Connecticut Climate Change

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Connecticut Climate Change Stakeholder Dialogue: Recommendations to the Governor's Steering Committee

The Center for Clean Air Policy

January 2004

Center for Clean Air Policy

This report was made possible through the support of the Connecticut Clean Energy Fund,
the Connecticut Department of Environmental Protection, the Emily Hall Tremaine Foundation, and the Energy Foundation.

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EXECUTIVE SUMMARY

The Governor's Steering Committee (GSC) asked Connecticut stakeholders to formulate policy recommendations to help the State to make progress toward or beyond greenhouse gas (GHG) targets established by the New England Governors/Eastern Canada Premiers (NEG/ECP) Climate Change Agreement of 2001. In response, stakeholders identified 55 separate recommendations that together achieve 72.7 percent of the gap toward the 2010 NEG/ECP target and 70.7 percent of the gap toward the 2020 target, not including actions that reduce black carbon emissions. When black carbon reduction actions for transportation are included, stakeholder recommendations achieve 75.6 percent of the gap toward the 2010 NEG/ECP target and 80.1 percent of the gap toward the 2020 target. Stakeholders participating in the dialogue unanimously agreed to 52 of the 55 final recommendations. The remaining three recommendations fell one vote short and were recorded as garnering a supermajority.

Recommendations cover all sectors and GHG types recognized by the NEG/ECP and employ a variety of implementation mechanisms under a portfolio approach. Covered sectors include transportation, electricity, residential, commercial, industrial, agriculture, forestry, and waste. In addition, stakeholders recommended cross-cutting education actions and discussed the potential need for implementing an emissions reporting and registry system.

Recommendations include administrative and legislative actions, voluntary and mandatory measures, and State and regional actions. Most actions involve financial incentives or disincentives. The second most common implementation approach involves adjusting regulatory programs or barriers.

Emissions reductions from actions in Connecticut were counted (as were emissions) whether they occurred inside or outside the State, as long as they were directly a result of Connecticut's actions (e.g., energy consumption by Connecticut consumers). Stakeholders formulated recommendations to include black carbon as another GHG toward NEG/ECP targets. They also noted key policy areas that appeared most promising for further action in meeting or exceeding targets and discussed the potential need to clarify the NEG/ECP long-term targets.

The Center for Clean Air Policy (CCAP) designed and facilitated the dialogue as a nonbinding advisory process to the GSC. Connecticut Innovations, on behalf of the Clean Energy Fund, provided most of the funding, with additional support from the Emily Hall Tremaine Foundation. In addition, the Connecticut Department of Environmental Protection (DEP) provided funding for advanced modeling for the electricity sector on recommendation from stakeholders.

The dialogue involved a series of regular stakeholder working group and public meetings, all of which took place between April 23, 2003, and December 5, 2003. All meetings and materials

were open to the public and posted on the CCAP website (http://www.ccap.org/). Stakeholders determined all policy proposals and designs along with data methods, sources, and assumptions; they received technical assistance from the technical working groups and CCAP. Public input and participation was present throughout the process. CCAP was asked by the GSC to play an impartial and expert role in the process.

This policy dialogue began with a review of the Connecticut inventory of GHG emissions and initial baseline forecasts of GHG emissions to the years 2010 and 2020. Stakeholders approved a set of recommended decision criteria, which included primary factors of cost-effectiveness and GHG reduction potential and secondary factors involving ancillary impact and feasibility issues. As a next step, stakeholders reviewed a "long list" of existing state and local GHG actions from other jurisdictions. This list was refined through stakeholder and working group discussions and public input to a list of initial priorities for analysis.

Initial recommendations by working groups and stakeholders were made as assessments became available for individual actions. These were refined based on stakeholder guidance through the remainder of the dialogue. Stakeholders and working groups developed final sector baselines as they discussed mitigation actions. As working group assessments of actions became available, they were compared, in aggregate, to State baselines and GHG targets and shared with stakeholders. The level of proposed GHG reduction actions increased over the course of the dialogue as stakeholders proposed successively more aggressive actions to meet the targets. Stakeholders and working groups formulated final actions from assessments of baselines, targets, and actions and exploration of alternative policy designs.

At the next-to-last stakeholder meeting, stakeholders identified and unanimously agreed to 28 measures and designated several remaining measures as pending. Working groups explored alternative policy designs and further analysis prior to the final stakeholder meeting. At the final meeting, stakeholders identified and recommended 27 additional measures. The three measures that fell one vote short of unanimous consent were classified as having a supermajority of support. Participants unanimously approved the 24 remaining measures after extended discussion and development of alternative policy designs.

Following receipt of the final report, the GSC will develop and deliver a set of recommendations to the Governor for further action and adoption.

Tom Peterson
Domestic Policy Director, CCAP
Project Director and Facilitator of the Dialogue

Table ES.1
Connecticut Climate Change Stakeholder Dialogue (CCSD) Policy Recommendations

Transportation Sector
California LEV II standards
Greenhouse gas (GHG) feebate program*
Fleet vehicle incentives and initiatives**
Tailpipe GHG standards*
Public education initiative
Hydrogen infrastructure research and demonstration program** *
Transit, smart growth, and vehicle miles traveled (VMT) reduction package* **
Multistate intermodal freight initiative**
Clean diesel and black carbon* **

Residential, Commercial, Industrial Sector
Appliance standards*
Appliance-swapping program
Electric hot water heater replacement program
Bulk purchasing of appliances
Upgrade residential and commercial building energy codes*
Promote energy efficient and energy improvement mortgages**
Revise Energy Conservation Loan Program
Weatherization Assistance program**
Energy Star Homes program
High-performance buildings: schools and other State-funded buildings** *
High-performance buildings: privately funded projects** *
Shared savings program for government agencies
Training of building operators
Green campus initiative
Energy benchmarking, measurement, and tracking program for municipal buildings
Pilot fuel-switching projects
Remove barriers to third-party load-management techniques*
State procurement of environmentally preferable services and products
Review of New England Regional Demand Response Initiative (NEDRI) recommendations
Promote voluntary programs and actions
Encourage clean combined heat and power* **
Restore conservation and load management fund* **
Create Heating oil conservation fund* **
Create Natural gas conservation fund* **
Identify measures to reduce high-global warming-potential gases

Agriculture, Forestry, Waste Sectors
Install centralized manure digesters
Reduce nonfarm fertilizer use**
Buy local produce**
Forest management and forest carbon offsets
Urban tree planting program
Forest and agricultural land preservation**
Promote use of durable wood products over other construction materials
Support economically viable landfill gas-to-energy projects
Increase recycling, source reduction to 40 percent** (and possibly *)

