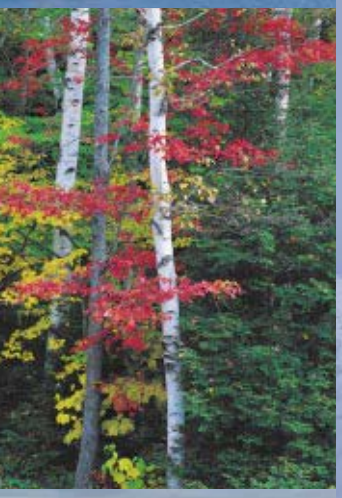

Climate Change Roadmap for Connecticut

Economic and Environmental Opportunities

Part I: Overview

Environment Northeast
Hartford, CT • Rockport, ME

Funding provided by the Emily Hall Tremaine Foundation

ABOUT US

Environment Northeast (ENE) is a not-for-profit, membership supported environmental research and advocacy organization focusing on the northeastern United States and eastern Canada. Our mission is to address large-scale environmental problems through policy analysis, collaborative problem solving efforts, and an advocacy program that promotes environmental sustainability. Our staff has professional backgrounds in the areas of environmental law, energy policy, climate change, ecosystem planning and forestry.

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PREFACE

This report provides a climate change "roadmap" for Connecticut. It is intended to help policymakers and stakeholders identify, prioritize and design the steps for Connecticut to reduce emissions that cause climate change. In so doing, this state can develop new business opportunities, increase the efficiency of its economic base, and improve air quality for its citizens.

Much of what must be done to address the risks of climate change will need to occur at the national and international levels. But in the end, it will come down to reducing emissions of greenhouse gases (GHGs) and other global warming emissions out in "the real world" where people live, businesses sell products and government at every level makes decisions that affect us all. The U.S.—and the international community—cannot reduce emissions far enough or fast enough to halt the pace of global warming without taking action at the state and local level. It will be the responsibility of each state to pull its own weight in order to successfully address this challenge.

Each state is capable of analyzing how best to move forward.

Connecticut could wait for instructions from the outside world about how to fulfill its responsibilities. However, the premise of this *Roadmap* is that each state is capable of analyzing how best to move forward. Connecticut is home to the finest academic institutions and world-class companies. It boasts environmental groups and an informed citizenry that are committed to working on climate change issues. State government in Connecticut has demonstrated that it can lead the nation on all-important energy policy, the primary source of global warming emissions. In short, this state has the tools to establish a comprehensive climate change action plan.

Connecticut should have the motivation to put such a plan in motion. If it moves aggressively to get ahead of the curve on climate change policies, its citizens, schools, businesses, municipalities and the state government itself will be well positioned to accommodate and profit from whatever national and international climate regimes ultimately emerge.

To be successful, an effective plan must stand on three legs. First, there must be a map of the course that can lead us from "business as usual" to a new set of policies and institutions that will achieve the necessary levels of reduction. Second, we need a deliberate, thoughtful stakeholder process that will study the issues and assess the available options. This process must also begin the work of public education and constituency building that will provide political support for whatever changes need to be made. Third, we must have a statewide commitment to take on the task of dramatically reducing emissions that are causing harmful climate change.

This *Roadmap* is an effort to chart Connecticut's course for minimizing future climate change. We do not pretend to have all of the data, all of the analysis or all of the right answers. Nonetheless, our aim is to present enough of these ingredients to start a meaningful discussion on the issues. We look forward to the path that lies ahead.

Daniel L. Sosland
Executive Director
1 May 2003

BACKGROUND

UNDERSTANDING WHERE TO START

In 2001, Environment Northeast published *Protecting our Biosphere*, a report outlining a climate change "action plan" for the United States. In it, we drew upon the latest international research to answer the first threshold question that will dictate the priorities for any climate change action plan.

Question 1: How much, and in what timeframe, must we reduce our emissions of greenhouse gases (GHGs) and other global warming emissions?

As a leading industrial nation and the largest per capita emitter of GHGs in the world, the United States should aim to reduce its GHG by 75% from current levels by the year 2050.[1]

A corollary to this target assumes that every state in the U.S. should be responsible for reducing its own GHG emissions by 75% in the same timeframe.

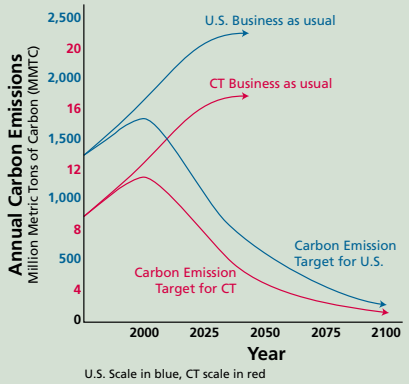
These reduction levels and timeframe are arrived at by considering the following observations from the scientific community:

