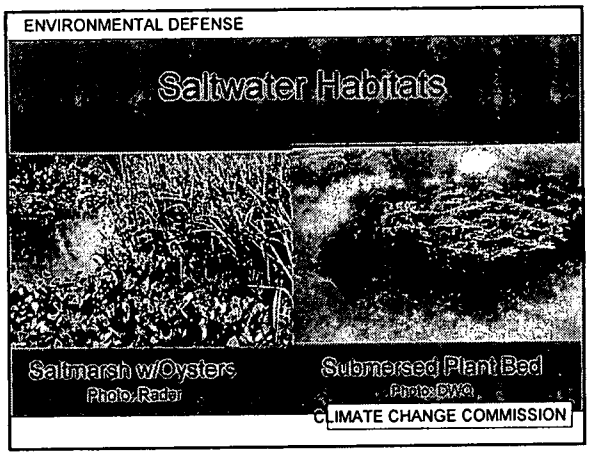

ENVIRONMENTAL DEFENSE
Brackish Marshes
Photo: T.R. Lake
Photo: SCDNR
Photo: SFI
Primary Nursery Areas
Photo: Numberg
CLIMATE CHANGE COMMISSION


ENVIRONMENTAL DEFENSE
Saltwater Habitats
Saltmarsh w/Oysters
Photo: Reder
Submersed Plant Bed
Photo: DWQ
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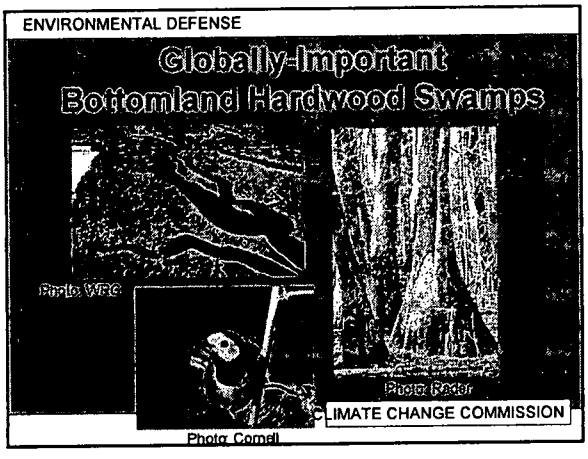
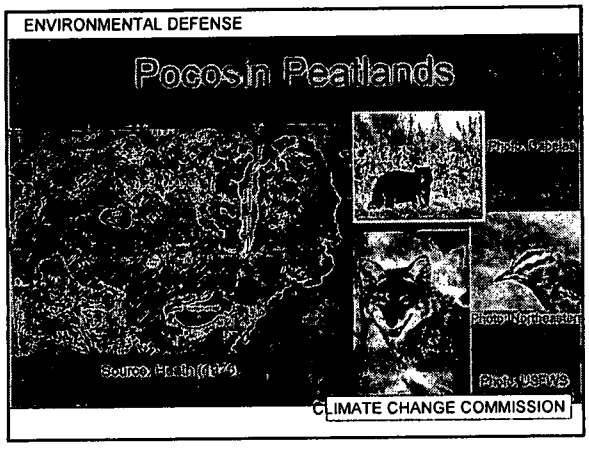

ENVIRONMENTAL DEFENSE
Globally-Important
Bottomland Hardwood Swamps
Photo: Reder
CLIMATE CHANGE COMMISSION
Photo: Cornell


ENVIRONMENTAL DEFENSE
Pocosin Peatlands
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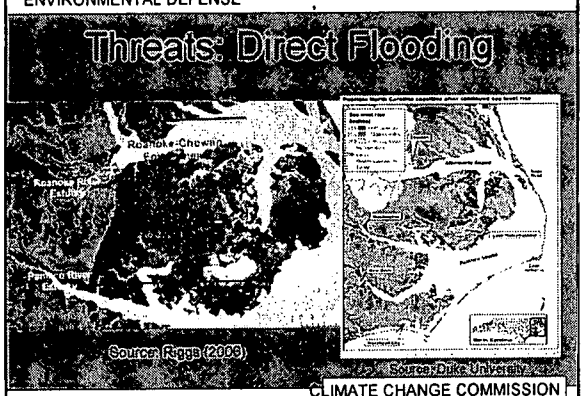
ENVIRONMENTAL DEFENSE

Threats: Direct Flooding



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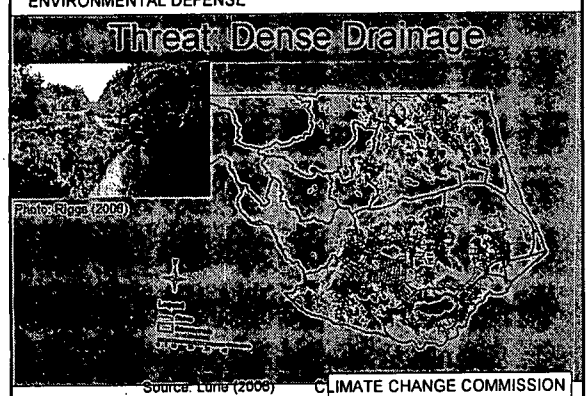
Threat: Dense Drainage



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Drainage Networks

- Oxidation of peats and subsidence
- Alteration of flows
- Salt waters "intrusion"
- Alteration of vegetation and habitat
- Alteration of human uses

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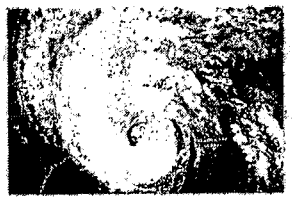
Threat: Hurricanes and Extra-tropical Cyclones



Hurricane Isabel

Photo: NASA

Floyd/Dennis Source: USGS

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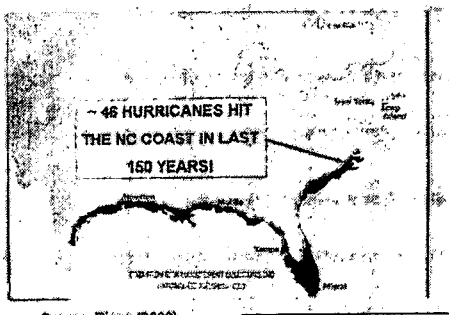
ENVIRONMENTAL DEFENSE

Storm Central!



Source: Riggs (2009)

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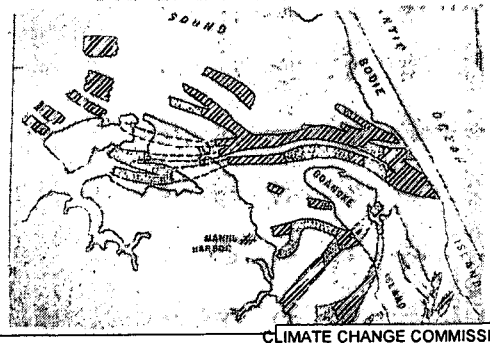
ENVIRONMENTAL DEFENSE

Old and New Inlets?



Source: Riggs and O'Conner (1974)

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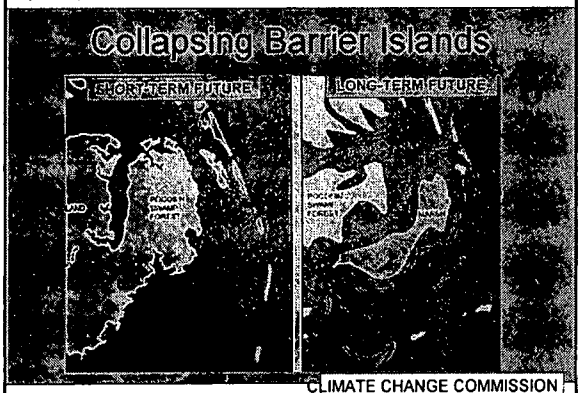
Collapsing Barrier Islands



Source: Riggs (2006)

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Threat: Disruption of Biogeochemical Cycles

Nitrogen

Water

Carbon

Albemarle Sound?

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Ecological Cascades

- New inlets
- Altered salinities
- Altered swamps and marshes
- Altered habitat values (e.g. migratory birds, fishes)
- Altered human usage (hunting, fishing, farming, forestry, etc.)

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ENVIRONMENTAL DEFENSE

Threat: Altered Rainfall

- Altered flows (higher peaks, lower averages)
- Altered water availability (human and ecosystem needs)
- Altered assimilative capacity (wastes)
- Competition for water and waste assimilation!!!!

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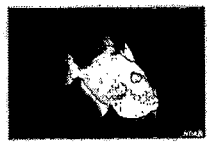
ENVIRONMENTAL DEFENSE

Threat: Changing Temperatures

- Altered vegetation (forests, crops and natural communities)
- Altered fisheries
- Human health???



Gray triggerfish

Photo: Florida Mus[illegible]

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Deepwater Coral Reefs!?

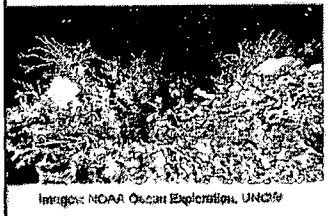
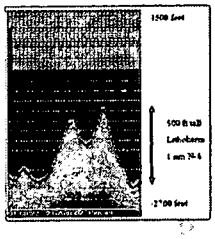


Image: NOAA Ocean Exploration, UNCW



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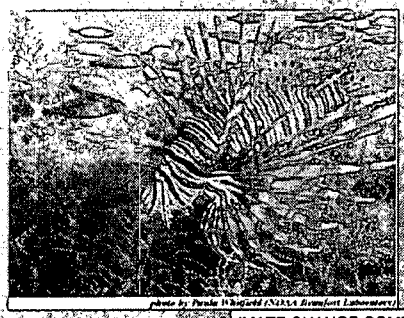
Threat: Invasive Species??



Pacific Red Lionfish

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ENVIRONMENTAL DEFENSE

Recommendations

- NC Climate Action Plan
- Leverage ALL existing environmental plans:
  - Coastal Habitat Protection Plan
  - A/P Comprehensive Conservation and Management Plan
  - State Wildlife Action
  - South Atlantic Fishery Ecosystem Plan
  - Basinwide Management Plans
  - State Beach and Inlet Management Plan
  - State Water Plan
  - State Ocean Plan?

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Recommendations (2)

- Flow targets for all rivers (remove or "reoperate" dams)
- Map and remediate drainage systems and drainage districts
- Prohibit new public and publicly licensed or permitted infrastructure in flood-prone and storm-surge-prone areas

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ENVIRONMENTAL DEFENSE

Recommendations (3)

- Remediate existing vulnerable or damaging infrastructure as storms occur ("strategic opportunism")
- "Balance" biogeochemical cycles
- Utilize existing and develop new markets for carbon, nitrogen, water and habitat
- Leverage current state investments (e.g. CWMTF)

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Recommendations (4)

- Protect and restore oyster reefs and SAVs as energy absorbing structures
- Facilitate shoreline retreat and upslope wetland migration (sand, bulkheads, etc.)
- Invest in research and monitoring (e.g. water levels monitors, invasive species)
- Address inevitable "publicization" of newly submerged lands: ease that transition (e.g. rolling easements?)

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ENVIRONMENTAL DEFENSE

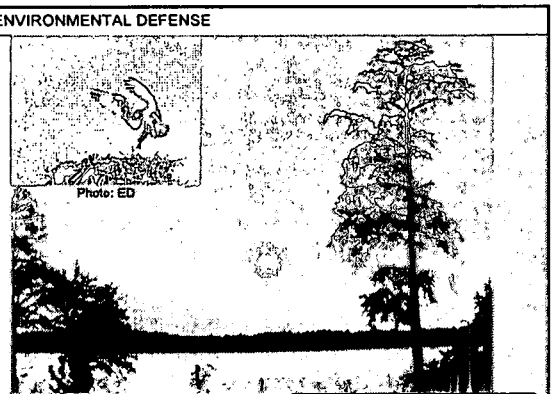

Photo: Rader

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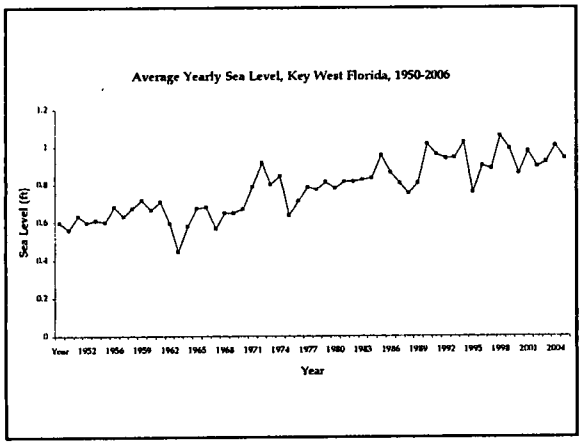
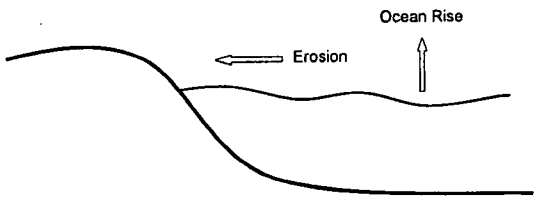
SEA LEVEL RISE IN NORTH CAROLINA

IMPLICATIONS FOR COASTAL POLICY

Relative Sea Level Rise

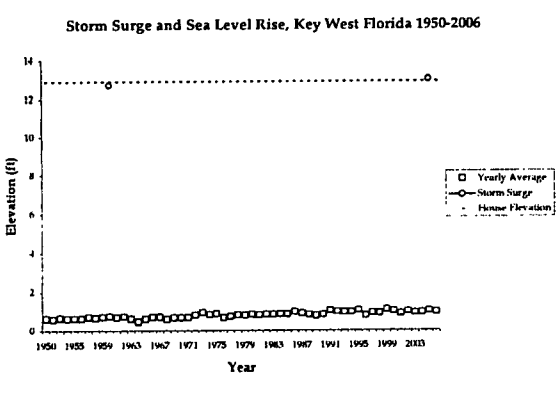


Relative Sea Level Rise

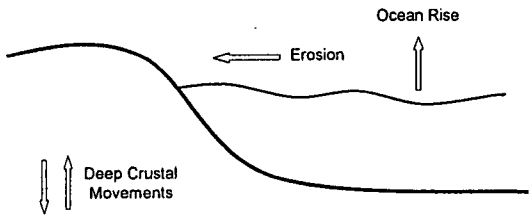


Policies and Rules

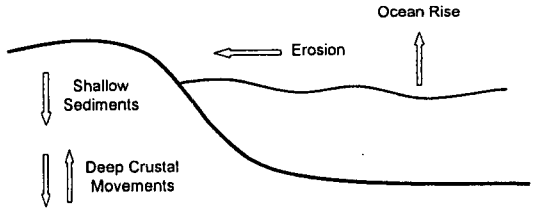
- Oceanfront Construction
  - Building codes
- Setbacks & Shoreline Retreat
  - 30 year life span
- Beach Nourishment
  - High costs & collateral environmental impacts
- Beach Hardening and Sandbag Walls
  - Prohibited and limits on sandbag size & lifespan
- Storm Damage Attenuation
  - Berms, local zoning, and federal insurance policy



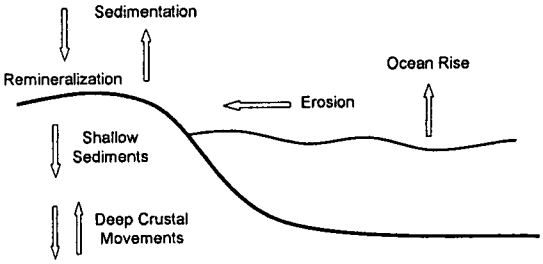
Relative Sea Level Rise



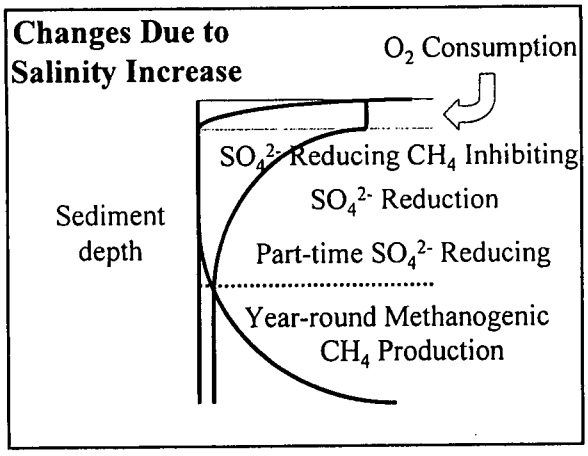
Relative Sea Level Rise

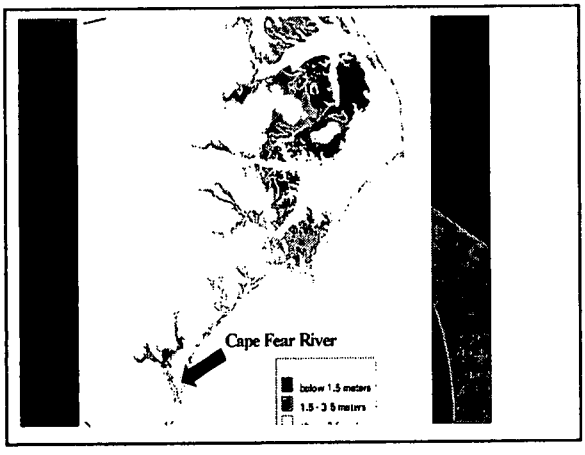


Relative Sea Level Rise



Changes Due to Salinity Increase





INNER COAST POLICY ISSUES

- Shoreline Erosion
  - Bulkheads and Wetland Issues
    - Non-coastal & 404 Wetlands
- Infrastructure
  - Roads, sewers, etc

LAND USE PLANS

- Mandated under CAMA
- Few integrate Sea Level Rise other than preparation for hurricanes
- Subject to change
- Do not have to be followed except in AECs where CAMA permits are required

PUBLIC AWARNESS

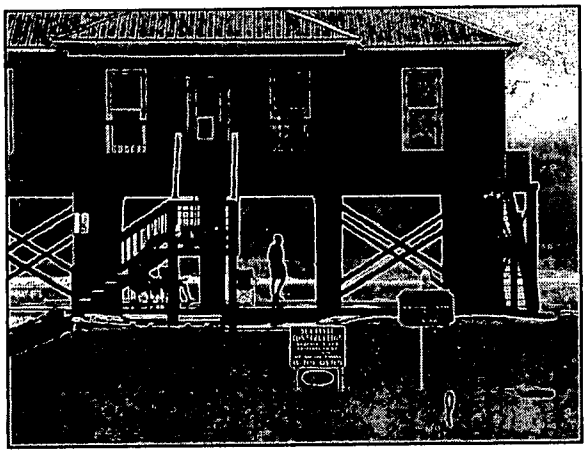
- Education
- Hazard Notification
- Disasters
- Insurance

OTHER ISSUES

- Dams trap sediments preventing sand from reaching beaches and accelerating Relative Sea Level Rise.
- Higher water tables limit effectiveness of septic systems and lead to water quality issues and potential human health problems
- Insurance Dilemma
- Cumulative Impacts

HURRICANE RESPONSE

- Human safety and health primary concern
- Reconstruction driven by emotion, not by planed shoreline retreat or response to sea level rise



QUESTIONS?

- Contact Information

- Courtney Hackney
- Dept. Biology and Marine Biology
- UNC-Wilmington
- 910-962-3759
- Hackney@UNCW.edu

Renewable Portfolio Standard

Analysis for the State of North Carolina

Prepared by: Jonathan Winer
Mon-Fen Hong
La Capra Associates, Inc.
Dick Spellman
GDS Associates, Inc.

Presented by: Commissioner James Y. Kerr, II
Sam Watson, Staff Attorney
North Carolina Utilities Commission

January 12, 2007

LaCapra Associates

Outline of Discussion

- Our Goal
- Key Findings
- Renewable and Energy Efficiency Potential
- Electric Rate Impact
- Other Potential Costs and Benefits

LaCapra Associates

Our Goal

Provide an objective view of the issues related to a possible Renewable Portfolio Standard for North Carolina.

LaCapra Associates

Three Key Findings

- North Carolina has sufficient renewable resources to meet a 5% RPS requirement for new renewable generation.
- It would be difficult to meet a 10% RPS with only new North Carolina renewable supply resources.
- Inclusion of energy efficiency would enable the State to achieve a 10% RPS and would reduce consumers' overall electricity bill.

LaCapra Associates

Three Key Findings

North Carolina has sufficient renewable resources to meet a 5% RPS requirement for new renewable generation.

- Less than 1% increase in retail electricity rates
- Doubles current level of renewables
- Potential job creation and property tax benefits

LaCapra Associates

Three Key Findings

It would be difficult to meet a 10% RPS with only new North Carolina renewable supply resources.

- Must include wind in both the west and off-shore locations and larger hydroelectric generation
- If these additional resources can be developed, a 3.6% estimated rate increase, at most, by the 10th year

LaCapra Associates

Three Key Findings

Inclusion of energy efficiency would enable the State to achieve a 10% RPS and would reduce consumers' overall electricity bill.

- Energy efficiency could easily meet one-quarter of RPS
- Both a 5% RPS and a 10% RPS with energy efficiency could produce net savings of about half a billion dollars over 20 years
- Less than 1% increase in rates, but average bill decreases due to less usage overall

LaCapra Associates

Renewable Resource Overview

North Carolina has over 2,000 MW of renewable generation already.

- Equal to 4% to 5% of the State's current energy needs

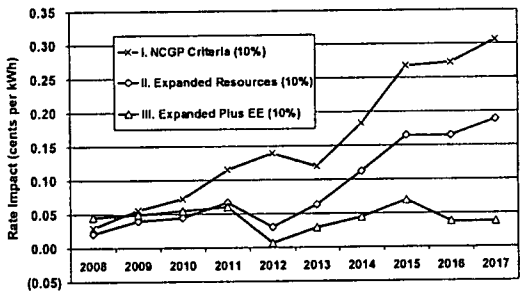
LaCapra Associates

New Renewable Resource Potential in North Carolina

- **Technical potential for over 12,000 MW of new in-state renewable supply resources**
  - Strong logging and farming sectors – fuel for additional renewable generation
  - Good wind resources, but development may be more challenging
- **Practical potential is as much as 3,400 MW**
  - Maximum amount that could reasonably be expected to be implemented

LaCapra Associates

Range of Rate Impacts for 10% RPS is 0.4% to 3.6% by 2017*



*Assumes average electricity rates of 8.5 cents per kWh by 2017

16

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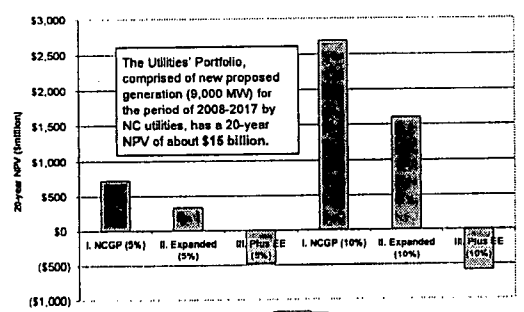
Total Incremental Cost/Savings (NPV) Over 20 Years

Total Cost for RPS Scenarios



17

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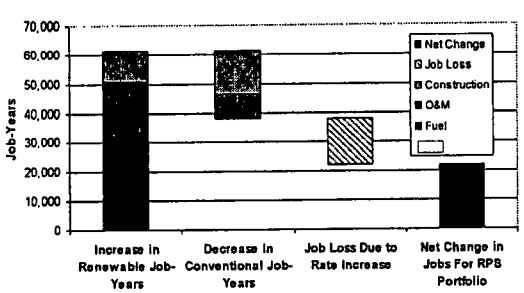
Jobs: 5% RPS Without Energy Efficiency*



*Job-years for O&M and Fuel assume 20 years of operation. Electricity rate impact assumed over 20 years.

18

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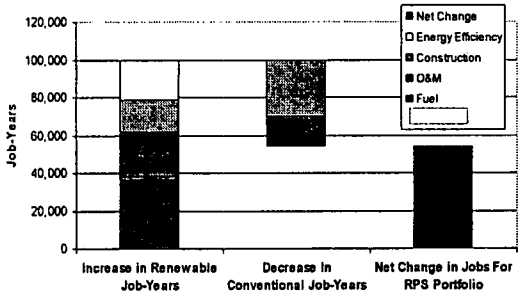
Jobs: 10% RPS With Energy Efficiency*



*Job-years for O&M and Fuel assume 20 years of operation. No electricity rate impact or job losses because overall electricity bill decreases.

19

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Key Environmental Benefits

- **Energy efficiency would have the greatest positive impact.**
- The annual **displacement of Carbon Dioxide**, once a 5% or 10% RPS is achieved, could total at least 7.3 to 13.6 million tons per year, respectively.
- **Potential displacement of emissions related to air quality and health**, such as Nitrogen Oxides, Sulfur Dioxide, particulate matter, and mercury.
- Renewable generation facilities either **do not produce waste or the waste products are more benign** than from coal and nuclear fuels.
- Renewable energy resources **do not have significant environmental impact from fuel extraction** in contrast to the extraction impacts of coal, oil, natural gas, and nuclear fuel.

20

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Conclusions

- There should be sufficient renewable resources within the State to meet a 5% RPS requirement for new renewable generation.
- The State would have difficulty meeting a more aggressive 10% RPS with only new renewable resources located within North Carolina.
- Inclusion of energy efficiency would enable the State to achieve a 10% RPS and reduce average electricity bill.
- An RPS would produce direct economic and environmental benefits to the State.
- An RPS may enable the State to avoid the development of 1,000 MW or more of baseload conventional generation.

21

LaCapra Associates

The full RPS Report is available on the
North Carolina Utilities Commission website:
www.ncuc.net

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.

North Carolina
Climate Action Plan Advisory Group

NC Legislative Commission on Global Climate Change -- CAPAG Update

Brock Nicholson DAQ, Tom Peterson CCS

January 12, 2007

ncdenr
North Carolina Department of Environment and Natural Resources

CCS
CENTER FOR CLIMATE STRATEGIES

Introduction

- First Round of Recommendations Will Come From CAPAG After Its Meeting on January 24, 2007
- Results of Draft Mitigation Options Are Preliminary
  - Several in process of being quantified
  - Not yet considered by CAPAG
  - Design and analysis may be modified by the CAPAG at the next or subsequent meetings
- Considerable Opportunity for Economic Benefit to NC Through the Mitigation Options Being Considered
- Comment and Advice From LCGCC Welcome

Today's LCGCC Meeting

- Review Draft CAPAG Mitigation Options
  - Summary list of draft options and initial results
  - Detailed draft mitigation option templates at www.ncclimatechange.us
  - Beginning of CAPAG voting process on final recommendations
  - Beginning of CAPAG process of formulating alternatives to address barriers to consensus
  - LCGCC feedback helpful to CAPAG decisions

Next LCGCC Meeting

- Review Results of CAPAG Meeting #5 on January 24, 2007
  - First round of approval by CAPAG on individual mitigation options
  - Additional CAPAG meetings will continue process of identifying agreement, structuring further development of options with barriers

Interim Report to LCGCC

- Progress on development of draft CAPAG mitigation policy options
  - Summary list and initial results of analysis
  - Detailed initial results of analysis for each mitigation option
  - Detailed descriptions, design and template for each mitigation option
  - Potential cumulative GHG reduction and cost/cost savings for all draft mitigation options

CAPAG Work Plan

- Meetings in May, July to finalize recommendations
- Additional meetings possible
- LCGCC feedback can be considered as input to decisions
- Final report with recommendations and analysis to DENR from CCS at conclusion
- CAPAG can provide additional development of final recommendations of interest to LCGCC, if/as needed
- DENR, CCS can provide technical assistance on development of LCGCC recommendations, if/as needed

Draft CAPAG Mitigation Options

- Current Number of Draft Potential Mitigation Options (52)
  - Residential, Commercial and Industrial (11)
  - Energy Supply (10)
  - Transportation and Land Use (13)
  - Agriculture, Forestry and Waste Mgmt (12)
  - Cross Cutting Issues (6)
- Original Number of Potential Options from Catalog of States Actions (251)
- Updated Number of Potential Options, Including CAPAG Additions (307)

Draft Mitigation Option Template

Mitigation Option Description

Mitigation Option Design

Implementation Mechanisms

Related Policies/Programs in Place

Types(s) of GHG Reductions

Estimated GHG Savings and Costs per $MTCO_2e$

Key Uncertainties

Additional Benefits and Costs

Feasibility Issues

Status of Group Approval and Level of Group Support

Barriers to Consensus, if Any

Key Decision Variables for Draft Mitigation Options

- Design
  - Goals, Timing, Participation
- Type of implementation mechanism
  - Codes & Standards, Funding programs, Technical Assistance, Voluntary & Negotiated Agreements, Market Based Systems, Information & Education, Disclosure & Reporting, Etc.
- Analysis
  - Data sources, Methods, Assumptions

Residential, Commercial, Industrial/Institutional

1. Demand Side Management Programs for the Residential, Commercial and Industrial Sectors
2. Expand Energy Efficiency Funds
3. Energy Efficiency Requirements for Government Buildings
4. Market Transformation and Technology Development Programs
5. Improved Appliance and Equipment Efficiency Standards
6. Building Energy Codes
7. "Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction
8. Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)
9. Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment
10. Distributed Renewable and Clean Fossil Fuel Power Generation
11. Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation

Energy Supply

1. Renewable Energy Incentives
2. Environmental Portfolio Standard
3. Removing barriers to CHP and clean DG
4. CO2 tax and/or cap-and-trade
5. Legislative changes to address environmental & other factors
6. Incentives for advanced coal
7. Public Benefit Charge
8. Waste to Energy
9. Incentives for CHP and clean DG
10. NC Greenpower renewable resources program

Transportation and Land Use

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

Agriculture, Forestry & Waste Management

1. Manure Digesters & Energy Utilization
2. Biodiesel Production (incentives for feedstocks and production plants)
3. Soil Carbon Management
4. Preserve Agricultural Land
5. Agricultural Biomass Feedstocks for Electricity or Steam Production
6. Policies to Promote Ethanol Production
7. Forest Protection – Reduced Clearing and Conversion to Nonforest Cover
8. Afforestation and/or Restoration of Nonforested Lands
9. Expanded Use of Forest Biomass
10. Better Forest Management
11. Landfill Methane and Biogas Energy Programs
12. Increased Recycling Infrastructure and Collection

Cross Cutting Issues

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

Contact Information

- www.ncclimatechange.us
- www.ncair.org
- Tom Peterson
  - tdp1@mac.com
  - 703-692-2199
- Brock M. Nicholson
  - Brock.nicholson@ncmail.net
  - 919-715-0587

North Carolina

Climate Action Plan Advisory Group

WWW.NCCLIMATECHANGE.US

Memo

To: North Carolina Legislative Commission on Global Climate Change

From: The Center for Climate Strategies

CC: North Carolina Department of Environment and Natural Resources, North Carolina Climate Action Planning Advisory Group

Subject: Background for the Fifth Meeting of the North Carolina Climate Action Plan Advisory Group Members on January 24, 2007

Date: January 12, 2007

At the fifth meeting of the North Carolina Climate Action Plan Advisory Group (CAPAG) on January 24, 2007, the CAPAG will review and begin approval of 52 draft climate change mitigation options developed since the launch of the CAPAG process in February 2006. The CAPAG will review, discuss and modify options as needed to reach final approval. Those options not fully agreed to at this meeting will be referred to the Technical Work Groups (TWGs) for further development and presentation at subsequent CAPAG meetings. Results of the CAPAG discussion will be presented at the next meeting of the Legislative Commission on Global Climate Change (LCGCC) in February.

A summary of the 52 pending draft mitigation options is attached, and a detailed description of each of the draft mitigation options is posted to the CAPAG website at: www.ncclimatechange.us. Updates to these documents will be made prior to the meeting.

A summary of draft mitigation options is attached below:

Table #	Technical Work Group	# Mitigation Options
1	Residential, Commercial and Industrial Pending Options List	11
2	[illegible]	[illegible]
3	Transportation and Land Use Pending Options List	13
4	[illegible]	[illegible]
5	Cross Cutting Issues Pending Options List	6
Total		52

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

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2010	2020	Total 2007-2020			
RCI-1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors	6.5	27.9	208.2	-$5,890	-$28	TBD
RCI-2	Expand Energy Efficiency Funds	1.2	6.5	44.3	-$1,350	-$30	TBD
RCI-3	Energy Efficiency Requirements for Government Buildings	0.0	1.8	9.8	-$130	-$13	TBD
RCI-4	Market Transformation and Technology Development Programs	0.0	2.1	11.0	-$339	-$31	TBD
RCI-5	Improved Appliance and Equipment Efficiency Standards	0.0	1.0	5.5	-$336	-$61	TBD
RCI-6	Building Energy Codes	0.6	4.5	29.4	-$490	-$17	TBD
RCI-7	"Beyond Code" Building Design Incentives and Targets, Incorporating Local Building Materials and Advanced Construction	0.5	3.0	20.9	-$293	-$14	TBD
RCI-8	Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)	*Not quantified*					TBD

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	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2010	2020	Total 2007-2020			
RCI-9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	0.0	0.4	2.6	-$19	-$8	TBD
RCI-10	Distributed Renewable and Clean Fossil Fuel Power Generation	1.1	4.1	30.5	$28	$1	TBD
RCI-11	Residential, Commercial, and Industrial Energy and Emissions Technical Assistance and Recommended Measure Implementation	0.7	2.9	20.9	-$653	-$31	TBD
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS						
	REDUCTIONS FROM RECENT ACTIONS (table to be added below)						
	SECTOR TOTAL PLUS RECENT ACTIONS						

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#	Policy Name	GHG Reductions ($MMtCO_2e$) 2010	2020	Total 2007-2020	Net Present Value (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
ES-1	Renewable Energy Incentives	0.0	0.0	0.2	$3	$13.2	TBD
ES-2	Environmental Portfolio Standard	5.7	37.7	244.6	-$3,081	-$12.6	TBD
ES-3	Removing barriers to CHP and clean DG	0.4	1.6	11.6	$66	$5.7	TBD
ES-4	CO2 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	TBD
ES-7	Public Benefit Charge	0.7	4.5	28.4	-$685	-$24.1	TBD
ES-8	Waste to Energy	0.00	0.01	0.08	-$4	-$49.9	TBD
ES-9	Incentives for CHP and clean DG	Combined with ES-3					
ES-10	NC Greenpower renewable resources program	0.0	0.0	0.2	$1	$7.9	TBD

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Table 3.
Transportation and Land Use Technical Work Group
Summary List of Pending Mitigation Options

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2008-2020			
TLU-1a	Land Development Planning	2.6	8.0		*Expected net savings*		TBD
TLU-1b	Multi-modal Transportation & Promotion	2.8	3.0				TBD
TLU-3a	Feebates to raise revenue						TBD
TLU-3a	Feebates to change fleet mix						TBD
TLU-5	Truck-stop Electrification						TBD
TLU-6	Tailpipe GHG Standards						TBD
TLU-7	Biofuels Bundle	1.9	4.5				TBD
TLU-8	Procure Efficient Fleets						TBD
TLU-9	Anti-idling	.1	0.2				TBD
TLU-10	Diesel Retrofits						TBD
TLU-11	Fuel tax (50 cents/gallon)	6.4	13.9				TBD
TLU-12	Pay As You Drive Insurance	5.8	13.3		*Expected net savings*		TBD
TLU-13	Incentives for Advanced Tech Vehicles						TBD

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	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2008–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2012	2020	Total 2008-2020			
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS[a]	14.7	34.1				
	REDUCTIONS FROM RECENT POLICY ACTIONS						
	SECTOR TOTAL PLUS RECENT POLICY ACTIONS						

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[redacted]

	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2010	2020	Total 2007-2020			
AFW-1	Manure Digesters & Energy Utilization	0.2	0.9	6.3	387	$67	TBD
AFW-2	Biodiesel Production (incentives for feedstocks and production plants)						TBD
AFW-3	Soil Carbon Management						TBD
AFW-4	Preserve Agricultural Land						TBD
AFW-5	Agricultural Biomass Feedstocks for Electricity or Steam Production						TBD
AFW-6	Policies to Promote Ethanol Production						TBD
AFW-7	Forest Protection – Reduced Clearing and Conversion to Nonforest Cover						TBD
AFW-8	Afforestation and/or Restoration of Nonforested Lands						TBD
AFW-9&10	Expanded Use of Forest Biomass and Better Forest Management						TBD
AFW-11	Landfill Methane and Biogas Energy Programs	0.2	1.9	12.8			TBD
AFW-12	Increased Recycling Infrastructure and Collection	0.2	0.5	4.1			TBD

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	Mitigation Option	GHG Reductions ($MMtCO_2e$)			Net Present Value 2007–2020 (Million $)	Cost-Effective-ness ($/tCO_2e$)	Level of Support
		2010	2020	Total 2007-2020			
	SECTOR TOTAL AFTER ADJUSTING FOR OVERLAPS						
	REDUCTIONS FROM RECENT ACTIONS (table to be added below)						
	SECTOR TOTAL PLUS RECENT ACTIONS						

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Table 5.
Cross-Cutting Issues Technical Work Group
Summary List of Pending Mitigation Options

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

PRELIMINARY RECOMMENDATIONS FOR MITIGATING THE CONSEQUENCES OF CLIMATE CHANGE WITHIN NORTH CAROLINA

Prepared by: Stanley R. Riggs,
James H. Stephenson, &
Walter Clark

January 9, 2007

As the consequences of climate change begin to have more direct impact upon businesses and industries in NC, there will be adjustments as to how they respond to the increased "high risks" (e.g., the recent move by some insurance companies to limit their risk exposure by not insuring properties in specific coastal areas). In order for North Carolina to be in a proactive position to carry out the mitigation for the consequences of climate change within the coming decades, the State must take positive steps now to develop the appropriate legislated programs, data bases, management strategies, and plans for public education and involvement. North Carolina should be prepared for this shift in business response by taking the following steps.

1. The General Assembly should create and fund a state-sanctioned Blue Ribbon Commission on Adaptation to Climate Change.

   A. The commission should be charged with developing a comprehensive State Climate Change Adaptation Plan that identifies opportunities to address the issues and risks and recommends tangible measures to help implement the opportunities within the public and private sectors.

   B. The commission should include an economic cost/benefit analysis to determine the potential costs of a "status quo" alternative and of implementing recommendations proposed in the State Climate Change Adaptation Plan. The study should prioritize recommendations in the adaptation plan based on the certainty of impact, and minimization of adverse impacts to citizens, ecosystems, and local economies.

2. The General Assembly should create a Coastal Adaptation Program funded through a surcharge on the NC Beach Plan. Funds should be utilized for the following purposes.

   A. Purchase of land or conservation easements on "at risk" portions of the low-lying coastal zone.

   B. Cost share incentives with land owners for construction of ecologically beneficial erosion control structures on estuarine shorelines.

C. Research, mapping, and inventory of coastal resources, as listed below, to provide an assessment of the physical and ecological properties of the coastal system and the potential cumulative impacts.

3. Legislation for the Coastal Adaptation Program should include the framework for mapping and inventorying the State's extensive coastal and riverine resources including the land areas within the coastal zone, the ocean and estuarine shore zones, and sub-aquatic bathymetry, sediments, and vegetation. This mapping should include the following aspects.

A. Undertake an extensive field survey and inventory of the geologic and ecologic character of the entire shoreline system and map the detailed distribution of shoreline types.

B. Carry out a field survey and inventory of the anthropogenic modifications of the entire shoreline system (e.g., hardened shoreline structures, piers, marinas, channels, etc.) and map their distribution.

C. Initiate a periodic coastal land survey (every 5 years) that incorporates high-resolution, geo-referenced, infrared aerial photography and LiDAR topography of the entire coastal zone to monitor absolute changes in shorelines, ecosystems, and land use.

D. Produce a bathymetric survey of the inland coastal waters that can be utilized for detailed modeling of estuarine storm surge, water quality, and sea-level rise, as well as supplying critical data for modeling shoreline erosion, distribution of submerged aquatic vegetation, and ecosystem migration, etc.

4. Legislation for the Coastal Adaptation Program should include the framework for establishing two kinds of permanent monitoring stations within the NC coastal zone.

A. A system of oceanic, estuarine, and riverine stations should be established to measure the absolute changes in sea-level rise, characterize the dynamics of storm surges and tides, and monitor water flow and quality through the coastal system, etc.

B. A series of land-based sites should be established in different ecosystems to monitor ecological change of habitats through time (e.g., growth rates, structure and function, freshwater resources, saltwater intrusion, sedimentation and erosion rates, and development, etc.).

5. The Blue Ribbon Commission on Adaptation to Climate Change and/or the Coastal Adaptation Program should develop policies concerning the following controversial economic and resource maintenance issues for the NC coastal zone in the face of potential direct consequences of climate change (e.g., changes in rates and amounts of sea-level rise; frequency and intensity of storms, floods, droughts, and fires; and shoreline erosion, resulting land loss, and ecosystem changes; etc.)

A. Hardening of estuarine shorelines with engineered structures (e.g., bulkheads, rip-rap sills, revetments, etc.) versus ecosystem migration in response to ongoing sea-level rise.

B. Managing and/or retreating from the barrier island, high hazard ocean and inlet shorelines.

C. Maintaining and/or moving the infrastructure (e.g., roads, bridges, ferries, water lines, power lines, sewer lines, etc.) associated with barrier islands.

D. Building and maintaining barrier-dune ridges along the ocean shoreline of barrier islands to prevent storm overwash events and opening of new inlets to take place versus allowing these critical island building processes to occur naturally.

6. The Blue Ribbon Commission on Adaptation to Climate Change and/or the Coastal Adaptation Program should define a set of short-term (5-10 year), mid-term (25-50 year), and long-term (50-100 year) environmental change targets and mitigation measures that should be required if specific effects of climate change reach projected levels.

A. Develop a set of metrics upon which the mitigation measures will be based along with a set of mandatory action policies and appropriate economic incentives to make the mitigation measures successful.

B. Develop and implement an environmental "score card" that tracks ecosystem change resulting from climatic shifts with specific focus on those resources that have direct economic priorities (e.g., agriculture, silviculture, tourism, fisheries, etc.).

C. Explore the potential for market opportunities associated with each of the mitigation measures.

7. 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 within coastal counties that either are directly on ocean, inlet, or estuarine shoreline frontage or are within the 100 year flood zone.

NICHOLAS INSTITUTE FOR ENVIRONMENTAL POLICY SOLUTIONS
DUKE UNIVERSITY

Recommendation Proposal to N.C. Commission on Global Climate Change:

Use of a Carbon Fund to Convert Lagoon-and-Sprayfield Systems on Hog Farms

Submitted by

Tim Profeta,
Director of the Nicholas Institute and Member of the Commission

In the search for "win-win" approaches to addressing global climate change in North Carolina, no clearer candidate deserves the attention of the Commission more than the management of hog manure. The swine industry has become a key economic cog in the state -- over a five-year period, the hog production grew to a multi-billion dollar industry, catapulting North Carolina to the second largest pork-producing state in the nation, and increasing the number of hogs from 2.6 million to more than 10 million, most of which are concentrated in approximately 2,400 farms across the state's central and eastern coastal plain.

The environmental consequences, however, of this growth have increased just as dramatically. For example, hogs in North Carolina generate approximately 20 million tons of feces and urine every year, which is processed and stored in open-air, earthen lagoons until it can be sprayed on adjacent fields. The lagoon-and-sprayfield system was designed to protect groundwater by accentuating atmospheric losses of nitrogen. Problems arise, however, because the use of recycled lagoon water to flush barns, combined with the high density of animals in the barns and the use of high-pressure spray guns for irrigation, exacerbate the loss of ammonia and odor. In 2003, the National Academy of Sciences (NAS) identified losses of ammonia and odor in particular as the major concerns associated with lagoon-and-sprayfield systems based upon regional and local risks to public health and quality of life.

In addition to the nuisance and environmental problems associated with odor and nutrient loading, waste lagoons emit significant amounts of greenhouse gases. In testimony submitted to the Commission, Brian Murray of the Nicholas Institute at Duke University noted that livestock manure management (primarily hogs) produces about 1.7 million tons/yr of CO_2 equivalent greenhouse gases. This amounts to about half of the state's agricultural emissions, and approximately one percent of the emissions from the state.

These greenhouse gas emissions serve as an untapped revenue source. As the Commission heard in testimony from Michael Walsh of the voluntary Chicago Climate

Exchange, many major emitters of greenhouse gases would already be willing to pay for the averted greenhouse gas emissions that would result from converting lagoon-and-sprayfield systems to cleaner technologies. Once mandatory climate regimes are soon established in the Northeast and California, and perhaps federally, the demand in the markets for such avert emissions, or "offsets," will only rise. And, in a classic "win-win," this conversion would avert some of the other nuisances and environmental problems with large hog operations.

In consideration of these facts, it is the judgment of the Commission that the State should do everything possible to encourage the greenhouse gas market in the conversion of lagoon-and-sprayfield systems to cleaner technologies that meet stringent environmental performance criteria as set forth in North Carolina law. Thus, it is the recommendation of the Commission that the legislature create a fund that will finance the conversion of hog lagoons to cleaner technologies, with payments distributed on the basis of the greenhouse gas emissions that were averted, payments for which could either be established at a fixed rate – i.e., $5 per ton CO_2 equivalent – or be distributed on the basis of a competitive bidding process amongst entities willing to invest in conversion of lagoon-and-sprayfield management systems to cleaner technologies. By seeding the greenhouse gas market for North Carolina's transition from lagoon-and-sprayfield management systems, the State should succeed in demonstrating that the greenhouse gas market is sufficient to foment such conversion, provide the venture capital necessary to prove the feasibility of technologies, and increase on-the-ground knowledge and acceptance in the agricultural community with regard to the technologies.

***Draft ideas for discussion at Jan 12 LCGCC meeting –from Dee Eggers

Possible findings

1. Within the scientific community, there exists a level of consensus on climate change indicating that it presents a threat to the future economic health of North Carolina, the physical well-being of its residents, and its natural resources.

2. The North Carolina General Assembly is justified in taking action aimed at reducing greenhouse gas emissions, increasing sequestration to sinks, promoting economic opportunities afforded by climate change, and preparing to adapt to the effects of climate change.

Bases for policy recommendations

1. According to reports generated for the Utilities Commission, North Carolina can achieve a 14% reduction in electricity consumption at no cost and meet a 10% renewable energy portfolio standard by 2017 at no increased cost in utility rates.

2. North Carolina's annual CO_2 emissions are increasing faster than those of any other state except Arizona.

3. North Carolina already ranks 24th in the world for GHG emissions. (If one on regards each state in the U.S. as if it were a country, and then compares all states and countries.)

4. North Carolina ranks 46th in the nation on energy efficiency spending per capita.

5. Over the next 100 years, sea-level rise will affect North Carolina more than any other state except Louisiana.

6. North Carolina imports virtually all of its energy, exporting from the state economy over $12 billion per year for petroleum, natural gas, coal, and nuclear material.

7. Annual vehicle miles traveled, and related greenhouse gas emissions, are increasing at a rate faster than the population due to low-density, uncoordinated land use.

8. North Carolina has significant undeveloped alternative energy potential from solar, natural gas from anaerobic decomposition of organic material, wind - especially in the western mountains and off-shore, etc.

9. North Carolina power utilities invest little to no money in renewable energy, efficiency, or conservation due to their guiding language.

10. NC Green Power is not financially competitive with other renewable energy credit programs nationally for either large or small users.

11. Energy efficiency and conservation programs will result in a net increase in jobs in North Carolina, according to the State Energy Office, and cost less per kWh saved than construction of new power plants that would otherwise have to be build to meet increased demand.

12. Buildings account for 40-48% of electricity used.

13. Over 50% of state spending on electricity is accounted for by the UNC system.

14. State agencies have neither incentives nor financial support for investing in conservation and efficiency.

15. According to the Stern Review of the economics of climate change, every dollar invested in addressing GHG emissions will save five dollars.

16. The sign-up process for net-metering is extremely burdensome, and the purchase price for electricity from renewable sources is low in comparison to other states.

17. North Carolina farmers may have significant economic opportunities to participate in carbon markets by offering carbon sequestration services, a.k.a. emission offsets, from conservation tillage.

18. North Carolina farmers probably have significant economic opportunity for carbon sequestration and soil improvement through bio-char, however, additional research is needed to better understand this opportunity.

19. North Carolina probably have significant economic opportunity for biodiesel production from micro-algae, however, additional research is needed to better understand this opportunity.

20. Currently, NC DOT long-range planning assumes growth patterns continue as they are -- a sprawl pattern with little or no public transportation. Therefore, DOT builds roads to support future sprawl. Planners often identify DOT road building as the most powerful factor predicting the location and density of future growth.

Possible policy recommendations

1. Adopt an Environmental Portfolio Standard of at least 25% from a combination of renewable sources, conservation, and efficiency, by 2020.

2. Require all new state buildings to meet or exceed the U.S. Green Building Council LEED Silver standard.

3. Require and truly enforce more comprehensive lifecycle cost calculations for energy consumption by new buildings.

4. Provide financial support for state agencies to invest in conservation and efficiency by allowing them to retain a portion of the savings.

5. Invest in job creation through conservation and efficiency programs.

6. Simplify considerably the net-metering sign up process and significantly increase the kWh purchase price for renewable energy under that program.

7. Require local governments in the coastal plain to prepare plans detailing how they will adapt to decreased tax revenue as sea-level increases one meter by 2100.

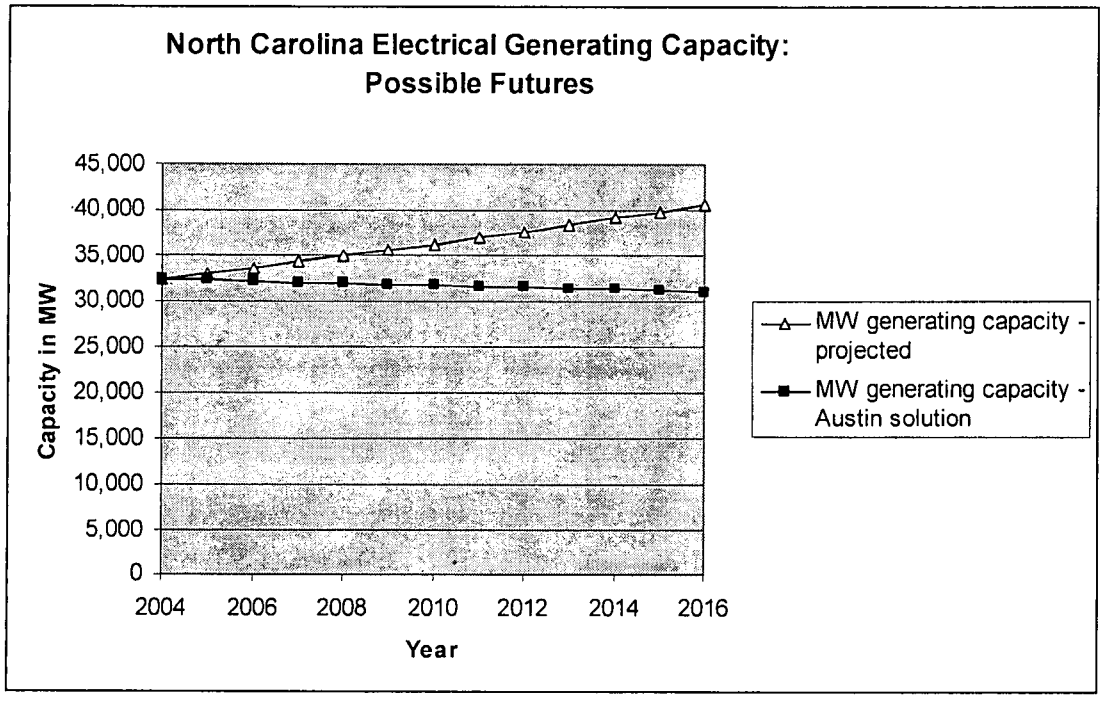
8. Change DOT long-range planning for new road construction and road-widening so it reduces annual vehicle miles traveled and anticipates population densities that can support public transportation.

9. Evaluate and revise Utilities Commission guiding language for electric utilities to significantly increase their investment in conservation, efficiency, and renewable energy sources.

10. Increase implementation and enforcement of existing policies that promote conservation and efficiency.

A side note - food for thought:
In the 1980s, Austin Energy was faced with building new electrical generating capacity to meet growing demand. They decided instead to invest in a "negawatt" program. According to the program director, Fred Yebra, they spent less on their conservation and efficiency programs than they would have if they had built new generating capacity. Other utilities have had experiences similar to Austin Energy. There is no reason to believe that North Carolina could not approximate their results.

If North Carolina had started a similar program in 2004, this is what electrical generating capacity (and consumption) would look like:



12 Jan 2007

Joe, John, George

The NC Coastal Federation, the NC Sustainable Energy Association, the Southern Alliance for Clean Energy, and Environmental Defense have worked together closely on the Commission on Global Climate Change. At the request of Representative Hackney at the last Commission meeting, we have put down on paper some thoughts on win-win opportunities that the full commission might consider. See the attached draft. It is our hope that some of these ideas may be the basis for broadly supported recommendations for the interim report. Please contact any of us if you have questions.

Michael Shore
828-582-3141

P.S. Regrettably, I have a long-time family commitment this Friday; and I will not be able to attend the Commission meeting. I will look forward to seeing you at the February meeting.

Win-Win Policy Measures to Combat Global Warming

Energy Win-Win opportunities	Policy Measure
Renewable and Efficiency Portfolio Standard	• Renewable and efficient energy generation via landfill gas, agricultural biomass, wind, solar, small hydropower, and energy efficiency measures. • Remove current barriers related to interconnection, net metering, and stand-by fees.
Extend and Enhance Energy Improvement Loan Program to 2020	• 1% interest rate for loans to fund renewable energy projects available to the residential, commercial, and industrial sectors.
Significant Resource Investments in Energy Efficiency Programs	• Residential, commercial, and industrial energy efficiency programs are designed to reduce electricity rates and global warming pollution.
State Government Lead by Example	• Develop and implement a plan to improve energy efficiency by 20% in government buildings by 2012.
Transportation Win-Win Opportunities	**Policy Measure**
Efficient Hybrid Vehicle Purchase Incentives	• Waive state Highway Use Tax (3%) on purchase of hybrid vehicles. • Waive license plate fee ($28.00) of hybrid vehicles. • Waive title fee for purchase of hybrid vehicles ($40.00). • Waive the Regional Transportation Authority Registration Tax where applicable for hybrid vehicles ($5.00). • Waive emissions testing fees of hybrid vehicles ($6.50-30.00). • Waive NC property tax fee of hybrid vehicles (varies).
Fuel Savings Measures (idle reduction)	• Truck Stop Electrification- Conduct a pilot program for electrification sites at truck stops so that truckers may plug in for power, rather than letting their vehicles idle. • Truck Auxiliary Power Unit expansion- Conduct an in-state pilot program to install portable, truck-mounted systems that can provide climate control and power for trucks without idling. • EPA Smart Way Transportation Partnership- promote participation in this program to North Carolina freight haulers to reduce global warming and air pollution.
Biofuels Incentives	• Incentives for producers, distributors, and retailers to increase capacity of biofuels production and consumption. • Create ASTM testing facilities in North Carolina to ensure Quality Control of various biofuels to allow easier access to testing for producers, particularly small producers, and ensure that all North Carolina biofuel products are being properly tested and meeting the specification. • Consumer education campaign on the non-market benefits of biofuels such as the reduction of greenhouse gas and other emissions, energy security, and rural economic development.

