Cornerstones

Building a Secure Foundation for North Carolina's Energy Future

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Southern Alliance for Clean Energy

Sources and methods for the inventory used in this report

The baseline energy and pollution inventory and some forecast factors were obtained from the US Energy Information Administration, utility reports to the North Carolina Utilities Commission, the US Environmental Protection Agency, the Intergovernmental Panel on Climate Change (IPCC), the North Carolina State Data Center, and similar sources. For policies where no reference authority was available or where a range of estimates are available, we followed prevailing practices in similar studies – typically adhering to the approach used by the Center for Climate Strategies in support of the North Carolina Climate Action Plan Advisory Group.[1]

Forecasting global warming pollution two decades into the future, as well as the policy impacts of the strategies presented in this report is a complex task.

Our inventory and forecast uses the most authoritative data available, applying the simplest possible assumptions to the data. For example, we projected electricity demand using data from the utilities for 2007 through 2016 and then extrapolated the data assuming future growth rates would remain unchanged. For our pollution mitigation analysis, additional electricity demand is included based on the projected use of plug-in hybrid electric vehicles.

Our baseline analysis includes actions taken by state or federal government through early 2007. For example, we assume nuclear power generation to meet North Carolina demand will remain unchanged because no formal action has been taken to approve or decommission plants serving North Carolina. The baseline also excludes the benefits of laws enacted in 2007, although those are discussed in the text.

Estimates of the potential to reduce pollution are based on existing and projected cost-effective technology opportunities. The most important sources we consulted for these estimates are cited as endnotes in this report. Projected technology opportunities are based on official government, expert panel or academic research findings, excluding "breakthrough" technology scenarios. For example, we included carbon capture and storage technology because it relies on a number of proven technologies, even though they have yet to be demonstrated for the specific purpose that is envisioned. In other words, we assumed continued *engineering* progress but did not assume *scientific* breakthroughs. Generally, we adopted the more optimistic cost-effective projections assuming the greatest level of effort by government and individuals to accomplish the pollution reduction.

In situations where behavioral response is a factor in the potential for implementation, we tended to assume the weakest level of success. Our premise here is that most technology solutions to environmental problems tend to achieve or exceed expectations, but generally behavioral solutions tend to fall short of expectations. We applied this broad generalization uniformly even though there is ample evidence that some behaviors are likely to respond effectively to policy initiatives.

Units for global warming pollution are expressed in millions of metric tons of carbon dioxide equivalent pollution, abbreviated simply to "million tons" in the text. "Carbon dioxide equivalent" refers to a common method of converting emissions of methane, nitrous oxide and other greenhouse gases into an equivalent amount of carbon dioxide in terms of potential global warming impacts. We adopted the most common metric for calculating equivalency used by the US EPA.

Acknowledgements

This document was prepared with assistance from many individuals, and we also particularly appreciate data and methods shared by the Center for Climate Strategies, Clean Air Task Force, Environmental Defense, and North Carolina Sustainable Energy Association.

Written by:

John D. Wilson and Ulla-Britt Reeves
May 2008

[1] North Carolina Climate Action Plan Advisory Group. *Recommended Mitigation Options for Controlling Greenhouse Gas Emissions.* Forthcoming from North Carolina Department of Environment and Natural Resources (2008). Note: The NC CAPAG emissions inventory and forecast is not identical to ours, as we used more recent data and incorporated more detail in certain respects to support policy analysis.

The Southern Alliance for Clean Energy offers this report as our blueprint to calm the impending crisis of global warming and provide solutions for visionary leaders and concerned citizens. North Carolina has a history of being a national leader on important air quality and environmental issues. The challenges and opportunities of global warming will test North Carolina's collective commitment to leading our region with real solutions to this most difficult problem.

We call our blueprint *Cornerstones* to highlight the four pillars of a sustainable path forward. These pillars serve as cornerstones to build the foundation for a clean energy future. If North Carolina fully develops this blueprint, the state's global warming pollution can be reduced by 60% over the next 20 years, a target that is consistent with what scientists say is needed to avoid irreversible damage. For North Carolina to do its part in solving the climate crisis, state leadership is required in four key areas, energy efficiency, clean energy, pollution capture and long-range planning.

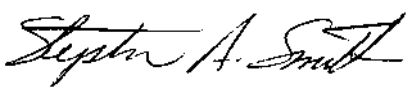
Energy efficiency has the greatest potential to reduce our global warming pollution. Cutting energy use, recycling wasted energy and increasing fuel economy accounts for over half of the pollution reductions we identified. These technologies are available today and are usually cost-effective if we embrace our ingenuity and overcome the traditional economic bias toward consumptive energy use.

Cornerstones also lays out a blueprint for a future built on clean energy using a growing amount of low-pollution generation and capturing pollution from the rest. Utilities have often described these strategies as too costly, or relying on resources that are outside the state's borders. While these strategies are indeed challenging, we can hardly afford not to invest in the abundant, available resources and job-creating technologies.

Our future also depends on visionary planning for our communities. State and local governments can prepare for our future with long-range planning that makes residents' lives safer, healthier and abundant with new employment opportunities. Federal policies are, of course, vital to unifying the nation around common climate solutions. Nevertheless, state and local governments will be hands-on managers of implementation of these solutions. Local communities have the greatest challenge, because it takes a decade or more to build a new foundation for measurable change.

Each year global warming pollution from North Carolina results in billions of dollars of global damages. These damages won't leave North Carolina untouched — sea level rise will almost certainly reach two feet higher between 2058 and 2089 and ever more severe weather will continue to disrupt lives. Today's decisions will determine the pace and severity of global warming damage.

North Carolina has a responsibility to listen to the warnings and advice of the scientific community. We must not continue to make forty-year commitments to high risk energy choices. With careful attention to the best science, and hope for unified global and national efforts, *Cornerstones* offers North Carolina's leaders a comprehensive blueprint for seizing the economic opportunities that a clean energy future creates.



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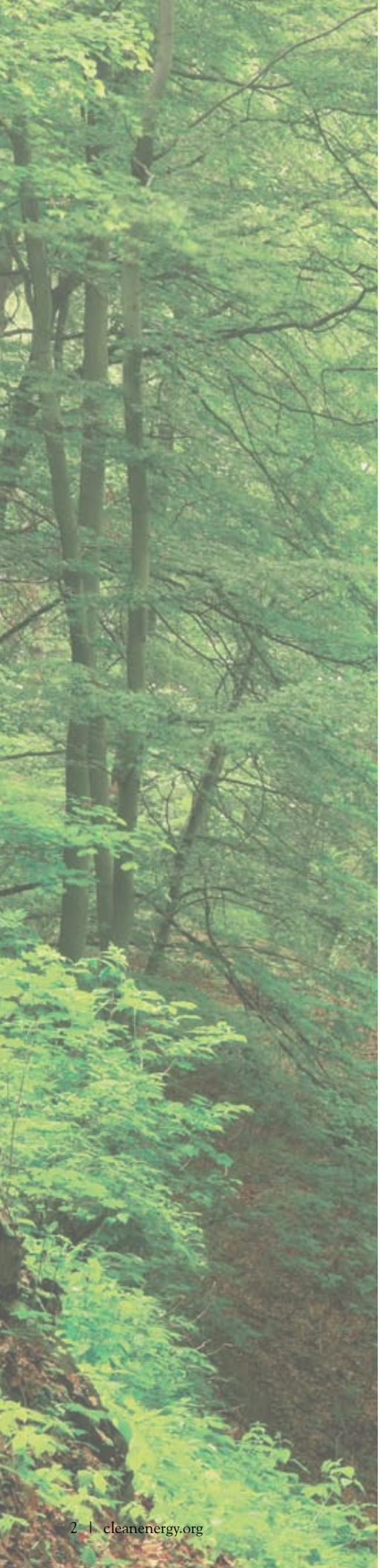


Introduction

Securing a clean energy future means North Carolinians coming together to invest in building a new economy that rests on FOUR CORNERSTONES: **energy efficiency, clean energy, pollution capture** and **long-term planning**. North Carolina has a legacy of leadership in taking action to protect public health and our quality of life. To meet our responsibility and avoid contributing to dangerous levels of global warming, North Carolina must call upon its legacy of leadership to build a new foundation with a clean energy economy.

Reducing the state's global warming pollution by 60% over the next two decades may be challenging, but the sooner we begin reductions, the better off we will be. North Carolina's global warming pollution could soon reach 200 million tons per year, with each year's pollution resulting in an estimated $15 billion in global damages.[1]

By 2030 our state's annual contribution to global warming could increase by more than 50% to 280 million tons, driven by new residents of North Carolina who are expected to consume even more energy. Instead of our pollution rate increasing from 20 to over 23 tons per resident, the strategy laid out in this report points the way toward reducing the average resident's global warming pollution to less than six tons per resident.

If North Carolina delays action on energy efficiency and clean energy, the likely alternative is building new, expensive, polluting power plants – investments that ratepayers will be obligated to finance even if energy efficiency makes those power plants unnecessary later. This example illustrates why the British Government concludes that "the costs of action will, under any realistic expectation of…innovation, almost certainly rise for every additional year of inaction."[2]

North Carolina's Global Warming Pollution Can Be Reduced 60% in Two Decades

Pollution Reduction Strategies

Strategies	Reductions by 2030 in millions of tons
Energy efficiency	**126.6**
Homes, buildings and factories	52.9
Energy recycling	33.1
Fuel economy	40.6
Clean energy	**37.2**
Wind, bioenergy and hydroelectric	25.6
Methane to energy (hog and landfill waste)	11.6
Pollution capture	**31.1**
Carbon enrichment of landscape	5.5
Underground storage of global warming pollution	25.5
Long-range planning	**19.0**
Total for 60% reduction	**213.9**

[1] Dietz, S et al."Reflections on the Stern Review: A Robust Case for Strong Action to Reduce the Risks of Climate Change." *World Economics* vol 8 (2007).
[2] Dietz (2007).

