North Carolina Department of Commerce
Energy Office

Beverly Eaves Perdue, Governor
John Morrison, Assistant Secretary for Energy

J. Keith Crisco, Secretary
Ward Lenz, Director, State Energy Office

Governor Bev Perdue
State Capitol
Raleigh, N.C. 27601

Lt. Gov. Walter Dalton
310 N. Blount Street
Raleigh, N.C.27601

House Speaker Joe Hackney
N.C. Legislative Building
16 W. Jones Street
Raleigh, N.C. 27601

Sen. Marc Basnight, Senate President Pro Tempore
N.C. Legislative Building
16 W. Jones Street
Raleigh, N.C. 27601

Edward S. Finley Jr., Chairman
N.C. Utilities Commission
Dobbs Building
430 North Salisbury St.
Raleigh, NC 27603-5918

April 29, 2010

Dear Gov. Perdue; Lt. Gov. Dalton; House Speaker Hackney; Sen. Basnight and Chairman Finley:

Enclosed please find the 2010 report on North Carolina Energy, submitted (via e-mail) to you as required in General Statute 113B-12. Copies of the report have also been sent to the chairs of the legislative appropriations, finance, energy, environment, public utilities and other appropriate committees. Two printed copies of this report have been delivered to the Legislative Library.

In addition to this report, the newly composed North Carolina Energy Policy Council is developing a series of recommendations it will present to Gov. Perdue prior to the start of the reconvening of the General Assembly in May, as well as additional recommendations it will offer at year's end.

Please do not hesitate to contact us with any questions you may have about this report.

Sincerely yours,

Tim Toben, Chairman
N.C. Energy Policy Commission

Ward Lenz, Director
N.C. State Energy Office

Mailing Address:
1340 Mail Service Center
Raleigh, NC 27699-1340

Telephone (919) 733-2230
Fax (919) 733-2953
www.energync.net
An Equal Opportunity/Affirmative Action Employer

Location:
1830A Tillery Place
Raleigh, North Carolina 27604

North Carolina State Energy Report

North Carolina Energy Policy Council

North Carolina
State Energy Report
March, 2010

Submitted by the

North Carolina Energy Policy Council

and

North Carolina Energy Office

Prepared By

Appalachian State University
Department of Technology
and Energy Center

March, 2010

Table of Contents

1. Introduction

During the first decade of the 21st century, North Carolinians have realized the critical importance of adequate energy and water for our future. While our traditional reliance on the major fuel sources – coal, petroleum, natural gas, and nuclear – remains intact, there has been a shift to efficiency and the use of renewable energy sources. The driving forces for this change include unpredictable energy prices, forecasts questioning future availability of certain fuels, most notably petroleum, and concerns about the environmental impact of fossil fuel combustion.

In recent years, North Carolina has set forth policies and programs that show the importance of energy issues in our state's future. Noteworthy recent legislation by the state's General Assembly includes:

- Establishment of a "renewable energy and energy efficiency portfolio standard" (Session Law 2007-397) that requires electric utilities in the state to meet a certain percentage of their customers' needs with renewable sources or reduced electricity consumption by implementing energy efficiency programs.
- Requirements that new and existing state buildings meet higher efficiency standards.
- Limits on municipalities and homeowner associations to ban the installation of solar collectors.
- Creation of the Biofuels Center of North Carolina. Goal: by 2017, 10% of liquid fuels consumed in North Carolina come from biofuels grown and produced within the state.
- Allow the distribution of gasoline-ethanol mixed fuels, providing a motor fuel tax exemption for biodiesel, mandating that state fleets only purchase diesel vehicles that honor warranties if a 20% biodiesel mix (B-20) is used, and requiring that all diesel public school buses be capable of running on B-20.

Other developments include:

- Approval of a new energy code for residential and commercial buildings, which was effective in January of 2009 by the North Carolina Building Codes Council and the North Carolina Department of Insurance. Work is progressing on the next revision of the state's energy code, which has the goal of increasing the efficiency of new buildings beyond that required by national energy codes.
- New efficiency programs by electric and gas utilities in the state.
- A variety of funding programs for implementation of renewable

Summary of Key Energy Policies and Programs in North Carolina, 2007-2009

- The General Assembly passed a Renewable Energy and Energy Efficiency Portfolio Standard (Senate Bill 3) that will require investor-owned electric utilities in the state to provide up to 12.5% of electricity needs via either renewable energy sources or energy efficiency (up to 5%) by 2021.
- The General Assembly required that existing state buildings reduce energy consumption by 20% from baseline energy use in 2002-2003 by 2010 (Senate Bill 668). New state buildings must exceed national standards by 30%.
- In House Bill 1473 in 2007, the General Assembly set aside $5 million for FY 2007-2008 to install efficiency measures in state buildings with funds administered by the State Energy Office. In 2008-2009 The General Assembly appropriated another $5 million for this purpose – $2.7 million for the State Energy Office and $2.3 million for the University of North Carolina system.
- The General Assembly established the Biofuels Center of North Carolina and provided $5 million in initial funding and another $5 million in FY 2008-2009.
- The General Assembly funded $1 million for a North Carolina Green Business Fund in Fiscal Years 2007-08 and 2008-09. Funding increased to $8 million in 2009-10 through support from the American Recovery and Reinvestment Act.
- Over $250 million in funds for efficiency measures in new and existing buildings, renewable energy measures, and a variety of other programs funded through the American Recovery and Reinvestment Act.

Figure 1:
Total Energy Consumption in North Carolina (TBtu)

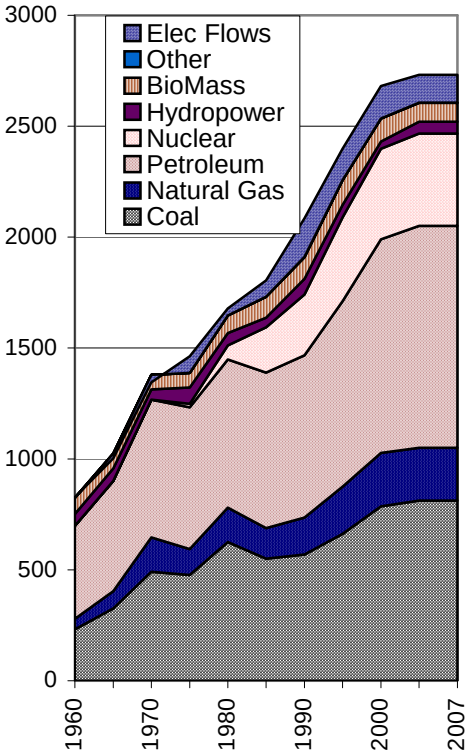
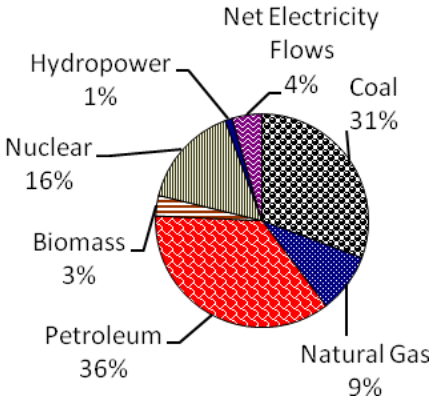


Figure 2:
Breakdown of Energy Use by Source in 2007
(Total = 2,700 Trillion Btu)



energy and energy efficiency measures throughout the state's economic sectors via the American Renewal and Recovery Act.

Energy Consumption in North Carolina

Figure 1 shows energy consumption in North Carolina continues to climb. The primary sources of energy remain petroleum, coal, nuclear fuel, and natural gas. Currently, North Carolina imports virtually all of its fuel resources. These imports cost the consumers, businesses, and institutions in our state over $17 billion in 2007. Only $1.5 billion came from in-state resources.

Table 1 shows the average growth rates for energy use and population since 1960 for North Carolina and the United States. Between 1970 and 2000, energy use increased at a greater rate in North Carolina than in the entire country, but population grew at a greater rate as well. Still, per capita energy use grew at a higher rate in North Carolina than the country from 1970 to 1995. In terms of actual values, between 1960 and 1970, statewide per capita use rose from 182 million Btu per capita in 1960 to 265 in 1970 (a 3.8% annual rate of increase). Between 1970 and 2005, per capita energy use climbed to 318 million Btu (a 20% overall increase equivalent to a 0.4% increase each year). While energy consumption continues to increase in response to a growing population, energy use per capita dropped slightly between 1995 and 2000 and substantially between 2000 and 2005 – a very positive development that will hopefully continue.

Figure 2 shows the percentage of energy consumption by fuel in 2007. Petroleum provided about 36% of the total, primarily for transportation while coal supplied about 31%, mainly for electricity generation. Nuclear fuel for electricity generation represented 16% of the total, and natural gas provided 9%, primarily for use in buildings and industry.

Table 1: Percentage Change in Energy Consumption and Population in Recent Decades

	North Carolina			United States		
	Energy	Popu-lation	Energy/ Capita	Energy	Popu-lation	Energy/ Capita
1960-1970	5.0%	1.1%	3.8%	4.2%	1.3%	2.9%
1970-1980	2.2%	1.5%	0.8%	1.5%	1.1%	0.4%
1980-1990	2.2%	1.2%	1.0%	0.8%	0.9%	-0.1%
1990-1995	2.8%	1.5%	1.3%	1.5%	1.2%	0.3%
1995-2000	2.3%	2.4%	-0.1%	1.6%	1.3%	0.3%
2000-2005	0.4%	1.9%	-1.5%	0.3%	1.2%	-0.9%

Source: Energy Information Administration. U.S. Department of Energy and U.S. Statistical Abstracts.

Efficiency has been an important energy source for many decades; however, its contribution does not typically appear in consumption data. The Alliance to Save Energy estimates that efficiency reduced national energy needs in 1999 by 31% and that businesses involved in activities related to energy efficiency comprised a $21 billion industry nationally in 1999 A study conducted by the Appalachian Regional Commission concluded that the implementation of energy efficiency measures could create tens of thousands of jobs in Appalachia and save the region billions in energy costs. Likewise, demand-side solar systems such as daylighting, passive heating and cooling, and solar hot water systems are typically not accounted for, but cut demand for traditionally generated power. New requirements for utilities to increase energy efficiency, as well as consumer responses to higher prices, will likely increase the role played by efficiency.

Figure 3 gives a different view of energy consumption in North Carolina, showing electricity as an energy source in itself and not including the energy used for power generation. For example, coal consumption is only shown for direct use by industry, commercial buildings, and residences, not for its contribution to electrical power production. Petroleum and purchased electricity dominate net energy consumption in the state, providing 89% of energy needs in 2007, with petroleum providing 36% of total energy and electricity contributing 53% (not including generation and transmission losses). Natural gas provides 7% of total use, while direct coal use and renewables, primarily biomass and hydropower, contribute smaller shares.

Figure 4 shows the energy use breakdown by sector in 2007, including electrical losses from generation. Note that all four sectors are very close in energy use – an important change from previous decades when energy use for industry and transportation was much higher than for residential and commercial. Energy use in residential and commercial buildings totals to 49% of energy consumption in the state in 2007 and thus constitutes the largest energy-using sector.

Energy Prices

Of course, the major impact consumers have felt related to energy in recent years has been the rising cost of fuels. Figure 5 displays recent trends, which show that until the latter months in 2008, natural gas increased in price an average of 7% per year since 2000 and motor gasoline increased an average of 17% over the same period. Recent declines have shown the continued unpredictability of fuel prices.

Electricity prices have remained relatively unchanged over the past decade for most North Carolinians. On the next page, Table 3 shows that North Carolinians paid a lower average price for electricity than the region and

Figure 3:
End Use Energy in North Carolina in 2007

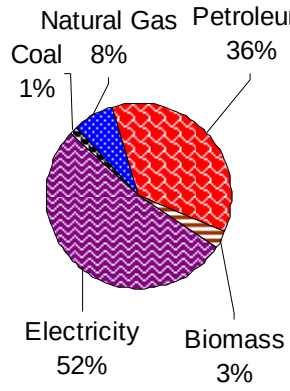
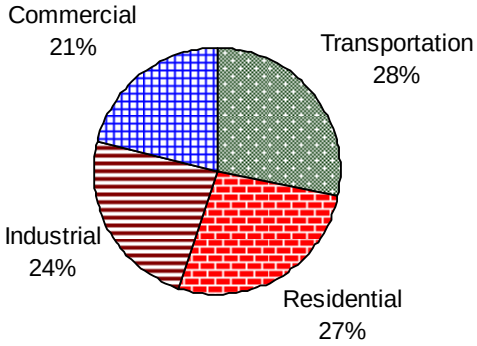
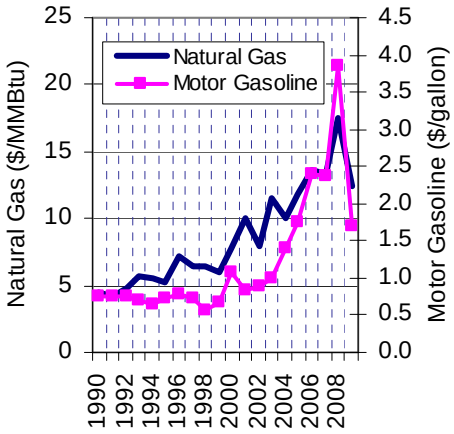


Figure 4:
Total Energy Use by Sector in 2007 (2.7 Trillion Btu total including electrical losses)



Source: Energy Information Administration. U.S. Department of Energy.

Figure 5:
Retail Fuel Prices



Source: Energy Information Administration,

Table 3:
Average Monthly Electricity Bill by Sector and Location, 2009

	Residential		Commercial		Industrial	
	¢ / kWh	Monthly Bill ($)	¢ / kWh	Monthly Bill ($)	¢ / kWh	Monthly Bill ($)
North Carolina	10.19	107	8.07	453	6.04	12,279
South Atlantic	11.39	116	9.71	639	6.74	8,686
United States	11.68	100	10.32	618	6.95	6,899

Source: EIA, www.eia.doe.gov/cneaf/electricity/esr/table5.html

nation as a whole. In fact, the only state in the south Atlantic region with lower residential and commercial rates is West Virginia. In the case of industrial electric rates, South Carolina has slightly lower rates than North Carolina, and West Virginia's rates are substantially lower.

Household energy costs place a disproportionate burden, depending on family income. Table 4 shows that households earning less than $50,000 annually devote about twice as much of their income for energy as those earning over $50,000. In residential units whose occupants earn less than $10,000 per year, energy bills may consume 46% of their annual income.

Table 4:
U.S. Average Percentage of Income Spent on Energy

Income Level	% of House-holds	Average Total Energy Costs/Yr	% of After-Tax Income
<$10K	8%	$2,592	46%
$10-30K	25%	$3,555	20%
$30-$50K	21%	$5,461	16%
>$50K	47%	$6,013	7%

Source: Trisko, Eugene M. *The Rising Burden of Energy Costs on American Families, 1997-2007*. Americans for Balanced Energy Choices.

Economic Change in North Carolina

North Carolina's economy is in transition, moving from a heavy dependence on manufacturing and agriculture to one concentrated in services and the high technology sectors. In twelve years North Carolina's Gross State Product grew to $400.2 billion in 2008 making it 10th in nation.

Table 5 on the next page shows how the individual economic sectors changed between 2000 and 2006. Other than in food manufacturing, all non-durable and durable goods manufacturing declined. At the same time, wholesalers; retailers; finance, insurance and real estate; services; and government sectors, along with construction, either grew or remained constant. By far the largest provider of employment was the services sector, with retailers second, and construction and government providing the third and fourth highest employment levels.

Environmental Considerations

Air Pollution Issues

In North Carolina, the link between energy and environment has indeed become visible. The National Park Service reports that visibility problems due to air pollution are:

"Worst in eastern parks such as Mammoth Cave NP, Kentucky; Shenandoah NP, Virginia, and Great Smoky Mountains NP, Tennessee/North Carolina. Sulfate particles formed from sulfur dioxide emissions associated with fossil fuel combustion, mostly from electric generation facilities, accounts for 60 to 80 percent of the visibility impairment in the eastern parks and 30 to 40 percent of the impairment in western states."