	Utilize billboards, radio, TV, and newspaper media.
Carbon Marketplace Win-Win Opportunities	**Policy Measure**
Farmer Assistance	• Provide a technical assistant position to help farmers join existing marketplaces, such as the Chicago Climate Exchange.
Incentives for Carbon Reduction Technologies in agricultural sector	• Grant farmers making global warming pollution reductions extra credit in a cost-share program that rewards farms utilizing Environmentally Superior Technologies.
**Other important carbon market opportunities that are not low hanging fruit, but may be appropriate over the long run	• Offset Program- Cap utility emissions. Utilities must then offset emissions exceeding the cap by buying credits from hog industry. • Carbon Neutrality- New base load generation of energy must be offset via closing old plants, investing in equivalent Energy Efficient/Renewable Energy programs. • Global warming pollution reduction goal.
Coastal Adaptation Win-Win Opportunities	**Policy Measure**
NC Coastal Strategy	• Develop a strategy to prepare for the impacts of global warming and sea level rise.

Minutes

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

Monday 11December 2006
10:00 a.m.
Room 643, Legislative Office Building

The Legislative Commission on Global Climate Change met on Monday 11December 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building with Representative Joe Hackney, Co-Chair, presiding. Other members present were Mr. John Garrou, Co-Chair, Senators Albertson, Cowell and Pittenger, and Representatives Harrison, Underhill, and Wilkins. Other members present were Dr. Ryan Boyles, Mr. Thomas Cecich, Dr. Douglas Crawford-Brown, Mr. Walter Clark, Dr. Dolores Eggers, Dr. Edward W. Erickson, Mr. Robert J. Glaser, Mr. Mitchell Peele, Mr. Tim Profeta, Dr. Stanley Riggs, Mr. Michael Shore, Mr. Robert Slocum, Dr. Stephen Smith, Mr. James Stephenson, Mr. Tim Toben, Mr. Ivan Urlaub, Ms. Susan Tompkins, Dr. Godfrey Uzochukwu, and Ms. Vicky Will. Staff members present were George Givens, Commission Counsel; Jeffrey Hudson, Assistant Commission Counsel; Jennifer McGinnis, Assistant Commission Counsel; Susan Iddings, Assistant Commission Counsel; Jennifer Mundt, Research Analyst; Thelma Utley, Commission Assistant and Genie Clark, Commission Assistant.

A copy of the meeting notice for this meeting, a copy of the agenda and the visitor's registration are attached to these minutes as **Exhibits A, B,** and **C.**

Representative Hackney called the meeting to order and explained the agenda. He then introduced and thanked the Sergeant-at-Arms staff, the Committee Assistants and the Counsel and Research Staff members. There were no remarks from Co-Chair Garrou.

Representative Hackney called on Mr. George Givens for his remarks and to explain the agenda. Mr. Givens welcomed everyone, announced the resignation of Commission Assistant, Mary Watson and introduced her replacement, Genie Clark. He also announced that the Environmental Review Committee would be meeting on Wednesday, December 13 and the second item on that agenda would probably be of interest to many of those present and he invited them to attend that meeting in Room 544. Mr. Givens explained that the North Carolina Utilities Commission would be reporting on the Renewable Energy Portfolio Standard Study that they had been conducting for some months. He said that some of that information would probably be presented to the Global Climate Change Commission at the January meeting if there was sufficient interest in the need to do that. Mr. Givens also announced the date of the next Commission meeting as Friday, January 12, 2007 at 10:00 a.m. in Room 544. Mr. Givens and Mr. Hackney announced that there would not be a lunch break in the present meeting.

Senator Robert Pittenger had handouts distributed entitled "The Science Is Settled" from the *Spotlight,* a publication of the John Locke Foundation. **Exhibit D.**

Representative Hackney then introduced the first speaker of the day, The Honorable Richard H. Moore, Treasurer of North Carolina and a former member of the Legislature, who then delivered a slide presentation. **Exhibit E.**

Treasurer Moore thanked the commission for the invitation to make a presentation. He first saluted the commission members for undertaking its mission. He said it was, in his view, impossible to ignore the evidence on what carbon emissions were doing to the good earth. He said he thought it was fitting that he had the opportunity to talk with the Commission at their December meeting in that last week there had been a fair amount of press coverage on the fact that China would pass the United States within the next two years in terms of carbon emissions, as they would be putting in the cheapest and most environmental damaging form of coal-fired electricity plants...one on line every nine days. He further stated that they had been at that pace for awhile and showed no signs of slowing down. Then he said that in today's *Wall Street Journal* there was an announcement stating that because there was irrefutable evidence that the earth temperatures were warmer, Allstate Insurance Company was beginning to stop writing policies in coastal areas. Treasurer Moore said that in some areas this would be of great interest from a public policy standpoint to the people of the State.

He then said that he would quickly do an overview of why he was invited to the Commission meeting and he explained what being the sole fiduciary of all the State's public pension funds allowed him to do. He explained his job description as being the State's chief banker and investment officer and stated that he handled both sides of the ledger. He said that he both borrowed money on behalf of the State and he invested the money on behalf of the State. He stated that the bulk of that money, just over $70 billion belonged to the various pension funds that whoever sat in his chair had the responsibility of investing. He added that there was always approximately $4-$5 billion of the State's actual tax revenues on hand. He explained that that's where that total figure of $75 billion shown in his hand-out came from. He said that we had about 700,000 public sector employees in the different systems and that North Carolina had a unified system and even those who were members of the General Assembly were strictly focused on the contributions made for State employees. He said that from a management standpoint, the State Treasurer ran every city and county plan as well. He added that while the General Assembly members made no financial contribution to those plans they did have some oversight responsibilities. He said he believed that everyone was aware of the Local Government Commission and he stated that his department also administered the unclaimed property program, which had doubled in size over the last couple of years. He said he had also been given some new investment guidelines by the General Assembly.

Treasurer Moore stated that North Carolina had the 9th largest public pension plan in the Unites States and the 17th largest in the world. He said that one in 8 working North Carolinians was a member of the State retirement system. He added that didn't mean that all of them were full-time, as the system included a lot of National Guard members and a lot of volunteer fire department members. He stated that was still a pretty powerful statistic of 1 in 8 state residents. He then added that he was very proud to say that the December issue of *Governing* magazine had ranked North Carolina as the number one

pension plan in the country and that about six months ago the *Wall Street Journal* had North Carolina listed as the second rated pension plan in the US...second only to Florida. He said that without trying to be partisan, he always pointed out that Florida seemed to have a history of not being able to count very well, so they might not really have all the money in their pension fund that they said they had. However he stated that he knew for sure that we in North Carolina really had what we said we had in our pension fund. He stated that the North Carolina pension fund included over $70 billion in assets for more than 700,000 active and retired members and included seven pension systems: He explained that that included teachers and State employees, local governmental employees, Firemen and Rescue Squad workers, Registers of Deeds, Legislative members, Consolidated Judicial, and National Guard members.

Treasurer Moore explained the way the North Carolina pension funds were invested and stated that it was a fairly conservative investment strategy. He said that about 58% of the funds were invested in public equities (stocks), about 35% were in fixed income (bonds) and less than 5% were invested in real estate and alternatives. He added that out of 58% that was in public equities 68% of that 58% was in either index products or in enhanced index products. He explained that meant that the Treasurer bought an index...an S&P or Russell 2000, whatever part of the market that he wanted the basic return of the market. He added that it was fairly common for pension funds as large as North Carolina's to have roughly 2/3 of the money either indexed or enhanced indexed which meant that for 2-4% of the portfolio, managers could overweigh a sector. He added that the reason that was important was because it meant that the State of North Carolina, even if the managers were asked not to own a particular type of stock or a particular segment, the State would still own somewhere around a quarter of a percent of about every publicly traded company in the country and on the face of the earth. So the State is always invested, he explained. He added that we couldn't vote with our feet, which meant that according to the old term that "if you don't like the way I run my business just sell your shares and go buy something else". He stated that this didn't apply to the State pension funds and explained that the State couldn't do that because we were indexed and we owned it all anyway.

This brought up the importance of good corporate governance, something that Treasurer Moore said that he has been very active in over the past few years. He said that somewhere between the Enron and WorldCom scandals he became mad...as mad as any other investor in the country. He said that he had seen the value of the State's holdings go down significantly and one night late at his desk it dawned on him that while he was as mad as any other individual investor that he had paid almost $100 million a year to Wall Street firms in the cost of managing the State's money. He said managers that he hired had always told him that when they owned a company that they knew everything there was to know about their company. He said that they understood the books of Enron unbelievably well...of WorldCom unbelievably well, and of Global Crossing.

Treasurer Moore said his favorite example was Tyco. He said that everyone believed that was such a great combination of companies and believed that a home alarm system company had great synergies with pet food and that those companies would work

together very well. Treasurer Moore stated that he and his staff woke up and in his view, those company combinations really weren't doing what they were supposed to do. So he said that in the summer of 2002, he came out with something called "Investment Protection Principles". He said that at the time this program was rolled out the pension funds had about $400 billion back of the principles and it was decided that the State would require more disclosure and more transparency, particularly on numbers that were put before the Treasurer. As an investor with the fiduciary responsibility he had, he stated that he didn't expect anyone to guarantee his losses and he didn't expect anyone to guarantee his profits. But he said that what he did expect for a publicly traded company was to put numbers in front of him that actually meant something. He added that in his view, that wasn't happening in the country in 2002 in the publicly traded markets. Treasurer Moore stated that the vast majority of businesses in the country and the vast majority of businesses in this state were private companies. He explained that when they needed capital they had to go to an independent third party...usually a bank and he added that we had some great banks in this state. He then stated that when those private companies needed money, they had to ask for the money and they had to prove that they were a good risk. He then stated that a publicly traded company could literally go to the kitchen table of about 58% of Americans and draw capital. He said, therefore, he believed that there ought to be some barriers in place to be a publicly traded company and he added that one of those barriers at the base, he believed, was transparency. He explained that was one of the things that the Investment Protection Principles provided and over $6 trillion was signed on to those protection principles by the end of 2002. He said that similar types of disclosures in the mutual fund area had been acted on by Congress with a result that mutual funds were much more transparent now than they were in 2003. He added that in North Carolina as of July 1, 2002, every money management firm retained by the State Investment Officer, as a condition of future retention, had to abide by a set of rules.

Treasurer Moore stated that one of the areas that the Treasurer's Department had focused on in corporate governance and transparency had been the area of global warming and from a carbon emissions standpoint he believed that it was a very simply prospect. He questioned that if someone owned stock in an insurance company or an oil and gas company, were these companies properly valuing their liabilities? He stated that from an investor's standpoint it was just that simple. He said that he was interested in knowing if the company had hidden liabilities in their balance sheet. He stated that if they did and they weren't being looked at the right way, then the company wasn't being run in a responsible manner that was going to reward the ultimate in long term share holders or public pension funds. He explained that Public pension funds were the ultimate long term share holders. He further explained that individual investors could make a lot of money in the public markets and private markets and the equity markets around the world getting in and out. But he explained that was not what long term share holders did. He said that was not what they were about.

He said that Ceres asked several of the large pension fund managers to try and get a group together and that was done on November 21, 2003 and there were 200 people in attendance in the Grand Chamber of the United Nations. He stated that there were about

a trillion dollars in assets represented. He said the group committed themselves to asking the companies that this group invested in and that the group felt had carbon emission exposure to just do a better job of disclosing those things. He said that this was followed up by a meeting in May 2005 and stated that the group had grown significantly and had made a tremendous amount of progress. He explained that this group's growth was led primarily by European insurance companies that seemed to "get" this a little more than our domestic insurance companies did a couple of years ago. He said that this was what Ceres had been up to... asking investors and environmental groups and other public interest groups to come together to work with companies on sustainability issues. He said that this represented the progress that had been made over the last few years and was specifically what companies were being asked. Treasurer Moore reminded everyone that he was not a regulator and was not an environmental policeman on the beat.

Treasurer Moore stated that the Ceres group was coming at this problem solely from a value add standpoint. He stated that in a capitalist society, we lived in the greatest nation on the face of the earth. He said that the reason this was true was that we had understood and perfected the use of capital markets better than any society ever had. He said that a dollar talked in our society. And he said that if we could quantify this particular risk, which Treasurer Moore personally thought was one of the greatest risks facing his children and grandchildren on this globe...this mother earth, if we could quantify this in economic terms we would see a real change. He added that the challenge was how we did that.

Treasurer Moore said he felt that the first step had been taken by just saying that the Ceres group wasn't telling anyone how to run their companies they just wanted to know if the companies were valuing the tremendous problem, as it was almost impossible to ignore the science that will exist 20 – 30 years down the road. He said those were the things that had been focused on and that companies had been asked to begin discussing and disclosing, both to the public in the public filings and particularly to the money managers of the world. Treasurer Moore had also asked his money managers if they rated the companies in targeted sectors on that particular issue. He questioned what had been done in terms of Corporate Governance, including letters to companies, meetings with Boards of Directors, shareholder resolutions, drafting of disclosure templates – making sure there was consistency in questions being asked and the answers given, media pressure, nominating directors, and withholding director votes.

As a shareholder, Treasurer Moore said he believed that he should not have any authority and responsibility in the terms of the day to day running of a company. He said he believed that the extension of a shareholder was the Board of Directors and believed that Board was supposed to sit over management and that anyone who owned stock in a publicly traded company or a privately held company did have a say so through the Board. He said he believed that a stockholder had a right to have input on the Board of Directors, as those people were held accountable for the day to day operations of a company, as well as, the long term and short term mission of the company. He said that much more needed to be done in that area but that a tremendous amount of progress had been made.

Treasure Moored stated that these were some of the specifics that had been worked on and that, of course, the oil and gas and insurance industries were the biggest problems. He said that those were the industries that had a tendency to question why someone thought there was a problem and to ask why they were being bothered by questions. He said that the items listed were the types of risks that the oil and gas industry were being asked to evaluate and they were being asked to put a dollar sign with each one. He added that the last item listed called on oil and gas companies to stop funding bad science on climate change. He stated that that one was particularly sensitive here in North Carolina with our great tobacco heritage and explained that when you looked at the science that was still being put out in the late 70's and late 80's stating that cigarette smoking was not bad for you, this emissions research just seemed to be replicating that same type of research. He said that it was awfully hard to make a strong case, no matter where you were on the political or scientific spectrum, to explain how this stuff wasn't making a difference. And as a shareholder, he added that he would certainly prefer that the oil and gas companies not use shareholder profits to fund science that gave them an answer that they wanted. He said they had the answer they wanted before a check was even written for the study and he stated he believed that was not healthy or good. But he said some progress was being made in that area.

Treasurer Moore said that work was also being done in the insurance industry. He stated that Swiss Re had actually been a great leader in this and said that they did a lot of the presentations at the last UN conferences held and were now saying "yeah" and were beginning to put these things into place. He said that was why it was particularly timely to see in the *Wall Street Journal* and to hear on the radio this morning that Allstate was looking at this situation too. And guess what? He said that they were seeing some things that they didn't like that were going to hurt their bottom line and that they were going to try to change behavior and change practices...once again after putting a dollar sign on it.

Treasurer Moore stated that in May, 2006 the largest of the top 30 insurance companies, AIG, had said that this group was exactly right and that AIG should take a closer look at the problem. He added that they now had a climate change policy that was directly attached to their bottom line and that they had joined the Investor Network on Climate Risk... the INCR.

Treasurer Moore stated that work was just beginning to be done specifically on carbon emissions and that this project was a part of the same group that had been focusing on proxy voting. He said that this was a way to achieve the goal of having companies have a sustainability section in their annual reports.

Treasurer Moore stated that Conoco Phillips was asked a couple of weeks ago to report on the company's efforts on renewable energy sources. He said that it would seem that if a company was making record profits and that what they used for those profits had a shelf life, why wouldn't they be churning those profits back in. He said that once again, this wasn't telling a company what to do, but from an investor standpoint, just asking for an

explanation of why something that makes common sense was not being done. He added that this problem would continue to be addressed.

Addressing Chairman Hackney, Treasurer Moore then said that he was at the Commission meeting to let the group know how important he believed the issue of global climate change was and to let the group know what his department had been doing with the platform that was available to them by virtue of the massive amount of money the department handled on behalf of the people of North Carolina.

Chairman Hackney thanked Treasurer Moore for coming and for his presentation and asked for questions.

Dr. Douglas Crawford-Brown stated that what was being done by the Treasurer's department was promising for a start on the problem...a sort of market driven approach to the control of CO2. He asked about the size of the group the Treasurer was working with, which had been stated to have a billion or more in assets, as compared to the larger pool of public and private investments being taken in. Dr. Crawford-Brown stated that he asked that question because often what was gotten as push back from the companies was that they had to answer to their shareholders. So his question was...was the group that the Treasurer represented a significant shareholder in the minds of those companies involved with the CO2 problem?

Treasurer Moore answered that after meeting with the Board of Disney and asking for Michael Eisner to be removed, he was told that Disney had to listen to all of their shareholders and, because of the deals he had, the largest shareholder was Michael Eisner.

Treasurer Moore said that Dr. Crawford-Brown needed to go back to the numbers because it was a sizeable chunk of money...it was $5 trillion involved participation. So Treasurer Moore stated that it wasn't a matter of the tail wagging the dog. He said that he believed that the domestic public equities market was around $18 trillion. He said he wasn't sure what it was world-wide but that you could probably assume that it would be twice the domestic amount. He said that he believed that $6 trillion was a very decent amount for a group of folks to band together to begin to ask questions. He reminded the Commission that no one was telling anyone what they had to do but that the group was just asking questions of companies like "how on earth they could run a responsible business and not ask certain questions". Treasurer Moore said he believed that if those questions could be asked of companies, things like the announcement from Allstate would begin to happen with other companies.

Mr. Tim Profeta thanked Treasurer Moore for his presentation and stated that it had been extremely helpful. He questioned the Cooperate Governance information. He said he was interested in knowing not only how the companies were doing with risks but also how they were seizing the opportunities. What were their strategies for capping out low carbon and renewables? Mr. Profeta also questioned the reference about some of the Treasurer's staff looking at and rating companies' responses. He asked if the companies'

responses were public documents that the Commission could see. He also asked if the Treasurer could give any sense, as the Commission looks for opportunities for North Carolina in the transition of climate change, of what business people were thinking of as opportunities for their companies in the low carbon future.

Treasurer Moore asked Lisa Schneider, one of his staff members if the documents referred to by Mr. Profeta were public documents.

Ms. Schneider answered that she didn't know for sure but believed that some of the documents might be public but she stated there was also the concern that if some of the documents were released too soon it might stop the companies from working to make changes.

Mr. Profeta said that he didn't want anything to be done to discourage the discourse with the companies but to the extent that the information would be available publicly he stated he believed it would be interesting to see.

Treasurer Moore said that to the extent that it was available publicly under North Carolina laws, he had no choice but to share the information. He further stated that he would check to see if there was anything that was public information that would be of interest to the Commission and if so, he would share it.

Chairman Hackney then recognized Dr. Steve Smith for a question.

Dr. Smith also thanked Treasurer Moore for his presentation and said that he was curious about something. H questioned the scan of the companies that the pension funds had been invested in, and said that there surely were some companies that had a North Carolina presence. Dr. Smith was interested to know if the Treasurer had engaged any of the more local companies in a more direct way about the issues being discussed and where those companies had come down. He said that he applauded the Treasurer's leadership on these issues and just wanted to connect all of the dots and see that this was being engaged at multiple levels. He wondered if the Treasurer had given much thought to that issue and if he was aware of any engagement with companies in North Carolina.

Treasurer Moore replied in the affirmative and said that just in terms of his own edification that he had talked with representatives of both Progress Energy and Duke. He stated he was also very proud to say that in the investor network, those two companies were known as having a great reputation in that area and in being open to discussion. He said that Duke, particularly, had been the sponsor of some of the discussions on some of the issues and had pushed to have those discussions. Other than that, he said there had not been much focus put on North Carolina, primarily because while initiatives needed to be developed in the State...the entire world had better get on the same page together. He said that those high sulfur emission coal fired plants that were coming online every nine days in China were certainly contributing to the problem in a substantial way. So for that reason, on this issue, he said the focus had been kept broad.

Chairman Hackney then recognized Mr. Michael Shore who stated that since he had a pension with the State of North Carolina, he thanked the Treasurer for being responsible with that investment and thanked him for his responsibility and concern for global warming pollution. He also stated that he would like to follow up on the Treasurer's response to the previous question about what states could do. He said that it appeared that real action on global warming and pollution at the federal level was probably a couple of years away, although was very likely. He also stated that there were commissions in various other states like the one here in North Carolina and that this commission had heard a lot of discussion about economic opportunities that had come with addressing climate change. He then asked Treasurer Moore if he had any advice for this commission. In addition to the Treasurer's efforts to address the global warming issue in advance of federal action, Mr. Shore also asked what the Treasurer would suggest that the state of North Carolina ought to be doing.

Treasurer Moore replied that Mr. Shore's question was a great one and stated that there were going to be tremendous economic incentives and advantages for people and societies that began to figure out ways to lessen dependence on fossil fuels. He stated that it was just that simple. He gave an example: that if he were the Governor of North Carolina, this issue would be a part of the economic incentive package that he would want to see pushing out. He said there were a lot of things that were being developed and expanded that there was a natural network for in the State and this issue was another one. He explained that we don't have a huge in-state dependency on those traditional issues or traditional entities...we don't' have big oil and gas in North Carolina. He added that we don't have tons of automobile manufacturing in the state, and although it would be nice to have some of those things, we just don't have them. He said that should give the state some freedom to say, "Let's do some tax incentives for this, and let's see if we can create a real market place for trading in this area". It is one of those things in which Treasurer Moore stated that he believed that government should lead with. He said that he believed the State of North Carolina should, as soon as possible, in terms of its government building and its government entities begin to trade credits very much as New Mexico had done. He said the state should set the example on what could be done. He said that these were not things that cost a huge amount of money but that should begin. Treasurer Moore stated that he had made a couple of investments in the venture capital area in companies that were looking at alternative technologies here. He further stated that what was going on in some companies was very exciting. He said that he had been told that technology was just one enzyme away from being able to make switch grasses to put in cars. He said that when he went home to Vance County and looked across eastern North Carolina he saw acres and acres and acres that could be used to grow switch grasses. He stated that we knew that in a hundred years from now we would be getting around in a different way than we did today. He stressed that this was not just "pie in the sky", crazy science fiction stuff and could have huge economic payoffs. He said that was what he tried to focus the conservation on. He said that we certainly wanted to push the federal folks on things outside of our control and to go on record, but we also needed to focus back on economic incentives and economic development around this. He said that there were huge upsides, which is why everybody was talking about it.

Chairman Hackney then recognized Dr. Dolores Eggers who also thanked Treasurer Moore for being awake and aware and for managing the state's pension funds in a responsible way. She said that when she looked at the overheads that she didn't know about INCR. She asked if it was INCR or INOCR and was told by Treasure Moore that he really didn't know which it was supposed to be and that Dr. Eggers could choose. She stated that one of the overheads had a lot of bullets on greenhouse gas emissions reductions and she said that she thought of this as a bathtub situation. She said that there was a faucet, a drain, and stuff needed to be done with the drain and there was another part of it that was adaptation. She asked if something had been set up to recognize a company that was not focusing on greenhouse gas issues per se but was an adaptation company. She gave an example of a company that made special straps for houses in the coastal plains that could be used to take them apart and put them on a truck and pull them back and asked if that was something with which the Treasurer's group would be dealing?

Treasurer Moore answered in the affirmative and said that he was very careful in his presentation and that the group had been very careful. He stated that it was really a two step approach and explained that first he needed to know if questions were being asked at all from a business stand point. He said that he needed to know if companies were being asked if they were impacting the environment in a positive or negative way. He said that if it was in a negative way and the company agreed that there was some value in asking the questions then if you came back to this network, there had been a very scientific and very professional way to say that it would be great if everyone asked a specific set of questions and reported back a specific set of data.

Chairman Hackney then recognized Mr. Ivan Urlaub who thanked Treasurer Moore for a presentation that explored insurance companies and stated that he thought it was a topic to be explored further. He stated that after hearing the statistics about China's new coal power plants coming on line every nine days he was curious about what the Treasurer thought about China as an investment opportunity for North Carolina pension funds given that they had 70% of the global solar thermal hot water market and about 40-50% of their citizens used solar thermal heated hot water everyday. He stated that they had higher fuel efficiency standards than we did and that they actually had a mandate to generate a portion of their electricity nationally from renewables. He said that seemed to be in concert with a lot of the corporate responsibility requirements that the Treasurer had shared. He said that it also put a lot of the Chinese corporations ahead of where US corporations might be now. He asked Treasure Moore to speak to those points as other nations, especially in Europe as well, exceeded the achievements of the US, in those important areas.

Treasurer Moore stated that part of the Chinese culture was really very much the same as part of the United States' culture in that it had been an agricultural society and understood "The Good Earth", the title of the book by Pearl S. Buck. As an aside, he also mentioned that he would recommend the reading of that book. He stated that the Chinese understood that they had to be better economic stewards. He shared the information that he had been lucky enough to be an Eisenhower Fellow this past summer and had spent

six weeks in China and India. He said all of their goals while laudable, were directly tied to money. He stated that China was an energy starved nation which was growing very quickly and that their stated environmental goals were totally economically driven because they understood the elasticity of power costs in order to grow as they wanted. He also shared that he had spent a couple of hours with the head Environmental Minister for the Peoples Republic last summer. H said he discovered that the Chinese were awfully convenient in bending and changing their guidelines when those guidelines weren't being met. He stated that the biggest thing that he took away from his visit was that their whole environmental policy, as best he could tell from a government standpoint, was financially driven. He said that it sort of made him want to refocus his efforts to what was being done in North Carolina.

Treasurer Moore also shared that there were a couple of really fascinating things being done in China. He stated that in the new hotels that were being built in China, a room key had to be put in at the door lock for anything in the room to work. He said the places where he stayed in Taiwan were the same way. He explained that as soon as the key was removed from outside the door, everything inside the room shut off...the air conditioning didn't run, the lights wouldn't work... nothing inside the room worked once the door was locked from the outside and the key was removed. He stated that he didn't know if that was something appropriate to be mandated here but that was the type of technology that he had go to China to see, as he had never seen it here. He stated that as a young man growing up he had spent a couple of summers cleaning rooms in motels in North and South Carolina and the first thing that was done in the summertime was to crank up the air conditioning to about 58 degrees in the rooms being cleaned. He said that the technology in China made him think of all the empty motel rooms all across the State that were sitting there cranking out either hot or cold air to an empty room. He stated that that was the sort of thing that he would encourage the commission to have good discussions about.

Chairman Hackney then recognized Senator Robert Pittenger. The senator stated that he thought it was ironic, and he would like to have comments from Treasurer Moore about the fact, that China had succeeded economically with our investment capital and our markets. He further asked that wasn't it a paradox that now the United States would be considering basically unilaterally placing mandates and restrictions while China, India and Mexico went unabated. He said that they would continue pushing their economies while even sweet little North Carolina seemed to think that they could do something about the impact of CO2 emissions. China has had a very negative impact on the economy of North Carolina and Senator Pittenger wondered if good judgment was being used in how things were being done. He stated that he believed that what ever was being done should be done in unilateral fashion and that China and India and Mexico and others should also be participants.

Treasurer Moore answered that Senator Pittenger made a great point and he thought that the way he himself came out on that, after spending a lot of time thinking about it, was that if we could get from point A to point B without too much of a negative impact on our economic growth and if we could take the opportunity costs of fossil fuels out of

competitive models for our business, then what a competitive advantage we would have over the developing countries of China and India. He said that they were wedding themselves to be dependent to a cost of doing business that would only go up. He stated that we in North Carolina were not going to solve all of this but that nibbling around the edges would help. He said he would love to be running a textile company in Gaston County that had almost no power costs. He said that was the kind of things that needed to be talked about and, in his opinion; he thought that we needed to dream towards that way, with the ultimate thing of it not being pie in the sky dreaming. He said that we knew that in 1906 people could not imagine the way we got around today, which had virtually not changed any since 1926. He added that a hundred years from today, we would not get around the same way we did today and we would not power our buildings the way we did today. He said it was shame on us if we didn't think about what that would look like.

Senator Pittenger asked for a follow-up question and asked Treasurer Moore if he didn't agree that free markets were the best way to adapt to that without the government mandating those types of controls.

Treasurer Moore replied that from a public policy standpoint there was a lot more to be done by letting the free markets work and using incentives versus straight mandates. He agreed that for most of this arena there was far more bang for the buck to just use the carrot than to use the stick approach.

Senator Hackney then recognized Dr. Eggers who asked Treasurer Moore to clarify his earlier answer concerning opportunity costs and handling them better. She asked that it be explained in layman's terms.

Treasurer Moore answered that if someone ran a business there were the fixed and variable costs –the two traditional economic categories of cost, which arrived, hopefully, at profitability and that the power costs depended on what the industry was. He gave an example of Google and said that one of the reasons that Google was coming to the northeast corner of North Carolina was because we had textile and furniture mills that had gone out of business and Duke Power had the ability to crank out all these kilowatt hours and to give them away. He said that if someone ran a business that was heavily dependent on power costs, this was where they could get the biggest bang for the buck. He asked wouldn't it be wonderful if 50 years from now we had a technology that allowed a business to have 5% of their overall costs devoted to power and who were competing against someone in China and India that would be doing it 50 years from now the same way they were doing it today? He said that would probably be 50% of the cost. He said that that was the point…that was the great silver lining in doing good and doing well in this area.

Chairman Hackney then recognized Representative Pricey Harrison who also thanked Treasurer Moore for his great leadership on the global warming issue and thanked him for his presentation. She said that she wanted to follow up on the investor network on climate risks and she apologized if that topic had already been addressed. She said she

was encouraged to see that there had been a pretty significant jump in investor numbers and assets from 2003 to 2006. She said the information she was looking at showed $3.7 trillion and she thought she had heard Treasurer Moore say that there was $18 trillion in assets out there.

Treasurer Moore asked Representative Harrison where she saw the information about the $3.7 trillion and was told that it was on about the 10th or 11th slide in the presentation. Treasurer Moore answered that that number represented the participants in the network and that the bigger number was a fairly educated guess at the total liquidity of the publicly traded marketplace.

Representative Harrison then remarked that the trend was obviously going up and Treasurer Moore agreed that absolutely that was true.

Representative Harrison then asked if Treasurer Moore believed that eventually most companies were going to come around. Treasurer Moore agreed and stated that he believed that if politics were peeled away someone would sound like a complete and utter fool if they stood up and said that this was doing no harm. He said he didn't know if that was the case 10 years ago but it was just a fact that now data was just mounting and mounting and mounting that there were some climate changes happening in this country. He said that a reasonable person would not ignore this problem and that in the Treasurer's experience, most people who ran large publicly traded companies were reasonable people and most of them were pretty good people. He said that sometimes they might just need a little kick in the pants and some might say that members of the North Carolina General Assembly and those who were elected to represent the people of the State also needed kicks in the pants from time to time.

Chairman Hackney then thanked Treasurer Moore for coming to the meeting and for his presentation.

Chairman Hackney announced that further business aspects of global climate changes would be discussed. He said the Commission had heard a lot about the Chicago Climate Exchange in meetings to date. He shared that he had told his committee co-chair about having just attended a meeting of the Fall Forum, the national conference of state legislators. One of the presentations there had been by the Iowa Farm Bureau, and they stated they were getting their farmers ready to participate in trade on the Chicago Climate Exchange. He added that this might be something that the Commission might want to investigate further. He then introduced and welcomed the next speaker, Dr. Michael J. Walsh, the Senior Vice President of the Chicago Climate Exchange.

Dr. Walsh thanked the group for his invitation to speak to them and announced that he had had to get up at 4:30 a.m. on a Monday morning in order to attend the meeting and he didn't know how advanced the commission was until he looked over some of the documentation on his flight here. He announced that he would be giving a Power Point presentation, and that he was somewhat unfamiliar with the equipment that he would be using. **Exhibit F.**

Dr. Welch then stated that he was very impressed with the commission's efforts and with the day's agenda. He also said there were some powerhouse leadership folks in attendance and mentioned Mr. Tim Profeta and Mr. Tom Castin, who had been working on those issues, with progress, for quite a long time. Dr. Walsh said he wanted to particularly acknowledge their participation.

Dr. Walsh stated that the concept of using markets as a tool for precisely and cost effectively managing air emission issues was no longer just a concept. He said he had to make note of that because he had started to work in 1996 to try to build from the bottom up, a "greenhouse gas emissions reduction in trading" approach. He said that the reason it was decided to start with the private sector was the sense, at that time, that governments would have a very difficult time working forward with that issue. He further said that what was needed was already known and understood at that time. He said the tool was available and feasible then. He stated that in 2000 the focus was more intently put on a research and development process which was funded by the Joyce Foundation. The proposition was that society would want those emissions to be managed. Dr. Walsh stated that there was real risk to the planet and society would want gas emissions reduced as affordably as possible to get the maximum bang for the buck. He stated that further, while there were some unknowns as to the exact scale of the risk, it was clear that the risk would get managed and that the market was the right way to go about doing that. He said that at that time anyone who would listen was gathered together and the lines were kept open to anyone who would like to call and the process of designing a market mechanism was begun. Dr. Walsh said that he could report that North Carolina was involved in the market now and although it might not be known or seen on a day to day basis it was happening all around. He stated that there was a price for carbon in Europe and in North America and that there was opportunity here and also that there were new financing tools available for things like sustainable energy, sustainable agriculture, and renewable energy and taking good care of the land.

Dr. Walsh stated the reason that market mechanisms for the environment were attractive was because in many cases there were lots of tools available to address the issue and each of those could contribute to the solution. Dr. Walsh said that in the case of greenhouse gases, problems could be solved using cleaner fuels, lower carbon fuels and things like biomass and more efficient use of technology through vehicle and building efficiency. He also mentioned things like capture and reuse as an energy source; such as methane obtained from agriculture and landfills. He stated that many of the members of the Chicago Climate Exchange in the technology sector such as IBM, an example of a North Carolina presence and a member of the Exchange had found it very inexpensive to reduce greenhouse gases that were not carbon dioxide but were gases used in the cleaning of semiconductor chips here in North Carolina. He said that similarly there were lots of ways to capture and remove carbon dioxide from the air, many of which were very attractive things to do socially, such as planting trees, better management of farmland and potentially taking carbon from industrial processes and burying it. Dr. Walsh stated that some of these things were going on now in North Carolina as a part of the Chicago Climate Exchange. He further stated that those things were happening today as a result

of an organized rules based market. He said there were lots of ways to manage these emissions and it didn't matter where it was done as long as it was done and it didn't matter why it was done as long as it was done but more of it needed to be done, according to what the top scientists in the National Academy of Sciences were saying. Dr. Walsh questioned that if there were so many options and each of them contributed to the solution then what should be done to get the maximum bang for the buck. He stated that that was where the pricing mechanism came in... so that the price was used to ask where the next mitigation option was that had the most value to society. He said that the market could be used to orchestrate and optimize the system so that it became a tool to harness the existing tactics. He stated that that was the rational for emissions trading and he listed three points.

- 1. Greenhouse emissions were a common pollutant problem and reducing greenhouse emissions anywhere would be a good thing for the atmosphere everywhere.

- 2. This was a proven tool and took advantage of flexibility to find the least cost way to specify an environmental goal.

- 3. The third point was the most important point, according to Dr. Walsh. He gave an example of putting a penny of gasoline tax on a gallon of gas and hoping that that would reduce emissions or maybe putting on a nickel a gallon tax or even a dollar a gallon on a gallon of gasoline and hoping it would reduce emission but not knowing how much emission would be reduced. He said that emissions trading relied on specified, quantified emission budgets. He said that worked because businesses knew how to manage to a budget and often would find lots of good things along the way in managing toward a budget. He stated that once account was taken for an external effect, then the market would begin to start to make problems much smaller than people made them out to be.

Dr. Walsh then summarized by saying that clear incentives must be provided... dynamic efficiency and incentive, so that someone could come up with a better invention knowing that they would get paid through the carbon market for doing better by society.

Dr. Walsh stated that President Bush proposed a CO2 cap in trade programs for the power sector and added that there was lots of legislation currently being proposed.

Dr. Walsh stated that North Carolina had approximately 150-200 million metric tons of CO2 equivalent. He then gave an estimate of heavy industry greenhouse emissions in North Carolina as being about 100 million tons a year. He then said that of about ¾ of that power sector probably another 25 million tons would come from heavy industry. He referenced the number of 100 million metric tons a year because that was the kind of cap in trade system that was in place at the present time in Europe and in the United States...primarily the heavy industry parts.

Dr. Walsh stated that the door had also been opened to universities and to cities and governments and other groups to participate in the Climate Exchange program and added that he would love to see a university such as NC State become active in the Exchange program.

Dr. Walsh stated the supposition that there were about 100 million tons of CO2 and other industrial greenhouse gases in North Carolina and he then asked how those emissions would be managed. He answered that he had been privileged to help launch a group of exchanges that were focal points for market machinists for environmental protection. Dr. Walsh stated that the Chicago Climate Exchange was launched in an atmosphere of no regulations. He stated that, therefore, the environmental parameters, the regulatory and the audits and the trading parameters had to be built into the system. Dr. Walsh further stated that in Europe there was a different model and that although the Futures Exchange in London had captured a leading share of the market, in Europe they were simply a transaction platform. He stated that some of the companies in North Carolina were in the European system and he named Michelin and IBM.

Dr. Walsh said that the Chicago Climate Futures Exchange had a Futures Exchange with sulfur dioxide emissions allowance trading to give a low cost transparent mechanism. He stated that the Exchange also had a joint venture in Montreal to activate a carbon market in Canada, should that emerge, and had similarly announced the intention to support, through an organized, transparent inexpensive market, the Northeastern State Emission Trading Program, if that came into existence.

Dr. Walsh then stressed that the organization had to be involved with the entire world and stated that he, too, had recently been in China and India and he was there to help get even more Chinese and Indian participation, although there was already a large amount of participation from those countries. Dr. Walsh explained his belief that that was where the 21 century economy was. He mentioned that people in rural India were talking about European Climate Exchange carbon prices and he said he believed that in some ways those countries were ahead of the United States.

Dr. Walsh then gave a quick update on where the global situation was by saying that a lot of business leaders agreed that society wanted them to get the job done and agreed to use a market universally.

Dr. Walsh then explained one of his slides and stated that the vertical scales told how much of emissions were under the cap and trade systems in the various regimes around the world. Dr. Walsh then said that there were two primary markets underway...the European Union and the Chicago Climate Exchange. He said that the green bars showed the markets that were live and were now running. He stated that Germany included, like most of the European countries, about half of the total emissions of about a billion tons a year. He stated that about half of those emissions were in the cap and trade system and represented heavy industry, power, oil and gas, chemicals, pulp and paper and metals, etc. He stated that the other half of the emissions would have to be managed in other

ways, such as by vehicle efficiently standards, technology standards, incentives, and by buying international credits if the government chose.

Dr. Walsh stated that all of the 25 members of the European Union system had activated their systems according to the green bars shown on the graft. He stated that the second highest green bar was a market here in America...the Chicago Climate Exchange, which included about the same amount of emissions that the United Kingdom included in the European System. He stated that the Chicago Climate Exchange included around 250 million metric tons of CO2 equivalent emissions in their cap and trade system.

Dr. Walsh said that if the Northeastern States Program, just for the power sector, came to life, it would include somewhere between 110-130 million metric tons of CO2 depending on whether or not other states would join the group. He stated that he had been told that there were no significant legal hurdles so that market would activate but he said he wasn't convinced that it would happen. However, he stated that if that market would start up that would include somewhere between 110-140 million metric tons or about half of what California now included. He stated that California was talking about a 2012 start date, however, emissions trading was not explicitly included in their legislation and that it had taken some further reinforcement action. He said that if those markets got going in the next 3-6 years they would still be rather modest in scale.

Dr. Walsh then stated that if North Carolina heavy industry was 100 million tons, then this state was bigger than most of the European countries in terms of what would be included in the cap and trade system. He reinforced that this state would not be a trivial footprint by any means.

Dr. Walsh said that if Canada got going that they would be a sizable market. However, it remains to be seen if Australia would get going.

Dr. Walsh stated that the second biggest market in the world was a voluntary driven market. He said that the Chicago Climate Exchange was a voluntary program and that they had no regulatory authority unless a contract was signed to legally commit emissions to their emissions reductions schedule that had been hammered out in an intensive negotiations process.

Dr. Walsh stated that the members of the Exchange had agreed to forget about national borders and since the world was a NAFTA world it had been decided that the Canadian and Mexican borders were not critical and said that therefore the Exchange members decided to bring in emissions standards from Canada and Mexico and after that was done, Brazil was also included.

Dr. Walsh explained the background process of the Exchange by saying that some world famous people had been brought in to get the Exchange going. He said that one of his favorite people was one of the leading energy experts at the TOTA Energy Research Institute in India and was a graduate of NC State with a Ph.D. in agricultural economics and who now headed up the primer global scientific organization where many American

scientists got together to try and figure out where the would was going. Dr. Walsh gave this example to say that if someone were to say that one person or one state couldn't make a difference, he liked to give that example.

Dr. Walsh then showed the slide that listed the members of the Chicago Climate Exchange and called attention to the fact that the group was global and was very diverse. He also called attention to companies that had North Carolina operations. He stated that the list he was showing wasn't complete, as there were several other Brazilian corporations that were signing up, especially in the forest product sector and in biofuels. He also pointed out that American Electric Power was the very biggest power generator in the country and was a member of the Exchange

Dr. Walsh stated that universities had also gotten involved with the exchange and he said that the universities wanted to learn what it was all about as it was a future economy. As an example, he explained that farmers would benefit from the program as they learned about financing methane collection and the carbon market. He added that universities could learn about the Exchange and pass on that information to the farmers in their areas.

Dr. Walsh said that governments could also benefit from the Exchange program and that Illinois and New Mexico had expressed aspirations for managing carbon and were including their state government operations.

Dr. Walsh also noted that DuPont, IBM, and Waste Management were cutting non CO2 gasses with co-benefits, which meant that they were saving money as well as reducing emissions. He stated that all emissions weren't CO2 and some could be reused for fuel.

Dr. Walsh stated that Amtrak was a member, as well as, Safeway grocery stores with a chain of 2,000 stores around the country.

Dr. Walsh also said that those businesses who might want to participate in the program by agreeing to offset their modest emissions at their businesses were allowed to join the Exchange as associate members.

Dr. Walsh also mentioned other groups which were members of the Exchange and mentioned the Rocky Mountain Institute, the World Resources Institute and said that one of the original investors was the Jesuit community of Santa Clara University. He said that group was managing a big endowment fund for cemetery space for Catholics in the Bay Area. He said that the Jesuit community even lent money to the Exchange for start up costs and then they converted the debt to equity.

Dr. Walsh stated that the financial sector needed to be involved in the Exchange, as well as, the agricultural sector. He said that he couldn't sign checks with individual farmers but worked through state farm bureaus who contacted farmers who were doing conservation tillage, tree plantings or doing methane collection on live stock operations and turning those into credits.

Dr. Walsh mentioned that all contracts had to go through a rules process and all had to be independently verified. He stated that the traders of the world were the folks who were going to make the Exchange idea another add-on to the capitalist system. He stated that there were about 225 members of the Exchange and that Blue Chips were signing on that would be announced in the near future. He said that these Blue Chip groups wanted to get in the market and get leadership opportunities by being part of the group and getting involved in a global scale in order to get ahead of regulations and drive the regulations. He said that many of those organizations faced real risks. He stated that American Electric Power was the biggest coal burner in the western hemisphere and it really mattered to them how the emissions trading systems for carbon worked. He further said that by getting and organizing focal point carbon emissions, a company would get really good at focusing on their fuel consumption and energy efficiency and would learn how to save money while reducing the emissions.

Dr. Walsh summarized by saying that there were a lot of reasons to invest in the Exchange, such as strategic reasons, reputational reasons, and the fact that lots of investment money was being funneled to those businesses that seemed to be doing the right thing because it would be a good business opportunity. He said that voters wanted carbon emission reduction and it was going to be something that would be coming. He also said that some companies questioned that if they didn't participate in the program, were not being proactive and were not seizing the opportunity they might not be meeting their fiduciary responsibilities to their shareholders.

Dr. Walsh mentioned that some of the government bodies that had gotten involved viewed participation in the carbon trading system as complimentary to their political and public policy goals. He said he believed that this would be the preferred tool of the 21st century for managing a lot of emissions. He said that was the reason that several governors had gotten involved and had asked their staff members to get up to speed so that if a policy needed to be pushed, the staff would understand what it would mean in the market context for their state.

Dr. Walsh explained that the core of the system was not all that different across the emission trading systems, depending on the pollutant. He said that the Exchange was begun with a four year commitment and the members agreed to cutting emissions by 1% per year to get to a point that by 2006 they would be 4% below their base line. He explained that the base line was the average of the emissions included during the years of 1998-2001. He said that all the members of the Exchange have had to include all of their major emitting activities in the United States. He added that if there were some small things, such as a vehicle fleet within a big power company, the vehicle fleet could be included if there was sufficient data, but the focus would need to be on the big things first. He said the important thing was that there must be entity wide participation.

Dr. Walsh stated that whenever anyone joined the Exchange, whether industrial enterprises, universities, cities, etc. they must quantify their missions. He said that they must look at their fuel burn and must use the World Resources Institute calculation tool and go through a grueling audit. He stated that some groups didn't have good data on

their energy consumption and that more than half of the emissions included was already reported to the US or Canadian authorities. He said the Exchange relied on a lot of existing high quality data from continuous emission monitors so when someone joined the Exchange they got an emissions baseline and were audited and given a batch of tradable permits. He stated that if someone joined in the first four years and had a baseline of 100 tons they were given a four year strip of tradable allowances. He explained that if a member had 100 tons the first year and was able to drop them down to 97, they were to give back 97 allowances and that would give the business 2 tradable allowances that could then be sold to someone else in the system. He said that those extra allowances could also be held and banked to be used in later years if needed. He stated that if the member didn't bring their emissions down to their budgeted amount then they had to buy a credit from someone else in the system. He explained that would be someone who had made an extra cut and registered and verified an eligible emission offset project such as a farm, forest, or renewable energy, etc. He further explained that a member would either make their goal or beat their goal or if they didn't meet their goal they would have to buy some credits. He stated that all the members were audited each spring and added that there was also an important feature of a quantitative safety valve involved. He said there was a limited amount of pain experienced in the process. Dr. Walsh stated that for the years of 2005-2006 the cap on exposure was 3% above baseline and added that the most that anyone would have to buy in terms of credits to reach their annual compliance in the year 2006 would be 7% of their baseline. He said they would be expected to cut 4% and they would have to offset 7% of their baseline. He stated that when this program was designed and the provision was established, people said that they were really glad to know that they wouldn't have to buy more than 7% of their baseline in 2006. He added that members of the Exchange have said that this program was working and wanted to extend the program by going 2 more points by 2010 or 6% below baseline. He said, however, that some members were concerned that they were getting too far ahead of legislation, which wasn't calling for such an aggressive target. Dr. Walsh then stated that the European Climate Exchange operated an environment that had very similar reduction goals and said that their goals this year were about 3 or 4% below baseline.

Dr. Walsh stated that the market had been extended but. if someone were to join on now, they would get to catch up. He stated that the members believed that it was better to grow the market and get more people budgeting and more people auditing and more people managing and to let them catch up.

Dr. Walsh than gave an example of North Carolina industry. As an example, he suggested that North Carolina industry had 100 million tons of baseline and became a member of the exchange. He said the worse case scenario would be if the state couldn't find its own internal emission cuts and would have to buy 4 ½% of its baseline or offsets. He said that the maximum recognized increase is 3% above baseline but the goal would be cut by ½% because they would be a new member of the Exchange. He stated that in that scenario, North Carolina industry would be on the hook to buy 4 ½ million tons of offsets from someone else in the system. He said that would probably be $4.00 a ton or so at current prices. He stated that would be $18 million a year and the next year it would

become 6 million tons at $24 million a year statewide. So he said in order to get audits going, baselines going, quantifications going, a price on carbon in the first 2 years of the program would cost the state approximately $2-$3 a citizen. He asked where that $18 million would go and answered that it would go to the sellers who made the extra cuts. He said it could go to North Carolina hog operations with methane recovery or to North Carolina farmers who were doing conservation tillage or to North Carolina foresters or other North Carolina industries or renewable energy providers or other people who could be on the sell side of the market. Dr. Walsh said that he didn't know if getting into the world of carbon markets-the 21st century markets would be worth the worst case scenario of $2-$3 per citizen per year to the state of North Carolina. He said he knew that this was certainly not a trivial amount of money and something that would have to be up to the state to think about and decide. Dr. Walsh then said that in addition to state involvement that universities and cities within the state could also get involved in the program. He said that he would love to have NC State, UNC, East Carolina and A&T become involved. He said that with all that knowledge it would be great to have North Carolina universities involved and he said that students loved the Exchange because it was a lot of excitement and a lot of fun. Dr. Walsh stated that the amount of money talked about to participate had been blown way out of proportion.

Dr. Walsh said that the upside of this was that the European market had an annual carbon crop value for 2008 that exceeded the crop value of the United States' soy bean market plus the United States' corn market, plus the United States' wheat crop so the EU carbon crop in 2008 would be bigger than the US agricultural crop. He said that this was going to be big but would not be all that painful for any particular entity because the dollar's amount was just not that significant. He asked if $2 or $3 dollars per capita per year to take a serious step to the frontier on this would be too much. He also stated that this would go up over time. He said the yield carbon crop was 2.2 billion tons of allowances allocated currently, trading at about $20 for 18 yields a ton. He said that came out to a value of about $45 billion a year of allowances allocated a year. He said that the US corn, bean and wheat crops weren't quite worth that.

He was asked about trees and said that Europeans didn't really care for trees that were said to pull carbon out of the air. He stated that the Chicago Climate Exchange was a fully integrated environmental audit and electronic trading system. He said that members got a registry account that was a bank account recording of all of their emissions that had been audited and all of their allowance trading, etc. He said the Exchange was a commodity market trading screen. He said that they traded their European allowances on the screen and their US allowances and their North American allowances and their US sulfur all on the same screen because it was a commodity market.

Dr. Walsh said that it was also very important to supplement not only what industry could do but what people outside of industry could do to bring those into the carbon market. He said that they didn't have the luxury of saying that they could only pick one country or one section to be included. He stated that every mitigation option in every possible location needed to be built out as soon as possible according to what the very best scientists, The National Academy of Sciences folks were saying. He said the best

scientists were saying that we needed to get going in every sector, in agriculture, in forestry and the way to do this was to encourage folks to do projects that mitigated those emissions. He stated that those projects needed to be identified and the door opened to new ones. He said that farmers could grow corn and soybeans above the ground and grow carbon below the ground and they could get a few bucks an acre a year if they were one of the eligible farmers.

Dr. Walsh stated that the offset concept was to bring in reductions from low cost sectors to provide some economic development opportunities in those other areas that needed to be built out and to broaden the participation base. He said those things were defined in a very conservative way and everything had to be verified and there was no cherry picking and people were encouraged not to go backwards. He stated the importance of this and added that there was a lot of opportunity and added that major opportunity was to mitigate these emissions through farm and forest. He said this would provide cleaner water, and give rural income and economic development possibilities. He said that a farmer could make money on methane collection...real money. He mentioned the methane lagoon covers that cost a $100 thousand and another $100 thousand if power generation was added. He said that if the NC government wanted to subsidize a few of those here to get some renewable energy and to reduce some odor problems and if they wanted to get carbon credits from that, there would be no problem as long as the pollutants were being removed from the air. He said that was also a supplemental financing source and, in fact, carbon finance had come full circle to do what it was supposed to do. He explained that the farmers would be raising money to invest in methane recovery operations at livestock operations knowing that they would be getting carbon credits from the Chicago Climate Exchange and would be able to pay back their debt with those carbon credits.

Dr. Walsh said that the market had been rather slow to get the thing started with prices of $1.00 or so per ton but they weren't concerned as long as all the checks cleared...and they had all cleared. He said that about 10 million tons had been traded this year and the price had been in the $4.00-$4.50 a ton range. He explained that meant about $2.00 an acre per year for a no till farmer. He added that that wasn't a bad shot in the arm if your real estate taxes were about a $1.50 an acre a year.

Dr. Walsh again stated that this was a complete system with an open-door policy. He said that anyone who wanted to get in and was willing to take the audit and take the commitment and live up to the commitment was certainly welcome. He said the goals had been achieved and members had beaten the reduction requirements. He added that some have had to buy credits to get to their yearly goal but they did that and that those were a very small piece of the overall Exchange.

Dr. Welsh stated that not everyone who had been invited to be a member of the Exchange had joined the Exchange. However, he said he felt that they had educated far more than just the members who were now a part of the Exchange. He said that now when he visited someone interested in joining the group he was amazed that there was a night and day difference. He explained that now people were getting it as a part of their business

and said that people were finding free savings on money that was previously going out the door that they wouldn't have captured if not for the Exchange program. He said there were significant side benefits taking place.

Dr. Walsh then stated that the Exchange was an apolitical enterprise and didn't lobby for or against legislation. Nevertheless, he added, anyone who tried to do something about global warming would attract some comment...and not always positive. He said that some people didn't want this to happen but some real leading thinkers had been very nice and that was much appreciated in a bipartisan context. Dr. Walsh mentioned some US legislators who had gotten involved in the program and had found the program to be another income source. He mentioned Senator Luegar, currently the Chairman of the Senate Foreign Relations Committee, who had brought his farm into the Exchange to demonstrate that carbon credits could be achieved in agriculture as another income source.