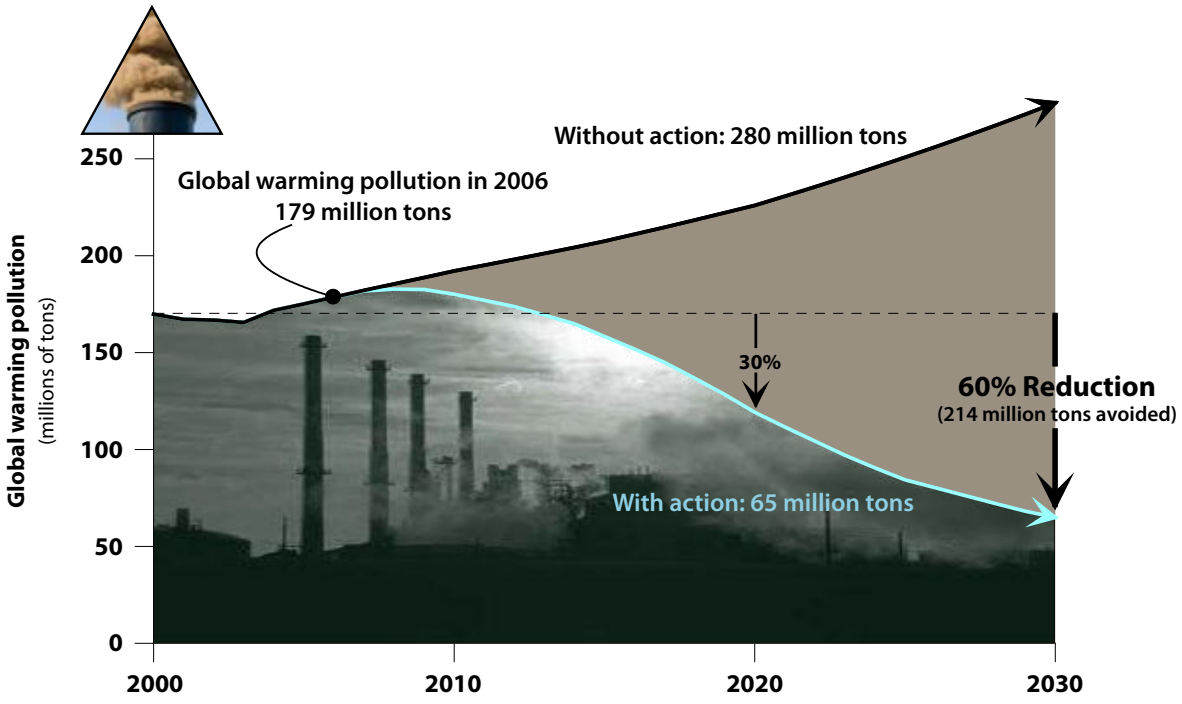
Four Cornerstones
for North Carolina's Energy Future

Energy Efficiency
Every North Carolina business, community group and individual can lead, beginning with their support of energy efficiency programs. Energy efficiency means more than just changing light bulbs and buying hybrid cars. An ambitious energy efficiency strategy means replacing energy-consuming equipment, renovating buildings, and engineering new transportation and power systems.

Clean Energy
North Carolina's ingenuity will be called upon to develop clean energy solutions such as biomass and wind energy to provide homegrown energy independence. After taking into consideration the potential of energy efficiency, North Carolina's wind and other homegrown clean energy resources, such as methane from hog waste, can produce over 20% of electricity generation by 2030.

Pollution Capture
North Carolina's integrity will be demonstrated by using pollution capture to meet its responsibility to prevent as much global warming as possible. North Carolina met its responsibility to public health with the Clean Smokestacks Act, which called upon utilities to use pollution scrubbers to protect people downwind from power plants. Today's larger responsibility calls for North Carolina to capture carbon dioxide for storage in the landscape and deep underground.

Long-term Planning
North Carolina must prepare for the future by anticipating and adapting to the impacts of global warming and providing safer and healthier communities through improved mobility. Our communities can fulfill a commitment to transportation and land use designs that make people's lives safer, healthier and rich with possibilities. Change is already underway, and thoughtful planning will help minimize further global warming pollution and enhance the productivity of our resources.



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Cornerstone: Energy Efficiency

Energy efficiency is the cheapest, most abundant, cleanest source of energy we can access, and every North Carolinian can begin to implement energy efficiency practices today. Our review of the leading research suggests that by 2030, energy efficiency and energy recycling could reduce North Carolina's annual global warming pollution by 121 million tons, or about half of forecasted emissions.

With strong state leadership:

- We will offset the need to build new power plants to generate over 40% of projected electricity demand by making homes, businesses and factories more efficient, and by expanding "energy recycling" at large commercial and industrial facilities.
- We will use similar technologies to reduce non-electrical fuel use in homes and businesses by 23%.
- We will adopt fuel economy measures to reduce transportation fuel use by 43%.

Individuals can help by changing light bulbs and buying hybrid cars, but North Carolina needs an official comprehensive energy efficiency strategy. Such a strategy should require extensive replacement of energy-consuming equipment, extensive renovation of buildings, and new engineering for vehicles and power systems.

The old economic paradigm depends on cheap energy – a commodity that we know will not endure. Energy efficiency is more than just lowering electric bills: It is a strategy to bring our dependence on outside energy resources to an end. A more independent, clean energy future will be built on the resources and people of North Carolina.

Exercising better stewardship of our energy resources is also a responsible way to begin reducing our impact on the global climate. The 2007 North Carolina General Assembly has taken a first step toward this goal by adopting a Renewable Energy and Efficiency Portfolio Standard (REPS) as part of Senate Bill 3. This legislation is expected to result in at least 5% of future electric generation avoided through energy efficiency by 2021. The 2007 Federal Energy Bill will increase vehicle fuel economy standards substantially by 2020.

The state and federal legislation fall short. First, we do not yet have a target that moves us toward reaching the potential of a 40% reduction in electricity demand by 2030. Second, these policies only affect electricity and vehicle fuels. These policies merely touch on the energy efficiency potential of North Carolina.

More efficient homes, businesses and factories

Energy efficiency can reduce North Carolina's energy demand by nearly 25% over the next two decades. Studies estimating this potential have tended to be fairly conservative, considering energy efficiency efforts that cost less than five cents per kWh (kilowatt hour), compared to an average eight cents per kWh paid by residential consumers. According to our detailed review of three recent studies,[1] electricity customers can afford:

- Residential energy efficiency measures that cut electricity use by 30%.
- Commercial energy efficiency measures that cut electricity use by 25%.
- Industrial energy efficiency measures that cut electricity use by 19%.

Achieving these ambitious goals depends on an aggressive, sustained effort over the next two decades. North Carolina has taken a strong first step by adopting legislation that effectively mandates a 5% reduction in electricity demand by 2021.

Photo courtesy of Greg Manter

While education to promote individual action is helpful, only 15% of potential electricity savings in homes can be achieved with relatively convenient actions such as replacement of inefficient appliances and lighting. For most customers, going further by upgrading home heating or insulation will require professional assistance to identify cost-effective steps and financing to make the project economical. Most states tap into these more difficult opportunities with utility or government administered energy efficiency programs.

Utilities are well positioned to help homeowners with major energy efficiency projects, and North Carolina's two

largest electric utilities are beginning to expand their energy efficiency activities. However, as monopolies, utilities in North Carolina are subject to rate regulation, and their energy efficiency programs must be fairly funded as well as effective.

The state's existing utility regulations are based on an old power generation-oriented vision and must be updated to remove what amounts to an energy efficiency penalty against utilities. As sales increase, revenues can increase to any level. North Carolina should switch to an alternate form of regulation that allows utilities to generate revenue from energy efficiency programs and limits electric utility revenues to a fair compensation level.

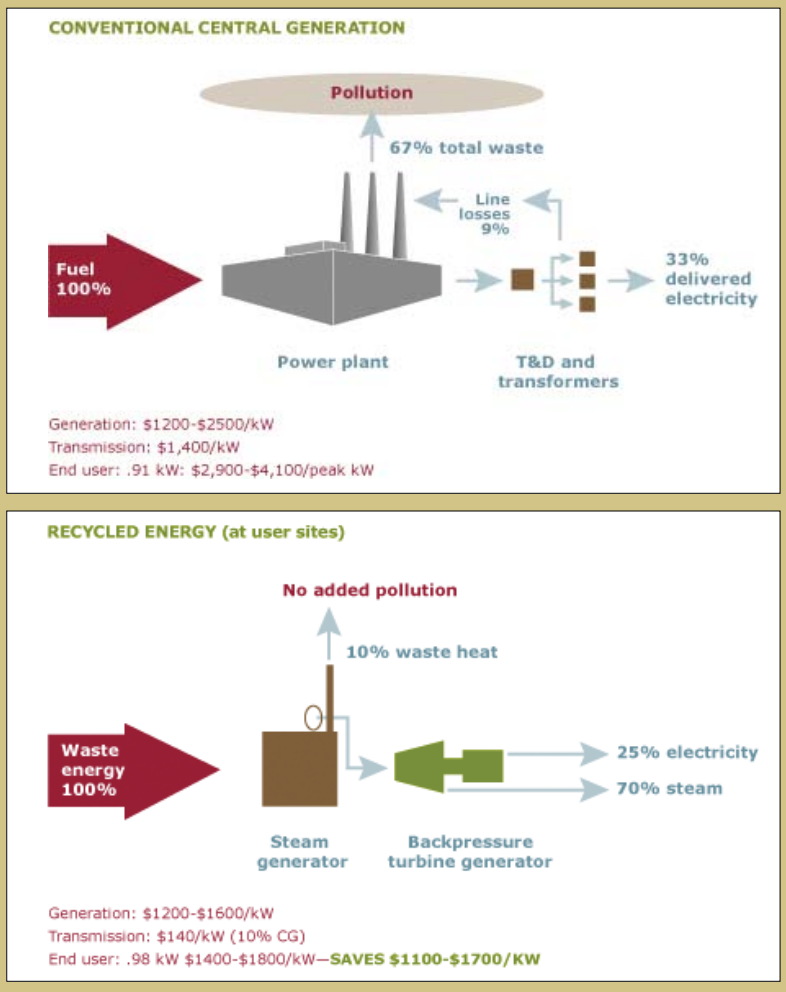
This alternate form of regulation includes "decoupling" of sales growth from the potential utility profits, including the costs of energy efficiency programs in electricity rates, and adding a performance incentive to reward results. A form of decoupling is already in place for North Carolina's natural gas utilities, so these utilities are already well positioned to adopt energy efficiency programs. Ideally, North Carolina would adopt a fuel-neutral regulatory approach that would encourage all energy utilities to support cost-effective fuel switching between electricity and fuels such as natural gas to promote energy efficiency.

Another regulatory strategy to support energy efficiency is more aggressive energy building codes to encourage and require new home construction to include greater energy efficiency features. Many builders do not consider energy efficiency measures unless required by code, even those that would result in substantial savings for the homeowner. Where efficient design is incorporated into new housing, it is typically the builder, not the homeowner, who makes the decision to invest in energy efficiency. In 2005, only 1.3% of new homes in North Carolina were Energy Star certified. One study suggests that by 2020, about 77% of new homes constructed in North Carolina could cost-effectively exceed current Energy Star efficiency standards.[2] By pushing beyond codes, residential electricity customers could collectively reap $9.7 billion with a statewide energy efficiency investment of $263 million.[3]

Even more difficult obstacles can explain the underinvestment in energy efficiency by commercial and industrial energy users. Commercial buildings are often owned by an investor (who decides how much to invest in efficiency) but the energy bills are often paid by the occupant. Similarly, industrial facilities often separate operating expense and capital investment budgets in different corporate divisions. To address these issues, utilities and regulators will need a variety of custom approaches to deal with each different kind of customer.