- Concentrations of global warming emissions in the atmosphere are increasing, which has already caused changes in the climate.
- If we stay on our current trajectory for these emissions, we face serious environmental risks from climate related problems.
- While the exact nature and magnitude of these potential risks is uncertain, scientists have argued that the most responsible policy for the U.S. is to limit future global temperature increases to the lowest possible level.
- An increase of 1-2 degrees Celsius is believed to be about the lowest possible level we can achieve over the next century.
- The most aggressive policy scenario that could limit global warming to no more than 1-2 degrees Celsius assumes that atmospheric concentrations of CO_2, the most prevalent greenhouse gas, can be kept at or under 450 parts per million (ppm) by 2100. Today atmospheric CO_2 levels are at about 370 ppm.
- For the world to keep concentrations of CO_2 below 450 ppm, it must reduce its annual CO_2 emissions to 50% of current levels by sometime in the decade between 2050 and 2060. (We now know that in addition to CO_2, several other gases and aerosols also contribute to global warming. It is reasonable to assign these non-CO_2 emissions the same levels of reduction we give to CO_2).
- To meet this mid-century target, developing nations can realistically be expected to reduce only 25% from their already low levels. The lion's share of the reductions must therefore come from industrial nations, and will need to reach 75% below current levels.
- There is time to achieve these projected mid-century reductions if we start immediately. But if we delay taking action, staying on the "business as usual" trajectory for the next decade, it may be impossible to constrain future warming to 1-2 degrees by the end of this century. We can capture economic and development opportunities if we start now—and avoid higher costs and uncertainties if we wait.

Capture economic and development opportunities . . . Avoid higher costs and uncertainties.

To keep CO_2 concentrations below 450 ppm, the full picture of a politically and economically tolerable trajectory for U.S. and Connecticut emissions reductions is shown in Table 1.

TABLE 1. EMISSION TRAJECTORIES



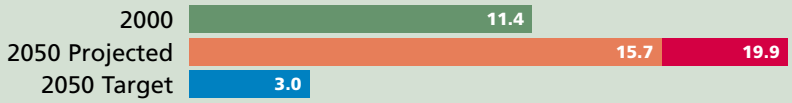
U.S. Scale in blue, CT scale in red

Question 2: How much GHG emissions do we have today in Connecticut, and if we keep going with "business as usual," what will our emissions be in 2050?

In 1999, the Connecticut Department of Environmental Protection completed an inventory of GHG emissions in the state for the years 1990 and 1995.[2] The DEP estimated that in 1990, Connecticut emitted just over 46 million short tons of carbon dioxide (or its equivalent), which is the same as 11.4 million metric tons of carbon (MMTC).[3]

We reviewed the latest available emissions data to make an educated estimate for the year 2000 inventory and also projected emissions levels for the year 2050 under a "business as usual" scenario.[4] What we found is that, after a dip in emissions during the mid-1990s, the state's "current" (2000) emissions are estimated to be back up around 11.4 MMTC. If no steps are taken to mitigate our emissions rates, Connecticut GHG emissions will swell to at least 15.7 MMTC by 2050, and could go as high as 19.9 MMTC.[5]

TABLE 2. CONNECTICUT GHG EMISSION LEVELS



By contrast, we need to be at about 3 MMTC in 2050 in order to meet a 75% reduction from current levels.[6]

Now that we know how much we must cut, we need to figure out where to make these reductions, which leads us to our third preliminary question.

Question 3: Where do Connecticut's GHG and other climate forcing pollutants come from, and what are the relative levels of emissions?

DEP's *GHG Inventory* generated Table 3 (page 5) which tells us where carbon emissions in the state came from in 1990 and 1995. It also shows that the largest six subcategories of emissions are all energy related. Energy Use emissions, together with Waste Management, account for 99% of the state's emissions, while Industrial Processes and Agriculture contribute less than 1%.

Where will Connecticut's carbon emissions come from in the future? In Table 4 (page 5) we estimate the relative contributions for the five major categories of energy emissions—electric power generation, mobility (transportation), industrial, commercial and residential—for 2000 (current levels) and 2050 (assuming business as usual).

The greatest increase in CO_2 emissions will be driven by mobility demand (over 60%) and by electric power production (at least 50%). Carbon impacts from thermal residential and commercial sectors are not projected to increase. This offers us a strong indication of where we will need to focus our emission cutting efforts, and leads us to the last of our preliminary questions before outlining the strategies of the Connecticut *Roadmap*.

The greatest increase in CO_2 emissions will be driven by mobility demand and by electric power production.

TABLE 3. ESTIMATED CONNECTICUT GREENHOUSE GAS EMISSIONS BY ANTHROPOGENIC ACTIVITY (REPORTED IN TONS OF CARBON DIOXIDE EQUIVALENT).

	1990 Emissions (TCDE)	1995 Emissions (TCDE)
Energy Use		
Residential	7,901,361	8,395,783
Commercial	3,858,436	4,068,033
Industrial	4,778,615	5,261,989
Mobile Sources	11,831,565	12,597,430
Other Transportation	4,135,035	3,287,276
Utilities	10,475,465	6,572,912
Natural Gas Distribution	204	240
Subtotal	**42,980,681**	**40,183,663**
Industrial Processes		
Limestone Use	197,446	226,336
Subtotal	**197,446**	**226,336**
Waste Management		
Solid Waste Management	2,881,212	2,351,042
Wastewater Treatment	23,113	20,870
Subtotal	**2,904,325**	**2,371,912**
Agriculture		
Domesticated Animals	138,714	135,550
Manure Management	41,130	38,373
Soil Management	52,516	60,136
Subtotal	**232,360**	**234,059**
TOTAL EMISSIONS	**46,314,812**	**43,015,970**
Land Use		
Storage by Forests	628,553	791,527
Subtotal	**628,553**	**791,527**
NET EMISSIONS	**45,686,259**	**42,224,443**

Source: DEP, *GHG Inventory* (1999).