Voluntary carbon offset program

Electricity Generation Sector

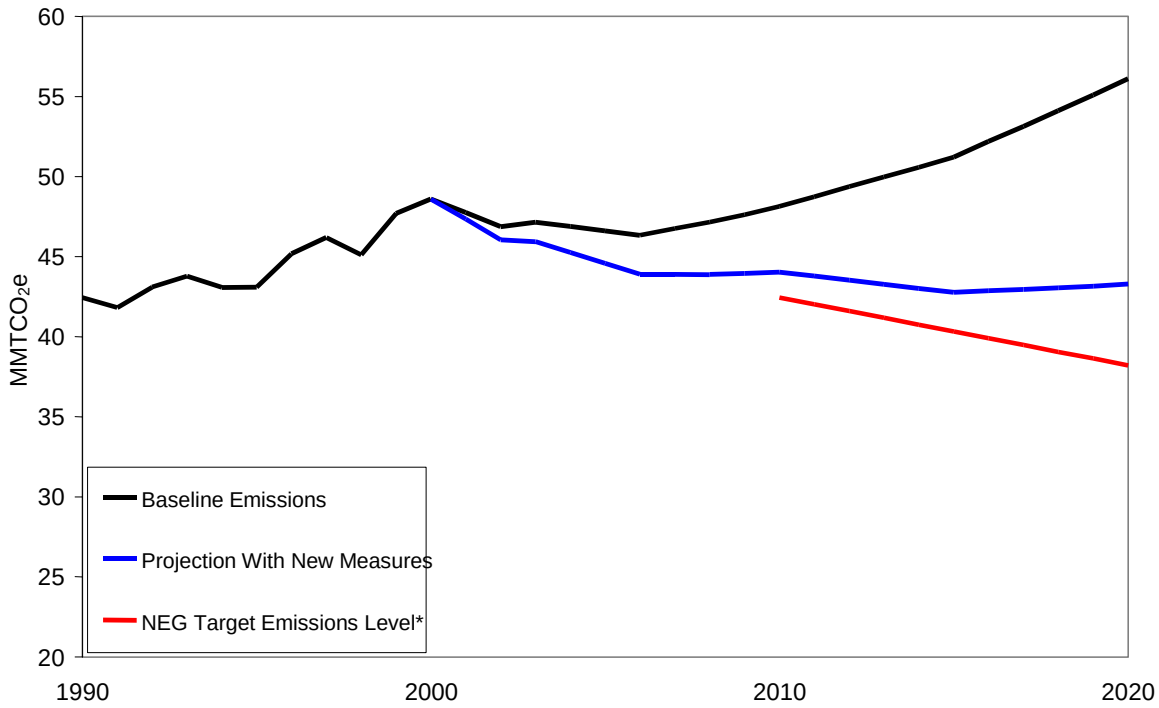
Renewable energy strategy (RES)
Renewable portfolio standard (RPS)*
Government green power purchase
Production tax credit*
Green power option
Energy efficiency and combined heat and power*
Regional cap-and-trade program*
Green tags
Restore Clean Energy Fund* **

Public Education Initiative

Emissions Inventory and Registry

* May require new legislation.
** May require significant budget authority.

Figure ES.1
Connecticut All-Sector GHG Reductions: Without Transportation Black Carbon



Note: NEG does not necessarily assume equal percentage reductions in each sector.

Figure ES.2
Baseline Emissions by Sector

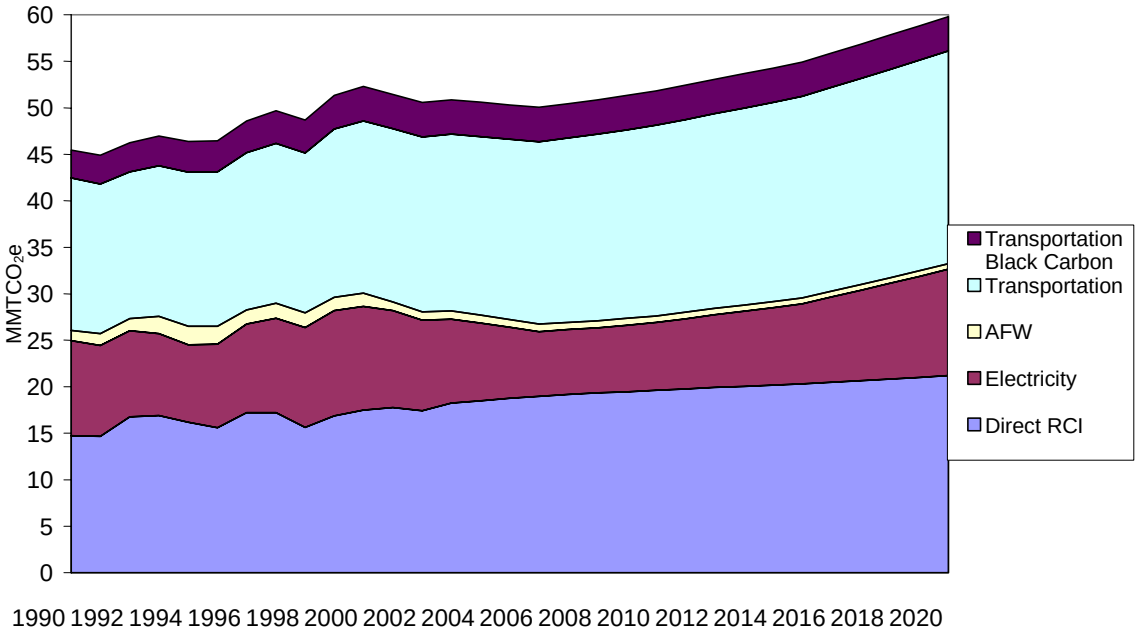


Figure ES.3
Emissions Reductions by Sector

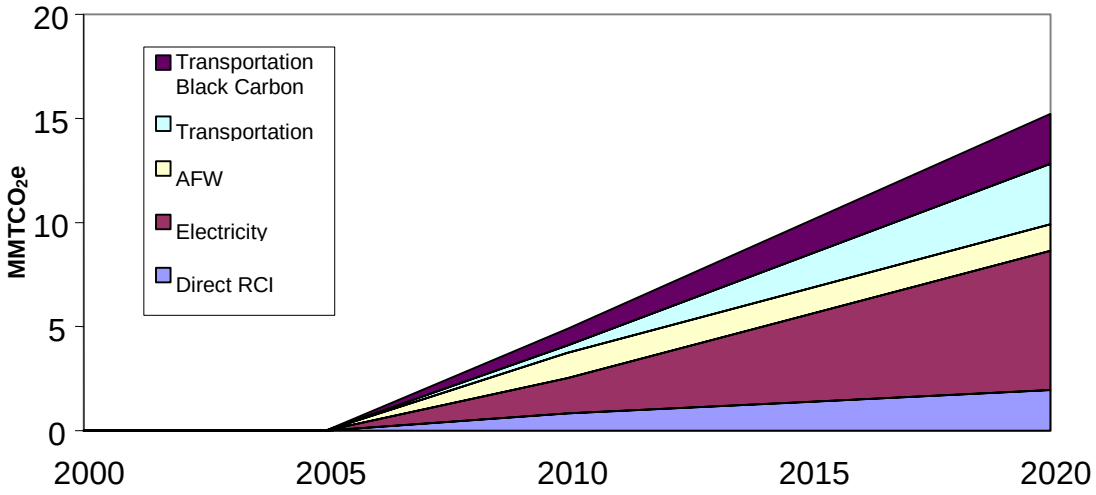


Table ES.2 Summary of Connecticut GHG Reductions Without Transportation Black Carbon ($MMTCO_2e$)		
	2010	**2020**
NEG/ECP Goal (1990 in 2010, 10% below in 2020)	42.40	38.16
Total $MMTCO_2e$ Baseline, from fuel use	48.14	56.15
Reductions needed to reach NEG/ECP goal	**5.74**	**17.99**
Projected Reductions by Sector		
Transportation	0.36	2.91
Residential, Commercial, Industrial	0.82	1.94
Agriculture, Forestry, Waste	1.20	1.28
Electricity	1.69	6.69
Total $MMTCO_2e$ Savings	**4.07**	**12.82**
% toward NEG goal	*70.9%*	*71.3%*
Additional reductions needed to reach goal	***1.67***	***5.17***

Table ES.3 Summary of Connecticut GHG Reductions With Transportation Black Carbon ($MMTCO_2e$)		
	2010	**2020**
NEG/ECP Goal (1990 in 2010, 10% below in 2020)	45.40	40.86
Total $MMTCO_2e$ Baseline, from fuel use	51.84	59.85
Reductions needed to reach NEG/ECP goal	**6.44**	**18.99**
Projected Reductions by Sector		
Transportation	1.16	5.31
Residential, Commercial, Industrial	0.82	1.94
Agriculture, Forestry, Waste	1.20	1.28
Electricity	1.69	6.69
Total $MMTCO_2e$ Savings	**4.87**	**15.22**
% toward NEG goal	*75.6%*	*80.1%*
Additional reductions needed to reach goal	***1.57***	***3.77***