Energy recycling

Industrial and commercial energy users can "recycle" their waste heat for many purposes, reducing global warming pollution by about 33 million tons. Studies suggest that North Carolina has about 5,500 MW (megawatts) of untapped potential for generating electricity using the combined heat and power (CHP)



Energy Recycling Technology

As illustrated, conventional central generation of electricity requires fuel. When waste energy is used, electricity and steam can be produced. This readily available cogeneration technology is more efficient and reduces pollution, effectively recycling waste energy.

Illustrations courtesy of Recycled Energy Development, LLC

approach.[4] Widespread energy recycling could reduce global warming pollution by meeting 25% of North Carolina's electric generation in 2030 and to improve environmental performance.[5]

Energy recycling is constrained by both utility commission rules and the business practices of electric utilities. The North Carolina Utilities Commission should establish rules governing energy recycling that provide a straightforward and fair basis for interconnection of CHP systems with the grid. Decoupling, as discussed above, could be a useful regulatory approach to help energy recycling become as common in North Carolina as it is in leading states. As energy recycling becomes easier to implement, the state should accelerate efforts through outreach targeted to those with the most promising opportunities.[6]

Fuel economy

North Carolina's drivers and equipment operators can reduce fuel use by 43% without compromising safety if more fuel efficient vehicles and equipment are brought into the market. The potential reductions are greatest for passenger vehicles, where fuel economy for cars and trucks could be increased from 25 to 39 miles per gallon by 2030.[7] This includes gradual introduction of plug-in hybrid electric vehicles. For freight vehicles, the technology challenges are somewhat greater, and fleet turnover occurs more slowly, suggesting that potential improvement may be about 20%.[8] In total, fuel economy improvements could reduce North Carolina's global warming pollution by 35 million tons in 2030.

As a state, North Carolina's best strategy is to advocate for and support national efforts to improve fuel economy; It should

- Adopt California vehicle emissions standards, which are a lower-pollution alternative to federal standards
- Revise state and local government procurement policies to favor the most fuel-efficient vehicles by considering life-cycle fuel costs and pollution impacts
- Using tax incentives or grants, expand clean vehicle research and development activities in North Carolina, particularly for plug-in hybrid electric vehicles
- Revise vehicle tax rates to include a fuel economy incentive
- Advocate for progressively cleaner federal fuel economy standards beyond those included in the 2007 Energy Bill

North Carolina should also take immediate steps to reduce diesel emissions. First, the state should facilitate and encourage electrification of trucking rest areas to reduce engine idling, thereby saving money, reducing pollution and increasing driver safety. Second, because the so-called "legacy fleet" of diesel vehicles is untouched by stringent emission standards for new diesel engines, the state should take steps to retrofit or replace high-pollution engines that will otherwise remain in operation for decades.

Coming Soon:
Plug-in Hybrid Electric Vehicles

Like other hybrid vehicles, these vehicles have a gas tank and engine but operate more efficiently due to their electric motor components. The "plug-in" feature means that their batteries can be charged from the grid. Using an all-electric drive diverts greenhouse gas emissions from tailpipe to power plant, where economies of scale mean that global warming pollution can be reduced somewhat. As the electric grid transitions to cleaner generation resources, the potential reduction grows.

Photo courtesy of Argonne National Laboratory

Keeping energy dollars in North Carolina: Part One

Using today's energy costs for comparison, by 2030 energy efficiency could

- Reduce total consumer electricity expenditures by about $500 million, due to reduced electricity use
- Create a $1.8 billion market for energy efficiency services delivered by North Carolinians by redirecting utility electric bill revenues away from coal-fired power plants and other high-pollution electricity sources
- Reduce transportation fuel demand from projected 2030 levels by over 4 billion gallons; save over $11 billion even with the extra expense of electricity used in plug-in hybrid electric vehicles

From a statewide perspective, energy efficiency "costs" represent benefits to the state. In contrast to the imported fuel that energy efficiency replaces, energy efficiency services and goods represent North Carolina jobs.

(See Part Two: page 14)

[1] Forefront Economics LLC et al. *Duke Energy Carolinas DSM Action Plan: North Carolina Report* (2007).
La Capra Associates, Inc. et al. *Analysis of a Renewable Portfolio Standard for North Carolina* (2006).
Tiller, J. *Energy Efficiency Opportunities for North Carolina Buildings and Industrial Facilities*. Appalachian State University (2007).
[2] Tiller (2007). Moderate impact projection, percent of new homes rated higher than "Energy Star."
[3] GDS Associates. *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 (2006).
[4] Hedman, B. *CHP Market Review.* Energy and Environmental Analysis, Inc (2005).
[5] Oak Ridge National Laboratory. *Quantitative Assessment of Distributed Energy Resource Benefits*. ORNL/TM-2003/20 (2003).
[6] In the future, these same major energy users are also the most likely market for new hydrogen-based energy technologies to replace carbon-based generation. Hydrogen can be blended with natural gas or used in fuel cells to produce electricity. However, hydrogen needs and emission-free source, such as solar powered electrolysis, if it is to become a technique for reducing global warming pollution. For this reason, hydrogen is not included in our analysis.
[7] Denholm, P and W Short. *An Evaluation of Utility System Impacts and Benefits of Optimally Dispatched Plug-In Hybrid Electric Vehicles*. NREL/TP-620-40293 (2006).
Gordon, D et al. *Sipping Fuel and Saving Lives: Increasing Fuel Economy without Sacrificing Safety.* International Council on Clean Transportation (2007).
Litman, T. *Efficient Vehicles versus Efficient Transportation: Comparing Transportation Energy Conservation Strategies.* Victoria Transport Policy Institute (2005).
[8] Ang-Olson, J and W Schroeer. *Energy Efficiency Strategies for Freight Trucking: Potential Impact on Fuel Use and Greenhouse Gas Emissions.* 81st Annual Meeting of the Transportation Research Board (2003).
Dierkers, G et al. *CCAP Transportation Emissions Guidebook, Part Two: Vehicle Technology and Fuels.* Center for Clean Air Policy (2007).
Elliott, R N et al. *Reducing Oil Use through Energy Efficiency: Opportunities beyond Cars and Light Trucks.* American Council for an Energy-Efficient Economy Report E061 (2006).
Frey, H C and P Kuo. *Assessment of Potential Reduction in Greenhouse Gas (GHG) Emissions in Freight Transportation.* US Environmental Protection Agency International Emission Inventory Conference (2007a).
Frey, H C and P Kuo. *Potential Best Practices for Reducing Greenhouse Gas (GHG) Emissions in Freight Transportation.* 100th Annual Meeting of the Air & Waste Management Association Paper No. 2007-AWMA-443 (2007b).

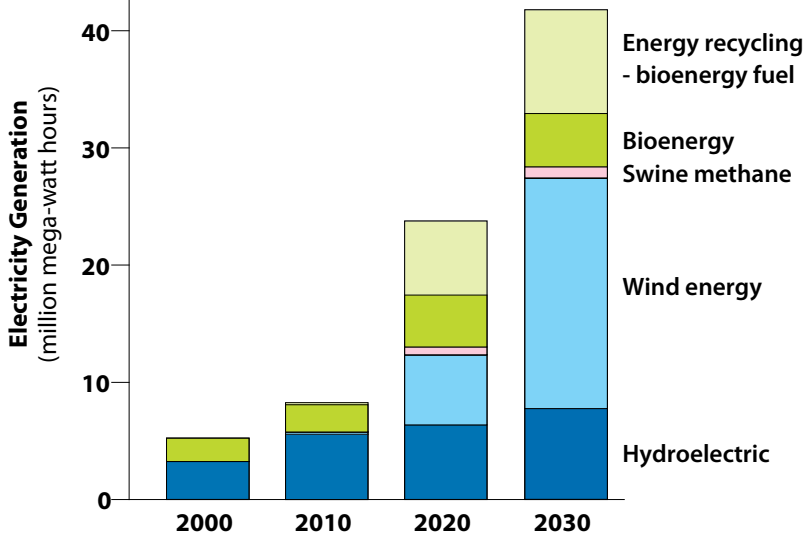
Cornerstone: Clean Energy

North Carolina has the resources and the ingenuity to develop clean energy solutions to meet power demand and give our state energy independence. Combining energy efficiency, wind energy, biofuels and other homegrown energy resources, North Carolina will be able to meet over 25% of its projected energy needs by 2030 with clean energy.[1]

The most accessible and readily developable clean energy resources are agricultural and forestry wastes to manufacture fuels and generate electricity. Of particular benefit to reducing global warming pollution from North Carolina is the capture and use of methane from hog waste and landfills.

After the expansion of bioenergy, the next likely step will be the development of moderately scaled wind and hydroelectric projects. Within a decade, we would need to begin to appreciate the vast potential of North Carolina's offshore wind resources. Solar energy could also contribute to the state's renewable energy capacity, particularly as a way to offset household and commercial energy now used to heat water.

As mentioned, the 2007 North Carolina General Assembly has taken a critical first step toward building a clean energy future. The Renewable Energy and Efficiency Portfolio Standard (REPS), a part of Senate Bill 3, requires at least 7.5% of future electric generation to be provided with clean energy sources by 2021.



While most elements of the REPS are welcome steps forward, it needs improvements in several respects. Its incentives for methane capture lack environmental performance standards for hog lagoons, and this is of great concern for North Carolina's air and water quality. North Carolina also needs to reach higher than the REPS toward 25% renewable energy generation – ideally by 2025, but certainly by 2030.

Meeting these challenging goals with homegrown electricity will give us independence as well as practical solutions to seemingly unrelated energy dilemmas. For example, the use of plug-in hybrid vehicles will help reduce the use of gasoline and diesel fuels, but it requires increased electricity supplies. As North Carolina drivers begin to plug in, many of these electricity customers will want to know that clean energy resources, like wind, will be powering their cars.

Developing Wind Resources in North Carolina

North Carolina's adoption of a Renewable and Efficiency Portfolio Standard has created a more attractive market for the wind industry. Yet clear rules must be set for the placement of wind turbines along ridge tops and on the outer continental shelf.[1] Policies should balance wind energy development with public interest to minimize environmental impacts and protect North Carolina's treasured places.

Ridge tops in western North Carolina represent a smaller portion of North Carolina's total wind potential, yet they are the most cost-effective opportunity for power generation.[2] Wind projects will stimulate the local economy, may attract factories to the state to support the production of wind turbines and related component parts, and help lower the cost barriers to the offshore wind development.

