Connecticut Responds to Global Warming

An Analysis of Connecticut's Emission Reduction Goals, Current Strategies, and Opportunities for Progress

CLEAN WATER FUND
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The New England Climate Coalition is a coalition of more than 160 state and local environmental, public health, civic and religious organizations concerned about the drastic effects of global warming in the Northeast.

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Executive Summary

Connecticut can make major strides toward reducing its emissions of global warming gases over the next several decades – and meeting reduction goals outlined by the New England Governors and Eastern Canadian Premiers – by adopting the policy recommendations of the Connecticut Climate Change Stakeholder Dialogue (CCSD) in conjunction with a series of additional global warming measures outlined in this report.

In 2001, the governors of the six New England states and the premiers of the eastern Canadian provinces adopted a landmark commitment to reduce the region's emissions of carbon dioxide and other gases that contribute to global warming. In December 2003, the Connecticut climate stakeholder group – which included participants from business, government, academia and the nonprofit sector – issued a series of 55 policy recommendations that would significantly reduce Connecticut's emissions of global warming gases if implemented.

However, the stakeholder recommendations would not, on their own, reduce emissions to the degree called for in the regional agreement (to 1990 levels by 2010 and 10 percent below 1990 levels by 2020). In addition, the recommendations are not designed to achieve the long-term goal agreed to by the governors and premiers of stabilizing atmospheric concentrations of global warming gases at levels that will prevent dangerous interference with the climate system – a goal that will require emission reductions of 75 to 85 percent below current levels.

By adopting eight near-term policy strategies – and considering adoption of an additional eight strategies – Connecticut can achieve its short-term global warming emission reduction goals and lay the groundwork for further medium- and long-term reductions.

Global warming, caused by human-induced changes in the climate, is a major threat to Connecticut's future.

- Since the beginning of the Industrial Age, atmospheric concentrations of carbon dioxide – the leading global warming gas – have increased by 31 percent, a rate of increase unprecedented in the last 20,000 years. Global average temperatures increased by about 1° F during the 20th century, a rate of increase greater than any in the last 1,000 years.

- The effects of global warming are beginning to appear in Connecticut and worldwide. Average temperatures in Connecticut have increased by about 1.4° F since 1895 and are expected to increase by between 2° F and 10° F over the next century. These temperature increases are expected to be accompanied by increased precipitation.

- The results of these changes could include higher sea levels, degraded air quality, increased heat-related deaths, and the loss of Connecticut's hardwood forest species. These impacts can be expected to negatively affect Connecticut's economy, the health of its citizens, and the state's delicate environmental balance.

Emissions of global warming gases are on the rise in Connecticut.

- Between 1990 and 2000, Connecticut's net emissions of global warming gases increased by 11 percent. According to projections compiled for the stakeholder dialogue, emissions could increase by an additional 21 percent between 2000 and 2020 in the absence of further action to reduce emissions.

Implementation of the Connecticut Climate Change Stakeholder Dialogue recommendations would represent a positive first step for Connecticut.

- Implementation of the stakeholder recommendations would reduce global warming emissions in Connecticut by 9 percent below projected levels by 2010 and 22 percent below projected levels by 2020. The recommendations achieve these goals largely through improved energy efficiency and reduced use of fossil fuels.

- Implementation of all 55 CCSD recommendations, however, would still not achieve emission reductions of the magnitude called for in the regional Climate Change Action Plan. The CCSD's final report estimated that global warming emissions in Connecticut in 2010 would remain 4 percent above 1990 levels in 2010 and 2 percent above 1990 levels in 2020 (assuming continued operation of the state's nuclear reactors beyond the expiration of their operating licenses).

Connecticut could significantly reduce its global warming emissions by adopting eight additional policy strategies.

- These eight policy strategies, if adopted and implemented along with the CCSD recommendations, would reduce Connecticut's emissions of global warming gases to 1990 levels by 2010, and bring the state closer to achieving the regional reduction goal for 2020 – even without the relicensing of the region's nuclear reactors, which pose significant threats to public health and the environment. (See Fig. ES-1.) The strategies would also put Connecticut in a better position to make the long-term changes necessary to achieve the goal of eliminating the state's negative impact on the climate.

The strategies are:

1. Setting energy-efficiency standards for at least seven residential and commercial appliances.

2. Reducing electricity use by increasing funding for energy efficiency programs through the state's Conservation and Load Management Fund.

3. Reducing heating oil and natural gas use through conservation programs with sufficient funding to maximize efficiency savings.

4. Implementing "pay-as-you-drive" automobile insurance, in which insurance rates are calculated by the mile, rewarding those who drive less, while potentially reducing accidents.

5. Requiring the sale of low-rolling resistance replacement tires that improve vehicle efficiency without compromising safety.

6. Implementing a public sector emission reduction strategy with concrete, measurable goals.

7. Implementing and funding an aggressive strategy to promote the use of solar photovoltaic systems in homes and commercial buildings.

8. Adopting limits on carbon dioxide emissions from power plants.

Fig. ES-1. Connecticut Emissions of Global Warming Gases

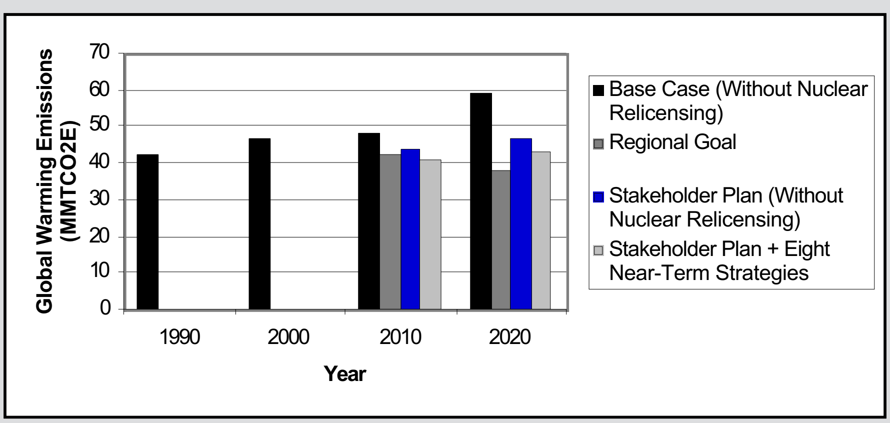


Table ES-1. Projected Global Warming Emission Reductions from Policy Strategies (MMTCO$_2$E)

	2010	2020
Appliance Efficiency Standards	0.29-0.66	0.80
Increased Funding for Electricity Conservation	0.29-0.68	0.68
Increased Funding for Oil and Gas Conservation	0.40	0.91
Pay-as-You-Drive Auto Insurance	0.72	0.80
Low-Rolling Resistance Tires	0.20	0.33
Public Sector Energy Savings	0.09	0.12
Solar Energy Strategy	0.003-0.006	0.010
Electric Sector Carbon Cap	Included as high end of range in above estimates	

Connecticut should also investigate additional policy strategies to further reduce global warming emissions.

- Connecticut should also consider the future adoption of a series of other strategies that could help the state achieve its emission reduction goals in both the short and long term. These strategies focus heavily on reducing emissions from cars and trucks, promoting "smart growth," and encouraging the generation of clean electricity close to the point of use.

Connecticut should seize the opportunity to reduce its emissions of global warming gases.

- The governor and legislature should move forward with implementation of the recommendations of the Connecticut Climate Change Stakeholder Dialogue, and build upon the stakeholder process by continuing dialogue on such difficult issues as reducing vehicle-miles traveled, limiting suburban sprawl, and encouraging the development of non-fossil, non-nuclear sources of energy.

- The state should adopt the near-term measures listed in this report, thus closing the gap between the stakeholder process results and the regional goal for 2010 and narrowing the gap for 2020.

- Connecticut should continue to participate in regional efforts to reduce global warming gas emissions, particularly the efforts of the Conference of New England Governors and Eastern Canadian Premiers and the northeastern states' negotiations to establish a regional power-sector carbon cap.

- Connecticut should commit to achieving the regional long-term global warming emission reduction goal by 2050 and begin to plan for making the technological and other changes that will be needed to achieve that goal.

- Connecticut can and should reduce its global warming emissions without increasing the use of nuclear power or extending the life of the state's nuclear reactors beyond their current operating licenses.

Introduction

Scientists have concluded that human activities – particularly the burning of fossil fuels – are warming the planet. Yet, in the United States, at least, political consensus to address the problem has been lacking at the federal level.

In New England, however, concern about the potentially devastating effects of global warming on the region has begun to mature into a political consensus that something must be done – as evidenced by the landmark commitment made by New England's governors and the premiers of the eastern Canadian provinces in 2001 to reduce the region's emissions of global warming pollution. The governors' and premiers' Climate Change Action Plan committed the region to reducing global warming emissions to 1990 levels by 2010, to 10 percent below 1990 levels by 2020, and eventually by the 75 to 85 percent scientists believe will be necessary to prevent dangerous interference with the climate.

To develop a policy roadmap for achieving its global warming goals, the state of Connecticut initiated a "stakeholder dialogue" in 2003 among representatives of business, government, academia and the nonprofit sector. In December 2003, the Connecticut Climate Change Stakeholder Dialogue (CCSD) issued its recommendations – a package of 55 proposals that would stabilize and begin to reduce Connecticut's emissions of global warming gases over the next two decades.

The recommendations, which achieved nearly unanimous support from the diverse group of stakeholders, provide a solid starting point for Connecticut as it begins to respond to the challenge of global warming. But they are just a start. The stakeholders' final report acknowledged that implementation of all 55 recommendations would not likely achieve the short- and medium-term emission reduction targets set forth in the New England governors' and eastern Canadian premiers' agreement. Nor do the recommendations provide enough reductions to put Connecticut on course to make the deeper, long-term changes that will be needed to bring human activities back into harmony with the climate.

This report looks at and beyond the stakeholder recommendations to envision a policy pathway that will enable Connecticut to achieve its global warming emission reduction goals. Several of the steps along that pathway can be adopted in the near term and make an immediate, concrete contribution to Connecticut's developing policy on global warming. Others represent needed investments in technologies and infrastructure that will pay long-term dividends. Still others require further development and discussion, but are potentially potent tools in the effort to prevent global warming.

Addressing the issue of global warming can seem overwhelming, but Connecticut has taken the first important steps in delineating the specific actions needed. Implementing those actions in conjunction with the policy suggestions in this report can achieve the initial greenhouse gas reduction goals. The path has been provided, the opportunity is here, and now action is needed.

Global Warming and Connecticut

Global warming poses a clear danger to Connecticut's future health, well-being and prosperity. Connecticut contributes to global warming primarily through the combustion of fossil fuels, which emits carbon dioxide to the atmosphere. Connecticut's emissions of carbon dioxide and other global warming gases have increased significantly over the last decade and will likely continue to increase in the absence of concerted action.

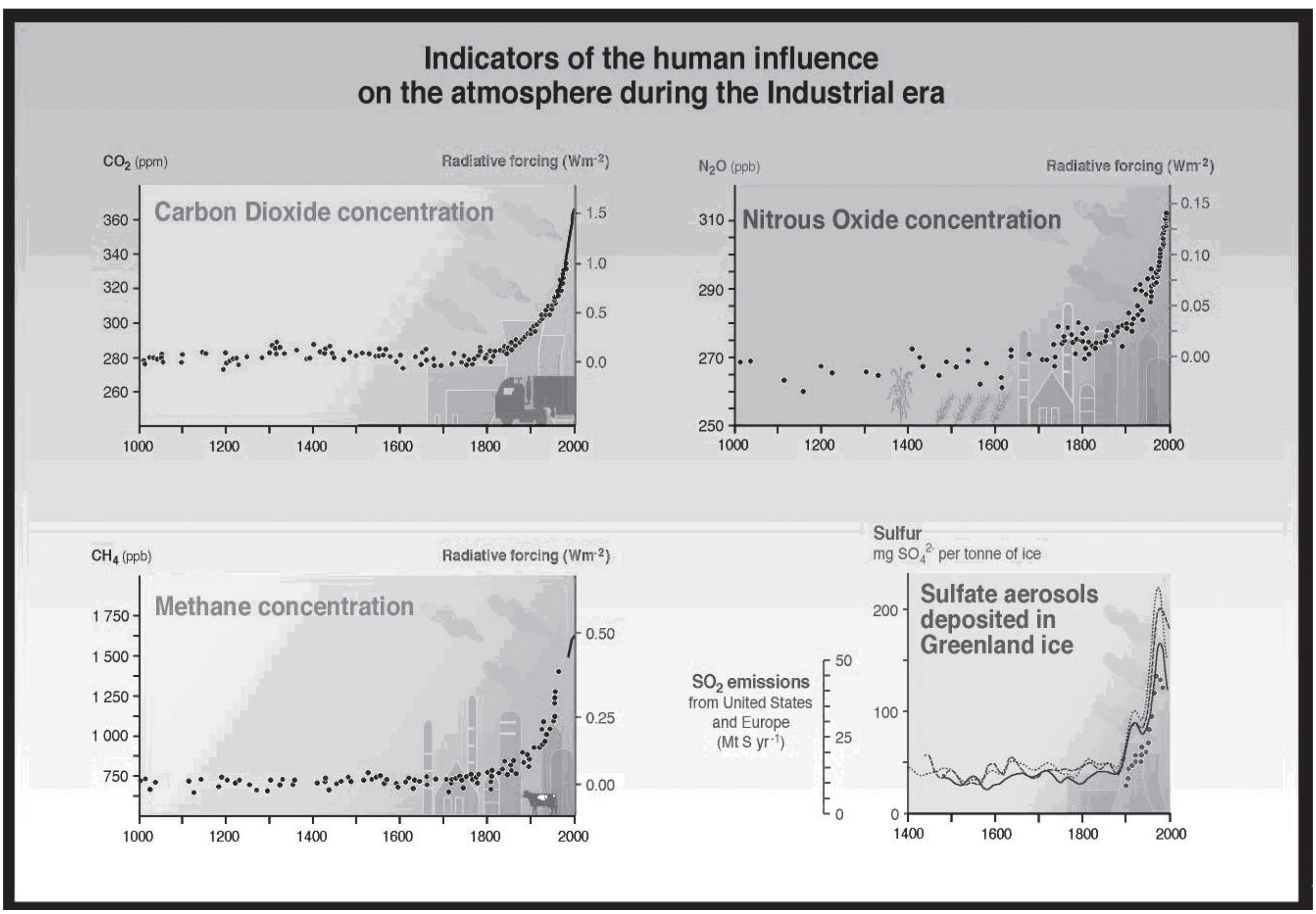
Causes of Global Warming

Global warming is caused by human exacerbation of the greenhouse effect. The greenhouse effect is a natural phenomenon in which gases in the earth's atmosphere, including water vapor and carbon dioxide, trap heat from the sun near the planet's surface. The greenhouse effect is necessary for the survival of life; without it, temperatures on earth would be too cold for humans and other life forms to survive.

Unfortunately, human activities, particularly over the last century, have altered the composition of the atmosphere in ways that intensify the greenhouse effect by trapping more of the sun's heat near the earth's surface. Since 1750, for example, the concentration of carbon dioxide in the atmosphere has increased by 31 percent as a result of human activity. The current rate of increase in carbon dioxide concentrations is unprecedented in the last 20,000 years.[1] Concentrations of other global warming gases have increased as well. (See Fig. 1.)

As the composition of the atmosphere has changed, global temperatures have increased. Global average

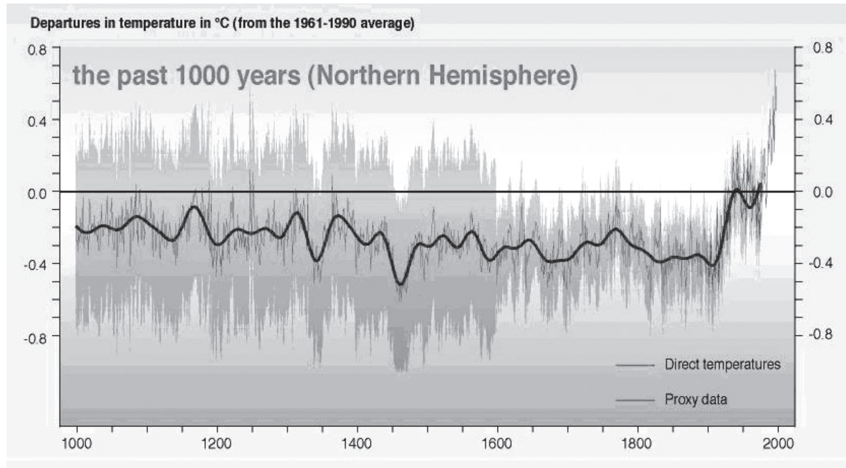
Fig. 1. Atmospheric Concentrations of Greenhouse Gases[2]



temperatures increased during the 20th century by about 1° F. In the context of the past 1,000 years, this amount of temperature change is unprecedented, with 1990 to 2000 being the warmest decade in the millennium. Figure 2 shows temperature trends for the past 1,000 years with a relatively recent upward spike. Temperatures in the past 150 years have been measured; earlier temperatures are derived from proxy measures such as tree rings, corals, and ice cores.[3]

This warming trend cannot be explained by natural variables—such as solar cycles or volcanic eruptions—but it does correspond to models of climate change based on human influence.[4]

Fig. 2. Northern Hemisphere Temperature Trends[5]



Global Warming Gases

Six substances are primarily capable of exacerbating the greenhouse effect that causes global warming. The major global warming gases are:

- **Carbon Dioxide –** Released mainly through the combustion of fossil fuels, carbon dioxide is by far the leading gas responsible for global warming.

- **Methane –** Methane gas escapes from garbage landfills, is released during the extraction of fossil fuels, and is emitted by livestock and some agricultural practices. It is the second-most important global warming gas in New England in terms of its potential to exacerbate the greenhouse effect.