Table ES.4 Summary of Connecticut GHG Reductions ($MMTCO_2e$) (With Transportation Black Carbon)					
	2010 Direct	**2010 Indirect***	**2020 Direct**	**2020 Indirect***	**Cost per metric ton CO_2**
Transportation					
California LEVII standards	0.04	--	0.47	--	not available
GHG feebate program	0.01	--	–	--	Revenue neutral or revenue positive
Tailpipe GHG standards (or alternative approach)	0.09	--	1.81	--	not available
Fleet vehicle incentives & initiatives	included with tailpipe GHG standards	--	included with tailpipe GHG standards	--	not available
Public education initiative		--		--	not available
Hydrogen infrastructure research & demonstration program**		--	--	--	not available
Transit, smart growth and VMT reduction package (includes road pricing pilot and other incentives)	0.22	--	0.49	--	$602/$MTCO_2$ ($280/$MTCO_2$ when infrastructure, health care and household savings are included)
Multi-state intermodal freight initiative	0.00	--	0.14	--	not available
Clean diesel & black carbon	0.80	--	2.40	--	$6–$13
Subtotal	***1.16***	--	***5.31***	--	
Residential/Commercial/Industrial					
Appliances					
Appliance standards (R/C)	<0.001	0.10	<0.001	0.20	–$89
Appliance-swapping program (R)	N/A	0.02	N/A	0.02	–$78
Electric hot water heater program (R)	N/A	0.01	N/A	0.01	–$121
Bulk purchasing program (R)	N/A	0.01	N/A	0.02	–$186
Bulk purchasing program (C)	N/A	0.01	N/A	0.03	–$158
Residential Buildings					
Mandatory upgrades to building standards (R/C)	0.05	0.01	0.18	0.04	–$172

Table ES.4 Summary of Connecticut GHG Reductions ($MMTCO_2e$) (With Transportation Black Carbon)					
	2010 Direct	**2010 Indirect***	**2020 Direct**	**2020 Indirect***	**Cost per metric ton CO_2**
Promote energy efficiency and energy improvement mortgages	<0.001	<0.001	0.01	<0.001	–$32
Revise conservation loan management program	NE	NE	NE	NE	Not available
Weatherization program (R)	<0.001	<0.001	<0.001	<0.001	$241
Energy Star homes program	0.01	0.01	0.02	0.02	–$3
Commercial Buildings					
High-performance schools and other State buildings	0.01	0.01	0.02	0.04	$419
High-performance buildings for private sector	0.01	0.01	0.02	0.03	$308
Shared savings program for government agencies & benchmarking (C)	0.03	0.10	0.04	0.16	Not available
Training of building operators (R/C)	0.01	0.02	0.01	0.02	–$140
Green campus initiative	0.09	0.10	0.09	0.11	Not available
Municipal buildings	0.07	0.05	0.10	0.09	Not available
Pilot fuel-switching project	<0.001	N/A	<0.001	N/A	$22
Third-party load management (C)	N/A	0.02	N/A	0.03	–$34
Industry					
Review New England demand response initiative (NEDRI) recommendations	NE	NE	NE	NE	Not available
Promote voluntary programs	NE	NE	NE	NE	Not available
Clean combined heat and power (I)	0.01	0.52	0.03	1.39	Not available
Comprehensive					
Restore C&LM Fund	N/A	0.28	N/A	0.61	–$56.00
Create oil conservation fund (R/C/I)	0.31	N/A	0.83	N/A	–$187.39
Create natural gas conservation fund (R/C/I)	0.23	N/A	0.60	N/A	–$302.65
Subtotal	**0.81**	**1.28**	**1.93**	**2.81**	
Agriculture/Forestry/Waste					
Install centralized manure digesters	0.01	0.01	0.03	0.03	$111.56–125.78

Table ES.4 Summary of Connecticut GHG Reductions ($MMTCO_2e$) (With Transportation Black Carbon)					
	2010 Direct	**2010 Indirect***	**2020 Direct**	**2020 Indirect***	**Cost per metric ton CO_2**
Ag biomass feedstocks for electricity	Included in electricity	--	--	Included in electricity	Not available
On-farm wind production	Included in electricity	--	--	Included in electricity	Not available
Reduce nonfarm fertilizer use	0.00	--	0.01	--	Not available
Increase purchase of locally grown food	0.00	--	0.00	--	Not available
Research program for forest management and carbon offsets	Not quantified	--	--	Not quantified	Not available
Urban tree planting	0.00	0.00	0.00	0.00	$9,815
Open space and agricultural land preservation	0.28	--	0.28	--	$137
Forest products biomass feedstocks for electricity	Included in electricity	--	--	Included in electricity	Not available
Promote use of durable wood products	Not quantified	--	Not quantified	--	Not available
Economic penetration of landfill gas to-energy (LFGE) through RPS	Included in waste reference case	Included in waste reference case	Included in waste reference case	Included in waste reference case	Not available
Recycling/source reduction	0.91	--	0.97	--	$4-5
Pilot program on carbon offsets	Not quantified	--	Not quantified	--	Not available
Subtotal	***1.20***	***0.01***	***1.28***	***0.03***	
Electricity					
Renewable energy strategy (RES) (including regional impact)	0.09		2.02		$22
Energy efficiency and combined heat and power (including regional impact)	1.17		3.86		–$18
Regional cap-and-trade program	Estimated but not adopted				
Green power option (offline)	0.43		0.81		In 2010=$34 In 2020=$22
Subtotal	***1.69***		***6.69***		
TOTAL REDUCTIONS	**4.86**	**1.29**	**15.21**	**2.84**	

Table ES.5
Summary of Connecticut Climate Change Stakeholder Dialogue Recommendations

Policy Action	Proposal Definition, Status
Transportation and Land Use	
1. California LEV II Standards The California Low Emission Vehicle II (LEV II) program establishes strict emission standards for all new cars sold in California as well as for any other state that adopts the program. These standards address nonmethane organic gas (NMOG), oxides of nitrogen (NO_x), and carbon monoxide (CO).	**Unanimous Consent** Connecticut should adopt the California LEV II standards. Implementation could begin as early as model year 2007 if Connecticut acts during the 2004 session. Under LEV II, Connecticut auto dealers, beginning with model year 2007, would be required to sell new vehicles certified to California emissions standards. **Expected Greenhouse Gas (GHG) Reduction** • 2010 = 0.04 $MMTCO_2e$ • 2020 = 0.47 $MMTCO_2e$ **Expected Cost per Ton GHG** Baseline LEV II vehicles are currently being sold at the same price as their non-LEV II certified counterparts, and manufacturers' costs for compliance are less than $100 per vehicle. A consumer premium of approximately $3,000 currently exists for hybrid vehicles. California Air Resources Board (CARB) has estimated the following incremental costs for advanced technology partial zero-emission vehicles (AT-PZEVs): • Stage I (2003-2005) $3,300 • Stage II (2006-2008) $1,500 • Stage III (2009-2011) $700. **Other Major Issues** These include reducing toxic pollutants by 104 tons in 2020.
2. GHG Feebate Program Under a feebate system, purchasers of high CO_2-emitting vehicles would pay a fee, whereas purchasers of low-CO_2-emitting vehicles would receive a rebate. The cutoff threshold can be designed to be revenue neutral so that total fees are equal to total rebates. A feebate system could be implemented regionally to strengthen the market signal to vehicle manufacturers and prevent adverse economic impacts in the State.	**Super Majority** • The State should establish a single-tier, GHG-based feebate program for all new passenger vehicles sold in Connecticut beginning in 2005. • The levels of fees and rebates for vehicles should be designed to maximize influence on consumer demand for low-emission vehicles. • The State should decide whether the feebate program should be designed to generate revenue beyond that required for administering the program and paying the rebates. • The design of the GHG feebate program should minimize potential leakage. • The State should engage in multistate and regional discussions on establishing a GHG feebate program for the region. **Expected GHG Reductions** • 2010 = 0.01 $MMTCO_2e$ • 2020 = 0.00 $MMTCO_2e$* * GHG feebates are assumed to phase out after 2009, upon adoption of GHG tailpipe standards. If a GHG feebate program persisted beyond 2009, reductions in 2020 would be 0.05 $MMTCO_2e$.