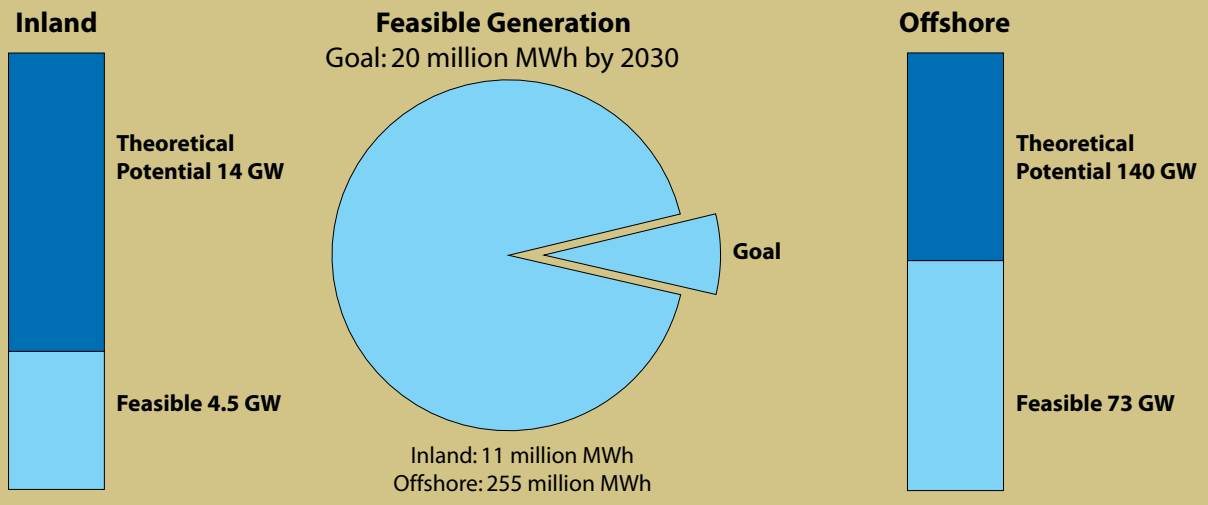
The potential energy from offshore wind farms in North Carolina is much higher than the onshore potential; however, currently the cost-effectiveness of offshore wind is not as great as onshore wind. As regulations for building offshore wind farms become clearer, so will the price of building offshore wind farms. A study by Georgia Tech and Southern Company suggests offshore wind may be developed at a cost as low as eight cents per kWh; however these estimates and others will likely increase due to rising construction costs for all new power plants.[3]


Inland Wind


Offshore Wind

Wind farm development in North Carolina, especially offshore, is also constrained by transmission capacity. While small projects more easily connect to the grid, larger projects will require new or upgraded transmission lines. Experience with wind development in West Texas demonstrates a need for planning transmission to accommodate future wind farm growth. If North Carolina begins public discussion and planning soon, the capacity can be built on an aggressive, but flexible, schedule to ensure that transmission capacity does not significantly delay wind energy development.

Our analysis considers only "feasible" wind resources, which excludes many sites with theoretical potential. Feasible inland wind sites exclude those without road access and proximity to current utility lines; those in national parks, national forests, and state parks; and those within a five-mile view shed on either side of the Appalachian Trail and a one-mile view shed on either side of the Blue Ridge Parkway. The estimate of North Carolina's feasible offshore wind resources is based on findings in Virginia that exclude all sites within seven miles of shore and excluded two-thirds of sites within 23 miles of shore based on geologic formations, shipping lanes, and other factors.



[1] Capua, A N. *Whether wind turbines ("windmills") are exempt from the North Carolina Mountain Ridge Protection Act (the "Ridge Law")* Watauga County Planning Board (2006).
[2] La Capra Associates, Inc. (2006).
[3] Southern Company and Georgia Tech (2007).

Wind energy

North Carolina's largest potential renewable energy source is wind, and we estimate that 20 million MWh (megawatt hours) of wind generation could be supplied by 2030. The most accessible wind resources are inland, most notably an estimated 11 million MWh of developable ridgeline sites in western North Carolina.[2] Studies estimate that typical supply costs for onshore wind are five cents per kWh.[3] However, offshore wind represents 96% of the state's feasible wind resources.[4] Offshore wind potential will take longer to develop due to higher costs and the current unclear regulatory process for permitting offshore wind farms.[5]

Bioenergy

Bioenergy is the key short-term opportunity for expansion of clean energy in North Carolina. Biofuels such as biodiesel and ethanol are already increasing in availability and use. Agricultural and forest resource wastes are often used for power generation, either in industrial applications or co-fired with coal in a conventional power plant. Expanded bioenergy is practical in North Carolina because of modest resource costs. There are relatively few technical challenges required to expand bioenergy use in our conventional energy systems.

Of particular benefit to reducing global warming pollution is the capture and use of methane from landfills and hog waste, because methane is 21 times more potent as a contributor to global warming than carbon dioxide. As the second-ranking state in pig and hog farming, North Carolina has a disproportionately high rate of methane emissions.[6] With proper environmental controls, the capture and beneficial use of methane also helps address the odors and wastewater issues associated with landfills and hog farms. Because most pigs and hogs are concentrated on just 1,270 farms, and because North Carolina's climate makes operation of animal waste-to-energy systems particularly efficient, North Carolina has more potential for generating energy from pig and hog waste than many other states.[7]

Homegrown biofuels could reduce transportation-related global warming pollution by about 5 million tons in 2030 (after taking into consideration pollution caused by their production).[8] As illustrated on page 12, biofuels would represent a fast-growing fraction of the transportation fuels market, especially after taking into account other pollution reduction measures included in this report.

Biopower

Electricity generation from agricultural and forest wastes is currently 2.1 million MWh,[1] and our plan points to a seven-fold increase by 2030. This growth would be supported by greater use of existing resources as well as converting marginally used or disused agricultural lands to production of new energy crops. Although these resources could initially be used to partially refuel existing coal plants, the most advantageous strategy is to direct them into smaller combined heat and power applications where the maximum energy value could be extracted through energy recycling, a component of the energy efficiency cornerstone.

[1] Energy Information Administration. *1990 - 2005 Net Generation by State by Type of Producer by Energy Source (EIA-906)* (2006).

North Carolina Transportation Fuels

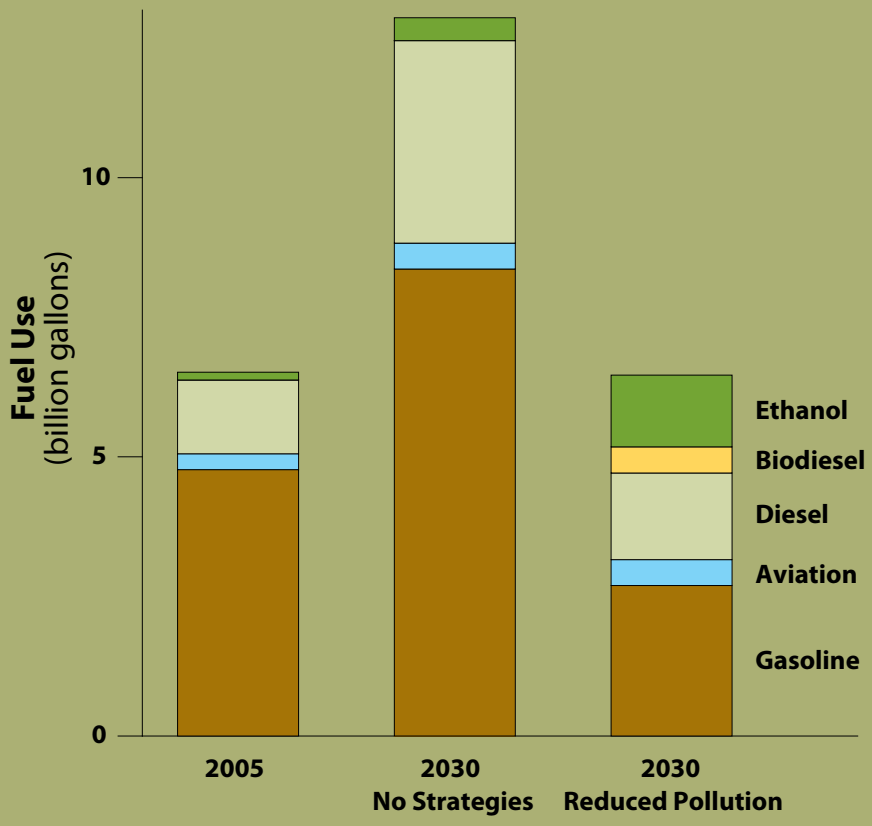
In 2007 the North Carolina General Assembly funded the establishment of the Biofuels Center of North Carolina, the first such state organization and research campus in the nation. Its goal is for 18% of liquid fuels sold in North Carolina to be produced from biofuels grown and refined within the state. If fuel economy and other targets in this report are met, North Carolina could potentially reach the 18% target by 2017.

The Biofuels Center intends to lead biofuels production away from important food and feed crops, such as corn, toward so-called cellulosic feedstocks such as wood waste, animal wastes and high-yield plants and grasses.[9] Ethanol produced from corn results in few reductions of global warming pollution because of its energy-intensive refining process.[10] With its rich forestry and agricultural resources, North Carolina is well suited to develop and grow lower-pollution feedstocks that will not compete with food production crops.

Commercial biodiesel is used across much of North Carolina, and at least two new biodiesel plants have been proposed.[11] Biodiesel can be produced for about $2 per gallon, making it competitive with conventional diesel fuel.[12] A wide variety of agricultural and commercial waste oils can be used to manufacture biodiesel.

Hydroelectric energy

Hydroelectric power is today's major clean energy source in North Carolina, although there are significant environmental impacts associated with reservoirs. This report is based on the assumption that existing resources sustain recent levels of power generation. By 2030, North Carolina could increase hydroelectric generation from about 5.5 million MWh using low-impact resources, as described below, to about 7.8 million MWh.



North Carolina Transportation Fuels

North Carolina can accommodate growth while relying on approximately the same amount of transportation fuel, resulting in far less global warming pollution. The transportation fuel mix in 2030 illustrated at left integrates the impact of fuel economy, biofuels and long-range planning. Note that energy content per gallon varies somewhat by fuel type, and for fuels other than gasoline — ethanol, diesel and biodiesel — energy content is expressed in gasoline-equivalent gallons.

A longer-term fuel option is the use of hydrogen-based energy systems to power vehicles. There are several challenges to this vision. First, extensive technology development (such as fuel cells) is required before a wide range of vehicles can be powered by hydrogen. Second, extensive investment in a hydrogen infrastructure is necessary. Third, hydrogen should be produced from carbon-neutral sources, rather than natural gas, to catalyze a reduction in global warming emissions.

Low-impact "low head" hydro power

North Carolina can access additional hydroelectric generation from upgrades of existing generation and from new, less intrusive "low head" hydroelectric power stations that do not require development of large-scale dam impoundments. These facilities are smaller than utilities prefer to own and operate, therefore, "low head" systems are generally operated by third-party contractors. Small-scale hydro systems are environmentally superior as they have a much lower impact on water quality and the ecology of the surrounding environment.

Photo courtesy of Energy Systems and Design

Solar energy

Solar energy can be a significant part of our clean energy supply as small photovoltaic and thermal systems are installed at homes and small businesses. Even though electric utilities are not currently expected to select solar energy for large-scale generation in North Carolina due to cost considerations, small and medium-sized systems are feasible for onsite generation and help to improve the performance of the electric grid. Expanding opportunities for small- and large-scale projects will make a significant difference and prepare the state to take advantage of future technology breakthroughs.