Dr. Walsh then asked for comments or questions and stated that when it came to emissions trading there was no such thing as a dumb question.

Representative Hackney said that he would ask the first dumb question and then asked about China and asked if they were paying attention to global climate change in spite of making some mistakes. He asked if they were trading or participating and how they were impacting the world market.

Dr. Walsh answered that China was very active and was, in fact, the leading participant in the international market under the Kyoto Treaty, where developing countries could undertake migration projects within the country, such as a methane recovery or fuel efficiency, etc. and be able to sell those credits internationally. Dr. Walsh said having just been there, that the Chinese wanted to sell in every market they could participate in. He said that he had met some incredibly innovative technical specialists on energy reuse, on blast furnace gas recovery, and on some other things. He said they were participating in every market that was available to them. He added that developing countries at this time do not have reduction requirements but he said he thought that they were probably smart enough to know that this was coming and they wanted to get up to speed. He said that he saw incredible knowledge being built every day by participating in the carbon market in China and in India and he said he was concerned it was more so in many cases there than what he was seeing in the US.

Chairman Hackney then recognized Dr. Uzochukwu, who asked about the cost to become a member of the CCX.

Dr. Walsh answered that it depended on what kind member would be involved. He explained that a really big emitter in a heavy industry would have dues levels in line with being a member of an industrial association. He added that an individual trader, and there were a lot of them, who came from the Board of Trade would pay $1,000 a year to join and then there was a processing of their application involved and there were regulatory requirements and that was another $1,000 fee per year to be a member. He

said the cost would range from $1,000 just to be a trader or an offset provider, up into the $10,000 range for a heavy industry where the audit expense would be more significant.

Chairman Hackney then recognized Dr. Crawford-Brown who asked about the 2 ways that people might go about this problem. He said that one would be to take the easy measures and improve efficiency and so forth but there was also another goal which was to stimulate the development of new technologies. He stated that in Europe the sense seemed to be that even though they were well above us in terms of the dollar amount per ton that they might have to drive up to a hundred or so in order to eventually stimulate technologies. He asked about Dr. Walsh's sense of how rapidly the dollar amount needed to evolve in the US to really start causing big changes.

Dr. Walsh answered that he was very bullish that the numbers were far lower than many people thought. He said that he was stunned at the number of calls he got from innovators who were very excited at the prospect of $4.00 or $5.00 a ton. He added that these things took time and were not overnight technologies or innovations. He said he believed there were enormous supplies well below $50 a ton CO2. He said that with significant cuts in emissions at realistic price ranges the cost hit to the economy was in the range of 1-2% of energy prices. He explained that that was 1, 2, or 3 cents a gallon for a really big reduction in emissions in realistic price levels. He stated that 1, 2, or 3 cents a gallon moved every day at the New York Mercantile Exchange so it was a dollar amount that was probably imperceptible as an economic hit but was a big incentive for new innovators. He said the economic hit and the notion of substantial industrial dislocation was completely off the mark because of the ability to innovate and respond. He said this was seen at universities here in North Carolina and was seen at the best university systems in the world and that some of the greatest technical innovators would respond at $5.00, $10.00 and $15.00 a ton. He said he thought that issue was just a "tempest in a teapot" and was just not that expensive a problem to solve. He said that the benefits would be cleaner air, and cleaner water and lower energy bills that went along with it at far lower than $100 per ton.

Chairman Hackney then recognized Representative Wilkins who said that according to Mr. Walsh's presentation that he saw three levels of membership but that he didn't see how the levels differed.

Mr. Walsh answered that the members were the emitters. He explained that they would take on emission reduction commitments of their 4% by 2006 and 6% by 2010 and that they were industrial entities that had sufficient emissions, such as power, pulp and paper, metals, and chemicals. He further explained that the associate members were really white collar organizations that had an office and flew around in airplanes and who had a small amount of emissions that they had agreed to completely offset by buying credits each year. He said then there were the sellers such as the farmers and the foresters who did forest and farm projects and sold those into the Exchange through an Iowa Farm Bureau or a North Carolina Farmers Union, etc. if they wanted to do that.

Chairman Hackney then called on Mr. Michael Shore for a question.

Mr. Shore said that he was asking his questions as a member representing an environmental organization and he said that he actually had two questions. First he asked about the major utilities in North Carolina wanting to expand their fossil fuel capacities, such as Duke Energy, which was proposing a new expanded coal fired power plant west of Charlotte, and he asked about a hypothetical situation in which Duke Energy were to commit to expanding that new facility by being carbon neutral and buying carbon offsets and by buying these credits from someone such as the state's swine industry which could have carbon credits to sell. He questioned the differences of those two entities working together to work out some kind of deal versus going through the Chicago Climate Exchange and wondered if there were some kind of advantages for the Exchange to be a broker in that scenario. He said his second question was that since there were renewable energy credits available, such as states that have renewable portfolio standards and a trading mechanism with that, then how did the renewable energy credits and the carbon credits interact with each other.

Mr. Walsh answered that both those questions were very good ones. He said he first wanted to be clear in stating that the Exchange was classified by the Commodity Futures Trading Commission as an exempt Exchange under the Commodity Exchange Act so they had a status as a regulated entity with NASD serving as an external regulator and that was a far different context and that their fees were set on a flat per ton basis. He added that, therefore, the term "broker" was not an accurate one as the Exchange was an exchange mechanism and brokers did participate in the Exchange.

Mr. Walsh further explained that there were folks around the country who were doing things along the lines that Mr. Shore had mentioned. He said there were people who were striking up their own deals and were fixing up their own rules and were making up their own side agreements. He said the Exchange's view was that whatever started people going in that area, such as pricing, auditing, base lining, quantifying, and setting goals was a good thing however it was being done. He stated that was what the planet needed more of and if there were people who wanted to do it on their own they were very likely to find what many folks had found when they did things that way – that it was really tricky to set the terms. He said groups could spend two or three years going back and forth with their lawyers or the groups could just adopt a set of structures and rules that were already in place. He mentioned that there were rules on the Exchange's web page and added that the bottom line was that if groups chose to go that route then so be it and that it would be up to those involved to decide. He said the Exchange had a member effect and was an organization that was already in place and which had taken quite a number of years to build the infrastructure for. He said that in terms of renewable credits that it was very complicated and it would be difficult to start from scratch to organize and to convert carbon credits into renewable energy credits. He said there was a provision that did allow, under very limited circumstances, for someone to convert a renewable energy credit into a carbon credit. He said that to a degree they kind of reflected some of the same things. However, he added that was a very difficult and technical area that he didn't want to dwell on at great length with the Commission because no one had actually done it yet. He said that maybe the Exchange's rules were too conservative or too

demanding for someone to make that kind of conversion. However, he said that the Exchange wanted to bring those markets together in some fashion.

Chairman Hackney then called on Representative Pricey Harrison who said she thought that her question was probably one of the dumb one and. Mr. Walsh responded that he had been waiting for one of those.

Representative Harrison stated that she wasn't quite sure that she understood what was going on in that Mr. Walsh had stated the Exchange had emitters that had voluntarily agreed to reduce their carbon emissions by 4% and then there were some folks who had joined in to sell their opportunities to reduce the emissions. She asked if that was basically how it worked with the Exchange and Mr. Walsh agreed that was a great summery. She questioned the companies' motives and asked if they were just altruistically minded or did they see an economic opportunity because it was inevitable that they would eventually have to cap and they wanted to take advantage of it now.

Mr. Walsh answered that both those things were true. He said some companies could see both opportunity and risk so that they needed to get going to correct things and he also stated that some companies were altruistically minded. As an example he stated that one CEO of a European company, who was a grandfather, said that this was an important issue and he didn't run the numbers and didn't ask if he was a buyer or a seller or otherwise but just felt that this was a very important issue. Mr. Walsh said there were companies that were worried about lawsuits or about shareholder resolutions and values and that there were also some companies that could see the upside and could see that they could make those things that reduced emissions and wanted a price on those things. He stated that there was really a wide range of motivations.

Representative Harrison than stated that she was starting to understand the agricultural component of this and she wondered about the how big a component conservation tillage was.

Mr. Walsh answered that there were several million acres enrolled in the US and several million acres enrolled in Canada in the Exchange program. He said that, unfortunately, the extent to which farmers currently did what the Exchange required of them year after year… low disturbance, was extremely rare. He said that fact was one of the reasons the Exchange believed that conservation tillage was a highly attractive activity and was a best in class and therefore was a credit. He said the upside was that there was such a lot of potential for this in this country, although it was a pretty rare practice. He said that at the present time that was a pretty modest part of the Exchange although they would really like for it to be more and it was certainly good for the land and for the water.

Chairman Hackney then called on Dr. Edward Erickson for questions and Dr. Erickson stated that Representative Harrison had basically already asked his question.

Chairman Hackney recognized Co-Chair John Garrou.

Mr. Garrou stated that because the Exchange was a voluntary organization one would expect that the price of credits would be less than was the case with the EEU, for example, because the Exchange members were self selected and probably included people who planned to make carbon reductions anyway. He questioned if that was a problem and if that was a problem that would continue forever or if Mr. Walsh thought the prices would tend to converse over time.

Mr. Walsh answered that that was a very thoughtful question. He said that if Mr. Garrou would go to the Exchange's web page and look at their annual environmental compliance report he would see that there were significant numbers of firms that had to buy credits, in fact, had to buy the maximum required under the Exchange rules. Therefore, he stated that it wasn't exactly as cut and dried as might be thought. He asked Mr. Garrou that with that information, did Mr. Garrou think that those facing a high price tag to be a member of the Exchange had come flooding to the Exchange with phone calls. He then answered that no, that was not the case. He said that it was certainly easier to bring in a seller than a buyer so one might make the conclusion that the prices would be different in a different kind of system. He said that he didn't know if the system would go on indefinitely. He said that the Exchange might be put out of business by a Federal program and that would be good news for him.

Chairman Hackney then recognized Mr. Thomas Cecich, who asked how long a company would be contractionally a member of the Exchange once they had signed on.

Mr. Walsh answered that the first phase had been four years and there were some people who were now saying that it had been great but that their business was far different or the company executives were different from when the company had first joined the Exchange and they had chosen not to participate further in the Exchange after those first four years. He stated that the Exchange had a market for the years from 2007 – 2010 and that most enterprises had renewed for another four year commitment and that new ones were being added for that second phase of the Exchange.

Chairman Hackney then called on Dr. Stanley R. Riggs who stated that is wasn't clear to him how the hog lagoons could represent credits. He said there were hog lagoons all over the place but they were scattered out ...one or two or three here and there, etc. He said the efforts to try to utilize those as a source of gas had not really materialized because of the collection problem. He asked how that could be counted as a credit. He asked if there was a potential innovation that could be expected to come down the pike or where did that problem fit.

Mr. Walsh answered that the collection of gas from hog lagoons was happening now. He said that it might not be happening in North Carolina as much as he might like but the technology was proven and there were a number of both lagoon cover with gas flaring in power generation facilities and manure digestion systems that were in the market at the present getting credits and cash. He said that if that methane was not captured it would otherwise be going up into the air. He stated that when the methane was burned off that was a big chunk of forward progress. He added that the Exchange didn't give as many

credits as some other systems did...they were pretty stingy about it. He said, however, that it was a financing source.

Dr. Riggs then asked why North Carolina wasn't doing that sort of thing already and Mr. Walsh answered that he really didn't know and that was why he was here to welcome as many North Carolinians to participate as would like.

Dr. Riggs asked who was doing that sort of thing at the present economically in the country.

Mr. Walsh answered that a number of dairy operators in Minnesota, Wisconsin, California, and Illinois were members of the Exchange. He said that dairy management practices tended to be more suitable for that type of thing. He said that Premium Standards Farms was a member of the Exchange and they had some methane capture systems that had been brought in...mostly swine operations in that particular case. He stated that that sort of thing was happening and that it was happening like gangbusters in places like Mexico and Brazil and China. He again stated that the methane capture was a new energy source and that it reduced pollution, and was better preparation for using it as a nutrient and hopefully it caused less water damage. He said this was a win-win situation.

Chairman Hackney then recognized Mr. George Givens who stated that he was aware that there was at least one company now trying to market lagoon covers in North Carolina and that one of the selling points they were using was the methane capture and the generation of credits through the company's membership in the Chicago Climate Exchange. He said that anyone using this product would be generating credits and, hopefully, the revenue from the credits would offset the cost of the cover.

Chairman Hackney then called on Dr. Eggers who asked if most of the participating companies were just capturing their methane and flaring it or if they were doing something else with it.

Mr. Walsh replied that that was a good question and answered that the first level of environmental benefit could be realized even if the methane was just flared because a 21-23 potency greenhouse gas would then be brought down to a 3 of CO2 that comes out of the flaring. So, he stated, that was not a bad thing and it was credited by the Exchange. He said that he didn't honestly know the breakdown of the agricultural sites or the landfill sites as far as the flaring was concerned. He said that even at some waste water treatment sites at municipal treatment facilities the flare was being reused for electric power or for heat generation and although he wasn't sure, he thought it was more than half. He also stated that could change over time as there could be a system to just control the gas and flare it and then power generation or steam generation could be added later.

Chairman Hackney thanked Mr. Walsh for educating the Commission about the Chicago Climate Exchange and thanked him for getting up at 4:00 am to come here and he stated that he hoped Mr. Walsh would have a pleasant trip back home.

Mr. Walsh said that it had been an honor to speak to the Commission and wished the Commission good luck in carrying out their work and stated that he wanted everyone to know that they had friends in Chicago who were willing to clarify any further questions or ideas. He stated that the Exchange was in a growth mode and a learning mode and he very much appreciated the opportunity to be with the Commission.

Chairman Hackney then told Mr. Walsh that the earlier flights to and from Chicago were usually on time and the later ones in the day were usually late and he advised Mr. Walsh to try to come and go early.

Mr. Walsh responded that he had had a difficult dressing challenge as he had to bring a coat even though it had been fairly warm when he had left Chicago because when he left Raleigh he would be off to Montreal to speak on the same issue. He stated that the Canadian government was maybe not as far along as the North Carolina Legislative Commission was on the issue

Chairman Hackney said the group would move on to a discussion of combined heat and power as a method of reducing greenhouse gas emissions and increasing energy efficiency and then introduced Mr. Thomas R. Casten, Founder and Chair of the Alliance For Clean Technology and Founder and former CEO of Trigen Energy and Primary Energy Ventures - **Exhibit G.** Chairman Hackney thanked Mr. Casten for being a speaker for the Commission.

Mr. Casten introduced himself by saying that in about 1975 he had become convinced that Global Warming was the biggest problem we were facing and he had spent the last 30 years trying to find ways to profitably reduce climate change. He stated that in 1998 he had written a book called "Turning Off the Heat" and he said that he would be giving a copy of his book to Chairman Hackney. He said he believed the book was still somewhat relevant. He said there was also another book that would be coming out that had been edited by some folks at the National Labs called Thirteen Energy Myths and there was a chapter in it entitled "Are Worldwide Power Systems Optimal?" Mr. Casten also mentioned that that book was available on the Alliance's website.

Mr. Casten said that if he understood the Commission's mission, it was to reach a consensus on what North Carolina could do to elevate or to prepare for the effects of climate change. He said he believed that the Commission was doing a wonderful job of soliciting ideas from experts and he said he believed the Commission should take advantage of economic opportunities. He stated that he was probably out of sync with most people who talked about the problem of climate change and said that they couldn't afford to deal with the problem. He said he didn't think that we could afford not to deal with it as we were currently spending much too much money buying fossil fuel which was wasted. He said everyone would be much better not spending that money and improving the job climate instead. He said that was an opportunity. He stated that the actions taken by the Commission would shape the North Carolina economy for decades to come. He said that one of the problems being dealt with was that the energy decisions tended to be fifty or seventy year decisions and once the decisions were made the state

would be stuck with them. He said, for instance, if a big new coal plant were built, it wasn't going to be shut down next year. He stated that his presentation summery was that he would tell the Commission that the central generation of electricity was no longer optimal and that it really hadn't been optimal for the last 45-50 years and everyone was just kind of stuck with it because of conventional wisdom. He said there was a much better option of local generation that recycled energy waste. He said he would be asked that if that idea was so good, why it wasn't being done. He stated that it faced regulatory barriers and it was denied most of the benefits that it created because there was a whole system set up to move forward with central generation, which had started being done in 1910-1920. He said that system had been outgrown. He said that he had recently helped to form a group called The Alliance for Clean Technology, which proposed a suite of ideas to encourage clean technology which the group believed would profitably reduce climate change problems. He said the Alliance believed that governments could profitably mitigate climate change with what the group called a "blue box" energy policy. He said he was pleased to see, coming in the door to the building, that there were containers to recycle paper and glass, etc. He said there was vastly more opportunity to recycle energy and it was simply not being done. He said that after his presentation that he hoped the Commission would understand what he was talking about a little better.

Mr. Casten then talked about the Alliance and explained that it was a coalition of local power developers, World Wildlife, Greenpeace, Sierra Club, Suzuki Foundation and a lot of environmental groups but amazingly there are also members who represented lots of union workers who were concerned about the loss of jobs. He said there were also members who were gas and electric distribution utilities that were concerned about the rules that prevented them from doing what they knew to be a better job. He said the mission of ACT was policies that induced deployment of clean technology to profitability reduce greenhouse gas emissions. He said that ACT wasn't trying to go all the way at the present but in order to get there a lot of things that cost money would have to be done. He said he was sure that was going to happen but why not go get the "low hanging fruit" and boost the economy up first and buy some time for some other technologies to improve. He said he believed those policies would reduce pollution, improve industrial competitiveness, would preserve good jobs, and most importantly of all would lower the societal cost of heat and power. He said he had used the word "societal" because energy was the most subsidized commodity on the planet. He said that nobody paid the actual cost of energy. He stated that when a commodity was subsidized people used more of it, spent less money on conservation and they just didn't get the signals.

Mr. Casten gave an example of a massive study done in Ontario that was very well done and peer reviewed, which indicated that the health and environmental benefits of every kilowatt hour of coal fired power was 12.3 cents. He said that Ontario sold the power to their citizens at about 6 – 8 cents a kilowatt hour and then there was 12.3 cents of health benefits. He said these health problems were not "pie in the sky" numbers but were things like emphysema, emergency room visits, premature death, pulmonary problems, as well as, environmental damages. He said that the market numbers were used in the study on carbon.

Mr. Casten said that in "An Inconvenient Truth" Al Gore described global warming as an inconvenient truth and by that Mr. Casten said he took Mr. Gore to mean that global warming was a reality that people would rather not face. Mr. Casten than asked why was it something people would rather not face and why was it inconvenient. He answered that it seemed inconvenient to 99.9% of people because we were locked in conventional wisdom. He said he hoped that if the Commission took one thing from his presentation that that fact should be that conventional wisdom was the enemy. He said all the other stuff was simple but it was getting over the conventional wisdom that was the tough part. He said that wisdom assumed that the markets worked very well and he said that as a capitalist and an environmentalist, he believed that markets did work but that they churned on the signals that they received. He said they didn't work magic but worked against whatever numbers they were given. He said that with the most subsidized commodity in the world, markets found a way to cause people to use a whole lot more of it or to be a whole lot more wasteful with it. He said that it was assumed that they were working optimally with it without realizing that there were problems of barriers, regulations and price signals and it was automatically assumed that anything that was done to mitigate climate change would increase energy costs.

Mr. Casten suggested that the Commission check an article in *Foreign Affairs* and look for a little paragraph in an article by Lord Brown addressing British Petroleum, not a small company, which decided that they would, on their own, go after the Kyoto targets and that they would lower their carbon footprint back to the 1990 levels. Mr. Castin stated that Lord Brown then said that British Petroleum found that it actually cost less than they had thought and that it was done in two years. Mr. Castin said the article stated that the company claimed to have created $600 million a shareholder value. He said that he had spoken with Lord Brown's assistant, a good friend of his, and asked if that meant that after taking account of the capital cost and the cost of capital the company had created an additional $600 million in net present value. Mr. Casten said his friend affirmed that statement. Mr. Castin said that he was very familiar with a lot of BP's operations and knew that they hadn't scratched the surface in what had been done, their big profit opportunities. But Mr. Castin said still it was thought to be inconvenient and asked why that thinking was wrong. He answered that the energy system was no where near optimal. He said that electric generation efficiency peaked 45 years ago and 38% of carbon emissions in the United States came from electric generation. Therefore, he stated that if people were going to go after that problem they must go after electric generation. He said that nothing else was of that magnitude.

Mr. Castin asked if the Commission could think of an industry that had not improved its efficiency in 45 years and was still functioning today. He said that wouldn't require a lot of thinking because there was only one...electric generation. He presented data from 1960 and said that it was also the 2003 data and stated that electric generation was the only static industry around. He said if there were a big power plant sitting somewhere remote and 1,000 units of fuel was thrown into that power plant, then a great deal of waste heat would come out the top. He said only so much fuel energy could be converted to power. He said there were also long transmission lines where another 7 ½ - 9% on average, and up to 25% during the peak of energy, would be lost. He said the end user

would get 33 units of electricity for every 100 units of fuel. He stated that the power going to the light bulbs in the Commission meeting room represented 1/3 of the fuel used to generate it and that that had not changed from when he was graduating from high school.

Mr. Castin then talked about a chart that he was presenting and stated that it represented fabulous work that had been done by his friend, Robert Ayers and explained that it was a picture of the past 105 years. He explained that the top line, the blue line, represented the conversion of potential energy to deliver electricity. He said it started out at just over 3% back in 2000. He said the graph showed that for the past 60 years there was a nice, good steady improvement, improvement, improvement. He said that by that time there had been monopolies so long and the competition had become so deadened and there were so many rules in place to block anyone from doing anything different and the reward structure didn't reward efficiency that the industry had not gained one percentage point improvement in the ensuing 45 years. He explained that the red line on his graph showed the delivered efficiency. He stated that electricity didn't do anything for anyone but what were needed were useful energy services. As an example, he explained what was needed in the committee room was the electricity and the air conditioning. He said that that number hadn't improved either. So, he said, the chart showed the reason there was a problem. He said that as the country had grown and economies had developed, efficiency hadn't kept pace. He said there were better electricity generation options available. He stated that local generation, which wasn't originally wanted because it was dirty and noisy, etc., now had technology that had gotten to be beautiful and yet we continued with 1910 policies.

Mr. Castin stated that ACT had a convenient truth which was that energy recycling would ease all the problems. He said that recycling industrial waste could generate 20% of US electricity. He said he believed that to be a staggering number just from capturing the waste that was thrown away by industry. He stated that industry used energy only once He said that where there wasn't wasted energy then heat and power generation should be combined because whenever fuel was used to make power there would always be heat left over. He said that heat could then be used, or more fuel would be bought to burn to make the heat that had just been thrown away. He said that was exactly what was done. He asked that the Commission imagine a side of beef that had tenderloin in it, which would be equivalent to electricity, and also brisket and hamburger in that side of beef which would be equivalent to heat. He explained that many years ago the world figured out a trade called butchering and the butcher very carefully would take the expensive stuff...the tenderloin... out of the side of beef and would sell it to one customer and would take out the cheaper stuff...the brisket and hamburger...and would sell it to another customer. He said that a butcher was needed in the electric industry today because what was done now was to buy sides of beef, burn the fuel to get the tenderloin and then throw all the rest, the heat, away. He said the equivalent would be that a nice steak house bought a side of beef, cut out the steak, and then threw the hamburger away. He said, however, that wasn't done. He said that another restaurant like McDonalds would get the hamburger. He stated that recycling waste energy would improve the US competitive position and would have many benefits. He then explained the term

"recycled energy" as being useful energy that was derived from exhaust heat from either power generation or from industrial waste. He explained that it was tail gas that would otherwise be flared. He said it could come from places such as chemical factories, refineries, and steel plants. He said that it was a pressure drop in steam or in any gas. He used the Legislative Office Building as an example and said that he had noticed that the building was on a steam system so there must be a central system and the pressure drop in that steam system would make electricity.

Mr. Casten stated that promoting energy recycling was what he would call a blue box energy policy and believed that it was imminently politically possible to do energy recycling. He said the public understood the concept of recycling as something that would make them feel good and was also good for them.

Mr. Casten then explained his next slide and stated that the power plant shown was smaller and represented one of many power plants. He said that the same 100 units of fuel would be put into the smaller power plant. He explained that there were very short wires shown because the power plant was located right at the automobile factory or whatever factory it was that needed some thermal energy. He said that instead of throwing the heat away, it would be recycled and boiler fuel was displaced so that it stayed on the site. He said the net result was that the user would still get 33 units of electricity but they would also get 33 units of thermal energy. He said that was not a particularly good CHP plant. He stated that one of the ones that his colleagues had built was 97% efficient over all. He said that many would go up into the 80-85% range. He said that was what would happen if there was no waste heat. He said that an even better case would be if there was waste heat. He explained that there were many industrial plants in North Carolina that were in this category. He said this meant buying electricity and processed fuel and producing finished goods and waste energy. He said a plant could be put in to take the heat that was being thrown away and turn it into electricity, steam and hot water. He said that would be a savings of electricity purchases and of fuel purchases. He said there would still be the same amount of finished goods and no laws of physics had been violated and the waste stream leaving the plant had been lowered. He added that would also mean a cutting of costs.

Mr. Casten explained his next slide showing backpressure turbine-generators. He said that normally steam was made at high pressure to pack into a pipe and then when the point of use was realized, a pressure reducing valve was used to lower it down to the pressure needed. He said that was a spinning pressure reducing valve and it produced electricity at about 84% efficiency or better. But he said that in order to do that, local generation was needed and also needed was a set of rules that would allow that to happen and to capture some of its benefits.

Mr. Casten stated that the next slide showed a bigger example and said that of the 275 projects he had been involved with in the last 30 years he was probably proudest of that plant. He said that the plant was in northern Indiana, showing Chicago in the distance. He explained that there were 268 coke ovens at the plant that turned metallurgical coal into blast furnace coke. He explained that that was baked for 48 hours, which changed

the structure and all the bad stuff went away and hot exhaust came out of the top of the stacks. He called attention to all of the little stacks sticking up and to a car shown in the slide to show how huge this operation was.

Mr. Casten then said that the company, of which he had been chairman, made on average, about 65 mega lots of power and about 400,000 pounds of steam an hour out of nothing. He said there was no incremental fossil used and no incremental carbon pollution was created. He said that it was about 1.6 billion kilowatt hours of clean energy a year. He stated that in 2004 the solar collectors that were connected to the grids in the world generated 1.7 billion kilowatt hours of clean energy. He said that the plant shown in his slide generated almost as much clean energy as the solar collectors. He said some other differences were that the plant had cost $165 million as opposed to about $5 billion for the solar collectors. He said that the plant provided about 20 million dollars a year in savings to the steel company and that made that company a little more competitive. He said that markets didn't work.

Mr. Casten then said that he was showing the same chart he had just shown but that the scale had been changed and he said that it was the most important chart he would be showing. He said the scale showing electric efficiency that started at 3% and went up to 30% had been changed up to 100 and the reason was that these were some samples of the 275 plants that he and his colleagues had been involved in over the last 30 years...about $2 billion worth of plants. He said the worst of them was trice as efficient at making electricity, net of the heat credit, as the central generation. He said that he wasn't cherry picking and people might not understand how that would effect a country or a state so he gave an example. He said that Denmark was a rather low lying country and had been a little concerned about ocean rise, maybe a little earlier than some other localities, although North Carolina also had some pretty flat coasts. He stated that Denmark was approaching 60% efficiency and that 52% of their power came from local generation. He said that if someone might be thinking about costs in markets, that they should instead be thinking about the savings if their policies had driven them up to that kind of efficiency. He said instead what had been done was 45 years of sleepwalking.

Mr. Casten mentioned the recycling effect on the grid and stated that there were big problems with the grid now and that every day and every week, more money was being committed to it. He said that everyone was going to pay for this, that they were guaranteed by everyone unless someone didn't want electricity. He said that local generation reduced the grid. He stated that all power didn't have to go through long wires. He said that the power shown in the slide with the steel company didn't travel more than a mile and that it stayed right inside the steel company and lightened the load on the transmission grid and the line losses. He said it also stabilized the voltage and reduced the vulnerability to extreme weather and to terrorism. He said that it wouldn't be surprising if one of the next acts of terrorists was to blow up 5 or 6 transmission lines on a real cold day. He said then we could watch the country reel for months and months afterward. He said that most transmission lines were protected and had chain link fences around the outside. But he said that one 3 odd 6 armor piercing bullet would blow a transformer out and it would take 3 weeks to get it repaired. He said if there were lots of

sources of generation, vulnerability would be lost. He stated that only local generation could recycle energy. He said the waste heat simply wouldn't travel very far. He gave an example of putting hot water in a pipe and sending it 100 miles the end result would be ground temperature water, plus it would cost a lot of money to move it. He said that the exhaust heat from the coke ovens in the Indiana plant couldn't be moved 100 miles up the road or even 2 miles up the road. He said it had to be done right there on site. He said that people had to move out of the conventional notion that electricity was something that was made somewhere else and it had to be made where people worked.

Mr. Casten then addressed economies of scale and stated that skeptics claimed that local generation had some advantages but that big plants were just cheaper to build. Mr. Casten stated that big plants were absolutely cheaper to build and when that point was understood, then the rest of his presentation would be understood.

Mr. Casten stated that the International Energy Agency estimated that the average cost of central generation in the world last year was $890.00 a kilowatt. He said that his internal numbers from all that he had done said it would cost at least $1,200.00 or maybe even $2,000.00 a kilowatt to build local generation. He said that was the point...it would cost $310 extra dollars to build local plants. He then said that was a very good answer to the wrong question. He said that it shouldn't matter what the cost was at generation but what should matter was the cost of generation and delivery. He then said that if the delivery costs were added to the generation costs it turned out that transmission distribution in all the stations cost more than the generation. He said that $1,380.00 per kilowatt was the number from the most prominent study he had found and that several studies showed numbers in the same range. He said that local generation only needed 10% of that much and maybe only 5%. He said that would be quite a savings. He stated that a new kilowatt of central generation and wires could be built for $2,270.00 or a local generation plant could be built for $1,300.00 and he said that was a very big savings. But he added that the story was not over because when central generation was built it had to be built for the losses on peak and the losses on peak were above 20%. He said the average was 9% but on peak when more generation was needed, maybe it was a very hot day in July, the lines were like toaster wires and they would just bleed power. Secondly, and he said that was a little complex, but when there was a system based on a few large plants, there had to be much more capacity for redundancy than if there was a system based on many small plants. He said that academic studies had indicated that about 18% redundancy was run with the current system but if there were small systems they could be run with 5% redundancy and there would be the same reliability. So, he summarized that when all that information was combined, central plants of 1.44 kilowatts could be built or local plants of 1.07 kilowatts could be built and when the whole thing was done, it proved that more than 200% more than should be spent was being spent on electricity. He said that he predicted, with absolute certainty, that North Carolina would make decisions in the next 3 or 4 years to continue to do the same things as had been done in the past. He said that would mean authorizing new transition lines and the building of new central plants. He said there were many reasons for that, not the least of which was that if the politicians ever allowed the public to not have power then the politicians would be out of power so

they would always take the path of least resistance...the one that had worked. He said that unfortunately we needed to think a little more creatively.

Mr. Casten gave options using his next chart which showed the efficiency and the cost. He said that the bottom of the chart showed units per unit instead of BTUs per kilowatt. He said that the coal fleet in the US used 3.3 units of coal for every unit of delivered electricity. He said that up the side of the graph was the cents per kilowatt hour. He said the 5.5 cents was the amount paid by industrials and he said that he was concerned about raising that number because that would drive them offshore. He said the 8.1 cents was what consumers paid. He said he would like to show the options available today because the business had totally changed. He said that old plants were no longer grandfathered in and clean air was being required and scrubbers were being required on the coal plants. He said that it turned out that building a new coal plant would require about 10 cents a kilowatt hour. He said those numbers wouldn't be seen from the utilities because they would tell you at the bus bar but he said, once again, why would anyone care what the cost would be at the bus bar. He said people cared what the cost was at their homes or at their factories.

Mr. Casten said the new combined cycle gas turbine could be seen to be much more efficient and was just a little over 2 units of energy per unit of delivered electricity but because of the cost of the natural gas, it cost the same as coal. He said that everyone was talking about coal/gas figation or combined cycle gas turbines. He said they were very capital intensive. He said it did improve efficiency so from a point of view of if there were only two choices...an old coal plant or a new one...then put in the new one but know that prices would be jacked up to everybody. He said there would also be the concern of not being able to do all the other things needed to be done and the prices would go right up and industry would continue to leave.

Mr. Casten then said there were some other options. He said if renewable were installed, such as renewable wind, those costs would be something on the order of 10 or 11 cents. He said that people seemed to think that wind was being greatly subsidized but it was about the same price as a new coal plant. He said that coal gas with CO2 sesqusegation, which people think is a coming thing, would add another 7 cents to the cost so that would bring the cost up to 17 cents a kilowatt hour. He said that maybe down the road that needed to be done but in the meantime why not get the low hanging fruit, which was the recycled energy. He said that was balanced combined heat and power. He said it was putting in a gas turbine at some place, like maybe the legislative complex, that needed heat and cooling that would make electricity first and then combine the generation of heat and power. He said that would be more than 50% efficient and it would be able to sell, at a profit, at about the range of the current industrial price. He suggested that even better, if places could be found to recycle industrial energy the cost could go down to 2-3 cents and there would be negative fuel. He said that in the coke plant he had mentioned earlier, they had started with no fossil fuel but had taken the back end of the steam generated to offset more fossil fuel in the boilers so that negative fuel was credited to electricity. He said he believed those options to be the ones that should be pursued. He said that as a Commission, that was where 38% of the CO2 was and that was what needed the focus.

Mr. Casten then talked about the comparative deployment of combined heat and power around the world and our trading partners. He showed the US back at 7% and Canada at about 10%, because of their pulp and paper. He showed Portugal, China, Japan, Poland, and Germany at close to the 20% range and Russia, which had done a lot of combined heat and power, was even higher. He mentioned Finland, the Netherlands and Denmark, which was up at 52%. He said that the Alliance for Clean Technology suggested that the goal of the United States should be 30% combined heat and power and that that goal should be met as soon as possible. He said that there was no reason that the US couldn't reach that goal. He said that other nations had already done it and he mentioned that we didn't hear about the Danes not having a good life as they had the same kind of standard of living that we in the US had. He said the difference was that the Danes were just doing a smarter job.

Mr. Casten then called attention to where North Carolina was in terms of recycling energy. He said that graph showed the capacity in megawatts per capita per million people. He said that North Carolina was 22nd in the US and that meant that the state was about in the middle of the pack. He said that North Carolina should be better because the state was much higher than 22nd in terms of industrial output and that recycled energy should match industrial output. He said that other states had already done it and that North Carolina could move over in those directions with correct policies. He said recycling potential was in the steel industry with blast furnace gas and exhaust pressure drop and in refineries and chemical factories. He said that someone driving by a refinery at night would see a flare, which didn't look all that big because it was usually off in the distance. However he said marshmallows could be toasted at about 30 yards from those things as they were releasing enormous amounts of energy which was just going up into the air. He said that natural gas pumping station exhaust was another option. He said that North Carolina was crisscrossed by natural gas lines coming from the south going north to compressor stations and virtually every one of the compressor stations, powered by gas turbines, generated 1,000 degree exhaust and that exhaust was being thrown away. He said this was because the commissions and the electric utilities and others couldn't figure out how to take that 8-10 megawatts and put it into the grid...fossil fuel free. He said the rules in the state prevented it from happening. He spoke about pressure drops of gas from delivery points. He mentioned the city gate where the gas came into North Carolina and said that another megawatt of power could be made by taking the gas out. He mentioned glass, fiberglass, exhaust, sewage gas, landfill gas, and biomass, hog farms, things that Mr. Walsh had already mentioned. He stated that in Nepal there was a methane generator that handled one family and one water buffalo and provided enough methane for the cooking, the light, and to eliminate the wood gathering. He said that all process thermal users could do the CHP.

Mr. Casten then stated that clean technology needed to be defined and he said that people assumed that clean technology was renewable, which was true but he said there were also other kinds of clean technology as well. He said that ACT had defined clean technology, although it was arbitrary. He said it had been decided that clean technology was over 57% delivered efficiency. He said that PERPA required 43%. He said that ACT also

said that greenhouse gas emissions less than equivalent to burning one unit of coal per unit of delivered electricity. He said these requirements wouldn't be made using a coal plant but that some other kinds of fuel would need to be used. He said there were no limits on size, technology, fuel, or location. He said it was a performance standard that said the future should be made with cleaner technology and then gave a definition of it and stated the reason the definition was so important was because once there was a definition then there could be policies put forth that would encourage the market to go build the stuff. He said the reason the market didn't already do this was because there were two very major barriers to clean technology and they had been built in and there were huge vested interests that wanted to keep those barriers. He said that first of all there were all kinds of barriers to local generation such as the interconnection costs and hassle involved. He said that ACT said that if a new load was going to be put in, the utility would be hooked up and would get paid for overtime in the rate base, but if a CH2 plant were going to be put in and needed to be hooked back to the utility, the assumption was that it would be for the benefit of the new plant and that plant should pay all the costs. He said that study after study had indicated that the new CHP plant had a net benefit to society and the benefit back to the grid was 3 times the cost of the grid to serve it. So he said that was one of the hassles involved. Then he said there would be standby charges on top of that which would knock the money down. He said that could be fixed but he said there was anther part of the problem which was more less talked about but was very important and that was that many of the benefits of clean technology created were simply not available to the people who developed it. He said as a developer of clean technology plants he could say that those benefits could not be obtained. He said the Climate Exchange was welcomed because at least there was a way to go get $4.00 a ton for carbon, and some of his projects were a ton per megawatt. So he said that was an extra $4.00 per megawatt or 4/10 a cent per kilowatt hour. He said that T & D were then avoided. He said that when new central generation was built it would cost somewhere between 3 ½ and 15 cents to move that power to the user. He said that would be 15 cents for a very dense city and that 3 ½ was the average number. He said that when a plant was put in downtown Raleigh no credit was given and there was the same offer for power as if the same plant were located way out in the boondocks. He said this was done because of the assumption that everyone would need a wire. He said there was line loss avoidance when his type plants were put in...the line losses went down immediately but that there would be no payment for this.

Mr. Casten reminded the group that he had talked about Canada being 12 cents a kilowatt hour. He questioned if the numbers were half of that, which he said he really suspected would not be the case, but if so, that was still 6 cents a kilowatt hour and nothing got paid. He said that ACT proposed that to spur clean energy there were several things that could be done. He said that distribution utilities could be required to interconnect anybody who qualified as clean technology and tell them to put in rate base. He said this was a benefit to the public so why not socialize it and put it into the rate base. He said this would eliminate all the augment about the arcs and sparks and the fact that it couldn't be done. He said the utilities knew how to do the inter-connect and they knew how to stall a co-generator for two years by auguring about the dangers that would happen. He said just eliminate all that and put it in the rate base. He said there should be no stand by

charges. He said if power was needed it should be paid for at the same rates but there shouldn't be a special standby charge which was only there to prevent local generation.

Mr. Casten then said that changes in regulation should also be addressed so that the utilities wouldn't be as biased as they usually were. He said he wasn't trying to kill utilities but the rules just gave them a throughput bias. He said if those rules weren't changed the utilities would have to behave in the way the money led them. He said they were responsible to their shareholders too. He also said that clean technology should be permitted as pollution control. He said if a clean technology plant were to be put in, there could be a 6-18 month process of applying for a new source permit to put it in. He said if it was clean technology and if it were called a clean technology devise, it would be a very different permitting scheme and a lot more would get built. He said a state-wide standard offer for clean technology should be set up to satisfy the expected load growth and retirements. He said it should be expected to fill every bit of electricity needed in the state with clean technology and only build something else when there was no other choice. He said there should be no size or time limits involved. He said not to make the mistake of saying that a plant was 5 kilowatts or 5 megawatts or 10 megawatts or that it would only be good until the following August. He said to just put it out there. He said if a refinery could build a 400 megawatt plant that was clean technology then that was a good thing and should be encouraged. He said if someone else put in a 40 kilowatt little micro-turbine and it met the standards that should be encouraged too.

Mr. Casten said that ACT suggested that the wholesale price for power should be paid and to let it float...not to lock it in at all. He said that half of the calculated benefits that the clean energy produced should be paid. He said that included health effects, T & D savings effects and he said that if half those benefits were to be paid, then every developer in North America would be setting up offices in Raleigh and trying to do business in North Carolina. He said that would be bringing in private capital, creating construction jobs, etc. He said that people got what they paid for in this world. He said developers were not going to come in and lose money to create benefits that they weren't going to be paid for. He said if the benefits were split then the public would win and climate change would be mitigated.

Mr. Casten said that if the best was to be stimulated, which would be the recycling of waste heat, a standard offer wouldn't work. He said the problem was that there was a risk involved. He gave an example and said if a developer came to a plant and built it based on the heat coming off the silicone making process and if the initial silicone plant went out of business then the developer would be left with an expensive bunch of spare parts so there would be a risk for him to build. He said that there would also be a risk for the state. He said he would suggest that the state set up a mechanism to insure the risk of industrial shutdown. He said that Wall Street wouldn't finance plants. He said the reason there were 65,000 megawatts of untapped industrial recycling was that Wall Street was afraid to go and provide the money needed, and he said that because if the plant shut down it would be a non-insurable risk. He said the way to solve the problem was to provide a limited loan guarantee for new industrial energy recycling facilities that stated it would be payable only if the host factory ceased production for a certain period of time

and then the developer could put that plant with the state and ask for the depreciated book value. He said that would cover the risk of industry ceasing and it would create a virtual cycle. He said that the weakest industries couldn't get funding to do the recycling so it wasn't done. He said they would have the extra costs so that made them uncompetitive and finally the factory would shut down. He said if funding was provided, the factory would remain competitive and more people would be hired and more money would be earned to pay more income tax. He said that could trigger an industrial boom and although there would be some fail, there would be cost offsets because of the extra taxes and benefits that wouldn't have to be paid to unemployed workers, etc. He said that the benefits of encouraging both kinds of recycled energy would be that a lot of new investment would happen, a lot of new jobs created and that new revenue streams for industry and improved industrial competitiveness, and public sector gains from taxes would occur. He said that convening the Commission was terrific and that the state could become a real leader. He said the convenient truth was that energy recycling could solve multiple problems. He said that North Carolina could mine industrial waste energy and could create or add revenue streams for industry and could recycle to provide affordable clean energy, but he added that conventional thinking would have to be overcome and that was the hardest thing there was to do. He said the barriers to efficiency would have to be removed and every barrier protected some vested interest. He said that part of the T & D would have to be paid and the health care savings included in order to have this thing come forward and that would cause some accounting problems because it would come out of different departments. He said that the beauty of the Commission was that it could look broader than the Health Department or the Energy Department.

Mr. Casten said the last slide showed that Denmark on the left in 1985 looked just like North Carolina except for the shape of the map. He said there was a handful of very large power generating facilities. He said that in 20 years Denmark had moved to the map on the right just by changing their policies and encouraging combined heat and power plants and plants that recycled energy and wind. He said Denmark had created a boom in their wind industry and had created industrial things. He said the US bought product from Denmark because they were now better at it than what could be gotten here because they had a big enough market to have developed it. He said that North Carolina could be turned into a sort of a mini-industrial center for recycling energy by being a prime mover.

Chairman Hackney thanked Mr. Casten for his presentation and asked for questions.

Representative Harrison thanked Mr. Casten also, and said she had a couple of quick questions. She asked if other states had pursued the barrier removal avenue and asked for examples.

Mr. Casten answered that there was barrier removal activity going on in probably half the states. He said that Connecticut had eliminated the standby charges and was providing a $450.00 grant for new power to help built desperately needed new power lines. He said the northeastern states had an ISO that managed the grid and that group had said there was a locational benefit and new plants would be paid between $40.00 - $80.00 per

kilowatt per year to build new plants which would get to start with the new barriers. He said that New York had done extensive work to try and eliminate the inter-connect and FURK had held very long hearings to bring everyone to the table to try and come up with a standard interconnect. He said that the interconnect had been absolutely disastrous for his industry. He said that in Colorado the utility had five months to respond to a new design and if one change was required the utility had to make the change and then the state had five months to respond again. He said it usually took at least three of those cycles before an inter-connect was approved. He stated he believe that everyone doing it had gotten it wrong because there really wasn't a standard inter-connect. He said that it was just complicated and what happened was that there were Commissions made up of lawyers, political scientists, etc. who would argue with utility guys who were electrical engineers. He said that approach just didn't work. He suggested that the inter-connection be socialized by telling the utilities to put it in a rate base and then money could be earned from it. He said that California had done standard offers and was absolutely the most successful state in encouraging cogeneration. He said that many people all over the world were having the same problems and were all chipping away at the issues. He said this Commission had a chance to chip away at the whole batch at once. He said that ACT didn't propose a Chinese menu.

Representative Harrison then asked if the plants required new source review or would trigger new source review.

Mr. Casten answered that what had happened over the past 30 years was that the environmental policy had said they would grandfather everybody who existed at their point of permitting and assumed that it would be like automobiles and that 11 years later they would be gone. He added that after that time everybody new would be required to come up to the current technology. He said that was a disastrous mistake. He said that that had given power plants immortality because the plant would just keep renewing the permits forever. He said that unlike automobiles, power plants could be run for 50 years. He said that what had happened was that if a new plant was put in now, 2006 standards would have to be met and then the power would have to be sold in competition with some other plant that was meeting no standards. He said that was finally changing. He said the Clean Air Interstate requirements were making all the power plants dump money on and many were now spending more money for pollution controls than the plant had cost. He said in the meantime, a clean plant still had to go through an environmental review, announce that it was a new source etc. and go through a long complicated expensive process and it made small plants uneconomic because the transaction costs were so high. He said if it was clean technology then it should be called a pollution control devise, and a hearing should be held and everyone should be asked if anyone objected to putting in a pollution control devise. He said if that was done then 30 days later there would be a permit for the plant.

Representative Harrison stated her belief that the source review was implemented at the state level so maybe there would be some flexibility there.

Mr. Casten stated that most of the rules were at state level.

Chairman Hackney stated that here were still two more presentations and he asked that any further questions and answers be kept brief and he called on Senator Pittenger for a question.

Senator Robert Pittenger thanked Mr. Casten for his presentation and then asked about a business plan for the businesses that Mr. Casten had discussed. He stated that if they were to embrace what Mr. Casten had outlined then wouldn't they be very successful? He said if that was the case, based on models such as Denmark's, then why would there be a requirement of guarantees to go to Wall Street to find capital, if those business models had so much upside potential? He asked why not just let the free market help them go find the required capital?

Mr. Casten replied that he would love to let the free market do it but the rules didn't let the benefits flow through. He said that companies typically wouldn't do that, that it wasn't their core competency because they were looking to outside third parties. He said the outside third part would look at the plan and would have to make a bet as to whether that company would be around for a long time to come. He said the fact of the matter was that out of about 80 thousand megawatts of potential, 10 thousand had been built and 70 thousand hadn't been built. He said he believed the reason that 70 thousand hadn't been built was because of the risk issue.

Chairman Hackney then called on Dr. Eggers for a question.

Dr. Eggers then asked about the term "inter-connect" and asked if that meant a new plant coming online.

Mr. Casten answered that inter-connect was the connection made to the grid. He said that nobody wanted to stand alone. He said that if plants went down, there needed to be backup and plants wanted to be able to buy and sell and go back and forth. He said because electric utilities were monopolies they had the ability to say that no one could inter-connect except by their standards.

Dr. Eggers asked about a reference by Mr. Casten of a study done in Ontario that did a full cost accounting of prices of electricity.

Mr. Casten answered that he couldn't give that reference off the top of his head but that he would get that information to Dr. Eggers and to the Commission.

Dr. Eggers next asked if there was some policy group that could provide some help on wading through the ocean of details that it would take to straighten out some of the policies in North Carolina.

Mr. Casten stated that the Sierra Club had agreed with him at the Clinton Global Initiative that the Club's main activity would be to promote ACT and that ACT had already engaged with the Sierra Club on that issue. He also mentioned that World Wildlife, Environmental Defense, and Greenpeace were all looking at those things and he

believed that any one of those groups would be happy to help. He said that they were all supporting combined heat and power.

Chairman Hackney then called on Mr. Ivan Urlaub.

Mr. Urlaub said that he could appreciate Mr. Casten's comments about the vulnerability of the grid. He asked if Mr. Casten could talk about the state of the US grid. He said that a lot of benefits had been discussed but that there seemed to be an 800 pound gorilla in the closet that no one had talked about, either here or in the southeast which was about the cost of keeping the grid up, must less about expanding it for new facilities.

Mr. Casten responded that the grid was enormously vulnerable. He said that most of the power for the country's big cities came through two or three 500 MVA transformer stations and they sat around the edge of the cities and they couldn't be rewound or repaired locally, they had to go off to a factory and they could be taken out with one armor piercing bullet. He said that was a way that terrorists could destroy our economy and not have to commit suicide. He said the lines that went back and forth were an intense web of lines and if a couple of those lines were dropped going across a river at a time when loads were peaking, especially in the winter, inordinate problems would result because most of people's heating systems wouldn't run without electricity. He said even if the heating units were oil fired, they still needed electricity. He said that even without the terrorist problem there had been 250 outages in the US since 2000 that had affected more than 5,000 people. He said everyone knew about the big outage that blacked out 50 million people. He said the rest of the blackouts tended to be ignored because they were considered to be "acts of God". He asked the question that if a tree branch dropped on a line and the system failed was that because of the fallen tree branch or was it because the system was so under-built and so over taxed? He said there was a problem in making the lines better because it was just getting harder and harder and harder to get the necessary rights-of-way to build transmission. He said that was the one thing that was absolutely going up in price and would continue to go up in price. He said if things weren't done about any other problems we would strangle ourselves trying to continue to have a system that could go through the grid. He said he didn't see a technical fix for the problem except for moving the power generation closer to the users.

Chairman Hackney thanked Mr. Casten for his provocative report and for coming to speak to the Commission.

Chairman Hackney stated that the Commission had heard about co-generation and those possibilities and that the next speaker had been doing that successfully for some time. He then introduced Mr. Raymond E. DuBose, the Director of Energy Services Department at the University of North Carolina at Chapel Hill. **Exhibit H**

Mr. Dubose thanked Chairman Hackney for his introduction and stated that his presentation would be a shorter one. He restated that he was the Director of the Energy Services Department, which was responsible for all of the energy supply and the utilities on the UNC-Chapel Hill campus. He said he had given similar presentations around the

country at various conferences and he said that he had known Tom Casten for several years. He stated that it was a personal and professional thrill and an honor to give his presentation about what was being done in Chapel Hill to such a distinguished group.

Mr. Dubose said that he would be giving an overview of the energy supply systems at UNC-Chapel Hill. He said he would talk about that cogeneration facility, which was the kingpin of the combined heat and power system at the university. He said that he would also be talking about the university's chilled water system. He said that chilled water was just that ... cold water. He said the cold water was made in central plants using refrigeration equipment and it was not too dissimilar from a refrigerator or a window air conditioner. He said that cold water was then pumped around campus and was used to air condition the buildings. He said he would also be speaking a little bit about combined heat and power performance.

Mr. DuBose stated that a district energy concept was used at UNC-Chapel Hill and explained about that concept. He said district energy was when thermal energy, in addition to electrical energy, was distributed throughout the system. He said there were central plants for the production of steam and there was an underground steam distribution system which reached all the buildings on central campus. He said there was also a central chilled water system. He explained that there were five central plants, which distributed water to large underground piping and then to the campus buildings. He said that an important factor was the fact that the university owned its distribution system and that it was an integral system with generation but they also purchased from Duke Energy. He said the campus facility generated about a third of the power used on campus and the remaining two thirds was purchased from Duke Energy.

Mr. DuBose said that he would use the terms cogeneration and combined heat and power interchangeably. He said that cogeneration was the term he had grown up with when he first went into the energy business back in the mid 70's. He said cogeneration was a term that was coined back in the Jimmy Carter days when the county was going through the energy crisis of the 70's. He said, however, the term most commonly used in the present time was combined heat and power. He stated that the meaning of the term at UNC-CH was the simultaneous generation of steam and electricity. He said the reason that was used at UNC-CH was that it had a very high thermal efficiency and he said he would go into that in a little more detail later in his presentation. He also said there was a low environmental impact from that usage.

Mr. DuBose restated the information given by Mr. Casten that the average US power plant had a thermal efficiency of about 33-35% at best. He said the combined heat and power system at UNC-CH had a thermal efficiency of about twice that amount or about 70%, which meant that their system got about two times the amount of usable heat from a unit of fuel burned.

Mr. DuBose said that on the UNC-CH campus, the combined heat and power concept had to do with the close relationship of steam, electricity, and chilled water. He said steam

was used to generate electricity and that it took electricity to generate steam and that chilled water could be generated using either steam, electricity, or both.

Mr. DuBose stated that the high pressure boilers in the UNC cogeneration facility generated steam. He said that steam went through a turbine and a turbine turned a 28 megawatt generator. He explained about the 28 megawatts by saying that the UNC campus peak demand for electricity last summer was about 80 megawatts. So, he said, the 28 megawatts was about a third of the peak campus demand. He said that electricity went out onto the campus grid and combined with the two thirds of the electricity which was purchased from Duke Energy. He further stated that the boilers generated high pressure steam and that the steam passed through the turbine and rather than condense it as utility power plants would do, the UNC-CH facility extracted the steam from the turbine and used it for the heating and cooling of all the buildings on the campus. He said hot water was generated for the residence halls, such as water for bathing, and also the steam was used to sterilize surgical instruments in the hospital and used to sterilize laboratory equipment in the research labs. He added that the steam was also used for cooking and for dish washing in the dining halls.

Mr. DuBose said that from an aerial view of a co-generation facility, as Mr. Casten had stated, the perception was that power plants were dirty and noisy. However, he said that the UNC-CH facility was in a very quiet neighborhood in Chapel Hill. He said that although there had been some problems with noise, about 99% of the time the facility was extremely quiet and was a major energy facility operating very successfully in a quiet neighborhood.