- **Fluorocarbons –** Used in refrigeration and other products, many fluorocarbons are capable of inducing strong heat-trapping effects when they are released to the atmosphere. Because they are generally emitted in small quantities, however, they are estimated to be responsible for only about 1 percent of New England's contribution to global warming.[6]

- **Nitrous Oxide –** Nitrous oxide is released in automobile exhaust, through the use of nitrogen fertilizers, and from human and animal waste. Like fluorocarbons, nitrous oxide is a minor, yet significant, contributor to global warming.

- **Sulfur Hexafluoride –** Sulfur hexafluoride is mainly used as an insulator for electrical transmission and distribution equipment. It is an extremely powerful global warming gas, with more than 20,000 times the heat-trapping potential of carbon dioxide. However, it is released in only very small quantities and was responsible for only about 0.2 percent of Connecticut's global warming emissions in 2000.[7]

- **Black Carbon –** Black carbon, otherwise known as "soot," is a product of the burning of fossil fuels, particularly coal and diesel fuel. Recent research has suggested that, because black carbon absorbs sunlight in the atmosphere, it may be a major contributor to global warming, perhaps second in importance only to carbon dioxide. Research is continuing on the degree to which black carbon emissions contribute to global warming.

This report focuses mainly on emissions of carbon dioxide from the combustion of fossil fuels in homes, businesses, industrial facilities and electric power plants – both because those emissions are responsible for the majority of Connecticut's contribution to global warming and because resource limitations prevent the consideration of other gases in this report. Steps to reduce emissions of other global warming gases must also be part of the state's efforts to curb global climate change.

Current Indications of Climate Change

The first signs of global warming are beginning to appear, both in Connecticut and around the world.

Average temperatures have risen. Global average temperatures have increased by about 1° F in the past century. In the same period, the average temperature in Storrs, Connecticut has increased by more than 2° F.[8] Statewide, average temperatures are estimated to have increased by 1.4° F between 1895 and 1999.[9]

Precipitation patterns have changed. Over the last century, precipitation has increased by 20 percent in some parts of Connecticut.[10] Maine, New Hampshire, and Vermont have experienced a 15 percent decrease in snowfall since the 1950s.[11] In other parts of the world, such as Asia and Africa, droughts have been more frequent and severe, a change that is consistent with models of climate change.[12]

Cold seasons have been shorter and extreme low temperatures less frequent. Since the late 1960s, Northern Hemisphere snow cover has decreased by 10 percent and the duration of ice cover on lakes and rivers has decreased by two weeks.[13] Glaciers around the world have been retreating.[14]

Oceans have risen as sea ice has melted. Average sea levels have risen 0.1 to 0.2 meters in the past century.[15]

Potential Impacts of Global Warming

The earth's climate system is extraordinarily complex, making the ultimate impacts of global warming in a particular location difficult to predict. There is little doubt, however, that the first signs of global warming are beginning to appear, both in Connecticut and around the world.[16] There is also little doubt that global warming could lead to dramatic disruptions in Connecticut's economy, environment, and way of life.

Temperature increases in the past century have been modest compared to the increases projected for the next 100 years. Global temperatures could rise by an additional 2.5° to 10.4° F over the period 1990 to 2100.[17] In Connecticut, some projections suggest that temperatures could increase by 2° to 8° F by 2100.[18] Others estimate that a 1.8° F increase in average temperature could occur across New England as soon as 2030, with a 6 to 10° F increase over current average temperatures by 2100.[19]

Precipitation levels could also change. Connecticut could experience an increase in precipitation of 10 to 20 percent, with greater change in winter and less change in spring and summer.[20]

In any event, the impacts of such a shift in average temperature and precipitation would be severe. Among the potential impacts:[21]

- Longer and more severe smog seasons as higher summer temperatures facilitate the formation of ground-level ozone, resulting in additional threats to respiratory health such as aggravated cases of asthma.
- Increased risk of heat-related illnesses and deaths – perhaps a 20 percent increase in heat-related deaths.
- Increased spread of mosquito and tick-borne illnesses, such as Lyme disease, Eastern equine encephalitis, malaria and dengue fever.
- Declines in freshwater quality due to more severe storms, increased precipitation and intermittent drought, potentially leading to increases in waterborne disease.
- Increases in toxic algae blooms and "red tides," resulting in fish kills and contamination of shellfish.
- Shifts in fish populations due to changing water temperatures and changes in the composition of coastal estuaries and wetlands.
- Shifts in forest species due to increased spread of exotic pests and changing temperatures – including the loss of hardwood forests responsible for Connecticut's vibrant fall foliage displays, a staple of the state's tourist economy.
- Increased coastal flooding due to higher sea levels, with sea level along the Connecticut coast projected to rise by about 22 inches over the next century.

The cumulative cost to protect Connecticut's coastline from a 20-inch rise in sea level has been estimated at between $500 million and $3 billion by 2100.

- Disruption to traditional New England industries such as fall foliage-related tourism, maple syrup production and skiing.

- Negative repercussions throughout the economy. For example, the Reinsurance Association of America reported that insurers paid $57 billion for weather-related losses in the first half of the 1990s compared with $17 billion for the whole previous decade – costs that can only be expected to increase with increased disruption of the climate.[22]

The severity of these potential impacts is difficult to predict. But this much is certain: climate changes such as those predicted by the latest scientific research would have a dramatic, disruptive effect on Connecticut's environment, economy and public health – unless immediate action is taken to limit our emissions of global warming gases.

Global Warming Emission Trends

In 2000, Connecticut was responsible for net emissions of 46.5 million metric tons carbon dioxide equivalent (MMTCO$_2$E) of global warming gases into the atmosphere (not counting emissions of black carbon). This level of emissions represented an 11 percent increase from 1990, when the state was responsible for 41.7 MMTCO$_2$E of net emissions.[23]

A Note on Units

There are several ways to communicate quantities of global warming emissions. In this report, we communicate emissions of different global warming gases in terms of million metric tons of carbon dioxide equivalent (MMTCO$_2$E) – in other words, the amount of carbon dioxide that would be required to create a similar global warming effect. Another frequently used term to communicate emissions is "carbon equivalent." To translate the latter measure to carbon dioxide equivalent, one can simply divide by 0.273.

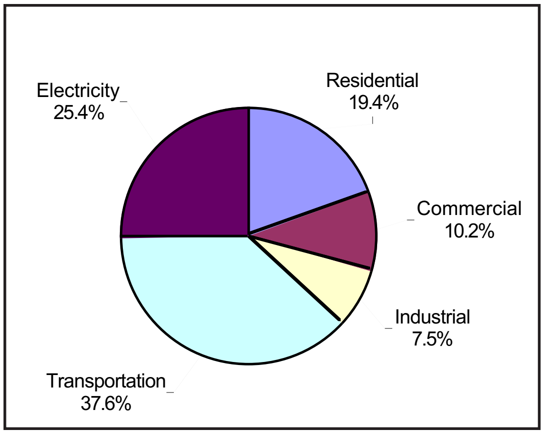
The vast majority of Connecticut's global warming emissions come in the form of carbon dioxide from the combustion of fossil fuels in homes, businesses, industrial facilities and electric power plants. In 2000, fossil fuel combustion in Connecticut released 42.9 MMTCO$_2$E into the atmosphere, accounting for about 89 percent of the state's emissions in terms of global warming potential (not including black carbon).[24]

Emissions of carbon dioxide from all segments of the Connecticut economy increased between 1990 and 2000, at varying rates. Direct emissions from the commercial sector (not including electricity use) increased at the fastest rate. (See Table 1.) The transportation sector, however, remains the largest source of carbon dioxide emissions in the state, responsible for about 38 percent of the state's emissions. (See Fig. 3.)

Table 1. Connecticut Carbon Dioxide Emissions from Energy Use (MMTCO$_2$E)[25]

	1990	2000	Percent Increase
Residential	7.14	8.31	16%
Commercial	3.51	4.36	24%
Industrial	2.96	3.20	8%
Transportation	14.59	16.10	10%
Electricity	10.68	10.88	2%
TOTAL	**38.88**	**42.85**	**10%**

Fig. 3. Connecticut Carbon Dioxide Emissions by Sector, 2000



Modeling performed for the Connecticut Greenhouse Gas Stakeholder Dialogue projects that global warming emissions in the state will increase by 4 percent between 2000 and 2010 and by 21 percent between 2000 and 2020 in the absence of further action to reduce emissions.[26] This projection, however, includes a dramatic projected drop in electricity sector emissions between 2000 and 2010 that may not be realistic.[27]

The stakeholders also assume the continued operation of the Millstone 2 nuclear reactor beyond the expiration of its operating license in 2015. For environmental and public health reasons, the relicensing of existing nuclear plants or the construction of new plants is not an appropriate strategy to address global warming. (See "The Dangers of Nuclear Power," below.) Should the Millstone 2 reactor be closed down at the end of its operating license, and the generating capacity it represents be replaced by natural gas-fired power plants within Connecticut, the state could expect global warming emissions in 2020 to be at least 3.0 $MMTCO_2E$ greater in 2020 than is reflected in the stakeholder report.[28]

The Dangers of Nuclear Power

For the last several decades, New England has relied upon nuclear power for a significant share of its electricity. However, between now and 2026, the operating licenses of all of New England's operating nuclear reactors are scheduled to expire. For environmental and public health reasons, neither the relicensing of existing nuclear reactors beyond their original 40-year lifespans nor the construction of new nuclear facilities should be considered as a means to reduce global warming emissions.

- **Terrorism and sabotage** – The security record of nuclear power plants is far from reassuring. In tests at 11 nuclear reactors in 2000 and 2001, mock intruders were capable of disabling enough equipment to cause reactor damage at six plants.[29] A 2003 General Accounting Office report found significant weaknesses in the Nuclear Regulatory Commission's oversight of security at commercial nuclear reactors.[30]

- **Accident risk** – In the short history of nuclear power, the industry has experienced two major accidents – at Three Mile Island and Chernobyl – that endangered the health of millions of people. The Chernobyl accident alone contaminated an area stretching approximately 48,000 square miles, with a population of 7 million. Even today, 18 years after the accident, the region surrounding the reactor continues to suffer from highly elevated rates of thyroid and breast cancer and long-term damage to the environment and agriculture.[31]

While the United States has thus far been spared an accident of the scale of Chernobyl, there have been numerous "near-misses." For example, in 2002, workers discovered a football-sized cavity in the reactor vessel head of the Davis-Besse nuclear reactor in Ohio. Left undetected, the problem could have eventually led to the leakage of coolant from around the reactor core.[32]

Regional and State Responses

The threat posed by global warming has provoked a variety of responses in Connecticut and the New England region. Despite a lack of leadership at the federal level – as evidenced by the U.S. government's unwillingness to support the Kyoto Protocol – regional organizations, governmental agencies, non-profits and some business groups have made efforts to craft solutions that would reduce New England's contribution to global warming.

New England/Eastern Canada Climate Change Action Plan

In August 2001, the governors of the six New England states, along with the premiers of the eastern Canadian provinces, adopted a regional Climate Change Action Plan that set specific goals for the reduction of global warming emissions in the region. The governors' and premiers' action was based on a history of international cooperation within the region to address environmental threats such as acid rain.

In the short term (by 2010), the plan calls for the reduction of global warming emissions in the region to 1990 levels. The medium-term goal, to be achieved by 2020, is to reduce emissions to 10 percent below 1990 levels. In the long run, the plan aims to achieve the reductions needed to eliminate any dangerous threat to the climate. Scientists currently estimate that this will require reductions of 75 to 85 percent below current emission levels.[36]

The agreement acknowledged that not every jurisdiction or every economic sector has the same potential to reduce its global warming emissions. However, in order to achieve the goals of the plan, it was envisioned that each state and sector of the economy would strive to make its share of the reductions.

The regional agreement also included a series of specific commitments for reductions in global warming emissions from conservation activities and from the

• **Spent Fuel –** Nuclear power production results in the creation of tons of spent fuel, which must be either stored on-site or in a centralized repository. Both options pose safety problems. Centralized waste repositories require the transport of high-level nuclear waste across highways and rail lines within proximity of populated areas. Once the waste arrives, it must be held safely for tens of thousands of years without contaminating the environment or endangering the public. On-site storage poses its own problems. Nearly all U.S. nuclear reactors store waste on site in water-filled pools at densities approaching those in reactor cores. Should coolant from the spent-fuel pools be lost, the fuel could ignite, spreading radioactive material across a large area. The cost of such a disaster, were it to occur, has been estimated at 54,000-143,000 extra deaths from cancer and evacuation costs of more than $100 billion.[33]

• **Cost –** Nuclear power has often proven to be expensive in market terms, due to the high cost of building, maintaining and decommissioning nuclear reactors. But looking only at market costs obscures the more than $100 billion spent by U.S. taxpayers in subsidies for an otherwise financially inefficient technology.[34] Without taxpayer money for protection against liability from accidents, research and development, and other subsidies for nuclear power, the nuclear industry likely could not have survived.

• **Aging –** Continued operation of nuclear reactors beyond their initial projected 40-year lifespan could lead to unforeseen safety problems. In 2001, the Union of Concerned Scientists identified eight instances in just the previous 17 months in which nuclear reactors were forced to shut down due to age-related equipment failures.[35]

For these reasons and others, nuclear power should remain "off the table" as a potential means to reduce global warming emissions in New England, and the region should begin to plan for the orderly retirement of New England's nuclear reactors.

transportation, electric and government sectors. Even if these sector-specific commitments are fulfilled, however, a 2003 New England Climate Coalition report estimated that the region's emissions of global warming gases will not be reduced enough to meet the goals of the Climate Change Action Plan.[37] (See Fig. 4.) To close the gap between the regional goals and the emission levels that would result from the sector-specific commitments, the Action Plan called upon states to develop their own plans and policies to reduce global warming emissions.

The Conference of New England Governors and Eastern Canadian Premiers (NEG/ECP) is continuing work toward implementation of the plan, focusing specifically on the development of an updated regional greenhouse gas inventory, the implementation of "lead by example" measures by state and provincial governments, and the investigation of measures to reduce transportation sector emissions and improve energy efficiency.

Connecticut Climate Change Stakeholder Dialogue

The regional Climate Change Action Plan also called upon each of the states to evaluate their current carbon dioxide emission levels and develop a plan for achieving required global warming emission reductions.

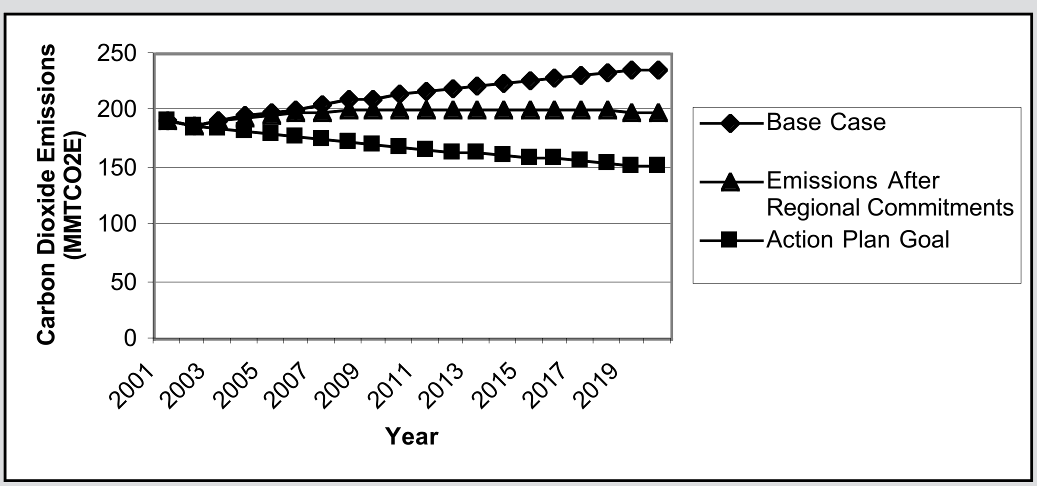
In the spring of 2003, the state of Connecticut initiated an extensive, public process designed to develop a list of recommended actions the state could take to achieve its global warming emission reduction goals. The recommendations from the stakeholder process – if adopted and implemented – would represent a positive step toward the achievement of the goals. However, the road to adoption and implementation of those policies is just beginning, and it is likely that more aggressive action in some areas (for example, in the transportation sector) will be needed to enable Connecticut to meet its climate protection goals. We will discuss the stakeholders' recommendations in greater detail in the next section.

In addition to the recommendations of the stakeholder process, Connecticut has also implemented several policies that will result in significant reductions in global warming emissions. Among the most important such policies are the state's revised renewable portfolio standard (RPS) for electricity generation, which will require 7 percent of the state's electricity to come from new, clean renewable resources by 2010, and systems benefit charges (SBC) on electricity bills that generate funding for energy efficiency and renewable energy programs (although recent moves to raid these renewable energy and energy efficiency funds severely undermine their effectiveness).

New England Climate Coalition Action Principles

In 2001, in response to the development of the regional Climate Change Action Plan, a coalition of

Fig. 4. Carbon Dioxide Emission Reductions in New England With Implementation of Climate Change Action Plan Commitments[38]



leading organizations throughout New England worked together to articulate a set of principles to guide the region's efforts toward achieving reductions in global warming emissions. The New England Climate Coalition's 10 action principles have been endorsed by 160 environmental, public health, civic and religious organizations in the six New England states and Canada.

1) **By 2010, reduce greenhouse gas emissions to levels 10 percent below 1990 levels.** The international community has negotiated a treaty with binding commitments on most of the industrialized nations to reduce emissions to well below 1990 levels. The U.S. has failed to sign onto the treaty, but as the biggest emitter of heat-trapping gases, we must lead by reducing our emissions by at least the same percentage as the other largest polluters.

2) **The NEG-ECP's long-term goal of reducing greenhouse gas emissions by 75-85 percent should be given a target date of 2050.** This timetable is necessary to minimize global temperature increases.