In addition to maintaining existing economic incentives, North Carolina should simplify and expand opportunities for net metering, which will give residential and small commercial utility customers the opportunity to generate electricity to offset their annual electric needs.[13] Typically, solar photovoltaic systems are installed to supply a large percentage of a household's annual demand and may produce more or less power than needed at any given moment. When excess power is produced, utilities should make it as easy as possible for that electricity to be put back onto the grid and thereby reduce pollution from power plants.

Risky, high-cost "solutions"

North Carolina must not rely on "solutions" that require disproportionate subsidies beyond the initial phase of technology development. Research assistance and subsidies during initial stages of technology development can be wise investments, but some industries, particularly the nuclear power industry, are heavily dependent on government subsidy.

Over the past 50 years, the federal government has provided about $157 billion in subsidies to the nuclear power industry. In contrast, only $10 billion was invested in wind and solar energy technologies.[1] Furthermore, at an international level nuclear power has consistently received half or more of research and development support from major industrial governments.[2] In addition to monetary subsidies, nuclear power plant owners are insured against large risks by the federal government.

In spite of the subsidies, the cost of electricity generated with nuclear power has increased over the past three decades. In contrast, with comparatively less government investment, the cost of clean, renewable energy has fallen rapidly. Renewable energy is simply a cleaner, smarter, cheaper investment with high returns.

[1] Goldberg, M. *Federal Energy Subsidies: Not All Technologies are Created Equal.* Renewable Energy Policy Project report no. 11 (2000).
US Government Accountability Office. *Federal Electricity Subsidies: Information on Research Funding, Tax Expenditures, and Other Activities That Support Electricity Production.* GAO-08-102 (2007).
[2] Stern, N. *Stern Review: The Economics of Climate Change,* United Kingdom Ministry of the Treasury (2007).

Keeping energy dollars in North Carolina: Part Two

Addressing global warming pollution in North Carolina will have three major impacts on state employment trends. On balance, it appears that the state would benefit primarily by shifting our energy strategy toward local, long-term investments and away from purchasing imported fuels that require out-of-state purchases.

The first major impact will be on statewide job growth. Investment in energy efficiency and renewable energy opportunities could create more than 39,000 jobs by 2020 and a renewable portfolio policy could produce $72 million in new capital investments by 2020.[14]

Second, the increased cost of energy would have a modest impact on economic competitiveness. A study of "vulnerable industries" in England suggested that adding $30 per ton of global warming pollution to the cost of manufacturing would primarily affect energy industries (15% or greater price increases) and the cement industry (a 10% price increase). Price increases in other industries, such as electronics, organic chemicals, pulp and paper, fishing and fertilizers, are estimated to be less than 5%.[15] North Carolina's economy is dominated by services such as finance, health care and education; thus, small price increases in "vulnerable industries" should not strongly affect the overall economy.[16]

(See Part One: page 8)

Photos courtesy of Wind Capital Group

[1] Clean energy resources could meet approximately 26% of total generation needed in 2030, or could meet approximately 20% of total demand. Total demand is met, in part, with energy efficiency, which does not require any generation resources, of course.
[2] Raichle, B. *Method for Estimating Potential Wind Generation in the Appalachians.* Appalachian State University (2007).
[3] Virginia Center for Coal and Energy Research. *A Study of Increased Use of Renewable Energy Resources in Virginia* (2005).
[4] Heimiller, D and S Haymes. *Offshore Wind Resource Summary by State, Wind Power Class, Water Depth and Distance from Shore.* National Renewable Energy Laboratory (2005).
[5] Southern Company and Georgia Tech Strategic Energy Institute. *Southern Winds: A Study of Wind Power Generation Potential off the Georgia Coast* (2007).
[6] North Carolina Department of Agriculture and Consumer Services, Agricultural Statistics Division. *Livestock Statistics*, 2005 and 2006 data (2007).
[7] US Environmental Protection Agency. *Funding On-Farm Biogas Recovery Systems, A Guide to Federal and State Resources.* AgStar Program Report EPA-430-F-04-002 (2004).
US Environmental Protection Agency. *Market Opportunities for Biogas Recovery Systems.* AgStar Program Report EPA-430-8-06-004 (2006).
[8] US Environmental Protection Agency. *Regulatory Impact Analysis: Renewable Fuel Standard Program.* EPA-420-R-07-004 (2007).
Farrell, A E et al. "Ethanol Can Contribute to Energy and Environmental Goals." *Science* vol 311 (2007).
[9] Biofuels Industry Strategic Plan Work Group. *North Carolina's Strategic Plan for Biofuels Leadership* (2007).
[10] US Environmental Protection Agency (2007).
[11] North Carolina Biomass Council. *The North Carolina Biomass Roadmap: Recommendations for Fossil Fuel Displacement through Biomass Utilization* (2007).
[12] Hill, J et al. "Environmental, Economic and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels." *Proceedings of the National Academy of Science* vol 103 (2006).
[13] Network for New Energy Choices. *Freeing the Grid: 2007 Edition.* Report No. 02-07 (2007).
[14] Tellus Institute and MRG & Associates. *Clean Energy: Jobs for America's Future* (2001).
[15] Stern, N. *Stern Review: The Economics of Climate Change.* United Kingdom Ministry of the Treasury (2007).
[16] Employment Security Commission of North Carolina. *North Carolina Occupational Trends 2002-2012* (2006).

Cornerstone: Pollution Capture

North Carolina has a responsibility to manage its contribution to global warming pollution. As we reduce pollution with a transition to the cleanest of possible energy futures, we should also capture our excess pollution. There are two ways to capture carbon dioxide pollution: Biological sequestration in trees and soil across our landscape and geologic sequestration deep underground. Appreciating that North Carolina's past actions contribute a significant amount of today's global warming pollution burden, it is our responsibility to redefine business-as-usual strategies about our energy infrastructure and land management.

Capture and storage in the landscape

Tree planting, soil management and other biological measures to increase carbon storage in the landscape are already helping reduce North Carolina's global warming pollution by a modest amount. Reaching beyond tree planting to make a bigger difference can start with greater efforts that use existing practices to secure more carbon in soil, plants and trees. For example, soil disturbance due to land development, agriculture and forestry causes carbon that is presently stored in the landscape to be released as carbon dioxide. Reducing such disturbances, or making them less frequent, is a useful step. No-till farming is one solution to agricultural carbon soil disruption.[1] If new, innovative capture and storage technologies were fully developed and utilized, North Carolina could achieve an annual landscape enhancement of five million tons of carbon dioxide by 2030.

A more aggressive form of storing carbon in soil is known as biochar. Biochar is produced by converting agricultural and forestry waste into a charcoal dust residue.[2] Targeted investment in a biofuels plant that produces biochar is needed to supply the biochar necessary to achieve this goal. Preliminary estimates indicate that a multi-year grant of $1 million per year would be sufficient to attract such a facility to North Carolina and supply the amount of biochar needed for demonstration and research purposes.[3] If the biochar is demonstrated to have value as a soil amendment or fertilizer, further production should be cost-effective without government support.

Capture and storage underground

Capture of global warming pollution from power plants that burn fossil fuels is essential because we are not likely to develop clean and safe energy sources quickly enough to fully replace all fossil fuel demand in our economy. Coal has many environmental drawbacks, including destructive mountain top removal mining, air pollution, excessive water consumption, and water

Storing carbon, improving farm productivity

Biochar is produced in Australia as a co-product in agricultural waste-to-energy plants. The use of biochar in indigenous agricultural systems in Brazil demonstrates its sustainability over many hundreds of years. One company in Georgia, Eprida, is developing a biochar-based fertilizer product. Research in several countries raises the possibility that biochar may stimulate microorganisms to accumulate carbon in soil at a substantially higher rate than assumed for this report, thereby further improving soil productivity.

Photos courtesy of University of Bayreuth

Photo courtesy of Alabama NRCS

quality impacts. To the extent that coal remains a fuel for electricity generation, the use of "IGCC" (integrated gasification combined cycle) plants is today's best option for coal combustion and is viable as a transition technology. Gasification of coal using IGCC produces a fuel that is similar to natural gas. The plant design allows for capture of carbon dioxide from the smokestack. Using this technology, North Carolina utilities and industries could capture about 25 million tons of global warming pollution by 2030.

Of the several policy proposals to promote investments in power plants that capture carbon dioxide, the use of an emission performance standard for all new fossil fuel plants based on the efficiency of available technology has the most appeal. Such a standard would generally favor IGCC coal plants over conventional plants, but allows for other competing technologies.

As a complement to this standard, carbon dioxide allowances should be sold by auction to the owners of existing power plants, with declining allowances over time.

Estimates suggest that it would cost about $800 million per year to reach a target of capturing 25 million tons of carbon dioxide by 2030.[4] Prior estimates that suggested costs as high as $4 billion per year[5] assume that North Carolina would continue to use energy inefficiently and fail to take advantage of its clean energy resources. Our findings suggest that capture and underground storage of carbon dioxide could add less than 1 cent per kWh to the average cost of generation.[6]

[1] Food and Agriculture Organization of the United Nations. "Soil Carbon Sequestration for Improved Land Management." *World Soil Resources Reports* no. 96 (2001).

Franzluebbers, A J and R F Follett. "Greenhouse Gas Contributions and Mitigation Potential in Agricultural Regions of North America: Introduction." *Soil & Tillage Research* vol. 83 (2004).

Nicholas Institute for Environmental Policy Solutions. *Harnessing Farms and Forests in the Low-Carbon Economy: How to Create, Measure and Verify Greenhouse Gas Offsets*. Duke University Press (2007).

Pimentel, D et al. "Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems." *BioScience* vol. 55 (2005).

[2] Marr, E. "Black is the New Green" *Nature* vol. 442 (2006).

[3] Personal communication with potential biochar refinery developers (2007).

[4] Working Group III of the Intergovernmental Panel on Climate Change. *IPCC Special Report on Carbon Dioxide Capture and Storage* (2005).

Smyth, Rebecca C et al. *Potential Sinks for Geologic Storage of Carbon Dioxide Generated in the Carolinas.* Gulf Coast Carbon Center (2007).

[5] Murawski, J. "Clean Coal Would Cost Billions – US Energy Department Puts $4 Billion Annual Price Tag on Cleansing Process." *The Charlotte News & Observer* March 24, 2007.

[6] The one-cent per kWh finding is based on the sources cited in this section (for total costs) and our forecast of total and coal-based electricity generation described elsewhere in this report.

Building a carbon storage system

Storing carbon dioxide deep underground is a proven technology at a small scale. It involves three steps: capture at a power plant or industrial facility, transportation to a suitable geologic storage location, and injection into a well for permanent storage. Capturing carbon dioxide from power plants is technically feasible, but it has not been implemented because it adds cost to electricity generation.

Storage of carbon dioxide at the scale envisioned here is a substantial undertaking that would exceed the size of existing projects. Nevertheless, leading scientists are optimistic about the likelihood of success and have developed detailed plans for careful development of the technology.