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	Expected Cost per Ton GHG Feebate impact is calculated on the basis of a $40/ton CO2 schedule, but can be designed to be revenue neutral or revenue positive. **Other Major Issues** These include reducing criteria and hazardous pollutants and potential operating cost savings for the State and consumers.
3. Fleet Vehicle Incentives and Initiatives Establish incentives and initiatives to encourage acquisition of low-GHG vehicles in public, private, and State fleets.	**Unanimous Consent** • Establish a procurement policy to reduce GHG emission rates for State cars and light trucks, whether owned, leased, or contracted. • Establish a program to encourage municipal fleets and private sector fleets to purchase low-GHG vehicles. • Partner with other northeastern states, local governments, and private fleets to develop bulk-purchasing proposals for low-GHG vehicles. • Work with the federal government to advance policies that will improve the market for low-GHG vehicles. **Expected GHG Reductions** Reflected in GHG tailpipe standards above. **Expected Costs per Ton GHG** Cost data are not available. **Other Major Issues** These actions will result in the reduction of criteria and hazardous pollutants and potential operating cost savings for the State and consumers.
4. Tailpipe GHG Standards (or alternative approach) Implement policies to reduce GHG tailpipe emission rates (grams [g] of CO_2-equivalent per mile), such as regulatory standards or an alternative approach.	**Unanimous Consent** Reduce tailpipe GHG emissions rate (g CO_2-equivalent per mile) by 33% below projected 2008 levels by 2020, through the following measures: • Adopt tailpipe GHG standards when California regulations go into effect. • Phase out GHG feebates when GHG tailpipe standards are adopted in Connecticut. • Explore alternative approaches to achieving the same GHG reduction as would be achieved by tailpipe GHG emissions regulation. • Consider coordination with other states. **Expected GHG Reductions** • 2010 = 0.09 $MMTCO_2e$ • 2020 = 1.81 $MMTCO_2e$ **Expected Cost per Ton GHG** Cost data for GHG tailpipe standards are not available, but preliminary estimates from California should be available in 2004. **Other Major Issues** The California GHG tailpipe standards will likely face a legal

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Policy Action	Proposal Definition, Status
	challenge from the automobile industry. Thus, the recommendation includes exploring alternative approaches to achieving the same GHG reductions, as tailpipe standards would generate.
5. Public Education Initiative Raise public awareness about the benefits of low-GHG vehicles, including the available incentives and potential maintenance options.	**Unanimous Consent** The State should develop an education program to raise public awareness about the benefits of low-GHG vehicles, including available incentives, such as GHG feebates and fleet procurement initiatives, and potential maintenance options, including the use of low-rolling-resistance replacement tires and low-friction engine oil. **Expected GHG Reductions** These are reflected in GHG tailpipe standards above. **Expected Cost per Ton GHG** Cost data are not available.
6. Hydrogen Infrastructure Research and Demonstration (R&D) Program Support research on low-GHG vehicle technology, such as fuel cells, and assess how best to facilitate the development of alternative fuel infrastructure and refueling networks through measures such as pilot projects, R&D, and incentives.	**Unanimous Consent** Develop a comprehensive hydrogen infrastructure R&D program in Connecticut. This should include pilot projects, R&D, and incentives for infrastructure and refueling networks. Consider several cross-cutting institutional measures, including a strategic R&D advisory council, a clean energy transportation fund, and a hydrogen education program. **Expected GHG Reductions** This effort will not result in any GHG benefits by 2020 (potential long-term benefits of up to 22 $MMTCO_2e$ in Connecticut). Long-term GHG reductions assume the availability of low-emissions hydrogen (i.e., hydrogen produced from gasification of fossil fuels), together with carbon capture and sequestration, achieving roughly 90% improvement in GHG emissions, or renewable energy sources. **Expected Cost per Ton GHG** Cost data are not available. **Other Major Issues** This program could create up to 33,000 jobs in the transportation sector.
7. Transit, Smart Growth and Vehicle Miles Traveled (VMT) Reduction Package Increase availability of low-GHG travel choices in Connecticut, such as transit (rail and bus), vanpools, walking, and biking. Provide complementary land-use polices and incentives to improve the attractiveness of low-GHG travel choices.	**Unanimous Consent** Implement a package of transit improvements and land-use policies and incentives to achieve a 3% reduction in VMT below the 2020 baseline. The package consists of six complementary elements: 1. Double transit ridership by 2020. 2. Consider potential funding mechanisms for new transit investments, such as road pricing and the Connecticut Transportation Strategy Board's fuel tax recommendation. 3. Establish a coordinated interagency program to promote smart growth in Connecticut using regulatory, financial, and planning tools. 4. Redirect at least 25% of new development (forecast population and employment) to growth-appropriate

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Policy Action	Proposal Definition, Status
	locations, as indicated by the State Plan of Conservation and Development. 5. Study a potential road-pricing pilot project, prepare a feasibility design study by 2006, and implement the pilot project if it is shown to be effective. Study the potential impact on equity and sprawl and consider broader implementation of road pricing in the long term. 6. Consider complementary VMT reduction incentives, such as commuter choices, location-efficient mortgages, and mileage-based insurance. *Expected GHG Reductions* • 2010 = 0.22 $MMTCO_2e$ • 2020 = 0.49 $MMTCO_2e$ **Expected Cost per Ton GHG** Annualized smart growth and transit costs over 17 years yield a marginal cost of \$602/$MTCO_2$ in 2020. This assumes a 7% discount rate. When other savings from avoided costs are included (infrastructure cost savings, health costs savings, and consumer fuel cost savings) the marginal cost is calculated to be \$280/$MTCO_2$ in 2020**.** **Estimated Total Costs** Estimated annual transit capital and operating costs are \$295 million. Estimated annual savings from avoided infrastructure costs, avoided health care costs, and avoided household expenditures are \$158 million. Total costs minus savings are estimated to be \$137 million per year. **Other Major Issues** Benefits of this program include reducing criteria and hazardous pollutants, increasing travel choices, helping to relieve traffic congestion, bolstering economic development and urban revitalization, reducing water pollution from runoff, and minimizing habitat fragmentation.
8. Multistate Intermodal Freight Initiative Develop infrastructure plan for providing alternatives to freight trucks, including enhanced freight rail infrastructure and intermodal transfer facilities (rail-to-truck and rail-to-barge). Such alternatives use less energy than freight trucks and thus offer a low-GHG alternative for goods delivery.	**Unanimous Consent** Engage in multistate and regional discussions on opportunities to divert a portion of the projected 70% growth in regional truck traffic to rail and barge in order to reduce significantly the GHG impact of freight transportation. **Expected GHG Reductions** • 2010 = 0.00 $MMTCO_2e$ • 2020 = 0.14 $MMTCO_2e$ **Expected Cost per Ton GHG** Cost data are not available. **Other Major Issues** This effort would reduce traffic congestion, wear-and-tear on the State's infrastructure, and air pollution as well as provide more efficient delivery of goods and redundancy in freight networks for economic and physical security.