3) **Each consuming sector should be responsible for at least its proportionate share of the targeted emission reductions.** Any changes to these responsibilities should be based on an explicit process, which justifies changes by the relative cost-effectiveness in each sector, and ensures that any shortfalls in one sector are offset by greater reductions in another. (The sectors to be included are transportation, industrial, commercial, institutional and residential. This recognizes that the electricity sector targets will overlap.)

4) **The region and each of the states should establish a system of mandatory reporting of CO_2 and other greenhouse gas emissions by 2005.**

5) **Reduce emissions from the electricity sector as a whole by 40 percent from current levels.** Every plan should include provisions for reducing CO_2 emissions from grandfathered plants. Increasing the use or output of nuclear power is an unacceptable strategy for reducing electricity sector greenhouse gas emissions.

6) **The region and each of the states should set a target of 10 percent of electricity consumption from new, clean renewable sources by 2010, and 20 percent of electricity consumption from new, clean renewable sources by 2020.**

7) **Every plan should include a target of increasing energy efficiency in each sector by 20 percent by 2010.** The plans should consider more efficient generation of power, strong efficiency and conservation measures and greater use of combined heat and power and micropower options.

8) **The states should lead by example by:**
   a. Purchasing 20 percent of state facility electricity from clean, renewable sources by 2010.
   b. Greening the state fleet by establishing policies that require each vehicle purchased to be the model that emits the least CO_2 and other air pollutants per mile traveled while fulfilling the intended state function; prohibiting the use of inefficient vehicles such as SUVs for non-essential purposes; and establishing a schedule for replacing all state vehicles with the most efficient models available.
   c. Reducing state government's energy use by 25 percent overall by 2010.

9) **Each plan should include long-term plans for controlling sprawl, which is one of the primary factors raising emissions from transportation and buildings.** At a minimum, this should start by incorporating an assessment of CO_2 impacts into the state environmental review process.

10) **Each plan should recognize the economic development and job creation benefits of strategies to reduce greenhouse gas emissions.** And, each plan should also recognize the importance of assisting displaced workers in making a successful transition to new employment.

Many of the recommendations of the Connecticut Climate Change Stakeholder Dialogue achieve results that go beyond those envisioned by the principles; in other cases, they fall short, and additional actions will be needed. But the principles provide a yardstick against which to measure the policy options proposed by the stakeholders, and those advocated in this report and elsewhere.

The Connecticut Climate Change Stakeholder Dialogue Recommendations: A Positive First Step

In December 2003, the Connecticut Climate Change Stakeholder Dialogue (CCSD) recommended a set of 55 policies for the state to pursue in reducing its emissions of global warming gases. If implemented, the policies would result in significant reductions in global warming emissions in Connecticut, moving the state closer to achieving the regional short- and medium-term goals for emission reductions.

Summary of the Recommendations

The 55 stakeholder recommendations are broken down into five categories: transportation and land use; residential, commercial and industrial; agriculture, forestry and waste; electricity generation; and cross-cutting issues.

Transportation and Land Use

The transportation sector poses the greatest challenge for reducing global warming emissions in Connecticut. Not only is transportation the largest source of global warming emissions in Connecticut, but it is also projected to produce a growing share of the region's emissions over the next 20 years. The CCSD projected that transportation-sector global warming emissions (including black carbon) would increase by 9 percent over 2000 levels by 2010, and by 20 percent over 2000 levels by 2020.[39]

For several reasons, the options available to Connecticut for reducing transportation emissions in the short- and medium-term are limited. First, the spread of widely dispersed suburban development in Connecticut since World War II has created dependency on the automobile for many daily tasks. Adjusting land-use patterns to allow for the effective provision of transit service and the creation of other transportation alternatives in these communities is a long-term endeavor.

Second, transportation technologies often have a long life-span. The average car or SUV sold in Connecticut in 2004, for example, will likely remain on the road for the next 12 to 15 years. Other types of vehicles – such as airplanes, buses, trucks and trains – may remain in service even longer. As a result, technological advances that improve fuel economy or reduce emissions often take a long time to percolate through entire vehicle fleets.

Finally, Connecticut's range of action in the transportation sector is circumscribed by federal law. Connecticut is barred by federal law from adopting policies regulating the fuel economy of cars and trucks or from adopting emissions standards for light-duty cars and trucks other than those in place at the federal level or in California. Similarly, Connecticut does not have complete latitude in how it directs the spending of federal transportation funds, although the level of flexibility has increased in recent years.

To begin to surmount these challenges, the CCSD made a series of nine recommendations for state action. To reduce global warming emissions from motor vehicles, the stakeholders recommended adoption of the California Low Emission Vehicle II program (which sets sales requirements for hybrid-electric and other clean vehicles) and California's forthcoming tailpipe emission standards for carbon dioxide; implementation of a "feebate" program to assess fees on the sales of cars with high carbon dioxide emissions and extend rebates to purchasers of low-carbon vehicles; and the creation of incentives for the purchase of low-carbon vehicles by fleets.

In addition, the CCSD proposed a package of measures to reduce the growth of vehicle travel in Connecticut, a multi-state project to encourage the use of freight rail, a program to reduce black carbon emissions from diesel vehicles, a project to support research on hydrogen fuel cells for transportation, and a public education initiative.

The CCSD projects that the recommendations – if implemented – would reduce transportation-sector emissions by approximately 5.3 $MMTCO_2E$ below projected levels by 2020 (including black carbon). This level of reductions would still leave transportation-sector emissions in 2020 about 1.9 $MMTCO_2E$ above 1990 emissions.

Residential, Commercial and Industrial Sectors

Considered as a whole, the residential, commercial and industrial (RCI) sectors are responsible for the bulk of Connecticut's global warming emissions, both through the direct combustion of fossil fuels for space heating and other uses, and through the consumption of electricity. Strategies to reduce RCI sector emissions focus on attaining the highest energy efficiency for new buildings and equipment, replacing older, less-energy efficient equipment, and retrofitting existing structures to maximize efficiency.

The potential for energy efficiency gains in Connecticut is large. The American Council for an Energy-Efficient Economy (ACEEE) estimated in 2003 that the cost-effective potential for efficiency savings in Connecticut within the next five years is approximately 1,083 gigawatt-hours, or about 4 percent of electricity consumption. Efficiency measures could reduce natural gas consumption in the state by about 5 percent over the next five years.[40]

Energy efficiency improvements often make economic sense, especially in the long run, but a number of barriers reduce their penetration in the market. Potential users may not know about the technologies or have an accurate way of computing the relative costs and benefits of adopting them. Even when efficiency improvements are plainly justifiable in the long run, consumers may resist adopting technologies that cause an increase in the initial cost of purchasing a building or piece of equipment. In some cases, as with low-income individuals, consumers may not be able to afford the initial investment in energy efficiency, regardless of its long-term benefits.

As a result, the CCSD recommendations focused mainly on improving the baseline energy efficiency of new buildings and equipment, while eliminating barriers to improved energy efficiency.

To improve the efficiency of new buildings and equipment, the CCSD recommended the regular updating of energy efficiency codes for residential and commercial construction, the adoption of efficiency standards for eight appliances, the creation of strong standards for the efficiency of new state-funded public sector buildings, and the establishment of programs to encourage the construction of energy efficient homes and other private-sector buildings.

Alleviating the upfront cost of energy efficiency measures was the focus of several recommendations, including restoration of the electricity Conservation and Load Management Fund (which had its funding cut by approximately half last year amid the state's fiscal crisis) and the creation of similar funds to promote oil and natural gas conservation. The oil and gas funds would be supported in the same manner as the electricity fund: through a small surcharge on energy bills. Each of the funds would promote efficiency through educational programs, rebates and other incentives.

The stakeholders also proposed plans to finance efficiency, including tax credits for green buildings, bulk purchasing programs for energy-efficient appliances, "pay-as-you-save" programs to reduce the upfront cost of replacing old appliances and heat pump water heaters, and increased funding for low-income energy efficiency and weatherization programs. In addition, the stakeholders recommended other steps – including public education and voluntary programs – to encourage energy savings in homes, businesses and industry.

The stakeholder recommendations are projected to reduce global warming emissions from the direct combustion of fossil fuels within the RCI sector (not including electricity use) by about 1.9 $MMTCO_2E$ by 2020 – or about 9 percent below projected emissions. Even with adoption of the recommendations, however, RCI sector emissions would remain significantly higher than they were in 1990. The recommendations would also reduce indirect global warming emissions from electricity consumption by about 2.8 $MMTCO_2E$ by 2020.

Agriculture, Forestry and Waste Sectors

Agriculture, forestry and waste management (AFW) are responsible for only a small portion of Connecticut's global warming emissions. Emissions of methane and carbon dioxide from landfills, carbon dioxide and nitrous oxide from waste combustion, methane from livestock and manure, and nitrous oxide from soil fertilization are among the relatively small, but still significant, sources of emissions from AFW activities.

However, agriculture, forestry and land management also play a positive role by acting as "sinks" for the removal and storage of atmospheric carbon dioxide. Because plants use carbon dioxide in photosynthesis and store carbon within their tissues, the reforestation of land in Connecticut can reduce the state's net emissions of global warming gases.

The CCSD proposed 10 strategies to reduce AFW emissions. Two of the recommendations (centralized manure digesters and landfill gas-to-energy projects) seek to harness methane emissions as energy sources. Three recommendations (forest management research, urban tree planting, and forest and agricultural land preservation) attempt to capitalize on the potential development of Connecticut's croplands and woods as carbon sinks. Other recommendations aim at reducing energy use by promoting recycling and source reduction, the purchase of locally grown produce, and the use of durable wood products in construction.

The strategies recommended by the stakeholders would reduce net global warming emissions from AFW activities within Connecticut to below zero. That is, the amount of carbon stored within the state's forests and crops would exceed the amount of global warming gases produced through other agricultural, forestry and waste management activities.

Electricity Generation

Global warming emissions from electricity generation can be reduced in two ways: by reducing the consumption of electricity and by reducing the amount of global warming gases produced per unit of electricity consumed. Reducing electricity consumption is mainly achieved through actions in the residential, commercial and industrial sectors. So the stakeholder recommendations for the electric sector focus mainly on encouraging less carbon-intensive forms of electricity generation.

Several of the CCSD recommendations focus on promoting renewable sources of electricity by extending the minimum renewable portfolio standard (RPS) for electricity consumed in the state, encouraging the purchase of renewable power by government and private entities, spurring research on and installation of renewable energy sources through a production tax credit and restoration of the Clean Energy Fund, and encouraging clean combined heat-and-power (CHP) systems. The CCSD also urged that Connecticut proceed with development of a regional cap-and-trade program for carbon dioxide emissions from electricity generation with other northeastern states.

Table 2. Historic and Projected Global Warming Emissions in Connecticut as Related to Regional Goal (MMTCO_2E) [41]

	1990	2000	2010	2020
Base Case (Without Nuclear Relicensing)	42.4	46.5	48.1	59.1
Regional Goal			42.4	38.2
Stakeholder Plan (Without Nuclear Relicensing)			43.9	46.4
Additional Savings Required to Meet Regional Goal			1.5	8.2

Cross-Cutting Recommendations

In addition to the sector-specific recommendations, the stakeholders also recommended that Connecticut engage in broader efforts to educate and involve the public in issues related to global warming, and to develop the state's capacity to inventory, register and track global warming emissions.

Cumulative Impact of the Recommendations

Even with the adoption and successful implementation of the 55 recommendations, Connecticut will still have much work to do to meet the New England Governors/Eastern Canadian Premiers short- and medium-term regional global warming emission reduction goals and prepare itself to make the long-term emission reductions necessary to bring the state's activities into balance with the climate.

Not counting transportation emissions of black carbon (and assuming the closure of Millstone 2 upon the expiration of its operating license in 2015), the stakeholder recommendations would reduce global warming emissions in Connecticut by 4.2 $MMTCO_2E$ (9 percent) below projected levels by 2010 and 12.7 $MMTCO_2E$ (22 percent) by 2020. These reductions would leave the state 1.5 $MMTCO_2E$ short of achieving the goal of reducing emissions to 1990 levels by 2020, and 8.2 $MMTCO_2E$ short of achieving the goal of reducing emissions to 10 percent below 1990 levels by 2020. (See Table 2.)

Thus, while the stakeholder recommendations are a positive first step – and should be implemented as quickly as possible – Connecticut still needs to take additional steps to rein in its emissions of global warming gases. The next section suggests a number of ways Connecticut could meet this challenge.

Beyond the Stakeholder Recommendations: Connecticut's Next Steps on Global Warming

As noted above, even if all 55 of the stakeholder recommendations were implemented, Connecticut would still fall short of achieving the short- and medium-term global warming emission reduction goals envisioned in the Conference of New England Governors and Eastern Canadian Premiers Climate Change Action Plan. And while certain of the recommendations would help Connecticut move toward achievement of the region's long-term goals, they fail to take full advantage of crucial opportunities for technological transformation – such as the widespread development of Connecticut's solar power potential.

Clearly, Connecticut will need to implement additional policy solutions to achieve its global warming goals. In some cases, these solutions are well-developed and can be adopted and implemented in the short-term. In other cases, significant hurdles will have to be overcome prior to adoption.

Strategies for Near-Term Adoption

1. Adopt Energy Efficiency Standards for Seven Appliances and Allow for Administrative Adoption of Future Efficiency Standards

Potential Savings: 0.29-0.66 $MMTCO_2E$ by 2010; 0.80 $MMTCO_2E$ by 2020[42]

Household appliances and those used by business are a major source of energy demand. Since the first state appliance efficiency standards were adopted in the mid-1970s (followed by federal standards beginning in the late 1980s), the energy efficiency of many common appliances has dramatically improved. For example, residential refrigerators complying with the latest national standards consume less than one-third the electricity of refrigerators manufactured in the early 1970s.[43]

Table 3. Products Covered Under Proposed Efficiency Standards[46]

Residential Products	In Stakeholder Plan	Federal Preemption Exists
Furnace fans		x
Torchiere light fixtures	x	
Ceiling fans		
Consumer electronics (standby power)		
Central air conditioners and heat pumps*		x
Commercial Products		
Unit and duct heaters	x	
Small packaged air conditioners and heat pumps*		x
Beverage vending machines		
Dry-type building transformers	x	
Commercial refrigerators and freezers	x	
Traffic signals	x	
Exit signs	x	
Commercial (coin-operated) clothes washers	x	
Ice makers		
Large packaged air conditioners	x	

** Subject to stronger federal standards recently reinstated through court action.*

The federal appliance standards program has led to great improvements in the efficiency of many appliances, but progress has slowed in recent years. Federal standards have failed to keep up with advances in efficiency technologies. In addition, the federal program does not cover some appliances with great potential for improved efficiency.

States are pre-empted from adopting their own efficiency standards for products covered by federal standards, but there are two opportunities for states to take action. First, states may adopt efficiency standards for products not specifically covered by the federal program. In addition, states have the opportunity to apply for a waiver of federal pre-emption to apply stronger standards to products currently covered by federal standards.

An analysis conduced in 2002 by Northeast Energy Efficiency Partnerships (NEEP) assessed the potential energy savings that would result from the adoption of improved efficiency standards for 15 commercial and residential products. (See Table 3.) Using NEEP's projections for total electricity savings, moving forward with standards for all such products would yield electricity savings of 2,343 gigawatt-hours (GWh) in 2020 – equal to about 8 percent of Connecticut's electricity use in 2001.[44] The NEEP study estimated that adoption of the package of appliance standards would bring Connecticut approximately $1.5 billion in net economic benefit by 2020.[45]

In estimating the carbon dioxide reductions that would result from efficiency standards and other measures that reduce electricity use, a key factor is the type of electricity generation that is assumed to be affected by the reduction in consumption. Coal- and oil-fired power plants (particularly older plants) release significantly greater amounts of carbon dioxide per unit of electricity produced than modern natural gas-fired power plants. Thus, the resulting emission reductions are low if it is assumed that electricity savings reduce the need for the construction of new gas-fired power plants, and high if they reduce the amount of power coming from older coal- and oil-fired plants.

In this report, where applicable, we present a range of emission reductions based on these different assumptions. The low end of the range is based on the assumption that electricity savings are first used to offset any reduction in generation from nuclear plants that would be closed down upon expiration of their licenses, with the remaining savings used to reduce the need for gas-fired generation in the New England grid. The high end of the range is based on the assumption that savings are first used to offset retired nuclear power, with the remainder used to reduce coal-fired generation. It is likely that the higher emission reduction estimate would only be achieved under a strong state or regional cap on electric-sector emissions. (See Strategy #8.)

The stakeholders recommended that Connecticut adopt efficiency standards for eight of the appliances identified in the NEEP report. While these eight products are the easiest to move forward with (not requiring a federal waiver and with alternatives readily available on the market and standards fully developed), they miss out on much of the potential for energy savings identified by NEEP. For example, the adoption of standards for standby power for consumer electronics and residential ceiling fans (neither of which is subject to federal preemption) would save more electricity than adopting standards for the eight products recommended by the CCSD.[47] Adding in products subject to federal preemption – such as furnace fans – would create even more savings.

Based on NEEP's projected electricity savings for the seven appliances not covered by the stakeholder recommendations, adoption of efficiency standards for those appliances could result in carbon dioxide emission reductions of 0.8 $MMTCO_2E$ by 2020.

The stakeholder recommendations are attractive in that they can be implemented quickly, with less controversy and without a federal waiver, and the adoption of a package of standards along those lines would be a good start for Connecticut. However, the significant energy savings that would result from other appliance standards suggest that Connecticut should also work to adopt standards that encourage manufacturers to install known efficiency technologies on their products (such as low-wattage standby power) and by forcing the issue of improved efficiency standards at the federal level.

Another way in which Connecticut can expand the benefits of efficiency standards is to grant administrative authority for the adoption of new standards, without the need for additional legislative action. Rapid advances in consumer electronics and other technologies mean that new devices are arriving on the market virtually every day – providing new opportunities for energy savings. Connecticut should have the flexibility to take advantage of these opportunities as soon as they become available.