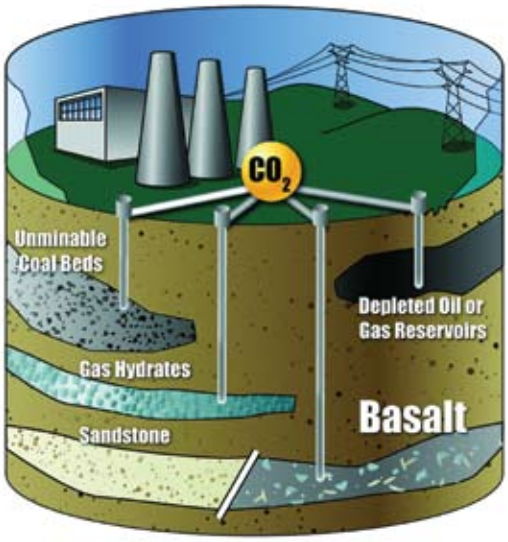
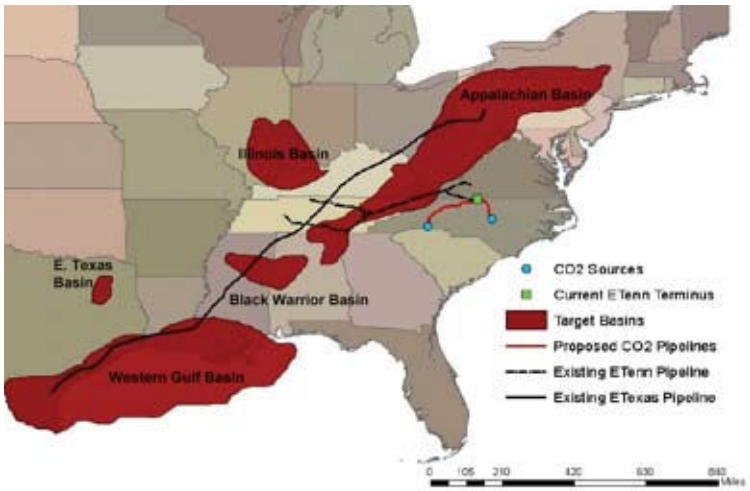


Illustration courtesy of Pacific Northwest National Laboratory



Transportation to suitable storage locations will require long-term planning and investment, but the cost of the necessary pipelines should not be a significant impediment to their construction. A study by researchers at Duke University explained how existing natural gas pipeline routes offer relatively easy access to potential storage areas in Tennessee and West Virginia as illustrated above. Offshore storage under the continental shelf is also a possibility. Studies suggest that pipelines would represent less than 15% of the total cost.

Illustration courtesy of Williams, E et al. *Carbon Capture, Pipeline and Storage: A Viable Option for North Carolina Utilities?* Nicholas Institute for Environmental Policy Solutions and The Center on Global Change at Duke University, report no CCPP WP 07-01 (2007).

Cornerstone: Long-Range Planning

The pollution that is already in our atmosphere has committed our world to a certain amount of global warming. As such, North Carolina must prepare for the future by anticipating and adapting to the changes that are on the horizon. Furthermore, we must prepare for our future by providing safer and healthier communities through improved mobility. Our communities can fulfill a commitment to transportation and land use designs that make residents' lives safer, healthier and richer with possibilities. Change is already underway, and thoughtful planning will not only help minimize further global warming pollution, but will give communities the necessary tools to enhance the productivity of local resources.

Reducing transportation demand is the most effective long-term strategy for decreasing emissions. Studies suggest that implementing a package of complementary transit, pricing and land use strategies can reduce travel demand by 20-40% for passenger vehicles[1] and 15-20% for freight movement.[2] A package like this would allow North Carolina to avoid nearly 20 million tons of global warming pollution by 2030.

Illustration by Hamilton Cort, courtesy of Asheville Design Center

A major challenge to achieving this potential is that while work on these measures must begin today, the benefits of long-range planning measures only become significant beyond 2020. Beyond 2030, the benefits of long-range planning measures will grow rapidly on the foundation put in place over the next few years.

Another challenge is that freight transportation and air travel are less sensitive to conventional transportation and land-use planning policies. Because of this, freight transportation and air travel could be the source of one-third of net global warming pollution in 2030, as other strategies demonstrate high levels of success.

A third challenge is for North Carolina to "be prepared" for the impacts of global warming.

Transportation and land use

Long-term decisions by communities and households are key factors "driving" transportation-related global warming pollution. Our past choices have brought us to the point where about one-third of North Carolina's global warming pollution comes from driving and freight.

The policies that work are those that integrate planning, transit and pricing policies. Studies show that adopting effective, coordinated strategies to reduce public dependence on driving results in increased employment, productivity and economic development, as well as pollution reductions.

- Planning policy changes can be specific steps such as removing excessive parking requirements from zoning ordinances; or the changes may be more general, such as coordinating regional development plans to help avoid a need for highway expansions.
- Transit can be expanded in coordination with pricing policies that help drivers "feel" fixed and external costs.
- Pricing policies are perhaps the most politically sensitive, but are essential to unraveling the implicit subsidies for high-pollution transportation patterns.

Adopting effective, coordinated strategies to reduce public dependence on driving results in increased employment, productivity and economic development, as well as pollution reductions.[3]

Freight planning

Today, freight and air travel in North Carolina contributes approximately 10% of the state's annual global warming pollution. Air travel and freight are the fastest increasing transportation sectors, which will lead their global warming pollution to increase to nearly 20% by 2030. Only recently have transportation planners begun to consider how to build the infrastructure necessary for a more energy-efficient, multi-modal system for moving freight and people.

The theoretical benefits of such planning are enormous. For example, replacing long-haul trucking with an optimal combination of rail and truck transport can achieve energy savings of 85%.[4]

This potential efficiency gain, however, is tempered by challenges. For instance, congestion at key points in shared freight and passenger transportation networks limits the capacity of rail and shipping to handle additional traffic. Despite these challenges, the huge reductions in global warming pollution that would result from increased efficiency and more use of alternative fuels for freight transport more than justifies making an effort to revamp these industries.

Preparing for global warming

In addition to mitigating the pollution from the utility and transportation sectors, another critical component of long-range planning is adaptation to the impacts of global warming. Global warming pollutants have atmospheric lifetimes ranging from 5 to 50,000 years, therefore impacts from pollutants emitted today and even hundreds of years ago will have a lingering effect on global warming long into the future. Impacts of these pollutants are "in the pipeline" and, as North Carolina scholars recently reminded us, "Virtually every climate impact projected to result from increasing greenhouse-gas concentrations…already exists as a major concern."[5]

We must anticipate these impacts if we are to protect our treasured ecosystems, public health, economies and communities of North Carolina. Places like North Carolina's Outer Banks could be disproportionately impacted by rising sea levels, stronger hurricanes and saltwater intrusion in fresh water aquifers compared to other parts of the Southeast and the nation. Likewise, North Carolina's mountain ecosystem in the western part of the state is uniquely vulnerable to increasing droughts, warmer temperatures, worsening air pollution and flooding from extreme storms.

Responses to global warming will require elected officials – both local and state – to cooperate in assessing and disclosing the potential

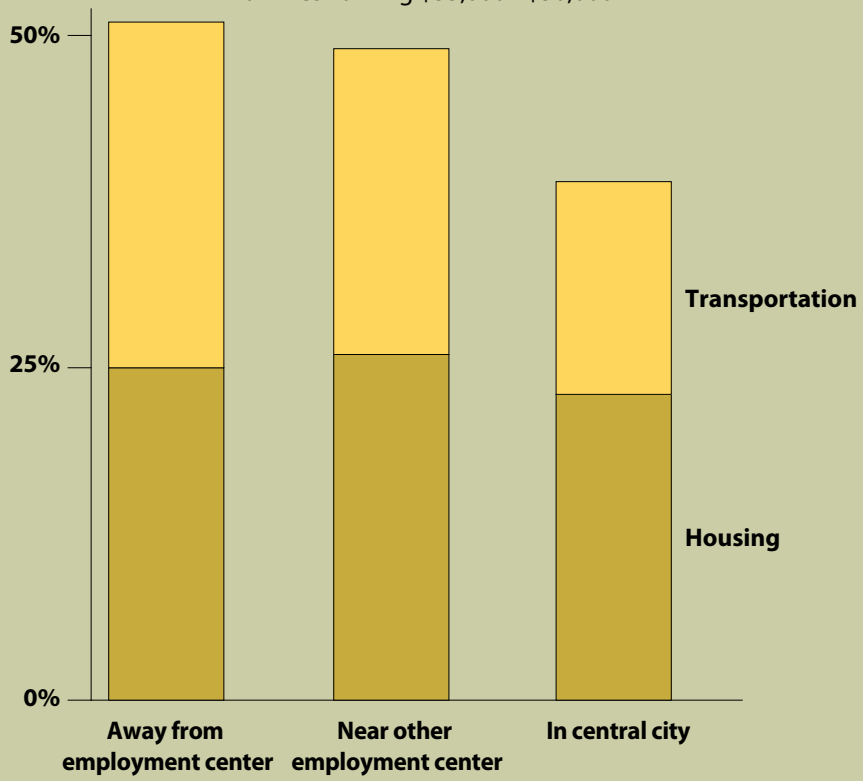
Housing Location and Transportation Costs

In addition to supporting lower-cost lifestyles that cause less global warming pollution, we also know that central cities offer cleaner, healthier transportation alternatives. The typical household spends about half of its budget on transportation and housing costs.[1] Most of these expenses, such as home purchases, are not visibly related to transportation-related pollution. For many, it is difficult to equate relatively small expenditures on fuel with a large contribution to global warming pollution.

Communities that adopt quality of life as a pollution-reduction strategy can aspire to reduce transportation demand by 20-40%.[2] Transportation growth rates, however, are expected to be so high that even these strategies cannot hold total transportation demand in check. The realities of population and economic growth should compel every community to plan aggressively for a future that does not leave us trapped in a high-pollution future of traffic congestion.

[1] Lipman, B J. *A Heavy Load: The Combined Housing and Transportation Burdens of Working Families.* Center for Housing Policy (2006).
[2] Litman (1999, 2005).

Share of Income Spent on Housing and Transportation
By Location of Neighborhood
Families Earning $35,000 - $50,000



Sea Level Rise on the North Carolina Coast
Elizabeth City, NC would be dramatically reshaped by a 1.5 meter sea level rise, as depicted by Architecture 2030, Inc.

Sea level rise can have consequences that reach far beyond the beachfront, affecting water resources, storm water management, transportation systems, land use decisions, business operations and other infrastructure that may be distant from the beach.