Mr. DuBose said that coal was primarily burned in the UNC-CH facility and that in the past 12 months, 98% of the fuel requirements had been met with coal. He said that natural gas and oil were also used but only as backup fuels. He said the UNC-CH boilers didn't do well by using only gas or oil.

Mr. DuBose stated that the UNC-CH facility used a technology that called for circulating fluid out of bed combustion to burn coal or CFB combustion that reduced the Nitrous Oxides (NOx) and Sulfur Dioxides (SO2), which was the purpose of the technology. He said Nitrous Oxides were reduced by controlling the furnace temperatures and he explained that the UNC-CH furnace temperatures operated at about 1500 degrees Fahrenheit, where typical coal combustion was done at about 2300 degrees Fahrenheit and above. He said that Sulfur Dioxide was also reduced in the university system by adding a sorbent into the combustion chamber with the coal. He said the sorbent was typically limestone and was a high calcium carbonate material which caused the calcium and the limestone to combine with the SO2 from the coal combustion process to form calcium sulfate, which precipitated with the ash from the coal.

Mr. DuBose again stated that the university facility was a very clean plant and was operated under the new source performance standards that were promulgated back in 1986. He said the university had been very successful in compliance with those

standards, which called for at least a 90% reduction of the potential SO2 0.6 pounds of NOx per MMBtu input and it had limits for opacity in particular.

Mr. DuBose stated that the next thing he was showing was a viewport into the combustion chamber. He said the orange glow was the coal actually burning and the orange color was indicative of the 1500 degrees Fahrenheit. He said that low temperature combustion meant that the material had to be held in the combustion chamber for a much longer period, so the plant was relatively tall at about 12 stories or 120 feet. He said the reason for the height was primarily the combustion chamber which had to be large enough to hold that coal burning for some period of time.

Mr. DuBose talked about the five central chilled water plants, two of which used steam to generate chilled water. He said the chilled water was then distributed through very, very large bore underground pipes and was pumped all over campus to air condition the buildings. He said that to do that either electricity or steam could be used.

Mr. DuBose said that he was next showing a picture of the university's north chiller plant in the Bell Tower parking lot. He said there were about 50,000 tons of chilling capacity in the university's central plants. He said there were about 7500 tons of steam absorption chillers and the chiller plant shown had about half of that steam absorption capacity.

Mr. DuBose then mentioned that one of the university plant's efficiency tools was the thermal energy storage system that was just completed earlier in the year. He said that he believed there was a similar one under construction just down the street from the Legislative Office Building. He said the university's tank was very large, about 130 feet tall by 80 feet in diameter and that it held over 4 million gallons of water. He stated that the water was cooled at night when the electric prices were low and then the cold water was used during the daytime to air condition the campus buildings. He said the tank had been operated very successfully last summer. He said the Gary Tompkins chilled water operation center was in the foreground of the picture he was showing, with the thermal storage tank in the background. He said the chillers in that particular plant were purchased and matched very well to the charging requirements for the tank.

Mr. DuBose stated that the UNC-Chapel Hill power plant purchased power from Duke Energy on a real-time pricing rate, which meant that Duke sold the university plant their power at Duke's cost so that the pricing varied. He said the cost could be high during the day and relatively low at night. He said that was the economic advantage for the operation of the university's thermal storage system. He said that it was not just the thermal storage but it was the overall ability to provide immediate response to pricing signals that allowed the university to use that purchase rate to their advantage. He said it was a combination of the steam absorption chillers and the thermal storage. He stated that the past summer the university power system was able to clip about 10 megawatts off the peak load using just the thermal storage system. He said it was, of course, the cogeneration of electricity.

Mr. DuBose then discussed the CHP performance. He said a recent study that a consultant had done showed that the value of the university's electric generation operation or combined heat and power performance was about $6 million in the year of the study. He said the value of the electric rate the university power plant was on, due to the operation of the generator, was about $2 million a year over and above the next best rate that the university might operate on if it weren't for their combined heat and power system.

Mr. DuBose stated that the UNC-CH power plant had been recognized several times by the EPA's Energy Star combined heat and power program for their combined heat and power system. He said the award was a certificate of recognition that was received for superior environmental performance of the university's combined heat and power system in the year 2000.

Mr. DuBose said that in 2003 the UNC-Chapel Hill power plant received the Energy Star Award for combined heat and power and that award was for significant fuel savings. He said the UNC-CH system wasn't competitive but that they were beating the criteria that the EPA had set. He said that the university plant had submitted 12 consecutive months of operating data and had qualified for those recognition awards from their actual performance data.

Mr. DuBose added that last year the UNC-Chapel Hill power plant had received a Combined Heat and Power Partner Greenhouse Gas Reduction Report award for the fact that the plant had produced about 230 tons of carbon equivalence less than separate heating and power plants. He said that was equivalent to about 1600 acres of forest or about 1100 automobiles.

Mr. DuBose said he was very proud of what the UNC-Chapel Hill power plant facility was doing and that they were only about 25 miles down the street so he welcomed the Commission members to come and see his facility and said he would be glad to give tours of the facility. He then asked for questions.

Senator Janet Cowell asked about one of the later power points showing the overall value at $6 million per year. She wanted information about the amount of capital investment in the plant and how that was calculated with the operation value.

Mr. DuBose answered that the plant had been built in the late 80's. He said construction was begun in 1988 and the plant was taken over from the contractor in January 1992. He said the cost was about $10 million for the generation equipment and the overall project was a $99 million project that built the boilers and some electric substation equipment and some chiller plant absorption chillers...the steam absorption chillers at the North Chiller Plant in that project. He said there was an additional $10 million or so invested in the higher pressure that was needed to generate power...making it a total investment somewhere in the neighborhood of $20 million out of the $99 million project. He said he believed he could answer Senator Cowell's question by putting it in perspective. He said studies in the mid 80's showed there would be a pay back for the cogeneration option of

about 5 years. He said that didn't happen and it was calculated that the system wasn't paid back that quickly but that it had taken about 10 years instead. He said that in the mid 80's the projection was that electric rates would increase and, of course, electric rates from the late 80's into the 90's actually stayed about the same because electric utilities were trimming back due to the threat of deregulation.

Chairman Hackney asked if the UNC-Chapel Hill power plant had investigated selling credits on the Chicago Climate Exchange.

Mr. DuBose answered in the negative and said that it was probably a good idea.

Chairman Hackney said it sounded as though there were some credits that could be sold. He then called on Dr. Stephen Smith.

Dr. Smith said he would like to know how many CHP operations there were in the State of North Carolina and if an analysis had ever been done to show the potential there could be for the state.

Mr. DuBose answered that he was not aware that any such study had been done. He said that as Mr. Casten had stated, most of the facilities were industrial. He said he had seen, at one time, that there were 50 plants which used combined heat and power technologies.

Chairman Hackney then asked if any other universities were doing what UNC-Chapel Hill was doing.

Mr. DuBose answered that most of the larger universities around the country were doing it.

Chairman Hackney asked specifically about North Carolina.

Mr. DuBose answered that he wasn't aware of any other North Carolina university that was doing it.

Chairman Hackney asked for other questions and said he was sure that some of the Commission members or guests would be showing up at Mr. DuBose's door to get his promised tour and he thanked Mr. DuBose for his presentation.

Chairman Hackney introduced the final speaker, Mr. Michael Cogsdale, President of the North Carolina Council of Churches and Rector of St. James Episcopal Church in Lenoir, North Carolina, who delivered the remarks as set out in his prepared statement which was distributed to the member of the Commission and which is attached to the minutes as **Exhibit I**

After the conclusion of Reverend Cogsdale's presentation, Chairman Hackney thanked him and asked for questions or comments.

Dr. Stanley Riggs congratulated Reverend Cogsdale and the NC Council of Churches for embracing the earth and said he had a question. He said that with respect to the Council of Churches and the position that Reverend Cogsdale had just presented he wondered if Rev. Cogsdale might be in contact in any form or fashion with the more conservative and more fundamental religious groups in North Carolina, who might not have the same attitudes.

Reverend Cogsdale answered that the short answer to that question was probably not.

Dr. Riggs then said it seemed to him that it was very critical for everybody to buy into this. He said it was everyone's earth and that Rev. Cogsdale represented 1 ½ million people and Dr. Riggs stated his belief that Rev. Cogsdale was in a very prime position to help open some doors. He said that Dr. E. O. Wilson, one of the world's great ecologists, had just written a beautiful book on the Creation and on the rate of lost of species on the surface of the earth. Dr. Riggs stated that Dr. Wilson had written the book as a letter to the fundamental preachers of the country. Dr. Riggs recommended that Rev. Cogsdale read the book. Dr. Riggs stated his belief that it was absolutely essential that everyone had a responsibility of trying to reach the rest of the religious community with respect to educating them about the earth. Dr. Riggs thanked Rev. Cogsdale for having the position that he had on the issue.

Rev. Cogsdale agreed with Dr. Riggs and thanked him for his remarks.

Chairman Hackney then called on Ms. Susan Tompkins.

Ms. Tompkins thanked Reverend Cogsdale for being willing to attend the Commission meeting and present his remarks. She then asked what people of faith should practically be doing, except maybe changing the types of light bulbs they used and carpooling.

Rev. Cogsdale answered that people should get involved with groups such as the Commission and should educate themselves and make their voices heard in terms of what their concerns were in their local communities. He said people should educate themselves about the problems and about the issues and involve themselves in the legislative process.

Chairman Hackney again thanked Rev. Cogsdale and announced that the normal agenda had been concluded except for Commission discussion and announcement and asked if anyone had any announcements.

Chairman Hackney stated that Mr. Givens had already announced the date of the next meeting as being on Friday, January 12 at 10:00 a.m.

Chairman Hackney recognized Dr. Stephen Smith, who said he wanted to briefly update the Commission members on the fact that at the request of the Commission Chairs, he had drafted a letter in response to the provisions about energy efficiency and renewable energy at the federal level for agriculture and forestry. He said that he had gotten the

letter to them late last week and that they hadn't had time to review it. He said that would continue to be deliberated upon. He said that he also wanted to engage anyone else on the Commission who might be interested in seeing the letter in draft form. He said that he would make sure that Bob and Mitch received a copy of the letter. He said that he would, hopefully, have something for the group to review by the next meeting in January.

Chairman Hackney said the Commission would also be talking about recommendations and all suggestions, particularly those pertaining to win-wins that would create jobs and reduce greenhouse gases and save energy, etc. He asked the group to be thinking about that and to feel free to circulate anything that needed to be circulated prior to the next meeting.

The meeting was adjourned at 1:40 P.M.

Representative Joe Hackney Presiding Co-Chair	Genie Clark Committee Assistant

EXHIBIT A	Meeting Notice
EXHIBIT B	Meeting Agenda
EXHIBIT C	Visitor's Registration
EXHIBIT D	Copy of "*Spotlight*" article entitled "The Science Is Settled" by the John Locke Foundation.
EXHIBIT E	Copy of presentation by North Carolina Treasure Richard Moore on the responsibilities of the State Treasurer's Department, a summary of the state pension fund, information about Ceres, Investor Network on Climate Risk (INCR), Corporate Governance approach to problem of climate risks and available tools and projects, information on how insurance companies were dealing with the problem of climate changes, information on what was being done to encourage companies to cut down on carbon emissions and to report results.
EXHIBIT F	Copy of presentation by Dr. Michael Walsh, Senior Vice-President of the Chicago Climate Exchange. This showed the options for reducing greenhouse gases, rationale for emissions trading, the growing CCX family, size of possible greenhouse gas markets, an explanation of the CCX and its members, reasons for becoming members of CCX, CCX market architecture, CCX registry, CCX trading screen, CCX emission offsets program and concept, defining CCX offsets: principles, stable, predictable offset rules contributing to successful GHG mitigation financing, CCX price and volume history. CCX progress, conclusions, and views.
EXHIBIT G	Copy of presentation by Mr. Tom Casten with the Alliance for Clean Technology and the Founder and former CEO of Trigen & Primary Energy. This presentation included the Commission's mission, introduced the Alliance for Clean Technology (ACT), an inconvenient truth, conventional central approach data, US electric efficiency 1900-2005. better electric generation options, ACT's "convenient truth" of energy recycling, explanation of recycled energy, decentralized generation option of combined heat and power, industrial energy options, backpressure turbine-generators, industrial energy recycling, energy recycling impact on the grid, economies of scale, future generation options, comparative deployment of combined heat and power in 2004, installed recycled energy capacity per capita, NC industry recycling potential, ACT definition of clean technology, barriers to clean technology, ACT proposals to spur clean technology, stimulating

	recycling of industrial waste energy and benefits, and changes in Denmark.
EXHIBIT H	Copy of presentation by Mr. Raymond E. DuBose, Director of Energy Services Department at UNC-Chapel Hill. This presentation discussed energy supply systems, cogeneration definition and concept, chilled water systems, thermal energy storage, and CHP performance
EXHIBIT I	Report presented by The Reverend Michael H. Cogsdale, President of the North Carolina Council of Churches, and Rector of Saint James Episcopal Church, Lenoir, North Carolina.

General Assembly of North Carolina

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

State Legislative Building
Raleigh, North Carolina

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

THELMA UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

GENIE CLARK
COMMISSION CLERK
1117 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-7850

JENNIFER R.F. MUNDT
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JESSICA M. DICAPUA
COMMISSION ASSISTANT
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

4 January 2007

Transmitted via electronic mail to debra@hernandezandcompany.com and hand delivery.

Debra Hernandez
President
Hernandez and Company
1105 Palm Boulevard
Isle of Palms, South Carolina 29451

Re: Presentation to the Legislative Commission on Global Climate Change

Dear Ms Hernandez:

This will confirm our understanding of your discussions with Jim Stephenson regarding your invitation to appear before the Legislative Commission on Global Climate Change (Commission) at its meeting on Friday 12 January 2007. The meeting is scheduled to begin at 10:00 a.m. and will be held in Room 643 of the Legislative Office Building in Raleigh, North Carolina. We anticipate that the meeting will last until mid afternoon.

In 2005, the General Assembly enacted legislation 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." (S.L. 2005-442).

The Commission consists of 34 members, nine appointed by the President Pro Tempore of the Senate, nine appointed by the Speaker of the House of Representatives, and 16 members or their designees that represent a variety of industries, organizations, and academic institutions.

I have attached the current Commission membership and the authorizing legislation to this letter for your review.

The 12 January 2007 meeting will be the fourth meeting of the Commission during this legislative interim and will include at least the following agenda items:

1. A comprehensive five-member panel presentation on the effects of global climate change as they relate to coastal adaptation including:

   (a) Discussion of coastal vulnerability to erosion, storm hazards, and potential sea-level rise.

   (b) Presentation of the National Academy of Sciences report *Mitigating Shore Erosion along Sheltered Coasts*.

   (c) Discussion of the projected impacts of global climate change on coastal ecosystems in North Carolina.

   (d) Discussion of the implications of sea level rise for coastal development policy.

2. 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, including a discussion of proposals currently under consideration by DENR's Climate Action Plan Advisory Group.

Your role in the meeting on 12 January is to present item 1(b) listed above. You should plan a presentation of approximately 20 minutes. Because there will probably be numerous questions from members of the Commission, I anticipate that the total time devoted to your presentation may be as much as 30 minutes. Note however, that I expect that the total time for item 1 will not exceed two hours.

The Commission will reimburse you for travel expenses for surface transportation to your airport of departure and from that airport to your home or office upon your return; round trip coach class airfare to Raleigh, North Carolina; surface transportation from Raleigh-Durham International Airport to your hotel and return; and one round trip between your hotel and the Legislative Office Building in downtown Raleigh. The Commission will reimburse you for up to two nights of overnight lodging if required and for meals at the rate allowed for employees of the State of North Carolina while in out-of-state travel status. We will need documentation in the form of original receipts for airfare, lodging expenses, and surface transportation, so please save your receipts for those. Receipts are not required for meals because the reimbursement amount is fixed. If you wish to submit a request for reimbursement, please provide Thelma Utley or Genie Clark, the Commission Clerks, with your social security number prior to or at Monday's meeting.

Please bring at least 75 copies of any written materials that you wish to distribute to the Commission. In the alternative, we will be happy to make copies here if you will provide us with an electronic copy of the written materials or a clear original of any handouts by noon on Thursday 11 January. A PowerPoint projector, laptop computer, and screen will be available in the meeting room. PowerPoint presentations are not expected, but are welcome. If you use either, please provide us with both a hard copy and an electronic copy of your slides or presentations as soon as possible, preferably before the end of the day on Thursday 11 January 2007 so that the slides or handouts can be assembled in advance of the meeting. You may also bring your presentation on a jump or key drive, or on a CD and locate Jennifer Mundt before the start of the meeting. Please let Ms Mundt (jennifermu@ncleg.net) know by Friday Thursday 11 January if you plan on using PowerPoint during your discussion.

We appreciate your willingness to attend this meeting and look forward to your presentation to the Commission. Please feel free to contact me if I can be of any assistance in connection with your appearance before the Commission.

Respectfully yours,

George F. Givens
Commission Counsel

cc: Representative Joe Hackney, Co-Chair
John L.W. Garrou, Co-Chair
Jeff Hudson, Commission Counsel
Jennifer McGinnis, Commission Counsel
Susan Iddings, Commission Counsel
Jennifer Mundt, Commission Analyst
Jessica DiCapua, Commission Assistant
Genie Clark, Commission Clerk
Thelma Utley, Commission Clerk
Jim Stephenson, North Carolina Coastal Federation
Rodney Bass, General Accounting Supervisor

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PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

JENNIFER R.F. MUNDT
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

AGENDA

10:00 a.m. Monday 11 December
Room 643 Legislative Office Building

1. Call to order
   Representative Joe Hackney

2. Introductory remarks by Cochairs
   Representative Joe Hackney
   John. L. W. Garrou

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

4. The investment policy of North Carolina as it relates to global climate change
   Richard H. Moore, State Treasurer
   North Carolina

5. Discussion of the Chicago Climate Exchange's greenhouse gas emission registry and reduction and trading system for greenhouse gases, including a discussion of the benefits to North Carolina agriculture of methane capture offsets at animal operations
   Michael J. Walsh, Senior Vice President
   Chicago Climate Exchange

6. Discussion of combined heat and power (CHP) as a method of reducing greenhouse gas emissions and increasing energy efficiency
   Thomas R. Casten, Founder and Chair
   Alliance for Clean Technology and founder and former Chief Executive Officer of Trigen Energy and Primary Energy Ventures

   Raymond E. DuBose, Director
   Energy Services Department, University of North Carolina at Chapel Hill

7. Perspectives on global climate change from the faith community of North Carolina
   Michael H. Cogsdale, President
   North Carolina Council of Churches and Rector at St. James Episcopal Church in Lenoir, North Carolina

8. Commission discussion and announcements

9. Adjourn

SCHEDULE OF FUTURE MEETINGS:

Below is the schedule of meetings of the Legislative Commission on Global Climate Change prior to the convening of the 2007 Regular Session.

Commission Meeting	**Location**
10:00 a.m. Friday 12 January 2007	643 Legislative Office Building

COMMISSION WEBSITE:

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

http://www.ncleg.net/committees/legislativecomm_/default.htm.

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.

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — 12-11-06

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
James Southerland	NC DAQ/DENR Raleigh James.Southerland@NCmail.net
Kathy Kaufman	NC DAQ/DENR Raleigh Kathy.Kaufman@ncmail.net
Charles O. Davis	NC DAQ Charles.O.davis@ncmail.net
Sharon Thoud	State Energy Office
Eric Fletcher	Dept. State Treasurer
Julie White	DST
Leslie Kleczek	Nicholas Institute, Duke University
Maximilian Merrill	NCDA+CS
Jane Lucy	St. Ambrose Episcopal
The Rev Lorraine L Jungeson	St Mark's Episcopal Church
JOHN GOODMAN	NCCBI

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION
Name of Committee **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Jack Floyd	NC Utilities Comm - Public Staff
Tom Lam	NCUC - PUBLIC STAFF
Daniel Miller	NC Council of Churches
RAY DuBOSE	UNC CHAPEL HILL
Larry Shirley	NC State Energy office
SAM WATTS	N.C. Center for Public Policy Research
Paul Sherman	NC Farm Bureau
Bill McAulay	PSNC Energy
Kathy Hawkins	Progress Energy
Shawn N. McKenzie	NC DST
Lisa Schneider	NC DST

VISITOR REGISTRATION SHEET

Name of Committee **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
JUNE SMALL	NC ELECTRIC MEMBERSHIP CORP.
Ted Frazer	N.C. Council of Churches
Jane Dan	NC Council of Churches
Alice M Loyd	NC Council of Churches/Interfaith Power & Light
Linda EADES Rodriguez	NC Council of Churches / Interfaith Power & Light
Robert GASTON RODRIGUEZ	NC Council of Churches / InterFaith Power AND Light
JAMES MAUNEY	NCCC/IP+L
Barbara Janeway	NCCC / Unity Center of Peace Church
Carol Meyer	Foundation for Earth Science
PAGE BLACKWELDER	Hunton & Williams
Sara M. Stohler	St. Mark's Episcopal Church

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — 12-11-06

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
David Renii	N&O
C Kirkpatrick	Observer
[illegible]	[illegible]
Cullen Browder	WRAL-TV
Frank Bell	Friend of Norway President WEBS - Waste Elimination Biosthil Systems Inc
DAN CRAWFORD	Electricites of NC Raleigh NC
Sara Nienow	Dept. of Commerce
Beth Henry	Carolinas Clean Air Coalition and Myers Park Baptist Church - Charlotte
[illegible]	Env. Defense/ISACE
Deatrice Williams	CUCA
Caroline Ham	Lt. Gov's Office
Jim Harlan	Global Warming Initiatives

VISITOR REGISTRATION SHEET

Name of Committee _____ Date _____

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Tommy Stevens	NEPC

John Locke FOUNDATION

200 W. Morgan, #200
Raleigh, NC 27601
phone: 919-828-3876
fax: 919-821-5117
www.johnlocke.org

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spotlight

No. 304 – December 10, 2006

The Science Is Settled

North Carolina Can Have No Impact on Climate Change

SUMMARY: **There is a consensus on global warming, but it is not the consensus that environmental groups and many in the media suggest. There is no consensus on the extent of future climate change or the extent to which current climate change is human induced or a result of natural variation. The true consensus — where there seems to be no disagreement whatsoever among scientists — is on the proposition that there is no public policy currently being considered to restrict carbon dioxide (CO_2) emissions by any level of government, including the State of North Carolina, that would have a measurable impact on the climate, either in the short or the long run (a century or longer). That proposition so far remains undisputed.**

There is a scientific consensus on global warming, but it is not the consensus that environmental groups and many in the media suggest. There is not a consensus on the extent of future climate change; particulars of the actual trend data tend to be inconsistent with both the theory and predictions of greenhouse warming.[1] Furthermore, the extent to which current climate change is human induced or a result of natural variation is also disputed. For example, a 2005 study in the *Geophysical Research Letters* argues that the sun contributed as much as 50 percent of the global warming that occurred between 1900-2000.[2]

The true consensus — where there seems to be no disagreement whatsoever among scientists — is on the proposition that there is no public policy currently being considered to restrict carbon dioxide (CO_2)[3] emissions by any level of government, including the State of North Carolina, that would have a measurable impact on the climate, either in the short or the long run (a century or longer). That proposition so far remains undisputed.

Even Kyoto Wouldn't Do It

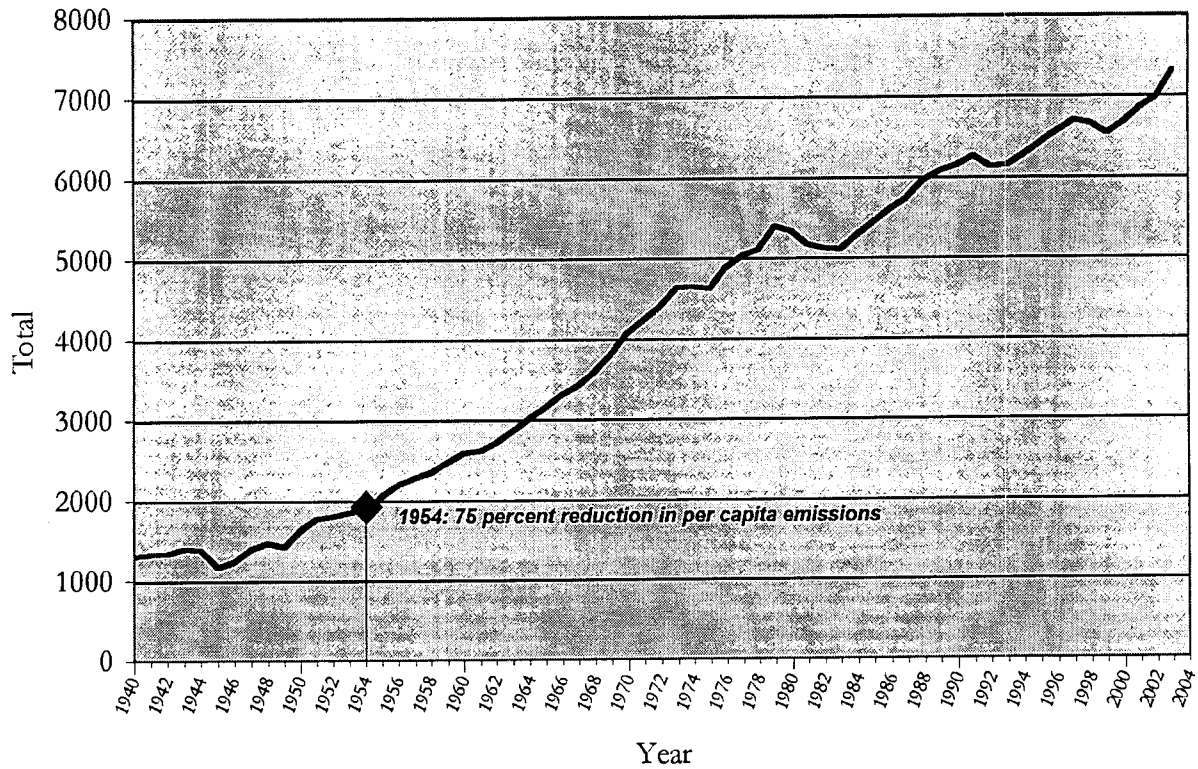
> [B]oth sides seem to agree that even full implementation of Kyoto would have a relatively small impact on greenhouse gas emissions or global climate change.
> — George Givens, Counsel to N.C. Climate Commission[4]

The highly touted United Nations' Kyoto Protocol, advocated by nearly all

more >>

Figure 1. Global CO_2 Emissions from Fossil Fuels and Cement Production, 1940-2003

(In millions of metric tons of carbon per capita)



climate-change alarmists, would have a trivial impact on global temperatures, and even that wouldn't occur for over a century. As was noted in a previous John Locke Foundation *Spotlight* report,[5] climatologist Thomas Wigley, himself a pessimist regarding the consequences of future global warming, has done the definitive study on this issue. He estimated that over the next 100 years the U.N. treaty, *even with 100 percent compliance,* would bring about only a trifling, 0.26-degree Fahrenheit reduction in the increase in global temperatures over what would occur if nothing were done.

Wigley's estimates are undisputed even by North Carolina's most vocal global-warming alarmist and global climate commission member, Dr. William Schlesinger, dean of Duke University's School of Environmental Science. Writing in *The News and Observer* (Raleigh), Schlesinger stated that "climatologist Wigley is right about Kyoto."[6]

These conclusions regarding Kyoto are important in the context of policies being considered by the state of North Carolina. This is because nothing that the Commission is considering even approaches the CO_2 emission reductions called for by Kyoto.[7] In fact, even California, which recently adopted the most intense restrictions on CO_2 emissions in the country, does not and will not have emission reductions that would come close to complying with what would be its share of Kyoto CO_2 reduction requirements. Unfortunately, most of the commissioners are unwilling to be informed by any of this and continue to advocate CO_2 reduction strategies in full knowledge that these forced reductions will not benefit a single citizen of North Carolina either currently living or yet to be born. It's equivalent to the drunk looking for his lost keys under the nearest streetlight, not because that's where he lost them, but because that's where the light is.

As an aside, Professor Schlesinger is an exception to the commission as a whole. He actually suggests that North Carolina go well beyond the Kyoto greenhouse-gas-reduction requirements. After acknowledging Kyoto's lack of impact on climate change, he argues that "we should devise an alternative that can stabilize the concentration of carbon dioxide in the atmosphere within the next couple of decades."[8]

Dr. Jerry Mahlman, also a global-warming alarmist and a climate scientist from the National Center for Atmospheric Research, states quite clearly what that would mean. To stabilize the concentration of CO_2 in the atmosphere,

"every person in the world would have to ... cut [fossil fuel consumption] by 75 percent." He further concludes that "that's a horrific number if you think about everything you do: whether it's talking on the phone, or driving our cars, or heating or cooling our homes."[9]

To put Mahlman's calculation into perspective, a 75-percent reduction would force each person in the world back to the levels of CO_2 emissions and the levels of oil, gas, gasoline, and coal consumption of the early 1950s (see Figure 1). For the United States, this was a world without computers, microwave ovens, or air conditioning; homes that were on average less than half the size they are today; and home entertainment systems that for most families did not even include a television. Most of the rest of the world at this time did not even have indoor plumbing or electricity widely available. The fact is that nothing being considered by the state of North Carolina, even if done in conjunction with the entire world, approaches this level of CO_2 reduction, which Mahlman rightfully suggested would be "horrific."

Ignoring Reality

None of this should be news to the N.C. Climate Commission. Over the past year, the Commission has heard from several prominent climate scientists, none of whom disputed the fact that the policy recommendations the Commission would come up with — either taken separately or in conjunction with other states — would have any impact on short-term or long-term temperatures. Those were scientists who disagreed on the underlying projections regarding the extent to which human-induced global warming would be a problem.[10] In light of this consensus among those scientists, it would seem that the logical thing for the commission to do is to wrap up its work and write a final report discussing that fact. The report might make an acknowledgment like the following:

> This commission heard testimony from prominent scientists regarding the future severity of global warming and its likely causes. They expressed a wide range of opinions on these issues. But one point came through loud and clear: regardless of the extent or severity of future global warming, there is no policy that the State of North Carolina could implement that would change the course of future climate change.

But making such an acknowledgment is not what is occurring. The commission will instead be considering a laundry list of possible policy prescriptions, all of which would ultimately alter the lifestyles of North Carolinians (see Table 1 for a selection of policies that will be under consideration[11]). In other words, the commission is looking to a host of policies, most of which would impose costs on and restrict the liberties of businesses and citizens of North Carolina, in full knowledge that none of the policies will have any benefits in terms of their ultimate goal — averting or ameliorating climate change.

So what is the argument in favor of pursuing this apparently irrational, "we must do something" strategy? Commissioner Schlesinger explained it with an analogy. He suggested that doing nothing about reducing CO_2 emissions was analogous to doing nothing with respect to helping the victims of Hurricane Katrina. He stated, "I could use the same logic to avoid sending a contribution to relieve the suffering in New Orleans. With this philosophy, contributions from North Carolina will make only a trivial difference to the total cost of cleanup, so why bother?"

But that analogy breaks down before it gets started. People know that collectively all of their efforts and donations will indeed have a measurable impact on the goal of helping the victims of the hurricane. Even a $100 contribution has the measurable effect of buying $100's worth of food or supplies for people in need. On the other hand, if it were clear that none of the donations would reach their intended beneficiaries and would therefore not help a single hurricane victim, it would indeed be irrational to make donations to the cause. It is the latter situation that would be truly analogous to North Carolina pursing policies to reduce CO_2 emissions.

Would the Katrina analogy work if North Carolina were to take Professor Schlesinger's advice and make the attempt to reduce per-capita CO_2 emissions by 75 percent? Dr. Mahlman argues that the earth would still warm by a full degree over the next 100 years even if the entire world were to adopt this "horrific" policy.

Going back to the Katrina example, how rational would it be for someone to make radical sacrifices in their lifestyle today — sacrifices that might include self-impoverishment — in the full knowledge of the fact that even if the same sacrifice were made by everyone else, its impact on the recovery of New Orleans would be very minimal and

would not be felt for a 100 years? In other words, what if the action would not help even a single one of the victims of Katrina, or their children, or probably even their grandchildren? Yet the kind of logic that many on the N.C. Climate Commissions are trying to foist on the citizens of North Carolina is even more strained than that, given that nothing the commission will suggest would have any impact at all.

As Professor Ed Erickson, N.C. State economics professor and climate commission member suggested, "it could turn out to be the functional equivalent to the Mayans sacrificing virgins."[12]

Table 1. Proposed Recommendations by the Dept. of Environment and Natural Resources to Address Climate Change in N.C. (partial list)
*Presented to the N.C. Legislative Commissions on Global Climate Change**

New Taxes
CO_2 tax
Legislative changes requiring the NC Utility Commission to consider environmental and other factors (this is a hidden tax embedded in electricity rates)
Public Benefit Charge on electricity bills for funding efficiency activities (tax)
Vehicle Miles Traveled Fee (tax)
Fuel Tax
Regulations and subsidies meant to manipulate lifestyle and energy usage choices
Demand-side management programs for the residential, commercial and industrial sectors (this refers to the demand for energy)
Energy efficiency requirements
Building energy codes
"Beyond code" building design incentives and mandatory programs, incorporating local building materials and advanced construction
Smart growth bundle (policies meant to encourage high density living arrangements and discourage more spacious low density living)
Improve transit bundle (typically this implies large expenditures on light rail)
Tailpipe greenhouse gas standards
Anti-Idling
Renewable energy incentives (biomass, wind, solar, geothermal, hydro)
Environmental portfolio standard (renewables and energy efficiency) with renewable energy credit trading (in most states this is paid for through higher electricity rates)
Cap and trade (this is a plan to indirectly ration the use of fossil fuels, i.e. gasoline, oil, and coal, by rationing CO_2 emissions)

** Groupings, headings, and bracketed statements are by the author.*

Economic Growth and Adaptation

While there is nothing North Carolina can do to change the future course of climate change, there are things that the state can do that will allow its citizens to prepare itself for the effects of possible future global warming, regardless of whether alarmists or optimists are correct about the scientific debate.

Since the beginning of mankind people have had to deal with the extremes of weather. What has allowed us as a species to overcome extreme heat, cold, snowstorms, hurricanes, etc., and live comfortably both at the equator and in Alaska is prosperity. In this context, probably the most important legacy that we can leave to future generations in terms of their ability to deal with the forces of nature (however mild or severe they would be) is a durable and useful capital stock in an economic system that allows entrepreneurs the flexibility to invest that capital in ways that will best accommodate people's desires for comfort in their surroundings.

It is this capital stock that future generations will both draw on and build upon in developing new technologies that will allow us to ameliorate and be sheltered from the effects of weather conditions. The fact is that our generation and the generations immediately preceding ours have been able to live more comfortably in the face of weather extremes because of the capital investment and technological advancements of the generations that have preceded us. Here are just a very few examples:

- ***Air Conditioning.*** Many argue it is responsible for the economic boom in the southern states like North Carolina.
- ***Widespread, Inexpensive Central Heating.*** This phenomenon of the last 100 years has allowed us to popu-

late the coldest regions of the north.

- ***Modern Building Techniques.*** They have made durable housing that can withstand earthquakes, high winds, and heavy rain and snowfalls.
- ***Modern Meteorological Science.*** Satellite tracking and radar allowed us to forecast weather events further in advance and make appropriate accommodations.
- ***Automobiles.*** They have given people the ability to move out of the way of oncoming weather more quickly and have allowed emergency response to adverse weather events to be much swifter.

All of these great developments have come about because of the capital investments of previous generations, made largely by entrepreneurs operating in a free market. What that means for policymakers in North Carolina is that the best thing they can do is help create an economic environment — a tax code, a regulatory system, and a property-rights regime — that will allow researchers and entrepreneurs to react to the future course of climate change and climate events in the same way they have in the past.

It should be noted that that would also include removing government subsidies from those who choose to live in areas prone to natural disasters, especially along the coastline. Those would include subsidized flood and wind insurance and subsidized loans and direct subsidies for rebuilding after disasters. The reason why the damage associated with hurricanes along the North Carolina coast is so much greater today than it was 50 or even 25 years ago is due not to global warming or an increase in the severity of storms, but to the fact that there has been a massive influx of new residents and coastal development. This, in turn, is at least partly the result of massive subsidies that coastal residents receive that shelter them from the full costs of their decision to live in more hazardous areas. The subsidy increases the amount of development, which in turn increases the amount of damages due to storms. People should be allowed to live wherever they choose, but they should also be forced to bear the costs of their decisions through private insurance that fully reflects the risks associated with their choices.

Conclusion

North Carolina's policy decision is not between preventing global warming or creating the economic conditions that will allow us to adapt to it. To pursue a strategy of global-warming prevention or CO_2 mitigation is tantamount to doing nothing in terms of helping real people deal with real problems associated with the vagaries of weather. In fact, to the extent that these policies restrict economic growth and retard capital formation, they will actually be counterproductive.

The strategy of adaptation through economic growth is the only strategy that is rational and that holds any real promise of generating benefits or alleviating suffering over any reasonable time frame. Sea levels along the North Carolina coast have been rising for centuries and will continue to rise at similar rates, and hurricanes have been plaguing this region forever. Every dollar that is used to pursue a CO_2 mitigation strategy — which can have no impact on natural occurrences — is a dollar that cannot be used to deal with these pressing problems directly and immediately.

The real choice is between a strategy that holds no promise of working and a strategy that both history and economic analysis show *does* work to provide the technological advancement and the wealth and capital that certainly will be needed over the next 50 to 100 years if the alarmists are right in their predictions about global warming. If they are wrong, then there is nothing lost. Economic prosperity is a wonderful thing to draw upon in the face of adversity, but it is even better when that wealth can simply be used to improve our standard of living.

Dr. Roy Cordato is vice president for research and a resident scholar at the John Locke Foundation.

Notes

1. For a summary of the theory and predictions of the global warming hypothesis and how they coincide with actual data, see Joel Schwartz, "Climate Change Science, Policy, Politics," www.joelschwartz.com/pdfs/Schwartz_IEA_111406.pdf.
2. N. Scafetta and B.J. West, "Estimated solar contributions to the global surface warming using the ACRIM TSI satellite composite," *Geophysical Research Letters*, Vol.32, 2005.
3. To clarify, carbon dioxide is a gas that is essential for all life on earth. It is exhaled by humans and "inhaled" by plants. Furthermore, it is not toxic or harmful if inhaled by humans at any relevant concentration levels. Its alleged negative effects come through its hypothesized impact

on future climate change. In other words, there is no reason other than climate change to restrict emissions of the gas.

4. Email to climate change commission member Senator Robert Pittenger, September 26, 2006.
5. Roy Cordato, "State Can't Change the Weather: Even global CO_2 reductions have little impact," John Locke Foundation *Spotlight* No. 277, January 18, 2006, found at www.johnlocke.org/spotlights/display_story.html?id=124. The data is from Thomas Wigley, "The Kyoto Protocol: CO_2, CH_4 and Climate Implications," *Geophysical Research Letters*, July 1, 1998
6. William H. Schlesinger, "A cooperative climate," *The News and Observer* (Raleigh), February 3, 2006, p. A15.
7. Kyoto calls for the United States to reduce emissions to 7 percent below 1990 levels. Even the targets recently adopted by California, which are the toughest in the nation, do not approach this goal.
8. *Op. cit.* at note 4
9. Jorge Salazar, "Interview: Straight talk about Climate Change. Jerry Mahlman on Dealing With Your Grandkids' Problem," *Earth and Sky*, www.earthsky.org/shows/observingearth_interviews.php?id=49567.
10. It should be noted that the climate scientists testifying before the commission all took more optimistic positions with respect to future climate change, while those scientists with no particular expertise in climatology, meteorology or related fields all held what might be called pessimistic or alarmist views regarding future global warming.
11. At a recent forum, this author asked Department of Energy and Natural Resources (DENR) Secretary William Ross if any or even all of DENR's proposals enacted together would have any impact on future climate change. He acknowledged that they would not. (Annual meeting, Carolina Air Pollution Control Association, October, 2006.)
12. Addressing a meeting of the Climate Commission, as reported in the *New Bern Sun Journal,* October 4, 2006, www.newbernsunjournal.com/SiteProcessor.cfm?Template=/GlobalTemplates/Details.cfm&StoryID=30274&Section=Local.

Addendum

The source for graph in Figure 1 (page two) is the Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee, cdiac.ornl.gov/trends/emis/glo.htm.

North Carolina Treasurer
Richard Moore

Legislative Commission on
Global Climate Change
December 11, 2006

Responsibilities of Department of State Treasurer

- Serve as state's chief banker and investment officer
- Serve as fiduciary for almost $75 billion in public monies and state investments
- Oversee pension fund for 700,000 public sector employees and retirees
- Assist local governments in debt management and maintenance of strong financial health
- Administer unclaimed property program

Summary of Pension Fund

- 9th largest *public* pension plan in United States
- 1 in 8 working North Carolinians is a member of the retirement system
- Ranked as #1 pension fund in nation (*Governing* magazine)
- Ranked as second strongest pension fund in nation (Wall Street Journal)
- Includes over $70 billion in assets for more than 700,000 active and retired members
- Includes 7 pension systems:
  - -Teachers and State Employees
  - -Local Governmental Employees
  - -Firemen and Rescue Squad Workers
  - -Registers of Deeds
  - -Legislative
  - -Consolidated Judicial
  - -National Guard

Basic Assets Overview

Pension Assets Under Management: $70 billion

■ Public Equities (Stocks)	58%
■ Fixed Income (Bonds)	35%
■ Real Estate and Alternatives	<5%

Origins of Corporate Governance movement

- Enron, WorldCom
- Auditor independence
- Excessive executive compensation
- Director independence
- Split Chairman/CEO position
- Proxy access
- Better corporate governance results in better value for shareholders

Investment Protection Principles

Effective July 1, 2002, every money management firm retained by a State Investment Officer, as a condition of future retention, must abide by a set of rules requiring:

- Disclosure of client relationships,
- Disclosure of analyst and manager compensation methods,
- Disclosure of commissions paid to broker-dealers,
- Safeguards to ensure that client relationships of affiliate companies do not influence a manager's investment decisions, and
- Consideration of financial statements, auditor independence and corporate governance standards

Mutual Fund Protection Principles

January 15, 2004

The MFPP provide protection for shareholders in four areas:

Shareholder Returns
- Billing
- Fees

Manager Reform
- Compensation
- Ownership
- Sale of Funds

Board Reform
- Independence
- Meetings & Resources

Fund Disclosure
- Holdings
- Trading Costs
- Soft Dollars
- Professional Staff

Institutional Investor Summit at the United Nations

- Original convener of the Summit.
- The Summit was convened for stakeholders to share information regarding the significant financial risks posed by climate change.

- FIRST SUMMIT
- November 21, 2003
- 200 participants
- Over $1 trillion in assets

- SECOND SUMMIT
- May 10, 2005
- 400 participants
- Over $5 trillion in assets

Ceres

- Investors, environmental groups and other public interest groups that have come together to work with companies on sustainability issues.
- Issues could cover wide range, like diminishing water supply or biodiversity, but the major focus now is easily global climate change.
- Which is why, during first UN Summit, INCR was formed.

Investor Network on Climate Risk

- INCR was formed at the first UN Summit in 2003
- Originally had 10 investors with $600 billion in assets
- Today has over 50 investors with $3.7 trillion in assets
- Financial risks and investment opportunities from climate change

What can we accomplish through Corporate Governance?

- Evaluation and disclosure of climate risks
- Disclosure of energy efficiency measures
- Companies set GHG emissions targets
- Companies reduce GHG emissions
- Strategies to capture opportunities in low-carbon world
- Strategies to capture opportunities in renewables market
- Disclosure of contributions relative to science of climate change
- Disclosure of impact of climate policy uncertainty

What tools are available?

- Letters to companies
- Meetings with boards of directors
- Shareholder resolutions
- Drafting disclosure templates
- Media pressure
- Nominating Directors
- Withholding Director votes

Projects through INCR

- Working on specific sectors
- Oil & Gas – e.g. ExxonMobil
  - Physical, regulatory and business risks
  - Disclosure of greenhouse gas emissions
  - Disclosure of potential costs from new regulations on emissions, less cheap energy
  - Opportunities from development of new energy technologies, renewable sources
  - Stop funding bad science on climate change

Insurance Companies

- NC is also part of insurance working group
- Different risks
  - Physical
  - Regulatory
- Best position to identify and evaluate risks, apply across board, public policy debate
- Following up with those who didn't respond to letter
- National Association of Insurance Commissioners (NAIC) Task Force

Success Story

- NC was part of a group of investors that sent letters to the top 30 insurance companies seeking information on climate risk policies.
- AIG is a large insurance company that received the letter.
- In May, 2006, AIG became the first U.S. insurance company to adopt a climate change policy.
- AIG Global Investment Group joined INCR in October, 2006.

Carbon Disclosure Project

- International coalition
- Coalition has written 4 letters already, working on next
- Going to over 3000 companies seeking carbon disclosure data
- Members follow-up with companies

Proxy Voting Guidelines

- Big part of corporate governance is voting proxies
- Can cast votes for resolutions related to climate change
- There are third party services that help to vote the proxies, but that also provide recommendations to large institutional investors
- Working with them to set guidelines relating to climate change disclosures

Most Recent Activities

- Filed shareholder resolution with ConocoPhillips: Seeks a report on company's efforts regarding renewable energy sources. (Nov. 28, 2006)
- Working to attract new partners: Staff spoke about NC activities at Chicago conference to audience including representatives from other state, city and union pension funds. (Dec. 7, 2006)

Chicago Climate Exchange

Briefing to the North Carolina Legislative Commission on Global Climate Change

December 11, 2006

Michael Walsh Ph.D.
Senior Vice President
Chicago Climate Exchange
312-554-3380

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Many Options for Reducing Greenhouse Gases

- Lower carbon fuel: natural gas, CO_2 neutral fuel (biomass)
- More efficient fuel use: MPG, lighting, insulation
- Methane capture/combustion
- Abatement devices, alternative chemicals
- Carbon sequestration:
  - reforestation, carbon accumulation, preservation
  - agricultural soils
  - geologic

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Rationale for Emissions Trading

- GHGs mix, cause warming throughout common global atmosphere
- Proven tool, with flexibility to meet a global problem: find least-cost means of reducing emissions anywhere in the world
- Clear and enforced emission limits
- Reduce cost to society of achieving specified emission limits: static efficiency at each point in time
- Harness capital markets to efficiently deploy new technologies
- Clear, market incentives to innovate: dynamic efficiency, improvement over time
  - **President Bush had proposed CO_2 cap-and-trade for power plants in his first campaign**
- **Numerous GHG cap-and-trade legislative proposals are circulating in the U.S. Congress, with sponsors as diverse as Senators McCain, Lieberman, Feinstein, Bingaman, etc.**

Chicago Climate Exchange®

The Growing CCX Family

Chicago Climate Exchange (CCX)
- Launched 2003 with 14 members, now 220+ members (US, CA, MX, BR, NZ, AU, CH)

European Climate Exchange (ECX)
- FSA-regulated futures market for European CO_2 Allowances
- Launched April, 2005 – accounts for 80-90% of total exchange traded volume in the EU ETS

Chicago Climate Futures Exchange (CCFE)
- CFTC-regulated futures exchange for U.S. SO_2 allowances
- Launched in December 2004, world's first environmental derivatives exchange

Montreal Climate Exchange (MCeX)
- Joint-venture with the Montreal Bourse
- To host Canadian GHG trading, other environmental markets

New York Climate Exchange™ and Northeast Climate Exchange™
- Developing instruments for northeast Regional Greenhouse Gas Initiative (RGGI)

Indian Climate Exchange
- Partnership with the Multi-Commodity Exchange of India
- In development

Chicago Climate Exchange®

"Business Increases pressure on G8 to set up global emissions trading system"

"Steve Lennon, chair of the environment and energy commission of the International Chamber of Commerce, which represents hundreds of thousands of companies in 130 countries, said:

"We see a global system of emissions trading as inevitable"

Financial Times, June 10, 2005, page 1

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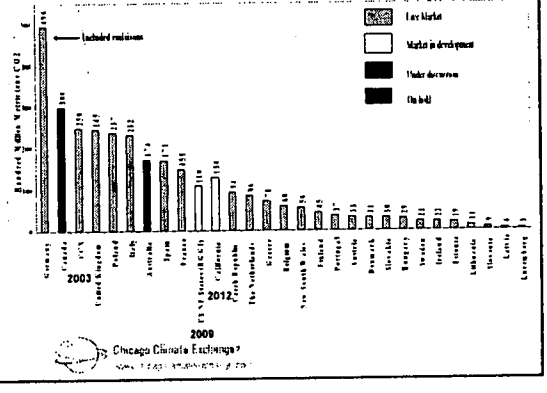
Size of Live, Emerging, Possible GHG Markets



Chicago Climate Exchange®

What is Chicago Climate Exchange?

Chicago Climate Exchange (CCX®) is the world's first and North America's only voluntary, legally binding greenhouse gas reduction and trading program for emission sources and offset projects in North America, Brazil and elsewhere.

Chicago Climate Exchange®

CCX Advisory Committee

Honorary Chairman
The Honorable Richard M. Daley, Mayor, City of Chicago

Warren Batts, former CEO, Tupperware Corporation, Mead.
David Boren, President, The University of Oklahoma; former governor of Oklahoma and U.S. Senator
Ernst Brugger, President, Brugger, Hauser & Partner
Paula DiPerna, former President of the Joyce Foundation
Elizabeth Dowdeswell, former Executive Director, UN Environment Program
Jeffrey Garten, Dean, Yale School of Management
Lucien Bronicki, Chairman, ORMAT International
Donald Jacobs, Dean Emeritus, Kellogg Graduate School of Management,Northwestern University
Jonathan Lash, President, World Resources Institute
Joseph Kennedy II, Chairman, Citizens Energy Group, former U.S. Representative (MA)
Israel Klabin, President, Brazilian Foundation for Sustainable Development
Bill Kurtis, Journalist and television producer
Thomas Lovejoy, President, Heinz Center, formerChief Biodiversity Advisor the World Bank
David Moran, President, Dow Jones Indexes
R.K. Pachauri, Chairman, Intergovernmental Panel on Climate Change
Michael Polsky, President and CEO of Invenergy
Leo Rosenthal, former Chairman, Chicago Board of Trade
Donna Redel, former Executive Director, World Economic Forum
Maurice Strong, former United Nations Under-Secretary General
James Thompson, Chairman, Winston & Strawn, former fourterm Governor of Illinois
Sir Brian Williamson, Chairman, London International Financial Futures Exchange
Robert Wilmouth, President and CEO, National Futures Association
Klaus Woltron, Austrian entrepreneur and Vice President of the Vienna Club
Michael Zammit Cutajar, former Executive Secretary, UN Framework Convention on Climate Change

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Chicago Climate Exchange Members

Aerospace and Equipment
Rolls-Royce

Automotive
Ford Motor Company

Beverage Manufacturing
New Belgium Brewing Company

Chemicals
Dow Corning
Dupont

Electric Power Generation
American Electric Power
Central Vermont Public Service
Duquesne Light Company
Green Mountain Power
Manitoba Hydro
TECO Energy, Inc.

Electronics
Motorola, Inc
Square D/Schneider Electric N A

Environmental Services
Waste Management, Inc

Food Processing
Premium Standard Farms

Forest Products Companies
Abitibi-Consolidated
Aracruz Celulose, S A
Cenibra Nbo Brasileira S A
International Paper
Klabin S A
MeadWestvaco Corp
Stora Enso North America
Temple-Inland Inc

Information Technology
IBM

Manufacturing
Bayer Corporation
Interface, Inc
Ozinga Bros, Inc

State & Local Governments
The State of New Mexico*
King County, WA*
City of Aspen
City of Berkeley
City of Boulder
City of Chicago
City of Oakland
City of Portland*

Pharmaceuticals
Baxter International Inc

Universities
The University of Iowa
Michigan State University
The University of Minnesota
The University of Oklahoma
Tufts University

Recreation
Aspen Skiing Company

Retail
Safeway Stores

Semiconductors
Freescale Semiconductor
STMicroelectronics

Steel
Roanoke Electric Steel Corp

Transportation
Amtrak
San Joaquin Regional Rail Commission

*In process
State of Illinois has announced

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CCX Associate Members

Architecture/Planning
Mithun Inc

Brokerage Services
Ameres Energy

Consulting
Domani, LLC
Global Change Associates
Natural Capitalism, Inc.
RenewSource Development LP
Rocky Mountain Institute

Documentary Production
Cleveland Inc

Energy and Management Services
Orion Energy Systems Ltd
Sieben Energy Associates
Thermal Energy International

Engineering
Rumsey Engineers, Inc.
Vanasse Hangen Brustlin, Inc

Financial Services
Access Industries, Inc.
MB Investments, LLC

Financing Agencies
Ohio Air Quality Development Authority

Green Power Marketers
Green Mountain Energy Company

Information Technology
Open Finance LLC
Intercontinental Exchange

Legal Services
Foley & Lardner, LLP
Sullivan & Cromwell LLP

Non-Governmental Organizations
American Coal Ash Association
American Council on Renewable Energy
Delta Institute
Houston Advanced Research Center
Midwest Energy Efficiency Alliance
World Resources Institute

Private Colleges
Presidio School of Management

Risk Management
The Professional Risk Managers' International Association

Religious Organizations
Jesuit Community at Santa Clara University

Renewable Energy
Arrticity
Intergy
Rehnewco, Ltd

Retiring/Offsets
Carbonfund.org
Terrapass Inc

Social Investment
KLD Research & Analytics
Pax World

Technology
Millennium Cell
Polar Refrigerant Technology

Trade Associations
Confederation of British Industry

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CCX Participant Members

Offset Aggregators
C-Green Aggregator LLC
Delta Institute
Environmental Carbon Credit Pool LLC
Environmental Credit Corp
First Capital Risk Management LLC
Iowa Farm Bureau
National Carbon Offset Coalition
North Dakota Farmers Union

Offset Providers
Beijing Shenwu Thermal energy Trading Co., Ltd
Intrepid Technologies Inc
Lugar Stinch Farm
Precious Woods Holdings
Sustainable Forestry Management Ltd

Liquidity Providers

AGS Specialists, LLC
Ameres Energy
Breakwater Trading, LLC
Calyon Financial, Inc
Cargill Power Markets LLC
Eagle Market Makers LLC
Evolution Markets, LLC
IDX Investments
FCT Europe, Ltd.
First New York Securities, LLC.
Friedberg Mercantile Group, Ltd

Gatlore International Master Fund, LP
GFI Securities LLC
Goldenberg, Hehmeyer & Co
Grand Slam Trading, Inc
Grey X Environmental Fund, LP
Hatley Capital Management
ICAP Energy, LLC
Kolitz Associates, LLC
The Leogue Corp
Marquette Partners LP
Natsource, LLC

Peregrine Financial Group
Rand Financial Services Inc
Serino Trading Co
Shatkin Arbor, Inc
S R Energy, LLC
SwissRe Financial Products Corp
TEP Trading 2 Ltd
TradeLink, LLC
Tradition Financial Services Ltd
TransMarket Group LLC

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Why do Companies Become CCX® Members?