Other key environmental considerations about energy use in the state include strategies for reducing emissions of the following:

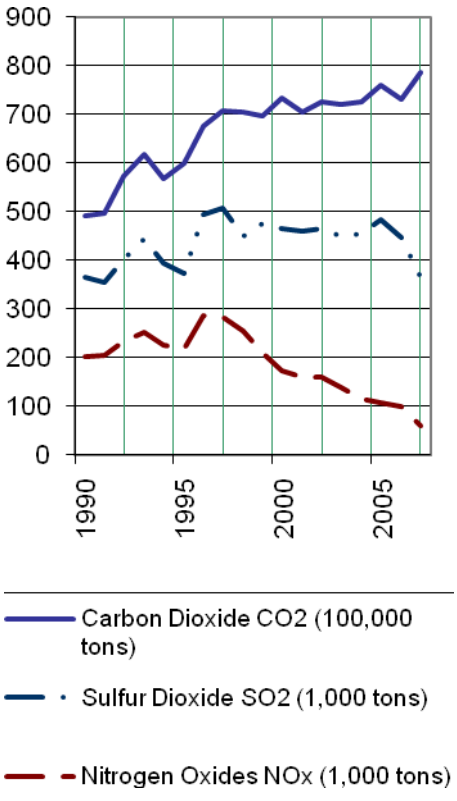
- Carbon dioxide, methane, and other greenhouse gases which contribute to global climate change. The impacts of climate change on North Carolina's economy could include rising shoreline levels, disruption of growing seasons, reduction in tourist trade, and deterioration of forests. Figure 6 on the next page shows that emissions of carbon dioxide have grown steadily over the past two decades.
- Nitrogen oxides and other volatile organic compounds which contribute to several pollutant sources including ozone and fine particulates.
- Sulfur dioxide emissions which cause increased acidity of rainfall and combine with other chemicals in the air to form fine particulates. Particulate emissions contribute to a variety of respiratory health problems, specifically asthma and bronchitis. Particulate emissions have also substantially reduced visibility in our western mountains, which could have negative financial implications for North Carolina's tourist economy. Sulfur dioxide emissions remained relatively constant during the last decade, but have recently begun to decline, in part due to North Carolina's Clean Smokestacks legislation described in the next section.
- Rising levels of mercury pollution have had negative impacts on many of North Carolina's lakes and streams. Mercury is a known neurotoxin and accumulates in fish and other water species. It is then transferred up the food chain to birds and, ultimately, humans.

Table 5: NC Employment by Sector 2000-2006 (thousands of jobs)

Description	2000	2006	Change 00-06
Agriculture	**31**	**30**	**-5.9%**
Construction	**231**	**243**	**5.2%**
Food Mfg	51	51	1.1%
Beverage & Tobacco Product Mfg	18	14	-22.4%
Textile Mills	109	49	-54.8%
Textile Product Mills	20	10	-49.4%
Apparel Mfg	47	21	-55.3%
Leather and Allied Product Mfg	2	1	-59.1%
Paper Mfg	23	19	-15.3%
Printing and Related Support Activities	18	15	-15.7%
Petroleum & Coal Products Mfg	1	1	-16.7%
Chemical Mfg	49	41	-16.0%
Plastics & Rubber Products Mfg	40	35	-13.5%
Total Non-Durable Goods	**378**	**258**	**-31.7%**
Wood Product Mfg	31	27	-14.2%
Nonmetallic Mineral Product Mfg	21	17	-18.6%
Primary Metal Mfg	9	8	-12.6%
Fabricated Metal Product Mfg	45	41	-8.7%
Machinery Mfg	41	32	-22.1%
Computer & Electronic Product Mfg	58	41	-30.4%
Electrical Equipment and Appliances	40	25	-37.3%
Transportation Equipment Mfg	39	36	-6.8%
Furniture and Related Product Mfg	79	52	-33.3%
Misc. Mfg.	18	15	-12.9%
Total Durable Goods	**381**	**295**	**-22.7%**
Total Manufacturing	**759**	**553**	**-27.2%**
Wholesalers	145	152	5.0%
Retailers	480	480	0.0%
Transportation/Utilities	161	152	-5.5%
Information	85	74	-12.8%
Finance, Insurance, Real Estate	174	201	15.3%
Services	1,575	1,812	15.1%
Government	216	224	3.4%
Total Non-Manufacturing	**2,837**	**3,095**	**9.1%**

Source: North Carolina Department of Commerce.

Figure 6:
Historical Air Pollutant Emissions



Environmental Policies

Clean Smokestacks Act

The "Clean Smokestacks Act" (Session Law 2002-4) enacted on June 20, 2002 is a critical step towards protecting the quality of the state's air. The bill will result in reduced emissions of sulfur dioxide and nitrogen oxides from coal-fired plants by 75% by 2013. As of 2008, Progress Energy had spent approximately $1 billion implementing the Act and had raised their compliance cost estimate 72% from the 2002 estimate of $0.8 billion to $1.4 billion in 2008. Duke Energy has spent $1.8 billion, nearly 123% of the original compliance cost estimate of $1.5 billion.

The Clean Smokestacks Act will have a dramatic impact on sulfur dioxide and nitrogen oxide emissions in the state – a potential decline of almost 80% in sulfur dioxide and 50% in nitrogen oxides. However, carbon dioxide emissions are projected to continue increasing into the foreseeable future. The use of sources including nuclear energy, hydropower, solar energy, wind energy, and biomass energy sources, or clean-coal power plants reduce all emissions from coal-fired generation substantially.

Other Energy-Related Environmental Policy Actions

The Tennessee Valley Authority, whose coal-fired plants have negatively affected air quality in North Carolina, has also followed suit. In November 2002, the Tennessee Valley Authority announced its approval of a $1.5 billion contract to install pollution-control equipment at four Tennessee Valley Authority fossil fuel plants that will improve air quality throughout the region.

North Carolina's legislature formed a study group on emissions of carbon dioxide and other greenhouse gases, as well as mercury. The Climate Action Planning Advisory Group worked with an outside consultant to develop a comprehensive set of recommendations for programs and policies. The Climate Action Plan Advisory Group's report, issued in October, 2008, is available online at www.ncclimatechange.us/index.cfm.

Energy Infrastructure Security Issues

If the state is to maintain a reliable energy supply, it is essential that this critical infrastructure system remain secure from both natural and man-made disasters. Because North Carolina imports nearly all resources needed for energy production, our state is vulnerable to disruptions in fuel supply. Infrastructure issues must be addressed by all parties of concern, including county and local officials, as well as private and public utilities and those in state government.

The North Carolina Emergency Petroleum Shortage Work Group has been developed to ensure plans are in place for emergencies that impact fuel supply and distribution. The State Energy Office has received nearly $1.1 million in federal funds to also ensure that the state is ready and proficient with issues related to energy planning. A primary goal is to minimize the impact of energy disruptions.

North Carolina Energy Emergency Plan

Detailed actions and responsibilities in the plan in case an emergency occurs that affects energy supplies or facilities in the state include:

(1) Assessing energy system damage, energy supply, demand, and requirements to restore such systems;

(2) Assisting local and state departments and agencies in obtaining fuel for transportation and emergency operations;

(3) Administering statutory authorities for energy allocation priorities;

(4) Assisting energy suppliers in obtaining information, permits, equipment, specialized labor, fuel, and transportation to repair or restore energy systems;

(5) Recommending local and state actions that will save fuel resources;

(6) Providing energy emergency information, education, and conservation guidance to the public;

(7) Coordinating information with local, state, and federal officials and energy suppliers regarding energy supply recovery assistance programs;

(8) Providing technical assistance involving energy systems;

(9) Recommending to the State Coordinating Officer and the Federal Coordinating Officer priorities to help restore damaged energy systems;

(10) Coordinating fuel and power requests for assistance received from county Emergency Operation Centers.

2. Fossil and Nuclear Fuels

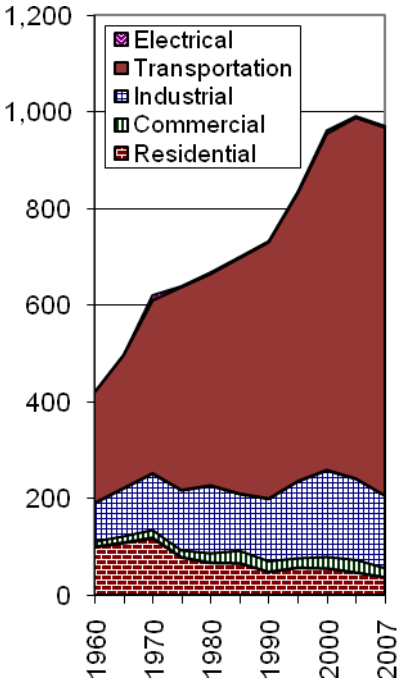
Petroleum

Petroleum supplies the highest percentage of energy for North Carolina of any fuel. The consumption of petroleum has increased an average of 1.9% per year since 1970; however, in the past seven years, the annual increase has slowed to 0.14%. Of the different petroleum-using sectors, transportation consumes most of the fuel – about 78%. Industrial uses almost 16% of total petroleum, while residential (3.8%), commercial (2%), and electric power generation (0.3%) consume considerably less. Figure 8 shows that motor gasoline and distillate fuel oil provide 79% of total petroleum consumption.

Natural Gas

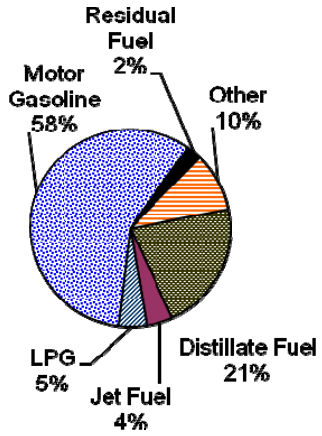
In North Carolina, natural gas contributes 9.1% of total energy use in the state, while it provides roughly 23% of national energy use. The price of natural gas rose considerably until recently, which is one reason that consumption of natural gas in North Carolina decreased during most of the past decade. In 2007 the industrial sector was the primary consumer of natural gas, using 37% of the total. The residential sector consumed 25% of total use, and commercial buildings 19% of natural gas. Historically, the electric utility and transportation sectors have used very little natural gas; however, in 2007, consumption in the electrical sector jumped to about 17%.

Figure 7:
Historical Petroleum Use (Trillion Btu) By Sector



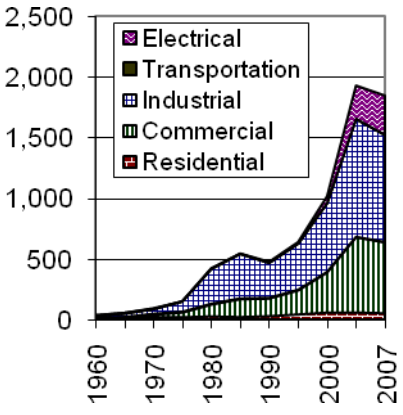
Source: Energy Information Administration, U.S. Department of Energy.

Figure 8:
Petroleum Use in 2007 (971 million Btu)



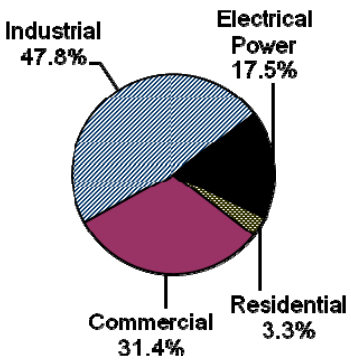
Source: Energy Information Administration, U.S. Department of Energy.

Figure 9:
Historical Natural Gas Use (Trillion Btu) By Sector



Source: Energy Information Administration, U.S. Department of Energy.

Figure 10:
2007 Natural Gas Use (245 million Btu)



Source: Energy Information Administration, U.S. Department of Energy.

Coal

Electric utilities consume most of the coal in the state – 96.3% of total coal consumption in 2007. Table 6 shows that the state now has 14 utility-owned, coal-fired power stations. Coal has traditionally remained relatively inexpensive, rising from $1.07 per million Btu to $1.98 per million Btu in 1985 and dropping to $1.43 in 2000. However, since 2000 the price of electricity has risen 51% to $2.16 per million Btu in 2009.

Nuclear Energy

In 2007, North Carolinians rely on nuclear electricity generation for 16% of total energy use and about 32% of all electricity generation. In 2007, nuclear power generation provided approximately 39% of Progress Energy Carolinas' total generation, 45% of Duke Energy's total generation, and 29% of NC Power's generation. The percentages for Duke and Progress exceed the state average because of higher percentage of nuclear power in their electricity generation mix in their South Carolina facilities

In-State Energy Sources

While North Carolina imports virtually all of its energy resources, particularly fossil and nuclear fuels, there could be potential economic and other benefits to increased production of in-state sources of energy. The 18-year federal moratorium on the development of offshore oil and natural gas reserves expired October 1, 2008. However, the expiration of the ban does not affect the state's lack of infrastructure for production. It will likely be five to eight years before any production could begin. The main other energy resources in North Carolina are renewables, such as wind, solar, hydropower, and biomass, which are discussed in other chapters.

In September of 2009, Governor Purdue created the Scientific Advisory Panel on Offshore Energy. The panel has been established to evaluate the best approach for utilizing the state's offshore resources. The panel is tasked with assessing the various oil, gas, wind, and other offshore energy resources and determine how best to work within current laws and regulations to responsibly realize the resource potential.

Table 6: NC Utility-Owned Coal Fired Power Plants & Generation Capacity

Utility	Plant	County	MW
PEC*	Roxboro	Person	2,462
PEC	Mayo	Person	745
PEC	LV Sutton	New Hanover	613
PEC	Lee	Wayne	407
PEC	Asheville	Buncombe	392
PEC	Cape Fear	Chatham	316
PEC	Weather-spoon	Robeson	176
Duke	Belews Creek	Stokes	2,240
Duke	Marshall	Catawba	2,090
Duke	GG Allen	Gaston	140
Duke	Cliffside	Cleveland	760
Duke	Buck	Rowan	369
Duke	Dan River	Rocking-ham	276
Duke	Riverbend	Gaston	454
Total Utility-Owned Generation Capacity			**11,440**

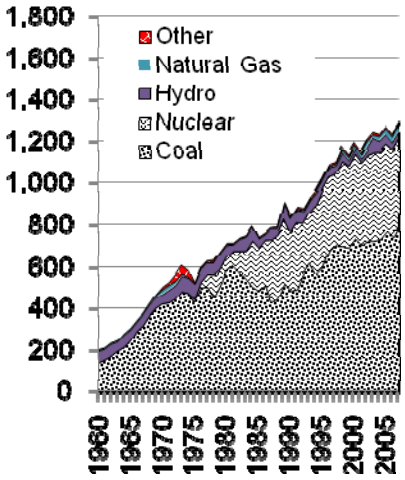
*PEC – Progress Energy Corporation

Table 7: North Carolina Utility-Owned Nuclear Power Plants

Utility	Plant	County	Capacity (MW)
PEC	Brunswick	Brunswick	1,631
PEC	Harris	Wake	860
Duke	McGuire	Mecklen-burg	2,200
Total Utility-Owned Generation Capacity			**4,691**

Sources: Duke and Progress Energy Annual Reports.

Figure 11:
Source of Electricity Sold by Utilities (TBtu) 1960 – 2005



Source: State Data Files. Energy Information Administration. U.S. Department of Energy.

North Carolina's Electricity Market

- In 2007 Duke Energy and Progress Energy Carolinas generated about 95% of the electricity sold within the state. Approximately two-thirds of Duke and Progress Energy's sales are within North Carolina, with the remainder in South Carolina.
- About 19% of the Investor Owned Utilities' electric sales in the state are to wholesale markets, primarily to electric membership corporations and municipally or university-owned utilities.
- 26 of the 31 electric membership corporations serving North Carolina customers have headquarters within the state. Together, they serve 900,000 customers – 2.5 million people – in 93 of the state's 100 counties.
- The state also includes a variety of municipal electric utilities, primarily in small cities and at universities. Electricities is a statewide organization that provides management services to many of these utilities.

3. Electric Utilities & Energy Use

Electricity encompasses about 25% of North Carolina's total energy consumption. However, the total amount of fuel used to generate electricity in the state, primarily coal and nuclear, represents about 50% of total energy consumption because coal and nuclear electric power plants operate at an efficiency of less than 40%.

Figure 11 shows fuel use by the electric utility sector. While nuclear energy assumed an increasing share of electricity production in the 1980s, coal has maintained its historic dominance. In 2005, coal provided about 61% of energy used to generate electricity in North Carolina, nuclear power provided about 33%, hydroelectric plants supplied 4%, natural gas plants supplied 2%, and biomass and petroleum each supplied less than 1%.