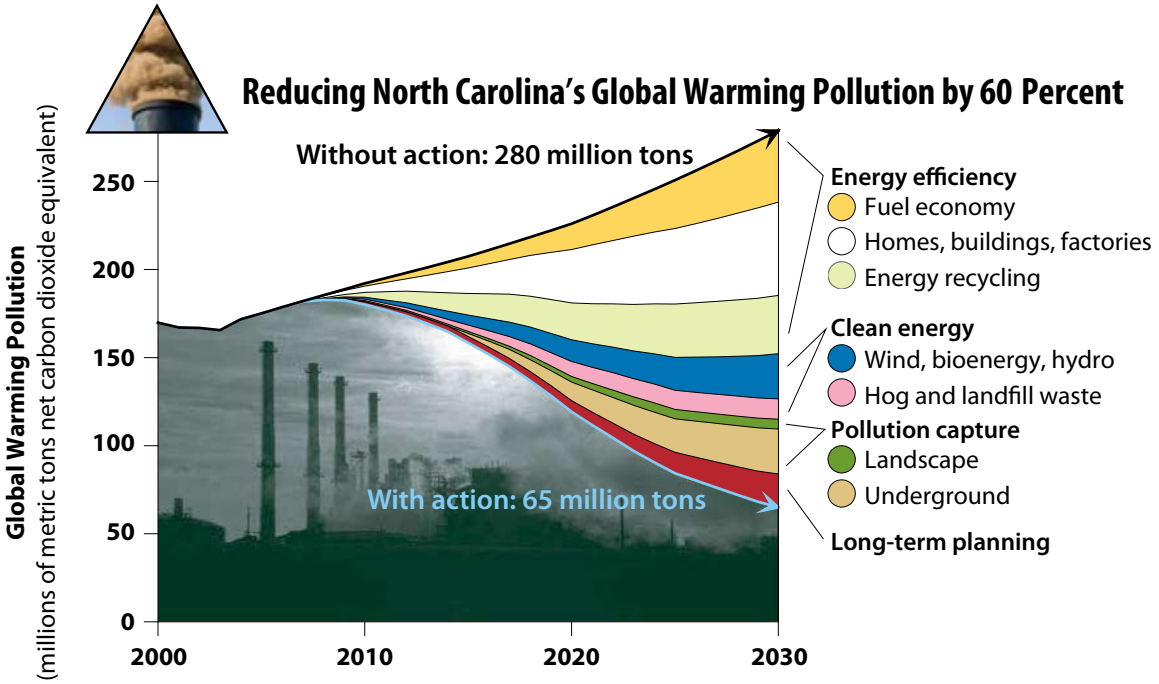
impacts of global warming to all sectors of the economy. Impacts will be felt throughout communities with interruptions to business activities, storm damage to natural resource industries (agriculture, forestry and commercial fisheries), disruption of tourism and recreation interests, and loss of residential and non-residential property holdings.[6] Cooperative steps and open dialogue are essential to developing a consensus among affected communities regarding updates to organizational plans, procedures and resource priorities. Together, these cooperative decisions are the strategies and actions that each community and the state must identify and formally adopt to be prepared for global warming.

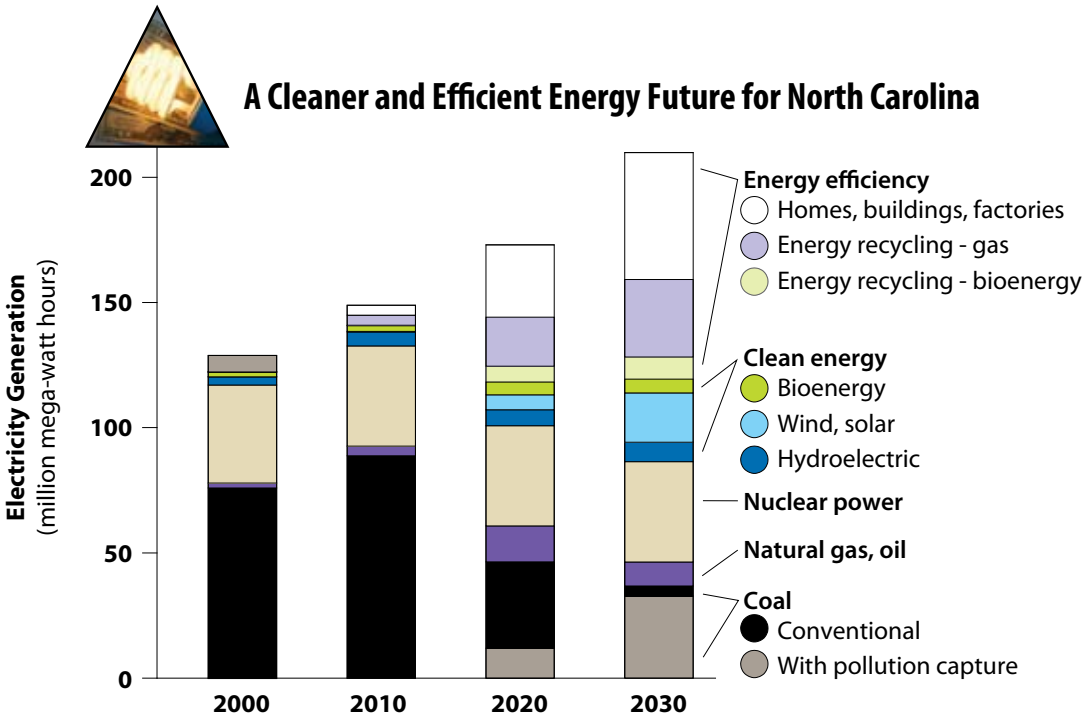
[1] Litman, T. *Socially Optimal Transport Prices and Markets*. Victoria Transport Policy Institute (2005).
Litman, T. *Transportation Cost Analysis*. Victoria Transport Policy Institute (1999).
Johnston, R A. *Review of U.S. and European Regional Modeling Studies of Policies Intended to Reduce Motorized Travel, Fuel Use, and Emissions*. Victoria Transport Policy Institute (2006).
[2] Dierkers (2007), Frey (2007a, 2007b).
[3] Lipman (2006), Litman (1999, 2005).
[4] Frey (2007a).
[5] Pielke, R et al. "Lifting the Taboo on Adaptation." *Nature* v. 445 (2007).
[6] Bin, O et al. *Measuring the Impacts of Climate Change on North Carolina Coastal Resources*. National Commission on Energy Policy (2007).

A Foundation for North Carolina's Future

The four cornerstones outlined in this report offer a foundation for North Carolina citizens, entrepreneurs, businesses and policymakers to invest in the creation of a new economy as global warming leaders. If North Carolina builds on these four cornerstones over the next two decades, future generations will live securely on a more independent economy made strong by a stable climate.

As illustrated below, a 60 percent reduction in North Carolina's global warming pollution means moving from 179 million tons in 2000 to 65 million tons in 2030. Global warming pollution includes carbon dioxide, as well as other global warming pollutants such as methane. The units of pollution follow accepted convention; we use metric tons (rather than short tons) and report other pollutants in "carbon dioxide equivalent" units.





Highlights of our plan include the following:

- Fuel economy – technology improvements in passenger and freight vehicles, including plug-in hybrid electric vehicles – **40 million tons reduced**
- Homes, buildings and factories – efficiency retrofits and standards, including lighting, appliances, HVAC and building envelope – **53 million tons reduced**
- Energy recycling – use of waste heat to generate electricity or to offset other energy uses – **33 million tons reduced**
- Wind, bioenergy, hydroelectric, solar – generation of electricity or offsetting energy use by using clean, renewable resources – **26 million tons reduced**
- Hog and landfill waste – capture of methane and its use to generate electricity or to offset other energy uses – **12 million tons reduced**
- Landscape storage – improved landscape management practices, including biochar, to promote increased carbon in soil and plants – **6 million tons reduced**
- Underground storage – capture and transportation of carbon dioxide from power plants and industrial facilities to geologic disposal – **26 million tons reduced**
- Long-range planning – transform communities for improved mobility, reducing demand for high pollution forms of transportation – **19 million tons reduced**

Without these actions, our state's annual contribution to global warming could reach a 50% increase by 2030 to 280 million tons of pollution, and could more than double by 2050.

These cornerstones represent a dramatic transformation of our energy system. Considering the impact on our electricity alone, in just two decades North Carolina can shift to cleaner, safer energy supplies.

- Energy efficiency benefits compound over time and reduce the need for investment in new generation and transmission facilities.
- Today, coal is the dominant source of electricity. By 2030, coal use can be dramatically reduced, with most coal being burned in power plants that include capture and storage of carbon dioxide.
- Today, most of North Carolina's renewable energy comes from hydroelectric plants. By 2030, bioenergy and wind will be substantial and growing resources. Bioenergy contributes to both energy recycling (when used in a combined heat and power unit) and clean energy (when used in a power plant).
- We assume that nuclear plants will have a constant output over the next two decades. As the success of cleaner and safer energy resources is proven, nuclear and coal generation can be phased out.

Plug-in hybrid electric vehicles represent an overall reduction in pollution but increase overall electricity use. This extra electricity is likely to be needed during off-peak periods, which tends to make clean energy even more cost-effective.

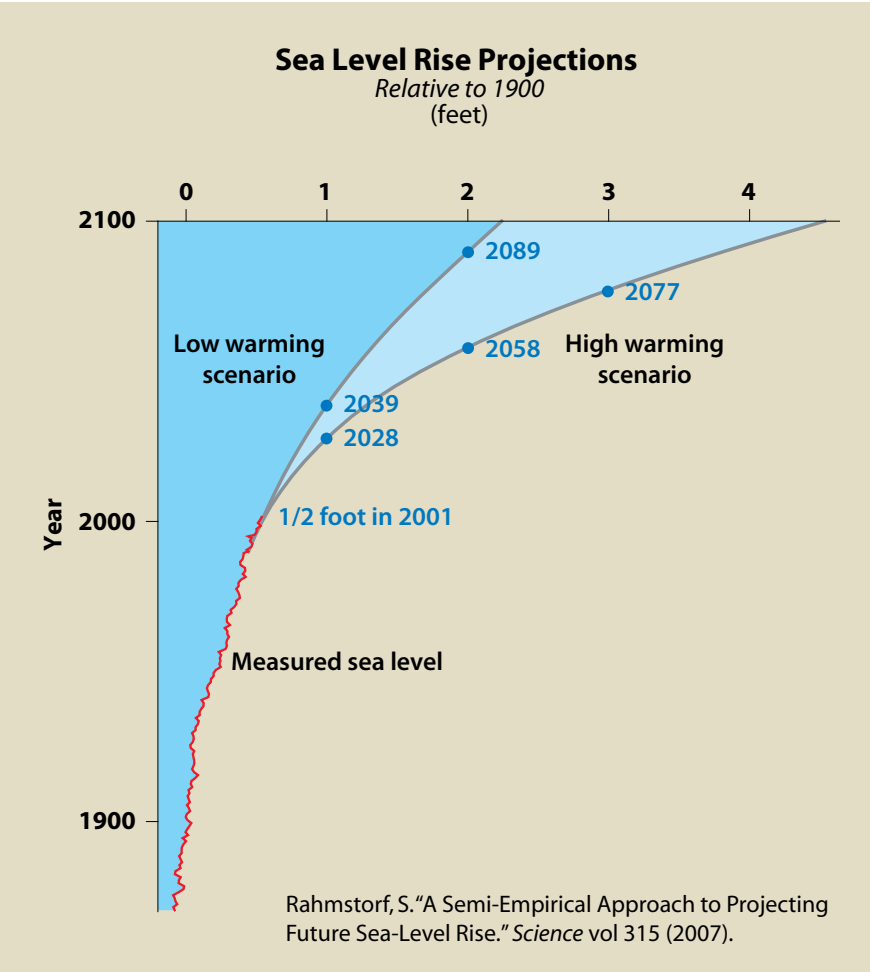
Understanding:
Global warming and the danger of inaction

For each year that we delay taking action to slow global climate change, the costs to take action in the future increase significantly, as do the costs of adapting to the impacts that are already occurring. Thus, early action is essential to fighting global warming. At the same time, avoiding higher costs depends on clear, long-term global and national policies to encourage innovation and development responses.