Practical drivers:

- Competitive advantages through leadership:
  - obtain practical expertise through "hands-on" participation
  - build institutions: first-mover; global linkages
  - get ahead of disparate regulations, prepare for policy
  - reduce long-term mitigation costs
  - improve focus on energy efficiency, identify free savings
  - build carbon price into minds of operators and planners
  - trading profits, possible early action crediting

Chicago Climate Exchange®

Why do Companies Become CCX® Members?

Strategic drivers:

- Reputation advantages: customers, employees, regulators
  - Major value of corporate goodwill
- Create shareholder value:
  - $2.3 trillion in socially responsible investments
  - Monetize emission reductions and sequestration
  - Save money by paying attention!
- Corporate risk management:
  - fiduciary responsibility: manage exposure
  - corporate governance concerns
  - reduce legal risks

Chicago Climate Exchange®

Carbon markets and cutting-edge energy policy go hand-in-hand

"I declared New Mexico "the Clean Energy State' in a 2004 executive order, based not only on our tremendous wind and solar potential but also on our aggressive new policies to encourage energy efficiency and clean energy development."

... governors... around the U.S.don't have to sit on their hands.Like major corporate partners who recognize the threat of climate change, they can make the binding commitment to the Chicago Climate Exchange, and move our nation forward to a new energy and emissions future.

"I decided to sign up the state of New Mexico"
Chicago Climate Exchange®

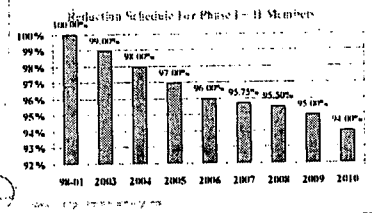
CCX Market Architecture (2003-2010)

Phase I: Members made legally binding commitments to reduce or trade 1% per year from 2003-2006, for a total of 4% below baseline.

Baseline = Avg. emissions from 1998-2001, emissions in 2000 (Phase II)

Phase II: Members make a legally binding commitments to reduce to 6% below baseline by 2010.

Economic Growth Provision limits recognized emission increase to 2% above baseline in 2003, 2004, 3% above baseline 2005-2010

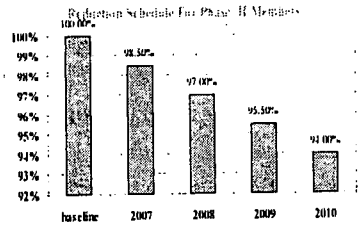


CCX Market Architecture: Phase 2 Only

Phase II: Members made legally binding commitments to reduce or trade 1.5% per year from 2007-2010, for a total of 6% below baseline.

Baseline = Avg. emissions from 1998-2001 OR emissions in 2000

Economic Growth Provision limits recognized emission increase to 3% above baseline 2007-2010



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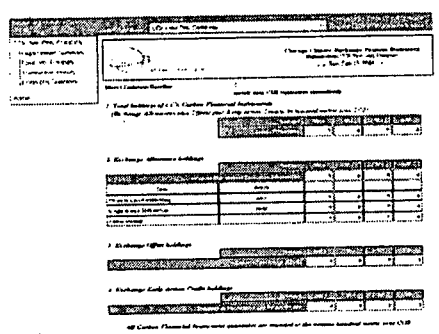
CCX Registry



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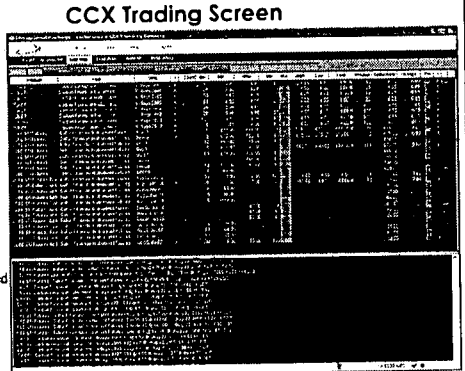
CCX Trading Screen



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CCX Emission Offsets Program

- Verified Offset projects sequester or eliminate GHGs and earn Carbon Financial Instruments that can be sold to other CCX members.
- **Pre-defined offset projects:**
  - Carbon sequestration: reforestation, agricultural soils
  - Landfill and agricultural methane destruction
  - Renewable energy, fuel switching, energy efficiency
  - Independent verification by authorized entities: SGS, DNV, First Environment, BvQi
  - Others in development

SES Field Inspector conducting soil sampling in no-till corn

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Emission Offsets Concept

- Get emission reductions from sectors/activities/locations not included in cap-and-trade portion of the system
- Offsets issued for doing better than baseline
  - "with project" situation has lower emissions /higher sequestration than "without project"
- Low-cost mitigation
- Economic development and opportunity (e.g. CDM goals)
- Broaden engagement
  - more players involved in action/trading
  - help prepare for deeper participation (caps?)

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Defining CCX Offsets: Principles

- **General provisions:**
  - Conservative crediting
  - Reserve pools for sequestration assurance
  - All Carbon Financial Instruments are equivalent
  - *Compliance through use of Offsets can be no more than half the required program-wide cut*
- **Project Eligibility:**
  - Predictability: facilitate carbon finance
  - Other than "Business as Usual": beyond regulation, rare (e.g. best-in-class), recent
  - Verifiable: eligibility, quantities, ownership
  - No cherry picking – emitters must take entity-wide reductions
  - Avoid perverse incentives: avoid encouraging bad acts

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Defining CCX Offsets: Principles

- **Target Actions with Major Mitigation Potential**
  - Non-CO_2 gasses: low-cost, multi-benefit
  - Agriculture: soils hold 183 years of global CO_2 emissions
  - Forestation: forests hold 75 years of global CO_2 emissions
  - Advance broader societal goals: sustainable agriculture and forestry, energy efficiency, renewables

Minnesota dairy farmer receives first check from sales of methane-destruction CCX Offsets

Chicago Climate Exchange®

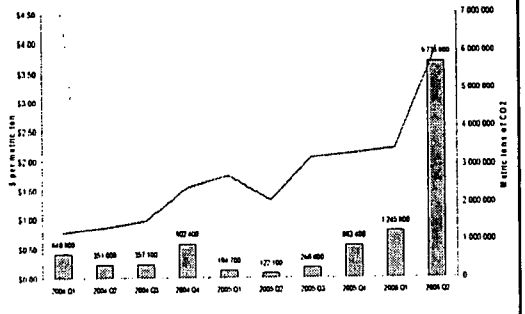
Stable, predictable offset rules contribute to successful GHG mitigation financing

IDAHO FALLS, Idaho, Sept. 8 /PRNewswire-FirstCall/ -- Intrepid Technology and Resources, Inc. (ITR) (OTC Bulletin Board: IESVI), a renewable energy company, has recently signed an Engagement Letter with the brokerage firm of Ferris Baker Watts, Washington D.C., to commence the marketing and placement of 17,790,000 dollars in Tax Exempt Industrial Revenue Bond financing. The financing, expected to be completed within 45-60 days, will provide ITR the capital to triple the size of their existing biogas facility near Rupert, Idaho, (and) construct the Westpoint Dairy biogas plant. ...

our ability to sell the substantial number of green credits that the system produces on the Chicago Climate Exchange makes these four projects very attractive to ITR's shareholders. At the same time we provide enhanced air, ground and water quality for the livestock owner.

Chicago Climate Exchange®

CCX Price* and Volume History 2003 - 2006



* Prices shown are last price of the quarter

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CCX® Progress to Date

- Complete operation implemented: rulebook, trading, clearing, registry, market, governance
- Member Baselines and 2003, 2004, 2005 Emissions Independently Audited
- Program-wide emission reductions achieved
- Trading and clearing mechanisms fully functional
  - > over 12 million tons exchanged
  - prices now in range of $4.00/metric ton CO_2
- Offsets from methane, ag soils, forestry, renewables verified, issued and sold

Chicago Climate Exchange®

Conclusions: CCX Big Picture Results

- Major pool of private and public sector talent engaged
  - Members
  - Other experts
- Thousands of individuals now far more informed on carbon management and trading
- Detailed rules and methods tested and refined
  - many second generation procedures now in place
  - hands-on experience for emissions and project verification experts
  - detailed expertise accumulated by members
  - practical experience now informing policy discussions

Chicago Climate Exchange®

Views on CCX®

"We are joining the Chicago Climate Exchange for two reasons. We want to strengthen a pioneering effort to create market-based solutions to the problem of climate change, and CCX helps us maintain our own organizational commitment to keep our net carbon dioxide emissions at zero."
Jonathon Lash, President, World Resources Institute

"... you could help to create the conditions for efficient emission trading systems, standardized accounting methods and the like. The successful launch of the Chicago Climate Exchange here in the United States is one example of an initiative to create a carbon market. We need more such innovative thinking on financing mechanisms and new insurance products."
United Nations Secretary-General Kofi Annan

"I want to congratulate the Exchange, which is the first comprehensive voluntary pilot program for domestic trading of greenhouse gases, on the announcement of its founding members. Their progress is great news for Chicago's economy and for America's environment." ***Senator Joe Lieberman***

Chicago Climate Exchange®

Views on CCX

"What would be wrong, at least on a theoretical basis, with taking what you have come up with by way of requirements for your (CCX) members and essentially mandating that everybody in the country comply with those?"
Senator Jeff Bingaman (D-NM), ranking minority member, Senate Energy & Natural Resources Committee, April 4, 2006

"The Chicago Climate Exchange is providing an innovative means of involving American businesses and citizens in the effort to protect the environment. Our nation's leading companies are buying and trading units of carbon as a way to reduce their impact on climate change. I am hopeful that the economic opportunities provided by the Exchange will enhance the incentives farmers already have to participate in the sequestration of carbon."
Senator Richard Lugar (R-IN), Chairman of Senate Foreign Relations Committee, May 18, 2006

"The CCX is leading the way toward a future in which reducing greenhouse gases could bring not only environmental rewards, but financial ones too."
Al Gore, from An Inconvenient Truth (book version), 2006

Chicago Climate Exchange

North Carolina Legislative Commission
On Global Climate Change
December 11, 2006

Recycling Energy:
Profitable Climate Change Mitigation by

Tom Casten
Alliance for Clean Technology
Founder, former CEO Trigen & Primary Energy

Thomas Casten

Exhibit G

Commission Mission

- Reach consensus on what NC can do to alleviate or prepare for the effects of climate change
- Solicit ideas from experts
- Take advantage of economic opportunities
- Actions taken will shape the direction of NC economy for decades

Presentation Summary

- The central generation of electricity is not optimal
- The better option – local generation that recycles energy waste – faces regulatory barriers, is denied benefits it creates
- The Alliance for Clean Technology (ACT) proposes a suite of policies to encourage 'clean technology'
- ACT believes governments can profitably mitigate climate change with a 'blue box' energy policy – recycling waste energy

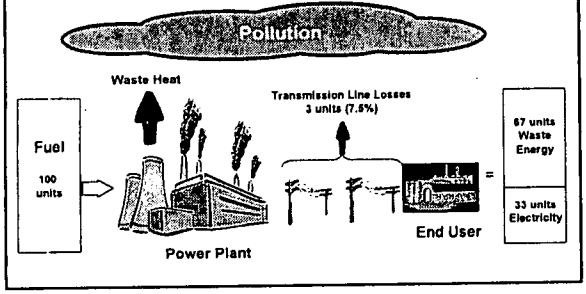
Introducing the Alliance for Clean Technology (ACT)

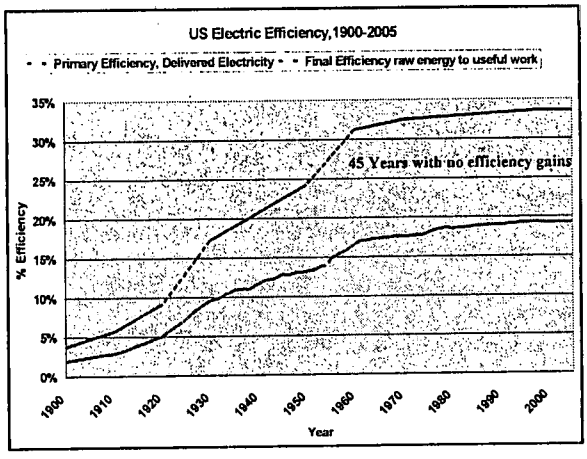
- ACT is new, a coalition of local power developers, WWF, Greenpeace, Sierra Club, Suzuki Foundation, unions, and gas and electric distribution utilities
- Mission is polices that induce deployment of *clean technology* to profitably reduce greenhouse gas emissions
- These policies will reduce pollution, improve industrial competitiveness, preserve good jobs and lower societal heat and power costs

An Inconvenient Truth

- Al Gore describes global warming as an 'Inconvenient Truth'– a reality that we would rather not face.
- Why inconvenient?
  - Conventional wisdom assumes energy conversion is optimal; thus mitigating climate change will increase energy costs
- Why wrong?
  - The energy system is not optimal
  - Electric generation efficiency peaked in 1960, creates 38% of US GHG

Conventional Central Approach 1960 Data (& 2003 Data)





We Have Better Electric Generation Options

Local generation can recycle energy to reduce costs and pollution

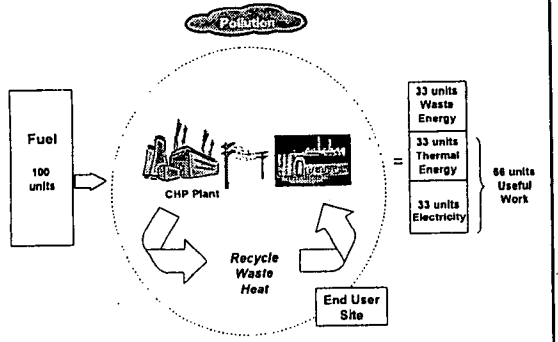
ACT's 'Convenient Truth'
Energy Recycling Eases All Problems

- Recycling industrial waste energy could produce 20% of US electricity, fuel free
- Combining heat and power generation (CHP) produces electricity with half the fossil fuel of conventional central generation
- Recycling waste energy will improve US competitive position

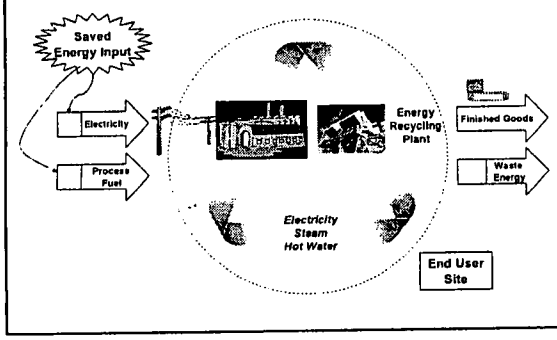
What is Recycled Energy?

- *Recycled energy is useful energy derived from:*
  - *Exhaust heat from power generation or industrial processes*
  - *Tail gas that would otherwise be flared*
  - *Pressure drop in steam or any gas*
- *Promoting energy recycling is a 'blue box' energy policy*

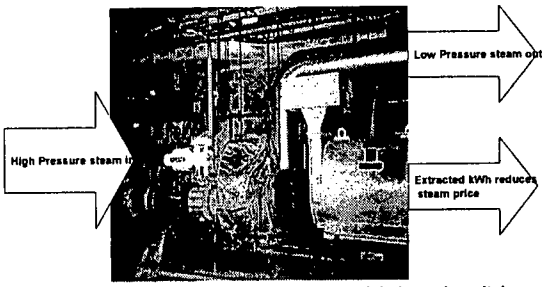
Decentralized Generation Option Combined Heat and Power



Industrial Energy Options

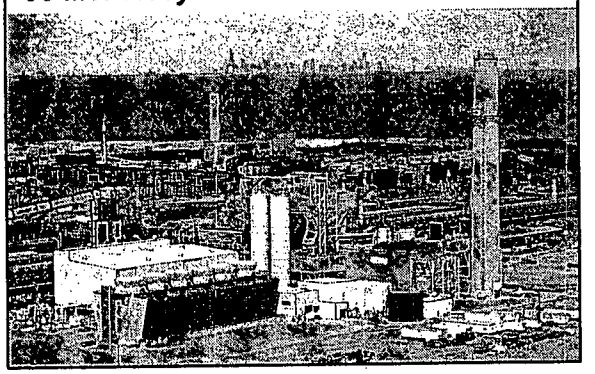


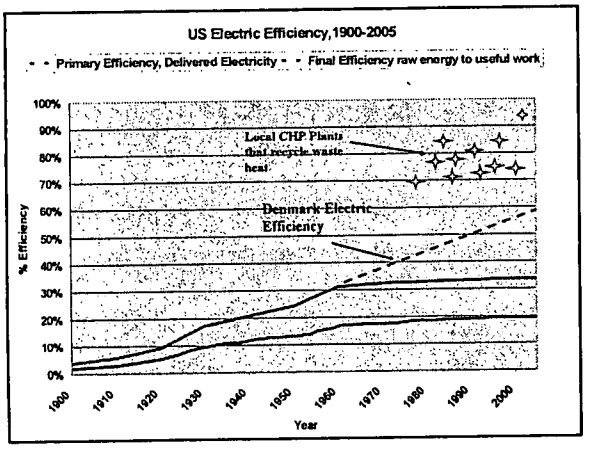
Backpressure Turbine-generators Extract Electricity from Gas/Steam Pressure Drop



Potential applications save money at industrial plants, hospitals, universities, and district energy systems and natural gas city gates

Industrial Energy Recycling 90 MW Recycled from Coke Production





Energy Recycling Impact on the Grid

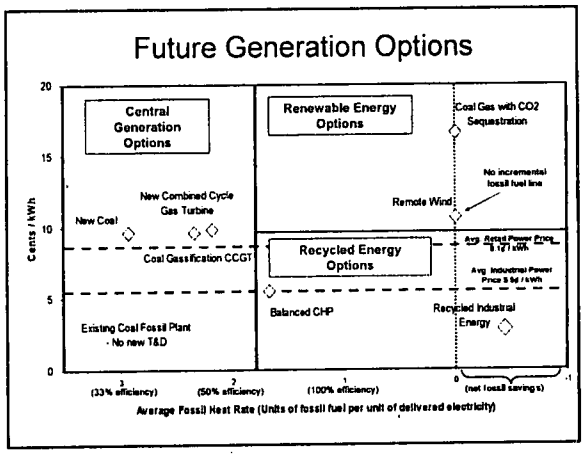
- Local generation reduces grid loading, line losses and need for new T&D
- Local generation stabilizes voltages and reduces vulnerability to extreme weather and terrorists
- Only local generation can recycle waste energy; it is not economic to recycle waste energy from remote generation plants

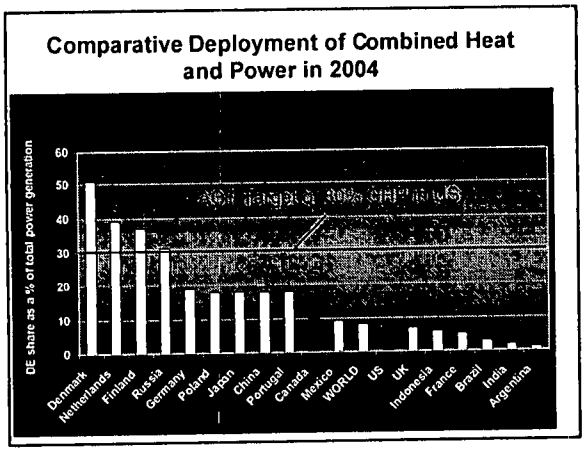
What About Economies of Scale?

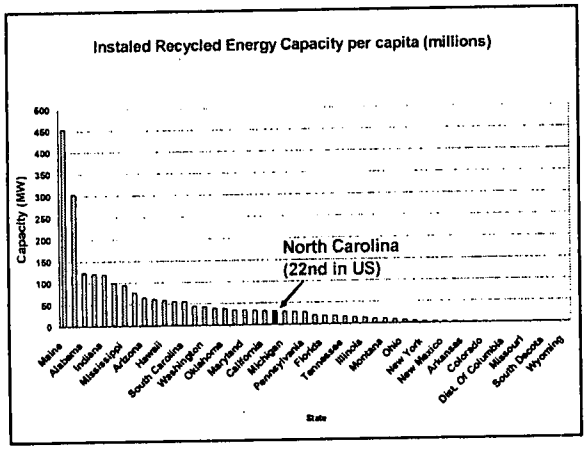
Skeptics claim local generation will raise capital costs

Economies of Scale?
Central versus Decentralized Generation

	Generation	Transmission & Distribution	Total / kW of Generation	KW required/ kW Load	Total costs/ kW New Load
Central Generation	$890	$1380	$2,270	1.44	$3,269
Local Generation	$1,200	$138	$1,338	1.07	$1,432
Savings (Excess) of Central vs. Local Generation	$310	$1,242	$1,068	0.37	$1,837
Central generation capital as a % of local capital	74%	1000%	213%	135%	228%


Future Generation Options
Central Generation Options
Renewable Energy Options
Recycled Energy Options
Coal Gas with CO2 Sequestration
No incremental fossil fuel line
Remote Wind
New Combined Cycle Gas Turbine
New Coal
Coal Gassification CCGT
Balanced CHP
Recycled Industrial Energy
Existing Coal Fossil Plant - No new T&D
Cents / kWh
Average Fossil Heat Rate (Units of fossil fuel per unit of delivered electricity)


Comparative Deployment of Combined Heat and Power in 2004
DE share as a % of total power generation
Denmark
Netherlands
Finland
Russia
Germany
Poland
Japan
China
Portugal
Canada
Mexico
WORLD
US
UK
Indonesia
France
Brazil
India
Argentina


Instaled Recycled Energy Capacity per capita (millions)
Capacity (MW)
North Carolina
(22nd in US)
State

NC Industry Recycling Potential

- Steel
  - Blast furnace gas, exhaust heat, pressure drop
- Refineries and chemical factories
- Natural gas pumping station exhaust
- Pressure drop at gas delivery points
- Glass & fiberglass factory exhaust heat
- Sewage gas, landfill gas, biomass, construction waste, recycled carpet, other
- All process thermal users, housing complexes, all central chilling users

ACT Definition of Clean Technology

- Over 57% delivered fossil efficiency (versus 33% for US central generation)
- GHG emissions less that one unit of coal-equivalent per unit of electricity (equal to 100% coal efficiency)
- No limits on size, technology, fuel, or location

Two Barriers to Clean Technology

- Barriers to local generation:
  - Interconnection costs and hassle
  - Standby charges
- Many clean technology benefits are not available to the facilities that create the benefits:
  - T&D avoidance
  - Line loss avoidance
  - Health and environmental savings

ACT Proposals to spur Clean Technology

- Require distribution utilities to interconnect with clean technology plants, add to rate base
- No standby charges for clean tech facilities
- Permit clean technology as 'pollution control'
- Statewide standard offer for clean technology to satisfy expected load growth, no size or time limits
  - Pay current market wholesale price for power and,
  - Pay half of calculated benefits that clean technology creates – roughly 4 to 6 cents per kWh

Stimulating Recycling of Industrial Waste Energy

- State insure risk of industrial shutdown
- Provide limited loan guarantees for new industrial energy recycling plants
  - Payable only if host ceases to provide waste energy
  - Covers risk of industries ceasing production, creates a virtuous cycle
  - Will trigger an industrial boom in NC
  - Costs offset with added income taxes

Recycled Energy Benefits

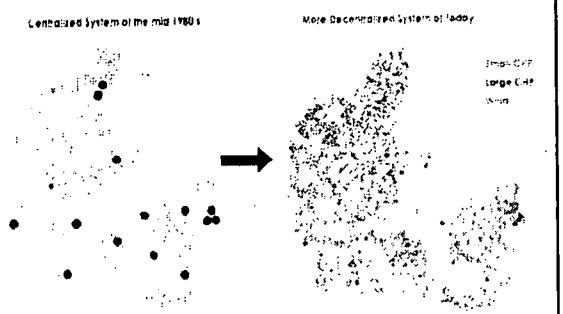
- New Investment
- Job Creation
- New Revenue Streams for NC Industry
- Improved Industrial Competitiveness
- Public Sector Gains

Conclusions: A Convenient Truth

Energy Recycling Solves Multiple Problems

- NC can 'mine'ind ustrial waste energy, create added revenue streams for industry
  - Recycle to provide affordable, clean energy
- Requires unconventional, innovative governance
  - Remove barriers to efficiency
  - Pay part of T&D and health savings to facilities that create those savings
  - Treat energy recycling as pollution control devices for environmental permits

Denmark Changed in Two Decades



Thank you

Combined Heat & Power at UNC Chapel Hill

Raymond E. DuBose, P.E.
Director
Energy Services Department

Introduction

- Energy Supply systems overview
- Cogeneration Facility
- Chilled Water System Features
- CHP Performance

Energy Supply Systems

- District Energy
- Central Steam Production
- Central Chilled Water Production
- Integral Electricity Generation, Purchase, & Distribution

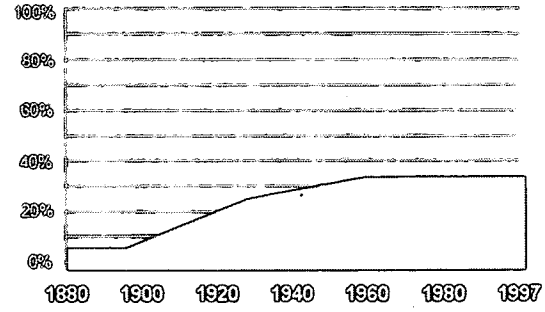
Definitions

Combined Heat & Power (CHP)
=
Cogeneration
=
Simultaneous generation of steam and electricity

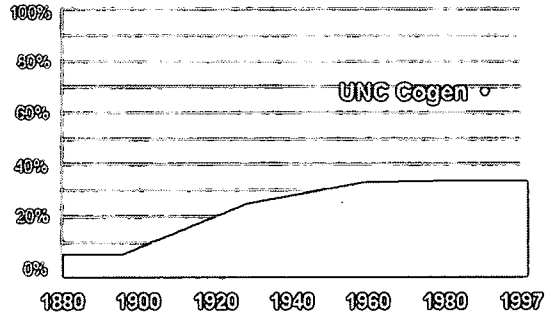
Cogeneration (CHP)

- Simultaneous production of electricity and steam
- High thermal efficiency
- Low environmental impact

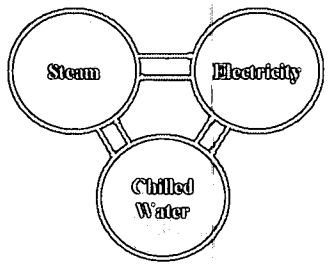
U.S. Average Generating Efficiencies



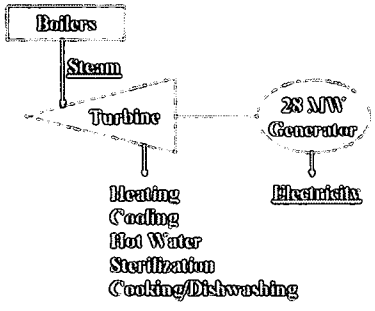
U.S. Average Generating Efficiencies

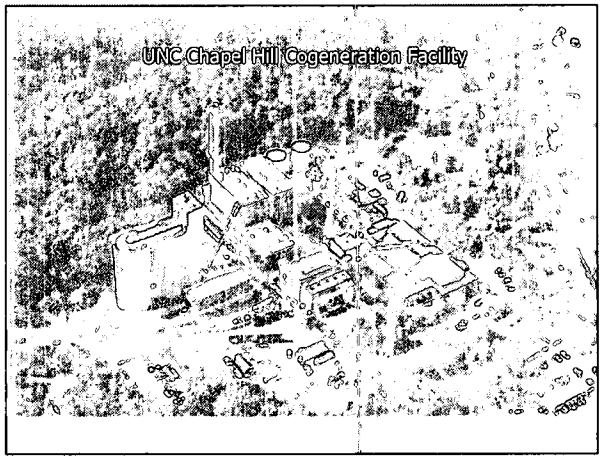


UNC Chapel Hill Cogeneration Concept



UNC Chapel Hill Cogeneration



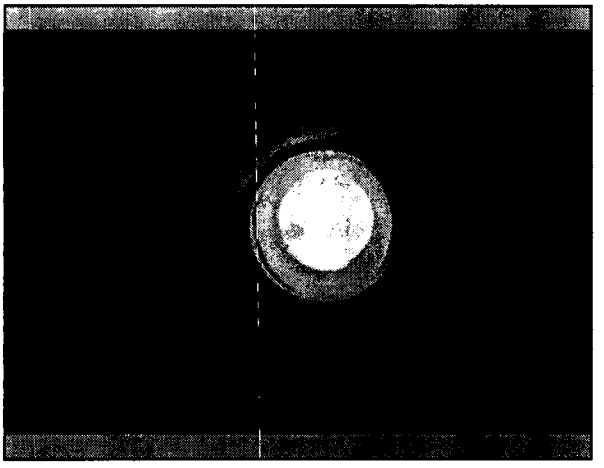


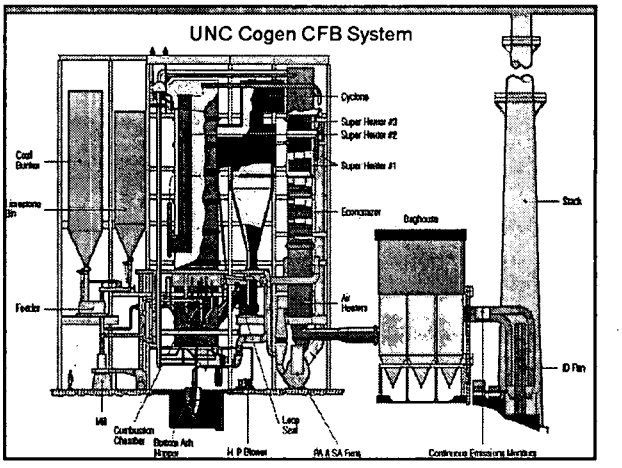
Circulating Fluidized Bed Combustion

- Nitrous Oxides (NOx) -- furnace temperature
- Sulfur dioxide (SO_2) -- sorbent

NSPS 40CFR60, Subpart Db

- SO_2
  90% reduction
  1.2 lbs/MMBtu
- NOx
  0.6 lbs/MMBtu
- Opacity
  20%
- Particulate
  0.5 lbs/MMBtu

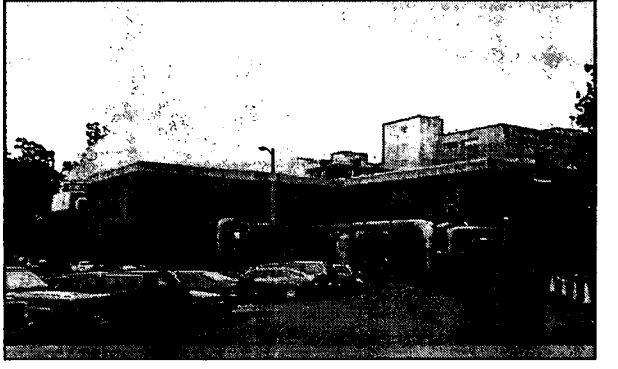




Chilled Water Systems

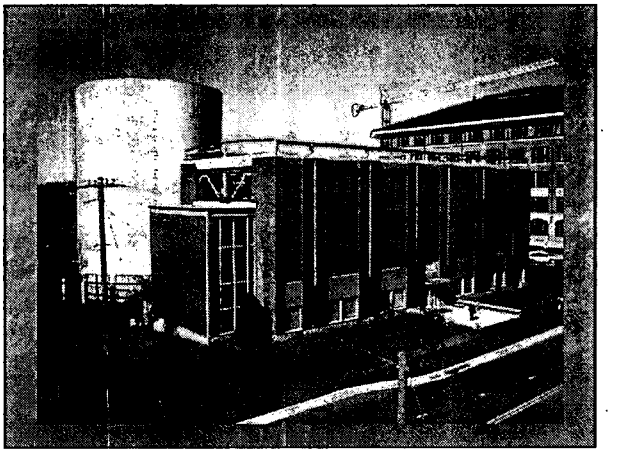
- Centralized production of chilled water
- Distribution of chilled water to serve campus needs
- Uses electricity and steam

North Chiller Plant



Thermal Energy Storage

- 40,000 ton-hours capacity
- 4,000,000 gallons of water
- Stratified storage tank 130 feet high x 80 feet diameter
- Completed 2006
- Interconnected to primary distribution lines
- Support plant chillers matched for charging tank

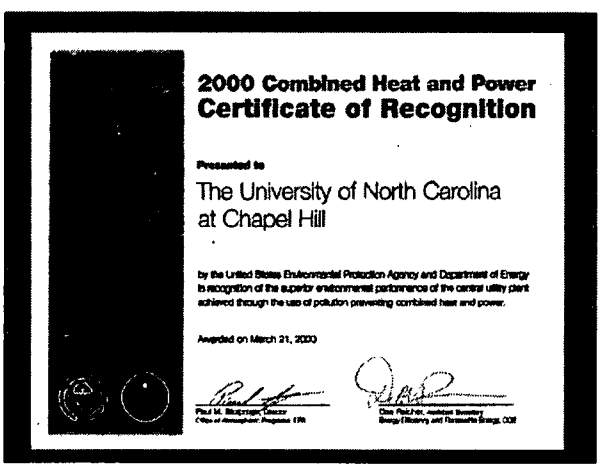


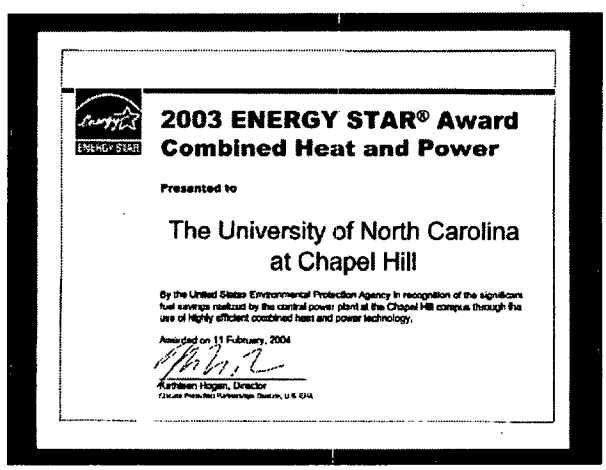
Duke Energy

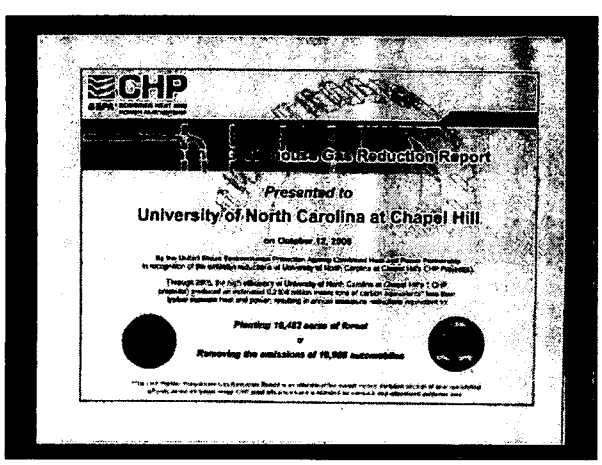
- Real-time pricing (OPT/HP rate)
- Immediate response to pricing signals
- Steam absorption chillers
- Thermal storage – 10 MW
- Cogeneration of electricity

CHP Performance

- Overall value $6,000,000 per year
- Rate performance $2,000,000 per year







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NC LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE
December 11, 2006

Testimony of The Reverend Michael H. Cogsdale,
President of the North Carolina Council of Churches, and
Rector of Saint James Episcopal Church, Lenoir, North Carolina

> *Text: Genesis 1...God saw how good it was...God said: Let us make humanity in our own image...Let them have dominion over...all living things...God looked at everything God had made, and found it very good.*

I am grateful to have this opportunity to come before you this morning. We at the North Carolina Council of Churches deeply appreciate your service to the citizens of our beloved state. We at the Council have advocated for the establishment of this Commission, we have cheered the quality of its appointments, and we have been close observers of its deliberations during its first year of study.

I am not here as an expert on the science or economics of climate change, but as one who would humbly comment on the ethical demands posed by the threat of global warming on our citizens, future generations, and by extension upon you as our governmental representatives. I speak you today as the President of the Executive Board of the North Carolina Council of Churches representing the Council's 25 denominational bodies and roughly 1.5 million people of faith here within our state.

Over the past ten years I, like a lot of other individuals in our state, have begun to intuitively and intellectually sense that there is something very wrong with our climate. The scale of such concern has grown among the people that I serve. It seems to me that the battle to address this issue is no longer among the fringe of our society. In my view, it is now firmly within the mainstream political, social, and religious agenda of our state. My children – ages 16 and 13 – know this: The snow that I enjoyed as child just doesn't seem to be a plentiful in their eyes, and I live at the base of the North Carolina mountains. Even some of the oldest members of my parish will concede that something is not right with the environment. I want to assure you that I serve both liberal and conservative folks. My parishioners are far from being wild-eyed fanatics about the environment. Even my Rotary Club, which I have

Methodist Building • 1307 Glenwood Avenue — Suite 156 • Raleigh, North Carolina 27605-3256
telephone (919) 828-6501 and (919) 828-6542 • fax (919) 828-9697
E-mail: nccofc@nccouncilofchurches.org
www.nccouncilofchurches.org

been a member of since 1990, is coming to be more and more of one mind regarding this issue. What encourages me the most is the fact that more folks than ever before are open to conceding that the spotlight in now clearly upon humankind, and our relationship to the earth. I believe people know that we must act, and act now before we move closer to a tipping point from which the earth cannot return.

Over the past 20 years or so, mainline denominations have come to a new appreciation for the natural environment and our relationship to it. We have moved from a perspective that extolled dominion over nature and subduing the earth toward a renewed understanding of our sacred writings that call for a new commitment to the stewardship of creation.

For too many of us, for far too long, we have simply assumed upon the generosity of our Creator, while taking too little responsibility for the care of Creation. The idea that nature exists solely for the benefit of humanity, which was thought to have derived from God's command to Adam to "have dominion over" the rest of creation is no longer accepted as the dominant view within mainline Christianity. We do not worship a God who is wholly transcendent, who is separated from the world with no continuing interest or involvement in its non-human elements.

Over the past 5 or 6 years, this new awareness has expanded to include the dangers posed to God's creation by climate change—most mainstream religions in the US, along with many evangelical faiths, have spoken directly to that threat.[1]

Some of the themes represented in those statements include some of the following thoughts: We are facing a global crisis like none previously known by humankind. It is time to join with our Creator in preserving and renewing Creation. Unless we act, the changes could be irreversible, and therefore our action or our inaction will affect millions in future generations. Although the effect will be felt worldwide, it is the weak and the vulnerable of the world that will suffer most. The US has a special responsibility to address this crisis because we emit so much of the world's greenhouse gases –we are 6% of the world's population and emit 25% of its green house gases. We must act because we have the technological capability to act.

In our own state, when my own children, ages 16 and 13, reach my age, I have to wonder if the beaches where we built sand castles together as a young family will have disappeared altogether because the sea level is likely to rise by 6 inches. And will places where we visit each summer, like Bogue Banks and the Outer Banks no longer exist? What will the road from the lighthouse at Cape Hatteras up to Nags Head be like if indeed the sea level is rising in ways that we have not yet begun to imagine? Some models predict that rising temperatures in the Southeast will rise by 1.8 to 3 degrees F. during the next 30 years.[2] In 30 years my oldest child will be younger that I am today. Such a rise in temperature will not only affect the environment, but also the economy at large and the public health my children, and my grandchildren – as it will yours. Global warming is personal—my relationship to Creation is tied to my relationship to future generations, and the life they will live.

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[1] Please see handout in packet: *Excerpts from Denominational Statements on Global Climate Change. NC Council of Churches Climate Connection.*
[2] Munger, Amber and Shore, Michael. *Understanding Global Warming for North Carolina. Environmental Defense. 2005.*

Our religious leaders also remind us that this crisis is not only about us here in the US —but that it is also global and it's about justice, and about how the poor and the most vulnerable will be impacted. Recently the United Nations Environmental Program documented the first formal displacement of an entire population of people because of climate change. A village on a small island nation was forced to move its village 500 meters inland after trying to adapt to the effects of a warming climate for nearly two decades.[3] Granted the village was small, but its story is bound to be repeated as indigenous communities around the globe are faced with similar threats to their survival.

While it is true that we in NC and in the US will not be impacted to such a degree, those of us from communities of faith know that we must work for the common good, not just our immediate communities. As we have come to realize - now more than ever – the people of the earth reside on an increasingly small globe. The commandment to love our neighbor especially includes the poor of this world who will have little resources to face the potential impact of climate change. This sense of oneness between human beings and their relationship to the earth is an important corrective, both to the idea that humankind has been placed in the world to dominate nature and take from it, rather than to conserve or protect it. One day we will be asked to give an account of how we have cared for something that it not ultimately ours – Gods creation. The Hebrew psalmist tells us this: "The earth is the Lord's and the fullness thereof." We cannot any longer afford to take and take from the earth more than we need; thereby, upsetting the delicate balance of the earth's natural environment. To do so is a spiritual problem that wrongly robs others of what is also rightfully theirs, and needed to maintain a modest level of human dignity.

As I have said there is a growing awareness in the faith community that global warming is real and that it will most certainly have devastating effects on the people of this and future generations. We are responding to the call to act, and act now.

Our NC Council of Churches Climate Connection program is affiliated with a national initiative called *The Interfaith Power and Light Campaign.* This organization now counts among its members 22 state-wide ecumenical and interfaith groups who have joined together in a national religious response to global warming—a response which includes promoting renewable energy, energy efficiency and conservation. Across the US, folks of all faiths are coming together to talk to each other, to pray and study together, and to support each other in their efforts to put their faith into action.

Recently, in an initiative sponsored by Interfaith Power and Light, more than 4000 faith congregations throughout the US, and more than 100 congregations across NC, viewed the film *An Inconvenient Truth* in fellowship halls and houses of worship, and the response conveyed to us from all quarters was this: "We must act on this knowledge!"

As I speak to you today I express the concern of these thousands and of countless other citizens who see the care of Creation as a religious duty.

---

[3] Gardner, Gary. T. *Inspiring Progress: Religion's Contributions to Sustainable Development. Norton & Co. 2006*

We see that people of faith want to respond, and that they genuinely understand the relationship between protecting creation and their love for the Creator.

Yet in a world where the hope for restoration of our creation seems to be shriveling daily with images of disappearing ice caps and rising sea levels, solving the problems can appear beyond human capabilities.

Therefore, we see that the challenge for church leadership is to provide a voice of hope, while channeling the desire to care for creation into actions, that when combined with others of similar sentiment, will achieve the necessary ends.

Our faith and our relationship to our Creator requires us to respond. Some of the things our judicatories and congregations and their members are doing are as follows:

- Re-visiting their own teachings and educating themselve about the relationship between love for God and care for Creation. *An example: A group of clergy and laity in the Episcopal Diocese of WNC exploring ways to more fully incorporate their denominational teachings on environment.*

- Forming regional interfaith coalitions on climate change issues. *Example: In Asheville, five faith communities distributed 500 compact florescent lights (cfl) along with our literature on energy conservation during their Thanksgiving Day Parade.*

- Forming Creation Care committees. *Some examples:*
  - *Myers Park Baptist Church in Charlotte.*
  - *St. Mark's Episcopal Church in Raleigh*
  - *Immaculate Conception Catholic Church in Durham*
  - *Church of the Reconciliation in Chapel Hill*
  - *The Catholic Diocese of Charlotte has recently formed a diocesan-wide Environmental Justice Advisory Committee*

- Conducting congregational energy audits, and using this information to reduce energy usage. *Some examples:*
  - *St. Philips Moravian in Winston-Salem changed out all their incandescent bulbs in 2005 following an energy audit.*
  - *United Church of Chapel Hill has bought dimmable CFL's for the chandeliers in their sanctuary.*

- Taking pledges to cut their energy usage by 10%. *Example: See the card in the folder. We just began asking folks less than a month ago to take this pledge, and we have received more than 100 responses to date, with more arriving daily.*

- Replacing light bulbs with compact florescent lights (cfl's). *Some examples: Several Christian congregations are using our Advent prayer/action guide and replacing a light bulb with a compact florescent light (cfl) as each new Advent candle is lit. In Asheville, the Jewish Temple is organizing a cfl replacement program around the lighting of candles on Hanukah.*

- Acting on their new knowledge in the public arena. *An example: At the Utility Commission public hearings in Raleigh and Asheville in May of this year that were attended by an unprecedented number of ratepayers, at least 12 of the citizens who testified were members of faith congregations related to the Council, and they spoke with the message that "we want to stop the wasteful consumption of energy, and address climate change through clean, safe generation, efficient use and conservation." Many others of our members told us they wrote the Commission chair conveying the same message.*

Many of us can sense deeply within that we are at a new place in the history of humankind where we are being called to a fundamental change in our relationship to nature and to creation. As I re-read, and re-ponder, Genesis 1, I am struck, to my core, with the knowledge that God loved the world and saw that it was good even ***before*** the creation of humankind. It was good before we ever came on the scene. We are only part of it, but we have a very special, solemn responsibility to carry out.

That awakens in me what all religious traditions have taught, that I must "walk humbly" before my Creator and Creation. I believe that we are the generation that must re-learn that. God never gives dominion to any creature, which has not received his image. The God I worship is a God of love and mercy. The God of creation will not place the ultimate reins of government into hands that have no heart for something that He has created and loves. I believe our authority to govern comes not only from the consent of the people but also from the very God in whom we profess our faith. I ask you to listen deeply to what your heart is telling you. Jesus told his disciples, "In as much as ye did it to one of the least of your brethren ye did it to me." Could he have been referring as much to our hurting globe as much as he was to us human beings? Could it be that that the sun and the moon, the wind and the stars, the fish of the beautiful Albemarle Sound, or the majestic forests of our Western mountains, the bear, the wolf, the native flowers of our state, dare I say the acid-rain scarred tree tops of Grandfather Mountain near my home are also our brothers and sisters in communion with our Creator?

I like what the Episcopal Bishop of Iowa recently said to his diocese, "For, I am convinced that it is our Creator who is waking us up to the impossible at this eleventh hour. We, who are the first generation to see the planet from beyond itself, still have choices to engage our creativity and imagination in new ways."

You may say that what I have presented here are religious sentiments that have no place in the world of politics. I will not offer apology for my idealism. I'm a preacher – it is my call. But let me remind you that our "constituents" are also the General Assembly's constituents. The people I serve are the people you serve. I know they talk as if they care only about the price of gasoline and not the fumes that make the smog in our cities or the carbon in the atmosphere. But they do care, and they expect us to care, too. This is the work that God has now called us to.

We hope that the measures that you recommend will be significant, not timid. That you will set goals that will really address the problem, even if those goals require some sacrifice. Maybe religious leaders feel more comfortable asking for noble responses from people, than do lawmakers. We commonly call for generosity, self-restraint, caution, or courage. For all of us, though, since global warming is a huge problem, it stands to reason that there must be big solutions that will call for us to change our ways. The familiar patterns of get and spend, rugged individualism, Me and Mine, won't work here. The task will call for the best we have, but I have confidence that our people will give their best to it when they see us doing the same.

We ask that the economic interests of the state's weaker, poorer and less politically empowered citizens will be kept in mind as you ponder our choices. We'd like to see solutions that employ not just the highly skilled in one or two counties but that provide living wages for the large numbers left behind by lost industries and dwindling supplies of fish or degraded agricultural land. I live in a county – Caldwell - that

certainly fits that bill. Yes, its good to serve the economic interests of the state's most enterprising entrepreneurs, but it is also good to enlarge the opportunities of the state's citizens who are less skilled and less privileged.

We ask that the solutions for this problem be based on a long-term appraisal of nature's laws rather than on short –term economic gain. The remedies for one crisis should not cause another crisis.

I will close by saying this: We are blessed to live where we do, and to live in such a wonderful country such as the United States. Let's view our good fortune as a blessing from God to be used for the good of all. Recently this summer I spent several days helping host some Anglican Christians from the northeastern part of India. When we were touring Western North Carolina, they expressed over and over that we were a country richly blessed with many resources. Never did they suggest that we should suffer from any embarrassment or remorse over our many resources when compared with the people of other countries. Their hearts seemed to convey, "Do not be ashamed of God's blessing, but know God intends you to pass it on. Do not tell them only about our poverty in India but what we are doing with what we have." God has indeed blessed us. Now we must pass it on. Perhaps our acts of mitigation should be in proportion to our good fortune rather than to our sins. We are blessed to live in this nation and we are so blessed to live in a state as beautiful as North Carolina. I deeply love this state, and this country in which I live. I know you do also. Thank you again for letting me speak before you. Please be assured of our prayers for your good work. May God bless you and your families.

NORTH CAROLINA COUNCIL OF CHURCHES

1307 GLENWOOD AVE. STE 156
RALEIGH, NC 27605
919-828-6501

MEMBERS

African Methodist Episcopal Church
Second Episcopal District
North Carolina Conference
Western North Carolina Conference

African Methodist Episcopal Zion Church
Eastern North Carolina Episcopal District
Albermarle Conference
Cape Fear Conference
Central North Carolina Conference
North Carolina Conference
Piedmont Episcopal District
Blue Ridge Conference
West Central North Carolina Conference
Western North Carolina Conference

General Baptist State Convention: North Carolina State Convention

Christian Methodist Episcopal: Carolina Conference

Christian Church (Disciples of Christ) in NC

Episcopal Church
Diocese of East Carolina
Diocese of North Carolina
Diocese of Western North Carolina

Evangelical Lutheran Church in America: Synod of North Carolina

Metropolitan Community Churches: Region 3

Moravian Church in America: Southern Province

NC Alliance of Baptists

Presyterian Church (U.S.A.)
Presbytery of Charlotte
Presbytery of Coastal Carolina
Presbytery of New Hope
Presbytery of Salem
Presbytery of Western North Carolina

Reformed Church in America: Regional Synod of New York

STATEMENT OF GLOBAL WARMING AND CLIMATE CHANGE BY NORTH CAROLINA'S RELIGIOUS AND SPIRITUAL LEADERS

As witnesses of the serious climate changes the earth is now undergoing, North Carolina's various spiritual traditions join together to voice our concerns about the health of the planet we share with all species. We acknowledge the need to commit ourselves to a course of action that will help us recognize our part in the devastating effects on much of our planet brought about by increasingly severe weather events. We declare the necessity for North Carolina's spiritual communities to be leaders in turning human activities in a new direction for the well being of the planet.

Scientific evidence indicates that greenhouse gases are linked to global warming which threatens the health of the entire planet and all its inhabitants. We believe that global warming is a challenge to all of earth's inhabitants, but particularly to the spiritual communities that recognize the sacredness of preserving all eco-systems that sustain life.

Global warming violates that sacredness. It leads to species extinction, destruction of habitat for all species, melting ice caps, and rising sea levels. It disrupts our supplies of food and water. Already we see people dying from extreme weather conditions exacerbated by climate change, including record-breaking storms, heat waves, floods, and droughts. The burdens of a degraded environment fall disproportionately upon the most vulnerable of the planet's people: the poor, sick, elderly, and those who will face still greater threats in future generations.

In response to the global warming crisis, we join with you in establishing the North Carolina Interfaith Global Warming Campaign.

We commit our spiritual community to join with others to address this serious issue in the following ways:

Attend with awe, humility, and gratitude to the beauty in nature as well as in scripture.
Pray for the wisdom to address global warming as a violation of the integrity of the earth.
Distribute educational materials, offer presentations, and convene study groups to help our communities understand the negative impact on the earth of some personal behaviors and lifestyles, and take action to conserve energy and reduce excessive use of fossil fuels.
Share our spiritual perspectives on global warming with representatives of key sectors in our business, agriculture, and environmental organizations, seeking ways to work together for the common good.
Encourage others in our North Carolina communities to act on their responsibility to care for the earth.
Organize our communities to meet with local and state political leaders, and members of Congress, to encourage their participation and support.
Declare our support for U.S. Senate ratification of the Kyoto Protocol, which commits the U.S. to limit its greenhouse gas emissions to 7% below 1990 levels, and thereby join the international effort to address the threat of climate change.

Let us now "join together as many and diverse expressions of one loving mystery: for the healing of the earth and the renewal of all life." (United Nations Environmental Sabbath Program).

The following North Carolina Religious and Spiritual Leaders signed the February 2001 Statement on Global Warming and Climate Change.