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Policy Action	Proposal Definition, Status
9. Clean Diesel and Black Carbon (BC) Scientists have identified BC, a component of diesel particulate matter (PM), as having a large and fast-acting warming impact on the atmosphere. Diesel engines emit roughly half of the BC in the United States. This program would provide incentives to accelerate the use of lower sulfur diesel and to accelerate adoption of engine improvements and tailpipe control technology to reduce emissions of BC.	**Unanimous Consent** • Include BC in the GHG baseline. • Recommend that the New England governors and the eastern Canadian premiers include BC emissions in GHG inventories and baselines. • Establish a Connecticut clean diesel program to reduce BC emission by 75% by 2020. • Include BC reductions in State procurement decisions. • Provide incentives for engine retrofits, early vehicle turnover, and early use of ultra-low-sulfur fuel. • Establish a regional incentive program to promote best available control technologies for in-use engines on long-haul trucks. • Provide a supportive regulatory framework. **Expected GHG Reductions** • 2010 = 0.8 $MMTCO_2e$ • 2020 = 2.4 $MMTCO_2e$ **Expected Cost per Ton GHG** A range of cost estimates for vehicle conversion, retrofit and replacement were aggregated and are equivalent to \$6 to \$13/$MTCO_2e$ in 2020. Health care cost savings due to reductions in PM emissions were not quantified. Costs were annualized over 17 years using a 7% discount rate. **Estimated Total Costs** Estimated annual capital and operating costs range from \$13 million to \$30 million. Estimated savings from avoided health care costs due to reduced exposure to particulate matter are not included. *Other Major Issues* Please refer to the transportation baseline discussion for the details of BC quantification. Health benefits due to reductions in PM emissions are not included in the cost estimate above.
Residential, Commercial, and Industrial	
10. Appliance Standards For appliances not covered under federal standards, the State can set minimum levels of efficiency for specific appliances.	**Unanimous Consent** This program would set efficiency standards for eight appliances that are commercially available and do not require a federal waiver for State regulation. These appliances include dry-type transformers, commercial refrigerators and freezers, exit signs, traffic signals, torchière lamps, large packaged A/C units greater than 20 tons, unit heaters, and commercial clothes washers. **Expected GHG Reductions** • 2010 = 0.104 $MMTCO_2e$ indirect, <0.001 $MMTCO_2e$ direct • 2020 = 0.205 $MMTCO_2e$ indirect, <0.001 $MMTCO_2e$ direct **Expected Cost per Ton GHG** The cost is estimated to be –\$89/$MTCO_2e$. **Other Major Issues**

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	Co-benefits of this program include reduced hydrofluorocarbon (HFC) and chlorofluorocarbon (CFC) emissions due to leaks from commercial refrigerators, freezers, and A/Cs; and reduced water consumption by commercial clothes washers.
11. Appliance-Swapping Program This program would encourage consumers to discard old appliances and replace them with new, more efficient appliances.	**Unanimous Consent** Develop a "pay-as-you-save" program under the Conservation and Load Management Fund (C&LM) to encourage residential consumers to replace old appliances with new Energy Star appliances. Appliances covered in the program include Energy Star tumble clothes washers, Energy Star refrigerators, Energy Star room A/C (6500 BTU), and Energy Star dishwashers. **Expected GHG Reductions** • 2010 = 0.016 $MMTCO_2e$ indirect (direct not applicable) • 2020 = 0.020 $MMTCO_2e$ indirect (direct not applicable) **Expected Cost per Ton GHG** The cost is estimated to be –\$78/$MTCO_2e$. **Other Major Issues** Co-benefits of this program include small reductions in HFC and CFC emissions leaked into the atmosphere from refrigerators and A/C units.
12. Heat Pump Water Heater (HPWH) Replacement Program Replace inefficient electric water heaters with new HPWH technology.	**Unanimous Consent** Develop a pay-as-you-save program under the C&LM to promote the WatterSaver, the next generation of HPWH technology. By using the ambient air, the WatterSaver attains an efficiency rating nearly three times that of the most efficient electric water heaters. **Expected GHG Reductions** • 2010 = 0.011 $MMTCO_2e$ indirect (direct not applicable) • 2020 = 0.013 $MMTCO_2e$ indirect (direct not applicable) **Expected Cost per Ton GHG** The cost is estimated to be –\$121/$MMTCO_2e$**.** **Other Major Issues** This appliance also can dehumidify the space in which it is located.
13. Bulk Purchasing of Appliances Bulk procurement can reduce the cost of energy efficient appliances or renewable technologies.	**Unanimous Consent** This program consists of two components: 1. Promotion of the Consortium for Energy Efficiency's bulk purchasing program for the residential sector in Connecticut and in the region. The program covers apartment-sized refrigerators, large refrigerators, subcompact fluorescents, reflector compact fluorescent lights, dedicated compact fluorescent recessed light fixtures and HPWHs. 2. Promotion of Pacific Northwest National Laboratory's commercial sector bulk purchasing program in Connecticut and in the region. This program covers unitary rooftop A/C products in the 65,000 to 135,000 Btu/h cooling capacity range. **Expected GHG Reductions** • 2010 (residential) = 0.012 $MMTCO_2e$ indirect (direct not

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	applicable) • 2020 (residential) = 0.018 $MMTCO_2e$ indirect (direct not applicable) • 2010 (commercial) = 0.011 $MMTCO_2e$ indirect (direct not applicable) • 2020 (commercial) = 0.028 $MMTCO_2e$ indirect (direct not applicable) **Expected Cost per Ton GHG** The cost is estimated to be –$187/$MTCO_2e$.
14. Mandate Upgrades to Residential and Commercial Building Energy Code Require buildings to meet the most recent energy code efficiency and performance standards established by the International Code Council (ICC).	**Unanimous Consent** Adopt the latest energy code standards from the ICC by July 2004 and require the automatic adoption of updated revisions within 18 months from availability for residential and commercial buildings. **Expected GHG Reductions** • 2010 = 0.009 $MMTCO_2e$ indirect, 0.048 $MMTCO_2e$ direct (residential only) • 2020 = 0.036 $MMTCO_2e$ indirect, 0.176 $MMTCO_2e$ direct (residential only) **Expected Cost per Ton GHG** The cost is estimated to be –$172/$MTCO_2e$.
15. Promote Energy-Efficient and Energy-Improvement Mortgages Energy-efficient mortgages (EEMs) allow purchasers to borrow a larger mortgage when purchasing an Energy Star home. Energy-improvement mortgages (EIMs) allow owners to borrow money for energy efficiency (EE) improvements on their homes, or to upgrade the energy efficiency of a home before purchasing.	**Unanimous Consent** This measure will increase the awareness of financial products that encourage people to purchase energy efficient homes. Activities include actively promoting EEMs in Connecticut; working with Connecticut Housing Finance Agency (CHFA), Fannie Mae, and others to develop an EIM, and actively promoting it; and working with CHFA, Fannie Mae, and others to develop a smart-commute mortgage and actively promoting it. Also, the program would require home inspectors to distribute educational information on energy efficiency during the sales process. **Expected GHG Reductions** • 2010 = 0.001 $MMTCO_2e$ indirect, 0.004 $MMTCO_2e$ direct (only EIMs) • 2020 = 0.002 $MMTCO_2e$ indirect, 0.012 $MMTCO_2e$ direct (only EIMs) **Expected Cost per Ton GHG** The cost is estimated to be –$32/MTCO2e. **Other Major Issues** Co-benefits include educating residential consumers about energy efficiency.
16. Revise the Energy Conservation Loan Program (ECL) The current ECL provides low-interest loans for EE improvements.	**Unanimous Consent** This measure recommends improvements to the current ECL program, which provides low-interest loans (interest rate based on income) for energy efficiency improvements. The program is under the auspices of the Department of Economic and