TABLE 4. SOURCES AND PROJECTED GROWTH OF CT CARBON EMISSIONS MILLION METRIC TONS OF CARBON (MMTC)

Category	2000	2050	% Increase from 2000
Electric power	2.5	3.8–8	52–220%
Mobility	4.1	6.7	63%
Residential	2.2	2.2	0%
Industrial	1.5	1.9	27%
Commercial	1.1	1.1	0%
STATE TOTAL	**11.4**	**15.7–19.9**	**38–75%**

Long-term reduction targets will be accomplished when they are understood to be economically and politically feasible.

Question 4: What principles can we use to sort through and prioritize the actions that will comprise a comprehensive climate change action plan for Connecticut?

Environment Northeast is guided by the following principles in its analysis and prioritization of climate change solutions.

1. **Address all pollutants that impact climate, not just CO2.** Most of the discussion to this point has been limited to CO_2 (and/or Carbon) since CO_2 is the most scientifically well-understood of the GHGs and because most of the data and inventories are expressed in terms of CO_2 (or its equivalent). But as noted in both the DEP *GHG Inventory* and ENE's *Biosphere* report, the scientific community is gaining a much better understanding of the climate change impacts of other, non-CO_2 pollutants. As Table 5 indicates, other major GHGs include methane (CH_4) and ozone, which comes principally from emissions of nitrogen oxides (NOx), volatile organic compounds (VOCs), carbon monoxide (CO) and methane. In addition to these gases, scientists are also beginning to understand that certain aerosols such as black carbon, sulphates and nitrates have significant climate impacts. CO_2 is only part of the equation to minimizing climate change.

2. **Capture near-term emission reductions that pay long-term dividends.** For example, many of the non-CO_2 emissions that cause climate change have short atmospheric lifetimes, which means that if we can make reductions in the next 10-15 years we may see a significant and immediate slowing of global warming and buy more time to deal with some of the tougher CO_2 reductions we will ultimately need to achieve. Reducing non-CO_2 emissions will also drive large, near-term public health and environmental benefits which will help facilitate many of these reductions.

3. **Use market mechanisms wherever possible,** and design policies that will provide economic incentives accessible through the marketplace so that the success of the climate change action plan does not rely exclusively on government administration and the goodwill of citizens. Examples of a market mechanisms that will be integral to a comprehensive climate action plan include an efficient GHG emissions credit trading program or a carbon tax on fuels. This principle recognizes that:

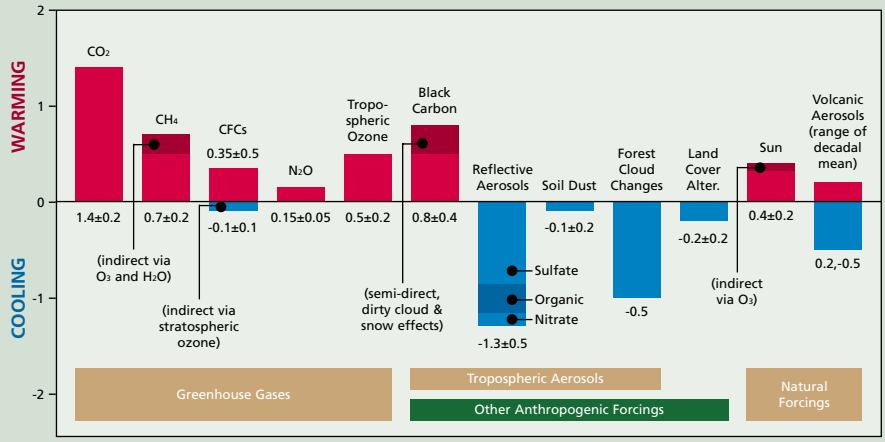
   - Long-term reduction targets will be accomplished when they are understood to be economically and politically feasible; and
   - Market forces will play a key role in guiding the precise and least costly mix of technology investment necessary to meet emissions reduction targets.

   Economic incentives and aggressive participation from the business sector must play an equal role if these new climate change policies and institutions are to be sustained over the next 50-plus years and if they are to penetrate every level of society.

4. **Government policies and laws will be needed to spur key action.** Regulatory approaches can be useful to jumpstart markets and mandate other changes.

5. **Focus support on commercialization of energy technologies and services** that have plausible "breakout" market potential in New England. Energy efficiency services, fuel cells, ocean power hold promise for the region.

TABLE 5. CLIMATE FORCINGS (W/M²) 1850-2000



Source: James E. Hansen and Makiko Sato (2001)

6. **Introduce government and non-government institutions, processes and policies** (e.g., trading systems, carbon offsets, carbon "buy-backs," carbon taxes) that are essential to achieving long-term reduction targets.

7. **Do not lose sight of the 2050 target.** Some "low hanging fruit" reductions can and must be harvested in the early years of any climate change action plan. But this endeavor cannot be allowed to obscure or postpone our focus on making the harder, long-term cuts that we need to meet our target. To be successful, an action plan must aggressively pursue a suite of both short-term and long-term solutions.

8. **Education and awareness are critical.** Countless decisions made in everyday life affect global warming. Helping individuals, businesses, local and state government to be aware of the implications of their decisions on climate change will be critical to success.