2. Improve Energy Efficiency by Increasing Funding for the Conservation & Load Management Fund

Potential Savings: 0.29-0.68 MMTCO$_2$E by 2010; 0.68 MMTCO$_2$E by 2020

One of the most promising opportunities for reducing carbon dioxide emissions in Connecticut is through improved energy efficiency, which also frequently saves money on fuel costs. Traditionally, states have required electric utilities to make investments in efficiency programs through the rate-setting process. In the wake of electric industry restructuring, however, some states have dropped efficiency requirements, while others – including Connecticut – have created a new means of financing efficiency improvements through the assessment of systems benefit charges (SBCs) on consumers' electric bills.

The concept behind the SBC is that all electric consumers share in the benefits when any consumer improves his or her energy efficiency. These benefits are both social (reduced global warming emissions and air pollution and improved long-run energy security) and purely economic (reduced need for expensive peak generation and ratepayer investments in transmission and distribution systems).

Connecticut established its system of SBCs through electric restructuring legislation adopted in 1998. SBCs are assessed in Connecticut to support energy efficiency programs through the Conservation and Load Management Fund, the development of renewable energy sources through the Clean Energy Fund, and low-income assistance programs.

The efficiency SBC is assessed to customers of United Illuminating and Connecticut Light & Power, which provide about 95 percent of Connecticut's electricity.[48] The SBC rate is 3 mills ($0.003) per kilowatt-hour (kWh), an assessment that generated more than $87 million in efficiency funding in 2002.[49] Connecticut's efficiency programs are run by the two electric utilities with the coordination and approval of the Energy Conservation Management Board. In 2002, the board reported that efficiency programs saved approximately 246 GWh of electricity (a savings rate of about 3 kWh annually per dollar spent), which will lead to economic savings of about $373 million over the lifetime of the efficiency measures.[50] SBC funds supported a wide variety of efficiency-related programs, ranging from research and development and public outreach to incentives for the purchase of energy efficient equipment for homes and businesses.

Unfortunately, with the state in the midst of a fiscal crisis, the Legislature moved in 2003 to divert SBC funds to fill shortfalls in the general state budget. The Legislature's action is expected to reduce by about half the amount of money available for efficiency programs.[51] As a result, efficiency improvements – and their associated short- and long-term economic benefits – will be reduced.

The stakeholders recommended that full funding be restored to the Conservation and Load Management Fund. But even with full funding, Connecticut's full potential for energy efficiency improvements will likely remain untapped. Should Connecticut increase the SBC for energy efficiency by 2 mills, the state could generate tens of millions of additional dollars for efficiency improvements. Even assuming that efficiency savings from added SBC revenue would come at a substantially lower rate (given the decreasing availability of "low-hanging fruit" over time), Connecticut could still achieve electricity savings of upwards of 650 GWh per year by 2010 and 1,500 GWh per year by 2020.[52] These savings represent 2 percent and 5 percent, respectively, of Connecticut's electricity consumption in 2001.[53]

The near-term impacts of expanded residential, commercial and industrial energy efficiency programs may represent just the tip of the iceberg of the potential benefits of an expanded SBC program. By funding research and development into efficient new technologies and practices and broadening public understanding of the potential benefits of energy efficiency, these programs can create new opportunities for cost-effective energy savings in the years to come.

3. Reduce Natural Gas and Heating Oil Consumption by Increasing Funding for Proposed Conservation Programs

Potential Savings: 0.40 MMTCO$_2$E by 2010; 0.91 MMTCO$_2$E by 2020

The stakeholder recommendations proposed the creation of two new funds to support energy efficiency: a natural gas conservation fund and a heating oil conservation fund. Both funds would be supported by a small levy on oil and gas bills, in much the same way that improvements in electrical energy efficiency are supported through Connecticut's systems benefit charge on electricity bills. The stakeholder recommendation proposes that each fund operate on a $20 million initial budget, funded through a roughly 2 percent charge on fuel bills.

The recommendation for oil and gas conservation funds is a good one, correcting the discrepancy by which electricity customers pay to support energy efficiency, while users of oil, gas and other fuels face no such obligation. While the stakeholder recommendation is a step in the right direction, it does not fully close the equity gap and should be expanded upon to create more funds with which to undertake energy efficiency improvements in homes, businesses and industry.

In comparing the proposed conservation charges for oil, gas and electricity, one can use one of two yardsticks. First, one can compare the proposed charges based on the percentage of the charge relative to energy cost. Based on EIA projected residential energy costs for 2005, the proposed 2 percent oil and gas surcharges appear to be smaller than the current electric SBC for efficiency.[54] (See Table 4.)

A second yardstick is the charge per unit of energy consumed. Assuming a New England-wide average heat rate for electricity generation of 9,581 BTU/kWh for 2005 (heat rate being a measure of the amount of energy consumed at power plants to produce a kWh of electricity at the point of use), and assuming that all residential, commercial and industrial sales of residual and distillate fuel oil are covered by the charge, oil and gas consumers would still pay significantly less per unit of energy than electricity customers.[56] (See Table 5, next page.)

By either measure, electricity customers would contribute more to energy conservation than oil and gas users. This disparity would be exacerbated if, as recommended above, the electric SBC for efficiency were increased to 5 mills/kWh.

An oil and gas conservation charge of approximately $0.35 per million BTU of energy consumed would help to level the playing field among the fuels, while generating approximately double the revenue of the conservation funds proposed by the CCSD. With such a charge, residential distillate fuel oil and natural gas customers would pay conservation charges amounting to about 4.6 percent and 3.7 percent, respectively, of their projected 2005 energy bills, while electricity customers paying a 5 mill SBC would pay charges of about 5 percent of their projected bills.

Assuming the same rate of energy savings as assumed in the stakeholder report (the equivalent of 34 cubic feet of gas per dollar spent), adjusted downward by 25 percent to account for the declining availability of "low-hanging fruit" savings over time, the proposed increase in the oil and gas conservation charges would reduce carbon dioxide emissions by about 0.91 million metric tons by 2020. In the meantime, by reducing consumption of natural gas and heating oil,

Table 4. Current and Proposed Efficiency Charges in Connecticut by Percent of Projected Residential Electric Price in 2005[55]

Proposed Charge	Percent of Residential Price
Existing Electric SBC (3 mills/kWh)	~3%
Natural Gas Conservation Fund	~2%
Oil Conservation Fund	~2%

Table 5. Current and Proposed Efficiency Charges in Connecticut by Primary Energy Use (Million BTU)[57]

Proposed Charge	Cost Per Unit of Primary Energy Use (Million BTU)
Existing Electric SBC (3 mills/kWh)	$0.31
Natural Gas Conservation Fund	$0.15
Oil Conservation Fund	$0.18

Connecticut would enjoy improved energy security, be less susceptible to fuel price spikes, and send less of its dollars outside the local economy for fossil fuel purchases.

The effect of increased conservation charges on low-income households should play a role in determining how funds from the charges are spent. Weatherization, appliance-swapping and other efficiency programs should place a special focus on reducing the energy bills of low-income residents. For those who participate in the programs, more efficient energy use can offset or eliminate the increased cost per unit of energy used.

4. Implement "Pay-As-You-Drive" Auto Insurance

Potential Savings: 0.72 MMTCO_2E by 2010; 0.80 MMTCO_2E by 2020

In a perfect market, the rates individuals paid for insurance coverage would accurately reflect the risk they pose to themselves and others. Automobile insurers use a host of measures – including vehicle model, driving record, location and personal characteristics – to estimate the financial risk incurred by each driver.

One measure that is not frequently used with accuracy is travel mileage. Common sense and academic research suggest that drivers who log more miles behind the wheel are more likely to get in an accident than those whose vehicles rarely leave the driveway.[58] Many insurers do provide low-mileage discounts to drivers, but these discounts are often small, and do not vary based on small variations in mileage. For example, a discount for vehicles that are driven less than 7,500 miles per year does little to encourage those who drive significantly more or less than 7,500 miles per year to alter their behavior. As a result, the system fails to effectively encourage drivers to reduce their risk by driving less.

Requiring automobile insurers to offer mileage-based insurance is just one of many potential policies that attempt to reallocate the upfront costs of driving. High initial cost barriers to vehicle ownership – such as insurance, registration fees and sales taxes – may reduce driving somewhat by denying vehicles to those who cannot afford these costs. But for the bulk of the population that can afford (or has little choice but to afford) to own a vehicle, these high initial costs serve as an incentive to maximize the vehicle's use. Per-mile charges operate in the opposite fashion, providing a powerful price signal for vehicle owners to minimize their driving and, in the process, minimize the costs they impose on society in air pollution, highway maintenance, congestion and accidents.

A pay-as-you-drive system of insurance in Connecticut might work this way: vehicle insurance could be split between those components in which risk is directly related to the ownership of a vehicle (comprehensive) and those in which risk is largely related to driving (collision, liability). The former could be charged to consumers on an annual basis, as is done currently. The latter types of insurance could be sold in chunks of mileage – for example, 5,000 miles – or be sold annually, with the adjustment of premiums based on actual mileage taking place at the end of the year. Of critical importance to the success of the system would be the creation of accurate, convenient methods of taking odometer readings and communicating them to the insurer.

A pay-as-you-drive system of insurance would have great benefits for Connecticut – not only for reducing global warming emissions but also for improving highway safety and reducing insurance claims. Because insurers would still be permitted to adjust their per-mile rates based on other risk factors, mileage-based insurance would add an additional incentive for unsafe drivers to drive sparingly.

Most importantly, however, a mileage-based insurance system would reduce driving – particularly in a state with high auto insurance rates such as Connecticut. Converting the average collision and liability insurance policies to a per-mile basis in Connecticut would lead to an average insurance charge of about nine cents per mile.[59] (By contrast, a driver buying gasoline at $1.50 per gallon for a 20 MPG car pays only 7.5 cents per mile for fuel.)

Research conducted by the U.S. EPA and updated by the Victoria Transport Policy Institute suggests that if 80 percent of the cost of collision and liability insurance in Connecticut were collected by the mile, vehicle-miles traveled would be reduced by about 11.2 percent, with carbon dioxide emissions from light-duty vehicles declining by roughly the same amount.[60] Assuming that half of Connecticut drivers participate in the program, this would translate to carbon dioxide emission reductions of about 5.6 percent from light-duty vehicles.

While many insurers remain resistant to the administrative changes that would be needed to implement mileage-based insurance, the concept is beginning to make inroads. The Progressive auto insurance company has offered a pilot pay-as-you-drive (PAYD) insurance system in Texas and other pilot programs are underway elsewhere. In 2003, the Oregon Legislature adopted legislation to provide a $100-per-policy tax credit to insurers who offer PAYD options.[61]

Connecticut should choose to introduce the concept by requiring insurers to offer it as an alternative to traditional insurance. If the concept proves successful, the state (or insurers) could then require liability and collision rates to be expressed in cents-per-mile.

Policy Alternative: Pay-At-The-Pump Insurance

A close relative of pay-as-you-drive insurance, pay-at-the-pump policies would require the state to collect a surcharge on gasoline sales that would then provide minimal insurance coverage to drivers. Drivers would still purchase additional insurance coverage in the traditional manner.

Pay-at-the-pump systems have three advantages. First, they do not require verification of odometer readings. Second, as a global warming measure, they tie insurance coverage to the amount of fuel used – encouraging both reductions in vehicle travel and the purchase of more efficient vehicles. Third, drivers of larger, less-fuel efficient vehicles (such as large SUVs) impose greater costs when they get into accidents. Evidence shows that SUVs and other large vehicles are more likely to kill or severely injure occupants of other vehicles in a collision and that the sense of security provided by driving in a large vehicle may lead to more dangerous driving behaviors.[62] To the extent this is true, pay-at-the-pump can put a price on the additional risk these vehicles pose.

Pay-at-the-pump has disadvantages, however, that make it an inherently less appealing policy. First is the administrative issue of whether the state itself or a private insurer provides the minimal coverage paid for at the pump. Second, pay-at-the-pump systems do not discriminate based on driving record or any other indicator of risk.

5. Require the Sale of Low-Rolling Resistance Tires

Potential Savings: 0.20 MMTCO$_2$E by 2010; 0.33 MMTCO$_2$E by 2020

Automobile manufacturers typically include low rolling resistance (LRR) tires on their new vehicles in order to meet federal corporate average fuel economy (CAFE) standards. However, LRR tires are generally not available to consumers as replacements when original tires have worn out. As a result, vehicles with replacement tires do not achieve the same fuel economy as vehicles with original tires.

The potential savings in fuel – and carbon dioxide emissions – are significant. A 2003 report written for the California Energy Commission found that LRR tires would improve the fuel economy of vehicles operating on replacement tires by about 3 percent, with the average driver replacing the tires on their vehicles when the vehicles reach four, seven and 11 years of age. The resulting fuel savings would pay off the additional cost of the tires in about one year, the report found, without compromising safety or tire longevity.[63]

Several potential approaches exist to encourage the sale and use of LRR tires – ranging from labeling campaigns (similar to the Energy Star program) to mandatory fuel efficiency standards for all light-duty tires sold in the state. A standards program that required the sale of LRR tires beginning in 2005 in Connecticut – assuming the same tire replacement schedule and per-vehicle emission reductions found in the California study – would ultimately reduce carbon dioxide emissions from the light-duty fleet by about 1.6 percent by 2010 and 2.3 percent by 2020, while also providing a net financial benefit to consumers through reduced gasoline costs.

6. Implement a Public Sector Emission Reduction Strategy With Concrete, Measurable Goals

Potential Savings: 0.09 $MMTCO_2E$ by 2010; 0.12 $MMTCO_2E$ by 2020

(Savings overlap with stakeholder recommendations.)

The New England Governors and Eastern Canadian Premiers agreement puts great emphasis on the need for government to "lead by example" in the effort to reduce global warming emissions. The stakeholder recommendations include at least six specific initiatives that embody this principle:

- Requiring new state-owned and state-funded buildings to meet high standards for energy efficiency.
- Creating a shared savings program to encourage energy efficiency improvements in state agencies.
- Encouraging colleges and universities to join in a "green campus" initiative.
- Creating new tools for benchmarking, measuring and tracking energy use in municipal buildings.
- Procuring environmentally preferable products.
- Purchasing significant amounts of renewably generated power for state use.

State and local governments also play important roles in several of the CCSD's recommendations in other sectors.

The policies recommended by CCSD are beneficial, but lack relation to an overarching goal for state energy use. If all of Connecticut is to be held accountable for achieving the NEG/ECP goals, then it only makes sense that state government be held accountable to its own aggressive goals for reducing carbon dioxide emissions.

We suggest three goals for the state to meet, consistent with the New England Climate Coalition's Action Principles:

- Purchasing 20 percent of state facility electricity from clean, renewable sources by 2010.
- Greening the state fleet by establishing policies that require each vehicle purchased to be the model that emits the least CO_2 and other air pollutants per mile traveled while fulfilling the intended state function; prohibiting the use of inefficient vehicles such as SUVs for non-essential purposes; and establishing a schedule for replacing all state vehicles with the most efficient models available.
- Reducing state government's energy use by 25 percent overall by 2010.

The first goal has already been adopted and expanded upon by the CCSD. As for vehicle efficiency, it is reasonable to expect that an aggressive policy of purchasing high fuel-economy gasoline vehicles and dedicated, low-carbon alternative fuel vehicles could reduce carbon dioxide emissions per mile traveled by 20 percent by 2010 and 28.5 percent by 2020 (corresponding to a 25 percent increase in real-world miles-per-gallon fuel economy by 2010 and a 40 percent increase by 2020.)

The proposed 25 percent reduction in state energy use by 2010 is roughly equivalent to the NEG/ECP commitment to reduce public-sector global warming emissions by 25 percent by 2012. In Connecticut, state government consumes about 2 percent of the state's electricity, along with large amounts of natural gas and heating oil.[64] Reducing the state's energy consumption would play a significant role in reducing overall global warming emissions while setting an example for private sector actors to follow.

Several of the stakeholder recommendations can play a part in achieving the targeted reductions in state energy use. But without an overall goal against which to mark progress (and the development of tools to inventory and track state government emissions), it will be difficult for the state to maintain focus on reducing its global warming emissions.

7. Adopt a Solar Photovoltaic Strategy With Adequate Funding

Potential Savings: 0.003-0.006 MMTCO$_2$E by 2010; 0.01 MMTCO$_2$E by 2020.

Solar power is currently a bit player in the generation of electricity in New England. Barring a technological breakthrough, it will likely remain a bit player for at least the next decade. But Connecticut and other New England states can play a leading role in positioning solar power to make a major contribution to the region's long-term global warming emission reduction goals.

Over the long term, solar photovoltaics (PVs) have the potential to be a major contributor to a clean energy future, offering power that is distributed (reducing transmission and distribution costs), scalable and pollution-free. However, solar PV remains significantly more expensive than other forms of centrally generated and distributed power.

Solar PV's path to market competitiveness is through volume-driven reductions in the per-piece cost of manufacturing, coupled with regulatory, technological and other changes that make it easier for homeowners and businesses to take full advantage of solar power. The impact of volume on price has been demonstrated clearly over the past decade, as U.S. shipments of PV modules have increased six-fold, helping to drive a 44 percent reduction in cost.[65]

Connecticut and other states can hasten the arrival of market-competitive prices for solar PV by investing in solar capacity and easing solar installations. In the short run, these investments in solar will appear more expensive than other renewables or efficiency programs. But the benefits of such an approach will be more than worth it in the long run, as Connecticut works to achieve the 75 to 85 percent long-term reductions called for in the NEG/ECP Climate Change Action Plan.