North Carolina's electricity generation capacity grew at an annual rate of 2.34% from 1995 to 2005. Summer peak demand for the state grew about 3% per year between 1990 and 2000, but is expected to grow about 1.6% annually until 2017.

The Structure of the State Electricity Market

North Carolina's retail electrical customers are served by three investor-owned utility companies, 31 electric membership corporations, and 74 municipality or university-owned electric distribution companies. The privately-owned investor-owned utilities are regulated in the state by the North Carolina Utilities Commission. Table 8 shows a breakdown of North Carolina's electricity sales. Retail sales in 2007 were 3.9% higher than in 2006. Duke Energy and Progress Energy Carolinas operate 96% of in-state

Table 8:
Electricity Sales in North Carolina, 2006-2007

	NC Retail GWh*		NC Wholesale GWh*		Total GWh Sales* (All States)	
	2007	2006	2007	2006	2007	2006
Progress Energy	37,733	36,225	14,661	13,870	59,825	57,875
Duke Energy	57,014	54,920	7,591	6,148	86,604	82,652
NC Power	4,268	4,172	630	397	84,881	79,907
New River (ASU)	232	225	0	0	232	225
Western Carolina	34	34	0	0	34	34

*GWh = 1 million kWh
Source: Annual Report of the NC Utilities Commission.

generation, but electric membership corporations, municipality or university-owned electric distribution companies, and NC Power sell approximately 26% of the electricity generated. Two universities, Appalachian State University and Western Carolina University, own two small electricity distributions companies. As displayed in Table 8, these two companies are responsible for only .1% of GWh sales in North Carolina.

Table 9 shows the actual power production by energy source for the investor-owned utilities. The capacity shown for Duke Energy and Progress Energy includes several electric power facilities located in South Carolina, and NC Power's data are for plants primarily located in Virginia. Coal and nuclear power remain the dominant sources, with hydroelectric power, natural gas, and fuel oil playing a smaller role. Although oil and gas plants provide a considerable percentage of total capacity, they are primarily peaking plants and do not produce much electricity.

Table 9:
Energy Resources for Electricity Production by Fuel Type for 2007

	Pro-gress	Duke	NC Power
Coal	49%	51%	35%
Nuclear	39%	45%	29%
Hydro	1%	0%*	0%*
Oil and Natural Gas	5%	1%	8%
Wood and Kerosene	0%*	0%*	1%
Purchased Power	6%	3%	27%

Source: 2008 Annual Report of the North Carolina Utilities Commission, October, 2008.

* Some resources may be used, but the amount rounds to zero.
** Hydro

Demand Side Management

Electric utilities have two means of meeting increases in customers' electricity demands: supply side management and demand side management. Supply side management consists of the utilities' plans and programs to increase the amount of electricity to meet the anticipated increases in demand, mainly through construction of new power plants. Demand side management attempts to reduce the demand for electricity or to shift it to times away from the system peak so that the need for additional generation capacity is minimized. The plans of the investor-owned utilities and electric membership corporations for meeting forecasted electricity demand are available to the public and are currently reviewed by the North Carolina Utilities Commission in an annual integrated resource planning proceeding.

Progress, Duke, and NC Power are pursuing demand side management through several incentive measures, such as bill credits for interruptible loads, cash incentives and/or low interest loans to encourage customers to install higher efficiency equipment, and special rate designs. These programs are intended to lower the electric bills of participating customers, cut per capita demand and reduce overall electricity costs to the remainder of the utility system.

Nationally, demand side management has played an increasingly cost-effective role as a "source" of energy, contributing about 2.1% of the country's electric capacity in 2008. Utility-provided electric capacity additions from energy efficiency increased from 11,662 megawatts (MW) in 1994 to 17,710 MW in 2007, while load management DSM capacity decreased from 13,340 MW in 1994 to 12,566 MW in 2007, Over the same period, the average national cost per-kilowatt hour (kWh) of utility-provided DSM

Typical Demand Side Management Activities

- Improved thermal efficiency and high performance heating and air conditioning in residences
- Interruptible service for air conditioners and water heaters
- Commercial energy-efficient lighting, heating, and cooling
- Commercial thermal energy storage
- High-efficiency off-street security lighting
- Industrial energy audits with incentives for efficiency measures
- Industrial time-of-use rates
- Interruptible service for large electrical loads
- Remote-controlled voltage reduction

Table 10:
Cost and Savings of National DSM Programs

Year	Cost of DSM Programs ($ million)	Energy Savings (million kWh)	Cost of Savings ($/ kWh)
1989	873	14,672	0.059
1990	1,177	20,458	0.058
1991	1,804	24,848	0.073
1992	2,348	35,563	0.066
1993	2,744	45,294	0.061
1994	2,716	52,483	0.052
1995	2,421	57,421	0.042
1996	1,902	61,842	0.031
1997	1,636	56,406	0.029
1998	1,421	49,167	0.029
1999	1,424	50,563	0.028
2000	1,565	53,701	0.029
2001	1,630	53,936	0.030
2002	1,626	54,075	0.030
2003	1,297	50,265	0.026
2004	1,557	54,710	0.028
2005	1,921	59,897	0.032
2006	2,051	63,817	0.032
2007	2,526	69,071	0.037

programs declined at an average annual rate of 3.7% from a 1994 cost of $0.052/kWh to $0.037/kWh in 2007. Table 10 summarizes activities and average cost of savings for the past 19 years.

Real-Time and Time-of-Use Pricing

In addition to methods for reducing and controlling electricity demand directly, real-time and time-of-use pricing structures encourage customers to actively adjust their demand based on the cost of electricity. Real-time pricing tariffs are offered by North Carolina utilities to non-residential customers, and time-of-use pricing structures are offered as residential subscription programs.

Under real-time pricing tariffs, electric customers are charged prices that can typically change every hour. The rates are usually quoted a day or less ahead of time. They provide customers with an opportunity to lower their electricity bill, but they also expose businesses to substantial energy price variability.

Under time-of-use pricing structures, electric customers typically agree to pay prices that differ depending upon the time the electricity is used. The price of electricity is higher during summer daytime, on-peak hours, and declines in the evening or on weekends during off-peak hours. Prices also typically vary by season, with summer prices typically higher than winter prices.

NC GreenPower Program

NC GreenPower, administered by Advanced Energy in Raleigh, is an independent, nonprofit organization established to improve North Carolina's environment through voluntary contributions toward renewable energy. NC GreenPower's goal is to supplement the state's existing power supply with more renewable energy, such as photovoltaics or solar electric, wind, and fuels from biomass and waste materials. There are two options in the NC GreenPower program. For individual contributors, such as households, a contribution of $4 purchases one block of 100 kilowatt-hours of green energy. Businesses and large-volume users that purchase 100 or more blocks have a rate of $2.50 per block. Currently, the NC GreenPower program has 293 producers of renewable energy:

- Wind – 7 facilities
- Landfill methane gas – 2 facilities
- Biomass-clean wood waste – 1 facility
- Small hydroelectric – 2 facilities
- Solar photovoltaic – 281 facilities (including 7 large systems)

There were 13,129 NC GreenPower subscribers in December, 2009. Total annual generation totaled 31.4 million kWh of renewable electricity, which is the equivalent to electricity use in about 2,000 homes per year.

Smart Grid Development

The national electric grid is in need of major renovations. The federal government has prioritized the modernization of the electric grid, and is designating $3.4 billion for grants to bolster the electric grid through the American Reinvestment and Recovery Act. After matching funds, nearly $8 billion will be applied towards the national electric grid.

North Carolina's two largest electric utilities, Progress Energy and Duke Energy, have been awarded maximum federal grant funds. The federal grants will help stimulate more rapid technology transfer within the electric grid and assist research of Smart Grid technologies. Smaller electricity cooperatives have taken initiative for their electrical services as well. Piedmont Electric Membership Corp., for example, utilizes "smart meters." Such meters will help customers keep track of their energy consumption with the capability of reviewing daily use.

Renewable Energy & Energy Efficiency Portfolio Standard

In response to a request from the Environmental Review Commission of the North Carolina General Assembly, the North Carolina Utilities Commission engaged La Capra Associates to conduct a study on the costs and benefits of a renewable energy portfolio standard for the state.

Table 11: Renewable Energy Portfolio Standard Requirements under 2007 Legislation

Year	Utilities	EMC-Muni	Solar	Swine Waste	Poultry Waste
2010			0.02%		
2012	3%	3%	0.07%	0.07%	170,000 MWh
2015	6%	6%	0.14%	0.14%	900,000 MWh
2018	10%	10%	0.20%	0.20%	900,000 MWh
2021	12.50%	10%	0.20%	0.20%	900,000 MWh

Conclusions from the LaCapra Report on the Renewable Energy Portfolio Standard to the North Carolina Utilities Commission:

- North Carolina's renewable energy resources have the practical potential to provide 16,700 GWh of electricity, about 13% of 2005 retail sales;
- 8,700 GWh of the practical potential is from biomass sources;
- A 10% Renewable Energy Portfolio Standard portfolio that included energy efficiency has the potential to create over 50,000 net new jobs;
- Renewable Energy Portfolio Standard may enable the state to avoid the development of 1,000 MW or more of baseload conventional generation;
- A Renewable Energy Portfolio Standard with energy efficiency could produce net savings of about half a billion dollars over 20 years.
- A separate report by GDS Associates, funded to support La Capra's efforts, had the following conclusions about the potential for energy efficiency in North Carolina:
- 33% of electricity use could be met via energy efficiency efforts.
- 14% is the potential for achievable savings of electricity via cost-effective strategies for the State.
- 25% savings are obtainable according to the study.

The December 2006 report, along with other technical and economic information, helped justify implementation of a statewide requirement for electricity generation from renewable energy sources.

In August 2007, North Carolina became the first state in the Southeast to implement a renewable energy and energy efficiency portfolio standard with Session Law 2007-397. This law requires investor-owned utilities to supply 12.5% of their electricity from renewable and efficiency sources by 2021, and municipal electric suppliers and rural electric cooperatives to supply 10% by 2018.

The law requires minimum amounts of electricity generated from hog waste, poultry litter, and solar power, as shown in Table 11. Up to 25% of the 12.5% and 10% can be can be achieved through energy efficiency and after 2021, the percentage energy from efficiency increases to 40%. Renewable energy credits from out-of-state generation may be used for meeting up to 25% of the requirements.

4. Alternative Fuels for Transportation and Electricity

The North Carolina Strategic Plan for Biofuels Leadership, drafted by Biofuels professionals in North Carolina and published in 2007, set a broad goal "to develop a liquid biofuels industry that is substantial in output, agriculturally and economically important, sustainable, and significant across the State." The plan has nine strategies, with the primary strategy being by 2017, 10% of liquid fuels sold in the state will come from biofuels grown and produced within the state. Pursuant to fulfilling this strategic plan, the General Assembly funded the development of the Biofuels Center of North Carolina. The Biofuels Center will take on the responsibility of fulfilling the remaining strategies laid out in the plan.

Ethanol and Biodiesel from Energy Crops

Ethanol and biodiesel, liquid fuels ideal for vehicles and, in some cases, electricity production, are the primary fuels obtained from biomass resources. Both fuels are produced widely across the nation. North Carolina has several biofuels facilities throughout the state including both biodiesel and ethanol plants, as shown in the sidebar.

Biodiesel

Biodiesel comes primarily from soybeans, recycled restaurant grease, and food processing waste products. It enjoys popularity as a fuel in many agriculture-intensive states. There are currently seven primary commercial producers of biodiesel in North Carolina, with many other companies capitalizing on demand for biodiesel- related products and research. At least 48 retail stations throughout the state sell biodiesel, with an additional 29 companies providing retail and distribution of the fuel. Many regions of the state that are not served by a commercial biodiesel pump have cooperative organizations dedicated to the distribution and sale of biodiesel.

Ethanol

Ethanol is perhaps the best known alternative fuel. Several states, including Minnesota, Washington, and Louisiana, have implemented minimum blending requirements for all motor fuels sold in the state. Figure 12 on the next page shows that North Carolina is currently the top consumer of ethanol in the Southeast.

Companies in North Carolina are taking the lead in the development of enzymes that can break down fibrous materials such as corn stalks and wood

Nine Strategies of the North Carolina Strategic Plan for Biofuels Leadership

1. Realistic Vision and Compelling Public Commitment
2. Statewide Biofuels Commission
3. Statewide Economic Development Imperatives
4. Creation of a New Industry Sector
5. A Biofuels Roadmap Across the State
6. Science, Research, and Development Capabilities
7. Advanced Biofuels Acceleration Facility
8. Advancing Public Commitment and Workforce Development
9. Appropriate and Targeted Incentives

Biofuels Facilities in North Carolina

Biodiesel

Piedmont Biofuels, Pittsboro

Blue Ridge Biofuels, Asheville

Foothills Bio-Energies LLC, Lenoir

North Carolina Biodiesel LLC, Roanoke Rapids

Oak Biodiesel, High Point

Evans Bioenergy, Wilson

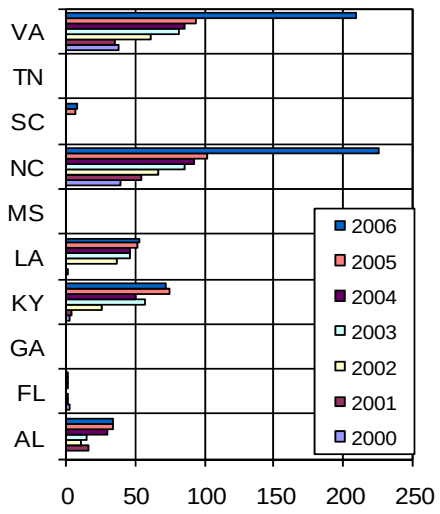
Numerous cooperatives

Ethanol

Clean Burn Fuels, Raeford* (Ethanol)

Source: Tazewell, Anne. Biofuels in North Carolina. Southeastern Bioenergy Conference. August, 2007.

Figure 12:
Ethanol Consumption by Southeastern States (Million Gallons)



chips – a key technology in cellulose ethanol. The distribution of ethanol blends of 85% (E85) is limited, with only nine stations offering the product – not many, but more than 32 other states.

Ethanol production is difficult in North Carolina largely because of market factors. Traditional ethanol production ordinarily uses corn as a feedstock and requires low-cost heat, often from natural gas – major factors that work against the viability of an industry in North Carolina. The state is a net importer of corn and has relatively low availability of natural gas compared to many other states, particularly in rural areas. Despite the challenges, Clean Burn Fuels, LLC finished building a 75 million gallon per year ethanol plant in Hoke County and began production in the winter of 2010.

The future production of ethanol in North Carolina appears to hinge on development of processes to produce ethanol from cellulosic fibers, such as corn stover, switchgrass, and woody biomass. The process will require biotechnology-derived enzymes or thermo chemical conversion to manufacture ethanol using these alternative feedstocks.

Municipal Solid Waste and Landfill Gas Reclamation

By capturing the methane from landfills, communities in North Carolina can help eliminate the largest man-made source of methane emissions into the atmosphere. Methane has a substantially greater impact on climate change than carbon dioxide per pound of gas, with its potency being 21 times greater than carbon dioxide. Thus, landfill gas energy projects not only utilize previously wasted fuel, but also help protect our environment by displacing fossil fuel use and significantly reducing greenhouse gas emissions.

In recent years, the landfill gas utilization industry has matured, and the value of landfill gas has increased. As a result, the areas adjacent to landfills have the potential to become "energy parks" – especially large regional landfills which have taken the place of the numerous smaller county landfills of the past. Table 11 shows landfills in North Carolina that have been developed.

Electrical generation from landfill gas is often less economically attractive than direct-use options. However, the electricity generated does have an increasingly important market with the established NC Green Power program and the new NC Renewable Energy Credit market. As of February 2010, The U.S. Environmental Protection Agency estimates that North Carolina projects provide about 18.9 million metric standard cubic feet per minute of landfill gas that is consumed in twelve direct-use projects and eight electricity projects with a nameplate capacity of 20.8 Megawatts (MW). Several landfill gas projects in North Carolina have adopted award-winning innovations by using the gas as a community development resource supporting economic growth from traditional industries, recruiting new

facilities that can utilize the gas, and establishing industrial parks around the landfill gas energy resource. If waste heat is captured from electrical generators, the resulting combined heat and power can make landfill gas projects more efficient and profitable.