PRIORITIES

FINDINGS AND RECOMMENDATIONS

Environment Northeast studied the existing and projected emissions inventories for Connecticut and researched a wide variety of technologies and programs that might conceivably play a role in a comprehensive climate action plan for the state. We prioritized these options through the following screen:

- the size and timing of reductions,
- economic and political feasibility,
- ability of the State of Connecticut to meaningfully implement the action, or
- the fact that the measure describes an institution or policy that will be fundamental to making all other measures successful.

In Part II of this *Roadmap*, we present what we perceive to be the 17 most important climate change "measures" that Connecticut should consider. For each of the 17 measures, Part II dedicates several pages to outline:

- the goal of the measure,
- a description of how the measure would work (the relevant technologies, economics and legal framework),
- a brief analysis of the emissions impacts, and
- implementation "next steps" such as organizing opportunities, additional research that is needed, and suggested references.

Also in Part II, these measures are divided into five broad strategies, and are listed in Table 6 (page 8) with an indication (where adequate data exists) of the range of achievable emission reductions.

As noted at the outset, this *Roadmap* is intended to help policymakers and stakeholders identify, prioritize and design a climate change action plan. Ultimately, this *Roadmap* finds that every one of these measures must play a role in helping Connecticut meet its responsibilities on climate change.

However, to sort out where to begin with this long and varied list, the remainder of this *Roadmap* will summarize our Top Ten Priorities for achieving Connecticut's target reductions. The Top Ten Priorities represent those individual measures that will have the largest long-term impact on meeting Connecticut's reduction goals.

All of these measures should be implemented now. Some—like energy efficiency and cogeneration—will produce immediate reductions. Others—like hydrogen infrastructure—have the potential to produce significant reductions if we start now to invest in their future.

TOP TEN PRIORITIES

1. Hydrogen Infrastructure
2. Coal and Oil Power Plants
3. Diesel Emissions
4. Energy Efficiency
5. GHG Credit Trading
6. Public GHG Purchase
7. Light Vehicle Emissions
8. Renewable Power
9. Terrestrial Carbon Sinks
10. VMT (Vehicle Miles Traveled)

UTC Fuel Cells. The U.S. Postal Service and Alaska's largest electric utility, Chugach Electric, use fuel cells. Five fuel cells, connected in parallel, now produce one megawatt of electricity and are the primary source of power for the Anchorage Mail Processing Center.

TABLE 6.

STRATEGY GROUP I: CREATE NEW PRIVATE SECTOR AND GOVERNEMENT INSTITUTIONS

Measure	Name	Potential Reductions
I-1	GHG Credit Trading	n/e
I-2	Public GHG Purchase Program	2.4–4.5
I-3	Comprehensive Clean Air Initiative	0.9–1.5
I-4	Hydrogen Infrastructure Development	7.8–13.2
I-5	Climate Friendly Procurement	n/e

STRATEGY GROUP II: MODERNIZE OUR ELECTRICITY AND ENERGY SYSTEMS

Measure	Name	Potential Reductions
E-1	Retire Coal and Oil Plants by 2020	2.3
E-2	Maintain and Expand Energy Efficiency	2.6–4.5
E-3	Reform Ratemaking and Regulation	n/e
E-4	Increase Renewable Power	1.4

STRATEGY GROUP III: TRANSITION TO NEW TRAVEL AND FREIGHT SYSTEMS

Measure	Name	Potential Reductions
M-1	Reduce Diesel Emissions by 90%	0.9–1.5
M-2	Regulate GHG Emissions	n/e
M-3	Improve Light Vehicle Efficiency	0.9
M-4	Reduce VMT (vehicle miles traveled)	0.5

STRATEGY GROUP IV: REDUCE METHANE EMISSIONS

Measure	Name	Potential Reductions
ME-1	Facilitate Methane Purchase and Trading	n/e
ME-2	Reduce Landfill Methane Emissions	0.2
ME-3	Reduce Natural Gas Pipe Leakage	.00006

STRATEGY GROUP V: RECONSIDER FOREST CUTTING AND LAND CLEARING PRACTICES

Measure	Name	Potential Reductions
S-1	Expand Terrestrial Carbon Sinks	0.7

All values are in millions of metric tons of carbon (MMTC).
Reductions from several of these Measures are mutually exclusive.

PRIORITY I: HYDROGEN INFRASTRUCTURE

Connecticut should identify and implement near-term actions that would facilitate a transition to using hydrogen fuel for mobility, building energy and power production by 2050-60. As part of this initiative, the Connecticut should develop a comprehensive Hydrogen Economy Research and Demonstration Program. Critical objectives for the program should include:

- Demonstrating hydrogen practicality and safety (for example, fuel cell vehicles using hydrogen fuel, vehicle fueling stations, local hydrogen production at fueling stations, local storage facilities, etc.);
- Demonstrating co-production of hydrogen for local mobility use at an advanced fossil (or biomass) power systems, potentially combined with carbon capture and geologic sequestration;
- Facilitating ongoing development and implementation of safety codes;
- Conducting public education on hydrogen, (e.g., role, codes);
- Facilitating commercialization of key technologies for stationary and portable power generation and mobility purposes; and
- Identifying potential funding sources (Department of Energy, the Connecticut Clean Energy Fund) for priority actions.

A successful R&D program will not only advance the goal of dealing with climate change emissions, it will also deliver jobs and tax revenue to the state economy.