One potential tool is to increase the systems benefit charge for renewables and dedicate the increased revenue exclusively to the installation of solar photovoltaic (PV) panels on homes and businesses. Connecticut currently assesses a renewables SBC of 0.75 mills per kWh (to increase to 1 mill in 2004), which funds the activities of the Connecticut Clean Energy Fund to support the development of renewable power. By adding 0.15 mills to the SBC dedicated exclusively to providing incentives for solar PV installations, Connecticut could help provide a significant boost to the development of solar PV.

Solar programs in New England are already being supported by SBCs. The Connecticut Clean Energy Fund is funding PV installations up to $5 per Watt for commercial, industrial and institutional applications.[66] In Massachusetts, the Massachusetts Technology Collaborative (which is supported by the state's renewables SBC) has launched a program providing subsidies of up to $5 per Watt for the installation of solar PV capacity on commercial buildings and in residential clusters.[67]

A $4 per Watt subsidy appears to be sufficient to make solar power cost-competitive in New England. A recent analysis found that commercial solar PV systems in Massachusetts (including the subsidy) could cost as much as $11 per Watt and still break even financially for the purchaser. Installed commercial PV systems in the U.S. range in price from $7 to $12 per Watt, making PV systems largely cost-competitive (with subsidy) in Massachusetts.[68] Similarly, a $4 per Watt subsidy would enable buyers to spend more than $7 per Watt on residential solar systems in Connecticut and still break even, putting solar PV on the margins of economic competitiveness.[69]

A subsidy program of the kind described here, if fully utilized, would result in the generation of about 12 GWh of power from new solar installations in Connecticut by 2010 and 47 GWh by 2020. Even with this ramp-up of solar power, total generation in 2020 would represent less than two-tenths of one percent of the electricity generated in the state in 2001.[70]

Much of this new solar power would likely be used to satisfy requirements under Connecticut's renewable portfolio standard for electricity, but it is likely that at least some of the new solar PV systems would produce renewable power not counted toward the RPS as a result of individuals' choice not to take RPS credit for the systems or through the market purchase of green power. The new solar PV systems would not even begin to tap Connecticut's potential for solar PV development, with the equivalent of only about 9,900 Connecticut homes bearing rooftop solar PV systems by 2020.[71]

These goals for solar development are conservative when compared to efforts in some other states and regions. New Jersey, for example, has adopted a statewide goal of generating 120 GWh of power per year from solar PV by 2008.[72]

Other financing and regulatory tools beyond the SBC can also aid in encouraging PV installations, including "pay-as-you-save" programs (see page 39, below) and the elimination of barriers to the installation of distributed generating capacity. Connecticut should also consider and eventually adopt building codes that require the construction of "solar-ready" residential and commercial buildings. Such codes could require that new construction be wired and plumbed to accept PV and solar water heating systems.

While a solar program such as the one envisioned here would have only a limited short- and medium-term impact on carbon dioxide emissions, the long-term impact is potentially great. The increased installation of solar PV systems would improve the economics of solar power and begin to change the perception of solar systems from exotic curiosities to a day-to-day feature of life in many communities. Should Connecticut and other states make a long-term commitment to solar, PV manufacturers would have the market confidence they need to make investments in new production capacity, ultimately contributing to lower prices for consumers. With such a development, the state and region would then be poised for a dramatic increase in solar installations in the 2020-2050 period; precisely the time when the region will be needing to make deep reductions in its global warming emissions in keeping with the New England governors' long-term goal.

8. Adopt a Strong Carbon Cap for Reducing Electric Sector Emissions Without Relicensing of Nuclear Reactors

Potential Savings: Included in above estimates.

Connecticut is currently working with nine other northeastern states, from Maine to Delaware, to develop a regional cap-and-trade system for electric-sector global warming emissions. The initiative, known as the Regional Greenhouse Gas Initiative (RGGI), parallels efforts in Massachusetts and New Hampshire to set carbon dioxide emission limits for electric generation in those states and discussions of similar limits at the federal level.

The RGGI process provides a unique opportunity to shift from widespread reliance on polluting, carbon-intensive coal- and petroleum-fired generation to the increasing use of renewable power and energy efficiency to meet the region's electricity needs. However, the promise of these efforts could easily be lost if the level of the cap does not drive significant emission reductions. It could also lose public support if the program makes the dangerous tradeoff of allowing nuclear power to get credit, subsidies or broad market advantage as a source of "clean" power.

- **Cap Levels** – The stakeholders recommended that the NEG/ECP goals for global warming emission reductions (1990 levels by 2010; 10 percent below 1990 levels by 2020) be the starting point for recommended cap levels and timing. This goal may be insufficiently ambitious. Opportunities for reducing emissions from the electric sector are numerous, including the promotion of energy efficiency in homes, businesses and industry; the retirement of old, inefficient fossil fuel-fired power plants; and the expansion of renewable and clean distributed generation.

  These initiatives are potentially mutually reinforcing. Reducing growth in electricity consumption reduces the amount of new generating capacity that must be built to satisfy demand. Renewable and distributed generation further reduces demand for fossil and nuclear generation. Together, these changes reduce the necessity to maintain existing, inefficient sources of generation and allow their expedited replacement with more efficient sources.

The New England Climate Coalition recommends an overall goal of reducing carbon dioxide emissions from electricity generation by 40 percent below current levels. The adoption of aggressive efficiency and renewables programs by all six New England states would bring this goal within reach by 2020, even without relicensing of the region's nuclear reactors. Should those nuclear plants be retired at the expiration of their operating licenses, New England could achieve reductions of as much as 30 percent below current levels, with further reductions possible in the years that follow. (This corresponds to a 22 percent reduction from 1990 emission levels. See box next page.)

The centrality of the cap level to the region's global warming reduction efforts cannot be overstated. The electric sector represents one of the largest potential sources of global warming emission reductions in the region. A cap goal that achieves only the level of reductions called for by NEG/ECP will reduce the chances that further electric sector reductions can compensate for rising emissions in other sectors – such as the transportation sector – in which the opportunities for near-term emission reductions are less apparent.

- **Nuclear Power and Offsets** – A carbon cap-and-trade program should not be allowed to become a backdoor subsidy for nuclear power. For environmental and public safety reasons, Connecticut and the New England states should be moving toward a phase-out of nuclear generating capacity, beginning with the retirement of existing nuclear reactors upon the expiration of their current operating licenses. The expansion or maintenance of nuclear generating capacity in New England or elsewhere should not be permitted to qualify as an offset under any cap-and-trade program.

  The use of offsets as a method of compliance with the carbon cap also produces other potential problems. Massachusetts' rule for its electric sector carbon dioxide emission cap requires that any offsets provide "real, surplus, verifiable, permanent and enforceable" emission reductions.[73] Practically speaking, designing offsets that meet these criteria is extraordinarily difficult. Demonstrating that an emission reduction is truly "surplus" requires administrators of a cap-and-trade program to assess what would have happened in the absence of a cap – for example, whether energy efficiency improvements used to generate offsets would have happened anyway. And assessing permanence requires frequent verification that previous emission reductions or sequestration activities remain in effect.

  A sure way to avoid these problems is to draw the initial boundaries of any trading program very narrowly – including only those sources that emit carbon dioxide, and only those within the region covered by the program (in the case of RGGI, within the 10-state region).

- **Leakage** – Modeling conducted for the CCSD suggested that many of the emission reductions achieved under a regional carbon cap could be largely offset by increased emissions from power producers outside the region that export electricity to the Northeast. To prevent this "leakage" of emission reductions, the region must ensure a level playing field between electricity generated in the Northeast and imported electricity, perhaps by setting carbon dioxide emission standards for imported electricity. Another alternative is to expand the cap to cover the widest possible range of generators over the greatest possible geographic area, while maintaining strong provisions to ensure that the cap is enforced.

- **Auctioning Credits** – Another point of tension revolves around whether existing electricity generators in the Northeast would be required to buy emission credits at the outset of a carbon cap or be given them for free. The free granting of emission credits to existing generators would act as a *de facto* subsidy to those plants, as well as grant those plants an effective "right to pollute." In addition, the auctioning of emission credits could produce a source of income that could be returned to all residents, used to support efficiency and renewable power, or used for transition help for displaced workers.

The resolution to these issues will come through extensive negotiations over the coming months. Connecticut should use its position in the talks to maximize the potential benefits of the regional carbon cap, and preserve its options to cap electric-sector emissions through other channels, such as through a New England-wide or state program.

The Role of a Regional Carbon Cap in Reducing Electric-Sector Emissions

To demonstrate the feasibility of a strong electric sector carbon cap without nuclear relicensing, estimates were made of current and projected New England electricity use and carbon emissions based on the adoption by all six New England states of the policies described in this report and a number of other policies similar to those recommended by the Connecticut stakeholders. A detailed discussion of the methodology for this analysis is presented in Appendix B.

The policy case assumes that all six New England states adopt:

• Updated residential and commercial building energy codes and future code updates.

• Appliance efficiency standards for all appliances identified in the CCSD recommendations and this report.

• An increase in electric systems benefit charges for energy efficiency to 5 mills/kWh.

• A renewable portfolio standard for electric generation that requires that 10 percent of electricity come from new renewables by 2010 and 20 percent by 2020.

• A solar PV program as described above.

• Reductions in state government energy use as described above and the purchase of 20 percent of state government electricity from renewable sources by 2010 and 50 percent by 2020.

Were a carbon cap to be structured so as to use efficiency savings and new renewables from these strategies to offset generation from nuclear reactors whose licenses expire, then from coal-fired power plants, New England could achieve up to a 29 percent reduction in electric sector carbon dioxide emissions by 2020 versus 2001 levels – assuming that New England produces as much electricity as it uses and that there is no "leakage" of emissions benefits out of the region.[74] By contrast, using those efficiency savings and new renewables to offset natural gas-powered generation (forecast by EIA to make up virtually all of New England's new generating capacity after 2009), would result in reductions of only 3 percent below 2001 levels by 2020. (See Fig. 5.) Both cases assume the retirement of New England's nuclear reactors at the expiration of their current licenses.

Decisions regarding the level of a regional carbon cap will invariably take many factors into account beyond achieving the maximum carbon dioxide emission reductions. It is likely that emission reductions from a well-structured cap would fall somewhere between the 3 percent and 29 percent reductions estimated here. However, it is also possible that an aggressive regional effort to promote renewables could enable them to become economically competitive with other forms of generation. Were that scenario to take place, the level of emission reductions possible under a carbon cap would be significantly greater.

Fig. 5. New England Projected Carbon Dioxide Emissions from Electricity Generation ($MMTCO_2E$)[75]

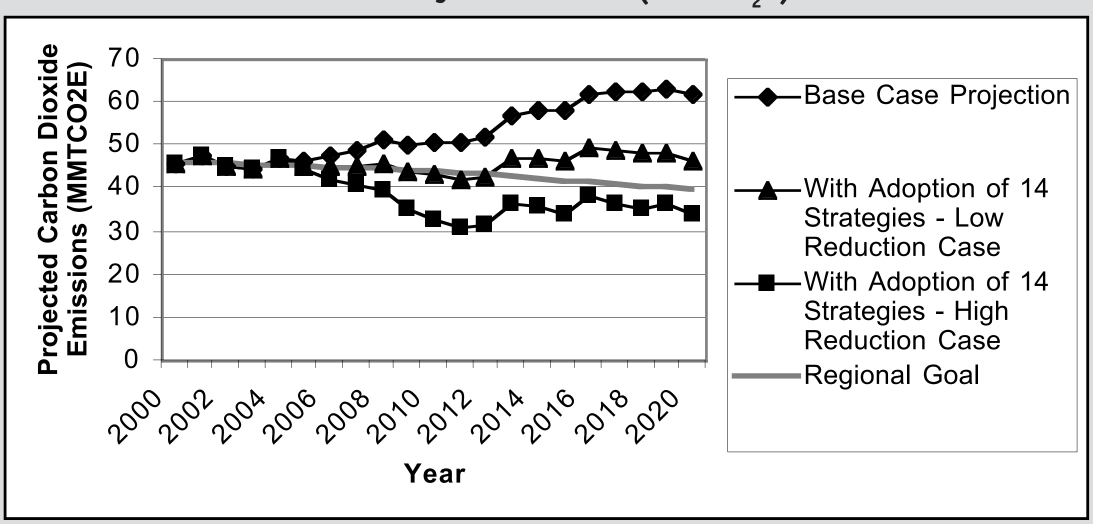
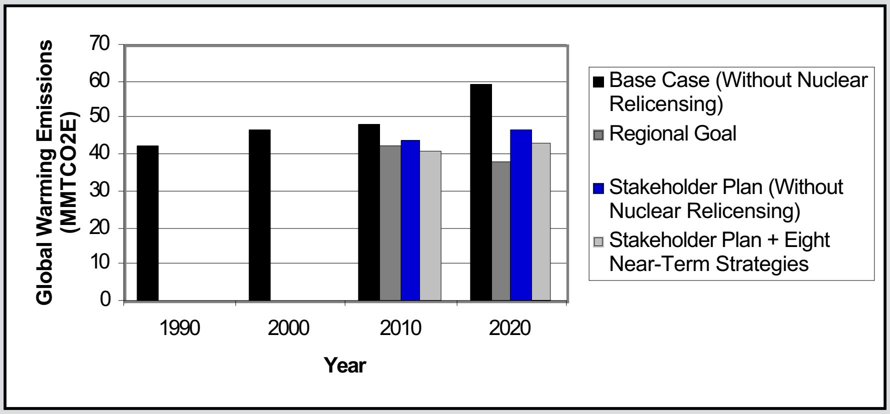


Fig. 6. Connecticut Global Warming Emissions ($MMTCO_2E$)



Summary of the Near-Term Strategies

Adoption of the eight near-term strategies listed above, in addition to the stakeholder recommendations, would enable Connecticut to achieve the short-term goal of reducing carbon dioxide emissions to 1990 levels by 2010, reducing carbon dioxide emissions by an additional 2.0-2.8 $MMTCO_2E$; more than the 1.6 $MMTCO_2E$ in additional reductions estimated by the stakeholders to be necessary to reach the regional goals. The strategies also move the state closer to achieving the medium-term goal of reducing emissions to 10 percent below 1990 levels by 2020, reducing emissions by 3.7 $MMTCO_2E$ of the 8.1 $MMTCO_2E$ remaining after adoption of the CCSD recommendations, assuming the closure of Millstone 2 at the expiration of its operating license.

Closing the remaining gap in 2020, and achieving the long-term goal of reducing emissions by 75 to 85 percent will require additional action on a variety of fronts. The following are suggested strategies that can help Connecticut meet those goals.

Additional Strategies Requiring Investigation

Even with adoption of the stakeholder recommendations, global warming emissions from the transportation and residential/commercial/industrial sectors are still projected to significantly exceed 1990 emission levels in 2020. Energy use in these sectors is closely tied to land use and development patterns in Connecticut.

Connecticut and other states are in urgent need of policy strategies that can effectively address the challenges posed in transportation, land use and energy consumption in homes, businesses and industry. The strategies listed below hold significant promise for reducing Connecticut's global warming emissions, but require either further investigation or consensus-building among affected stakeholders before they reach the level of policy proposals ready for implementation.

Transportation

Consider Increasing Motor Fuels Taxes

Increased taxes on gasoline and other motor fuels are potentially powerful tools to reduce global warming emissions within the transportation sector. The political unpopularity of higher fuel taxes – coupled with legitimate concerns about social equity and economic impact – make it difficult to envision adoption in the short term. But the potential power of higher fuel taxes as a global warming emission reduction strategy demands consideration.

Low fuel prices drive all sorts of economic decisions with short- and long-term ramifications for the climate. The reality and expectation of low fuel prices shapes the types of vehicles consumers buy; where they choose to live, work and shop; and how they go about their daily lives. Higher gasoline prices would cause many Connecticut residents to reconsider those choices in ways that would reduce the impact of their daily activities on the climate.

The academic evidence supporting the potential for higher motor fuel taxes to reduce fuel use (and, thus, carbon dioxide emissions) is strong. A variety of studies suggests that the short-run elasticity of fuel use with respect to fuel price ranges from -0.15 to -0.3, meaning that fuel consumption declines between 1.5 and 3 percent for every 10 percent increase in fuel prices. Long-run elasticities have been estimated at between -0.3 and -1.0, for a 3 to 10 percent decrease in fuel use for every 10 percent increase in fuel price.[76]

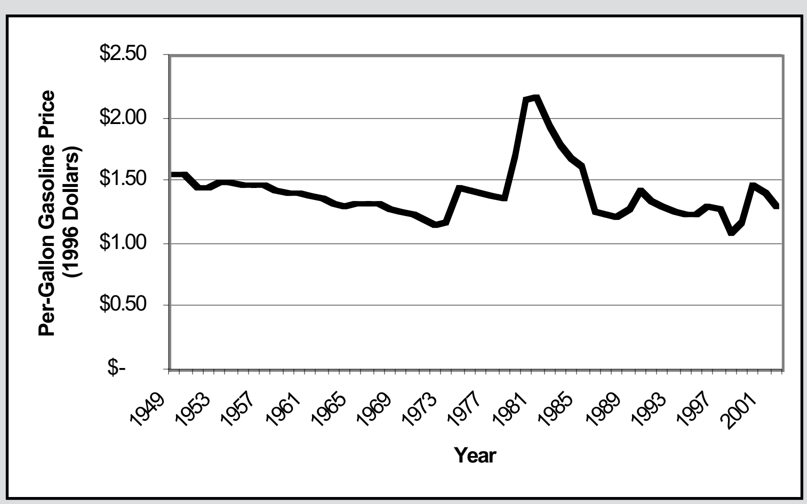
Short-run reductions in fuel use caused by higher fuel prices are driven largely by reduced driving, while long-term reductions are driven mainly by the choice of more efficient vehicles. As a result, motor fuels taxes represent one of the few policy alternatives to effectively and significantly reduce growth in vehicle-miles traveled in the short run, while also providing market incentives for the purchase of less-polluting vehicles in the long run.