These direct thermal projects are using about 8.6 million standard cubic feet of landfill gas per day, over 1.56 trillion Btu per year. While the energy generated by these projects is relatively small, only about 0.06% of total state energy use, it provides a cost effective option for dealing with a local environmental issue and can create projects that have a beneficial impact on local economies, such as the nationally known EnergyXchange at the Mitchell-Yancey landfill. In addition, landfill gases are much worse greenhouse gases than carbon dioxide. By using these gases to generate energy, their negative impacts are reduced substantially.

There are 25 landfills that are considered prime candidates for landfill gas development. These landfills have the potential of producing another about 200 MW of electricity. At least 8 are in the planning stages for gas projects. An additional 76 landfills have not planned to capture their gas. Many of these facilities have some potential for gas development as well.

In order to meet the renewable energy and energy efficiency portfolio, standard electric utilities will most likely expand electricity production from landfill gases, as it is one of the most economical options for renewable electricity generation, typically costing $0.03 to $0.06 per kilowatt hour.

Table 11:
LFG Developed Sites in NC

Landfill Name	Landfill City	Landfill County
Blackburn	Newton	Catawba
Buncombe County (Old)	Woodfin	Buncombe
Charlotte Motor Speedway	Concord	Cabarrus
City of Greensboro	Greens-boro	Guilford
City of Winston-Salem	Winston-Salem	Forsyth
CRSWMA-Interim Regional	New Bern	Craven
Cumberland County	Fayette-ville	Cumberland
Henderson County	Hender-sonville	Henderson
Iredell County	Statesville	Iredell
Jackson County	Dillsboro	Jackson
North Wake Solid Waste	Raleigh	Wake
Pitt County	Greenville	Pitt
Wilder's Grove	Raleigh	Wake
Yancey/ Mitchell County	Burnsville	Yancey

Biomass for Electricity Production

Table 12 shows the estimated potential for biomass to provide electricity for North Carolina. The biomass resources from the agricultural and waste management sectors could provide energy for the state via electricity generation and direct use as a fuel. As discussed earlier, the Renewable Energy and Energy Efficiency Portfolio Standard requires that electric utilities convert swine waste and poultry waste to electricity.

Mill and Forest Residues

According to Energy Information Administration data from 2007, 29% of North Carolina's renewable energy production comes from wood and derived fuels. The La Capra study estimated that softwood and hardwood wood waste could combine to provide 656 MW of electricity – about 70% of the total potential biomass electricity production.

Table 12: Biomass Resource Potential Summary

Resource	MW Potential Co-Fire	MW Potential @13,000 btu/kWh
Softwood	408	314
Hardwood	444	342
Urban Clean Wood Waste	194	149
Corn Stover	181	139
Wheat Straw	12	9
Total Potential	**1,239**	**953**
Additional Potential		
Pulpwood	1,031	793
MSW Wood Waste	180	139
Switchgrass	53	41
Hybrid Poplar	65	50
Total Additional Potential	**1,330**	**1,023**

Source: La Capra Associates (2006). Analysis of a Renewable Portfolio Standard for the State of North Carolina.

Fuels from Agriculture

Methane from Agricultural Wastes

The La Capra report examined methane production potential from the hog and poultry industries, in which North Carolina is a national leader. The report highlights the Barham farms swine operation in Zebulon as a facility currently using anaerobic digestion to capture methane from hog waste for generating electricity and heating water for farm use. According to the report, the realistic potential electrical generation capacity for hog waste is 93 MW for the state. The report cites an Environmental Protection Agency AgStar program study that estimated 766 million kWh/year potential from hog waste or 116 MW of generation capacity in North Carolina.

A 55 MW poultry waste-to-electricity plant is currently being constructed in Sampson County and should be running by 2011. The same developer, Fibrowatt, has also secured a site in Surry County for a 40 MW plant and in Montgomery County for a 55-megawatt power plant that will produce enough electricity to serve approximately 40,000 homes. The Montgomery County plant should be operating in 2012, but it is still too early in the planning process to accurately forecast an opening date for the Surry County plant.

Direct Firing of Agricultural Waste and Agricultural Crops

Interest in growing crops as fuels is increasing in the state as new supplies of renewable electricity are being investigated. The La Capra report projects potential for these crops, when co-fired, to be 53 MW for switchgrass and 65 MW for hybrid poplar. "Switchgrass and hybrid poplar are two energy crop options that may also serve as fuel inputs, but the costs for these fuels are higher due to the low density of distribution and higher harvesting costs."

5. Renewable Energy Sources

Renewable energy sources include:

- Solar energy – solar thermal, daylighting, and photovoltaics
- Wind energy
- Water-derived power – hydro-electric, tidal, wave, and ocean thermal gradient-derived electricity
- Waste-derived power (covered in the previous section)
- Agricultural energy sources, including crops burned directly as a source of energy and those converted into another fuel source
- Fuel cells

Renewable energy projects benefit from incentives currently available for North Carolinians, including:

- A personal/residential tax credit of 35% for the cost of a variety of renewable energy systems. The cap on the tax credit is $1,400 for solar water heating systems and $3,500 for solar space heating systems, including passive solar homes. The cap on tax credits is $10,500 for photovoltaic, wind, hydroelectric, and biomass.
- Commercial and industrial tax credit of 35% for renewable energy projects up to $2.5 million per application.
- A 30% federal tax credit to businesses that invest in or purchase solar or geothermal property in the United States.
- A federal Renewable Energy Production Tax Credit of 2.1 cents per kWh for electricity generated by wind, closed-loop biomass, or poultry waste during the first 10 years of operation. The tax section of the American Recovery and Reinvestment Act of 2009 provides a three-year extension of the tax credit for most renewable energy projects.
- The state's green power program, NC GreenPower, which provides a market opportunity for solar-generated electricity. The renewable energy and energy efficiency portfolio standard requires increased implementation of solar technologies in the state.

Table 13: Renewable Energy Consumption in North Carolina (2006)

Renewable Energy Consumption	Quad-rillion Btu	Change 2005-2006 (%)
Solar/ PV Energy	0.07	6.5
Wind Energy	0.258	45.1
Biomass	3.277	5.2
Biofuels	0.758	27.6
Waste	0.404	0.3
Wood-Derived Fuels	2.114	-0.1
Geothermal Energy	0.349	1.8
Hydroelectric	2.89	6.9
Total	**6.844**	**6.9**

Source: EIA, Renewable Energy Consumption and Electricity Preliminary 2006 Statistics.(2007).

Solar Energy

Solar technologies are available for many water and air heating applications, electricity production, and even cooling. Solar technologies are typically divided into two major categories: solar thermal technology and photovoltaics (PV). Photovoltaics produce electricity directly from sun light, while solar thermal technologies include collectors typically used to heat air,

water, or other fluids, as well as building integrated applications such as passive solar designs, where the sun is used for heating, and daylighting systems.

Solar Thermal Technology

With the tax credits and other incentives available in North Carolina, some solar thermal systems can provide economic paybacks in the 8 to 12-year range. However, the costs of solar thermal systems have increased dramatically in recent years. A typical residential solar water heating system that cost $3,000 to $4,000 in the 1980's costs $6,500 to $7,800 in 2010. The average price for installed systems, including all labor and materials, in 2010 is $100 per square foot.

Table 14 is an economic analysis of typical residential solar water heating systems, which should have maximum potential for implementation due to the large market for water heating in residences and commercial facilities. Commercial systems have two advantages: (1) there is a higher limit on the state tax credit ($2.5 million per application) and (2) businesses can take advantage of the depreciation on federal taxes. While the rate of return for residential customers is relatively low, it might be offset with financial security if energy prices climb.

Photovoltaics

Solar electric modules, or photovoltaics, convert sunlight into direct current (DC) electricity. They are made out of a semiconductor material, usually silicon. When sunlight hits the material, it excites the electrons and allows

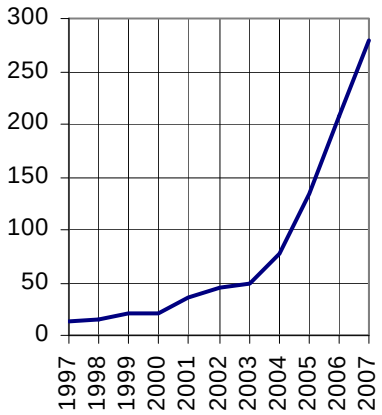
Table 14:
Economics of Medium-Temperature Solar Water Heating Systems

	Residential Water-Heating System	Residential Space Heating/ Water Heating System	Commercial Water Heating System
Energy Savings (kWh/ year)	3,000	5,600 - 6,500	48,000
Energy Savings ($/ year)	$250 - $300	$476 - $553	$3,600 - 4,200
Incremental Installed Cost	$6,000 - 7,500	$9,000 - 12,000	$100,000 - $120,000
Federal Tax Credit[3]	$1,800 - $2,000	2,000	$30,000 - $36,000
State Tax Credit	1,400	$3,150 - $3,500	$35,000 - $42,000
Depreciation	0	0	$29,000 - $35,000
Federal Tax on State Credit	-$420	-$945 to -$1,050	-$10,500 to -$12,600
Net Cost with Incentives ($)	$3,220 - $4,520	$4,795 - $7,550	$16,540 - $19,845
Payback Period (years)	11 to 18 years	10 to 16 years	4 to 6 years
Rate of Return (%/ year)	3% to 8%	4% to 8.5%	12% to 16%

them to flow through an electrical circuit. The electricity can be stored in batteries or directly fed into the utility grid.

Photovoltaic shipments in the United States increased by 72% from 2004 to 2005; 54% from 2005 to 2006; and 40% from 2006 to 2007. In North Carolina, interest has increased significantly in recent years with state and federal tax credits, new net-metering laws and the state's green power program – NC GreenPower. In addition, the state's renewable energy and energy efficiency portfolio standard (Session Law 2007-397) requires installation of solar-derived electricity by North Carolina's electric utilities – 0.02% of total electrical sales by 2010, 0.07% by 2012, 0.14% by 2015, and 0.20% by 2018 through 2020. Even these small percentages will substantially reduce implementation of solar-electric technologies in the state. Consider that 0.20% of total electrical sales would require installation of about 1.5 million photovoltaic modules in the state. This quantity would increase over time as electricity consumption increases in order to maintain the 0.2% standard. In order to meet the requirements, both Duke Energy and Progress Energy are working with photovoltaics. Sun Edison is building a 16 MW plant in Davidson County and Duke Energy has agreed to purchase power as part of its overall plan to install $50 million worth of photovoltaics at up to 425 sites, mostly at individual residences. Progress Energy recently completed a one megawatt photovoltaic system on the Cary Campus of SAS, a developer of business intelligence and analytics software. In addition, Progress has installed a 1.2 MW system in Wilmington, NC.

Figure 13: Annual Photovoltaic Domestic Shipments (peak MW)



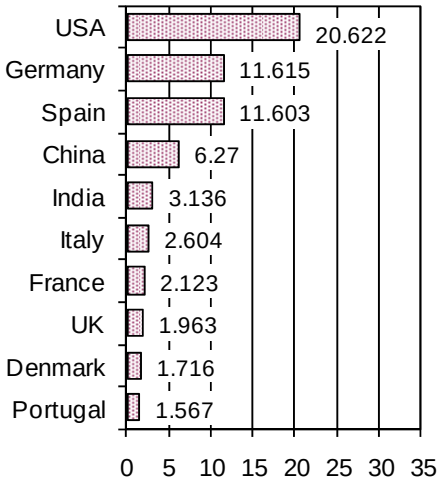
Source: EIA. "Solar Photovoltaic Cell/Module Manufacturing Activities", December, 2008.

Wind Energy

Wind energy is the fastest growing electricity generation technology in the world. In 2008 alone, installed global wind energy increased by 28.8%. The Global Wind Energy Council forecasts that by 2013, global wind generating capacity will stand at 332 GW, up from 120 GW at the end of 2008. In 2008, the United States surpassed Germany and became the country with the most wind capacity installed in the world. According to the American Wind Energy Association, the United States installed approximately 10,000 megawatts in 2009, which makes the total installed capacity in the United States to be 35,000 megawatts. This installed capacity is the equivalent of taking 10.5 million cars off the road. Incentives from the American Reinvestment and Recovery Act helped stimulate this growth. This increase in growth prompted the United States Department of Energy to suggest that wind energy could provide 20% of the United State's electricity by 2030.

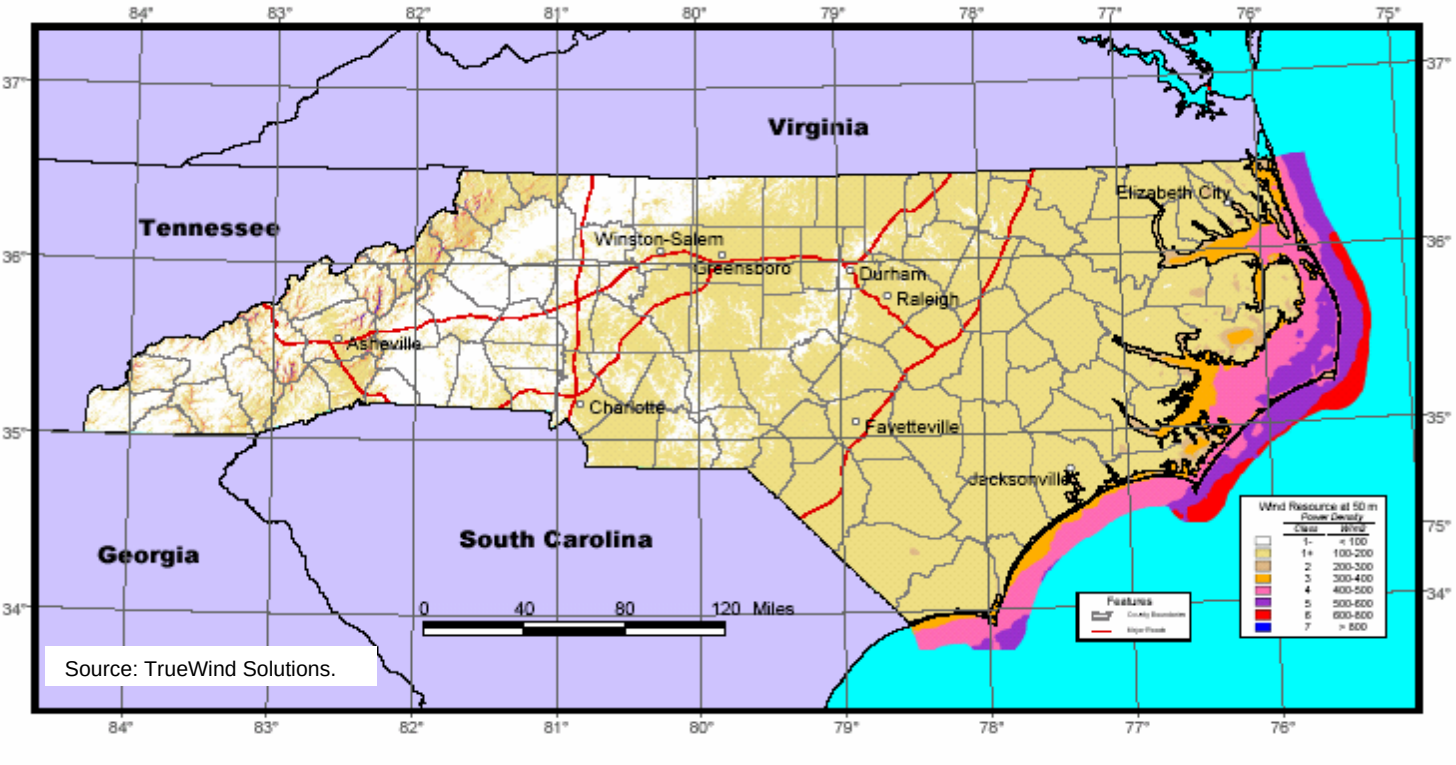
While the majority of North Carolina has poor wind resources, wind speeds in the western mountains and along the coast are excellent, as shown in Figure 15. The resource on the coast is up to class 6 and is widespread. The mountain resource is as high as class 7, the highest rating for land-based

Figure 14: Wind Energy Capacity by Country (1,000 MW)



Global Wind 2008 Report. Global Wind Energy Council. (2008).