This may be the most challenging of the measures we propose, but it is listed among our Top Ten Priorities for three simple reasons. First, the potential reductions are massive. We estimate that a successful transition to hydrogen by mid-century will reduce between 7.8 and 13.2 MMTC from Connecticut's GHG inventory each year. This is about double the best potential performance of the next closest measure. If even a portion of this reduction were achieved, it would make a tremendous impact on the state's ability to meet its targets.

Second, we believe that to successfully stabilize climate change, the U.S. and the rest of the world will ultimately need to move away from transportation systems that make direct use of fossil fuels. If this in fact is the direction the world is headed, Connecticut would be well served to get ahead of the curve. Third, Connecticut is home to several industry leaders in the field of hydrogen production, storage, transportation and consumption (in energy systems like fuel cells). A successful R&D program will not only advance the goal of dealing with climate change emissions, it will also deliver jobs and tax revenue to the state economy.

PRIORITY II: COAL AND OIL POWER PLANTS

Connecticut must reduce the large GHG emissions from oil and coal power plants within 20 years. Oil and coal-fired power plants in Connecticut emitted about 9.4 million tons of CO_2 (2.34 MMTC) in 2001. Together their carbon emissions represent 83% of the 2050 carbon emissions targets from all sources in Connecticut. These plants also emit heavy metals and other detrimental air pollutants. Many of these plants are located in urban areas with high incidence rates for childhood health problems such as asthma.

The six older oil units will likely be retired within the coming decade given their economics. But the two coal plants could remain economic for a long time if a plan is not developed to replace them.

A fair and reasoned approach to replacing these plants should be considered. First, these plants should be subjected to market competition. Any unfair obstacles or subsidies they may enjoy should be removed. A review of current ratemaking policies should be conducted to determine if these plants receive direct or indirect subsidies or incentives that support uneconomic operation of the plants. Second, we should explore financial incentives for replacing the two coal plants in the 2010–2020 time frame if market forces alone appear

unlikely to retire these units. Third, we might consider regulatory or statutory options, such as a stringent CO_2 emissions limit for power plants, and should study the costs and benefits of replacing these plants.

Replacing the electricity produced by these plants with electricity from new, efficient natural gas plants (the most carbon-intensive option) would reduce CT carbon emissions about 60%, or 1.35 MMTC/year. If the energy from these plants were to be replaced entirely with "no-carbon" renewables, Connecticut carbon emissions would be reduced by about 2.34 MMTC/year.

New technologies can reduce diesel emissions of particulate matter by 90%.

PRIORITY III: DIESEL EMISSIONS

Steep reductions in the emissions of diesel engines are available right now with current technology and fuels.

In 1995, Connecticut's DEP estimated that 30% of the state's global warming gases were emitted from mobile sources. This was before anyone realized that the black carbon and nitrogen oxides (NOx) emissions from mobile sources have a major additional warming effect on global temperatures. Diesel engines are the number one source of black carbon in Connecticut. U.S. EPA's official inventory of ozone forming NOx emissions shows that over one-third of Connecticut's NOx comes from mobile diesel engines. These engines are found in transit and school buses, long-haul trucks, garbage and dump trucks, construction equipment, trains and marine engines.

New commercially available technologies, used with low sulfur fuels, make it possible to reduce diesel particulate matter (PM) emissions by 80-90% for certain diesel engines and duty cycles. These technologies can be implemented either in new engines or by replacing, repowering or retrofitting existing engines. By the end of the decade, 80-90% reductions in NOx, a precursor to the GHG ozone, are expected to be commercially achievable. As a first step, the state should also use its procurement power to accelerate the purchase of new, clean engines and the retirement or retrofit of older, dirtier engines in its fleet and any fleets that receive state funding. Municipal governments could do the same.

It is very important to note that most of these 90% reductions—the equivalent of 1,345 to 1,810 tons of carbon each year—could be achieved in the next decade. But because the cuts are coming from black carbon, the cooling impact will be felt much faster than if it were CO_2. A 90% reduction in current diesel black carbon emissions within Connecticut would have the same impact in the next three to five years as eliminating 100% of Connecticut's CO_2 emissions for the next 1.25 to 6.75 years. To produce an equivalent amount of cooling in the year 2100 as would result from the 90% reduction in diesel black carbon emissions, current Connecticut CO_2 emissions would need to be cut by 0.9 to 1.5 MMTC (8% to 13% of 2000 CT CO_2 emissions) and this reduction would have to be maintained every year from now through 2100.

By 2050, we estimate the total savings from cleaning up heavy duty diesel engines would range from 0.9–1.5 MMTC.

PRIORITY IV: ENERGY EFFICIENCY

Perhaps the most cost-effective means of achieving large GHG reductions in Connecticut is to increase the efficiency with which we use electricity, natural gas and oil. Cutting back on end-users' rate and amount of consumption reduces GHGs that would have been associated with the avoided energy. There are numerous proven and affordable steps the state should pursue in this regard.

The state must maintain and expand the conservation and load management (C&LM) programs and push them to promote "next generation" solutions. The state should also adopt and enforce tighter building codes and standards for appliances and electrical equipment.

Given the success of the C&LM funds, Connecticut should establish similar funds surrounding the use of natural gas and oil. These funds can be used to promote new efficient equipment purchases and practices that will cut down on the emissions from these energy sources.

In addition, great efficiencies are achieved by integrating on-site customer production of steam and heat with electricity generation. Cogeneration, or combined heat and power (CHP), can produce reductions in GHG as fuels are used more efficiently. One promising use for CHP involves integrating stationary fuel cells for electricity generation while using the waste heat for steam and heat requirements.