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	Community Development. **Expected GHG Reductions** GHG emission reductions have not been estimated .. **Expected Cost per Ton GHG** The cost has not been estimated.
17. Weatherization Assistance Program (WAP) Weatherization programs help homeowners improve insulation, air leakage control, heating and cooling efficiency measures.	**Unanimous Consent** The State should provide the funding to double the number of households served under the federal WAP, which targets low-income households for comprehensive weatherization. **Expected GHG Reductions** • 2010 = 0.003 $MMTCO_2e$ indirect, 0.003 $MMTCO_2e$ direct • 2020 = 0.003 $MMTCO_2e$ indirect, 0.003 $MMTCO_2e$ direct **Expected Cost per Ton GHG** The cost is estimated to be \$241/$MTCO_2e$.
18. Energy Star Homes Program This program provides rebates for the purchase of newly constructed homes meeting higher efficiency standards established by the U.S. EPA and DOE Energy Star Program.	**Unanimous Consent** This program would expand rebates under the Energy Conservation Management Board (ECMB) to double participation in the Energy Star Homes Program (for new construction only). **Expected GHG Reductions** • 2010 = 0.008 $MMTCO_2e$ indirect, 0.009 $MMTCO_2e$ direct • 2020 = 0.021 $MMTCO_2e$ indirect, 0.023 $MMTCO_2e$ direct **Expected Cost per Ton GHG** The cost is estimated to be –\$3/$MTCO_2e$.
19. High-Performance Schools and State-Funded Buildings State-funded construction and renovation should meet higher EE and performance standards.	**Unanimous Consent** This program would mandate high-performance energy requirements for State-funded buildings, including State facilities and local schools, as follows: • New construction and major renovations of all building projects that receive some State funding (State facilities, local schools, etc.) must meet Leadership in Energy and Environmental Design (LEED) standard and receive U.S. Green Buildings Council (USGBC) certification. • Small construction and renovation projects that use State funding should also be required to meet a high-performance building standard. • For existing State buildings, owned and leased space should also meet certain energy standards. • USGBC is developing a LEED program aimed at tenant space (LEED for commercial interiors). • The program will provide recognition for those projects that go beyond LEED certification. Connecticut should work with the insurance industry to identify green building measures that also decrease risk and liability and encourage them to leverage these features in their products. **Expected GHG Reductions** • 2010 = 0.011 $MMTCO_2e$ indirect, 0.006 $MMTCO_2e$ direct

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	• 2020 = 0.038 $MMTCO_2e$ indirect, 0.020 $MMTCO_2e$ direct **Expected Cost per Ton GHG** The cost is estimated to be \$419/$MTCO_2e$. **Other Major Issues** Co-benefits include promoting sustainable site planning, safeguarding water and water efficiency, materials and resources conservation, and improving indoor environmental quality. In addition to the environmental benefits, there are economic, health, safety, and community benefits.
20. High-Performance Buildings: Privately Funded Projects Provide incentives for privately financed new construction and renovations to meet higher EE performance standards.	**Unanimous Consent** The recommendation includes the following: • Encourage privately financed new construction and renovations to meet high energy performance standards by offering LEED certification. • Encourage privately occupied existing buildings and leased space to use high energy performance standards by using future USGBC LEED programs or others to be determined. • Provide tax credits and other financial incentives for green buildings, similar to those offered in New York and Massachusetts. • Provide an awards program to recognize LEED buildings or use other measures to determine high performance. • Work with lending institutions and insurers to identify incentives that they could offer for high-performance buildings, such as preferred rates or using lifecycle costs. • Encourage municipalities to promote LEED or other high performance standards for projects that require local review within their jurisdictions. **Expected GHG Reductions** • 2010 = 0.012 $MMTCO_2e$ indirect, 0.007 $MMTCO_2e$ direct • 2020 = 0.034 $MMTCO_2e$ indirect, 0.018 $MMTCO_2e$ direct **Expected Cost per Ton GHG** The cost is estimated to be \$308/$MTCO_2e$. **Other Major Issues** Co-benefits include promoting sustainable site planning, safeguarding water and water efficiency, conserving materials and resources, and improving indoor environmental quality. In addition to environmental benefits, there are economic, health, safety, and community benefits.
21. Shared Savings Program for Government Agencies This program allows a State agency to keep a portion of the energy savings realized when it makes EE improvements to a building. The benchmarking program allows an agency to identify buildings performing below the average.	**Unanimous Consent** The State should revise the program referenced in CGS 16a-37c so that savings are claimed under more controlled terms and the program is workable within the OPM budget; promote its use by agencies. Review the Federal Energy Management Program Super Energy Savings Performance Contracts program and consider adopting a similar program for State agencies. Include stipulation that portion of savings go toward the purchase of green power for State agencies. **Expected GHG Reductions**

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	• 2010 = 0.098 $MTCO_2e$ indirect, 0.026 $MTCO_2e$ direct • 2020 = 0.160 $MTCO_2e$ indirect, 0.039 $MTCO_2e$ direct **Expected Cost per Ton GHG** The costs have not been estimated. **Other Major Issues** None.
22. Training of Building Operators Training building operators in how to maximize the efficiency of their buildings will decrease energy use if operators apply what they learned.	**Unanimous Consent** Expand existing Connecticut training programs to serve a larger number of building operators (including maintenance technicians, lead custodians, maintenance foremen, and plant engineers), who typically have little formal training in building efficiency. **Expected GHG Reductions** • 2010 = 0.020 $MTCO_2e$ indirect, 0.011 $MTCO_2e$ direct • 2020 = 0.022 $MTCO_2e$ indirect, 0.011 $MTCO_2e$ direct **Expected Cost per Ton GHG** The cost is estimated to be –$140/$MTCO_2e$. It is estimated that the program would cost $63,000 per year. First year cost savings are estimated to be over $1.3 million and would accrue for 5 years. **Other Major Issues** None.
23. Green Campus Initiative This program would promote energy efficiency and other environmental measures at all Connecticut institutions of higher education.	**Unanimous Consent** Promote a "green campus" initiative with all Connecticut colleges, universities, private and secondary schools. This initiative will inform school administrators and students about how to pursue energy policies with minimal environmental impact and create learning labs to teach sustainability. **Expected GHG Reductions** • 2010 = 0.099 $MTCO_2e$ indirect, 0.088 $MTCO_2e$ direct • 2020 = 0.106 $MTCO_2e$ indirect, 0.086 $MTCO_2e$ direct **Expected Cost per Ton GHG** Expected programmatic costs include $50,000 in the first year for program development; $50,000 annually for outreach, training, and rollout; $250,000 for a GHG inventory for all Connecticut colleges and universities; and $1,000,000 annually for administration, benchmarking, and action plan development. The cost of the energy savings measures was not estimated. **Other Major Issues** Co-benefits include improving water and waste management, increasing recycling, reducing the need for hazardous waste disposal, and promoting procurement of environmentally friendly products.
24. Energy Benchmarking and Tracking Program for Municipal Buildings This program encourages measurement and	**Unanimous Consent** Promote energy measurement, tracking, benchmarking, and strategic planning with municipal facilities, including public schools, to increase their participation in existing and new energy