Rabbi James M. Bennett, Temple Beth El, Charlotte

The Right Reverend Dr. Leonard Bolick, Bishop, Evangelical Lutheran Church of America, Synod of NC

The Reverend George Briggs, retired, Unitarian Universalist Church

Council of Christian Life and Public Affairs, Baptist State Convention of North Carolina

The Most Reverend William G. Curlin, Bishop, Roman Catholic Church, Diocese of Charlotte

The Right Reverend Michael Curry, Bishop, Episcopal Church, Diocese of North Carolina

The Right Reverend Clifton Daniel, III, Bishop, Episcopal Church, Diocese of Eastern Carolina

The Reverend Daniel Charles Davis, Unitarian Universalist Fellowship, Winston-Salem

Rabbi Lucy Diner, Temple Beth Or, Raleigh

Bishop Marion M. Edwards, Resident Bishop, United Methodist Church, North Carolina Conference

The Most Reverend F. Joseph Gossman, Bishop, Roman Catholic Church, Diocese of Raleigh

The Reverend Franklin W. Grice, District Superintendent, Northeast District, United Methodist Church, Western NC Conference

The Reverend Dr. Herman Haller, Interim Conference Minister, United Church of Christ, Southern Conference

The Reverend Charles M. Hawes, Chaplain, UNC-Greensboro, Episcopal Diocese of North Carolina

The Right Reverend J. Gary Gloster, Bishop Suffragan, Episcopal Church, Diocese of North Carolina

The Reverend Lone T. Feusen, Unitarian Universalist Fellowship, Wilmington

The Reverend Glenda N. Johnson, District Superintendent, Durham District, United Methodist Church, North Carolina Conference

The Reverend Nelson Johnson, Pulpit Forum, Greensboro

The Right Reverend Robert H. Johnson, Bishop, Episcopal Church, Diocese of Western North Carolina

The Reverend J. Michael Leatherwood, District Superintendent, Lexington District, United Methodist Church, Western NC Conference

Sister Evelyn Mattern, Program Associate, North Carolina Council of Churches

The Reverend Jack McKinney, Pullen Memorial Baptist Church, Raleigh

The Reverend Alan Neely, Wake County Interfaith Alliance

Taitaku Pat Phelan, Priest, Chapel Hill Zen Center

The Reverend James Pike, Binkley Memorial Baptist Church, Chapel Hill

The Reverend J. George Reed, Executive Director, North Carolina Council of Churches

The Reverend Charles M. Smith, United Methodist Church, North Carolina Conference

Mr. Howard Smither, President of the Chapel Hill Zen Center

The Reverend Frank Stith, III, District Superintendent, Greensboro District, United Methodist Church, Western NC Conference

Mrs. Barbara Volk, President of The Christian Women United, North Carolina

The Reverend Larry D. Wilkinson, District Superintendent, Waynesville District, United Methodist Church, Western NC Conference

The Reverend T. Melvin Williams, Jr., Watts Street Baptist Church, Durham,

Excerpts from Denominational Statements on Global Climate Change

In addition to writing statements reminding their believers of the obligation to care for God's creation, most denominations have issued specific calls to stop the threat of global climate change. The most recent is The Evangelical Call to Action signed by 90 evangelical leaders, issued January 2006. Following are excerpts from statements by several US denominations urging their members to take very seriously the danger to God's creation that climate change presents.

From North Carolina Religious Leaders

As witnesses of the serious climate changes the earth is now undergoing, we leaders of North Carolina's various spiritual traditions join together to voice our concerns about the health of the planet we share with all species. We acknowledge the need to commit ourselves to a course of action that will help us recognize our part in the devastating effects on much of our planet brought about by increasingly severe weather events. We declare the necessity for North Carolina's spiritual communities to be leaders in turning human activities in a new direction for the well being of the planet.

From a statement on Global Warming and Climate Change by North Carolina's religious and spiritual leaders. February, 2001. Signers include nine bishops from the Roman Catholic, Lutheran, Methodist and Episcopal denominations, along with several rabbis and Muslim leaders, a Buddhist priest, and the Council on Christian Life and Public Affairs of the Southern Baptist State Convention.

Church of the Brethren

Planet earth is in danger. The ecological crisis that threatens the survival of life on earth is evident now not only to professional biologists, botanists, environmental scientists, but to all. Awareness grows that humanity is facing a global crisis..... The Creator-Redeemer seeks the renewal of the creation and calls the people of God to participate in saving acts of renewal. ...Our task is nothing less than to join God in preserving, renewing and fulfilling the creation. From *"Creation: Called to Care." 1991.* http://www.brethren.org/ac/ac_statements/91Creation.htm

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Episcopal

We are called to be good neighbors and act with love and care for all of what God called "Sacred". The natural greenhouse effect set up by God has been disrupted and the imbalance is causing temperatures to rise. Global warming means not only higher average temperatures, but also changes in weather patterns, precipitation, and ranges of plants insects and animals. Such changes would threaten natural resources, human health, already endangered species, and fragile ecosystems. Although no person would be immune from the consequences of climate change caused by global warming, the world's poor would be especially vulnerable. From a resolution adopted by the Executive Council of the Episcopal Church, 2001. http://www.ecusa.anglican.org/1866_70059_ENG_HTM.htm

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Evangelical

As American evangelical Christian leaders, we recognize both our opportunity and our responsibility to offer a biblically based moral witness that can help shape public policy in the most powerful nation on earth, and therefore contribute to the well-being of the entire world.[1] *Whether* we will enter the public square and offer our witness there is no longer an open question. We are in that square, and we will not withdraw.

Over the last several years many of us have engaged in study, reflection, and prayer related to the issue of climate change (often called "global warming"). For most of us, until recently this has not been treated as a pressing issue or major priority. Indeed, many of us have required considerable convincing before becoming persuaded that climate change is a real problem and that it ought to matter to us as Christians. From: "Climate Change: An Evangelical Call to Action." Signed by 90 Evangelical Leaders, Issued January 2006. *http://www.christiansandclimate.org/statement*

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Jewish

We have a solemn obligation to do whatever we can within reason both to prevent harm to current and future generations and to preserve the integrity of the creation with which we have been entrusted. Not to do so when we have the technological capacity - as we do in the case of non-fossil fuel energy and transportation technologies - is an unforgivable abdication of our responsibility. *From a resolution adopted at the 111th Convention of the Central Conference of American Rabbis: March 2000.* http://www.interfaithpower.org/TDSjewish.CCAR.htm

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Lutheran (ELCA)

Christian concern for the environment is shaped by the Word of God spoken in creation, the Love of God hanging on a cross, the Breath of God daily renewing the face of the earth. The earth is a planet of beauty and abundance; the earth system is wonderfully intricate and incredibly complex.

But today living creatures, and the air, soil, and water that support them, face unprecedented threats. Many threats are global; most stem directly from human activity. Our current practices may so alter the living world that it will be unable to sustain life in the manner we know. From "Caring for Creation: Vision, Hope and Justice," August 1993. http://www.interfaithpower.org/TDSevangelicalLutheran.htm

Orthodox

God's creation delivers unsettling news. Earth's climate is warming to dangerous levels ....To continue to walk the current path of ecological destruction is not only folly; it is sin ....

Churches, as communities of God's people in the world, are called to exist as representatives of the loving Creator, Sustainer, and Restorer of all creation. We are called to worship God with all our being and actions, and to treat creation as sacred. We must engage our political leaders in supporting the very future of this planet. We are called to cling to the true Gospel - for "God so loved the cosmos" (John 3:16) - rejecting the false gospels of our day. From "God's Earth is Sacred: An Open Letter to Christians in the United States" Conference of Canonical Orthodox Bishops in the Americas (SCOBA), July 2005

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Presbyterian USA

"The church has powerful reason for engagement in restoring God's creation. God's works in creation are too wonderful, too ancient, too beautiful, too good to be desecrated." (1990 General Assembly)

"...Reaffirms the call of the 202nd, 210th, and 211th General Assemblies (1990, 1998, and 1999) for the United States to ratify the Convention on Climate Change and the Kyoto Protocol.... Calls on the United States government to join in the world effort to reduce greenhouse gas emissions, and to develop and enact a national emergency response, underwritten by law, with adequate financial support, and economic enforcement mechanisms, to be fully functioning by 2005, with targeted reductions by that time." (2003 General Assembly) www.prcweb.org/

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Reformed Church in America

The threats to creation represented by global warming are a cause for concern for everyone on the planet, but for Christians the issue is more than a matter of self preservation; it is a matter of faithfulness... From "Climate Change Update." 1993. http://www.rca.org/mission/witness/climateupdate.html

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Roman Catholic

At its core, global climate change is not about economic theory or political platforms, nor about partisan advantage or interest group pressures. It is about the future of God's creation and the one human family. It is about protecting both "the human environment" and the natural environment.[1] It is about our human stewardship of God's creation and our responsibility to those who come after us. From "Global Climate Change: A Plea for Dialogue, Prudence, and the Common Good" US Catholic Bishops. June 15, 2001. http://www.nccbuscc.org/sdwp/international/globalclimate.htm

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Society of Friends

Protecting God's Earth and its fullness of life is of fundamental religious concern to the Society of Friends. The links between human activity, the dramatic rise in atmospheric greenhouse gas concentrations, and the rise of average global temperatures are now of sufficient concern to lead us to action. From Society of Friends statement on global climate change. June 2000. http://www.interfaithpower.org/TDSsocietyOfFriends.htm

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Unitarian Universalists

Our seventh Principle challenges contemporary Unitarian Universalists to remember that we are part of the interdependent web of all existence. The choices we make, coupled with the choices made by government and the private sector, profoundly affect our environment. We have a moral responsibility to future generations to mitigate global warming while there is still time. *From "Threat of Global Warming Study/Action Issue" 2004 General Assembly*
http://www.uua.org/csw/threatofgw.html#Threat%20of%20Global%20Warming

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United Church of Christ:

(United Church of Christ) recognizes the dangers of global warming and our biblical mandate as stewards of God's creation to be diligent in our efforts to decrease the emission of greenhouse gases;

- affirms the greater responsibility of industrial nations and especially the United States to reduce greenhouse gas emissions;
- encourages local churches, Conferences and national agencies to engage in efforts to educate and advocate for ratification of the Kyoto Climate Change Treaty and to address their own lifestyles (institutional and personal) to assure the minimum production of wastes that threaten the environment;

From "Statement on Global Climate Change," Twenty-second General Synod. http://www.interfaithpower.org/TDSunitedChurch.htm

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United Methodist Church

The decisions that humans are now making will either enhance or degrade the quality of life on the planet. We have entered an era of greater energy interdependence. As the world confronts global issues such as climate change, energy inequity, and pollution, energy-related problems will require international solutions based upon the values of justice and sustainability....We support strenuous efforts to conserve energy and increase energy efficiency. A transition to energy efficiency and renewable energy sources will combat global warming, protect human health, create new jobs, and ensure a secure, affordable energy future. From the General Board of Church and Society Energy Policy Statement, *Resolution 5*, 2000. www.umc-gbcs.org

Climate Connection: Interfaith Eco-Justice Network of the North Carolina Council of Churches and Interfaith Power & Light
1307 Glenwood Avenue, Suite 156, Raleigh NC 27605 Phone 919-828-6501 www.nccouncilofchurches.org

Please indicate below how you will continue to make Earth a better place to live. Please keep one for yourself as a reminder, and send one to us, so we can calculate the carbon dioxide reduction of respondents.

10 simple things to do to reduce global warming

CHANGE A LIGHT Replacing one regular light bulb with a compact fluorescent light saves 150 pounds of carbon dioxide a year (up to 730 pounds over the life of the CFL). **By replacing four bulbs this Advent, you've saved 600 pounds of carbon dioxide.**	We've replaced this many bulbs this: _____ which has saved _____ pounds of CO^2. We plan to replace this many more bulbs _____ which will save _____ pounds of CO^2
DRIVE LESS You'll save one pound of carbon dioxide for every mile you don't drive! Walk, bike, carpool more often.	We will reduce our driving by _____ miles each month, and save _____ pounds of CO^2.
ADJUST YOUR THERMOSTAT Move your thermostat down 2 degrees in winter and 2 degrees up in summer and save about 2,000 pounds of carbon dioxide.	We will adjust our thermostat by this many degrees _____ and save _____ pounds of CO^2.
RECYCLE MORE You can save 2400 pounds of carbon dioxide per year by recycling half of your household waste.	We will recycle _____% of our household waste and save _____ pounds of CO^2.
REDUCE WASTE Avoid products with a lot of packaging. You can save 1,200 pounds of carbon dioxide if you cut down your garbage by 10%.	We will cut down our garbage by _____% and save _____ pounds of CO^2.
USE LESS HOT WATER It takes a lot of energy to heat water. Use less by installing a low flow showerhead (350 pounds of carbon dioxide) and washing your clothes in cold or warm water (500 pounds per year).	We will install a low flow showerhead and save 350 pounds of CO^2 _____ (yes). We will wash our clothes in cold/warm water and save 500 pounds of CO^2 _____ (yes).
PURCHASE NC GREEN POWER For only $4.00 more on your monthly utility bill, you can add one block of 100 kWh's of clean energy onto the electric grid, replacing 100 kWh's of conventional power. To learn more go to www.ncgreenpower.org.	To discover the reduction in emissions that can result from your participation, go to www.ncgreenpower.org/signup/calculator.html. _____
PLANT A TREE A single tree will absorb one ton of carbon dioxide over its lifetime.	We will plant _____ tress and save _____ tons of CO^2.
TURN OFF ELECTRONIC DEVICES Simply turning off your television, DVD player, stereo, and computer when you're not using them will save thousands of pounds of carbon dioxide a year.	We will save CO^2 this year by turning off the following:
BE INFORMED ABOUT ENVIRONMENTAL ISSUES. Join Climate Connection listserve to keep track of global warming public policy issues, and learn how to affect legislation that could save millions of pounds of carbon dioxide.	We will join the Climate Connection listserv so we can let our legislators know that global warming is a moral issue that they must address, which can potentially save millions of pounds of CO^2.

Please send this copy to Climate Connection, 1307 Glenwood Avenue, Suite 156, Raleigh NC 27605.
Name _____
Address: (street, city, zip) _____
Phone _____ Email _____

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REDUCE WASTE Avoid products with a lot of packaging. You can save 1,200 pounds of carbon dioxide if you cut down your garbage by 10%.	We will cut down our garbage by _____% and save _____ pounds of CO^2.
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PURCHASE NC GREEN POWER For only $4.00 more on your monthly utility bill, you can add one block of 100 kWh's of clean energy onto the electric grid, replacing 100 kWh's of conventional power. To learn more go to www.ncgreenpower.org.	To discover the reduction in emissions that can result from your participation, go to www.ncgreenpower.org/signup/calculator.html. _____
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Please keep this copy as your reminder.

(THIS IS ONLY A DRAFT)

Minutes

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

Tuesday 3 October 2006
10:00 a.m.
Room 643, Legislative Office Building

The Legislative Commission on Global Climate Change met on Tuesday 3 October 2006 at 10:00 a.m. in Room 643 of the Legislative Office Building with Representative Joe Hackney, Co-Chair, presiding. Other members present were Mr. John Garrou, Co-Chair, Senators Cowell, Pittenger, and Representative Harrison. Other members present were Dr. Ryan Boyles, Dr. Douglas Crawford-Brown, Mr. Walter Clark, Dr. Dolores Eggers, Dr. Edward W. Erickson, Dr. George Everett, Mr. Robert Glaser, Mr. Michael Nelson, Mr. Mitchell Peele, Mr. Tim Profeta, Dr. Stanley Riggs, Mr. Michael Shore, Mr. Robert Slocum, Dr. Stephen Smith, D.V.M., Mr. James Stephenson, Mr. Tim Toben, Mr. Ivan Urlaub, Ms. Susan Tompkins, Dr. Godfrey Uzochukwu and Ms. Vicky Will. Staff members present were George Givens, Commission Counsel, Jeff Hudson, Commission Counsel, Jennifer McGinnis, Commission Counsel, Jennifer Mundt, Research Analyst, Thelma Utley, Commission Clerk and Mary Watson, Commission Clerk.

A copy of the meeting notice for this meeting, a copy of the agenda and the visitor's registration are attached to these minutes as Exhibits **A, B, and C**.

Representative Hackney opened the meeting, welcomed the newest members of the Commission, and asked them to introduce themselves. The President's designee from Progress Energy, Ms. Vicky Will, said she became the Director of Environmental Services in April and prior to that was the plant manager of the Cape Fear plant in Chatham County. The President's designee for the Citizens for Business and Industry is Lewis "Lew" Ebert, who was not present today, and the new State Climatologist, Dr. Ryan Boyles, replacing Dr. Sethu Raman who recently retired, said he has been with the State Climate office as a graduate student and then as a scientist since 1997 and was appointed State Climatologist, effective September 1, 2006.

Representative Hackney called on Mr. Givens for his remarks and to explain the agenda. Mr. Givens welcomed guests and asked them sign the visitor's registration. He also reminded members to sign their reimbursement sheets and return them to the clerks.

Mr. Givens noted that a copy of Senate Bill 1591 extending the legislative Commission on Global Climate Change and a copy of a list of recommended speakers for the Commission had been placed on each member's desk. These handouts are listed as **Exhibit D**.

Mr. Givens also announced a change in the Environmental staff. Tim Dodge, Commission Analyst, was recently accepted to law school at UNC-Chapel Hill and

has been replaced by Jennifer R. F. Mundt. An additional Research Assistant is in the process of being hired.

Mr. Givens said that a revised roster had been distributed reflecting all of the Commission members and staff changes. He asked members to make sure that all of their information was correct. A copy of the new member roster is attached as **Exhibit E**.

Mr. Joshua Bushinsky, State Solutions Fellow, Pew Center on Global Climate Change, gave a report on actions taken or under consideration by other states to address global climate change. A copy of his slide presentation is listed as **Exhibit F.**

Mr. Bushinsky said that one of the things he works on is to track and analyze actions across the country and work closely with commissions such as this one as well as state officials to help inform climate policy based on the best available science, economics and the lessons learned from other government entities that have begun to address climate change.

Mr. Bushinsky said he would focus on recent state actions, of the most interest to the Commission, that have occurred over the past six months and to give some background on how some state, national and other entities have begun to set targets for greenhouse gas emission reductions.

Mr. Bushinsky said that the pace of policy development and diffusion with regard to state action over the past year and a half has increased rapidly. States are acting for a variety of reasons. There are concerns about impacts from climate change, changes in weather patterns that will cause droughts, wildfires, increases in intensities of storms and damage to tourism, industry, to water resources, etc.

Mr. Bushinsky said they had also seen concerns about economic development, both hedging against impacts to the economics of the state as well as looking for opportunities for how to address climate change in ways that improve the states' economy and provide robust opportunities for innovation and export of technologies and strategies to address climate change.

Mr. Bushinsky said that part of the motivation is dealing with price volatility for energy resources which drive a number of states to adopt policies. Energy dependence is another concern as well as addressing greenhouse gas emissions in the context of other air quality concerns. Traffic congestion and other policy goals have been drivers for policies that are reducing greenhouse gas emissions in states and cities across the country today.

Mr. Bushinsky said that what has changed over the year is that states are beginning to act on climate change because they are realizing that to act on climate change is to get ahead of the regulatory curve. There is an increasing consensus that, over the next three to five years, the federal government is likely to address climate change in a comprehensive and mandatory way. And, the result of that policy may be that there are states that are winners and states that are losers. There are industries that will win and industries that will have to try harder to address these policy concerns. What states are realizing is the earlier they act on climate change the earlier they can

offer incentives for their state industries and entrepreneurs to develop the technologies and policies that will address climate change. They will be able to export to the growing market for these technologies the solution those other states and other nations are already demanding.

Mr. Bushinsky said there is action across the country on policies from energy, transportation, agriculture and forestry, directly addressing greenhouse gas emissions and indirectly addressing greenhouse gas emissions in order to achieve other policy goals. Legislatures and governors are acting and there is a bottom up drive for policy innovation from citizens who are realizing that the impacts to their states and opportunities that climate change creates for their economies and there is top down recognition from high place government and elected officials that this is a problem they need to address, now. States are not acting to drive federal policy but they believe in doing what they are doing.

Mr. Bushinsky said that the Regional Greenhouse Gas Initiative (RGGI), a program to cap and trade carbon dioxide emissions from power plants, in a set of New England and Mid-Atlantic states has made an enormous amount of progress over the last six months. The RGGI will stabilize emissions at current levels from 2009 to 2015 and reduce emissions of carbon dioxide by 10 percent from power plants by the year 2019. In August, the group of states developing this program has put together a model rule that each state would have to adopt individually, either through legislation or regulation. This will form a market for carbon dioxide reduction from power plants as well as incentivizing opportunities to reduce emissions outside of the power sector and sell those emission reductions to power plants that find it more cost effective to reduce their emissions.

Mr. Bushinsky said that Maryland, which was not one of the states originally part of this program or its development, passed a bill in April 2006 to compel the state to join this program. The legislators in Maryland saw that addressing climate change and carbon dioxide emissions as part of a broader strategy to reduce the environmental impacts of their power sector. This is the first state outside of the program that has joined and there is possibility of other states joining this market to achieve the lowest cost emission reductions from their power plants.

Mr. Bushinsky said that California recently passed legislation, AB32, Global Warming Solutions Act of 2006. Fran Pavely, an assembly member, introduced the California vehicles legislation passed in 2004. Eleven states are now poised to follow those rules. She also introduced a bill to set into law the cap that Governor Swartzeneger had proposed last summer. After seeing the amazing amount of attention that this the clean vehicle legislation garnered, the Speaker of the Assembly became the co-sponsor and lead sponsor of this bill and pushed through an agreement with the Governor in August 2006. What this bill does is set into law the Governor's target of establishing an executive order to achieve 1990 levels of greenhouse gas emissions by 2020. That is essentially equal to about a 25 percent reduction in greenhouse gas emissions compared to business as usual. This is the first enforceable statewide program to cap industrial greenhouse gas emissions. It not only covers power plants but also a variety of sectors and there will be opportunities across the state to reduce emissions to achieve this target. It leaves a lot up to the regulatory process.

Mr. Bushinsky said that one of the key parts of this legislation (AB32) is that is authorizes the implementation of market based mechanisms such as the cap and trade mechanism used in the RGGI that allows different entities to either reduce their own emissions beyond their targets and sell those to other entities or for entities to buy emission allowances to achieve their targets as opposed to making reductions within their own business.

Mr. Bushinsky said that California has been extremely active on this issue and have put together an electricity performance standard which sets a standard on both instate electricity generation and on out of state imports of electricity generation in terms of the environmental attributes that this electricity has. They have also upped their renewable portfolio standard now slated to achieve 20 percent of its electricity by 2010. This is an ambitious goal but one that is in line with what many other states have done. There are now 22 states, plus the District of Columbia, that have such renewable portfolio standards that mandate a certain percentage of electricity generated from renewable sources.

Mr. Bushinsky said there are continuing efforts in California, including the vehicle greenhouse gas standards and a number of other initiatives including a carbon adder, that compels utilities to think about the impacts of their investment in terms of greenhouse gas emissions over the lifetime of the plants and contracts that they sign for and build. The public utilities commission is also developing a cap on greenhouse gas emissions that will be dovetailed into the efforts by the legislature to cap greenhouse gas emissions. This is another good example of policy diffusion that the states have the ability to either follow federal or California standards for vehicle emissions. The California standard is currently being challenged. If it survives legal challenge, there are 11 states poised to adopt this standard, which is over 30 percent of the new vehicle market.

Mr. Bushinsky said that a huge issue for states over the last six or eight months has been gasoline prices. In response to the developing market for alternative fuels, 10 states over the past six months have adopted either standards or incentives for renewable fuels. This has been an explosion over the last six months and achieves a number of policy goals. It helps states hedge against volatile energy crisis, it achieves a measure of energy independence for states and for the nation instead of importing oil or producing vehicle fuels at home using crops grown in the United States, and it has environmental benefits. If this is done right greenhouse gas emissions can be reduced substantially. But, the caveat is that if you make the ethanol using corn, you get less of a benefit than if you use cellulosic ethanol produced from the woody biomass from plants. That provides more in the way of greenhouse gas benefits. Brazil has been very successful in doing this with sugar cane.

Mr. Bushinsky said that this Commission is one of a number of commissions that are actively working on climate change across the country. Over the last year, there have been a number of states that have begun to consider their options to mitigate the impacts of climate change, to find economic opportunities to address climate change, and to figure out how to export those solutions to other states and profit by doing so.

Mr. Bushinsky said that Arizona recently came out with an emissions profile, which is not a state that is traditionally led on environmental policy initiatives. Fossil fuels are part of their economic strategy. They are also concerned about impacts from climate change in terms of drought, heat waves, wildfires and water resources. There has been enormous growth in this state over the last 10 years and is projected to continue. The growth in the state has driven greenhouse gas emissions and ambitious targets to achieve reduction in greenhouse emissions will need to come while they are still growing.

Mr. Bushinsky said that, after the report of the Governor's Advisory Commission in Arizona, an executive order was issued that set ambitious goals for the state in reducing greenhouse gas emissions to 2000 levels by 2020 and a 50 percent reduction below 2000 levels by 2040. The elements of this plan are diverse. There are 47 recommended actions and they cover the breadth of the economy.

Mr. Bushinsky said that this brings us now to 12 states with targets for greenhouse gas emissions. He referenced the handout showing the state and regional targets for greenhouse gas emissions as well as proposed federal targets and targets adopted by other countries. He noted that the targets adopted by other countries are targets that those countries are actually working towards today. The federal legislation is all proposed. This gives a good sense of what the range of targets are and what people think is possible.

Mr. Bushinsky said that states generally tend to have a variety of emission targets. A short term target to compel action today and to serve as a metric for success are reductions in line with what scientists believe are necessary to avoid dangerous climactic change; 80 percent by 2050 is what California has adopted and a 2040 target for Arizona. While the magnitude of that reduction may seem overwhelming; the important part is taking the first step. The sooner that states begin to address global climate change, the less costly and easier it is for states to achieve those goals. And, it will help them move into working under a federal system that many people anticipate will come into a fact within the next five or ten years, depending on how optimistic or pessimistic people are.

Mr. Bushinsky said that the short term targets, as in the Arizona process and in many other processes, come from looking at what is achievable today, using strategies that have been adopted elsewhere and using technologies that are on the shelf today. Companies have done similar things in setting their own targets. A number of examples include BP, which achieved early and at profit their greenhouse gas reduction targets. DuPont was the same story and Entergy has also met its goal to stabilize carbon dioxide emissions from their U.S. generation at 2000 levels by 2006. And, there are also opportunities in sectors you would not normally think of. IBM has reduced it carbon emissions from its semi-conductor manufacturing process significantly. These are in many cases a cost saving to these companies.

Mr. Bushinsky said that companies also have longer term aspirational goals. Forty percent reduction in greenhouse gas emissions by 2020 is similar to those longer term aspirational goals that many states have adopted.

Mr. Bushinsky said it is helpful to look at what has been done elsewhere. The target sheet shows what other people in reasoned and considered processes have thought

are appropriate and achievable for their states, countries and companies. What is important is defining a baseline. There is a difference between returning to a given level versus projecting your business as usual emission reductions. It is important to think what sort of growth is expected and what sort of opportunities are anticipated. Many of the options that exist for greenhouse gas emissions can achieve other policy goals. It is important to think about the cost, the co-benefits and how you can achieve other policy goals to reduce greenhouse gas emissions. Many states and companies have done this, and across the world people are developing technologies and strategies to do this.

Mr. Bushinsky continued by saying that within this country and across the world, we are seeing these emerging markets for greenhouse gas emission reductions and for clean energy. The RGGI is likely to be the first mandatory program that goes into effect in the U.S. California will likely follow closely behind. These are markets where people can participate and either reduces emission outside of the power sector and outside of the region and sells those emission reductions into that region given a set of constraints that has been set up by the state. This is a real opportunity that many innovators and entrepreneurs are starting to take advantage of.

Mr. Bushinsky said that based on a long research process, the Pew Center has found that the benefits from just incentivizing technology development and adoption or just setting caps on greenhouse gas emissions make the cost much higher than pursuing a two prong strategy to both push and pull emission reduction opportunities and strategies into the market. By both setting a clear cap that sends a price signal to the market and unleashes the power of the market as well as supporting those technologies that require to get through some hurdles to be brought to market, you can most effectively achieve reductions and similarly you can begin to create the industries lowest costs. If you put money on the table and show a clear incentive to do something, someone will find a better way to do it.

Mr. Bushinsky said there are a couple of emerging markets listed for renewable energy credits as well as for energy efficiency. In Oregon and Washington there is a standard to offset emission reductions from their power plant. This is reducing emissions outside of the power plant in order to offset the greenhouse gas emissions from those plants. There is a voluntary effort in the Chicago climate exchange where both business and government entities sign up and commit to a given amount of emission reductions under a legally binding contract. All of these markets are going to create a strong incentive for innovation. If you can set the conditions to do it in your own state and region, you can help get ahead of the curve that folks are anticipating at a federal level. You can get your businesses, industries and entrepreneurs to become the winners in this game as opposed to getting behind the curve and having to catch up once those regulations come down the pipe. Doing that early can help earn emission reduction credits under a federal program. There is a precedent for this in other market systems and can help create the conditions to move ahead of the curve and addressing a regulatory regime.

Mr. Bushinsky concluded by saying that the pace of action on climate change has steadily increased. The lessons that are available from other states are helpful in deciding how to effectively address greenhouse gas emissions. The targets provide certainty for companies, they provide a metric for success for government and enforced targets with penalties provide an incentive and propel the market forward

for greenhouse gas emissions and the technologies that are going to be necessary to achieve the clean energy feature that we require and avoid the dangerous climactic change impacts that are coming down the pike if we don't act sooner as opposed to later.

Dr. Everett said, "North Carolina has passed some landmark legislation to address the emissions of NOx and SO2. One of the things that were an encouraging sign was, if steps were taken early, there would be some credit given in the future for actions. It wasn't long after the Clean Smokestacks Legislation passed that we had federal legislation that gave us targets that are even lower. And, now we can't use those credits we earned to meet the federal targets. So, when you suggest that maybe we will have this opportunity to use what we do now to address what might happen in federal legislation, it makes me nervous."

Mr. Bushinsky said he understands Dr. Everett's concern and the precedent that he was referring to was a program to address acid rain. It is certainly a possibility and what is important and what the Pew Center and other organizations that have studied this have found is that one of the important factors is actually state level lining of the federal government to make sure that those early reductions. And, in North Carolina's case with the Clean Smokestacks Act, there are fewer states to band together with and lobby for those. With greenhouse gas emission reductions, there are enough states that have already begun to take action that there is likely a sizeable lobbying effort that is a possibility.

Dr. Everett said that we would be able to trade in the federal program except we have a prohibition against doing that. He said, "The other thing that this suggests to me is the fundamental principle that was in the Clean Air Act always guided these activities around the state to avoid a situation where you create a shopping center attitude. For example, if you are a new industry and you are going to look for where you might put a new facility, the Clean Air Act gave us a set of federal standards by which no matter where you went there would not be an incentive for you to locate based on what you might have to meet in terms of an air quality standard so that the playing field was even. You would not decide to go to South Carolina because they had less stringent air regulations versus North Carolina. But, when we do these things on a patchwork basis, we do just that strange incentive to find the state with the climate that is the best for you to operate in. If you look at the map of states that have taken action and look at their utility rates, I think you will see what we are creating is that same patchwork opportunity."

Mr. Bushinsky said that Dr. Everett's point about a patchwork opportunity is absolutely correct and he thinks that the stated position at the Pew Center is that they much prefer federal policy to do this. The important issue is how the policies are developed and whether you can create both the push and pull for innovation.

Mr. Profeta said that in the Clean Air Act, credit for early action was written into it and the reason North Carolina didn't get it was because it didn't happen in the legislature, it happened in the administration. He said he was tracking every piece of federal legislation out there and every single one has a provision for credit for early action. There has been a registry in place, federally, since 1992 to allow those emission reductions to be tracked. So, it is an absolute important point that there is legislative action taken.

Mr. Profeta said that the point to be taken in Mr. Bushinsky's presentation is there are market opportunities that are available in North Carolina. In RTP we have a thriving biotech industry and we should be trying to grab that and create the right signals.but not create a situation where people decide to locate outside of our borders. He would submit there is a sweet spot in between that we should be shooting for.

Dr. Everett agreed that there are certainly opportunities; we just need to be careful as we move forward. In fact, what kept us from participating in the federal trading program was not activity at the federal level but activity here in North Carolina.

Representative Hackney said it was a retirement of the credits.

Dr. Everett said that was correct but at that time there was no federal legislation.

Senator Cowell asked Mr. Bushinsky if he had information on the commercial consumer utility rates before and after actions were taken.

Mr. Bushinsky said that most of these actions are all anecdotal at this point. There really has not been any data collected yet; however, some of these renewable energy sources have come out winners under high gas prices and so forth. It is anticipated for most of the public utilities commissions that have approved them have done studies and work to mitigate rate impacts.

Senator Pittenger asked Mr. Bushinsky if he was aware of a letter sent by 60 climatologists to the Prime Minister in Canada regarding their commitment to Kyoto and their concerns regarding the implementation of Kyoto relative to the lack of significant effect in other countries and the fact that the cost related to it as well as the lack of science that these climatologists feel is not sufficient to support Kyoto is similar to the mandates the Pew Center is suggesting.

Mr. Bushinsky said he was not trying to tell North Carolina what mandates and goals to set. But, in regards to claims by a very small minority of sets of climate scientists, it has been made clear that both the science has strengthened over the last five years and the overwhelming consensus among climate scientists that the science is compelling and that action is required.

Mr. Peele asked Mr. Bushinsky about the need to get ahead of the curve and especially the regulatory curve at the federal level. He said that most of the examples in his presentation cite states that are taking legislative or regulatory action to mandate changes in action. He asked Mr. Bushinsky to give some more examples of voluntary things that states are doing other than the carbon credit trading program and some success that have had with that.

Mr. Bushinsky said that there are a variety of both voluntary and mandatory programs that states have adopted: renewable portfolio standards that have set mandatory standards, and likewise public benefit funds that have set aside funds from pay for renewable and energy efficiency improvements as well as a variety of voluntary actions taken to incentivize alternative fuels both here and in many other states to address smart growth and agricultural greenhouse gas emissions. What has been clear nationally and state by state is, while voluntary initiatives can help

drive some amount of action, mandatory emissions actually drive real reductions and help companies and states think more clearly about where the lowest cost emission reduction opportunities are in both of these voluntary incentives and mandatory policies to provide the cheapest way to achieve reductions. There are both federal and state level voluntary programs to reduce greenhouse gas emissions in the building sector and energy sector but it is not clear that these voluntary efforts have actually achieved more than real modest success for the most part. There have been some voluntary standards such as Energy Star which is an appliance efficiency standard that manufacturers can meet that have had a fair amount of success in reducing emissions from power.

Mr. Shore said that Dr. Everett's comments on federal and state standards brings up what he thinks is an opportunity for this Commission and an area where we can make a difference. There is a large acceptance that there will be federal standards to reduce global warming pollution. Duke Energy has called on the federal government to cap global warming pollution and we don't know how far that will be down the road. However, we in North Carolina have a great interest in what those federal standards look like to make sure that the business sector in our state can win in the standards that come down the pike. We need to make sure that our hog industry and agricultural and forestry industries have an opportunity to play well and participate in the carbon market place. So, food for thought for us as a Commission is how we figure out where we can make a difference of setting out principles or guidelines that we share with our Congressional delegation on what we think federal standards should look like so that North Carolina's economy can win and where we could chose to put some effort.

Mr. James Y. Kerr, II, Commissioner of the North Carolina Utilities Commission, gave an update on the study by the Utilities Commission of a renewable energy portfolio standard.

Mr. Kerr said he was asked by the Environmental Review Commission to present an update on the study being conducted by the Utilities Commission on the cost benefits of a renewable energy portfolio study. He said that both his presentation and Mr. Gruber's presentation are a good follow-up to Mr. Bushinsky's presentation.

Mr. Kerr said that he would talk about a more discrete effort the Utilities Commission has been funding and supervising in North Carolina to look at a renewable portfolio standard.

Mr. Kerr said there has been a growing interest in looking at renewable energy as a means of meeting the state's growing demand and hopefully having a less harmful impact on the environment. These resources have traditionally, in terms of their delivered cost, been viewed as more expensive than some of the traditional fossil fuel based generation technologies. So, when you think about renewable energy, one of the concerns is what the cost impact is on consumers.

Mr. Kerr said that a number of states have adopted a renewable portfolio standard which is to require a certain percentage of the generation provided and used in the state to come from various renewable technologies. North Carolina does not have a renewable portfolio standard. We do, however, have a voluntary green power program. It is the first voluntary state program in the country. All customers in the

state have the ability to voluntarily pay an additional amount of money each month on their electric bill to purchase blocks of renewable energy.

Mr. Kerr asked a show of hands for those who are signed up for green power. He said this has been a successful program and the state's initial step towards trying to support renewable energy. The logical step in the continuum would be to require a certain percentage of generation.

Mr. Kerr said that the ERC asked the Utilities Commission if they would fund and oversee the study on renewable portfolio standards. They agreed to do this with the goal of conducting a conclusive study that would involve and reflect the views and opinions of all of the relevant stakeholders.

Mr. Kerr said the goal of the study is not to make actual policy recommendations but rather to come up with an objective piece of analytical work to provide to the General Assembly that would be informative and useful as they wrestle with some of the actual policy decisions that are needed to be made.

Mr. Kerr said they also wanted to obtain the services of a national, high caliber and experienced consultant who had done this type of work before and who would work with the representatives of the stakeholders here in North Carolina to design and conduct and present the study when it is completed. Another goal is to complete the study before the General Assembly reconvenes in January 2007.

Mr. Kerr said that in February 2006, after receiving the request, they first formed the Renewable Portfolio Standards Advisory Group (RPSAG). Members of the GCCC who serve on the advisory panel are Dr. Erickson, Mr. Urlaub and Mr. Howard. He added that other members are Mitch Williams from Progress Energy, David Beam from the Co-ops, Chris Corocini from Environmental Defense, Sue Gucheau from North Carolina Solar Center, James McLawhorn representing the public staff, and Lynn Green representing the Attorney General's office.

Mr. Kerr said that one of the things they learned in the NC Green Power experience was that they were able to get folks with different viewpoints to work cooperatively through persuasion and by getting them in the room together to work through some of these issues.

Mr. Kerr said that the RPSAG is a group of folks representing the various stakeholder interests and perspectives who have come together to try to help design the RFP. They have a role in the selection of the consultant and to participate in the study and be the local executive committee that would answer questions, provide information, review preliminary results, review the draft final report and guide the process along. The study should benefit from that approach and they believe it will be a fair balanced prospective.

Mr. Kerr said that because the study involved the use of state funds, they had to go through the state's competitive bidding process and lost more weeks than anticipated by navigating purchase and contracting. The advisory group did develop the RFP and contacted 16 consultants who had experience and received five bids. After going through the bid evaluation process, LaCapria Associates, based in Boston, was selected. In July, LaCapria met with both the Commission and the RPSAG to

work on the design of the study. Fundamentally, what the study is designed to do is to discern the impact on electric rates as well as the broader impact on North Carolina's entire economy through the use of standard, widely accepted economic modeling tools. There has been some discussion about some of the additional benefits and costs that might be associated beyond electric rate impacts and the study is going to try to look at things like potential for job creation or offsetting negative impact on industrial rates.

Mr. Kerr said that one of the things that have developed in the course of designing the study was a collective desire on both the part of the Commission and the Advisory committee to look at energy efficiency. Energy efficiency is not classically a renewable energy resource, it is looking at methods that you can lessen and displace load but it obviously is a benign resource. This had not been an original part of the RFP; however, the group thought it should be part of the various scenarios that would be run. A lot of the data needed to do the modeling exists here either with the utilities or with the other load serving entities. Some work has been done at Appalachian State University at the State Energy Office. Some of their role was to hook the consultants up and point them in the right direction and help them access the information that they needed to do the economic modeling.

Mr. Kerr said that a draft report is anticipated in late October with a final report in November 2006. The goal is to meet that target to deliver the report to the General Assembly on December 1, 2006. One of the things they want to do is also provide the opportunity for the various stakeholders to comment on the report. They think it is important to allow stakeholders who are interested to comment on the report. The report will be put out for comment between December and January when the General Assembly convenes.

Mr. Kerr said that the goal is to provide some North Carolina specific objective high quality consultant driven expertise to the GCCC to help in making the kind of decisions they are confronted with.

Representative Harrison asked Mr. Kerr if, when considering costs for renewable energy and energy production, they are taking into account public health or environmental impacts.

Mr. Kerr said they are not taking these things into effect in this study. The study is designed to focus on the inputs of provision of electric service. He said he did not believe they are trying to quantify and calculate what the externalities would be.

Dr. Smith asked Mr. Kerr how many megawatts of generation there is in the RPS program and asked how that compares with what is being generated by the state.

Mr. Kerr said that as voluntary programs go, it is performing at a level that is comparable to other voluntary programs. It has struggled some because of a lack of money available for advertising and public awareness. Some money was obtained in that direction in approving the Duke Merger case. Voluntary programs do not displace the percentage of energy that a mandatory renewable portfolio standard would.

Mr. Kerr said what is interesting is how a voluntary program is necessary to see how many people are willing to pay out of their own pocket short of a policy making body telling people they have to do it.

Dr. Smith asked about energy efficiency and the investment in North Carolina.

Mr. Kerr opted not to answer Dr. Smith's question. He did say that North Carolina has enjoyed a situation of having lower than national average electricity rates through more traditional means. If you look at RPS or energy efficiency, it is harder to justify them on a cost basis, the lower your other traditional energy production methods are. What has changed is, as we look at the demand growth and we look at the need bring new generation online, the open question for all of us as policymakers about what makes sense going forward. For the last few years, we have enjoyed the cost benefits, as compared to other parts of the country, of the nuclear investments that we made historically. They were expensive to get in the ground. But once they are up and running they are, on a marginal basis, cheaper to run. Coal and gas are the same; however, there are higher commodity prices out there in the market and a need for new generation.

Dr. Smith asked Mr. Kerr if he was comfortable in talking about how the Commission is viewing the concept of carbon risk in utility investments and where they stand on this issue.

Mr. Kerr declined to discuss Dr. Smith's request; however, he said that as we look at investments you might make in traditional fossil fuel type generation, there is an effort in the integrated resource plans that are filed with the Utilities Commission in building new generation. The proponents of different types of generation have raised the question about how you discern the future cost of the choices you make given the uncertainty about carbon regulation. There is an effort made to model what the various scenarios would be. The question now is what we do going forward and what the carbon regulation environment is going to be and what that will cost. If we look at coal and somehow think there will be a carbon tax, this obviously will affect the cost analysis.

Mr. Shore encouraged everyone to sign up for Green Power. He also commended the Utility Commission for embarking on the RPS portfolio study and the process they are going through. It looks like a credible process. One of the results produced will be how different renewable energy sources or efficiency will impact rates and the total cost that North Carolinians pay for electricity.

Mr. Shore asked Mr. Kerr about carbon and what one of the results would be with regard to how much carbon emissions would be under various scenarios and add renewables to the grid. And, if not, would it be possible to give us carbon impacts as well.

Mr. Kerr asked Mr. Urlaub to answer this question.

Mr. Urlaub said that what he understands so far is that the advisory group has been tackling the components of the study and no decision has been made with reference to carbon.

Mr. Shore asked that this be included in the study.

Mr. Kerr said that in doing the modeling, what they are looking at is what a base case is, and what the availability of various resources is.

Mr. Robert Gruber, Executive Director, Public Staff, North Carolina Utilities Commission, gave a report on the proposal by the Public Staff of the North Carolina Utilities Commission to create a public benefits fund. A copy of Mr. Gruber's handout is listed as **Exhibit G**. Below are his comments in entirety.

The Public Utilities Act states that, in planning for future growth of reliable utility service, it is the policy of the State of North Carolina to "include use of the entire spectrum of demand-side options, including but not limited to conservation, load management and efficiency programs" so as to result in the "least cost mix of generation and demand reduction measure..."

The NCUC has been considering demand-side management (DSM) options along with supply-side options such as new power plants for over 20 years. During the late 1980s and early 1990s, activity before the Commission involving DSM was fairly vigorous, and there were major expenditures made by the utilities on DSM programs. However, during the later part of the 1990's DSM fell out of favor in NC and around the nation due to several factors:

1. Retail competition seemed imminent and there was a danger that utility expenditures for DSM would be stranded;
2. The need for expensive base load plants declined, and new natural gas plants were becoming less and less expensive;
3. Natural gas and coal costs declined;
4. Wholesale competition allowed utilities to make economical purchases of firm power from neighboring utilities; and
5. Rates in NC and the Southeast were low relative to other regions and this made it difficult for many DSM programs to "prove in."

As a result of the focus on competition and the accompanying de-emphasis of DSM, the NCUC streamlined its IRP rules and did not hold evidentiary hearings regarding resource planning for eight years. During the past few years, the energy environment has changed dramatically and the pendulum has swung back in DSM's favor. Retail competition has not developed as expected and many states, including NC, are no longer considering it. Rapid customer growth has created a need for new base load power plants, and coal and natural gas prices have risen dramatically, causing larger fuel cost adjustments.

In 2005 and early 2006 it became obvious to the NCUC that it needed to place demand-side management and renewable energy back on the "front burner" and it took several important steps.

1. The NCUC decided to conduct a study of the potential for a renewable portfolio standard (RPS) in North Carolina. This study would determine whether the utilities should be required to supply a

certain percentage of their power from renewable energy such as wind, solar and biomass. This study will assess the technical and the practical potential of renewables and the costs and benefits of an RPS.

2. The NCUC decided to hold an evidentiary hearing for the first time in eight years and set the following issues for hearing:

   (a) The validity of utility forecasting methods;
   (b) Whether the utilities are employing and developing adequate DSM and displacing the need for additional generation assets;
   (c) The potential opportunities for cost-effective energy efficiency and conservation;
   (d) The degree to which utility programs can effectively reduce consumption; and
   (e) What funding mechanisms could be employed to implement specific energy efficiencies measures?

3. The NCUC decided that progress on certain issues could best be made in a collaborative setting rather than an adversarial hearing, and ordered the Public Staff to conduct a collaborative workshop on these issues and include all of the important stakeholders. The issues to be considered were the following:

   (a). The criteria that the Commission should consider in deciding to approve a DSM program in the future;
   (b) Whether the Commission Rules on IRP proceedings should be changed to allow for more expansive review of efficiency and conservation programs in future IRP proceedings.;
   (c) Ratemaking issues, such as "decoupling" of sales from profits;
   (d) Carbon regulation; and
   (e) Renewable portfolio standards and public benefits funds.

The Commission stated that consideration of these issues by the workgroup could prove beneficial to the Commission in its efforts to remain adequately informed about important industry issues. It ordered the Public Staff to report back to it any agreement or consensus reached during the workshop.

The hearing on the utilities' 2005 Annual Resource Plans was held on June 27-28, 2006. Both Duke and PEC testified that they had 15 to 20 ongoing DSM programs. Duke testified that its programs had reduced 2005 peak demand by 722 MW, and PEC testified that its programs had reduced demand by 374 MW.

The NCUC issued an order on August 31, 2006, approving the 2005 integrated resource plans. The NCUC found that the utilities' forecasting methods were adequate and that "the utilities' development and deployment of DSM resources for the purpose of displacing the need for additional generation assets is adequate for the 2005 IRP, but may not be adequate for future proceedings."

The Commission's Order required that future IRP filings by the utilities include a more comprehensive analysis of their DSM plans and activities, including cost/benefit

information, and required the utilities to cooperate with the Public Staff and other interveners in reviewing and designing programs.

During the hearing, the utilities and some of the environmental witness testified that utilities have a disincentive to develop and implement DSM programs, which increase annual utility expenditures and result in lower kWh sales. The utilities recommended that the Commission approve some form of rate recovery rider to allow timely recovery of their capital investments, operating and maintenance expenses, programs costs and any incentives paid to customers.

In its Order, the Commission reviewed the history of the funding of DSM programs and the ratemaking treatment of DSM costs and stated that "it is premature to settle on any particular funding mechanism or ratemaking treatment as a means of meeting the policy expressed in G.S. (62-2(3a)." With regard to lost revenue, the Commission stated that "special ratemaking treatment could be unnecessary if DSM efforts are to be administered by an independent third party statewide", and that, "once the picture becomes clearer, additional steps can be taken to develop or refine any funding mechanisms and ratemaking treatment or to consider innovative funding options, such as a third party administrator of DSM efforts...".

The collaborative workgroup facilitated by the Public Staff met on July 27, 2006, and considered the delegated issues, including whether a cost recovery mechanism should be adopted. Participants in the workgroup were the electric investor owned utilities (Duke, PEC, and Dominion NC Power), the cooperative utilities, the Attorney General, the North Carolina Sustainable Energy Association, Environmental Defense, Southern Environmental Law Center, the Southern Alliance for Clean Energy, the North Carolina Waste Awareness and Reduction Network, Inc., the North Carolina Advanced Energy Corporation, Carolina Utilities Customers Association, Inc., and the Carolina industrial Group for Fair Utility Rates.

On September 1, 2006, the Public Staff filed a report regarding the progress of the workshop. Just as they had at the evidentiary hearing, the Public Staff and the environmental groups again recognized that utilities have a financial disincentive to provide DSM programs. The North Carolina Sustainable Energy Association noted that having an independent third party administer DSM programs, rather than the utilities, prevents the need for special rate treatments to address the lost revenue problem. Vermont and Wisconsin's energy efficiency programs, which use third party administrators, were discussed as potential models. Finally, there were concerns expressed by members of the work group that any cost recovery mechanism, such as a rider or surcharge, might not be permissible without legislation.

There was no consensus reached by the work group regarding whether it should recommend that a DSM cost recovery mechanism be recommended to the Commission. However, the Public Staff decided that cost recovery is critical to significant progress being made in the development and implementation of DSM by utilities and decided that it should recommend that the Commission consider the establishment of a Public Benefit Fund for statewide DSM programs that would be administered by an independent, non-utility third party. The Public Staff stated in the report that "[a] PBF totally avoids the disincentives that the utilities face when

considering DSM programs that reduce their sales." It further stated that the Advanced Energy Corporation, which administers the Green Power program, appears to be a qualified third-party administrator and requested the Commission to solicit comments from Advanced Energy on how it would propose to manage a PBF and finance the development and implementation of DSM programs in the state.

The Public Staff believes that there is a legitimate question as to whether the Commission has the statutory authority to approve a cost recovery mechanism to collect for DSM program costs, including mechanisms that would be administered by either the utilities or a third party administrator. The Public Staff also believes a public benefits fund surcharge should be applicable to the municipals providing electric service and to the electric membership cooperatives, which is clearly beyond the Commission's authority. The Public Staff does not at this time have a proposed draft of legislation authorizing such a cost recovery mechanism, but we would be willing to assist Legislative Staff in drafting an amendment to Chapter 62, if so directed.

Mr. Urlaub asked Mr. Gruber about the idea behind the public benefits fund and making funds available for energy efficiency. Is it possible to find out how the money is spent and could it be measured and help us avoid having to build base load generation power plants. Is it fair to say there is a potential tradeoff where energy efficiency is a supply side option?

Mr. Gruber said it could meet some base load need but, as you know, most of the discussion before the Commission about the potential utilities have to address their needs through Demand Side Management (DSM) is talking about the 200 megawatt range for each utility. Over the next five years, the coal plant at the Cliffside Unit, which Duke Energy has requested to be approved by the Commission, involved 1600 megawatts of capacity. The Utilities Commission does not see any way that even an aggressive DSM program could displace the need for that plant or even delay a plant that is required over the next five years. The same is going to come up if Progress Energy makes an application for a plant. DSM requires an effort by the utilities to spend money on the programs and also requires change in consumer behavior.

Mr. Brock M. Nicholson, Deputy Director, Division of Air Quality, Department of Environment and Natural Resources (DENR), gave an update on and discussion of activities of the Climate Action Plan Advisory Group (CAPAG). A copy of the report from the CAPAG and a copy of Mr. Nicholson's slides are listed as **Exhibit H**.

Mr. Nicholson said he was glad to report that a lot of activity has been underway since the GCCC last met. Mr. Nicholson said that during his presentation there would be comments from GCCC members who are on CAPAG.

Mr. Nicholson said that Mr. Tom Peterson from Climate Change Strategies was present to assist in the presentation and discussion as needed.

Mr. Nicholson said there are 45 members on the Climate Action Plan Advisory Group (CAPAG). There are 11 members of the GCCC on CAPAG. And, on the technical workgroups, or TWGS, there are members on each of the five workgroups, 18 on residential, commercial and industrial, 18 on energy supply, 18 on transportation and

land use and 14 on crosscutting issues, those not necessary source type or source sector specific.

Mr. Nicholson said the first CAPAG meeting was held in February 2006 and the second and third in May and July. At the meeting in July, the group looked at those mitigation options that were to be chosen for the more detailed analysis. A meeting is scheduled for October 12, 2006 in Raleigh. The technical workgroups have had 41 meetings and forty more meeting are anticipated among the five groups between now and May 2007. Additional meetings of CAPAG are expected to number three or four, depending on the need.

Mr. Nicholson said that the purpose of the July meeting of CAPAG was to take what started out to be a large number of potential options; 251 listed in Center for Climate Strategies catalog for state options. Looking across all of the states that have been involved in similar activities, there a number of groups included from our Clean Smokestacks Act and State Energy Plan. In addition, 307 mitigation options were considered for reducing greenhouse gases. A process was gone through with each of the technical workgroups to consider this whole range of options and a vote was taken to decide those 52 options the group felt were the most worthy of more cost and benefit analysis. That is not to say that the balance of those not chosen were not worthy of consideration.

Mr. Nicholson said that among the five groups they ended up with 11 options in the residential, commercial and industrial energy use category, 10 in the energy supply, 13 in transportation land use, 12 in agriculture and forestry, and 6 in crosscutting issues.

Mr. Nicholson referred to a list of GCCC members active in the various workgroups. In July those higher priority items were selected for further analysis and the next step or phase leading up to the meeting of October 12, 2006, is the fleshing out of what those options mean; i.e. defining the options. The process of defining is very much a group effort and in fact some of the individuals on the GCCC are helping to draft these measures in terms of the definition of the measure itself.

Mr. Nicholson called on Mr. Toben, member of the CAPAG, to talk about his role in the working group.

Mr. Toben recognized the Division of Air Quality and the Center for Climate Strategies for a decision making process that is extremely well managed and well run. He said he had spent the last 22 years of his career in the private sector where they pride themselves in efficient, effective well managed operations. Mr. Toben said that this process is highly structured, highly efficient, and is designed to leverage the knowledge and expertise of the stakeholders in the process.

Mr. Toben spoke on behalf of the Energy Supply technical work group. Mr. Toben focused on the environmental portfolio standard (EPS), a hybrid between a renewable portfolio standard, a policy requiring utilities to provide a certain percentage of their retail electricity from renewable resources by a specified date, and an RPS. The difference between the environmental portfolio standard and an RPS is that you are blending a measurable energy efficiency goal with an RPS in order to create this hybrid, referred to as an EPS.

Mr. Toben said that the process in evaluating the viability of these different mitigation measures, looks at the potential emission reductions and cost from each one of these items. This is one item where the potential emission reductions are high (high being defined as at least 1 million metric tons of carbon dioxide effecting at least one million metric tons of carbon dioxide equivalents per year by 2020). The specific cost will be informed by the RPS study that Commissioner Kerr described. Relative to other RPS's across the country we know that the cost relative to the return is low. So, energy efficiency applications that might be married to an RPS might include investment in combined heat and power, a metered solar thermal, and energy star appliance standards. Utilities will have the option either to generate their own renewable energy or to purchase these renewable energy credits (RECS).