We estimate that between 2.6 and 4.5 MMTC can be reduced each year through aggressive implementation of these recommendations.

Establish a robust and rigorous system for capping and trading GHG credits.

PRIORITY V: GHG CREDIT TRADING

One way to send price signals to GHG emitters (and reducers) is to establish a robust and rigorous system for capping and trading GHG credits. A credit represents an amount of emissions (e.g., 1 ton of CO_2) that has been successfully reduced.

As a first step, the state should develop an effective GHG registry. Large energy users and industrial emitters of global warming emissions should develop a baseline inventory of the annual emissions associated with their operations and report these baselines to the registry using one of the recently developed accounting tools. As a second step, a campaign should be started in Connecticut to enroll participants in pilot projects for GHG credit trading.

The newly announced Chicago Climate Exchange project is a voluntary, business-driven pilot project intended to help participants get familiar with accounting for their annual GHG emissions and trading GHG credits. The concept and mechanisms of this system are based on the programs established by the U.S. EPA for trading sulfur and NOx credits.

In a voluntary GHG credit trading system, all participants agree to establish a baseline of GHG emission levels (typically their own emission level in a previous period of time), and then commit to reduce their emissions by a fixed amount over time (e.g., 1% per year). Every year, participants individually find the most cost-effective way to meet their target. They earn a credit for every ton of emissions reductions that exceeds their annual target, and can trade (sell) the credit to another participant who has fallen short of its target. In this way participants are given flexibility to determine what reductions work best for them, and they receive (or pay) a market-based financial incentive depending on their success in meeting the targets. In the aggregate, gradual but significant reductions can be achieved among the participants.

Initial GHG emissions reduction targets for CCX participants are 1%/year for a four year period. This system supports trading of reductions in all six "Kyoto" greenhouse gases. In addition to direct "in house" reductions in GHG emissions, qualifying reduction projects will include renewable energy, energy efficiency improvements, terrestrial carbon sink expansion or protection, landfill methane recovery and vehicle fleet fuel efficiency improvements. Industrial sources, state and municipal governments, universities and companies managing carbon "sinks" (e.g., forests) are eligible to participate. At least one Connecticut-based company is already involved.

One of the advantages of the CCX is that the participation and trading "rules of the game" have already been established. This task is complex and time consuming, and its completion at CCX means that participants can start reducing emissions and earning credits immediately. Other state or regional trading systems are under development that could also provide an opportunity for early emissions reduction trading and these other tools should be examined for their accuracy in accounting for emissions reductions and enforcement effectiveness.

Reductions achieved by a GHG credit trading system will depend on a variety of factors, including how aggressively the caps are reduced over time, who is invited to participate, and what types of reductions are eligible for credit. Even without an estimate for reductions, this measure is high on our priority list because it offers an immediate opportunity to gain experience with and confidence in the concept of GHG credit trading and also provides early financial signals to emitters, consumers, and to the marketplace. Such

signals will help facilitate the most cost-effective emission reduction technologies and practices.

PRIORITY VI: PUBLIC GHG REDUCTION PURCHASE

Connecticut should establish a public program to purchase greenhouse gas reductions. A public greenhouse gas reduction purchase program would buy GHG reductions through an auction, in which participating parties offer (or "bid") the number of tons of GHG emissions they will reduce and the price at which they will do so. The state then buys up all of the lowest cost bids until the annual budget is used up. In the state of Georgia, for example, this system is used to pay farmers for giving up their water rights (for irrigation) to deal with the state's drought crisis.

A Connecticut GHG Purchase could be funded through any number of mechanisms, including small taxes on fossil-fuel sales in Connecticut reflecting fuel carbon content. To put the cost in perspective, Connecticut's sales taxes on motor fuels (gasoline and diesel fuel) and natural gas produced about $458 million in FY 2000-2001 revenues. An initial GHG reduction purchase program starting at $1 million per year and rising to $10 million per year by 2013 would be an incremental tax burden initially of 0.2% of existing fuel tax revenues rising to about 2% in 2013. (Connecticut does not appear to currently tax sales of coal or of residual oil used by stationary sources such as power plants, industrial and commercial boilers, etc.).

At a funding level of $10 million/year, we estimate that this program could reduce GHGs by 0.5–0.9 MMTC. In some hypothetical future year, we estimate that a fund of $50 million/year could buy down between 2.4 and 4.5 MMTC.

PRIORITY VII: LIGHT VEHICLE EMISSIONS

Connecticut should do what it can to improve light duty vehicle efficiency through bulk purchases and other measures to jump start markets for more efficient vehicles.

Currently, the State runs a fleet of 3,000 cars and 1,200 vans and light trucks. It turns over one-sixth of the fleet each year, achieving complete fleet turnover every six years.

The State should establish a procurement policy that would upgrade the efficiency of its fleet of cars and light trucks (owned or leased) and develop programs to do the same for private vehicle fleets. The State could lead by example by ensuring that every vehicle it purchases gets the best achievable mileage per pound of CO_2 emitted in its class. For example, a new 4-door gas-electric hybrid car now gets 52 mpg city, 45 mpg highway and emits roughly 4 tons of CO_2/year. By comparison, the Pontiac Sunfire (in the same Small Car Class as the 4-door hybrid), gets 24 mpg city and 33 mpg highway and emits 6.9 tons CO2/year. Not only would the hybrid save the State more than $450/year in fuel costs compared to the Sunfire, it also would avoid 2.9 tons CO_2/year, or 29 tons over ten years. Within every class of vehicles (e.g., small car, sedan, station wagon, pickup, van, etc.) there is at least a 25% difference in the amount of CO_2 emitted annually between the most efficient and least efficient car in the class.