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tracking of energy consumption, strategic planning, and benchmarking against other buildings.	conservation and environmental programs and raise EE and Energy Star levels. This involves creating a program that engages communities in developing energy sustainability plans, implementing these plans by measuring, tracking, and assessing their current efficiency levels, and using existing energy conservation and environmental programs to improve targeted inefficient municipal facilities. **Expected GHG Reductions** • 2010 = 0.046 $MMTCO_2e$ indirect, 0.073 $MMTCO_2e$ direct • 2020 = 0.086 $MMTCO_2e$ indirect, 0.104 $MMTCO_2e$ direct **Expected Cost per Ton GHG** The estimated cost of program administration and outreach to communities is $250,000 annually. The estimated cost for benchmarking is $0.005 per square foot. Costs were not estimated for implementing the specific energy saving measures. **Other Major Issues** Program benefits include energy and environmental education at public schools.
25. Pilot Fuel-Switching Project This pilot project will test the use of B20 biodiesel fuel (diesel blended with 20% low/no GHG biodiesel) at a few State facilities.	**Unanimous Consent** In Year 1, undertake a pilot project for fuel switching to B20 biodiesel blend at two State facilities (e.g., one State university campus and one State office facility). Determine pilot facilities with assistance from DPW. Assuming the pilot project shows that the fuel is acceptable, begin to require that additional State buildings use B20 in Year 2 and beyond. Increase the number of buildings using B20 each year. **Expected GHG Reductions** • 2010 = (indirect not applicable), <0.001 $MMTCO_2e$ direct • 2020 = (indirect not applicable), <0.001 $MMTCO_2e$ direct **Expected Cost per Ton GHG** The costs are estimated to be –$22/$MTCO_2e$.
26. Remove Current Barriers to Third-Party Load-Management Techniques Remove barriers to allow energy service companies to manage the energy load at commercial or industrial facilities.	**Unanimous Consent** Overcome existing regulatory barriers to increase the market diffusion of third-party load-management for nonintrusive commercial loads. Recommended changes include • integrating information and load management solutions into the local distribution company bill • enabling demand resources to participate in the wholesale electric markets, and • including an EE component in the alternative transitional standard offer. **Expected GHG Reductions** • 2010 = 0.018 $MMTCO_2e$ indirect (direct not applicable) • 2020 = 0.033 $MMTCO_2e$ indirect (direct not applicable) **Expected Cost per Ton GHG** The costs are estimated to be –$34/$MTCO_2e$.
27. State Procurement of Environmentally	**Unanimous Consent**

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Preferable Services and Products This measure would promote procurement of environmentally preferable products and services by State agencies.	Several policies require the State of Connecticut to consider environmentally preferable products, those using recycled content, and other similar products. CGS 4a-67h requires the Connecticut DAS to establish procedures that promote procurement of environmentally preferable products and services and create the position of environmental purchasing advisor to develop the program. State agencies should consider increasing preferences for products and services that decrease GHG emissions and/or mitigate the impact on climate change. **Expected GHG Reductions in 2010 and 2020** GHG emission reductions have not been estimated. **Expected Cost per Ton GHG** The cost has not been estimated.
28. Review New England Regional Demand Response Initiative (NEDRI) Recommendations The State should review the recommendations from the NEDRI report.	**Unanimous Consent** Recommend consideration of the NEDRI report as a whole. ISO NE and various state DPUCs, wires companies, and DEPs worked together to develop a series of recommendations over an 18-month period. The NEDRI report provides a good overview and identifies many measures that can be implemented at the federal and state level. In addition, the Federal Energy Regulatory Commission plans to use NEDRI as a model for other state ISOs. The group could not recommend the entire package of measures because of time limitations and potential conflicts of interest among certain stakeholders (e.g., DPUC and DEP cannot prejudge proposals that may come before them; they need to be impartial). **Expected GHG Reductions in 2010 and 2020** This measure has not been estimated. **Expected Cost per Ton GHG** The cost has not been estimated.
29. Promote Voluntary Programs and Actions To promote GHG reductions in particular sectors, a state government may enter into direct voluntary or negotiated agreements with industries or industrial sectors. Negotiated agreements, for example, would result in agreed-upon GHG emission reductions or offsets as an alternative to compliance or enforcement actions resulting from violation of air pollution legislation (such as violations of Clean Air Act state implementation plan requirements), or as an alternative for possible regulation of GHG emissions.	**Unanimous Consent** Strongly promote voluntary programs and actions to the appropriate sectors. State agencies would need to play a coordinating role and devote some resources to these activities. Partners who have joined these programs could also play a mentoring role to those not involved**.** Although some programs already exist at the national level, opportunities to develop additional programs in Connecticut may exist. **Expected GHG Reductions in 2010 and 2020** GHG emission reductions have not been estimated. **Expected Cost per Ton GHG** The cost has not been estimated.
30. Encourage Clean Combined Heat and Power (CHP) CHP is the simultaneous production of electricity and heat using a single fuel. The heat produced from the electricity-generating	**Unanimous Consent** The goal of this policy is to push the development of new clean CHP electricity generation using existing and available technology, which is extremely clean and efficient. The policy consists of two elements: 1. Reducing the current barriers to developing CHP projects

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process is captured and used to produce high- and low-level steam. The steam can be used as a heat source for both industrial and domestic purposes and in steam turbines to generate additional electricity (i.e., combined-cycle power).	(such as permitting and interconnection hurdles and standby power rates) 2. Exploring further mechanisms to promote CHP, such as a CHP portfolio standard. **Expected GHG Reductions** • 2010 = 0.523 $MMTCO_2e$ indirect, 0.009 $MMTCO_2e$ direct (based on 4% CHP in 2010) • 2020 = 1.389 $MMTCO_2e$ indirect, 0.025 $MMTCO_2e$ direct (based on 8% CHP in 2020) **Expected Cost per Ton GHG** The cost has not been estimated.
31. Restore the Conservation and Load Management Fund The Conservation and Load Management Fund is directed towards electrical efficiency measures in the residential, commercial, and industrial sectors. It is generated through a ratepayer surcharge on electricity.	**Unanimous Consent** Restore full funding ($87 million) to the Conservation and Load Management Fund. The business-as-usual scenario assumes that funding will total $50 million in the first and second years, and $60 million in subsequent years. In addition, consider expanding the fund based on the findings of a recent study commissioned by the ECMB. A mechanism should be in place to ensure that the funds are directed and applied to the intended use for the lifetime of the fund. (DPUC abstained from voting due to pending regulation.) **Expected GHG Reductions** • 2010 = 0.279 $MMTCO_2e$ indirect, (direct not applicable) • 2020 = 0.606 $MMTCO_2e$ indirect, (direct not applicable) **Expected Cost per Ton GHG** The cost is estimated to be –$56/$MTCO_2e$. This program requires $37 million in 2004 and 2005 and $27 million from 2006-2010. Funding from 2011 to 2020 would be $87 million. These funds are to be generated from a surcharge on electricity. Cost savings would begin to accrue to residential, commercial, and industrial customers immediately and would continue to accrue for the lifetime of the measure or an estimated 15 years (e.g., measures implemented in 2020 would continue to achieve cost savings through 2035).
32. Create Oil Conservation Fund Similar to a public benefits fund, the revenues for this fund could be collected from oil consumers to support EE or conservation projects in these areas.	**Supermajority** (with one objection) Establish an annual fund of $20 million with EE investment programs for equipment and buildings that use heating oil. Ensure that funds are directed and applied to the intended use for the lifetime of the fund. The fund's board will report annually on the cost effectiveness of the fund's programs ($/$CO_2$ saved). **Expected GHG Reductions** • 2010 = indirect not applicable, 0.311 $MMTCO_2e$ direct • 2020 = indirect not applicable, 0.828 $MMTCO_2e$ direct **Expected Cost per Ton GHG** The cost is estimated to be –$187/$MTCO_2e$. This program requires $20 million annually from 2005 to 2020. It

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	was assumed that the fund would be generated through a charge on oil sales. Cost savings would begin to accrue to residential, commercial, and industrial customers immediately and would continue to accrue for the lifetime of the measure, or an estimated 20 years (e.g., measures implemented in 2020 would continue to achieve cost savings through 2040). **Other Major Issues** Keep administration and funds of the Oil Conservation Fund separate from the Natural Gas Conservation Fund, but move through the legislative process with the Natural Gas Conservation Fund
33. Create Natural Gas Conservation Fund Similar to a public benefits fund, the revenue for this fund could be collected from natural gas consumers to support EE or conservation projects in these areas.	**Supermajority** (with one objection) Establish an annual fund of $20 million for EE investment programs for equipment and buildings which use natural gas. Ensure that funds are directed and applied to the intended use for the lifetime of the fund. The fund's board will report annually on the cost effectiveness of the fund's programs ($/$CO_2$ saved). **Expected GHG Reductions** • 2010 = indirect not applicable, 0.225 $MMTCO_2e$ direct • 2020 = indirect not applicable, 0.601 $MMTCO_2e$ direct **Expected Cost per Ton GHG** The cost is estimated to be –$303/$MTCO_2e$. This program requires $20 million annually from 2005 to 2020. It was assumed that the fund would be generated through a charge on natural gas sales. Cost savings would begin to accrue to residential, commercial, and industrial customers immediately and would continue to accrue for the lifetime of the measure, or an estimated 20 years (e.g., measures implemented in 2020 would continue to achieve cost savings through 2040). **Other Major Issues** Keep administration and funds of the Natural Gas Conservation Fund separate from the Oil Conservation Fund but go through the legislative process with the Oil Conservation Fund.
34. Identify Measures to Reduce High Global Warming Potential (GWP) Gases High-GWP gases, potent GHGs, include HFCs, SF_6, and PFCs. Opportunities to reduce high GWP gases include leak reduction programs, substitution programs, and improved maintenance, among others.	**Unanimous Consent** Further explore measures to reduce high GWP gases. **Expected GHG Reductions in 2010 and 2020** GHG emission reductions have not been estimated. **Expected Cost per Ton GHG** The cost has not been estimated.