Figure 15:
Average Wind Velocity Map for North Carolina



winds, and is primarily located on mountain ridge crests. According to the U.S. Department of Energy's Wind Powering America Program, North Carolina has the potential for 1,610 MW of utility-scale wind energy capacity which would supply about 3.4% of our current electricity needs. The La Capra study estimated a land-based developable potential of 1,500 MW or 3.0% of current demand. The gross potential of NC land with a wind resource of class 3 or greater is 6,840 MW. Approximately three quarters of that land is excluded from the developable wind potential after factoring in potentially environmentally sensitive areas, viewshed impacts (locations where wind turbines would potentially disturb scenic sites), steep slopes, wetlands, urban areas, offshore development and other exclusions. Residential-scale wind turbines are feasible in areas with a wind resource of class 2 or greater. The mountain and coastal areas possess widespread areas of class 2 winds that are potentially suitable for small-scale wind projects up to 100 kW.

Wind energy turbines located in North Carolina's sounds or offshore would have greater potential than in the mountains due to the large areas of winds of Class 5 and 6. A number of wind energy developers are considering coastal projects.

Offshore wind is currently being evaluated in North Carolina. An offshore Energy Advisory Panel has been developed to help guide the state in its evaluation of this realm. The University of North Carolina at Chapel Hill has conducted 9-month a feasibility study of offshore wind that determined certain areas of the coast are indeed favorable to wind development. The feasibility study, requested by the North Carolina General Assembly, has lead to Duke Energy funding a pilot study of up to three turbines to further assess offshore wind development in the Pamlico Sound.

The federal renewable energy production incentive (commonly known as the production tax credit) provides renewable energy generation facilities, including wind energy, annual incentive payments that are currently at 2.1 cents per kilowatt-hour. The production tax credit was renewed at the end of 2004 and again as part of the federal Recovery Act through 2012. There is also a 35% state tax credit available to wind energy projects.

The single largest barrier to wind energy development in North Carolina is the ability to site wind machines in areas with the greatest wind resources – namely the high ridges in western North Carolina and the coast. The Mountain Ridge Protection Act of 1983, known as the Ridge Law, was designed to prohibit the construction of unsightly structures taller than 35 feet on North Carolina ridges above 3,000 feet. Although a "windmill" exemption was written into the law, North Carolina's Attorney General specifically excluded the exemption in a 2007 opinion regarding a facility planned for location on the North Carolina-Tennessee border.

Some localities, such as Watauga County, have adopted local ordinances for approval of wind power facilities. Students at Appalachian State University's Renewable Energy Initiative financed and installed a 100 kW turbine on campus. In other areas, such as Ashe County and the city of Blowing Rock, and certain localities along the North Carolina coast, opposition to wind power has stymied development. The North Carolina Wind Working Group has developed a model ordinance governing implementation of wind projects in counties, cities, and other municipalities. Without consensus on how to allow large-scale wind turbines in the mountains, it is unclear how North Carolina will develop substantial wind power capacity in the higher, windier areas of the western counties of the state.

Hydroelectric Power

Hydropower represents the primary renewable energy supply from utilities in North Carolina. In 2007, North Carolina's hydroelectric plants totaled 1,960 MW in capacity and supplied over 2,984 million kWh of electricity – about 2.3% of total state electricity sales.

Table 15: Potential Developable Hydropower Sites in North Carolina

Capacity of Facilities	# of Sites
Under 100 kW	13
100 kW to 499 kW	22
500 kW to 999 kW	13
1 MW to 4.9 MW	24
5 MW to 9.9 MW	5
10 MW to 24.9 MW	11
25 MW to 49.9 MW	4
50 MW to 99.9 MW	1

Source: US Hydropower Resource Assessment for North Carolina by Idaho National Engineering and Environmental Laboratory.

Hydroelectric generation often requires less initial capital per kW than coal and nuclear facilities, depending on site conditions and the presence of existing dams, but more than natural gas-fired power plants. At an average cost of less than $0.025 per kWh, the cost of hydroelectric generation is the cheapest source of electricity available for North Carolina. However, concern over hydropower's environmental implications has slowed expansion in recent decades.

In 1998, the Idaho National Engineering and Environmental Laboratory, under contract by the U.S. Department of Energy, conducted an assessment of North Carolina's undeveloped hydroelectric generation potential. The study found 93 sites in North Carolina with approximately 508 MW of undeveloped generation capacity. Although 76 MW represents the greatest capacity of any site, 77% were less than 5 MW, as shown in Table 15.

According to the La Capra study on the potential for a renewable energy and energy efficiency portfolio standard, hydropower could provide a range of 66 to 425 Megawatts of electrical power by the year 2020, which could generate 300 to 1,700 Gigawatt-hours of electricity, about 0.2% to 0.9% of projected 2017 electricity consumption.

Hydrogen and Fuel Cells

Fuel cells use hydrogen to produce electricity through a highly efficient and low-emission electrochemical conversion process. One of the technology's challenges is the cost to produce hydrogen. Although it is the most plentiful known element, hydrogen is rarely found in a pure form. Hydrogen fuel can be produced from water using electrolysis, or from common fuels such as oil, natural gas, coal, biomass or any refined product of these fuels. Fuel cells today are running on many different fuels, even gas from landfills and wastewater treatment plants.

The future market for fuel cells is largely dependent on technological innovation. Fuel cell manufacturing companies have been locating in the state, so the state should be aware of the economic potential of these industries and consider the policy implications.

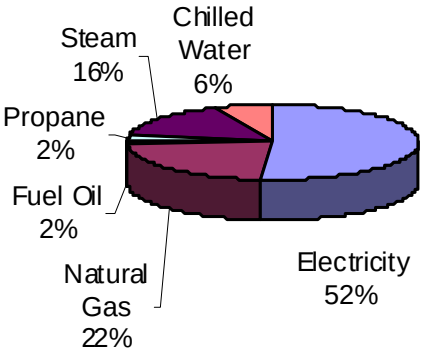
6: Energy Use in the Public Sector

From lighting our school buildings, heating our hospitals and fueling our police cruisers, North Carolina taxpayers at all levels of government spend a lot of money on public sector energy bills. Just how much energy is used in the public sector is difficult to determine. Since 1997 state government accounting systems have allowed department-by-department reporting of energy costs. The inability to track the same information in local governments is a significant gap in information energy consumption in the public sector.

State Government Energy Use

Agency financial data indicates state government spends about $236 million on energy bills (excluding transportation) in 2006-2007, up from $199 million in 2005-2006. Electricity represented about 51% of energy expenditures - $121 million; natural gas 23% - $53 million; steam 16% - $37 million; chilled water 6% - $15 million; and propane and fuel oil each 2% - $5 million and $4 million respectively.

Figure 16:
FY06-07 Energy Cost Profile for State Buildings (Total = $236 million)



Source: State Energy Office.

Figure 17:
FY06 Breakdown of Energy and Water Costs by State Agency

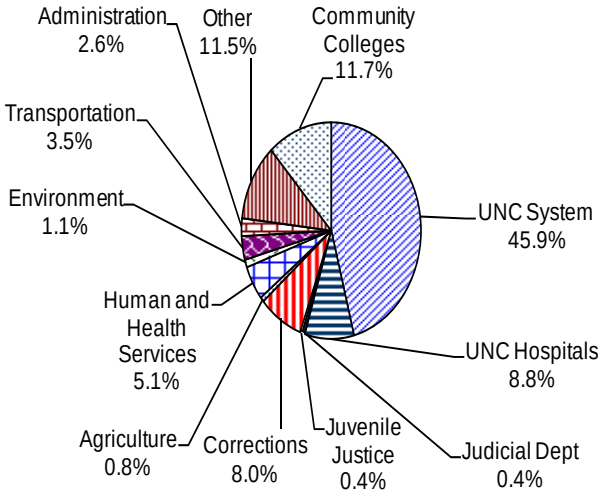
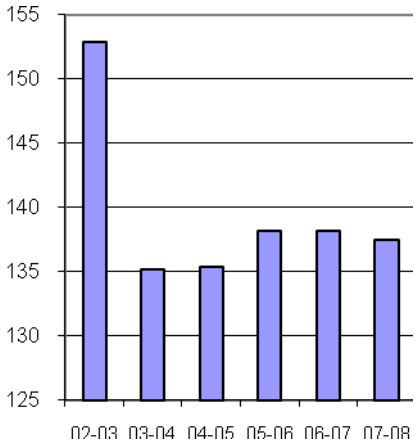


Figure 17 shows that the University System is the largest consumer of energy in North Carolina's state government, with over half of expenditures devoted to the 16 institutions, the UNC Hospital, and their administration. Among the universities, UNC-Chapel Hill and N.C. State University together consume nearly half of the total university expenditures, not including the UNC hospitals, which are funded separately.

Figure 18: Average Annual Energy Use per Square Foot (1,000 Btu) in State Buildings



Source: Hoey, Leonard. North Carolina State Energy Office. Personal Communication.

Utility Savings Initiative and Other SEO Programs

The Utility Savings Initiative, North Carolina's award-winning program administered by the State Energy Office, follows a comprehensive approach to reduce utility expenses and resources in state buildings. Goals of the Utility Savings Initiative include:

- Make sure all agencies and universities use the most economical rate schedule;
- Implement no-cost and low-cost conservation measures on a widespread basis;
- Require that each agency develop a strategic energy plan; and
- Train agency personnel to identify energy efficiency opportunities and provide the necessary resources.
- To meet the objectives, the Utility Savings Initiative works with representatives from agencies, universities, and private firms to develop plans for increasing building energy efficiency and seek funding mechanisms. Figure 18 shows the total estimated energy use per square foot in state buildings.
- The General Assembly supported the Utility Savings Initiative program in 2007 with funding that included about $600,000 for training and technical assistance programs and $5 million to purchase materials and equipment that offered quick energy savings paybacks on initial cost. Typical efficiency measures target lighting, hot water use, and improved control of heating and air conditioning systems.
- To provide additional technical resources for private and public building owners, the State Energy Office has funded the Energy Management Program and the Industrial Assessment Center at N.C. State University, Waste Reduction Partners (a nonprofit organization of retired engineers), N.C. A&T University's Center for Energy Research and Technology, and others.

Public Sector Related Legislative Actions

North Carolina's General Assembly passed legislation in 2007 that requires state, university, and community college buildings to meet a higher energy standard. For example, the General Assembly ratified Session Law 2007-546, which requires the Department of Administration to administer and oversee the implementation of a program that establishes performance criteria and goals for sustainable, energy efficient public buildings. The measure includes all state-owned buildings, state university buildings, and community college buildings. The program, which was implemented in August, 2008, contains the following provisions:

- Renovations to major public agency buildings greater than 20,000 gross square feet are required to include energy consumption reducing renovations and increase energy efficiency 20% greater than the ASHRAE (the American Society of Heating, Refrigerating and Air-Conditioning Engineers), 90.1 2004 standards. ASHRAE 90.1 2004 was the standard for the national energy code for commercial buildings used by the General Assembly for the legislation.
- New construction projects must be 30% more energy efficient than comparable buildings meeting ASHRAE 90.1 2004 standards.
- Additionally, new construction projects must reduce indoor water consumption by 20% compared to the baseline calculations required by the 2006 North Carolina Plumbing Code. Outdoor water use must be reduced by 50%.
- Building commissioning practices must be employed to verify installation of design requirements and performance measures.

The General Assembly set aside $5 million each year, for fiscal 2007-08 and fiscal 2008-09 to install efficiency measures in state buildings through the Utility Savings Initiative. The funding, known as the Energy Efficiency Reserve, was administered by the State Energy Office along with the State Construction Office. In 2008-09, $2.7 million was directed to the Energy Efficiency Reserve and $2.3 million to the University of North Carolina system.

Performance Contracting

North Carolina initiated a number of performance contracts between energy service companies and public agencies and universities. These agreements, typically multi-million dollar contracts, provide funding for energy efficient improvements and allow agencies to pay back the investment over time using the energy savings. For example, if a given set of energy efficiency measures cost $5,000,000 and save $700,000 on energy costs per year, the performance contract may specify that the agency pays $500,000 per year for 12 years to repay the costs of design and implementation. The State Energy Office established rules and guidelines for Performance Contracting projects. The office is now implementing over $50 million in such projects.

Public Schools

There were 115 individual school administrative units across the state in 2008-2009, with each responsible for paying its own energy bills. The state had approximately 2,500 individual schools, including charter schools, with almost 1.5 million students enrolled in 2008. The North Carolina Public

Table 16: Examples of LEED Buildings in North Carolina

Platinum Projects

Proximity Hotel, Quaintance-Weaver, Greensboro

Silver Projects

Third Creek Elementary School, Irdelle-Statesville Schools, Statesville

Orr Admission & College Relations Bldg, Warren Wilson College, Swannanoa

Blue Ridge Visitor Center, National Park Service, Asheville

EPA National Computer Center, Morrisville

ImaginOn: The Joe and Joan Martin Center, Public Library of Charlotte and Mecklenberg, Charlotte

East Regional Branch, Durham County Library, County of Durham, Durham

Duke University: Center for Interdisciplinary Engineering, Duke Medical Science Research Building 2, School of Nursing, and French Family Science Center

First Environments Early Learning Center, US EPA, Research Triangle Park

Carrboro High School, Carrboro-Chapel Hill Schools, Carrboro

Certified Projects

Addition to Carrington Hall, UNC-Chapel Hill

Triangle Wastewater Treatment Plant, Durham County, Durham

Duke University: Smith Warehouse, Kilgo Dormitory Renovation II, School of Law Addition

Butner FCI #3, FBOP, Butner

W. G. Pearson Elementary School, Durham Public Schools, Durham

FY04 Fire Crash Rescue Station (Main and Satellite facilities), USAF, Goldsboro

The John James Audubon Lodge & Camp, Crescent Resources, Charlotte

Source: U.S. Green Building Council.

Schools Statistical Profile 2008 cites savings of $518,000 system-wide for fiscal year 2006-2007, under the line item entitled "Installment Purchases - Guaranteed Energy Savings." Guaranteed energy savings are generally derived from performance contracting arrangements with energy service companies, described in the previous section.

The total cost of student transportation is a substantial portion of the total cost of energy for education. State funding for public school transportation in 2008-09 amounted to some $393 million out of a total state public school expenditure of $12.5 billion. Total expenditures for public school transportation totaled $498 million, which included federal, state, and local funding.

LEED in Public Buildings

The U.S. Green Building Council's Leadership in Energy and Environmental Design Program, known as LEED, has achieved widespread respect and recognition among architects, engineers, and building owners. LEED is a green building program that assigns points for measures to reduce site impacts, save water and energy, improve environmental air quality, and decrease materials use. Depending on the number of points, buildings earn a Certified, Silver, Gold, or Platinum rating, in order of difficulty. Table 16 shows examples of buildings in North Carolina that have qualified for LEED designation. Public buildings have been a frequent location for LEED certification. All but two of the buildings in the table are government or university owned. In 2008, there were a total of 129 LEED certified buildings in North Carolina. In addition to the buildings already certified, almost 700 other North Carolina buildings now under construction or in the design stage have been registered for LEED certification on the U.S. Green Building Council's website.

7. Energy Efficiency for Buildings and Industry

Residential Energy Use

In 2007, residences accounted for 27% of all energy consumption in North Carolina. Figure 19 shows that residential energy users in North Carolina purchased about 302 Trillion Btu of energy for their homes in 2007. The major sources, in units of energy, were electricity (63% of total energy use), natural gas (20%), and petroleum (12.2%). Renewables, primarily wood energy, supplied 4.4% of residential needs.

Figure 20 shows the breakdown of residential energy sources in terms of cost. Because electricity costs more per unit of energy than other fuels, its percentage of total cost, approximately 75%, is greater than its percentage of total energy, 63%, as shown in Figure 19. Natural gas and petroleum cost residential consumers about 13% and 12% of total energy purchases, respectively. North Carolina is unusual among other Southeastern states in its relatively high consumption of petroleum in the residential sector, primarily for space heating.

Residential End Uses for Energy

Figure 21 shows the rapid rate of increase of both population and housing units for North Carolina since 1980. Population has grown at a 2.7% annual rate, while housing units have grown at a rate of 3.85% per year – meaning the state has 69% more housing units in 2004 than in 1980.