While a significant increase in the gasoline tax may seem economically onerous, it is important to recognize that current gasoline prices are below the historic levels that have prevailed in most of the years since World War II, when viewed in inflation-adjusted terms. In constant 1996 dollars, the average price of gasoline in the U.S. in 2002 was $1.30 per gallon, 40 percent below the peak price of $2.17 per gallon in 1981. As a result, even a 42-cent increase in the gasoline tax would still leave the real cost of gasoline at or below the levels that prevailed during the period 1979 to 1984.[77]

Assuming baseline gasoline prices of $1.50 per gallon and the elasticities listed above, a 42-cent increase that was adjusted in future years to account for inflation would bring about 4 to 8 percent reduction in fuel use (and carbon emissions) in the short run, and an 8 to 28 percent reduction in fuel use in the long term. This would likely yield carbon dioxide emission reductions of at least 0.5 $MMTCO_2E$ by 2010 and 1.1 $MMTCO_2E$ by 2020 – a level of reductions greater than all but two of the transportation-sector recommendations endorsed by the CCSD.

A growing number of economists is coming to believe that an increased gasoline tax makes economic, as well as environmental sense. A 1997 survey of economists at top research universities in the U.S. found that, while there were high levels of disagreement on all other economic policy proposals, there was consensus support for a 25-cent increase in the gasoline tax.[79] A recent Congressional Budget Office study concluded that a 46-cent increase in the gasoline tax nationwide would save about 50 percent more gasoline over its first 14 years at lower cost than an increase in Corporate Average Fuel Economy standards (although the CBO's cost analysis did not include the benefits of a gasoline tax increase for reducing dependence on foreign oil, air pollution, and highway congestion).[80]

Fig. 7. Per-Gallon Gasoline Prices in Constant 1996 Dollars[78]



Two groups of consumers, however, could be adversely affected by an increased gasoline tax: rural residents who tend to drive more miles than their urban counterparts, and low-income individuals, for whom fuel expenses account for a greater share of income. With creativity, however, the concerns of these groups could be addressed. Funds raised by a gasoline tax increase could be used to improve transportation alternatives in rural and urban areas or to provide subsidies for the purchase of more fuel-efficient vehicles, lessening the impact of the tax.

Another option is to use a gas tax increase primarily as a "tax-shifting" measure; essentially making the tax increase revenue neutral by reducing income, sales, property or other taxes. The amount raised by the gasoline tax could be refunded to taxpayers at a flat rate as a credit on their income tax returns, providing a reward for individuals who drove less than average during the previous year and a penalty for those who drove more than average. Or the funds could be used to offset the most regressive taxes in the system, easing the burden on low-income individuals.

A prudent course of action for the state would involve dialogue among various stakeholders to address concerns about motor fuels tax increases. A package of policies could then be developed that attain the efficiency and travel-reduction gains of the gasoline tax while addressing the most significant economic concerns. Then, the increase in the gasoline tax could be phased in over several years to give Connecticut residents time to adjust. Finally, Connecticut should work with neighboring states to encourage them to follow a similar path.

Experiment With Congestion Pricing as a Tool to Reduce Congestion and Vehicular Emissions

Another way to use pricing tools to address transportation-sector emissions is to set prices for travel on certain roads, particularly at specified times. Like VMT-based insurance and gasoline taxes, "congestion pricing" has beneficial side effects – in this case, through reduced congestion on highways covered under the program.

The theory behind congestion pricing is simple: roadway space during "rush hour" periods is a scarce commodity. Currently, there is no disincentive for driving during rush hour, other than the long delays during those periods. These delays, in turn, create external effects that are not accounted for in the price of travel, including higher automobile emissions caused by excessive idling. Congestion pricing attempts to convert the time cost of travel delays into monetary costs paid for by drivers who contribute to the congestion.

The effectiveness of congestion pricing as a global warming strategy has not yet been proven. Other than any emission savings generated by reduced idling, congestion pricing has a significant effect only if it reduces overall vehicle travel. To achieve that end, any congestion pricing system would need to have wide coverage, reducing the chances for motorists to "escape" by driving alternative routes, which would then become congested. It would also need to have a per-mile charge large enough to alter driver behavior. Finally, congestion pricing relies on the existence of alternatives to driving – such as carpooling, telecommuting and transit – for success as a global warming measure. Even with all of these attributes, however, a congestion pricing system would likely induce some drivers to travel at different times of day rather than travel less – a result that would ease congestion during rush hour but achieve little in terms of reducing global warming emissions.

Still, the potential emission reductions that would result from congestion pricing are significant. A 1996 study conducted for the California Air Resources Board projected carbon dioxide emission reductions ranging from 4.8 percent to 9.6 percent by 2010 in metropolitan areas implementing congestion pricing of 8 to 19 cents per mile on all congested roadways.[81]

Those savings would be magnified if the revenue from congestion pricing were used to support transportation alternatives. One recent analysis projected that a congestion pricing program that charges 10 cents per mile on Interstate highways in Connecticut would generate about $206 million per year.[82] Additional savings – both in monetary and emissions terms – could be generated if reduced congestion alleviated the demand to expand Connecticut's existing highway network.

A potential strategy for experimenting with congestion pricing would be the conversion of existing, underused high occupancy vehicle lanes on I-84 and I-91 into high occupancy/toll (HOT) lanes, which drivers of multiple-occupancy vehicles could continue to use for free, but which single-occupancy vehicle drivers would be eligible to use for a fee during rush hour. If the concept proves successful on these highways, it can be expanded to current general-use lanes on other highways (although states attempting to expand tolls on Interstate highways may be liable for the reimbursement of federal highway funds).

It is important to note, however, that the creation of *new* HOT lanes that provide additional highway capacity will likely do little to reduce global warming emissions and may even result in emission increases versus the status quo. The addition of highway capacity has been shown to provoke changes in land-use and transportation patterns that lead to increased vehicle travel, which can be expected to lead to higher emissions of carbon dioxide. The conversion of underused lanes to HOT lanes, therefore, provides an opportunity to test the reaction of drivers and system performance, but not the validity of the congestion pricing concept itself. To truly succeed as a global warming measure, congestion pricing will have to be applied to the state's existing highways.

Pursue Truck-Stop Electrification and Enforce the State's Anti-Idling Law

Trucks produce carbon dioxide and black carbon emissions both while they are traveling along Connecticut's highways and while they are sitting still. Truck engines are frequently left to idle during rest stops to provide power, heating and cooling to the cab and to keep the engine warm. Researchers at Argonne National Laboratory calculated that the average class 8 truck (large single-unit truck or tractor trailer) idles for six hours/day (10 hours/day in winter; 4.5 hours/day in summer), 43 weeks per year.[83] This is an average of 1,830 hours/year.[84] Argonne researchers acknowledge that even this estimate may be low, citing information from J.B. Hunt, a trucking company, that suggests that trucks idle for 40 percent of the day compared to Argonne's estimate of 25 percent.[85]

An idling truck burns roughly one gallon of fuel per hour, creating total carbon dioxide emissions of about 21 tons per truck per year.[86] Idling trucks also produce emissions of black carbon, which is thought to be a significant contributor to global warming. Assuming that an estimated 2,700 trucks idle in Connecticut each day, those trucks would emit approximately 58,800 tons of carbon dioxide in the state each year.[87]

There are several alternatives to idling that can provide power, heat and cooling to resting trucks with reduced carbon dioxide and black carbon emissions. Some alternatives, such as providing on-board auxiliary power or shorepower, require significant modifications to the vehicle. Others, such as window-sized consoles that provide electricity, telephone, heat and other services, require no such modifications. New York has adopted the latter approach by installing at least 43 truck-stop electrification units at two service plazas on the New York Thruway.[88] Were Connecticut to eventually electrify half of its approximately 1,200 private and public truck parking spaces, and each space were occupied for six hours per day, carbon dioxide emissions from truck idling could be reduced by about 11,000 tons per year, accompanied by significant reductions in black carbon emissions.[89]

Truck stop electrification (TSE) is a capital-intensive endeavor and will take time to implement. A good starting point would be for the state to begin offering TSE at rest areas along major Interstate highways such as I-95, followed by a program to encourage the installation of TSE at private truck stops.

Long-haul trucks are not the only vehicles that produce excessive carbon dioxide and black carbon emissions through excessive idling. Buses, local trucks and even cars often idle excessively, wasting fuel and polluting the air. Connecticut law bars idling for more than three consecutive minutes. However, the law makes exceptions for refrigerated trucks, engine warming, operation in temperatures below 20° F, as well as marine vessels, locomotives, aircraft and other mobile sources of pollution.[90] Active enforcement of the anti-idling law in Connecticut, however, is minimal.[91]

Stronger enforcement of anti-idling laws, combined with increased truck-stop electrification and the extension of limitations on idling to vehicles such as marine vessels (as recommended by Environment Northeast), could significantly reduce global warming emissions, while also saving energy.

Expand and Improve Passenger Rail Service

The stakeholders recommended that Connecticut engage in a multi-state initiative designed to shift future growth in freight transport from highways to rail. This initiative is sorely needed, but the state must also place a renewed emphasis on the expansion and improvement of passenger rail service.

Passenger rail must be an important component of the state's short- and long-range global warming emission reduction plans. In the short term, improvements in passenger rail service can displace travel growth that would otherwise have taken place by automobile. But the long-run implications are even greater because – barring an unforeseen technological breakthrough – there is almost no conceivable way in which the state can achieve its long-range global warming goals without shifting much of the travel that currently occurs by car to other, more efficient modes of travel.

Passenger rail is already an integral part of Connecticut's transportation system. The Connecticut Department of Transportation estimates that 75 percent of work trips from Connecticut to New York City are accommodated by rail.[92] The New Haven Line now serves approximately 33 million riders annually, and ridership has increased by 29 percent since 1987. Ridership on both Amtrak Northeast Corridor trains and Shore Line East has also increased in recent years.[93]

However, the effectiveness of rail to serve the travel needs of Connecticut residents is currently constrained by both limitations in the current system and its lack of geographic scope. Commuter rail ridership has grown to such an extent that it is now testing the capacity of the system. A shortage of train cars places limitations on the degree to which more frequent service can be provided on existing lines, while shortages of parking spaces in park-and-ride lots and inadequate connecting bus service at some stations makes rail travel a less-attractive alternative for commuters.[94]

Purchasing new rail cars, providing more frequent service and improving access to rail stations should all be short-term priorities of the state. Connecticut should also experiment with novel ways to deal with the parking crunch around rail stations. Several New Jersey and Long Island communities have had positive experiences with low-cost local jitney or shuttle bus services that bring commuters from surrounding communities to the train stations.

Rail service in southwestern Connecticut and along the Connecticut shore is extensive, but connections with other population centers – particularly the Hartford area – are limited to infrequent service via Amtrak. The current proposal to initiate commuter rail service between New Haven, Hartford and Springfield, Mass., with a direct transit link to Bradley Airport would, if implemented, be a very positive step.

All of these improvements require money. Connecticut should prioritize rail when it comes to allocating federal and state transportation funds. The state can also consider using increased motor fuel taxes, roadway tolls or other funding mechanisms to support rail improvements.

But short-term improvements and extensions of the existing system are only the starting point. Connecticut must develop a long-range vision for the state's future rail infrastructure needs and dedicate its transportation resources accordingly. Such a plan should consider the extension of rail service to new or currently dormant corridors, the infrastructure investments needed to provide additional high-speed intercity service along the Northeast Corridor and other corridors, and ways to integrate rail with sustainable land-use and development practices.

Prioritize Trip Reduction in State Transportation Planning

As of 2000, four out of five Connecticut commuters drove to work alone. During the 1990s, the number of commuters driving to work alone increased by 11,000 statewide, despite a decrease of more than 32,000 in Connecticut's adult working population. The number of commuters traveling by carpool or walking to work declined by nearly 50,000 over the same period.[95] Trip reduction has not traditionally been a major emphasis in overall state transportation planning. To achieve long-term reductions in vehicle-miles traveled, that must change.

Commuting contributes both to highway congestion and to global warming emissions from automobiles. The state of Connecticut operates or supports a number of programs to reduce single-passenger commuting, including regional ridesharing agencies in southwestern Connecticut, and the Waterbury, Hartford and New Haven areas.[96] These agencies work with employers and commuters to design vanpool programs, employee transit incentives, bike-to-work and telecommuting programs, guaranteed ride programs and other initiatives that can reduce single-passenger commutes. Expansion of these programs, combined with the development of additional incentives for employer and commuter participation would be beneficial.

The state and municipalities must also recognize that commuting patterns are strongly related to land-use and development patterns in the state. State and local planning efforts should be directed toward encouraging the development of new commercial space in areas that are well-served by transit, eliminating excessive parking requirements for new commercial space, and developing policies and incentives that encourage individuals to live near where they work.

Ultimately, Connecticut must raise transportation demand management to a co-equal level in its transportation decision-making with highways, transit and other modes of transport. Washington state, for example, enacted a commute trip reduction law in 1991 that covers large employers in major metropolitan areas. As of 2000, the program included 1,100 employers with a half million employees. From 1993 to 1999, the percentage of commuters driving alone to work dropped from 72 percent to 67 percent at participating companies, removing 18,500 vehicles from the state's roadways.[97] Moreover, demand management has become integrated into the region's transportation planning, with the Seattle metropolitan region developing a transportation demand management plan in 1998 and demand management techniques being woven into major multimodal transportation projects in two highway corridors.[98]

Connecticut should pursue ways to increase the funding and effectiveness of current commuter trip reduction programs; investigate planning tools to reduce the number of single-occupancy vehicle commutes; and initiate a major effort to develop an ambitious transportation demand management program with aggressive goals and benchmarks to evaluate progress.

Land Use

Plan For, and Take Credit For, Energy Savings From "Smart Growth"

The stakeholders recommended that the state engage in a "smart growth" strategy for future development that would reduce future growth in vehicle miles traveled. While smart growth – which can be defined loosely as encouraging new growth to take place at higher densities in or near already-developed areas – has major potential impacts on transportation-sector emissions, smart growth strategies can also be designed to encourage energy savings in other sectors.

In Connecticut and elsewhere since World War II, planning and zoning laws have tended to encourage the segregation of land uses (residential, commercial and industrial) and, in many cases, the construction of new housing on large lots. Through these policies (along with overt taxpayer subsidies for the construction of new roads, infrastructure and public buildings in suburban areas), increasing public resources have been channeled to newly developed communities, while older urban and suburban areas have struggled to maintain an adequate and diversified tax base.

In recent years, however, architects, planners and activists supporting "New Urbanist" forms of development have brought about a rethinking of these policies and assumptions. New Urbanist development is typically characterized by the renovation and reuse of existing urban structures, the construction of new mixed-use developments that are friendly to pedestrian traffic and transportation alternatives such as transit, and a return to more traditional forms of residential development on smaller lots with greater access to a wider variety of community amenities.

Several aspects of New Urbanism (or Traditional Neighborhood Development) have the potential to achieve energy savings beyond the transportation sector. The reuse of existing structures reduces the need for the creation and transportation of new building materials. Mixed-use development can reduce energy use by allowing offices, residences and stores to share building infrastructure. And New Urbanist residential designs are typically characterized by smaller homes that require less energy to heat and light than "McMansion"-style new suburban development.

Many of the policies recommended by the CCSD (including channeling state funds to priority growth areas, enhancing regional planning, and expanding pedestrian and bicycling infrastructure) can help move Connecticut toward more sustainable development, as can financial tools such as Location-Efficient Mortgages (see below). But it is likely that action will be required in other policy arenas as well. Connecticut's policies on urban redevelopment, brownfield redevelopment, infrastructure financing, and allocation of tax burden and revenues – among others – have a profound impact on the course of development in the state, as do the local planning and zoning decisions made by the state's cities and towns.

It would be appropriate for Connecticut to investigate the energy savings that could be gained by the promotion of smart growth strategies and New Urbanist developments and identify the policy handles that could be used to promote sustainable forms of development. Integration of effort among state agencies and various levels of government will also be crucial.

Encourage Location-Efficient Mortgages

The concept of location-efficient mortgages is similar to the concept of energy-efficient mortgages – households that reduce their daily expenditures on transportation or energy use have more disposable income that should enable them to be eligible for larger mortgages than they otherwise would.

Location-efficient residences are those in which automobile use is not necessary for many daily tasks. Typically, they are homes in neighborhoods in which work, shopping, recreation and other services can be accessed either on foot or by using transit. As a result, transportation expenses – including the cost of owning, maintaining and insuring one or more automobiles – can be significantly lower than in less densely populated areas. It is estimated that doubling residential density reduces vehicle travel by 20 to 25 percent, potentially saving individuals hundreds of dollars in monthly transportation expenses.[99]

Under location-efficient mortgages, these transportation savings are factored into the overall calculation of a household's ability to make mortgage payments. Prospective homebuyers in location-efficient neighborhoods are permitted to borrow up to higher housing-to-income and debt-to-income ratios, enabling them to purchase housing that might be outside their reach in less location-efficient areas.[100]

Location-efficient mortgages have the advantage of being a tool to promote "smart growth" development, particularly in urban and suburban infill areas that are serviced by transit. Mortgage lending giant Fannie Mae is currently sponsoring a $100 million experiment in location-efficient mortgages in the Chicago, San Francisco, Los Angeles and Seattle areas.

Location-efficient mortgages would appear to be a good fit for Connecticut, where high automobile insurance rates make the cost of owning a car a significant drain on household expenses. The state should consider ways to encourage lenders to issue location-efficient mortgages within Connecticut.

Residential, Commercial, Industrial Sectors

Investigate a Pay-As-You-Save Program for Distributed Electricity Generation

Distributed generation of electricity – that is, generation close to the point of use – has the potential to achieve reduced emissions of carbon dioxide and other global warming gases. Several clean distributed generation technologies – including solar PV, fuel cells, small-scale wind and combined heat-and-power (CHP) – produce electricity with greater efficiency or lower carbon emissions than central, fossil fuel-fired power plants. These efficiency gains are magnified by the avoidance of power losses that result from the transmission of electricity from central power plants to points of use.