According to scientists, the planet is currently heating up faster than at any other time in history because of global warming pollution. Acting as heat-trapping blankets, global warming pollutants affect not only the temperature, but melt ice sheets and glaciers, raise the sea level, increase the severity of hurricanes and worsen droughts. The world has already warmed by an estimated 1°F in the past century and is predicted to warm 2.5°F to 10.4°F by 2100. We are already losing Arctic sea ice at an increasingly rapid rate.

The severity of projected and potential impacts put our health, economy and essential natural resources at risk. The following resources offer details about the science of global warming and its effects.

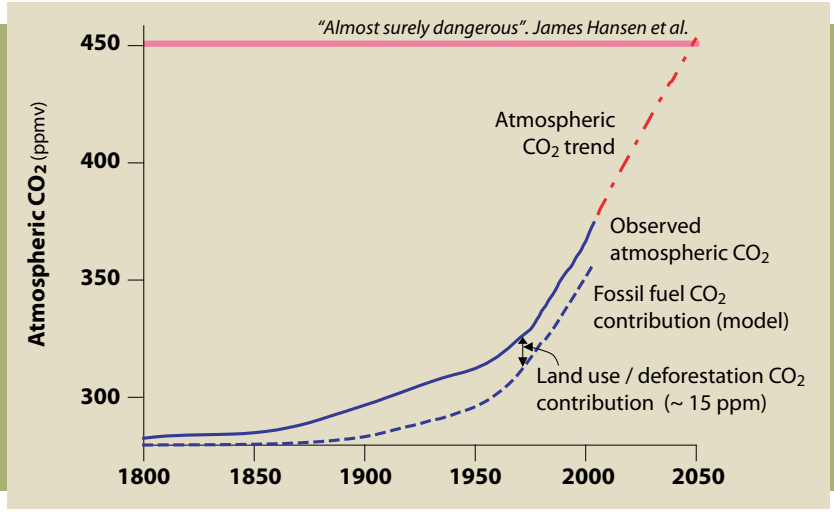
- Reports by the Intergovernmental Panel on Climate Change (IPCC). IPCC policymakers' summaries are relatively non-technical compared to the more scientifically-written full reports. These represent the authoritative source of scientific consensus on the causes and impacts of global warming.
- *The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth*, by Tim Flannery is a clear, accessible review of the complex science behind global warming.
- *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It*, by Al Gore is a visually-oriented summary of the dangerous risks of global warming and solutions.
- *Stern Review: The Economics of Climate Change*, by British Treasury economists, describes the future costs of global warming and estimate the cost-effectiveness of solutions.



Understanding:
Global goals and local leadership

Reducing the state's global warming pollution by 60% over the next two decades will not be easy, but the sooner we begin reductions, the better off we will be. North Carolina's global warming pollution could soon reach 200 million tons per year, with each year's pollution resulting in an estimated $15 billion in global damages.[1]

While federal leadership to reduce global warming pollution is essential to meeting long-term goals, most pollution reduction actions will be implemented at the state government level.



Global Warming Pollution Trend (CO_2)

Global warming pollution comes from energy consumption, such as power plants, cars, trucks, and industrial facilities, as well as some other sources of carbon dioxide, methane and several other pollutants. The concentration of carbon dioxide (the principal global warming pollutant) is rising at a steady rate.

Kharecha, P A and J E Hansen."Implications of 'Peak Oil' for Atmospheric CO_2 and Climate." *Global Biogeochemical Cycles*, submitted (2007).

- Energy efficiency programs affecting energy purchased from utilities, other than national appliance and equipment standards, are under the jurisdiction of the state, particularly the North Carolina Utilities Commission.
- Fuel economy standards are primarily a federal responsibility. However, many states are choosing to adopt tougher California pollution control standards, and North Carolina could choose to as well.
- Energy recycling policies are affected by both the Federal Energy Regulatory Commission and the North Carolina Utilities Commission.
- Federal and state governments have the jurisdiction to implement clean energy policies. Offshore wind is under federal permitting jurisdiction, but otherwise most generation and utility activities are under state authority. Likewise, biofuels are affected by federal fuel regulations, but refinery permitting and agricultural policies are heavily influenced by state priorities.
- Pollution capture depends on national research efforts and interstate coordination and will be driven by state permit requirements for power plants or a federal carbon cap. Landscape storage of carbon dioxide will be a shared responsibility among federal, state and private partners.
- Long-term planning is primarily a local government responsibility, although it is driven in part by state policy leadership and federal funding, especially for transportation infrastructure.

Thus, regardless of how assertive the federal government becomes, a state-based policy is essential to the success of global warming pollution reduction.

State action is informed by the growing global consensus regarding the needed level of pollution reductions. Setting targets is a complex but necessary political and scientific challenge. Scientists worldwide agree that restricting global warming to no more than 3.6° F (2° C) is vital to avoiding dangerous impacts and that the threshold would probably be reached if carbon dioxide levels reach 450 ppm.[2] Since carbon dioxide levels have already exceeded 380 ppm and are rising at a rate of about 2 ppm per year, this threshold could be reached in three decades.[3] Many leaders are translating this warning of scientists into a goal of 60% reduction in global warming pollution by 2030 and 80% reduction by 2050.

[1] Stern (2006).
[2] Hansen J E et al."Dangerous Human-Made Interference with Climate: A GISS ModelE Study." *Atmospheric Chemistry and Physics* vol 7 (2007).
Scientific Expert Group on Climate Change. *Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable.* Sigma Xi and the United Nations Foundation (2007).
[3] Schmidt, G."CO_2 Equivalents." *RealClimate* posted on October 11, 2007.

Action today:

State and federal policies to lay the cornerstones

Rather than building for the past or even for today, North Carolina's best foundation for the future will be built on cornerstones that support us for decades and anticipate coming changes for the world's energy resources. For example, if North Carolina delays implementation of energy efficiency efforts, the likely alternative to meet growing demand is building new power plants – investments that ratepayers will be obligated to cover even if energy efficiency makes those power plants unnecessary later.

North Carolina's leaders are beginning to respond with an appropriate focus on the next decade or so of efforts. In that spirit, in this section we consider 2020 as an interim guidepost to reaching a target of 60% pollution reduction.

Pollution reduction areas	Our 2020 targets	Initial actions
Energy efficiency - electricity demand reduction	❖ 18% residential ❖ 18% commercial ❖ 14% industrial	❖ NC Law – 5% energy efficiency by 2021 ❖ New utility proposals ❖ Utility commission review
Energy efficiency - natural gas, other fuels demand reduction	❖ 18% residential ❖ 18% commercial ❖ 14% industrial	❖ No pending NC action
Energy efficiency - fuel economy	❖ 16% reduction in fuel per mile	❖ No pending NC action ❖ 2007 Energy Bill raises fuel economy standards
Energy efficiency - energy recycling	❖ 15% of electricity supply	❖ No pending NC action
Clean energy - electricity	❖ 16% of electricity supply ❖ Ridge and coastal law for wind projects	❖ NC Law – 7.5% renewable energy by 2021 ❖ US Congress considering renewable energy standard
Clean energy - biofuels	❖ 18% of fuel supply ❖ 71% hog methane capture and use for electric generation	❖ NC Law – support for biofuels center ❖ Hog methane systems eligible for grants, higher electricity purchase price
Pollution capture - underground storage	❖ State permitting requirement for new plants to capture and store pollution	❖ No pending NC action

Two advisory bodies have recommended action beyond those adopted by the 2007 North Carolina General Assembly ("NC Law" above). The Legislative Commission on Global Climate Change released interim recommendations in February 2007. The Climate Action Plan Advisory Group completed its final report in October 2007 (publication is pending). This report generally endorses those official recommendations, and calls for further action.

Action tomorrow:
Research and planning to build on the cornerstones

Although state or federal government action can be taken to achieve most of the pollution reductions in this plan, some areas require research. Typically this research is needed because the general policy concept has not been widely applied in North Carolina or similar areas. In these cases, future action follows a clear path once the research is complete.

Pollution reduction areas	Research needs	Future action
Energy efficiency - natural gas, other fuels demand reduction	❖ Efficiency study and policy development for natural gas and other non-electric fuels	❖ Adoption of goals and policies based on findings
Clean energy / pollution capture - landscape storage	❖ Pilot biochar / biofuel plant ❖ Biochar demonstration fields	❖ Demonstration of biochar value and market potential
Pollution capture - landscape storage	❖ Urban tree benefits studies ❖ Forest soils and rotation management studies ❖ Agricultural soil studies	❖ Revised "best practices" ❖ Support for "best practices" in land use regulations ❖ Revise state and federal conservation incentives
Pollution capture - underground storage	❖ Identify future right-of-way needs for CO_2 pipelines	❖ Revise local plans to avoid development conflicts
Long-range planning	❖ Require local plans ❖ Build state capacity to assist local governments ❖ Investigate freight-specific issues	❖ Local land use and transportation plans offering better mobility and access ❖ Identification of state law and policy changes to support plans ❖ Investment plan for freight infrastructure to improve efficiency

However, in some other cases there are policy questions that need to be addressed. Typically, these questions revolve around how to balance competing values or demands on resources. Inclusive deliberation will provide a foundation for action that respects the values and experiences of all North Carolina residents.

Pollution reduction areas	Policy questions
Clean energy - electricity	❖ Where are wind farms technically, politically, and publicly viable in North Carolina? What regulatory process can best assure that our standards are met when wind generation is constructed?
Clean energy - biofuels	❖ How much of our agricultural and forest resources (including waste) can be used for electricity generation and vehicle fuels, while maintaining the health of our ecosystems, protecting soil quality and storing carbon dioxide in the landscape?
Pollution capture - landscape storage	❖ How much carbon dioxide can be usefully drawn from the atmosphere into our landscape, and how can this be achieved while meeting other land use objectives?
Pollution capture - underground storage	❖ What steps need to be taken to prepare for pipelines to take carbon dioxide from power plants to safe underground storage areas?
Long-range planning	❖ What transportation and land use planning practices should be adopted by local governments in North Carolina, and what state resources should be redeployed to assist with implementation?

Cornerstones

Building a Secure Foundation for North Carolina's Energy Future

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