Mr. Toben said that the utilities IRP plan from 2005 indicated that the growth in electricity demand will be about 35 percent by 2020. The estimated cost of this RPS is then compared against the portfolio of new nuclear natural gas power, not against existing conventional generation resources.

Mr. Toben said there are currently 22 states, plus the District of Columbia, that have an RPS and 13 states that have proposed RPS legislation. These are policies which have induced the private sector to invest $52 billion into the states that have these standards. North Carolina is not the beneficiary of that private capital investment because we don't have an environment that is friends today with these renewable generators. We need those policies if we really want to see significant utility scale renewable generation coming to North Carolina.

Mr. Toben said that no state has repealed their RPS target and several have increased their targets. What we are seeing is, contrary to our intuitive sense, these are policies that are not anti growth. These are not policies that will drag the economy but policies that have stimulated the economy.

Mr. Toben said that when we talk about renewable energy we are talking about two forms: wind and solar and biomass, including wood, landfill gas, agriculture and clean construction and demolition waste. These are resources that would offset base load electric generation, roughly half of which is from coal fired power plants in North Carolina.

Mr. Toben said that if we look across the states today and we take North Carolina's particularities into account, it looks like the recommendation from the technical working group would look like a one to ten percent gradually ramping up a RPS starting in 2008 and moving up to 10 percent by 2017. It would be married to an energy efficiency goal of 10 percent, ramping up from the current period of 2008 to 2020. So, where we believe we could end up in a conservative way that really stimulates the economy and creates little to no drag, is about a 20 percent EPS by 2020 with about half coming from renewables and about half coming from energy efficiency measures.

Mr. Toben said the types of reductions we would see from such a policy would be carbon dioxide reductions that would offset existing coal generation and be put in place instead of new coal generation capacity in the future peaking renewables such as solar and coastal wind, which peaks at high demand times and would offset

carbon dioxide emissions from combined cycle and combustion turbine natural gas facilities. To some extent, renewables would offset carbon dioxide emissions in other areas.

Mr. Toben said that they would also be looking into taking animal waste and landfill gas and converting it to energy. These would reduce methane emissions by changing those to carbon dioxide.

Dr. Everett agreed with Mr. Nicholson and Mr. Toben that we have a structured process which meets a lot. In addition to the technical workgroups, there is the bigger advisory group that has conference calls and exchanges of e-mail, routinely. It is very difficult to keep up with all of the progress being made, but it is being made in the right direction.

Dr. Everett cautioned that the list has been whittled from a couple of hundred to about 50. This list is in no way an endorsement of any concept but simply a list of things that would then get further study to evaluate their cost effectiveness against any greenhouse gas reduction capability. So, they have a long way to go before they have a single recommendation for the Commission to look at.

Representative Hackney pointed people back to slide five where all of the items are labeled "priority for analysis draft potential mitigation options for analysis". This goes along with Dr. Everett's comments.

Mr. Nicholson added that they do plan to follow on analysis once they have decided the definition of the measure and what all of its features are. They would add to that where they think significant opportunity is for economic benefit to the state.

Dr. Everett added that there is some frustration with the energy supply team as this is also a subject of study by the Utilities Commission. So, there is a duplication and overlap that takes a lot of time and effort from those of this Commission.

Dr. Smith complimented the process and said it is moving forward with deliberate speed. Although they have not reached any firm conclusions, they have the outline and methodology by which they will be able to come back to this Commission with some good analysis and objective facts about what is available to the state. We need to establish a good baseline and recognize where the problems are to be as proactive as possible.

Mr. Profeta recommended that, as a Commission, we discuss how to align our work plan with everything else that is going on. We need to work out a plan to work in tandem and collaboration with these processes.

Mr. Profeta said he had two questions for the energy supply workgroup. One is in the analyses planning, how much are you looking at the effects of other criteria pollutant programs? And, would there be some way to allow for some type of comprehensive permitting for other air pollutants as well as carbon?

Mr. Nicholson said we would definitely want to look at that. He called on Mr. Tom Peterson with CCS.

Mr. Peterson added that they are now in the process of trying to firm up policy design, focused on what to do and then on how to do it. He said at some point they would be able to take a look at the wide range of options on the table and see if there were some more cross cutting implementation mechanisms that might be brought into play in support of the packages the group is beginning to focus on. They anticipate those issues would come up at the next meeting on October 12, 2006.

Mr. Nicholson responded with the efforts underway regarding RPS and public benefits fund, they would want to look at policy design. They could certainly provide some additional analysis for those approaches being looked at by the Utilities Commission and offer some analysis on certain other options.

Mr. Profeta asked if the benefits would be looked at with regard to other emissions and how to avert other emissions.

Mr. Peterson said they were looking at the will of the group to identify those key issues.

Dr. Everett said that someone may be able to help in answering Dr. Smith's question on how to measure where we are in energy intensity. One of the things we need to be careful with is, with the rate of growth occurring in the state, we are going to have a change in the baseline no matter what we do. One of the things we can look at is energy intensity across a time curve which will give us a better measure of how we are performing.

Representative Hackney asked Dr. Everett to explain energy intensity across a time curve.

Dr. Everett explained that it was energy we use in developing products in this state per state gross product versus how we are doing compared with other economies around the country.

Mr. Peterson said that in the inventory and forecast report developed, there are measures both of absolute emissions and relative emissions rates broken down by all of the sectors that will be focused on in the next week.

Following the lunch break, Mr. Michael Shore was called on to discuss Residential, Commercial, and Industrial as well as Transportation and Land Use.

Mr. Shore said that part of the opportunity for this Commission is to see what things on the list is worth our debate in the near term and which of the things should be waited on for the CAPAG process to be finalized.

Mr. Shore said that one of the issues is the energy efficiency funds which may impact the global warming issue in the carbon emissions. Another issue that seems interesting is the building codes. There is tremendous opportunity in the building sector to be more efficient with the energy that sector uses and how we can use building codes to improve energy efficiency and reduce global warming pollution.

Mr. Shore said that education is also important and is one of the things that are a barrier for us to be able to have more renewables. We do not have a trained

workforce to help homeowners and businesses implement such measures. We should be using our excellent community college system or other educational resources to develop the infrastructure and train the people to do this work. These are near term considerations.

Mr. Nicholson added that while we have not tallied the numbers for these measures in our process, what has been observed in other states is one of the largest and quickest ways to get greenhouse gas reductions is through the energy efficiency energy conservation area.

Representative Hackney said that we have a State Energy Office that is actively working on that already and we have various energy saving initiatives in state government. There is also real significant energy efficiency in the private sector.

Mr. Garrou asked Mr. Nicholson if there was any effort to correlate the economics of energy efficiency with the reality of the useful life of a particular facility.

Mr. Nicholson said that one realization they have is, with any of the options they pick, the numbers have to work from an economic standpoint. They design the option to allow for it to work.

Mr. Peterson said that the payback periods are explicitly looked at and are particularly shorter term. The questions that typically come up are questions such as what standard payback period in the market these things will work under standard payback. If they don't work, how much can they be stretched for various reasons and how best to stretch them.

Mr. Peterson said he did not know exactly where the payback numbers are on this. They certainly could be provided but he believes that they are pretty near term.

Mr. Nicholson added that the work group is working closely with members from the State Energy Office. In current drafts under this category, those activities they have or are initiating are in terms of energy savings.

Mr. Urlaub added that there are 15 corporations in North Carolina called the Energy Services Corporations who provide performance contracting services to the state government through a current law which was just expanded in the last legislative session. This was doubled in size from $50 million to $100 million in contracts in place at any given time and was expanded to include water resources as well as energy.

Mr. Urlaub said that one of the things they learned in the Energy Independence Act last year was with state facilities, even though the government owns the facilities, there is no common disconnect between builder and home buyer or commercial lease with government. Matching that up with the savings and subsequent years in the operations budget is a challenge before us as a state. It is very difficult to estimate the energy savings or avoided energy costs of building a more energy efficient building in North Carolina. This is a change that could also impact other aspects of government as well.

Representative Hackney asked the members their feeling about green power purchasing. He asked if we wanted to wait for the Utilities Commission studies to play out before jumping into that or is there sentiment one way or the other on that subject.

Dr. Eggers said that some students at UNC Asheville have done a recent analysis of what it would take for us to offset our total electricity consumption with green power. Last year we consumed 15.8 million kilowatt hours. They found that Renewable Energy Choice in Bolder, CO is only 1/5 the price of N. C. Green Power. N. C. Green Power is extremely expensive when compared to national competitors. So, she said that if want to do this, she would want people to buy from outside of the state where there appear to be more efficient markets and more competition.

Dr. Smith asked Representative Hackney if he was talking about the voluntary program that N. C. Green Power has or was he talking about the larger issue of renewal energy as an opportunity for the state going forward on a broader sense.

Representative Hackney said he was talking about the latter.

Dr. Smith said he believes that this is one area where it will be valuable to wait for the study because the voluntary N. C. Green Power program was really not designed for nor has it been carried through to be a program that really leads to significant renewable energy investment in the state. It is a leading edge kind of program that provides a certain amount of value in customer education in letting early adopters who are willing to put some money on the table initially to give them choice, but it isn't designed for nor was it really constructed to be a program that really gets you megawatts.

Representative Hackney asked what the program was designed for.

Dr. Smith said it was designed to provide some customer education about renewables, to meet a certain level of frustration within the early adopters in the market who don't have a choice, and it is a program used extensively by utilities as a public relations program to say that they are doing something on the area of renewables.

Mr. Toben explained the difference between a voluntary program and a RPS or mandated program from a renewable energy corporate viewpoint. The voluntary program can't work at large scale because you need forward guarantees of ten to twenty years in the form of power purchase agreements from the utilities to purchase hundreds of megawatts of green energy in order to stimulate the renewable sector in North Carolina. The way that these deals are financed is typically 60/40 debt equity deals. In order to finance a 100 megawatt wind farm, you need to raise $40 million of equity and borrow $60 million of debt. The only way to finance that debt is for the bank to see that there is a long term purchaser, and that purchaser has to be the utilities in North Carolina because of our regulated environment. It really boils down to a scale issue. In order to do any of these deals, you need debt financing at a magnitude that N. C. Green Power or any voluntary program is never going to get to.

Dr. Smith said that he would reinforce Mr. Toben's statement. Dr. Smith said that in the entire program they looked at with other utilities, the N. C. Green Power program

was the only program where the utilities did not put some money up front to guarantee the capital for the renewables to be deployed. That is one of the real challenges with this program.

Mr. Urlaub said that the way they have designed their program, N. C. Green Power does not supply any kind of long term contract purchase to folks. So, what we have is small residential systems. On the up side, this has been a great educational opportunity for us in the state. The first homeowner to connect to N. C. Green Power had to work with the utility four to five years before they finally got their system online. Now we are down to a year. This program played an integral role in learning how to integrate different types of energy generation into our system. Mr. Urlaub did agree that it is limited in its potential even if government decides to purchase a green power to offset its own use. What we would not realize is the market competition because the way the green power program is set up is to facilitate small residential systems. If it got a big infusion of money from the government to purchase really large utility scale systems, which only an out of state company would likely provide, you would not get competitive pricing.

Mr. Shore said that we are fortunate that the Utility Commission has embarked on the study of the RPS and that they are planning on having drafts being done by the end of this year. That gives the advisory committee some real information to work with.

Mr. Shore said, with regard to the energy efficiency issue, we are at a crossroads in North Carolina with our electricity demand. The utilities are moving forward with pursuing new power plants and there is a proposal for the new Duke Energy plant at Cliffside that will raise rates. Many of the energy efficiency opportunities in front of us are going to be half the cost of building a new power plant. Another way we can make a real difference is by figuring out what the energy efficiency opportunities that are cost effective for businesses and households are that make sense for the state as a whole that could put off the need for the new power plant or displace it altogether.

Mr. Nicholson reviewed the Energy Supply Goals listed on page 4 of the slides in Exhibit H.

Dr. Smith said that he had the benefit of listening to a presentation by a company that was doing combined heat and power and following that presentation had a chance to speak with someone from that company who has representation in North Carolina. He said that as we look at upcoming meetings, having more discussions of combined heat and power may be a very useful exercise for all of us. Anywhere from two thirds to one half of the heat which is energy goes overboard. Capturing that heat and putting it to use for industrial processes is a tremendous benefit to looking at issues around carbon emissions and increasing industrial efficiency and ultimately increasing better use of the fuels that we use.

Dr. Smith said he would be willing to share some information in a briefing of combined heat and power for our group in the coming months.

Representative Hackney said that he believes the power plant at Chapel Hill does this by heating the dorms with waste heat.

Mr. Urlaub said he was curious about what other members of the Commission think about the economic benefits side of a combined heat and power system that could have a cost recovery of a decent period which could free up money for a business such as an industrial facility or a farm application.

Mr. Givens said that the study by Dr. Mike Williams at NCSU, to identify environmentally superior and economically feasible technologies, is complete. Now the question is what we do to implement it.

Mr. Toben said he would be interested in hearing from the utilities about the cost structure at a high level of pulverized coal versus IGCC. In order to recommend incentives we have to have a better idea of what the difference is in cost structure. While an IGCC plant has a higher first cost, it runs with such greater efficiency that its cost per kilowatt hour of production is the same as a pulverized plant. With IGCC we can capture 98 percent of the carbon coming from these plants. If that cost is similar, it seems like that would be an area that would be ripe for the picking if we can provide folks with the incentive to get over that hump.

Mr. Nicholson reviewed the Transportation goals listed on page 5 of Exhibit H.

Senator Cowell asked about tax credit for biofuels and what different approaches are being made, given the expense of this approach, and how they can drive a market.

Mr. Nicholson said they had looked at reducing the fuel tax or a per gallon credit.

Representative Hackney noted that we enacted tax credits for both bio diesel and ethanol in the last session. What will happen as a result of this is unknown. There is a big bio diesel plant opening in Chatham County which carries with it a big tax credit so they have to make money to use it. The resistance to a moratorium on a motor fuel tax was considerable.

Mr. Givens said that the General Assembly did freeze the variable rate on the motor fuels tax in the face of rapidly escalating gas prices. This also has some consequences for transportation funding that are less welcome.

Mr. Glaser said there is a great deal of activity going on within the automotive industry about these issues. He said he was interested in what technology is out there right now in the area of transportation. Most of us are driving around in vehicles that we could be putting ethanol into rather than E-10 or regular gasoline. There is a consumer awareness issue that needs to be addressed.

Dr. Riggs said the state could benefit from addressing the transportation infrastructure down in the barrier islands. Also, we have hundreds of miles of state highways 264 and 64 that form these incredible dikes around the peninsulas. For mid term or long term, we need to deal with evolution of ecosystems and land loss associated with that. Long term this is a very big part of the transportation problems associated with the climate action planning advisory group.

Mr. Nicholson said that we have an item called adaptation that needs to be addressed.

Mr. Givens followed up by saying that we were looking at climate change from an air quality perspective but the other impacts that Dr. Riggs pointed out are equally as important.

Mr. Shore asked Mr. Glaser about his recent editorial in the Charlotte Observer and asked him to reiterate what he had stated in his article.

Mr. Glaser said that he had stated there was a tremendous opportunity relative to alternate fuel vehicles that is not being touched at this point. General Motors, Toyota, Honda and Ford are spending an incredible amount of money on research and development of these alternative fuel vehicles and maybe there is opportunity for state legislation to provide some type of tax credit for the purchase of these vehicles.

Senator Cowell said that would be a secondary step since we don't have any infrastructure in place.

Representative Hackney said it may be productive for us to have a discussion about infrastructure at some point from the petroleum marketers or someone equally knowledgeable.

Dr. Uzochukwu asked Mr. Nicholson if there has been input from the transportation industry on these ideas.

Mr. Nicholson said that these are ideas that others have looked at, so the list was made for raising the discussion and consideration of them.

Dr. Uzochuckwu asked Mr. Nicholson if he planned to involve DENR or DOT in finalizing the list.

Mr. Nicholson said that someone from the Board of Transportation is on the workgroup.

Dr. Smith added that diesel has almost a double whammy in the climate scenario. You have the actual petroleum diesel that is predominately being used until we get the bio diesel market up and running. But diesel also puts out black carbon particles, which are the fine particles that cause health problems and change the reflectivity of clouds and snow. There are some good federal legislation required mandates that are kicking in next year regarding diesel. Finding ways to either incentivize or require some of those older engines to be retrofitted to the new standards that are coming on will help tremendously in co-benefit of human health but also has a very direct benefit for climate. In the grand scheme of things, it is not a real costly expense to do the retrofits with the benefits that have been clearly documented.

Mr. Givens noted that there was a provision in the Energy Independence Act that created the biofuels industry strategic plan workgroup. That group consists of NC State, NC A&T, The Rural Center, Biotech Center and other folks who work cooperatively with it. They are supposed to prepare an interim plan and submit that by January 15, 2007 and a final plan is supposed to be submitted by April 1, 2007.

Mr. Nicholson reviewed the Agriculture, Forestry and Waste Management goals listed on page 5 of Exhibit H.

Mr. Peele was called on to explain the pending draft CAPAG Mitigation Options listed on page 10 of Exhibit H, CAPAG group advisory report. He said the best way to keep people involved in farming was to make farming more profitable. So, some of these mitigation options offer some promise in those areas.

Mr. Peele said he would focus on options one through six. With the regard to bio diesel production, there are a number of small projects in place in North Carolina now producing somewhere in the neighborhood of 5 to 10 million gallons of bio diesel.

Mr. Peele said that they are working with a group of farmers in eastern North Carolina to build the first large scale bio diesel plant in the state producing 30 million gallons a year. This will give farmers an opportunity to move some of their products in additional markets and get some return in that area and also help clean the environment by promoting the use of cleaner fuels. It also gives them ownership in these large diesel processing operations.

Mr. Peele said that this project is moving forward and is expected to break ground sometime in either the first or second quarter of next year. By 2008, we will have the capacity of bio diesel production in the state increase dramatically.

Mr. Peele said that the working group went through each mitigation option and provided a brief description of them and also set goals for bio diesel production. By 2010 we could increase that capacity to capture about two percent of the diesel use in the state. Currently we are using somewhere around 125 to 150 million gallons of diesel in North Carolina each year.

Mr. Peele said that in North Carolina we have the capacity to produce somewhere between 150 and 250 million gallons of ethanol by 2008, so by 2020 we could double our capacity. There are a lot of opportunities for ethanol production, not just using corn but cellulosic ethanol. Currently, we do not have a commercial scale operation in the U. S. In Canada, a company called Iogen is the closest to coming online with a commercial cellulosic ethanol production plant. The technology is very promising but there still needs to be some tweaking before it becomes commercially viable.

Mr. Peele said that he serves on the national level on the administration's biomass research and development advisory committee. They have set long term goals for the U.S. to achieve by the year 2030 in terms of bio fuel production. The goals are extremely ambitious. They are proposing that we produce 51 billion gallons of renewable fuels in the U.S. by 2030.

Mr. Peele added that they are dealing with preserving open space: anything we can do to keep farmers in business and make them more profitable. They are working with the Department of Agriculture but need to make sure the program gets funded adequately.

Mr. Peele said that there is a lot of research going on with biomass feed stocks for electrical and steam production. Mississippi State University has proven the technology where you can take waste sludge from human wastewater treatment plants and make bio diesel. They are even looking at certain types of algae to produce bio diesel at a large scale. If we are going to meet some of these ambitious

goals of 51 billion gallons of renewable energy a year, we are going to have to look at some of those new and promising technologies.

Mr. Slocum was called on to review the forestry goals of the working group. He said that strong markets and making it profitable or economically viable to keep land in forests is to a large degree what they have looked at. One very promising alternative or option is value added prior to pulping. What that would do is, once the commercialization of the process is available, it is very easy to tack that on to existing pulp and paper facilities and turn these facilities into bio refineries. There are five pulp and paper mills in North Carolina that have the entire infrastructure to handle wood, gather wood and break it down. It is very easy within that process to pull off what is needed for ethanol production and send the cellulose forward into the pulping process, continue to make paper and develop a whole new product screen for the industry.

Mr. Slocum said on the wood energy side, the current green power program in North Carolina really limits the utilization of wood as a renewable energy source and only allows for a very narrow stream of wood waste to be considered green power. This is an unnecessary limitation.

Representative Hackney asked Mr. Slocum how much of forestry products are now underutilized.

Mr. Slocum said that we need more markets for low end, low value materials or first thinning to produce management and growth of residual stands. There are foreign firms looking at exporting significant volumes of wood from North Carolina to burn as renewable energy in power plants overseas. Mr. Slocum said he would like to see that resource stay here.

Mr. Slocum said that on the energy efficiency carbon dioxide reduction side, there is research available from a group called Quorum, which is the consortium for research on renewable industrial materials. The work that has come out of that group shows that wood products are superior to all of the other alternative sources when it comes to utilization of construction in housing. From every standpoint, whether it greenhouse gas potential, air and water pollution, solid waste, energy efficiency, wood is a superior product yet in North Carolina and other states we are considering environmental building standards that are biased against utilization of wood. A good example is the Lead Program. It actually gives more value to using recycled steel than it does to using wood. This limits wood to only wood that can be certified under what is known as the forest stewardship council standard. This limits your ability to plant trees after harvest.

Mr. Slocum said with new markets you also have a need to look at the long term wood supply and keeping land under good management and reforestation. One of the programs in North Carolina that could use an infusion of additional funds is the State Cost Share Development Program which provides a cost share to landowners for reforestation and timber stand improvement work. Currently that program is funded two thirds by the forest products industry and the state puts in about $600,000. Conservation easements is another viable and very useful tool that is part of the mix but unfortunately far too many of the conservation easement programs that are out there significantly limit or even prohibit forest management on the part of the

program. Again, counterproductive is how do we reduce our carbon footprint, how do we utilize our forests to help soak up carbon dioxide as well as provide products.

Dr. Everett said he was interested in the cross cutting scenario. One of the things Mr. Slocum talked about as a way to increase use of some of these products would run directly into the RPS proposal which says what should be eligible for a resource would be biomass and coal-fired power plants. So, we need to make sure that when we write the RPS or look at one we are also looking at encouraging the use of biomass and that we don't take away that option.

Dr. Smith said that during the time that the N. C. Green Power program was being debated amongst the stakeholders, there was recognition that when you are asking customers to voluntarily pay extra, you would give them what is characterized as a premium product. The market surveys that have been done show that customer preference is higher for renewable technology like solar and wind over biomass. It was actively discussed that if you had a RPS or an across the board renewable type program, biomass should not be limited and should be a full player.

Dr. Smith said that the agriculture and forestry industry should be the area that North Carolina has the most to gain from in the win/win scenario. He strongly promotes using forestry for renewable energy production and also looking at cellulosic ethanol. Anything we can do to incentivize that and get the market straight to take advantage of that is a tremendous possibility that has real economic development and national security implications and is also good for the environment.

Mr. Peele added that the only way to meet the 51 billion gallon a year goal that the national committee has set is through the use of cellulosic ethanol and that represents 37 of the 51 billion gallon a year goal.

Mr. Slocum said that in North Carolina, forests are the dominant land use in the state. What makes us different from the west coast is our ownership pattern. Ninety percent of that forest land base is privately owned by over 600,000 individual forest land owners. The best way to encourage and keep that land in forests and properly manage it is to provide strong markets for what they are growing and to help them in the reforestation and long term management.

Mr. Urlaub said it strikes him that the cross cutting issues may also address some of the forestry and agriculture goals. There is a clear interface with energy supply. In the instance of biomass coal firing, if we only consider that under energy supply or under agriculture and forestry, we will miss the electric rate impact.

Representative Hackney asked if there was an electric biomass generating plant in the United States.

Dr. Smith said we had one in North Carolina located in Craven County. It is a 42 megawatt wood energy facility that also coal fires other materials such as clean construction and demolition waste.

Mr. Peele said there was a company called Fiber Watt that is looking to locate in North Carolina. They will build a large scale operation that takes poultry litter and convert it into electrical power.

Ms. Will said that they had successfully completed coal firing of biomass trials at the plant in Sutton. This has helped industrial customers manage wood waste. They are also working with NCSU researchers on a process to make some wood use waste that could be coal fired. Coal firing can provide some solutions for us.

Senator Pittenger asked Mr. Nicholson what we could anticipate in terms of impacting global climate change as a committee.

Mr. Nicholson said that the economic benefits to our state are a significant co-benefit in greenhouse gas reductions.

Senator Pittenger asked that we consider at future meetings some further input in terms of the science of global climate change. He said he had recommended speakers (see Exhibit D) for consideration by staff and asked that we have some additional input from climatologists.

Representative Hackney said that his suggestions would be considered.

Mr. Nicholson concluded his comments by saying that an extension of these discussions will lead to the issue of what carbon sequestration benefits can we take to both the farmers and forest land owners.

Mr. Garrou asked Mr. Slocum to clarify converting wood to cellulosic ethanol and then being able to use the wood product for its original intended use. Mr. Slocum said that the wood sugars are extracted to produce ethanol and the cellulose moves forward into the pulping process. You take a single product and create a bio refinery.

Dr. Smith said that turning wood waste into a bio char is used as a soil amendment to decrease the amount of fertilizer that has to be put into the soil and increases the productivity of the output whether it is forests or crops. That carbon char in the soil stimulates the biological activity of the soil which then causes the microorganisms in the fungus to increase the amount of carbon uptake. Fertilizer is obtained from natural gas and that is where the nitrogen comes from in the fertilizer. That process is carbon intensive. So, by creating this bio char, you basically use it as a soil amendment. This could focus on opportunities to build consensus about some low hanging fruit that would be part of an interim recommendation to be brought to the legislature in the next session.

Mr. Nicholson reviewed the cross cutting issues on page 6 of Exhibit H (slide presentation). He reiterated that public education does cross all of the necessities for general public education and outreach and specific to industry sectors and individuals.

Mr. Nicholson said that we are one of the few states that are looking at the issue of adaptation and what should be considered given that we may very well experience some effects of global warming.

Mr. Nelson said it is important to make sure companies that take steps now get credit for it and that we continue adaptation issues of exploring goals and targets for North Carolina.

Dr. Riggs said it disturbed him that the issue of adaptation is low on the list of goals. When we start talking about the effects floods, storm dynamics, droughts and the impacts of sea level rise, and the fact that we are not dealing with that on the short term can be catastrophic. Another big storm would blow our economy in this state. There are 4,000 miles of estuarine shoreline that are eroding with each storm up to as much as 50 to 100 feet. This is driving everyone who is building down there to hardening shorelines. We are dealing with a rise of sea level that is at least two feet per century. And, with a very high probability of going to four to six feet of land loss, one hundred years from now, a little rise will have a dramatic effect. If we don't deal with that today, we are going to be in terrible straights 25 years from now.

Mr. Tom Peterson, Executive Director, The Center for Climate Strategies gave the next steps for the Climate Action Plan Advisory Group (CAPAG).

Mr. Peterson reviewed the slides of greenhouse gas growth rates (Exhibit H) and the associated impacts of sea level rise. He said to put the next step goals in context for North Carolina, Arizona is the fastest growing state in the U. S. in terms of emissions and North Carolina is the second fastest growing state. These numbers are in the process of being reviewed. The average growth rate is at about the 50 percent level. Growth rates play a very important role in structuring the level of effort in the solutions that come out of the climate change planning processes and all states are not created equal whether it is in terms of their size or their growth rates. The differences in states have played a critical role in the establishment of goals.

Mr. Peterson said that in the goal setting process, it was important to close the alligator's jaws. The top jaw of the alligator is the uphill climb in emissions that we see and the downhill jaw is where we want to go in the future. They are in the process of identifying pathways of finding ways to close the alligator's jaw to reduce emissions. Mr. Peterson referred to Exhibit H, State Climate Goals on page 7.

Mr. Peterson said the most recent data in California is AB32, the first state to establish a mandatory economy wide cap. The rest of the goals are voluntary goals.

Dr. Everett said that this raises the question of carbon intensity.

Mr. Peterson said that carbon intensity or greenhouse gas intensity is a very important forecasting variable. These growth rates in emissions are to a large extent driven by the amount of greenhouse gas that is emitted per capita, per dollar, per some series of measures. This is one of the ways growth rates are forecasted for the future. It is also one of the control variables they look at. If the emission intensity levels were to remain static, then the growth rates would continue because of expanded economic and population growth.

Mr. Peterson added that there are a variety of factors that affect emission levels. In forecasting they try to split out the underlying variables that are driving growth and figure out what they can do to manage them.

Mr. Urlaub asked Mr. Peterson, for their projection for North Carolina up to 2020, if they assume for the utility portfolio that it will be the same as it is today.

Mr. Peterson deferred Mr. Urlaub's question to Dr. Everett.

Dr. Everett said that the folks participating in that workgroup will be discussing the utility portfolio projections at their meeting on 12 October 2006.

Mr. Shore asked for further discussion generally about the value of goals in North Carolina: the reasons why North Carolina might consider goals and the potential disadvantages of the goals and what has motivated other states to go in that direction.

Ms. Tompkins asked Mr. Peterson if they were to give a forecast for the percentage for 2010, what that percentage might be for North Carolina.

Mr. Peterson said from 1990 to 2010 would be two thirds of whatever the overall level of growth is.

Mr. Profeta asked Representative Hackney and Mr. Givens how we can use the work of the CAPAG in the Commission and apply it to our mandate.

Representative Hackney said that to continue to do and redo what we have done today and to try to reach consensus using the work of CAPAG and the other information from various sources is a process that will work.

Representative Hackney said he sensed a fair degree of acceptance and openness of minds with respect to the CAPAG work. He said this Commission would continue to hear relevant presentations to add to and continually hear from CAPAG.

Mr. Garrou added that there seems to be tension between not wanting the Commission to sit back and await developments but on the other hand not duplicate the efforts of what these task forces are spending a lot of time on. Mr. Garrou said that his feeling is to set out on some course that might or might not be a duplication of what CAPAG is doing. He also said that we ought to at least wait another cycle or two before we decide what we should do in relation to what they have produced.

Dr. Smith said there is clearly a good amount of good work within CAPAG and that is going to continue. He senses that there are some issues that may be riper towards consensus or a general support of than others that may take a little more time to bake and analyze. One suggestion would be to spend some of our time going ahead and bringing those issues forward and discussing them as the CAPAG makes their recommendations and some of those things begin to fall out so that we don't get a big slug all at once. There are some issues that CAPAG may need to refine and some that need to be discussed where others may be able to be bring forward their reports in a more timely fashion. There is also the challenge of the interim report that will be coming up in January 2007. If we can talk about and identify some of that low hanging fruit within the context of this discussion over the coming fall meetings, it may enlighten us and lighten our load down the road when we will need to spend more time on the more thorny issues. Surfacing those issues would be a good use of our time and will make sure that everybody in this group is comfortable with those winning, no regret scenarios.

Mr. Givens said that the goal question is an important aspect of the authorizing legislation the Commission directed to consider. Mr. Givens said that in the time he has been at the General Assembly, he has been involved with the setting of two goals. In late 1989, a goal of 25 and 40 percent solid waste reduction goal was set and in 1995 a 30 percent reduction goal of nitrogen in the Neuse River was also set. He realizes those are very different questions than the ones here but there is something to be learned from those efforts. We have achieved the solid waste reduction goal magnificently in the negative. The nitrogen reduction goal has by and large succeeded. He said we need to take these things into consideration as we set goals for this Commission.

Representative Hackney said he did not see the issue of a goal as a matter for the interim report.

Mr. Slocum said that with regards to the interim report and the CAPAG process, it might be appropriate for the purpose of moving forward if there were some direction either from this group or from the Chairs back to the CAPAG as to what they would like to see them produce for us to consider as part of that interim report. It might give some additional direction or finality to the issues of the CAPAG group while providing the Commission with information that we could begin to discuss in some detail as part of an interim report.

Representative Hackney said the idea of coming up with 250 suggestions and synthesizing them down to 50 is a right on target way to go about it and also allows us for the interim report to pick the easy ones if we want to.

Mr. Peterson referred to page three of the memo in Exhibit H which lists the next steps and a timeline of the CAPAG process. To coincide with the interim report, what they expect to have under present plans at that time would be a first round of analysis completed for all 52 of the options that the group has agreed to quantify. So, they would see a complete economic analysis for each option. At that stage of the process they would be inviting the CAPAG to identify options they believe there is a consensus for moving forward on and identifying the remaining set that requires more work.

Mr. Garrou asked Mr. Peterson when the first round of analyses would be available.

Mr Peterson said a meeting date had not been set for January 2007 but they would expect to have all of that information completed by early to mid January 2007 as preparations for the next decisional meeting of the CAPAG.

Representative Hackney asked Commission members to e-mail him with any questions they have about how we are proceeding.

Dr. Smith said that we had discussed at a previous time about the concept of committees and the fact that we did not want to be redundant. He asked if the issue of adaptation was an area that needs special attention given the vulnerabilities that are unique to a coastal state and some of the things referenced earlier by Dr. Riggs. He asked if that may be an area that we might want to make an exception for as to where we do have some additional work to be done between these meetings to

really dig down to further identify those vulnerabilities and to understand adaptation and the economics of it.

Dr. Smith asked if we should contemplate looking at the adaptation question in a little more detail and figure out a way to bring some recommendations to probe that further as part of the interim report.

Representative Hackney thanked members, speakers and staff for attending and said there was a considerable amount of thought that went into the construction of today's meeting and he believes we are off to a good fall start.

The meeting was adjourned at 3:10 PM.

Representative Joe Hackney Presiding Co-Chair	Mary R. Watson Committee Assistant

EXHIBIT A	Meeting Notice
EXHIBIT B	Meeting Agenda
EXHIBIT C	Visitor's Registration
EXHIBIT D	Copy of Senate Bill 1591 and list of recommended speakers for future meetings of the Commission
EXHIBIT E	New member roster
EXHIBIT F	Copy of slides presented by Mr. Joshua Bushinsky, State Solutions Fellow, Pew Center on Global Climate Change, on actions taken or under consideration by other states to address global climate change
EXHIBIT G	Report presented by Mr. Robert Gruber, Executive Director, Public Staff, North Carolina Utilities Commission, on the proposal by the Public Staff of the North Carolina Utilities Commission to create a public benefits fund
EXHIBIT H	Report presented by Mr. Brock M. Nicholson, Deputy Director, Division of Air Quality, Department of Environment and Natural Resources (DENR on and discussion of activities of the Climate Action Plan Advisory Group (CAPAG)

General Assembly of North Carolina

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

State Legislative Building
Raleigh, North Carolina

REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER R. F. MUNDT
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

12 September 2006

TO: Members of the Legislative Commission on Global Climate Change
Interested Parties

FROM: George F. Givens, Commission Counsel

RE: **Notice of Meeting**

COMMISSION MEETING:

The Legislative Commission on Global Climate Change will meet at 10:00 a.m. on Tuesday 3 October 2006 in Room 643 of the Legislative Office Building.

Potential agenda items for the 3 October meeting include:

1. Report on activities of the Department of Environment and Natural Resources to develop and implement standards and plans to control emissions of carbon dioxide and other greenhouse gases.
2. Report on actions taken by other governmental units to address global climate change.
3. Discussion of the state of the science related to global climate change.
4. Other matters related to the powers and duties of the Commission.

OTHER 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

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REPRESENTATIVE JOE HACKNEY
CO-CHAIR
410 AIRPORT ROAD
CHAPEL HILL, NORTH CAROLINA 27514

JOHN L. W. GARROU
CO-CHAIR
PO BOX 5958
WINSTON-SALEM, NORTH CAROLINA 27713

GEORGE F. GIVENS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
300 NORTH SALISBURY STREET
RALEIGH, NORTH CAROLINA 27603
(919) 733-2578
FAX: (919) 715-5460

JEFF W. HUDSON
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

JENNIFER L. MCGINNIS
COMMISSION COUNSEL
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

SUSAN S. IDDINGS
COMMISSION COUNSEL
401 LEGISLATIVE OFFICE BUILDING
(919) 733-6660

MARY R. WATSON
COMMISSION CLERK
1129 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 715-3050
FAX: (919) 754-3255

THELMA T. UTLEY
COMMISSION CLERK
1323 LEGISLATIVE BUILDING
16 WEST JONES STREET
RALEIGH, NORTH CAROLINA 27601
(919) 733-5775
FAX: (919) 754-3191

JENNIFER R.F. MUNDT
COMMISSION ANALYST
545 LEGISLATIVE OFFICE BUILDING
(919) 733-2578

AGENDA

10:00 a.m. Tuesday 3 October
Room 643 Legislative Office Building

1. Call to order
   Representative Joe Hackney

2. Introductory remarks by Cochairs
   Representative Joe Hackney
   John. L. W. Garrou

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

4. Report on actions taken or under consideration by other states to address global climate change
   Joshua Bushinsky, State Solutions Fellow
   Pew Center on Global Climate Change

5. Update on the study by the Utilities Commission of a renewable energy portfolio standard
   James Y. Kerr II, Commissioner
   North Carolina Utilities Commission

6. Report on the proposal by the Public Staff of the North Carolina Utilities Commission to create a public benefits fund
   Robert Gruber, Executive Director
   Public Staff
   North Carolina Utilities Commission

7. Update on and discussion of activities of the Climate Action Plan Advisory Group (CAPAG)
   Brock M. Nicholson, Deputy Director
   Division of Air Quality, Department of Environment and Natural Resources

- Technical Working Group Updates and Discussion:
  - Agriculture, Forestry, and Waste
    Mitchell A. "Mitch" Peele
  - Energy Supply
    Tim Toben and George T. Everett
  - Residential, Commercial, and Industrial
    Michael Shore
  - Transportation and Land Use
    Michael Shore
  - Cross-Cutting Issues
    Stephen A. Smith
- Next Steps for the Climate Action Plan Advisory Group (CAPAG)
  Tom Peterson, Executive Director
  The Center for Climate Strategies

8. Commission discussion and announcements

9. Adjourn

COMMISSION WEBSITE:

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

http://www.ncleg.net/committees/legislativecomm_/default.htm.

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.

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — 10-3-06
Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Chris Hayes	Civitas
Heather Hawkins	NC DAQ
Jim Sutherland	NC DAQ
Tom Mather	NC DAQ
Charles Davis	NC DAQ
JAMES HAVEN	GWI
LISA RIEGEL	NHTF
Ellis Cowling	NC State University
Amy MacDonald	DACE / Env. Defense
Emrys Treasure	USDA, Forest Service, Southern Global Change Program
Christine Voss	East Carolina Univ. Greenville, NC

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — 10-3-06

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Sharon Miller	CUCA
Paul Sherman	NC Farm Bureau
JUNE SMALL	NC ELECTRIC MEMBERSHIP CORP
Patrick Buffkin	ALLEY ASSOCIATES, INC.
DAREN BAKST	John Locke Foundation
Megan Cooke	MCIC - North Carolina
FRANK W. FOLGER	HELMS MULLISS WICKER - 2600 Two Hannover Sq. Raleigh
Tommy Stevens	NCPC
Tyler Felgenhauer	UNC, Dept. of Public Policy
Charlie Dell	NCTA
[signature]	NCAOA

VISITOR REGISTRATION SHEET

GLOBAL CLIMATE CHANGE COMMISSION — 10-3-06

Name of Committee — **Date**

VISITORS: PLEASE SIGN IN BELOW AND RETURN TO COMMITTEE CLERK

NAME	FIRM OR AGENCY AND ADDRESS
Harry Simmons	NCBIUA PO Box 1317 Oak Island NC 28465
Johanna Reese	DOT
LINDA RIMER	US EPA
[signature]	NCICU
Leslie Coolidge	Columbia SC
Sarah Price	Beason Government Affairs
[signature]	Beason Govt Affairs
[signature]	Hunton & Williams

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

North Carolina General Assembly
Senate Chamber
State Legislative Office Building
Raleigh 27603-5925

SENATOR ROBERT M. PITTENGER
ASSISTANT REPUBLICAN LEADER
39TH DISTRICT

OFFICE ADDRESS: 300 N. SALISBURY STREET, ROOM 521
RALEIGH, NC 27603-5925
TELEPHONE: (919) 733-5655
(919) 828-3508
EMAIL: robertp@ncleg.net

DISTRICT ADDRESS: 4521 SHARON ROAD, SUITE 120
CHARLOTTE, NC 28211
TELEPHONE: (704) 365-0065
(704) 365-0910 FAX
EMAIL: rp@pittengercompany.com

COMMITTEES:

APPROPRIATIONS/BASE BUDGET
FINANCE
RULES AND OPERATIONS OF THE SENATE
COMMISSION ON GLOBAL CLIMATE CHANGE

Recommended Speakers for Legislative Commission on Global Climate Change

Dr. Richard S. Lindzen
Alfred P. Sloan Professor of Meteorology
Department of Earth, Atmospheric and Planetary Sciences
Building 54-1720
Massachusetts Institute of Technology
Cambridge, MA 02139-4307
Phone: 617-253-2432
lindzen@wind.mit.edu

Dr. Sallie L. Baliunas
Solar, Stellar, and Planetary Sciences Division
Harvard-Smithsonian Center for Astrophysics
60 Garden Street
Cambridge, MA 02138
Phone: 617-495-7415
sbaliunas@cfa.harvard.edu

Dr. Robert Mendelsohn
Edwin Weyerhaeuser Davis Professor
School of Forestry and Environmental Studies
Yale University
360 Prospect Street
New Haven, CT 06511
203-432-3809
robert.mendelsohn@yale.edu

Dr. S. Fred Singer
Professor Emeritus of Environmental Sciences
University of Virginia
1600 S. Eads St, #712-S
Arlington, VA 22202-2907
703.920.2744
singer@sepp.org

Dr. Edward W. Erickson
Environmental Economist
Professor of Economics
Box 8110, North Carolina State University
Raleigh, NC 27695-8110
Phone: 919-513-2876
ed_erickson@ncsu.edu

Dr. John R. Christy
Professor and Director
Earth System Science Center, NSSTC
University of Alabama in Huntsville
320 Sparkman Drive, NSSTC 4040
Huntsville, AL 35805

LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE

2005-2006 Membership

(Revised 29 September 2006)

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:

John L. W. Garrou, Co-Chair
P. O. Box 5958
Winston-Salem, NC 27113
(336) 714-8050
E-mail: jgarrou@slickenterprises.com

Senator Charlie Albertson
136 Henry Dunn Picket Road
Beulaville, NC 28518
(910) 298-4923
E-mail: Charliea@ncleg.net

Senator Janet Cowell
230 Grand Avenue
Raleigh, NC 27606
(919) 858-5337
E-mail: Janetc@ncleg.net

Senator Robert M. Pittenger
4521 Sharon Road, Suite 120
Charlotte, NC 28211
(704) 365-0065
E-mail: Robertp@ncleg.net

Speaker of the House of Representatives Appointments:

Representative Joe Hackney, Co-Chair
P. O. Box 1329
Chapel Hill, NC 27514
(919) 929-0323
E-mail: Joeh@ncleg.net

Representative Becky Carney
P.O. Box 32873
Charlotte, NC 28232
(704) 332-1893
E-mail: Beckyc@ncleg.net

Representative Pricey Harrison
P.O. Box 9339
Greensboro, NC 27429
(336) 292-1953
E-mail: Priceyh@ncleg.net

Representative Wilma Sherrill
P.O. Box 18561
Asheville, NC 28814
(818) 254-0991
E-mail: Wilmas@ncleg.net

Walter Clark
310 Pogue Street
Raleigh, NC 27607
(919) 515-1895
E-mail: walter_clark@ncsu.edu

Representative Alice Underhill
3910 Country Club Road
New Bern, NC 28562
(252) 633-2270
E-mail: Aliceu@ncleg.net

Dr. Dolores "Dee" Eggers
Department of Environmental Studies
CPO#2330
University of North Carolina Asheville
Asheville, NC 28804-8511
(828) 251-6654
E-mail: eggers@unca.edu

Representative W. A. "Winkie" Wilkins
210 Fair Oaks Drive
Roxboro, NC 27574
(336) 599-7336
E-mail: Winkiew@ncleg.net

Dr. Edward W. Erickson
Professor of Economics
Box 8110, North Carolina State University
Raleigh, NC 27695-8110
(919) 513-2876
E-mail: ed_erickson@ncsu.edu

Thomas F. Cecich
113 Kenneth Ridge Court
Apex, NC 27523
(919) 303-6802
E-mail: tom@tfc-assoc.com

Tim Toben
8300 Pickards Meadow Road
Chapel Hill, NC 27516-4861
(919) 280-1103
E-mail: tobent@bellsouth.net

Robert J. Glaser
1029 Wade Ave.
Raleigh, NC 27605-2167
(919) 828-4421
E-mail: rglaser@ncada.com

Ivan Urlaub
P. O. Box 6465
Raleigh, NC 27628
(919) 832-7601
E-mail: ncseapolicy@mindspring.com

Susan Tompkins
815 Hungerford Place
Charlotte, NC 28207
(704) 375-3276
E-mail: stompkins@bellsouth.net

Ex Officio Members:

The President of Duke Power or the President's designee

Dr. George T. Everett
Director of Environmental and Legislative Affairs
Duke Power
225 Hillsborough Place, Suite 480
Raleigh, NC 27603
(919) 235-0955
E-mail: gteverett@duke-energy.com

The President of Progress Energy or the President's Designee	Ms. Vicky K. Will Director - Environmental Services Progress Energy 410 South Wilmington Street, Suite 4A Raleigh, NC 27601 (919)-546-4803 E-mail: Vicky.Will@pgnmail.com
The President of the North Carolina Citizens for Business and Industry or the President's designee	S. Lewis "Lew" Ebert President and CEO North Carolina Citizens for Business and Industry (NCCBI) 225 Hillsborough Street, Suite 460 Raleigh, NC 27603 (919) 836-1410 E-mail: lebert@nccbi.org
The President of the Manufacturers and Chemical Industry Council of North Carolina or the President's designee	A. Preston Howard, Jr. President Manufacturers and Chemical Industry of North Carolina (MCIC) 620 N. West Street, Suite 101 Raleigh, NC 27603 (919) 834-9459 E-mail: preston.howard@mcicnc.org
The President of the North Carolina Farm Bureau Federation or the President's designee	Mitchell A. "Mitch" Peele Director of Public Policy North Carolina Farm Bureau Federation P.O. Box 27766 Raleigh, NC 27611 (919) 788-1004 E-mail: mpeele@ncfb.net
The President of the North Carolina Forestry Association or the President's designee	Robert W. Slocum, Jr. Executive Vice President North Carolina Forestry Association 1600 Glenwood Avenue, Suite I Raleigh, NC 27608 (919) 834-3943 E-mail: rwslocum@ncforestry.org

The Southeast Regional Director of Environmental Defense or the Regional Director's designee	Michael Shore Manager, Southeast Climate & Air Program Environmental Defense 186 Pearson St. Asheville, NC 28801 (828)-254-7359 E-mail: mshore@environmentaldefense.org
The Executive Director of the Southern Alliance for Clean Energy or the Executive Director's designee	Stephen A. Smith, DVM Executive Director Southern Alliance for Clean Energy 29 North Market Street, Suite 604 Asheville, NC 28801 (865)567-7429 E-mail: sasmith@cleanenergy.org
The Executive Director of the North Carolina Coastal Federation or the Executive Director's designee	James H. Stephenson Program Analyst North Carolina Coastal Federation 3609 Highway 24 (Ocean) Newport, NC 28570 (252) 393-8185 E-mail: jims@nccoast.org
The Executive Director of the North Carolina Conservation Council or the Executive Director's designee	Michael Nelson Director of Governmental Relations Conservation Council of North Carolina 112 S. Blount Street Raleigh, NC 27601 (919) 839-0020 E-mail: mike@conservationcouncilnc.org
The Dean of the Nicholas School of the Environment and Earth Sciences, Duke University, or the Dean's designee	Timothy Profeta Director, Nicholas Institute for Environmental Policy Solutions P.O. Box 90328, Duke University Durham, NC 27708 (919)613-8709 E-mail: tim.profeta@duke.edu

The Dean of the College of Agriculture and Life Sciences at North Carolina State University or the Dean's designee	Dr. Daniel J. Phaneuf Associate Professor of Agriculture and Resource Economics Box 8109 North Carolina State University Raleigh, NC 27695 (919) 515-4672 E-mail: dan_phaneuf@ncsu.edu
The Dean of the School of Agriculture and Environmental Sciences at North Carolina Agricultural and Technical State University or the Dean's designee	Dr. Godfrey A. Uzochukwu Professor of Earth and Environmental Sciences North Carolina Agricultural and Technical State University 261 Carver Hall Greensboro, NC 27411 (336) 334-7030 E-mail: uzo@ncat.edu
The Director of the Carolina Environmental Program at the University of North Carolina at Chapel Hill or the Director's designee	Dr. Douglas Crawford-Brown Director, Carolina Environmental Program Professor of Environmental Science and Public Policy University of North Carolina at Chapel Hill Chapel Hill, NC 27599-1105 (919) 966-6026 E-mail: douglas_crawford-brown@unc.edu
The Distinguished Research Professor (with expertise in sea level change), Department of Geology at East Carolina University	Dr. Stanley R. Riggs Distinguished Research Professor Department of Geology, College of Arts and Sciences East Carolina University Room 101, Graham Building Greenville, NC 27858 (252) 328-6015 E-mail: riggss@mail.ecu.edu

The North Carolina State Climatologist

Dr. Ryan Boyles
Director and State Climatologist
Research III Building, Centennial Campus
Box 7236, North Carolina State University
Raleigh, NC 27695-7236
Telephone: 919-513-2816
Email : ryan_boyles@ncsu.edu

STAFF

George F. Givens, Commission Counsel
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Georgeg@ncleg.net

Jeff Hudson, Commission Counsel
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Jeffreyh@ncleg.net

Susan Iddings, Commission Counsel
Bill Drafting Division
North Carolina General Assembly
401 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-6660
Fax: (919) 715-5459
E-mail: SusanI@ncleg.net

Jennifer McGinnis, Commission Counsel
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Jenniferm@ncleg.net

Mary Watson, Senate Commission Clerk
1129 Legislative Building
16 West Jones Street
Raleigh, North Carolina 27601
Phone: (919) 715-3050
Fax: (919) 754-3255
Email: Forresterla@ncleg.net

Thelma Utley, House Commission Clerk
1323 Legislative Building
16 West Jones Street
Raleigh, North Carolina 27601
Phone: (919) 733-5775
Fax: (919) 754-3191
E-mail: Lucasmla@ncleg.net

Jennifer Mundt, Commission Analyst
Research Division
North Carolina General Assembly
545 Legislative Office Building
300 North Salisbury Street
Raleigh, NC 27603
Phone: (919) 733-2578
Fax: (919) 715-5460
E-mail: Jennifermu@ncleg.net

Update on U.S. State and Regional Action on Climate Change

Josh Bushinsky
State Solutions Fellow
Pew Center on Global Climate Change

North Carolina Legislative Commission on Climate Change

October 3, 2006

Overview

- Update since Judi Greenwald's February 3 presentation
- Highlights of recent state action
- Background on state-level target setting

Motivations for GHG reductions

- Concern about climate impacts
- Economic development
- Energy price volatility
- Energy independence
- Air quality concerns
- Traffic congestion

→ Getting ahead of the regulatory curve

The Landscape of State Policies

- Direct and Indirect GHG Emission Reductions
- Governors and legislators are acting
- Almost Every State is Doing Something

RGGI

Regional Greenhouse Gas Initiative

An initiative of the Northeast & Mid-Atlantic States of the U.S.