Clean distributed generation can also reduce demand on the electric grid, particularly in areas such as southwestern Connecticut in which current transmission capacity is strained, thus avoiding the need for costly improvements to the grid that would be paid for by ratepayers.

A series of regulatory and market hurdles, however, are restraining the deployment of distributed generation technologies in homes and businesses. The stakeholders recommended the removal of regulatory barriers (including permitting and interconnection hurdles and standby power rates) as part of their recommendation to promote clean combined heat and power; an action that would also improve the prospects for other distributed generation technologies. The economic barriers facing distributed generation, however, would remain the same as the barriers for energy efficiency: high upfront costs, lack of consumer information about costs and benefits, etc.

One way to lower the economic barriers to distributed generation would be to implement a pay-as-you-save (PAYS) plan for installations that meet certain emission and safety standards. The CCSD has recommended that Connecticut implement pilot PAYS programs for the purchase of efficient appliances and heat pump water heaters, and the same principle could be applied to distributed generation.

A pay-as-you-save system is akin to a loan to a consumer to install energy efficiency measures or distributed generating capacity, but with several important differences. First, the consumer pays for the equipment over time through a charge on his or her electric bill. To be approved to participate in a PAYS installation, the amount of money saved by the efficiency measure must exceed its cost. A second difference is that the PAYS charge continues to be assessed on the electric bill regardless of who is currently residing at that location. This removes a major hurdle that impairs energy efficiency improvements: the concern that a resident or business may not stay at one location long enough to recoup the benefits of efficiency investments. Finally, because the monthly energy savings are estimated ahead of time to be greater than the monthly addition to the bill, consumers begin to see monetary savings from the measures right away.[101]

Should the state follow the stakeholder recommendation, its experience with a PAYS program for efficiency measures should provide a solid grounding for the expansion of the concept into distributed generation. In addition, the state, regional grid managers and utilities will need to work together to determine how to maximize the benefits of PAYS for the electric system and minimize any potential problems.

Conclusion: Taking the Long View

Connecticut's efforts to reduce global warming emissions will ultimately be judged not by the state's ability to achieve arbitrary goals, but by the speed with which the state can reduce – and eventually eliminate – its contribution to the alteration of the climate. Achieving the long-term reductions in emissions of 75-85 percent that scientists believe will be needed to eliminate any harmful threat to the climate – and doing so in time to prevent major damage to the climate (by about 2050) – is the true test by which the state's efforts must be assessed, and should remain the state's overarching goal.

Implementing the stakeholder recommendations and the supplementary recommendations in this report will not only move Connecticut far toward achievement of the short- and medium-term goals, but they also begin to lay the groundwork for a deeper transition that will bring the long-term goals within reach.

Adoption of a clean cars requirement, standards to limit global warming emissions from automobiles, and programs to reduce diesel emissions will ensure that each mile traveled on Connecticut's highways produces less global warming pollution. Developing "smart growth" policies, investing in rail transportation, and setting appropriate prices for driving commensurate with its impact on the state's infrastructure and climate will all make a large contribution to slowing – and ultimately reversing – the trend toward automobile dependency and increased vehicle travel.

Meanwhile, new buildings and appliances will have maximum levels of energy efficiency built in, while owners of existing buildings and appliances will be able to take advantage of energy efficiency programs to reduce their energy consumption. Homeowners and businesses will be able to generate more of their own power, while the power they receive from the region's electric grid will increasingly come from renewable sources.

The vision of Connecticut's future contained in these proposals is a bold one. Affecting these changes will require an unprecedented amount of research, discussion, cooperation and political will – as well as a commitment to achieve the long-term goal within a reasonable time frame; for example, by 2050. The early signs are positive: Connecticut and the other New England states are now engaged in the discussion and study of global warming, its impacts, and the means of addressing the problem in a way they have never been before. But the critical test – implementation – lies ahead.

The strategies laid out in this report show the way forward. By using existing technologies and reasonable public policy tools, Connecticut can reduce its contribution to global warming in the near term, while in many cases improving public health, economic well-being, and energy security, and providing a model of leadership for others to follow.

Appendix A: Glossary of Abbreviations

ACEEE – American Council for an Energy Efficient Economy
AFW – Agriculture, forestry and waste sectors
BTU – British Thermal Unit
CCSD – Connecticut Climate Change Stakeholder Dialogue
CHP – Combined heat and power
DG – Distributed generation
EIA – U.S. Energy Information Administration
HOT lanes – High-occupancy/toll lanes
LRR – Low-rolling resistance tires
MMBTU – Million British Thermal Units
$MMTCO_2E$ – Million metric tons carbon dioxide equivalent
NEEP – Northeast Energy Efficiency Partnerships
NEG/ECP – Conference of New England Governors and Eastern Canadian Premiers
PAYD – Pay-as-you-drive insurance
PAYS – Pay-as-you-save
RCI – Residential, commercial and industrial sectors
RGGI – Regional Greenhouse Gas Initiative
RPS – Renewable portfolio standard
SBC – Systems benefit charge
SUV – Sport utility vehicle
VMT – Vehicle-miles traveled

Appendix B: Methodology and Technical Discussion

General Assumptions and Limitations

This report relies primarily on data and projections from the U.S. Energy Information Administration (EIA) to estimate present and future global warming gas emissions in Connecticut. Future emission trends in Connecticut are generally based on EIA's projected rates of growth for New England as a whole. Trends within Connecticut will differ, but the EIA growth projections provide a reasonable approximation of future trends, particularly given the regional context of Connecticut's global warming emission reduction efforts.

In assessing the potential benefits of the various policies, we have attempted to take a conservative approach to the available data. In other words, we anticipate that the global warming emission benefits of these policies are likely to be greater than projected here.

This analysis focuses exclusively on emissions of carbon dioxide from energy use in Connecticut. Many of the policies discussed here will also result in reductions in other global warming gas emissions.

This report also limits its scope of analysis to the six New England states. Several of the policies described here could have effects outside the region that would either create additional carbon dioxide emissions or reduce emissions further than projected here. Because global warming is a global problem, it is important to consider these potential spill-over effects when setting policy, but it is beyond the scope of this report to do so.

All fees, charges and other monetary values are in 2003 dollars and are assumed to be indexed to inflation. In other words, the systems benefit charge assessed on electricity purchases in 2020 is assumed to have the same buying power as a 5-mill charge would have today.

Baseline Emission Estimates

All emission reductions estimated here are based on reductions from baseline estimates calculated by applying projected growth factors for New England estimated by EIA in *Annual Energy Outlook 2003* (AEO 2003) to baseline emission levels from 2000 based largely on EIA, *State Energy Data 2000* (SEDR 2000). To calculate carbon dioxide emissions, energy use for each fuel in each sector (in BTU) was multiplied by carbon coefficients for 2000 as specified in EIA, *Emissions of Greenhouse Gases in the United States 2001*, Appendix B.

Significant changes in EIA's methodology for collecting and presenting data render some information in *SEDR 2000* unreliable for estimating 2000 carbon dioxide emissions. Specifically, EIA has changed the sources of some of its energy use data and reallocated energy use and emissions from non-utility producers of power from the industrial to the electric sector.

There are several possible methods for obtaining state-specific energy use data for fuels and sectors in which *SEDR 2000* data are inaccurate. Our approach was to seek out the most recent available data for 2000 from EIA's fuel-specific reports or to follow EIA-specified methodologies for adjusting data presented in *SEDR 2000*.

The following sources and methods were used by fuel:

- **Coal** – Coal use and emissions were reallocated between the industrial and electric sectors based on the following method, adapted from EIA, *Emissions of Greenhouse Gases in the United States 2000,* Appendix A:

  1) Total coal use for all sectors in BTU was obtained from *SEDR 2000*.

  2) Residential and commercial coal use in BTU was subtracted from the total, leaving total industrial and electric sector consumption.

  3) Electric utility consumption was estimated by multiplying utility consumption of coal in short tons from EIA, *Electric Power Annual 2001, Consumption by State* by the appropriate heat rate, obtained from EIA, *SEDR 2000*, Appendix B.

  4) Consumption by non-utility power producers was estimated by multiplying the remaining coal consumption from the electric power sec-

tor (from *Electric Power Annual 2001*) by the appropriate heat rate.

5) Estimated consumption by utility and non-utility power producers was summed to arrive at total electric energy use from coal. This figure was then subtracted from the electric-plus-industrial consumption estimate to arrive at estimated consumption in the industrial sector.

This method appears to result in lower estimated energy use and emissions from the industrial sector for 2000 than are reported in the regional data compiled by EIA in *AEO 2003*. These estimates should be revised when EIA updates its state-specific energy use data to account for the new methodology.

- **Natural Gas** – Sector-specific natural gas consumption data for Connecticut in million cubic feet were obtained from EIA, *Connecticut Natural Gas Consumption by End Use*, downloaded from http://tonto.eia.doe.gov/dnav/ng/ng_cons_sum_sct_m_d.htm, updated 21 August 2003. Consumption data were converted to BTU values using a conversion factor from *SEDR 2000*, Appendix B.

- **Petroleum** – Data for consumption of distillate and residual fuel were obtained from EIA, *Fuel Oil and Kerosene Sales 2001*, and then converted to BTU values using heat rates from *AEO2003*, except for use of petroleum in the electric power sector, which was obtained from EIA, *Electric Power Annual 2001* spreadsheets, Consumption by State. Estimated use of other petroleum products was based on *SEDR 2000*.

Several additional assumptions were made:

- Carbon dioxide emissions due to electricity imported into New England were not included in the emissions estimates, nor were "upstream" emissions resulting from the production or distribution of fossil or nuclear fuels.

- Combustion of wood and other biomass was excluded from the analysis per EIA, *Emissions of Greenhouse Gases in the United States 2001*, Appendix D. This exclusion is justified by EIA on the grounds that wood and other biofuels obtain carbon through atmospheric uptake and that their combustion does not cause a net increase or decrease in the overall carbon "budget."

- Electricity generated from nuclear and hydroelectric sources was assumed to have a carbon coefficient of zero.

- Carbon emissions from the non-combustion use of fossil fuels in the industrial and transportation sectors were derived from estimates of the non-fuel portion of fossil energy use and the carbon storage factors for non-fuel use presented in U.S. EPA, *Comparison of EPA State Inventory Summaries and State-Authored Inventories*, downloaded from http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/JSIN5DTQKG/$File/pdfB-comparison1.pdf, 31 July 2003. To preserve the simplicity of analysis and to attain consistency with future-year estimates, industrial consumption of asphalt and road oil, kerosene, lubricants and other petroleum, and transportation consumption of aviation gasoline and lubricants were classified as "other petroleum" and assigned a carbon coefficient of 73.3 $MMTCO_2E$ per quad BTU for that portion that is consumed as fuel.

Known Discrepancies with Other Published Estimates

Due to variations in methodology, the adjustment of energy use figures over time, and inherent disagreement in the data presented in various EIA reports, the emissions estimates for 2000 on which the estimated savings in this report are based differ somewhat from those presented in the *Connecticut Greenhouse Gas Inventory* and regional emission estimates derived from *AEO 2003*. Total carbon dioxide emissions from energy use for the 2000 baseline used in this report were 2 percent below those reported in the *Connecticut Greenhouse Gas Inventory*, due to a difference in estimated industrial sector emissions.

Because the baseline estimates used in this report were compiled using a common methodology applied to all six New England states, it is also possible to compare the regional total emissions estimate with estimates derived from *AEO 2003* and presented in the New England Climate Coalition's 2003 report, *Glo-*

bal Warming in New England. Estimated 2000 carbon dioxide emissions for the region based on the sources and methodology in this report are about 3 percent lower than estimated emissions based on *AEO 2003*'s regional energy use figures – assuming the continued operation of the region's nuclear power plants in both cases. Specifically, the methodology of this report appears to significantly underestimate emissions from petroleum use in the commercial sector and natural gas use in the industrial sector and to overestimate emissions from natural gas use in the commercial sector when compared to estimates based on *AEO 2003*. These discrepancies are likely due to the use of varying EIA reports for fuel use estimates. The expected publication of an updated version of *SEDR* in 2004 should clear up these discrepancies and we encourage a revisiting of the data at that time.

Future Year Projections

Projections of energy use and carbon dioxide emissions for Connecticut are based on applying the New England year-to-year projected growth rates for each fuel in each sector from *AEO 2003* to the Connecticut baseline emissions estimate for 2000, with two exceptions.

1) In the transportation sector, EIA's estimates of vehicle travel increases are significantly higher than projections produced by the Connecticut Department of Transportation and recent experience in the state. Instead of using EIA's projected growth rates for motor gasoline use, we used a growth rate of 1 percent per year, commensurate with the Connecticut DOT's projections of vehicle miles traveled increases for 2002 to 2020, obtained from Paul Buckley, Transportation Supervising Planner, Connecticut Department of Transportation, personal communication, 22 October 2003. While it is likely that EIA's methodology also overstates emissions for diesel fuel use, we used the EIA assumptions because of the difficulty of disaggregating vehicular diesel fuel use from use by other transportation modes.

2) Unlike EIA, we assume that nuclear reactors in New England are retired at the expiration of their current operating licenses. Thus, the base case estimate for power-sector energy use in Connecticut was adjusted by eliminating any nuclear generation from the power-sector energy mix beyond 2015 and replacing it with gas-fired generation. The level of electric-sector natural gas consumption needed to replace nuclear generation was estimated first by determining the percentage of nuclear generation in Connecticut represented by the Millstone 2 plant. This was done by dividing the capacity of Millstone 2 by Connecticut's total nuclear generating capacity, based on figures from the Nuclear Regulatory Commission, *Facility Info Finder*, downloaded from http://www.nrc.gov/info-finder/region-state/, 26 January 2004. This percentage was then multiplied by the projected electric-sector nuclear energy consumption in Connecticut for 2016 through 2020 based on AEO 2003 annual New England growth rates applied to 2000 energy use figures as described above. This figure – which represents nuclear generation "lost" due to the closure of Millstone 2 – was then multiplied by the ratio of the calculated heat rate for natural gas generation divided by the imputed heat rate for nuclear generation, from Supplementary Table 66 of *AEO2003*, to arrive at the amount of additional natural gas consumption that would be needed to replace power from Millstone 2. Heat rates were calculated by dividing energy consumption for each fuel by net generation for each fuel. This method will tend to slightly overstate energy use – and therefore emissions – from natural gas, since it is likely that new natural gas-fired generation will be more efficient than the average efficiency of all natural gas plants in the region.

Carbon Dioxide Reductions from Electricity Savings and Renewables

Carbon dioxide reductions for measures that reduce electricity use or expand renewable resources were generally estimated based on the impact of the reductions on the entire New England grid. For individual strategies, a range of savings was projected based on two sets of assumptions:

- **Low savings estimate** – The low-savings estimate was based on the use of efficiency savings and renewables to first offset power lost through the closure of in-state nuclear plants whose licenses have expired, then to offset natural gas generation on the New England grid, which is projected by EIA in *AEO 2003* to account for virtually all of New England's new electric generating capacity beyond 2009. The formulas used to calculate these reductions are similar to those described above for the replacement of nuclear power in the base case, with differences in heat rates among the fuels used to estimate the amount of generating capacity that would be displaced. This case is intended to replicate a scenario in which efficiency and renewable savings are used to avoid the need to construct new generating capacity, rather than retire less-efficient old generators.

- **High savings estimate** – The high-savings estimate was based on the use of efficiency savings and renewables to first offset power lost through the closure of in-state nuclear plants whose licenses have expired, then to offset coal-fired generation, followed by oil-fired generation. The assumed offset of coal-fired generation may not yield the maximum carbon reductions possible under a regional carbon cap, since some oil-fired generating units in New England produce greater carbon dioxide emissions per unit of delivered electricity than coal-fired plants. The examination of power plant-by-power plant data was, however, beyond the scope of this report. As a result, the simplifying assumption to reduce coal-fired generation likely produces a conservative estimate of the maximum potential benefits of an electric-sector carbon cap.

The two estimates suggest the potential impact of an electric-sector carbon cap, with greater savings arising from a strong cap that creates pressure to retire old generation and lesser savings arising from a weak cap or the absence of a cap. In reality, it is likely that both the high and low estimates are somewhat extreme – that is, that some old coal- or oil-fired generation would be retired in the absence of a cap and that some will remain even with a cap.

In addition, all electricity-related estimates assume that New England produces all the power it consumes and is neither a net importer nor a net exporter of electricity. The potential for "leakage" of emission reductions – in which public policies result in increased importation of high-emission electricity from elsewhere, thus leading to greater emissions in the aggregate – is an important issue for policy-makers to address, but was beyond the scope of this report to incorporate.

Savings from Policy Strategies

Low Rolling Resistance Tires

All estimated reductions from transportation-sector strategies were derived by estimating the percentage reductions in light-duty vehicle motor gasoline use from the base case projection arrived at by the methods above. Light-duty vehicle gasoline use was estimated by multiplying the transportation motor gasoline estimate by the percentage of transportation motor gasoline used by light-duty vehicles, derived from the supplementary tables to *AEO2003*.

Percentage reductions in emissions were calculated by multiplying grams/mile emission factors for carbon dioxide (based on a modified version of the Argonne National Laboratory's Greenhouse Gases, Regulated Emissions and Energy Use in Transportation, or GREET, model, version 1.5a) by projected percentages of total VMT accumulated by type and age of vehicle, calculated as described below. Estimates for light-duty carbon dioxide emissions were based on the following sources:

- **Vehicle-miles traveled (VMT) percentages** – VMT percentages by vehicle class were derived by dividing projected national light-duty VMT for each year by the projected national light-duty vehicle stock as reported in supplementary tables to *AEO 2003*. This average VMT/vehicle/year figure was then adjusted to reflect the slightly higher VMT/vehicle/year of passenger cars vs. light trucks (based on a two-year average of VMT/vehicle derived from Federal Highway Administration data) and multiplied by the projected nationwide passenger car and truck stocks in *AEO2003*. Light-duty truck VMT was further divided into heavy and light categories by multiplying the total truck VMT by vehicle stock percentages contained in EPA, *Fleet Characterization Data for MOBILE6*, September 2001. The projected VMT for each vehicle class was then divided by the total light-duty VMT to arrive at the percentage of total VMT traveled by vehicles in each class in each year.