Figure 22 on the next page shows the changes in energy use per capita and per housing unit between 1980 and 2006. Energy use per housing unit dropped in the early and late 1980's, but regained its reductions by 1992 and has remained virtually unchanged since then. Energy use per person rose fairly steadily between the early 1980's and the present. The average annual increase has been relatively small – only about 0.2% per year since 1990.

Homes use energy also known as end uses, includes space heating, cooling, hot water, lighting, and appliances. About 44% of energy use goes to space heating and cooling, while water heating for domestic purposes such as showering, clothes washing, and dishwashing consumes 18%. Lighting fixtures, appliances and plug loads use 32% of total residential energy – a percentage that will increase in coming years as homes reduce energy consumption for space heating, cooling, and water heating.

Figure 19:
North Carolina 2007 Residential Energy Purchases (Total of 302 Trillion Btu)

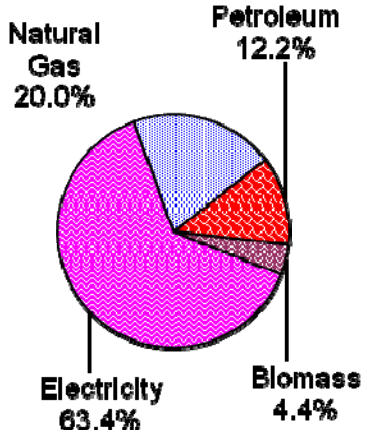


Figure 20:
North Carolina 2007 Residential Energy Purchases (Total of $7 Billion)

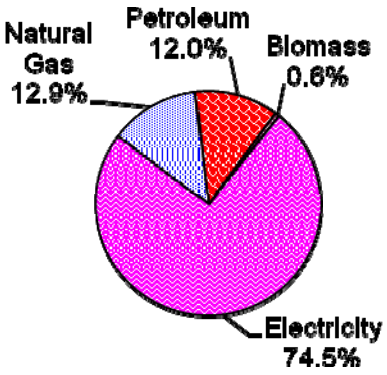


Figure 21:
Growth in NC Population and Number of Housing Units (in millions)

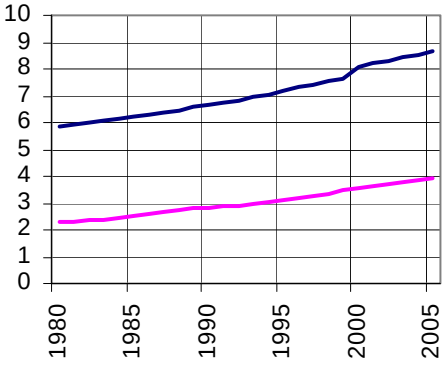
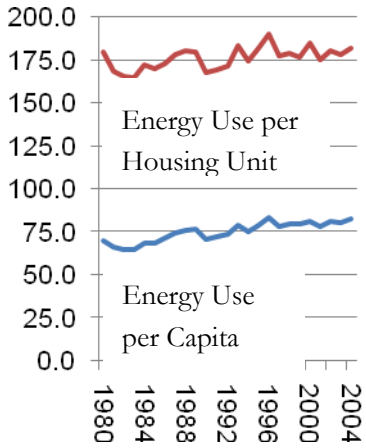


Figure 22:
Residential Energy Use (Million Btu) Per Housing Unit and Capita



Energy Codes

Energy efficiency has had a dramatic impact on energy use for space heating and cooling, in part due to strengthened energy codes implemented over the past twenty years. North Carolina's residential energy code primarily impacts two end uses, space heating and cooling, by requiting improved insulation, sealed air leaks and duct leaks, new window technologies, and improvements in heating and cooling systems. The North Carolina Building Code Council has approved the 2009 Energy Code, which is similar to the 2006 International Energy Conservation Code. Figure 24 summarizes the insulation and window requirements for the three zones in the state.

The North Carolina Department of Insurance is working currently with the Building Code Council's Ad Hoc Energy Code Subcommittee on the next version of the state's energy code. The effort seeks to improve the efficiency of new residential and commercial buildings beyond national code provisions.

Figure 23:
Energy by End Use

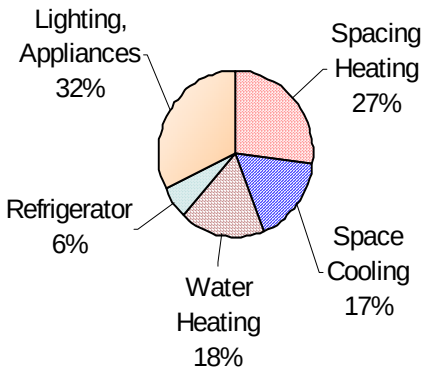
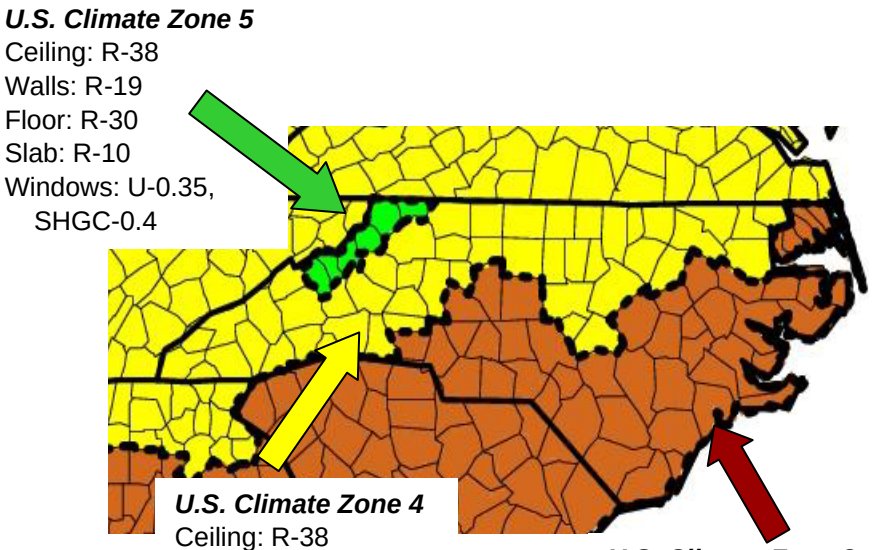


Figure 24:
Climatic Zones and Summary of Requirements for 2009 NC Residential Energy Code



U.S. Climate Zone 5
Ceiling: R-38
Walls: R-19
Floor: R-30
Slab: R-10
Windows: U-0.35, SHGC-0.4

U.S. Climate Zone 4
Ceiling: R-38
Walls: R-13
Floor: R-19
Slab: R-5
Windows: U-0.4, SHGC-0.4

U.S. Climate Zone 3
Ceiling: R-30
Walls: R-13
Floor: R-19
Slab: R-0
Windows: U-0.4, SHGC-0.4

Potential Reductions in Residential Energy Use

The Role of Energy Efficiency

Global Insight projects that household energy use in North Carolina will increase from 90.4 MMBtu in 2005 to 92.9 in 2020, a 2.8% increase. In recent years, energy use per household has begun to increase, reversing the trend from 1970 to 1995. Factors contributing to the increase include larger home sizes in new construction, larger appliances, and more entertainment and computer equipment. However, at the same time, more efficient products are available for each component of a home. There has been considerable analysis, evaluation, and speculation about how much energy could be saved from increased implementation of energy efficiency measures.

Energy Efficiency Potential Studies in North Carolina

North Carolina has been the subject of at least three studies evaluating the potential to reduce energy use in the residential sector. In 2003, Stan Hadley, a researcher at Oak Ridge National Laboratory, conducted a study titled, "The Potential for Energy Efficiency and Renewable Energy in North Carolina," which examined four scenarios aimed at reducing electricity use in the state. The market based projection, entitled "Lowered Discount Rates" saves about 4% in electricity bills annually for the residential and commercial sector, the projection based on lowered discount rates and employment of high technologies saves about 9%, and the "Best Technology" projection saves over 18% on electricity use in the two building sectors.

The State Energy Office asked Appalachian State University to conduct an evaluation of the potential for reducing energy use in North Carolina. The 2007 study examined a variety of efficiency measures for new and existing residences and found considerable potential in the existing home sector. The projected savings by measure totaled over 12% of residential energy use.

A study conducted by GDS in December of 2006, as part of the La Capra study, found that "achievable, cost effective measures", with average costs of $0.05 per kilowatt-hour or less, could save 16.9% of total electricity consumption by the year 2017. The total savings would be about 12,000 gigwatt-hours. Table 16 shows the percentage savings by measure type in the GDS study. Measures directed at reducing space heating consumption provided almost 60% of total savings.

Table 16: Percentage Savings by Measure in the GDS Report

Lighting	11.87%
Cooling (Programmable Thermostat, Room AC, Central AC)	9.52%
Minor Appliances (Dehumidifier & Standby Power)	3.71%
Major Appliances (Clothes Washer, Refrigerators, Freezers, Dishwashers)	0.51%
Low Income	3.32%
Space Heating (Windows, Insulation & Weatherization)	58.89%
Water Heating	8.76%
Efficient Furnace Fan Motor	3.42%

GDS Associates, Inc. A Study of the Feasibility of Energy Efficiency as an Eligible Resource as Part of a Renewable Portfolio Standard for the State of North Carolina. December 2006. Report for the North Carolina Utilities Commission. Raleigh, NC.

Efficiency Programs for Residences

New Home Programs

In order to encourage implementation of efficiency measures in residences, a number of programs have emerged in North Carolina. The U.S. Environmental Protection Agency's Energy Star program for new construction represents the first step toward energy efficiency beyond the energy code – Energy Star homes must be 15% more efficient than the 2004 International Energy Conservation Code. To receive Energy Star qualification for a home, builders or homeowners must hire a Home Energy Rating company to certify that the home complies.

Energy Star homes in North Carolina have witnessed considerable growth, as shown in Figure 25, with about 5% of total housing starts in 2007. The number of Home Energy Raters in the state has also grown to 31 companies operating in North Carolina that can certify a home as Energy Star.

Advanced Energy's Systems Vision program has more stringent requirements than the Energy Star home program. The Systems Vision program is targeted at affordable housing and includes an incentive for the builders of homes that qualify. Over 1,500 Systems Vision homes have been constructed in North Carolina over the past seven years. There are currently 350 to 400 Systems Vision homes built per year.

Green Home Programs

The state also has a number of homes that have been constructed under other green building programs. The HealthyBuilt Home Program has been designed and operated by the North Carolina Solar Center for the State Energy Office. There are currently 454 HealthyBuilt Homes with an additional 419 in the design or construction stage. Other green building programs that are active include the Earthcraft Home Program of Southface Energy Institute, the National Association of Homebuilders' green building program, and Leadership in Energy and Environmental Design's residential green building program known as LEED-H.

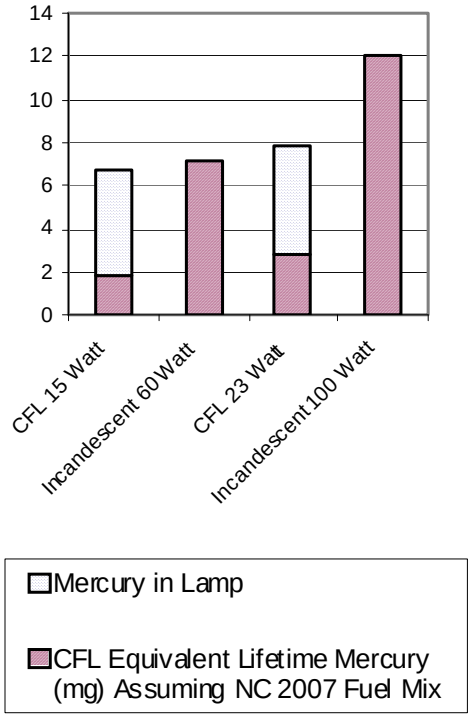
Manufactured Home Programs

In North Carolina, manufactured homes constituted about 10% of new housing permits in 2007. While the manufactured home industry provides options for energy efficient models, most existing units, as with site-built homes, are in need of energy improvements. However, energy efficiency features in existing manufactured homes are more difficult to install than in standard homes. The difficulty is compounded by the fact that many manufactured home occupants do not have sufficient disposable income for energy improvements.

In the manufactured home sector, the Energy Office's Upgrade and Save program provides incentives for more efficient new homes. East Carolina University conducted an initial pilot program and provided 131 incentive payments (as of June 30, 2005) for new homes that had heat pumps instead of more typical electric furnaces. Heat pumps provide space heating at approximately half the cost of electric furnaces, saving an average of $632 annually.

In a second phase of Upgrade and Save projects, East Carolina University, along with N.C.A&T University and Appalachian State University, has provided incentives to over 300 new manufactured homes. In discussions with dealers, Appalachian State found that heat pumps were fairly standard in new manufactured homes in western North Carolina. The project team decided to require that homes meet the Energy Star provisions for manufactured homes in its program to obtain the incentives. Thus far, two manufacturers are participating actively in the project, along with over a dozen retailers.

Figure 26: Potential Mercury Emissions from Lamps (mg of Mercury)



Existing Home Programs

Energy efficient retrofits of existing homes can save more energy than most other sectors. However, the energy efficient retrofit industry is relatively small. And as a consequence, there is little marketing of energy efficient business services despite the growing interest in efficiency.

The North Carolina Housing Finance Agency conducts a high efficiency retrofit program in conjunction with its other rehabilitation programs. The efficiency measures installed under the program must meet protocols developed by Advanced Energy. As of 2010, the agency has spent over $2.5 million to improve the energy efficiency of more than 325 homes.

Piedmont Natural Gas worked with Advanced Energy and Building Performance Engineering in Boone on a project intended to stimulate the retrofit efficiency industry. In a pilot program in Hickory and Wilmington, the gas utility advertised two incentives – either a rebate or an interest-free loan for those who install specific efficiency measures. Home energy specialists who have successfully completed several training programs provided the energy retrofit services by first conducting a home energy assessment and then managing installation of the efficiency measures.

Other utilities in the state are developing efficiency programs. For example, Duke Energy is offering a financing program with flexible measures. The program, called Save-A-Watt, was approved in February 2010 by the North Carolina Utilities Commission. The utility is considering other programs in conjunction with a group of building professionals and other stakeholders known as Duke Energy's Energy Efficiency Collaborative. The utility reports plans to save 1,700 Megawatts of generation capacity via energy efficiency

Figure 27:
2007 Commercial Energy Purchases in North Carolina (232 Trillion Btu)

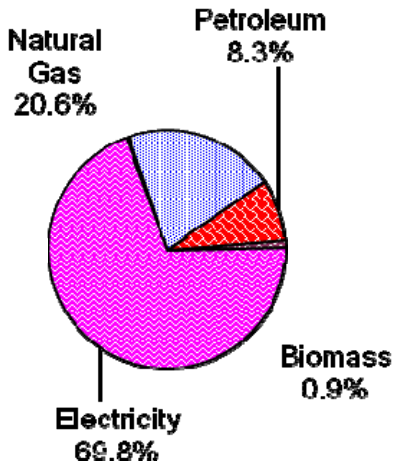
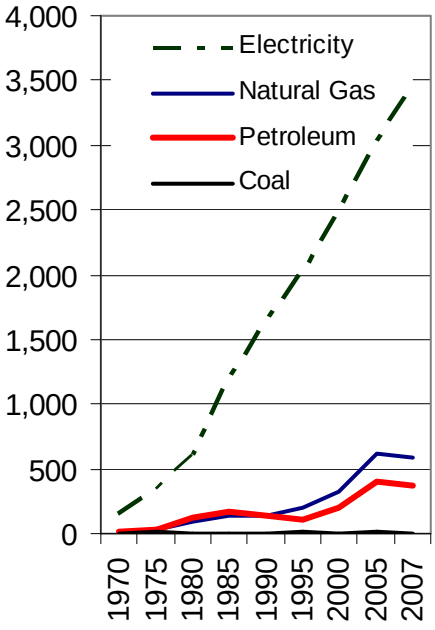


Figure 28:
Annual Cost of Commercial Energy Purchases ($ million)



Source: Energy Information Administration. U.S. Department of Energy.

measures. One environmental issue with both new and existing efficiency programs concerns the mercury contained in fluorescent lighting, in particular compact fluorescent lamps (CFL's). CFL advocates contend that the mercury contained in the lamps is balanced by the mercury emissions of coal-fired electric power plants.