A more ambitious task would be for the state to investigate the possibility of aggregating demand from fleets in the state (or the broader Northeast region) to cause manufacturers to introduce a new, significantly more efficient vehicle (or vehicles) for use in these fleets. This "golden carrot" approach has been successfully used in the past, for example to convince manufacturers to introduce very high-energy efficiency refrigerators into the commercial marketplace. Several light-vehicle manufacturing companies are currently exploring introduction of more advanced and much larger hybrid vehicles than are currently offered. These vehicles would be more fuel-efficient than similar non-hybrids. Industry experts tell us that a manufacturer requires a minimum annual market size of about 25,000 vehicles before it will introduce a new model vehicle to the marketplace. Connecticut, with other states in the Northeast or in the NEG/ECP, could work together and with private sector fleets to implement this initiative.

Net reductions in light vehicle carbon dioxide emissions of about 17% could be achievable by 2020 combining these actions, assuming aggressive action and currently available technology. This would provide reductions of about 0.68 MMTC in 2020 and 0.9 MMTC in 2050.

Connecticut like the rest of the world must find ways to increase levels of clean, renewable energy in its power supply mix.

PRIORITY VIII: RENEWABLE ENERGY

Certain kinds of renewable energy have zero (or net zero) GHG emissions. Over time, Connecticut like the rest of the world must find ways to increase levels of clean, renewable energy in its power supply mix and displace conventional fuel sources that are causing climate change. Among all renewables, those that are both the cleanest and have the biggest potential for growth (and displacement of dirtier power) are also currently not commercially available or are available only at a premium price.

The priority of a climate-oriented renewable energy policy for the state should be on commercializing those renewable technologies that have a reasonable chance of deep penetration into the marketplace and adding significant capacity to the power sector of the Northeast. We identify three straightforward programs the state should pursue to achieve this goal. First, the state government should use its own purchasing power to procure an increasing portion of its power supply from new, clean technologies. Innovative use of state supplemental environmental projects (SEPs) can redirect environmental penalties towards productive green power purchases. Second, the state should establish an improved Renewable Portfolio Standard (RPS) that helps spread the premium cost of bringing some initial new, clean renewables online across a broad cross-section of consumers. Third, the state should adopt certain regulations and market rules that will help green markets get a foothold in the state. This could include one or more temporary green power options offered to utility customers. Only if businesses have a chance of making a reasonable profit under Connecticut's market rules will they make the investments in technology and advertising that will inform customers and offer them quality green products and services.

We project that the state could reduce about 1.4 MMTC per year over the long term if this suite of green power options were successfully implemented.

PRIORITY IX: TERRESTRIAL CARBON SINKS

Connecticut should explore ways to expand the use of terrestrial storage of carbon through targeted timber cutting practices, new approaches to land clearing and open space protection. The Connecticut landscape is removing about 0.9 MMTC/year (equivalent to about 8% of current carbon emissions) from the atmosphere, while land conversion is releasing about 0.44 MMTC/year and timber harvesting is releasing about 0.27 MMTC/year. A wide range of changes in land and forest management practices could potentially reduce or avoid carbon releases, increase the annual volume of carbon removed from the atmosphere by Connecticut's landscape and thus expand the amount of carbon storage, or "sinks." Expanding such carbon sinks beyond "business as usual" levels presents an important "bridge" opportunity to remove carbon from the atmosphere at a relatively low cost, while technology evolution lowers the costs of reducing carbon emissions.

Carbon sinks could be expanded by:

- Reforesting land not currently forested;
- Minimizing removal of site carbon when converting forested land to other uses and maximizing future tree growth on such sites;
- Modifying forest management practices to increase the growth rates of forest stands, and expand harvesting of trees that would otherwise die and decay; and,
- Modifying agricultural practices to expand soil carbon content.

We estimate that as much as 0.7 MMTC could be saved each year within Connecticut, and that in a cap and trade system, this number could be much larger in the Northeast and Eastern Canada where forestry is a major industry.

PRIORITY X: VMT (VEHICLE MILES TRAVELED)

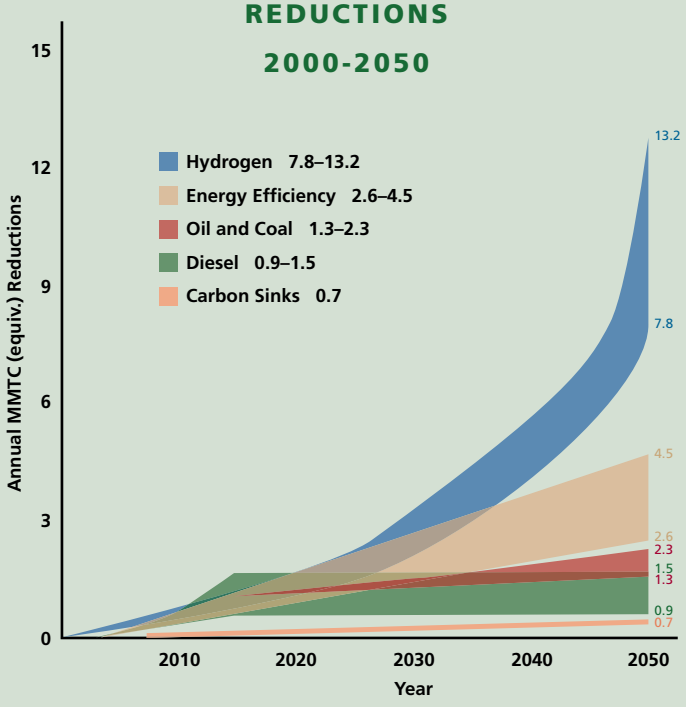
The state must promote programs that will reduce VMT for passenger vehicles and freight. Several mechanisms for reducing VMT have been developed for transportation planning. Examples of potentially effective measures include:

- Expanded and more convenient public transportation services;
- Expanded ridesharing and high-occupancy vehicle (HOV) incentives;
- Encouraging high-density housing development around public transit stations;
- Introducing road user fees to fund public transit, encourage car pooling, etc.; and,
- Exploring options for long-term implementation of high-efficiency transport for goods and people traveling through Connecticut (which could reduce the number of trucks passing through the State).

The Connecticut Fund for the Environment (CFE) is developing a comprehensive VMT reduction advocacy program for Connecticut. The CFE program could provide a good mechanism for studying and implementing activities related to this measure. We estimate that as much as 0.5 MMTC could be eliminated by these activities.

TABLE 7. PROJECTED TIMING OF EMISSION REDUCTIONS

2000-2050



The impact of these Top Ten Priorities, together with the other measures detailed in Part II of the Roadmap, could reduce emissions in the amounts and time periods illustrated in Table 7.

SUMMARY

Connecticut can achieve the goal of minimal global warming over the next 50–100 years. States that grasp the need to address climate change emissions will be the first to modernize their economies, products and services while cleaning up the environment and improving public health. The decisions we make now will determine our success in achieving these objectives.

Connecticut—its government, private sector, non-profit institutions and individuals—should collectively take steps now to refine an action plan and start down the road implementing this plan. We recommend focusing immediately on the following steps:

- **Agree to Meaningful Targets and Goals** – To frame climate change reductions, we need to be clear on what goals we seek to reach by what date. Our recommendation is that we initially set a target of achieving 75% reductions from current levels in all global warming emissions by 2050 as our primary goal.

- **Start Now to Implement Already Proven and Affordable Strategies** – We already know how to implement many important emission reduction strategies. The state and other stakeholders should make a commitment to start now to invest in broader energy efficiency efforts; to clean up diesel emissions; to purchase and support green power markets; to protect open space; and to reduce emissions from cars and light trucks. These initiatives will deliver immediate reductions in global warming emissions and will continue to generate reductions for decades to come.

- **Start Now to Implement Longer Term Strategies** – Many of the measures outlined in this Roadmap will produce large emission reductions—but these will occur in the future, after technology improvements, economies of scale and other developmental hurdles are overcome. Nonetheless, to arrive at the deep reductions we require in the longer term, we have to begin work on the necessary institutions and infrastructure. For example, establishing hydrogen demonstration projects, engaging in GHG reduction trading initiatives, and devising an exit strategy for the state's coal and oil power plants must start now.

- **Educate and Listen to the Public and Decisionmakers** – Public education and feedback about the implications of climate change and the opportunities for addressing it are critical. Members of the public and key decisionmakers, such as town and state officials, regulators, and business owners, can help develop and refine ways to reduce GHG emissions. Through education, better solutions will be developed, and appropriate decisions will be made as we conduct our business and our daily lives.

The decisions we make now will determine our success in achieving these objectives.

With these commitments, Connecticut will be on the path to real climate change policies that will benefit our economy, our children, our communities and our environment.

ENDNOTES

[1]Unless otherwise indicated, the *Roadmap* uses the shorthand "GHG" to refer to both gases and aerosols that cause global warming.

[2]CT DEP, Connecticut's Greenhouse Gas Emissions Inventory: 1990 and 1995 Calendar Years, March, 1999, http://www.dep.state.ct.us/air2/emiss/grnhous.htm

[3]For purposes of the Roadmap, we convert all measures of CO_2 and CO_2-equivalents into million metric tons of carbon, the measurement used in most climate change circles.

[4]The DEP's calculation for 2000 may vary slightly from this figure. It was not available at the time of publication. Our projections are based on "Energy-Environmental Policy Integration and Coordination Study," December, 2000 by the Electric Power Research Institute (EPRI) that used DOE's National Energy Modeling System (NEMS) and projected model results through 2050. We applied the national growth trends through 2050 from this report to each major sector to develop a general portrait of CO_2 emissions in CT in 2050 under "business as usual" conditions. Because the CT DEP inventories determined that most CT GHG emissions were of CO_2, ENE developed year 2000 estimates and year 2050 projections only for CO_2.

[5]It is possible that much of Connecticut's current power generation from nuclear resources will retire over the next several decades, which will tend to push the state's carbon emissions toward this higher level.

[6]A 75% reduction from 11.4 MMTC is actually 2.85 MMTC, which we round up to 3 MMTC recognizing that there is uncertainty in various assumptions underlying the projections.

CREDITS

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This report was prepared by Environment Northeast staff.

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