  VMT were further disaggregated into VMT by model year and vehicle class for each year between 2001 and 2020, based on estimates of VMT accumulation rates presented in EPA, *Fleet Characterization Data for MOBILE6*. No attempt was made to customize the national VMT percentages for Connecticut.

- **Carbon dioxide emission factors** – Grams-per-mile emission factors for each model year and class were based on modifications to the GREET model, version 1.5a. For conventional gasoline vehicles, the only modification to the model was the substitution of "real-world" fleet average miles per gallon (MPG) estimates for each model year from 1970 to 2020. For 1975 through 1999, real-world MPG was calculated by multiplying EPA-rated MPG for cars and light trucks (as reported in EPA, *Light Duty Automotive Technology and Fuel Economy Trends, 1975 Through 2003*, April 2003) by an adjustment factor of 0.8. For model years prior to 1975, 1975 figures were used. For 2000-2020, new car and truck on-road miles per gallon was based on Supplementary Table 49 to *AEO2003*.

  Real-world fuel economy projections were then input into the GREET model, producing grams-per-mile carbon dioxide emission factors for vehicle operations. Carbon dioxide emissions resulting from feedstock and fuels were not included in this analysis. The resulting emission factors for vehicles greater than three years old were then divided by 0.97 to account for the loss of fuel economy resulting from the replacement of low-rolling resistance tires with less-efficient replacement tires.

Savings from the use of low-rolling resistance replacement tires were estimated by reducing carbon dioxide emission factors by 3 percent from baseline assumptions for vehicles reaching four, seven and 11 years of age beginning in 2005, per California Energy Commission, *California Fuel-Efficient Tire Report, Volume II*, January 2003. This estimate assumes that the tire stock will completely turn over; that is, that LRR tires will supplant non-LRR replacement tires in the marketplace through a state requirement. Other policies to encourage, but not mandate, LRR tires will likely produce reduced savings.

Pay-As-You-Drive Automobile Insurance

Estimates of the impact of PAYD insurance are based on the assumption that 80 percent of collision and liability insurance payments in Connecticut would be transferred to a mileage-based system, with participation in the system increasing by 10 percent per year from 2005 to 2010, and 50 percent of all light-duty vehicle drivers participating in the system from 2010 to 2020. The average per-mile cost of insurance was computed by multiplying the average expenditure on collision and liability insurance in Connecticut in 2001 (as reported by the Insurance Information Institute, *Facts and Statistics: The Rising Cost of Auto Insurance*, downloaded from http://www.iii.org/media/facts/statsbyissue/auto/content.print/, 29 October 2003) by the number of light-duty vehicle registrations in Connecticut from FHWA, *Highway Statistics 2001*. This total expenditure figure was then divided by light-duty VMT derived from adjusted FHWA figures to arrive at an average per-mile cost for liability and collision insurance. This per-mile cost was then multiplied by 0.8 to account for any non-mileage related aspects of liability and collision coverage and to ensure the conservatism of the estimate, yielding an average per-mile charge of 7.4 cents. The estimated reduction in VMT that would result from such a charge was obtained from Victoria Transport Policy Institute, *Online TDM Encyclopedia: Pay-As-You-Drive Vehicle Insurance*, downloaded from http://www.vtpi.org/tdm/tdm79.htm, 3 December 2003. It was assumed that the decrease in VMT (11.2 percent) for drivers participating in the program would take place beginning immediately upon program implementation in 2005. We also assume that the average VMT of drivers opting for pay-as-you-drive insurance is the same as for drivers overall. In reality, individuals who drive fewer miles may be more likely to opt for pay-as-you-drive insurance, reducing the potential for VMT reductions. Policy-makers should consider this factor as they discuss whether to make pay-as-you-drive insurance an optional or mandatory program.

Other Transportation Assumptions

- We assume a "rebound effect" of 20 percent on measures that improve fuel economy or reduce per-mile carbon dioxide emissions. The rebound effect occurs when reduced per-mile costs of driving (such as would result from purchasing a vehicle with better fuel economy) encourage drivers to increase their VMT.

- We assume no mix shifting effects from any of the above policies. In other words, we assume that the strategies would not encourage individuals who would have purchased a car to purchase a light truck, or vice versa.

Appliance Efficiency Standards

Estimates of potential energy savings from appliance efficiency standards were based on Ned Raynolds and Andrew Delaski, Northeast Energy Efficiency Partnerships, *Energy Efficiency Standards: A Low-Cost, High Leverage Policy for Northeast States*, Summer 2002. Savings were assumed to begin in the adoption year specified in the NEEP report, with savings increasing in a linear fashion until 2020. We assume that standards for all products listed in the NEEP report, but not included in the CCSD recommendations, are adopted as described, including those subject to federal preemption. We assume that the adoption of future efficiency standards would yield savings equivalent to 20 percent of the annual savings resulting from the above standards beginning in 2012.

Increase in Funding for Conservation and Load Management Fund

Projections of benefits from a 5-mill electric SBC for efficiency were computed based on the average kilowatt/dollar savings rates from five New England SBC-supported programs for the most recent period for which data were available.[102] (Maine was excluded due to a recent transition in the program from utility to state management.) Additional revenues generated by the increased SBC were determined by subtracting the projected revenue of existing SBC programs from projected revenue of a 5-mill efficiency SBC, then multiplying the increased fee by projected electricity use in Connecticut. These revenues were then multiplied by the average kWh/$ savings rate, with the savings reduced by 33 percent to reflect the likely higher marginal cost of additional kWh savings due to the reduced availability of "low-hanging fruit" as a result of the original SBC programs. This produced an estimate of annual electricity savings as a result of efficiency programs due to the increased SBC. Future year savings from efficiency measures were assumed to be 90 percent of annual savings in the first through fourth years after implementation of the measures, 80 percent in years five through nine, 60 percent in years 10-14 and 50 percent afterward. These estimates are arbitrary, but yield maximum "lifetime" savings of about 12 times annual savings by the end of the study period, a rate lower than most estimates of lifetime savings from efficiency programs. Carbon dioxide savings were then calculated as described in "Carbon Dioxide Reductions from Electricity Savings and Renewables" above.

Increase in Funding for Proposed Oil and Natural Gas Conservation Funds

Savings resulting from the implementation of an oil/gas conservation fund program were estimated based on projected BTU per dollar savings rates of a Vermont gas conservation program, as documented in Center for Clean Air Policy, *Connecticut Climate Change Stakeholder Dialogue: Recommendations to the Governor's Steering Committee*, January 2004. This savings rate was then reduced by 25 percent to ensure the conservatism of the estimate. The rate of the charge was set at 3.5 cents per 100,000 BTU for natural gas and distillate and residual oil used in the residential, commercial and industrial sectors, with the total BTU savings estimated in a manner similar to savings from the 5-mill electric SBC. Carbon dioxide reductions were then estimated by allocating the total BTU savings from the charge proportionally among the three fuel types based on use and then multiplying the result by the appropriate carbon coefficients.

Solar Program Supported by Renewables SBC

The amount of funding that would be provided by a 0.15-mill earmark for solar programs in a renewables SBC was estimated in a similar manner as the SBC and conservation fund programs above. The amount of new solar capacity that would be created with that funding was estimated by assuming the rate of subsidy needed to spark installation of solar PV systems. This figure was estimated at $4,000/kW for 2005-2010, $3,000/kW for 2011-2015, and $2,000/kW for 2016-2020. The initial $4,000/kW figure is based on the amount that would be required to increase the breakeven turnkey cost of residential solar to greater than $7,000/kW, per Christy Herig, Richard Perez, Susan Gouchoe, Rusty Haynes, Tom Hoff, *Customer-Sited Photovoltaics: State Market Analysis*, 2002. Figures for later years are conservative estimates based on the anticipated drop in prices for solar PV systems as estimated in U.S. Department of Energy and Electric Power Research Institute, *Renewable Energy Technology Characterizations*, 1997, 4-5, and other sources. Electricity output from this new installed capacity was estimated based on operation at average 18 percent efficiency. All new solar capacity was assumed to be distributed, with no line losses. One-half of the new solar electricity was assumed to count toward fulfillment of RPS requirements, the other half surplus to offset existing or new generation as described in "Carbon Dioxide Reductions from Electricity Savings and Renewables" above. This split is arbitrary, but would allow for the addition of solar capacity above and beyond RPS requirements through individual purchases for which RPS credit is not sought as well as the purchase of solar power through green power purchasing options.

Public Sector Strategy

Emissions savings from state government are based on two categories of action. In each case, we assumed that government does not grow, an approach that makes our savings estimates conservative.

Data on current state energy use was provided by Ray Wilson, State of Connecticut, Energy Management Services, personal communication, 7 November 2003. To calculate the emissions savings from reducing energy use in state facilities by 25 percent by 2020, we multiplied the energy savings for each fuel by its carbon coefficient.

Savings from improving the efficiency of the state's vehicle fleet come from both gasoline and diesel savings. Data for state government transportation fuel use were not available; thus we relied on the Federal Highway Administration's figures for gasoline use by non-federal governments—meaning our data represents fuel consumption by state, county, and local governments. Total statewide diesel use figures are from the same source. We estimated non-federal public sector diesel use by assuming that government diesel use is the same portion of total diesel use as government gasoline use is of total gasoline use. Projected efficiency improvements assume that non-federal government vehicle fleets achieve 20 percent more gallons per mile by 2012 and 28.5 percent more gallons per mile by 2020. We assumed that there would be no rebound effect of increased miles driven. Carbon savings were calculated by multiplying the energy savings for each fuel by its carbon coefficient.

New England Electric Sector Carbon Reduction Case

To estimate the potential for carbon dioxide emission reductions in the electricity sector without the relicensing of nuclear reactors, a policy case was constructed assuming that all six New England states adopt the package of measures described on page 32, with demand reductions from conservation and new renewable generation being used either a) to offset nuclear power from retired reactors, then coal-fired resources, or b) to offset nuclear power and then natural gas, which EIA estimates will provide most of New England's new electric generating capacity through 2020.

The methodology for estimating benefits from appliance efficiency standards, increases in electric systems benefit charges, solar photovoltaic programs and reductions in state government energy use in the other five New England states is similar to the methods described above.

The projected impact of residential energy codes was derived by estimating the percentage of residential energy use that would take place in new homes under EIA projections and applying estimated percentage reductions in energy use that would take place under updated codes. Revised codes were not assumed to affect energy use in existing homes.

The proportion of projected residential energy use from new homes was derived by subtracting estimated energy use from homes in existence prior to 2004 from total residential energy use for each year based on *AEO 2003* growth rates. Consumption of energy by surviving pre-code homes was calculated by assuming that energy consumption per home remains stable over the study period and that 0.4 percent of homes are retired each year, per EIA, *Assumptions to AEO2003*.

Energy savings from updating residential building codes to 2000 IECC standards were assumed to be 15 percent below projected levels for 2004-2010 for states that have not already adopted the code, based on Steven Nadel and Howard Geller, American Council for an Energy-Efficient Economy (ACEEE), *State Energy Policies: Saving Money and Reducing Pollutant Emissions Through Greater Energy Efficiency,* September 2001. Additional energy savings from future updates to residential building codes were assumed to be 20 percent from 2011-2020, also based on ACEEE. Energy savings from residential building energy codes were assumed to take place equally among the various fuels.

For commercial building codes, New England-specific commercial building retirement percentages were estimated by determining the approximate median age of commercial floorspace in New England based on data from EIA, *1999 Commercial Building Energy Consumption Survey* (CBECS), estimating a weighted-average "gamma" factor (which approximates the degree to which buildings are likely to retire at the median age), and inputting the results into the equation: *Surviving Proportion=1/(1+(Building Age/Median Lifetime)*^{Gamma} as described in EIA, *Model Documentation Report: Commercial Sector Demand Module of the National Energy Modeling System*, March 2003. Baseline 2003 commercial energy demand was then multiplied by the percentage of surviving pre-code commercial buildings to estimate the energy use from buildings not covered by the code. Energy use by buildings subject to the code was estimated by subtracting energy use from surviving pre-code buildings from the total commercial energy use projected based on the application of regional energy use growth rates in *AEO 2003* to baseline 2000 energy use figures as described above. For new buildings in states not already covered by the code, electricity use was reduced by 8 percent between 2005 and 2010 to reflect the savings projected from adoption of the ASHRAE 90.1-1999 code. These savings are based on a quantitative analysis of the differences between the 1989 and 1999 versions of the code obtained from the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy at http://www.energycodes.gov/implement/determinations_com.stm, November 2003. The adoption of future upgrades to commercial energy codes was estimated to result in an additional 20 percent reduction in the use of all fuels in new construction from 2011 to 2020 per Nadel and Geller (ACEEE), *State Energy Policies.* No attempt was made to estimate the impact of commercial code revisions on energy use due to renovations of existing commercial space.

For renewable portfolio standards, emission savings were estimated by first determining the electric demand that would remain after the implementation of other conservation strategies in this report. New renewable generation was assumed to satisfy 2 percent of overall electric demand in 2005, with the percentage increasing by 2 percent each year until 2010 and 1 percent per year between 2010 and 2020. New renewable generation resulting from the Massachusetts RPS was estimated separately and subtracted from the total under the assumption that it is already factored into EIA's baseline energy projections.

Carbon savings from state "lead by example" efforts are based on measures similar to those in this report, in addition to having state government purchase 20 percent of its electricity from renewable sources by 2010 and 50 percent by 2020. State energy use reduction estimates are based on baseline energy use figures provided by the states, obtained from federal government sources, or estimated based on data provided by other New England states.

To determine the total amount of fossil power able to be displaced by conservation savings and new renewables, we summed EIA's projected site electricity consumption for all fuels. The surplus renewable power and conservation savings were applied first to eliminating new gas-fired generation that had been added to the EIA's projection to account for the closure of nuclear plants whose operating licenses had expired. In the high-reduction case, the remaining savings were used to offset coal-fired generation; in the low-reduction case, the savings were used to offset gas-fired generation.

Notes

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12. See note 1.

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17 See note 1.

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21 Impacts from U.S. Environmental Protection Agency, *Climate Change and Connecticut*, September 1997; New England Regional Assessment Group, U.S. Global Change Research Program*, Preparing for a Changing Climate: The Potential Consequences of Climate Variability and Change. Foundation Report*, September 2001.

22 Christopher Flavin, "Update: Climate Change and Storm Damage: The Costs Keep Rising," *World Watch Magazine*, January/February 1997.

23 See note 7. Note: NESCAUM's estimate of 1990 net emissions differs from the estimate produced for the stakeholder dialogue of 42.4 $MMTCO_2E$. In order to maintain a consistent baseline, the stakeholder estimate will be used in evaluating the impact of the stakeholder recommendations and other recommendations toward the regional goals. Both the NESCAUM and stakeholder estimates include the impact of terrestrial sinks, which reduce Connecticut's net emissions; the state's gross emissions are higher.

24. See note 7.

25. Ibid.

26. 2000 figures based on Northeast States for Coordinated Air Use Management (NESCAUM), Connecticut Department of Environmental Protection, Connecticut Clean Energy Fund, *Connecticut Greenhouse Gas Inventory, 1990-2000*, August 2003. 2010 and 2020 projections based on Center for Clean Air Policy, *Connecticut Climate Change Stakeholder Dialogue: Recommendations to the Governor's Steering Committee*, January 2004.

27. The dramatic decrease in electricity sector emissions in the CCSD's projections (from 10.9 $MMTCO_2E$ in 2000 to 7.3 $MMTCO_2E$ in 2010 – a 33 percent decrease) appears to be the result of a discontinuity between the greenhouse gas inventory data for 2000, which are based on estimates of actual energy use, and the results of ICF Consulting's electric sector modeling for the CCSD process, which was conducted for the years 2006 through 2025. ICF's modeling results for its 2006 base year, for example, include virtually no oil-fired electricity generation in Connecticut, despite the fact that, in 2001, there were 11 large steam generating units in Connecticut with residual oil as their primary fuel that generated a total of 6,000 GWh of electricity (based on EIA-767 data files for 2001). It is unlikely that all of these units will have been displaced or retired or will run on gas by 2006. Therefore, the electric sector carbon emission estimate in the CCSD report for 2010 should be viewed with caution.

28. The level of electric-sector natural gas consumption needed to replace nuclear generation was estimated first by determining the percentage of nuclear generation in Connecticut represented by the Millstone 2 plant. This was done by dividing the capacity of Millstone 2 by Connecticut's total nuclear generating capacity, based on figures from the Nuclear Regulatory Commission, *Facility Info Finder*, downloaded from http://www.nrc.gov/info-finder/region-state/, 26 January 2004. This percentage was then multiplied by the projected nuclear energy consumption in Connecticut for 2016 through 2020, arrived at in the same manner as other future energy consumption estimates as described in Appendix B. This figure – which represents nuclear generation "lost" due to the closure of Millstone 2 – was then multiplied by the ratio of the calculated heat rate for natural gas generation divided by the imputed heat rate for nuclear generation, based on data from Supplementary Table 66 of U.S. Energy Information Administration, *Annual Energy Outlook 2003*, to arrive at the amount of additional natural gas consumption that would be needed to replace power generated at Millstone 2. Heat rates were calculated by dividing energy consumption at generating plants for each fuel by net generation for each fuel. This method will tend to slightly overstate energy use – and therefore emissions – from natural gas, since it is likely that new natural gas-fired generation will be more efficient than the average efficiency of all natural gas plants in the region.

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