Low Income Programs

An Economic Opportunity Study by Meg Power in 2005 looked at energy bills for families who were eligible for Low Income Household Energy Assistance Program, which provides partial energy bill payments to qualifying households with limited income. Funding for the program has remained relatively fixed in recent years while the costs of fuels typically used for space heating have increased markedly. In the South Atlantic region, which includes North Carolina, the Low Income Household Energy Assistance Program eligible households saw their average energy bills increase from $1,255 in 2001 to $1,922 in 2006. As a result, the percentage of income spent on energy increased from 14% to 17%.

The state's Weatherization Assistance Program provides energy efficient retrofit services for many years. Administered through the North Carolina Energy Office the program installs weatherization measures, such as insulation, air sealing and duct sealing, and hot water efficiency measures, on the homes of those with low incomes. Currently the program is funded through $9.7 million annually from the U.S. Department of Energy. Additional funds approaching $132 million are designated through the American Recovery and Reinvestment Act funds. The Weatherization Program in the state has added efficiency measures in the homes of those on limited income. Typical savings in weatherized homes are about $470 per year in households using natural gas for space heating.

Commercial Sector Energy Use and Efficiency

Privately-owned commercial buildings, public buildings, large multi-family dwellings, facilities for non-profit organizations, and religious buildings comprise the commercial sector. Buildings in the commercial sector consumed about 21% of total energy use in North Carolina in 2007, including generation losses from electric power plants. Figure 27 shows an energy resource mix for North Carolina's commercial sector in 2007 (electricity purchases do not include generation losses):

- Electricity purchases provide about 67% of total energy needs, totaling 151 TBtu.
- Natural gas supplies 21.4% for a total of 48.7 TBtu.
- Petroleum provides about 10% for a total of 22.3 TBtu.
- Coal supplies 1.2% for a total of 2.7 TBtu.

Table 18:
Breakdown of Projected Commercial Energy Sources

	Electricity	Natural Gas	Petroleum	Coal	Renew-ables
Space Heating	40%	45%	10%	2%	3%
Space Cooling	99%	1%	0%	0%	0%
Water Heating	73%	21%	4%	1%	1%
Lighting	100%	0%	0%	0%	0%
Electronic Equipment and Appliances	100%	0%	0%	0%	0%

- Renewable sources (primarily wood) provide about 1% of energy needs totaling 2 TBtu.

Figure 28 shows the breakdown of energy purchases by cost. Of the $4 billion spent by commercial buildings, about 79% goes to purchase electricity, while natural gas costs about 13% of the total, and petroleum only represents about 8.2%.

Commercial Energy Use Characteristics

Table 18 shows the estimated breakdown of commercial energy sources by end use. The bulk of energy used by the commercial sector is for heating, cooling, and lighting; with less energy used for domestic hot water, refrigeration, cooking, electronic equipment, and other operations.

In the commercial building sector, Table 19 shows the results of Energy Information Administration's 2003 Commercial Buildings Energy Consumption Survey for buildings in the South Atlantic region – Florida, Georgia, South Carolina, North Carolina, and Virginia. Note that only 40.8% of buildings have multi-paned windows. This number is most likely skewed by the fact that Florida, which has a higher percentage of buildings still using single pane windows, is one of the states in the region.

In regard to lighting, the survey found that about half of the fluorescent lighting uses more efficient electronic ballasts, but only 1.7% of commercial buildings use lighting control systems. When the buildings are not in use, 76.6% reduce lighting levels, 56.2% reduce heating, 60.3% reduce cooling, and 31.5% reduce office equipment use.

Building renovations typically provide valuable opportunities to improve energy efficiency. The 2003 Energy Information Administration survey also examined the number of renovation projects in commercial buildings in the nation and the entire Southern region. 15.5% of buildings in the region have had renovation projects; 6.2% of all buildings reported an upgrade to their

Table 19:
Commercial Building Data
(from 2003 EIA survey)

	South Atlantic	
	# of Bldgs	% of Total
Number of Buildings (1,000's)	**926**	
Window and Lighting Features (more than one may apply)		
Multi-paned Windows	378	40.8%
Tinted Window Glass	292	31.5%
Reflective Window Glass	53	5.7%
Exernal Overhangs/ Awnings	219	23.7%
Skylights or Atriums	56	6.0%
Daylighting Sensors	9	1.0%
Specular Reflectors	155	16.7%
Electronic Ballasts	456	49.2%
Energy Mgt Systems for Lighting	16	1.7%
Equipment Usage Reduced When Building is Not in Full Use (more than one may apply)		
Heating	520	56.2%
Cooling	558	60.3%
Lighting	709	76.6%

Source: Energy Information Administration, 2003 Commercial Buildings Energy Consumption Survey. U.S. Department of Energy. 2004.

Table 20:
Estimated Costs for Efficiency Measures in Commercial Buildings

Cost Under $0.01/ kWh
CFL Screw-in
Programmable Thermostats
High Efficiency Heat Pump (New)
Low Emissivity Windows (New)
Refrigerated Case Covers

Cost Under $0.01 to $0.02/ kWh
Door Heater Controls
Retrocommissioning
Efficient Motors
Vending Miser for Vending Machines
30% More Efficient Design - New Construction
DX Packaged System, CEE Tier 2, <20 Tons
High Efficiency Ice Maker
ENERGY STAR Transformers

Cost Under $0.02 to $0.03/ kWh
Compressed Air – Non-Controls
Commercial Reach-In Refrigerators/ Freezers
Variable Speed Drive Control, 40 HP
CFL Fixture
Induction Fluorescent 23W
Commercial Ice-makers
High Efficiency DX Packaged System
Occupancy Sensors

Cost Under $0.03 to $0.04/ kWh
Lighting Controls
T5 Fluorescent High-Bay Fixtures
Dual Enthalpy Economizer - from Dry Bulb
Chiller Tune Up/Diagnostics
Variable Speed Drive Control, 15 HP
Electronic HID Fixture Upgrade
Heat Pump Water Heater

Cost Under $0.04 to $0.05/ kWh
High Efficiency Packaged AC
Super T8 Fixture and LED Exit Sign
Dual Enthalpy Economizer

Source: GDS and Associates.

heating and cooling system; 5.8% to their lighting system; 2.7% to their windows; and 2.7% to their insulation system.

Estimated Potential for Energy Savings

Table 20 shows energy efficiency measures for which the GDS study projected the cost per kilowatt-hour of electricity saved was less than $0.05 per kWh. The list of over 40 measures includes a wide variety – lighting, mechanical controls, appliance-related measures, fan motor options, window, and heating and cooling system measures.

Industrial Sector Energy Use and Efficiency

North Carolina's industrial sector uses about 700 Trillion Btu (TBtu) of energy per year or about 28% of the total energy used in the state. Figure 29 shows that petroleum is presently the major supplier of energy to the industrial sector. Petroleum, electricity and natural gas provide about 35%, 23%, and 21% of fuel needs, respectively, while coal, biomass, and hydro together contribute a significant 21%. Note that biomass – primarily from wood and waste products – alone provide 14% of industrial energy needs. The major changes in industrial fuel mix over the past forty years has been a substantial drop in the amount of coal used in the sector balanced by a rise in natural gas and electricity use.

Figure 30 shows the historical costs for energy in the industrial sector. The costs for electricity and petroleum have represented the largest share of industrial fuel costs for many years. The rapidly rising cost for both petroleum and natural gas in 2005 and 2006 caused a dramatic increase in their contribution to total industrial energy costs.

Figure 30: 2007 Energy Use in North Carolina Industry (700 Trillion Btu total)

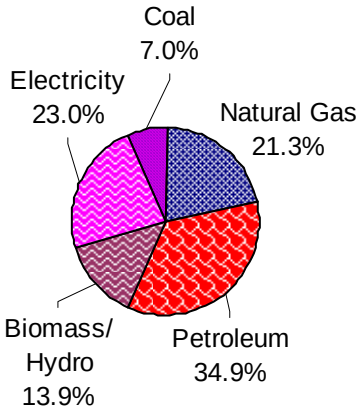
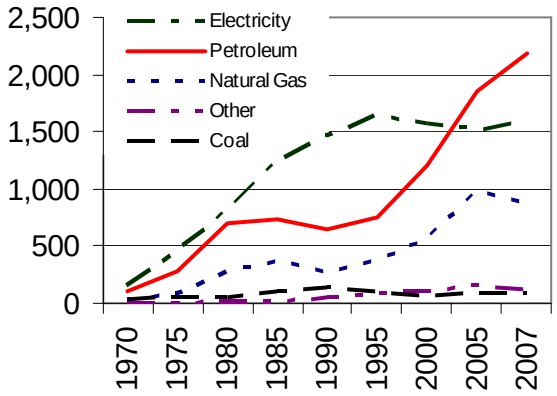


Figure 31: Historical Energy Costs by Source in North Carolina Industry ($ million)



Energy Consumption Patterns

Table 21 summarizes the Energy Information Administration end-use data for both the nation as a whole and for the southern region, which includes the states from Texas eastward and Kentucky southward. Note that the end use percentages are quite similar for all categories. Industries chose not to report certain data, citing that it might violate privacy concerns.

The two highest end uses reported were process heat and boiler fuel, with machine drive (mainly motors) and heating and cooling showing moderate use. Minor end uses included the use of electro-chemical processes, facility lighting, refrigeration and process cooling, and several other needs.

Figure 32 shows the results of the Energy Information Administration's industrial energy facility survey for several years. The chart indicates the number of energy efficiency measures that have been installed recently. There were 15,500 respondees to the survey of all industrial establishments in the country.

The survey estimated that 35,000 industrial facilities in the nation have had energy audits, while over 25,000 facilities have implemented improvements in machine drive equipment, heating and cooling, lighting, load controls, and power factor correction.

Saving Energy in Industrial Facilities

Industrial energy-saving improvements can be grouped into four categories:

1. General energy-saving technologies: technologies which are applicable to all manufacturing sectors. Examples are high-efficiency lighting and computer control of air conditioning.
2. Industry-specific energy-saving technologies.
3. Energy management activities: examples include energy audits, load control, and full-time energy managers.
4. Broader changes like alterations of processes or new approaches for industrial development, such as industrial ecosystems – industrial facilities grouped to allow optimal use of feedstocks, waste products, fuels, waste heat, and electricity.

Some key considerations in developing policies and programs targeted at the industrial sector include:

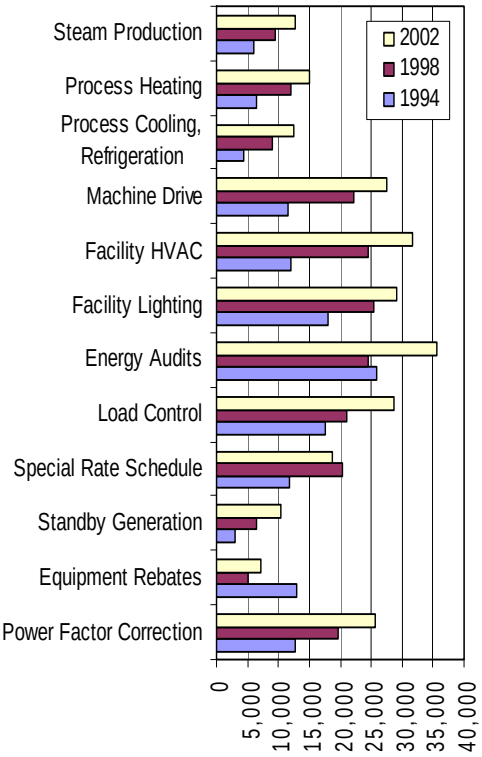
- What energy saving technologies and management activities should be considered for implementation by manufacturing industries in North Carolina?
- To what extent have these energy saving measures been adopted?
- What government policies and actions can be effective in

Table 21: Percent of Industrial Energy Use by End Use Category

	National	South
Other	1.34%	1.29%
Refrigeration	1.19%	1.18%
Lighting	1.19%	0.89%
Electricity Generation	1.37%	1.85%
Electro-Chemical	1.69%	1.32%
HVAC	3.91%	2.53%
Machine Drive	9.57%	8.53%
Boiler Fuel	20.56%	21.92%
Process Heat	22.94%	23.65%
Not Reported	36.23%	36.84%

Source: U.S. Energy Information Administration, End Uses of Fuel Consumption.

Figure 32: Implementation of Energy Conservation Measures



Source: Energy Information Administration, 2002, 1998, 1994 Manufacturing Energy Consumption Surveys.

encouraging efficiency improvements in the industrial sector?

Table 22:
Estimated Cost/kWh for Industrial Efficiency Measures

Advanced lubricants	-0.0636
Industrial sensors and controls	-0.05
Pump system efficiency improvements	-0.0007
Advanced Air compressor Controls	0.0002
Industrial motor management	0.0013
Air compressor system management	0.0015
Fan system improvements	0.0023
Motor system optimization (including ASD)	0.0025
Other industrial energy efficiency measures	0.01
Efficient industrial lamps and fixtures	0.0114
Industrial Lighting	$0.05

Source: GDS

Projections of Savings from Industrial Energy Policies

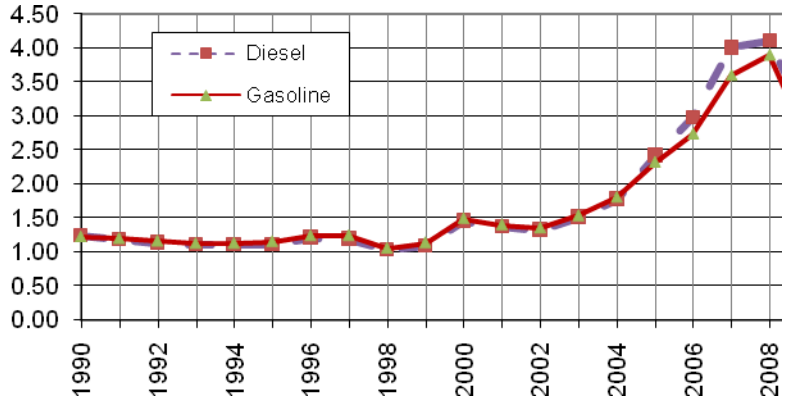
The GDS study, referenced in the residential and commercial chapters, found that electricity savings of 10.8% were achievable and cost effective for the year 2017, while 21.5% savings were technically feasible. Table 22 shows the measures that were considered in the study, all of which cost $0.05 per kWh or less.

8. Transportation Energy Use and Efficiency

North Carolina's transportation sector, specifically, the movement of people, goods and services consumed about 28% of total energy used in the state in 2007. Furthermore, the transportation sector represented one-third of total energy-related carbon dioxide emissions in 2006.

Historically, there has been little economic incentive for individuals, businesses, and government to reduce transportation energy use. However, with gasoline prices passing $3.50 per gallon in mid-2008, there has been a dramatic shift in priority towards higher fuel efficiency. In addition to the reductions in the cost of energy, vehicles with improved miles per gallon ratings can help improve air quality, reduce noise, and decrease carbon dioxide emissions. Figure 33 shows the incredible recent increase in the cost of motor fuels. Since 1990, gasoline and diesel fuels have risen over 300% -- 7% per year. The overall impact of higher energy prices on the state's economy is still uncertain. The trends are partly responsible for the 2008 economic downturn.

Figure 33:
Fuel Prices for Transportation ($/gallon)



Vehicle Miles Traveled

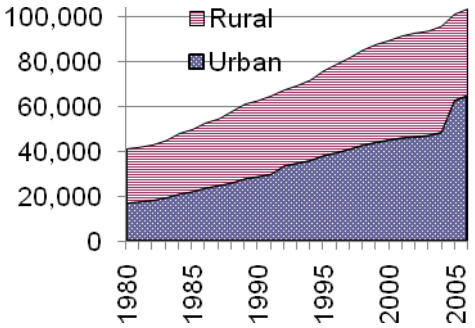
One of the primary reasons for the increasing use of transportation fuels in North Carolina has been the rapid growth in vehicle miles traveled, or the total number of miles driven in the state each year. Figure 34 shows that both rural and urban vehicle miles traveled increased over the past 25 years, urban miles at a 5.3% annual rate, rural miles at a 1.9% rate, and total miles at a 3.6% rate. Figure 35 shows that vehicle miles traveled per capita increased 2.8% annually between 1980 and 1995 – from 7,000 annual miles per capita in 1980 to about 10,600 in 1995. While VMT per capita continued to rise between 1995 and 2005, the rate was much slower – only 0.7% annually.