- Regional cap-and-trade program initially covering power plant CO_2 emissions
- Stabilize emissions at current levels 2009-2015, 10% reduction by 2019
- Adoption through legislation or regulation
- What's new:
  - Model rule finalized in August 2006
  - Maryland joined in April 2006

California Actions

- September 27th, Governor Schwarzenegger signed AB 32: Global Warming Solutions Act of 2006
  - "Nunez/Pavley" bill
  - Set California's targets at 1990 levels by 2020 (25% reduction compared to business as usual)
  - First enforceable state-wide program to cap industrial GHG emissions and include penalties
  - Authorizes market-based mechanisms (cap-and-trade); allows one-year extension on target

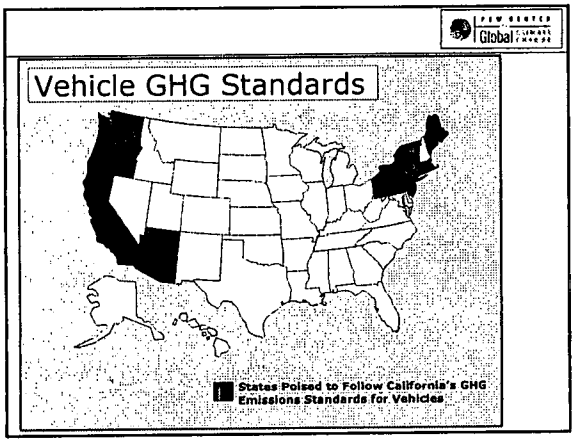
Other California Actions

What's new:

- GHG Electricity Performance Standard
- Renewable Portfolio Standard (20% by 2010)

Continuing:

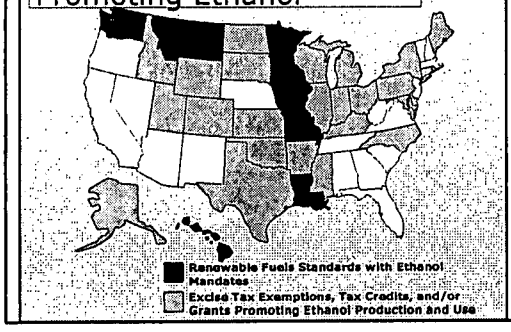
- Governor's Climate Action Team
- Vehicle GHG standards: 22% reduction by 2012; 30% by 2016
- CPUC carbon adder
- CPUC emissions cap under development



States recently adopting Renewab le Fuel Standards and incentives

- Indiana: August 11, 2006
- Michigan: July 7, 2006
- Missouri: July 5, 2006
- Hawaii: June 26, 2006
- Florida: June 15, 2006
- California: June 15. 2006
- Louisiana: June 12, 2006
- Washington: June 11, 2006
- South Carolina: June 1, 2006
- Iowa: May 30th, 2006

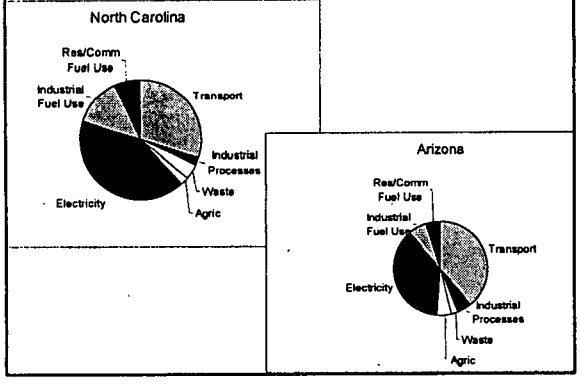
Mandates and Incentives Promoting Ethanol



Climate Commissions Across the Country

- Florida
  - Legislative Commission (June 2006)
- Alaska
  - Legislative Commission (May 2006)
- New Mexico
  - Governor's advisory council (June 2005)
- Montana
  - Governor's advisory council (April 2006)
- Arizona
  - Governor's advisory council (Feb. 2005)

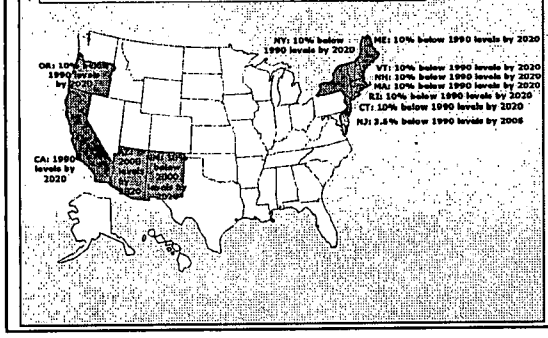
Arizona: A Recent and Relevant Example



Arizona Action

- September 8, Governor Napolitano issued an Executive Order:
  - Goal to reduce GHG emissions to 2000 levels by 2020
  - 50% below 2000 by 2040
- Climate action plan elements
  - Transportation
  - Energy Supply
  - Waste Management
  - Agriculture and Forestry

State GHG Emission Targets



Setting State GHG Emission Targets

- States tend to have short, medium, and long-term targets (e.g., CA, AZ, NM, etc.)
- Long-term (~ 2050) reduction targets of 50-80%
  - What scientists say is necessary to stabilize the climate and avoid dangerous climatic change
- Short and medium (2010-2020) targets come from both top-down and bottom-up analysis
- Companies set targets similarly

Company Emission Targets

- ✓ BP: Reduce GHG emissions by 10 percent from 1990 levels by 2010.
- ✓ DuPont: Reduce GHG emissions by 65 percent from 1990 levels by 2010.
- ✓ Entergy: Stabilize CO_2 emissions from U.S. generation at 2000 levels by 2006
- ✓ IBM: 10 percent reduction in PFC emissions from semiconductor manufacturing processes by 2005
- Weyerhaeuser: Reduce GHG emissions 40 % by 2020

Setting State GHG Emissions Targets

- If North Carolina chooses to set a target, it may help to look at what other states, companies, and countries are doing
  - Examine options for GHG reductions
    - Costs, co-benefits, achieve other policy goals
  - Define a baseline – has big impact on stringency
- Comparing to a historic year is different than comparing to base case forecast.
- Numerous examples of both targets and actions

Emerging markets for GHGs and clean energy

- RGGI
- California
- Renewable Energy Credit Market
  - Green Tags and White Tags
- Oregon offset standard
- Voluntary efforts: Chicago Climate Exchange
- Motivate entrepreneurs and innovators
- Achieve lowest-cost emission reductions

Conclusion

- Pace of state action on climate increasing
- Multiple drivers, multiple benefits for state action
- Tailor strategies to North Carolina
- Targets provide certainty and a metric for success

Further information

Pew Center on Global Climate Change
www.pewclimate.org

PEW CENTER on Global CLIMATE CHANGE

United States: State and Regional Targets

Entity	*Target*	*Notes and Source*
Arizona: State-wide	2000 levels by 2020 50% below 2000 by 2040	Executive Order 2006-13
California: State-wide	2000 levels by 2010 1990 levels by 2020 80% below 1990 by 2050	Executive Order S-3-05
California: Major industries state-wide	1990 levels by 2020	AB 32
Connecticut: State-wide	1990 levels by 2010 10% below 1990 by 2020	Connecticut Climate Change Action Plan
Maine: State-wide	1990 levels by 2010 10% below 1990 by 2020	LD 845 (HP 622)
	75-80% below 2003 long-term	
Massachusetts: State-wide	1990 levels by 2010 10% below 1990 by 2020 75-85% below 1990 long-term	Massachusetts Climate Protection Plan of 2004
Massachusetts: Electric Utilities	10% below 1997-1999	CO_2 target only. 310 CMR 7.29
New Hampshire: State-wide	1990 levels by 2010 10% below 1990 by 2020 75-85% below 2001 long-term	The Climate Change Challenge
New Hampshire: Electric Utilities	1990 levels by 2006	CO_2 target only. HB 284
New Jersey: State-wide	3.5% below 1990 by 2005	Administrative Order 1998-09
New Mexico: State-wide	2000 levels by 2012 10% below 2000 by 2020 75% below 2000 by 2050	Executive Order 05-033
New York: State-wide	5% below 1990 by 2010 10% below 1990 by 2020	State Energy Plan of 2002
Oregon: State-wide	Stabilize by 2010 10% below 1990 by 2020 75% below 1990 by 2050	Oregon Strategy for Greenhouse Gas Reductions
Rhode Island: State-wide	1990 levels by 2010 10% below 1990 by 2020	Rhode Island Greenhouse Gas Action Plan
Vermont: State-wide	1990 levels by 2010 10% below 1990 by 2020 75-85% below 2001 long-term	
Regional Greenhouse Gas Initiative: CO_2 emissions from power plants	Cap emissions at current levels in 2009 Reduce emissions 10% by 2019.	
New England Governors and Eastern Canadian Premiers: Regional economy-wide	1990 levels by 2010 10% below 1990 by 2020 75-85% below 2001 long-term	Climate Change Action Plan of 2001

United States: Proposed Federal Legislation

Entity	*Target*	*Notes & Source*
Climate Stewardship Act of 2003 (McCain-Lieberman) SA. 2028	2000 levels by 2010	As voted on 8/2003 Pew Center Analysis
Climate Stewardship Act of 2003 (McCain-Lieberman) S. 139	2000 levels by 2010 1990 levels by 2016	As introduced 1/2003
Climate and Economy Insurance Act of 2005 (Bingaman)	2.4% yearly reduction in *intensity* during 2010-2019 2.8% yearly reduction in *intensity* during 2020-2024	Pew Center Analysis
Strong Economy and Climate Protection Act of 2006 (Feinstein) **discussion draft**	2006 levels through 2010 0.5% yearly reduction during 2011-2015 1% yearly reduction during 2016-2020 7.25% below current levels in 2020	Discussion draft announcement 3/2006
Clean Air Planning Act of 2006 (Carper) S.2724	2006 levels in 2010-2014 2001 levels in 2015	CO_2 from electric generation sector. As introduced 5/2006
Safe Climate Act of 2006 (Waxman) H.R.5642	2009 levels in 2010 1990 levels in 2020 80% below 1990 levels in 2050	As introduced 7/2006
Global Warming Pollution Reduction Act (Jeffords) S.3698	1990 levels in 2020 27% below 1990 by 2030 53% below 1990 by 2040 80% below 1990 levels in 2050	As introduced 7/2006

International

Entity	*Target*	*Notes & Source*
Canada	6% below 1990 by 2008-2012	Kyoto Target
European Community	8% below 1990 by 2008-2012	Kyoto Target
Japan	6% below 1990 by 2008-2012	Kyoto Target
New Zealand	1990 levels by 2008-2012	Kyoto Target
United Kingdom	20% below 1990 by 2020 60% below 1990 by 2050	CO_2 target only. Energy White Paper of 2003
European Community Kyoto Bubble Targets[i]	*Target for 2008-2012*	European Community Council Decision of April 2002
Austria	13% below 1990	
Belgium	7.5% below 1990	
Denmark	21% below 1990	
Finland	1990 levels	
France	1990 levels	
Germany	21% below 1990	
Greece	25% above 1990	
Ireland	13% above 1990	
Italy	6.5% below 1990	
Luxembourg	28% below 1990	
Netherlands	6% below 1990	
Portugal	27% above 1990	
Spain	15% above 1990	
Sweden	4% above 1990	
United Kingdom	12.5% below 1990	

COMMENTS TO THE LEGISLATIVE COMMISSION ON GLOBAL CLIMATE CHANGE REGARDING DEMAND-SIDE MANAGEMENT COST RECOVERY

Robert Gruber, Executive Director
Public Staff-North Carolina Utilities Commission

October 3, 2006

The Public Utilities Act states that, in planning for future growth of reliable utility service, it is the policy of the State of North Carolina to "include use of the entire spectrum of demand-side options, including but not limited to conservation, load management and efficiency programs" so as to result in the "least cost mix of generation and demand reduction measure..."

The NCUC has been considering demand-side management (DSM) options along with supply-side options such as new power plants for over 20 years. During the late 1980s and early 1990s, activity before the Commission involving DSM was fairly vigorous, and there were major expenditures made by the utilities on DSM programs. However, during the later part of the 1990's DSM fell out of favor in NC and around the nation due to several factors:

1. Retail competition seemed imminent and there was a danger that utility expenditures for DSM would be stranded;
2. The need for expensive base load plants declined, and new natural gas plants were becoming less and less expensive;
3. Natural gas and coal costs declined;
4. Wholesale competition allowed utilities to make economical purchases of firm power from neighboring utilities; and
5. Rates in NC and the Southeast were low relative to other regions and this made it difficult for many DSM programs to "prove in."

As a result of the focus on competition and the accompanying de-emphasis of DSM, the NCUC streamlined its IRP rules and did not hold evidentiary hearings regarding resource planning for eight years. During the past few years, the energy environment has changed dramatically and the pendulum has swung back in DSM's favor. Retail competition has not developed as expected and many states, including NC, are no longer considering it. Rapid customer growth has created a need for new base load power plants, and coal and natural gas prices have risen dramatically, causing larger fuel cost adjustments.

In 2005 and early 2006 it became obvious to the NCUC that it needed to place demand-side management and renewable energy back on the "front burner" and it took several important steps.

1. The NCUC decided to conduct a study of the potential for a renewable portfolio standard (RPS) in North Carolina. This study would determine whether the utilities should be required to supply a certain percentage of their power from renewable energy such as wind, solar and biomass. This study will assess the technical and the practical potential of renewables and the costs and benefits of an RPS.

2. The NCUC decided to hold an evidentiary hearing for the first time in eight years and set the following issues for hearing:

   (a) The validity of utility forecasting methods;
   (b) Whether the utilities are employing and developing adequate DSM and displacing the need for additional generation assets;
   (c) The potential opportunities for cost-effective energy efficiency and conservation;
   (d) The degree to which utility programs can effectively reduce consumption; and
   (e) What funding mechanisms could be employed to implement specific energy efficiencies measures.

3. The NCUC decided that progress on certain issues could best be made in a collaborative setting rather than an adversarial hearing, and ordered the Public Staff to conduct a collaborative workshop on these issues and include all of the important stakeholders. The issues to be considered were the following:

(a). The criteria that the Commission should consider in deciding to approve a DSM program in the future;

(b) Whether the Commission Rules on IRP proceedings should be changed to allow for more expansive review of efficiency and conservation programs in future IRP proceedings.;

(c) Ratemaking issues, such as "decoupling" of sales from profits;

(d) Carbon regulation; and

(e) Renewable portfolio standards and public benefits funds.

The Commission stated that consideration of these issues by the workgroup could prove beneficial to the Commission in its efforts to remain adequately informed about important industry issues. It ordered the Public Staff to report back to it any agreement or consensus reached during the workshop.

The hearing on the utilities' 2005 Annual Resource Plans was held on June 27-28, 2006. Both Duke and PEC testified that they had 15 to 20 ongoing DSM programs. Duke testified that its programs had reduced 2005 peak demand by 722 MW, and PEC testified that its programs had reduced demand by 374 MW.

The NCUC issued an order on August 31, 2006, approving the 2005 integrated resource plans. The NCUC found that the utilities' forecasting methods were adequate and that "the utilities' development and deployment of DSM resources for the purpose of displacing the need for additional generation assets is adequate for the 2005 IRP, but may not be adequate for future proceedings."

The Commission's Order required that future IRP filings by the utilities include a more comprehensive analysis of their DSM plans and activities, including cost/benefit information, and required the utilities to cooperate with the Public Staff and other interveners in reviewing and designing programs.

During the hearing, the utilities and some of the environmental witness testified that utilities have a disincentive to develop and implement DSM programs, which increase annual utility expenditures and result in lower kWh sales. The utilities recommended that the Commission approve some form of rate recovery rider to allow timely recovery of their capital investments, operating and maintenance expenses, programs costs and any incentives paid to customers.

In its Order, the Commission reviewed the history of the funding of DSM programs and the ratemaking treatment of DSM costs and stated that "it is premature to settle on any particular funding mechanism or ratemaking treatment as a means of meeting the policy expressed in G.S. (62-2(3a)." With regard to lost revenue, the Commission stated that "special ratemaking treatment could be unnecessary if DSM efforts are to be administered by an independent third party statewide", and that, "[o]nce the picture becomes clearer, additional steps can be taken to develop or refine any funding mechanisms and ratemaking treatment or to consider innovative funding options, such as a third party administrator of DSM efforts...".

The collaborative workgroup facilitated by the Public Staff met on July 27, 2006, and considered the delegated issues, including whether a cost recovery mechanism should be adopted. Participants in the workgroup were the electric investor owned utilities (Duke, PEC, and Dominion NC Power), the cooperative utilities, the Attorney General, the North Carolina Sustainable Energy Association, Environmental Defense, Southern Environmental Law Center, the Southern Alliance for Clean Energy, the North Carolina Waste Awareness and Reduction Network, Inc., the North Carolina Advanced Energy Corporation, Carolina Utilities Customers Association, Inc., and the Carolina industrial Group for Fair Utility Rates.

On September 1, 2006, the Public Staff filed a report regarding the progress of the workshop. Just as they had at the evidentiary hearing, the Public Staff and the environmental groups again recognized that utilities have a financial disincentive to provide DSM programs. The North Carolina Sustainable Energy Association noted that having an independent third party administer DSM programs, rather than the utilities, prevents the need for special rate treatments to address the lost revenue problem. Vermont and Wisconsin's energy efficiency programs, which use third party administrators, were discussed as potential models. Finally, there were concerns expressed by members of the work group that any cost recovery mechanism, such as a rider or surcharge, might not be permissible without legislation.

There was no consensus reached by the work group regarding whether it should recommend that a DSM cost recovery mechanism be recommended to the Commission. However, the Public Staff decided that cost recovery is critical to significant progress being made in the development and implementation of DSM by utilities and decided that it should recommend that the Commission consider the establishment of a Public Benefit Fund for statewide DSM programs that would be administered by an independent, non-utility third party. The Public Staff stated in the report that "[a] PBF totally avoids the disincentives that the utilities face when considering DSM programs that reduce their sales." It further stated that the Advanced Energy Corporation, which administers the Green Power program, appears to be a qualified third-party administrator and requested the Commission to solicit comments from Advanced Energy on how it would propose to manage a PBF and finance the development and implementation of DSM programs in the state.

The Public Staff believes that there is a legitimate question as to whether the Commission has the statutory authority to approve a cost recovery mechanism to collect for DSM program costs, including mechanisms that would be administered by either the utilities or a third party administrator. The Public Staff also believes a public benefits fund surcharge should be applicable to the municipals providing electric service and to the electric membership cooperatives, which is clearly beyond the Commission's authority. The Public Staff does not at this time have a proposed draft of legislation authorizing such a cost recovery mechanism, but

we would be willing to assist Legislative Staff in drafting an amendment to Chapter 62, if so directed.

North Carolina Climate Action Plan Advisory Group

WWW.NCCLIMATECHANGE.US

Memo

To:	North Carolina Legislative Commission on Global Climate Change
From:	North Carolina Department of Environment and Natural Resources and the Center for Climate Strategies
CC:	North Carolina Climate Action Plan Advisory Group Members
Subject:	Current Status of North Carolina Climate Action Plan Advisory Group Activities
Date:	October 3, 2006

The North Carolina Department of Environment and Natural Resources (DENR) launched the North Carolina Climate Action Plan Advisory Group (CAPAG) process on February 16, 2006 in concert with the Legislative Commission on Global Climate Change. This fact based planning process is highly participatory, with 45 members of the CAPAG -- 11 of whom serve on the LCGCC -- and as many as 75 Technical Work Group (TWG) representatives. The Center for Climate Strategies (CCS) provides facilitation and technical support to the group.

Since its launch, CAPAG participants have completed a number of key milestones, including:

- Identification of a full range of potential North Carolina options for mitigation of greenhouse gas emissions, including 307 possible state actions
- Identification of 52 initial "priorities for analysis" of draft mitigation options
- Formulation of "straw proposals" for the design of these initial draft mitigation options
- Technical revisions to the statewide inventory and forecast of greenhouse gas emissions

The next stage of the CAPAG process (through April 2008) will include completion of the following milestones:

- Completion of the first round of economic analysis of draft mitigation options by CCS
- Review and revision of mitigation option design, analysis, and lists of draft options as needed
- Finalization of CAPAG mitigation option recommendations
- Finalization of the statewide inventory and forecast of greenhouse gas emissions
- Development of implementation plans and approaches

A summary of key activities of the CAPAG is attached below, along with lists of current draft mitigation options for each of the TWGs of the CAPAG. We have also attached a sample draft mitigation option template for discussion at the LCGCC meeting.

We look forward to our discussion of these issues at the October 3 meeting of the LCGCC.

Vital Statistics of the CAPAG Process:

Membership	#
CAPAG Members	45
LCGCC Members on the CAPAG	11
TWG Members:	
• Residential, Commercial and Industrial	18
• Energy Supply	18
• Transportation and Land Use	18
• Agriculture, Forestry and Waste	18
• Cross Cutting Issues	14
Meetings	
CAPAG Meetings Held to Date (February, May, July 2006)	3
CAPAG Meetings to be Held (October 2006; January, May 2007)	3
TWG Meetings Held to Date	41
TWG Meetings to be Held (October 2006 - May 2007)	~ 40
Additional Meetings of the CAPAG and or TWGs After May 2007	TBD
Status of Draft Mitigation Options	
Original Number of Potential Options Presented to the CAPAG from the CCS Catalog of States Actions	251
Updated Number of Potential Options on the CCS Catalog of States Actions, Including CAPAG Additions, Such as Actions from the Clean Smokestacks Act and State Energy Plan	307
Current Number of "Priority for Analysis" Draft Potential Mitigation Options for Analysis	52
• Residential, Commercial and Industrial	11
• Energy Supply	10
• Transportation and Land Use	13
• Agriculture, Forestry and Waste	12
• Cross Cutting Issues	6

Next Steps	Date
Finalize Straw Proposals for Draft Mitigation Option Design; Begin Analysis of Draft Options	October 12, 2006
Complete First Round of Analysis of Draft Mitigation Options	January, 2007
Review and Revise Policy Design, Analysis, List of Draft Options as Needed	January – May 2007
Finalize CAPAG Mitigation Option Recommendations	June 2007
Develop Implementation Plans and Approaches	June 2007 – April 2008

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

#	Mitigation Option Name	Drafting Volunteers
RCI-1	Demand Side Management Programs for the Residential, Commercial and Industrial Sectors	Jeff Tiller, Full TWG
RCI-2	Expand Energy Efficiency Funds	Ward Lenz, Full TWG
RCI-3	Energy Efficiency Requirements	Len Hoey, Dona Stankus, Jeff Tiller, Full TWG
RCI-4	Market Transformation and Technology Development Programs	Ward Lenz, Full TWG
RCI-5	Improved Appliance and Equipment Efficiency Standards	Full TWG
RCI-6	Building Energy Codes	Full TWG
RCI-7	"Beyond Code" Building Design Incentives and Mandatory Programs, Incorporating Local Building Materials and Advanced Construction	Dona Stankus, Full TWG
RCI-8	Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)	Full TWG
RCI-9	Green Power Purchasing (required for state facilities) and Bulk Purchasing Programs for Energy Efficiency or Other Equipment	Len Hoey, Full TWG

RCI-10	Distributed Renewable and Clean Fossil Fuel Power Generation	Full TWG
RCI-11	Residential, Commercial, and Industrial Energy and Emissions Audits and Recommended Measure Implementation	Jeff Tiller, Full TWG

* Denotes membership on the LCGCC

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

#	Mitigation Option Name	Drafting Volunteers
ES-1	Renewable Energy Incentives (biomass, wind, solar, geothermal, hydro)	*George Everett, Vicky Will
ES-2	Environmental Portfolio Standard (renewables and energy efficiency) with renewable energy credit trading	*Tim Tobin, *Ivan Irlaub
ES-3	Removing barriers to CHP and clean DG (including utility rate and interconnection barriers, financing, information, etc.)	Alex Hobbs, Vicky Will
ES-4	CO2 tax and/or cap-and-trade (including covering sources including fossil, renewable, and nuclear on life-cycle basis)	*Steve Smith
ES-5	Legislative changes requiring the NC Utility Commission to Consider environmental and other factors	*Michael Shore
ES-6	Incentives for advanced coal, including IGCC and carbon capture and storage (CCS).	*George Everett, Vicky Will
ES-7	Public Benefit Charge on electricity bills for funding efficiency activities	Ward Lenz, Alex Hobbs
ES-8	Waste to Energy	Technical Work Group
ES-9	Incentives for combined heat and power (CHP) and clean DG	Alex Hobbs, Vicky Will
ES-10	NC Greenpower renewable resources program	Ward Lenz, Alex Hobbs

* Denotes membership on the LCGCC

Table 3.
Transportation and Land Use Technical Work Group
Summary List of Pending Mitigation Options

#	Mitigation Option Name	Drafting Volunteers
TLU-1	Smart Growth Bundle	Lisa Riegel, Daren Bakst, Nina Szlosberg, Roger Sheats
TLU-2	Improve Transit Bundle	Roger Sheats, Nina Szlosberg, Lisa Riegel
TLU-3	Feebates	Anne Tazewell, Denise Choy
TLU-4	VMT Fee	Carolyn McCormick, Skip Yeakel
TLU-5	Truck Stop Electrification (TSE)	Skip Yeakel, Anne Tazewell
TLU-6	Tailpipe GHG Standards	Daren Bakst, Denise Choy
TLU-7	Biofuels Bundle	Anne Tazewell, Lisa Riegel, Anne Coan
TLU-8	Procurement of Efficient Fleet Vehicles	Anne Tazewell, Carolyn McCormick
TLU-9	Anti-Idling	Skip Yeakel
TLU-10	Diesel Retrofits	Vicki Chandler, Skip Yeakel
TLU-11	Fuel Tax	Will Schroeer
TLU-12	Pay as You Drive Insurance	Will Schroeer
TLU-13	Incentives for Advanced Technology Vehicles	*Michael Shore, Denise Choy

* Denotes membership on the LCGCC

Table 4.
Agriculture, Forestry, and Waste Management Technical Work Group
Summary List of Pending Mitigation Options

#	Mitigation Option Name	Drafting Volunteers
AFW-1	Manure Digesters/Other Waste Energy Utilization	*Mitch Peele, Marion Deerhake, Kraig Westerbeek
AFW-2	Biodiesel Production (incentives for feedstocks and production plants)	John Bonitz, Mitch Peele
AFW-3	Conservation Tillage/No-Till (carbon sequestration and reduced energy use)	*Mitch Peele, Chris Hopkins, David Smith
AFW-4	Preserve Open Space/Agricultural Land	David Smith, Mitch Peele, Bill Holman
AFW-5	Agricultural Biomass Feedstocks for Electricity or Steam Production	*Mitch Peele, Dennis Hazel
AFW-6	Policies to Promote Ethanol Production	John Bonitz, *Mitch Peele, Chris Hopkins, *Bob Slocum
AFW-7	Forest Protection – Reduced Clearing and Conversion to Nonforest Cover	Chris Hopkins, Bob Hazel, Stephen Whitfield
AFW-8	Afforestation and/or Restoration of Nonforested Lands	*Bob Slocum, Chris Hopkins, Bob Hazel, Stephen Whitfield, Dennis Hazel
AFW- 9 &10	Expanded Use of Forest Biomass for Electricity, Heating and Liquid Fuels	Chris Hopkins, *Bob Slocum, Stephen Whitfield, Dennis Hazel
AFW-11	Landfill Methane and Biogas Energy Programs	Jim Hickman, Chris Hopkins
AFW-12	Increased Recycling Infrastructure and Collection	Jim Hickman, Chris Hopkins

* Denotes membership on the LCGCC

Table 5.
Cross-Cutting Issues Technical Work Group
Summary List of Pending Mitigation Options

#	Mitigation Option Name	Drafting Volunteers
CC-1	GHG Inventories and Forecasts	Whole TWG
CC-2	GHG Reporting	Whole TWG
CC-3	GHG Registry	Whole TWG
CC-4	Public Education and Outreach	Steve Kalland, Steve McNulty
CC-5	Adaptation	Ulla-Britt Reeves, Jim Stephenson, Tom Cecich, Janice Godfrey
CC-6	Options for Goals or Targets (for CAPAG in support of LCGCC)	Steve McNulty, Chuck Pickering, Ulla-Britt Reeves, *Michael Shore, Jim Stephenson

* Denotes membership on the LCGCC

AFW-6 Policies to Promote Ethanol Production

Mitigation Option Description

Trees, crops and other plants convert atmospheric carbon to carbohydrate or fiber stocks that can be converted to liquid fuels, such ethanol. The use of these renewable, biological fuels can offset fossil fuel use and reduce associated net carbon dioxide emissions. Production incentives for the conversion of crops, forest sources, animal waste and other sources to ethanol through existing or new technologies can increase the level of ethanol use in future markets.

Mitigation Option Design

- **Goals:** Several projects are being proposed in North Carolina that would result in the production of 250 million gallons of ethanol annually in North Carolina by 2008. Production incentives could increase this amount by 10% beyond expected levels in 2010, and 25% by 2020.
- **Timing:** Startup in 2008 and ramp up to higher levels in 2010 and 2020, consistent with goals.
- **Coverage of parties:** Suppliers of feedstocks, ethanol producers and distributors. Associated agencies would include: NCDA&CS, Department of Administration, Motor Carrier Enforcement Division, DENR, Department of Commerce, NC Rural Center, NCSU, NCA&T, and other state agencies.
- **Other:** As needed, identify incentives that encourage the growing and supply of feedstocks, and the utilization of ethanol in transportation markets across the state.

Implementation Mechanisms

TBD

Related Policies/Programs in Place

TBD

Types(s) of GHG Reductions

Net reduction in CO2 emissions.

Estimated GHG Savings and Costs per $MtCO_2e$

TBD

- **Data Sources:** TBD

- **Quantification Methods:** Full life cycle analysis
- **Key Assumptions:** TBD

Key Uncertainties

TBD

Additional Benefits and Costs

TBD

Feasibility Issues

TBD

Status of Group Approval

TBD

Level of Group Support

TBD

Barriers to Consensus

TBD

North Carolina

Climate Action Plan Advisory Group

WWW.NCCLIMATECHANGE.US

List of Members

Stan Adams
NCDENR Div. Forest Services (ret.)

Daniel Besse
Elected Official

Thomas Cecich
Pharmaceutical Consultant

Jerry Coker
Weyerhaeuser

Marion Deerhake
Environmental Management Commission

Barry Eveland
NC Citizens for Business & Industry

George Everett
Duke Power

Jim Fain
NC Dept. of Commerce

George Givens
Environmental Review Commission

Dennis Grady
Appalachian State University

Steve Halstead
North Carolina Council of Churches

Bob Hazel
Senior Citizens Interest

Dennis Hazel
NCSU Forestry & Environmental Outreach

Alex Hobbs
North Carolina Solar Center

Bill Holman
Clean Water Management Fund

Preston Howard
Manufacturers & Chemical Industry Council

Gary Hunt
DENR Pollution Prevention and Sustainability

Robert Jackson
Duke University

Robert Koger
North Carolina Green Power

Edward Kruel
International Paper

Carolyn McCormick
Outer Banks Visitor Bureau

Jack McDonald
McDonald - York Developers

David McLeod
Environmental Review Commission

Steven McNulty
USDA Forest Service

Marily Nixon
Southern Environmental Law Center

Mitch Peele
North Carolina Farm Bureau

Chuck Pickering
The Biltmore Company

Simon Rich
Energy Industry

Lisa Riegel
NC Natural Heritage Fund

Jo Anne Sanford
NC Utilities Commission

Roger Sheats
Global Warming Initiatives

Larry Shirley
NC State Energy Office

Michael Shore
Environmental Defense

David Smith
NC Dept. Agriculture and Consumer Services

Steven Smith
Southern Alliance for Clean Energy

Jim Stephenson
NC Coastal Federation

Nina Szlosberg
NC Board of Transportation

Anne Taylor
Environmental Education Fund

Tim Toben
Carolina Clean Energy

Ivan Urlaub
NC Sustainable Energy

Kraig Westerbeek
Murphy-Brown

Stephen Whitfield
North Carolina Woodlands

Vicky Will
Progress Energy

Jim Witkowski
International Paper

Skip Yeakel
VolvoTrucks of North America

Committee Alternates

Anne Coan
North Carolina Farm Bureau

Adam Costanza
International Paper

Steve Kalland
NC Solar Center

NC Dept. of Environment & Natural Resources Division Of Air Quality

Bill Ross
Secretary DENR

Keith Overcash
Director Division of Air Quality

Brock Nicholson,
Deputy Director DAQ, Committee Facilitator

James Southerland
Program Coordinator DAQ – Liaison

Charles Davis
DAQ - Liaison

Kimberly Garnett
DAQ - Liaison

Heather Hawkins
DAQ - Liaison

Phyllis Jones
DAQ - Liaison

Hoke Kimball
DAQ – Liaison

Center for Climate Strategies

Tom Peterson
Committee Facilitator

Ken Colburn
Adviser

Karl Hausker
Adviser

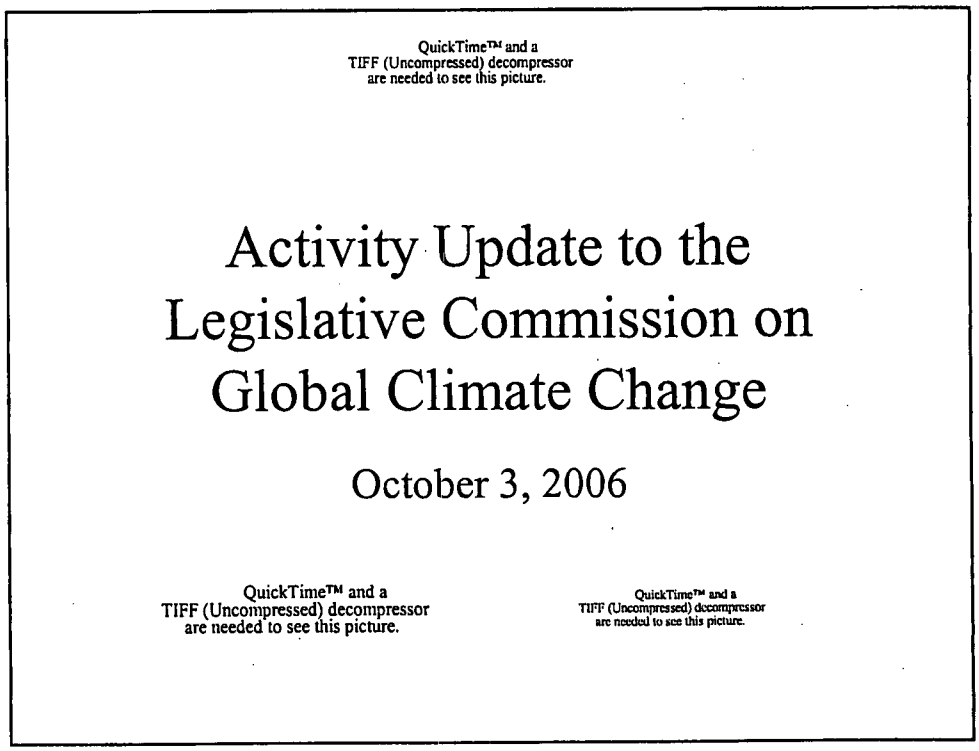
David Von Hippel
RCI Facilitator

Steve Roe
AFW Facilitator

Bill Dougherty
ES Facilitator

Will Schroeer
TLU Facilitator

Randy Strait
CC Facilitator



Activity Update to the Legislative Commission on Global Climate Change

October 3, 2006

Topics

- Update on activities of the North Carolina Climate Action Planning Advisory Group (CAPAG) and Technical Work Groups (TWGs)
  - Review of activities to date
  - Discussion of current draft mitigation options for analysis
  - Discussion of next steps, using one sample option

Participants

- CAPAG Members (45)
- LCGCC Members on the CAPAG (11)
- TWG Members:
  - Residential, Commercial and Industrial (18)
  - Energy Supply (18)
  - Transportation and Land Use (18)
  - Agriculture, Forestry and Waste (18)
  - Cross Cutting Issues (14)

Meetings

- CAPAG Meetings Held to Date (February, May, July 2006) (3)
- CAPAG Meetings to be Held (October 2006; January, May 2007) (3)
- TWG Meetings Held to Date (41)
- TWG Meetings to be Held (October 2006 - May 2007) (~ 40)
- Additional Meetings of the CAPAG and or TWGs After May 2007 (TBD)

Draft Mitigation Options

- Original Number of Potential Options Presented to the CAPAG from the CCS Catalog of States Actions (251)
- Updated Number of Potential Options on the CCS Catalog of States Actions, Including CAPAG Additions from the Clean Smokestacks Act, State Energy Plan, Etc. (307)
- Current Number of "Priority for Analysis" Draft Potential Mitigation Options for Analysis (52)
  - Residential, Commercial and Industrial (11)
  - Energy Supply (10)
  - Transportation and Land Use (13)
  - Agriculture, Forestry and Waste (12)
  - Cross Cutting Issues (6)

LCGCC Participants on the CAPAG and TWGs

- Dr. Delores "Dee" Eggers - CC
- Tim Tobin - ES
- Ivan Irlaub - ES
- Tom Cecich - CC
- George Everett - ES
- Vickie Will - ES
- Preston Howard - ES
- Mitch Peele - AFW
- Robert Slocum - AFW
- Michael Shore - CC, ES, TLU
- Steven Smith - CC, AFW, ES
- James Stevenson - CC

Residential, Commercial, Industrial

- RCI-1 Demand Side Management Programs for the Residential, Commercial and Industrial Sectors
- RCI-2 Expand Energy Efficiency Funds
- RCI-3 Energy Efficiency Requirements
- 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 Mandatory Programs, Incorporating Local Building Materials and Advanced Construction
- RCI-8 Education (Consumer, Primary/Secondary, Post-Secondary/ Specialist, College and University Programs)
- 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
- RCI-11 Residential, Commercial, and Industrial Energy and Emissions Audits and Recommended Measure Implementation

Energy Supply

- ES-1 Renewable Energy Incentives (biomass, wind, solar, geothermal, hydro)
- ES-2 Environmental Portfolio Standard (renewables and energy efficiency) with renewable energy credit trading
- ES-3 Removing barriers to CHP and clean DG (including utility rate and interconnection barriers, financing, information, etc.)
- ES-4 CO2 tax and/or cap-and-trade (including covering sources including fossil, renewable, and nuclear on life-cycle basis)
- ES-5 Legislative changes requiring the NC Utility Commission to
- Consider environmental and other factors
- ES-6 Incentives for advanced coal, including IGCC and carbon capture and storage (CCS)
- ES-7 Public Benefit Charge on electricity bills for funding efficiency activities
- ES-8 Waste to Energy
- ES-9 Incentives for combined heat and power (CHP) and clean DG
- ES-10 NC Greenpower renewable resources program

Transportation

- TLU-1 Smart Growth Bundle
- TLU-2 Improve Transit Bundle
- TLU-3 Feebates
- TLU-4 VMT Fee
- TLU-5 Truck Stop Electrification (TSE)
- TLU-6 Tailpipe GHG Standards
- TLU-7 Biofuels Bundle
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- TLU-9 Anti-Idling
- TLU-10 Diesel Retrofits
- TLU-11 Fuel Tax
- TLU-12 Pay as You Drive Insurance
- TLU-13 Incentives for Advanced Technology Vehicles

Agriculture, Forestry & Waste Management

- AFW-1 Manure Digesters/Other Waste Energy Utilization
- AFW-2 Biodiesel Production (incentives for feedstocks and production plants)
- AFW-3 Conservation Tillage/No-Till (carbon sequestration and reduced energy use)
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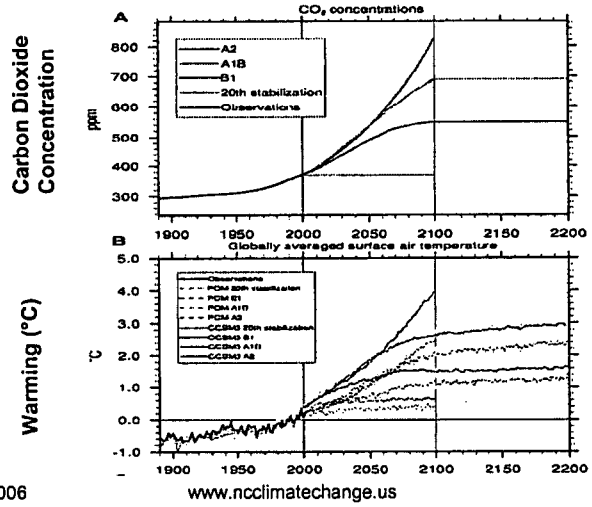
- AFW-11 Landfill Methane and Biogas Energy Programs
- AFW-12 Increased Recycling Infrastructure and Collection

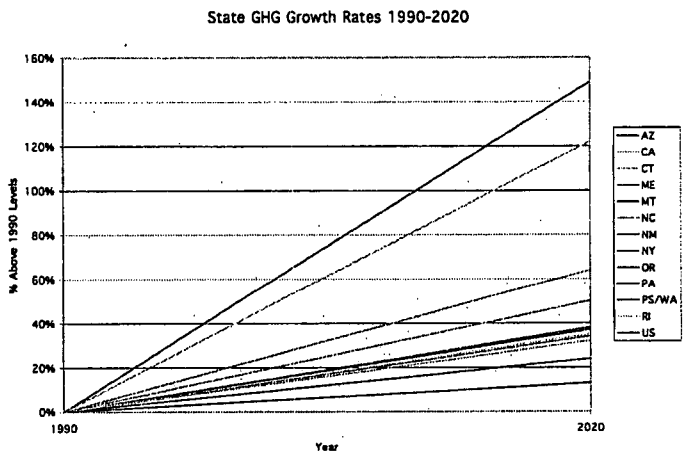
Cross Cutting Issues

- 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 (in support of LCGCC)

High v. Low GHG Scenarios



State GHG Growth Rates



State Climate Goals

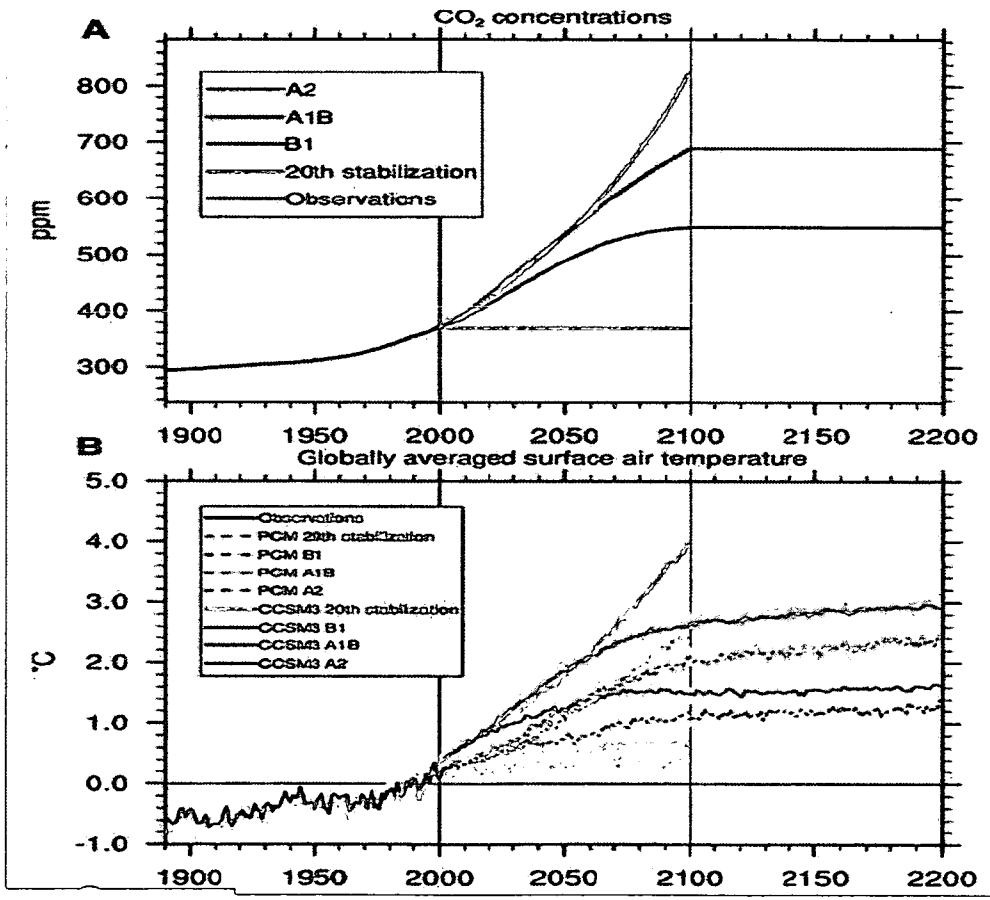
State	1990-2020 GHG Forecast	State Goals	Climate Plan Coverage
Arizona	149%	2000 levels by 2020; 50% below by 2040	106%
California	34%	- E.O.: 2000 level by 2010; 10% below by 2020; 80% by 2050 - AB-32: 1990 levels by 2020	TBD
Connecticut	32%	1990 level by 2010; 10% below by 2020; 75-85% ultimately	100%
Massachusetts	?	1990 level by 2010; 10% below by 2020; 75-85% ultimately	?
Maine	34%	1990 level by 2010; 10% below by 2020; 75-85% ultimately	100%
North Carolina	113%	?	TBD
NEG/ECP	?	1990 level by 2010; 10% below by 2020; 75-85% ultimately	TBD
New Jersey	?	5% below 1990 by 2005	100%
New Mexico	48-64%	2000 level by 2012; 10% below by 2020; 75% by 2050	TBD
New York	24%	5% below 1990 by 2010	?
Oregon	38%	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; 75-85% ultimately	100%

Next Steps - Sample Draft Mitigation Option

- Mitigation Option Description
- Mitigation Option Design
- Implementation Mechanisms
- Related Policies/Programs in Place
- Types(s) of GHG Reductions
- Estimated GHG Savings and Costs per MtCO2e
- Key Uncertainties
- Additional Benefits and Costs
- Feasibility Issues
- Status of Group Approval
- Level of Group Support
- Barriers to Consensus

High v. Low GHG Scenarios

Carbon Dioxide Concentration



State GHG Growth Rates

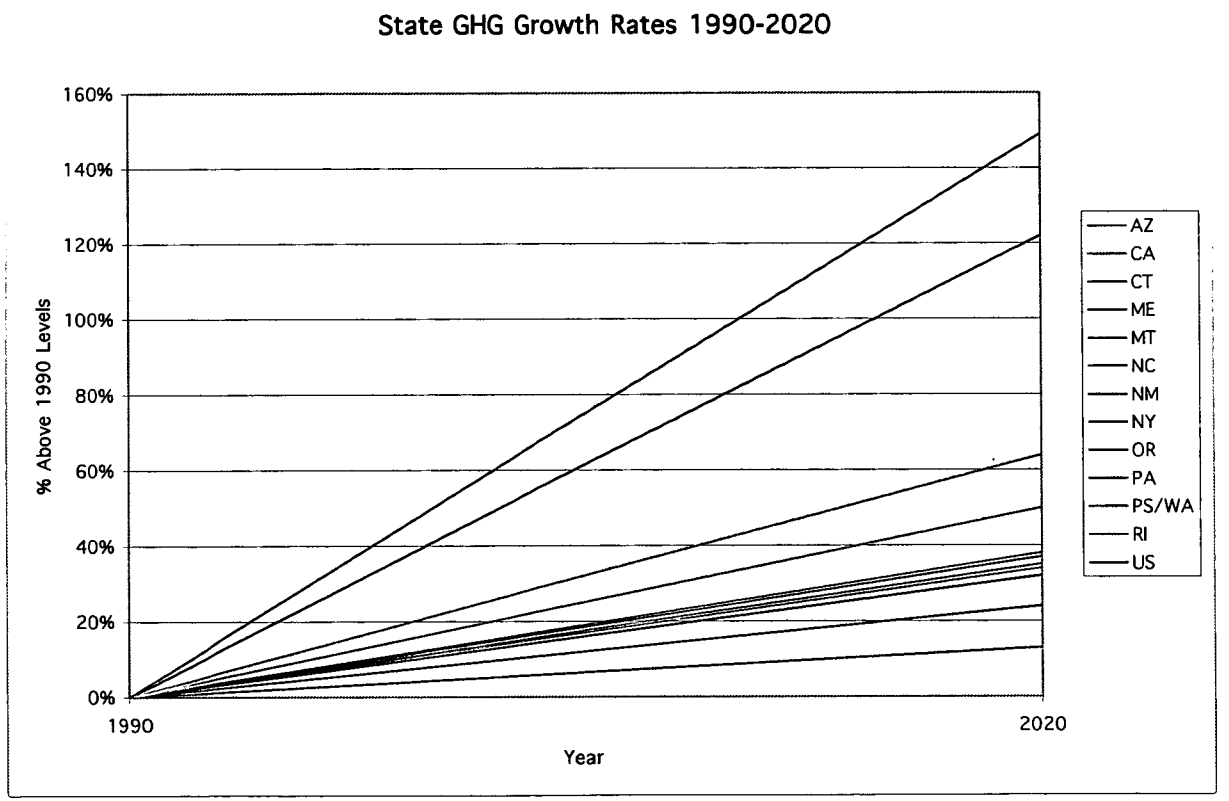
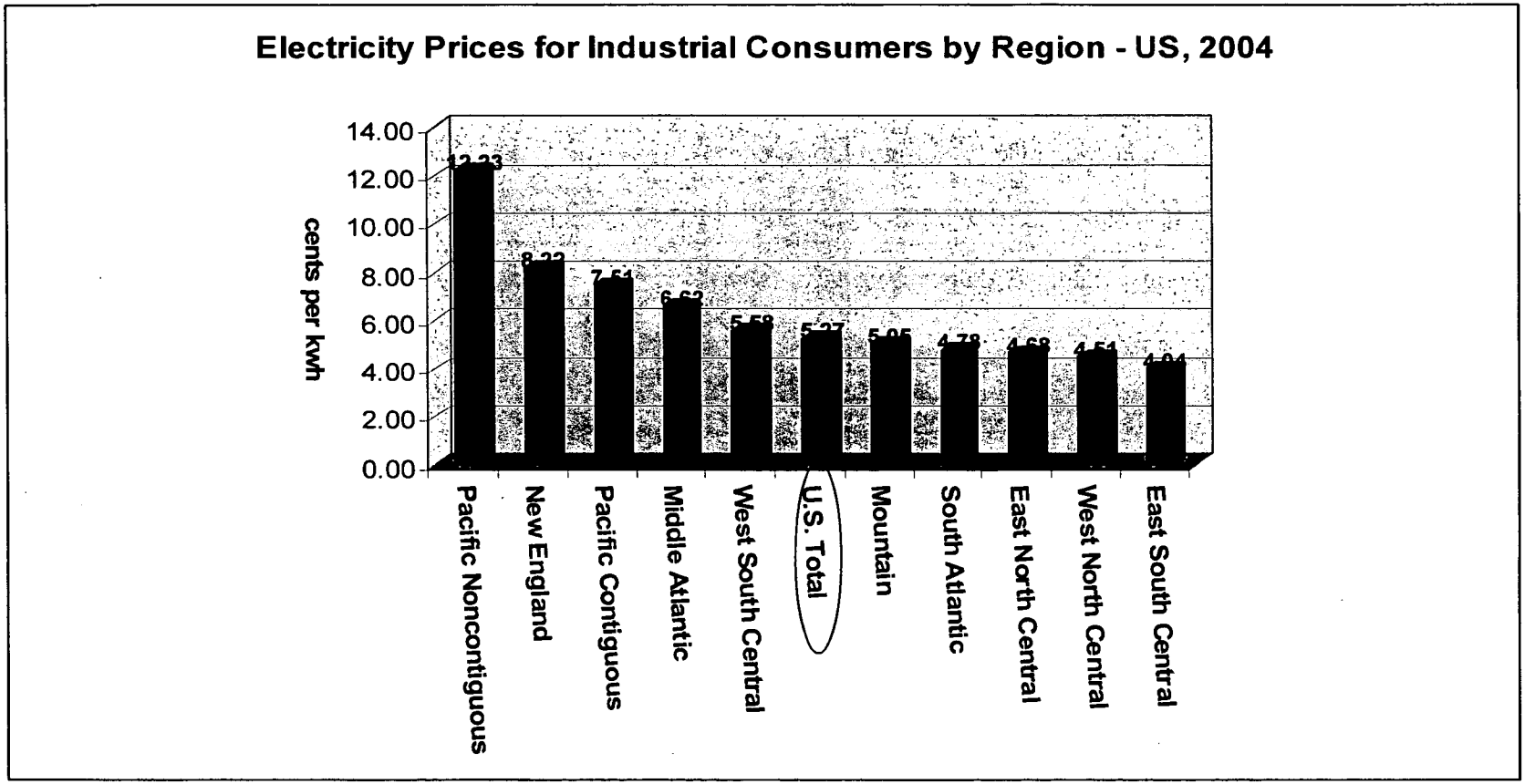


Table 3. Average Retail Price for Bundled and Unbundled Consumers by Sector, Census Division, and State, 2004

CENSUS DIVISION	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	TRANSPORTATION	ALL SECTORS
State					
New England	**11.91**	**10.61**	**8.22**	**5.48**	**10.61**
CT	11.63	9.90	7.89	7.25	10.26
MA	11.75	10.99	8.48	4.65	10.77
ME	12.16	9.89	6.56	-	9.69
NH	12.49	10.99	10.01	-	11.37
RI	12.19	10.53	9.37	-	10.96
VT	12.94	11.42	7.96	-	11.02
Middle Atlantic	**11.81**	**10.98**	**6.62**	**8.02**	**10.29**
NJ	11.23	9.96	9.03	10.94	10.29
NY	14.54	12.98	7.04	7.92	12.55
PA	9.58	8.51	5.87	7.32	8.00
East North Central	**8.28**	**7.40**	**4.68**	**6.14**	**6.64**
IL	8.37	7.54	4.65	5.70	6.80
IN	7.30	6.31	4.13	8.76	5.58
MI	8.33	7.57	4.92	7.89	6.94
OH	8.45	7.75	4.89	9.21	6.89
WI	9.07	7.24	4.93	-	6.88
West North Central	**7.57**	**6.16**	**4.51**	**5.87**	**6.17**
IA	8.96	6.75	4.33	-	6.40
KS	7.74	6.45	4.69	-	6.37
MN	7.92	6.31	4.63	6.75	6.24
MO	6.97	5.80	4.62	4.91	6.07
ND	6.79	5.86	4.13	-	5.69
NE	6.96	5.84	4.28	-	5.70

Figure 4. Electricity Prices for Industrial Consumers in US by Region, 2004



Source: US Energy Information Administration < http://www.eia.doe.gov/neic/a-z/electrica-z.htm>

CENSUS DIVISION	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	TRANSPORTATION	ALL SECTORS
SD	7.65	6.18	4.59	-	6.44
South Atlantic	**8.33**	**6.96**	**4.78**	**6.54**	**7.05**
DC	8.00	7.45	4.74	7.37	7.47
DE	8.78	7.44	6.06	-	7.53
FL	8.99	7.61	5.84	7.45	8.16
GA	7.86	6.88	4.43	5.12	6.58
MD	7.80	7.56	5.99	6.46	7.15
NC	8.45	6.70	4.88	-	6.97
SC	8.12	6.91	4.13	-	6.22
VA	7.99	5.88	4.27	6.25	6.43
WV	6.23	5.46	3.83	5.70	5.13
East South Central	**7.12**	**6.89**	**4.04**	**11.75**	**5.83**
AL	7.62	7.12	4.15	-	6.08
KY	6.11	5.60	3.34	-	4.63
MS	8.21	7.99	4.83	-	7.00
TN	6.90	7.05	4.46	11.75	6.14
West South Central	**9.05**	**7.54**	**5.58**	**7.03**	**7.47**
AR	7.36	5.64	4.16	-	5.67
LA	8.05	7.58	5.82	7.09	7.13
OK	7.72	6.55	4.76	-	6.50
TX	9.73	7.90	5.87	7.02	7.95
Mountain	**8.24**	**7.06**	**5.05**	**6.25**	**6.86**
AZ	8.46	7.28	5.35	-	7.45
CO	8.42	6.89	5.11	5.81	6.95
ID	6.10	5.37	3.82	-	4.97
MT	7.86	7.42	4.15	-	6.40
NM	8.67	7.39	5.22	-	7.10
NV	9.69	9.08	7.24	-	8.56

CENSUS DIVISION	RESIDENTIAL	COMMERCIAL	INDUSTRIAL	TRANSPORTATION	ALL SECTORS
UT	7.21	5.90	4.01	6.57	5.69
WY	7.21	5.98	3.91	-	4.98
Pacific Contiguous	**10.33**	**10.10**	**7.51**	**5.82**	**9.62**
CA	12.51	11.53	9.52	5.77	11.45
OR	7.18	6.45	4.43	6.50	6.21
WA	6.37	6.17	4.28	6.44	5.80
Pacific Noncontiguous	**15.84**	**14.02**	**12.23**	**-**	**14.05**
AK	12.44	10.99	8.33	-	10.99
HI	18.06	16.19	13.35	-	15.70
U.S. Total	**8.97**	**8.16**	**5.27**	**7.13**	**7.62**

Source: US Energy Information Administration http://www.eia.doe.gov/neic/a-z/electrica-z.htm