Transportation Energy Trends

- Motor gasoline provided 78.3% of transportation energy use in 1960, reached a maximum share of 81.6% in 1976, but dropped to 71.7% in 2007.
- Diesel fuel increased its market share from 8% in 1960 to about 21% in 2007.
- Jet fuel represented 5.4% of transportation energy use.
- Natural gas reached a market share of 1.2% in 1999, but held only 1.0% in 2001 and further dropped to 0.7% in 2007.
- Ethanol consumption rose slightly from 0.5% in 2000 to 0.6% in 2007.

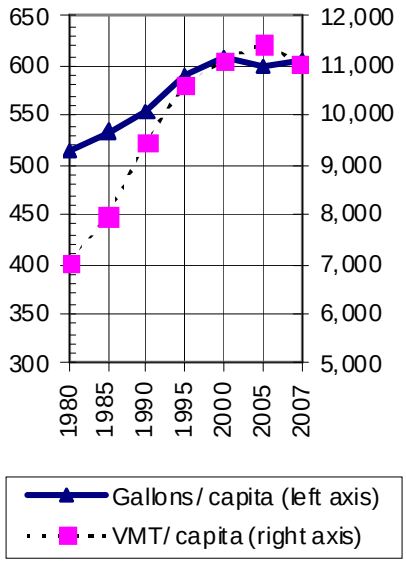
Source: U.S. Energy Information Administration. www.eia.doe.gov/emeu/states/sep_use/tra/use_tra_nc.html.

Figure 35:
North Carolina Vehicle Miles Traveled (million miles)



Source: Federal Highway Administration. (2007). *Highway Statistics, 2007*

Figure 35:
North Carolina Per Capita Vehicle Miles Traveled and Fuel Gallons Consumed



Source: Federal Highway Administration. (2007). *Highway Statistics, 2007*

Vehicle Miles Traveled per capita actually dropped in 2007 and will continue to decline in 2008 and 2009 due to fluctuating fuel prices and the economic downturn.

Figure 35 also shows gallons of motor gasoline and diesel fuel consumed per capita. The rate of growth mirrored that for vehicle miles traveled between 1980 and 1995, due to the lack of increase in vehicle efficiency, but actually dropped in recent years. With recent high gasoline prices, the unpredictability of future prices, and the economic slowdown, motor fuel use per capita should decrease in the next few years

Strategies to Reduce Vehicle Miles Traveled

The North Carolina Department of Transportation began support of local Transportation Demand Management programs in 2004. Transportation Demand Management programs operated in five urban areas – Asheville, Charlotte, the Triad, the Triangle and Wilmington. These programs strive to reduce single-occupant vehicle miles traveled by encouraging more use of public transit, car and vanpooling, walking, cycling and telecommuting.

Mass Transit Use

Many North Carolina residents have the option to use mass transit to meet at least a portion of their daily transportation needs. During the 2005 to 2006 fiscal year, the state had a total of 106 transit systems that operated about 2,500 vehicles during peak hours. The systems had over 55 million passengers and logged over 80 million vehicle miles – a 102% increase since 1994. The vehicles operated a total of 4.7 million hours – a 115% increase since 1994.

One recent mass transit development in the state is Charlotte's LYNX Blue Line, which initiated light rail service on November 26, 2007. The LYNX line is North Carolina's first light rail system and runs 9.6 miles from Uptown Charlotte to Interstate 485/South Boulevard. The first full year average daily ridership was 15,000-16,000, which greatly exceeded the projected number of 9,100. By 2025, ridership is expected to double. While mass transit has been moderately successful in the state, most citizens continue to rely on their private vehicles for their daily commutes, errands, and other transportation needs.

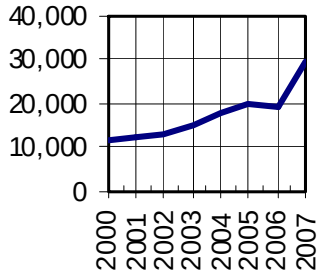
Vehicle and System Efficiency

While North Carolina cannot realistically mandate higher efficiency standards than those set nationally, the state can require increased efficiency of state vehicles and increased purchase of vehicles that use alternative fuels, as is now required. Transportation system efficiency improvements strive to provide free-flowing traffic networks, which will reduce gasoline consumption and air pollutant emissions. The supply of transportation infrastructure (adequate roads with properly scheduled traffic lights) serves to reduce the amount of time automobiles are in operation.

One of the initiatives seeking to increase vehicle efficiency in the state is the newly formed Advanced Transportation Energy Center at NC State University. The Center, with funding from Duke Energy and Progress Energy, has three primary goals:

- Create infrastructure for plug-in hybrids,
- Manage the electrical grid in terms of supply and distribution related to supplying power for charging plug-in hybrids, and
- Improve batteries in terms of weight, cost, charging time, and capacity.

Figure 36: Number of Alternative Fuel Vehicles in North Carolina



Source: Energy Information Administration. U.S. Department of Energy. *Estimated Number of Alternative Fueled Vehicles in Use, by State.*

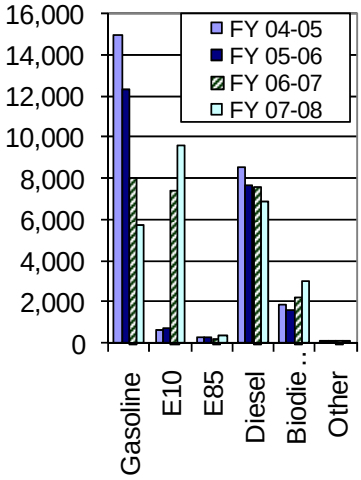
Alternative-fueled Vehicles

Alternative-fueled vehicles use fuels such as natural gas, propane, electricity, or ethanol. North Carolina had about 30,000 alternative-fueled vehicles in use in 2007. Figure 36 shows that the number of alternative-fueled vehicles in the state has grown by over 20% per year since 2000, with a substantial jump between 2006 and 2007.

State Fleets

The North Carolina General Assembly required that state fleets achieve a 20% displacement of petroleum consumption by January 1, 2011, in SL2005-276 (S622). Although the overall petroleum displacement goal, 4.6 million gallons, was met in the 2008-2009 FY, certain agencies, such as Motor Fleet Management, did not meet their goals. Increased E 85 stations throughout the state should assist these agencies with meeting their goals. In meeting this displacement goal, the state required that 39 agencies, universities and community colleges provide a plan that outlines the strategies they will undertake to reach their entire displacement requirement and report vehicle and fuel use by September 1st each year, documenting the achievement towards their petroleum displacement goal.

Figure 37: Fuel Use in State Vehicles (1,000 gallons)



Source: North Carolina FY 2006-2007 Petroleum Displacement Report.

Figure 37 shows the substantial shift in fuel use over the past three years. Achievements highlighted in the 2008-2009 Petroleum Displacement Program Report prepared by the State Energy Office include:

- In FY 2008-09, State agencies reduced mileage by 2.7%, and on the contrary, the FY 2007-08 there was an increase of 3.4%. This change was caused by the economic downturn,
- Total fuel use (including all fuels) reported in FY 2008-09 is 24 million gallons, a reduction of 10.2% from adjusted baseline from fiscal year 2004-2005 (FY 04-05),
- State fleets used 21.4 million gallons of petroleum in FY 2008-09, 18.2 % of the adjusted baseline ,
- Previously, in FY 2007-08, petroleum use was 25.8 million gallons, down 2 million gallons or 7.5% from the baseline. Much of the savings were due to agencies implementing travel freezes for employees.
- Agencies met their goal through utilizing the following measures:
  - 2.7 percent was from displace mileage
  - 3.5 % was displaced through E10 use.
  - 4.3 % was displaced through biodiesel use.
  - 7.7 % was from conservation

9. Energy Education and Research

North Carolina devotes approximately 59% of total state spending to its system of public schools, community colleges/ technical institutes, and 16-campus university system.

Education – A High Priority in North Carolina

North Carolina's focus on energy education and research includes programs provided by the State Energy Office, including examples such as the following:

- Change a Light Program
- Energy Efficiency Workshops for residential and commercial office buildings
- Industrial and commercial, and governmental energy assessments
- www.energync.net (State Energy Office website offers a variety of educational resources)
- Exhibits on energy efficiency, renewable energy and alternative fuels at public venues such as the North Carolina State Fair
- 1.800.662.7131 (North Carolina-only toll free number allows North Carolinians access to a variety of energy experts.)
- energyinfo@ncmail.net (E-mail allows North Carolinians access to a variety of energy experts.)

Through the ongoing support of the State Energy Office, North Carolina's three university energy centers also play a key role in energy education and research. The centers provide invaluable technical assistance to a wide variety of the state's energy consumers.

The North Carolina State University Solar Center, the NC A&T State University Center for Energy Research and Technology, and the Appalachian State University Energy Center conduct programs, workshops, continuing education, presentations and exhibits to thousands of people annually. Examples of these educational efforts include K-12 programs on renewables, and energy efficiency; Students Making Advancements in Renewable Transportation Technologies (SMARTT); Junior Solar Sprint; Clean Green World Program; NC Solar House Tour; SMARTT Mobile Classroom program; Energy Engineers Starters Program; conferences on Energy Star homes green building products; workshops for professional audiences on energy efficiency, Home Energy Ratings and Energy Star homes, LEED, Zero Energy Homes, NC Healthy Built Homes, biofuels, micro-hydro, solar thermal, photovoltaics, other solar topics, and higher efficiency manufactured housing; and consumer workshops on a variety of similar topics.

In addition to State Energy Office programs, the state has a wide variety of other educational activities, such as:

Current and Potential Research Areas in North Carolina

- Offshore natural gas and petroleum resource and economic assessments
- Economic analysis of energy and environmental policies
- Renewable energy and energy efficiency improvements
- Industrial process energy efficiency
- Job creation and retention in the energy area
- Building systems, such as roof systems that integrate power production, moisture control, thermal energy collection, and insulation
- Advanced fuel cells, fuel cells that use propane for rural areas
- Land planning and energy use
- Energy efficient manufactured housing
- Improving energy decision-making in the marketplace
- Energy education in schools—awareness and training in industry schools, etc.
- Biogas
- Distributed generation and grid interconnection studies
- Embodied energy analysis
- Agricultural wastes
- Coastal and mountain wind power
- Daylighting and high performance designs for buildings
- Tidal and wave energy
- Clean coal technologies

- In January of 2010, Appalachian State University received a Wind for Schools grant from the Department of Energy's National Renewable Energy Laboratory. The grant will annually supply ASU with $60,000 for three years. The funding will support the creation and implementation of wind energy education programs in North Carolina schools.
- Weatherization and home energy retrofit training programs by the state's Weatherization Action Programs, community colleges, and organizations such as Advanced Energy and Building Performance Engineering.
- Graduate and under graduate degree programs such as the Appropriate Technology program at Appalachian State, and energy-related curricula at North Carolina State University, and North Carolina A&T.
- Electric utilities are also funding a variety of training programs and energy outreach activities throughout the state.

References

Appalachian Regional Commission. (2009). *ARC Study: Efficiency Measures can save Billions in Energy Costs.* Retrieved from: www.arc.gov/news/article.asp?ARTICLE_ID=161

Appalachian State University. (February, 2007). ***Energy Efficiency Opportunities for North Carolina Buildings and Industrial Facilities***. Presentation to the North Carolina Energy Policy Council.

Bull, Leonard. ***Animal Waste to Energy in North Carolina.*** Presentation to the Energy Policy Council. April 2003.

Burke, S., Hall, B., Shahbazi, G.,Tolson, E., Wynne, J., (2007) ***North Carolina's Strategic Plan for Biofuels Leadership.*** Retrieved February 2007 from www.ncbiotech.org/biotechnology_in_nc/strategic_plan/documents/biofuels_plan.pdf

Center for Legal Policy at the Manhattan Institute. ***A state's public nuisance lawsuit that succeeded***. Point of Law.com Information and opinion on the U.S. litigation system. Retrieved March 2009 from www.pointoflaw.com/archives/2009/02/a-state-public.php.

Efland, C. (2009). Coastal Wind Energy for North Carolina's Future: A study of wind turbines in the Pamlico and Albemarle Sounds and Ocean Waters off the North Carolina coast. Retrieved from www.climate.unc.edu/coastal-wind

Fibrowatt. (2009). North Carolina Projects. Retrieved from www.fibrowattusa.com/projects/north-carolina/

Hadley, S. W. ***The Potential for Energy Efficiency and Renewable Energy in North Carolina***. ORNL/TM-2003/71. Oak Ridge National Laboratory. Oak Ridge, TN. April 2003.

Hoey, Leonard. ***Energy Consumption Data for North Carolina State Buildings.*** North Carolina State Energy Office. Personal Communication. October 2008.

La Capra Associates (2006). Analysis of a Renewable Portfolio Standard for the State of North Carolina. La Capra Associates, Inc. Boston.

Murawski, J. (01/24/2010) Smart grid, smart meters. *The Raleigh News and Observer.* Retrieved from www.newsobserver.com/business/story/299551.html

Murawski, J. (11/21/2009) 'Smart grid' making jobs. The Raleigh News and Observer. Retrieved From www.newsobserver.com/business/local_state/story/207895.html

National Park Service U.S. Department of the Interior. ***Ten-Year Study Shows Improvement in Air Quality in National Parks***. Retrieved September 2007 from home.nps.gov/applications/release/Detail.cfm?ID=310

NC GreenPower Website. Newsletters. Retrieved December 2007 from www.ncgreenpower.org

North Carolina Public Schools Statistical Profile 2008. State Board of Education, Department of Public Instruction.

North Carolina Public Schools Statistical Profile 2009. State Board of Education, Department of Public Instruction.

North Carolina Solar Center. (08/27/2009) *Database of State Incentives for Renewable Energy and Energy Efficiency.* Retrieved from www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NC09R&state=NC&CurrentPageID=1&RE=1&EE=1

North Carolina State Energy Office. ***Utility Savings Initiative Database 2006.*** North Carolina Department of Administration. 2008.

North Carolina State Energy Office. (2009). North Carolina Weatherization Assistance Program. Retrieved from www.energync.net/Weatherization.pdf

North Carolina Utilities Commission. *Report Implementation of the Clean Smokestacks Act of 2009*. Retrieved January 2010. www.ncuc.commerce.state.nc.us/reports/report

North Carolina Utilities Commission. *Report Implementation of the Clean Smokestacks Act of 2008*. Retrieved January 2010. www.ncuc.commerce.state.nc.us/reports/report

SAS Institute Incorporated. (February 2010) Solar Farm at SAS. Retrieved from www.sas.com/corporate/solarfarm.html

North Carolina State Energy Office. ***Utility Savings Initiative Database 2006.*** North Carolina Department of Administration. 2008.

Office of Governor Purdue. (2009). *Gov. Perdue Establishes Offshore Energy Advisory Panel.* Retrieved from www.governor.state.nc.us/NewsItems/PressReleaseDetail.aspx?newsItemID=637

Prindle, William. Energy Efficiency as Part of a Balanced Energy Policy. Presentation to the Energy Policy Council, Raleigh, NC. March 2002.

Reuters. (2009). Duke Energy to fund offshore North Carolina wind project. Retrieved from www.reuters.com/article/idUSTRE5956SL20091006

Scenarios for a Clean Energy Future. ORNL/CON-476. November 2000.

Unknown Author. (01/18/2007) Public Hearing from Creston Wind Project. *The High Country Press.* www.highcountrypress.com/weekly/2007/01-18-07/public_hearing.htm

US Department of Energy, Table 8.13 Electric Utility Demand-Side Management Programs, 1989-2005. Retrieved February 2008 from www.eia.doe.gov/emeu/aer/txt/ptb0813.html.

U.S. Environmental Protection Agency. ***LMOP Landfill Database***. Retrieved on July 2008 from www.epa.gov/lmop/proj/index.htm#1.

U.S. Green Building Council. Retrieved on February 12, 2010 from www.usgbc.org.

U. S. Department of Energy (2009). Secretary Chu Announces *Nearly $38 million in state awards for Energy Emergency Preparedness.* Retrieved from www.energy.gov/news/7791.htm

U.S. Department of Energy (2009). President Obama Announces $3.4 billion Investment to Spur Transition to Smart Energy Grid. Retrieved from www.energy.gov/news/8216.htm.

U.S. Energy Information Association. (2009). North Carolina Quick Facts. Retrieved from tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=NC