Agriculture, Forestry, and Waste

35. Install Centralized Manure Digesters Install anaerobic digesters to process	**Unanimous Consent** Provide funding to support installation of one central manure digester by 2010; two by 2015; and 3 by 2020.

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agriculture manure into energy (e.g., heat, hot water, or electricity). This process also produces digested manure, which can contain more valuable nitrogen for crop production.	**Expected GHG Reductions** • 2010 = 0.0084 $MMTCO_2e$ indirect, 0.0087 direct $MMTCO_2e$ • 2020 = 0.0255 $MMTCO_2e$ indirect, 0.0260 direct $MMTCO_2e$ **Expected Cost per Ton GHG** The expected cost would equal \$112 to 126/$MTCO_2e$. It is estimated that the program would cost \$2.8 million: 940,800 per digester. The group deliberated on a number of implementation approaches for the manure digester option; however, no specific actions were suggested. Depending on the implementation approach chosen, some or all of the funding could come from the federal government, State government, or private entities. **Other Major Issues** This project could provide ancillary benefits such as odor control, water quality, and improved farm economics through generating additional income. In addition, this project could support the continuation of farming in the State which can support both smart growth initiatives and the "increase purchase of locally grown food" option mentioned later.
36. Reduce Use of Nonfarm Fertilizer A portion of nitrogen applied to the soil is subsequently emitted as N_2O; therefore, a reduction in the quantity of fertilizer applied can reduce N_2O emissions.	**Unanimous Consent** Support education program to reduce nonfarm (i.e., commercial and residential) fertilizer use 7.5% by 2010 and 15% by 2020. **Unanimous Consent** Build on existing programs, such as the organic land care program of the Connecticut chapter of Northeast Organic Farming and the Freedom Lawn initiative. Consider a requirement to report nonfarm fertilizer use. **Expected GHG Reductions** • 2010 = 0.003 $MMTCO_2e$ • 2020 = 0.003 $MMTCO_2e$ **Expected Cost per Ton GHG** Not Estimated **Other Major Issues** These efforts can reduce nutrient loading in water bodies; increase the organic content of soil (and thus increase carbon sequestration); reduce GHG emissions and water consumption through natural lawn care methods, such as decreased mowing, and watering; and increase biodiversity.
37. Buy Local Produce Encouraging consumers to buy local produce reduces emissions associated with the transport of agricultural products.	**Unanimous Consent** Purchase an additional 10% of Connecticut's farm products from local sources instead of conventional markets. **Unanimous Consent** Examine assumptions in the calculation by transportation working group. The program can be accomplished through • Enhancing the Connecticut-Grown Program • Creating an agricultural identity for Connecticut • Increasing the development of farmers' markets and

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	ensure that participating farmers sell Connecticut-grown products exclusively • Encouraging and promoting the purchase, marketing, and selling of Connecticut-grown produce by State institutions and State agencies • Supporting Senior and Women, Infants and Children (WIC) Farmers Market Nutrition Programs • Supporting programs and efforts to improve access to Farmers Markets by low-income households, and • Helping farmers develop value-added agricultural products through a Department of Agriculture or other supporting agency business development/grant program or general marketing assistance. **Expected GHG Reductions** • 2010 = 0.003 $MMTCO_2e$ • 2020 = 0.003 $MMTCO_2e$ **Expected Cost per Ton GHG** The expected cost has not been estimated. **Other Major Issues** These efforts can provide ancillary benefits such as the reduction of air emissions from reduced food transport, economic development for Connecticut farms, and lower levels of pesticide and water pollution, depending on the type of farming practice supported.
38. Forest Management and Forest Carbon Offsets This program will support a research program for forest management programs to protect the productivity of existing forest and reduce or prevent the loss of forest due to fires, storms, diseases, or pests; implement reduced-impact logging regimes to minimize the damage to nonharvested trees; increase biomass stocks through activities such as planting, thinning, and fertilizer application; and encourage prolonged rotation periods in harvested forests.	**Unanimous Consent** Support a research program to evaluate management systems and standards for carbon "sink" offset projects. **Expected GHG Reductions in 2010 and 2020** The measures have not been quantified. **Expected Cost per Ton GHG** The expected cost has not been estimated.
39. Urban Tree Planting Program Plant urban trees to reduce the consumption of energy for heating and cooling buildings, thereby helping avoid fossil fuel emissions in the energy sector and increasing the carbon stock of nonforest land.	**Unanimous Consent** Provide funding and other support to plant an additional 15,000 sufficiently sized trees by 2010, and 20,000 more by 2020 **Expected GHG Reductions** • 2010 = 0.0008 $MMTCO_2e$ indirect, 0.00003 $MMTCO_2e$ direct • 2020 = 0.0019 $MMTCO_2e$ indirect, 0.00007 $MMTCO_2e$ direct **Expected Cost per Ton GHG** The expected cost would equal \$9,815/$MTCO_2e$. It is estimated that the program would cost \$500,000 per year starting in 2004, and have a potential mix of federal and State government

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	funding. **Other Major Issues** This program could lead to reductions in other air emissions. Planting programs in urban areas should have few barriers to implementation because many communities are actively pursuing tree-planting programs for reasons other than climate change, such as aesthetics.
40. Forest and Agricultural Land Preservation This program would support the protection of forestland and agricultural land preserves and the carbon-absorption capacity of existing forest and agricultural lands, enabling continued carbon sequestration from the atmosphere.	**Unanimous Consent** Provide funding to preserve existing forest and agricultural land. One federal analysis estimates that an average of 8,200 acres per year—4,700 acres of forest and 3,500 acres of agricultural land—are converted to development in Connecticut. Reduce consumption of land by using smart growth measures for development. **Expected GHG Reductions** • 2010 = 0.283 $MMTCO_2e$ • 2020 = 0.283 $MMTCO_2e$ **Expected Cost per Ton GHG** The expected cost would equal \$137/$MTCO_2e$. It is estimated that the program would cost \$57 million per year: \$46.6 million for the forestland preservation and \$10.5 million for the agricultural land preservation. A significant portion of the open space land preserved through State funds was conducted under a program in which the DEP provided towns and private conservation groups with matching grants, usually 50% of the land cost. If such a program were to comprise half of the DEP's efforts, the 4,700 acres could be acquired at a cost to the state of approximately \$21.4 million per year. The agricultural land preservation is assumed to come from State government funding. **Other Major Issues** Ancillary benefits include promoting wildlife habitat, protecting and improving water quality, improving the "livability" of the State, supporting smart growth initiatives in the State, supporting economic development (especially in rural parts of the State) by maintaining agricultural capacity, and enabling the continued consumption of locally grown agricultural products.
41. Promote Use of Durable Wood Products Over Other Construction Materials Durable wood products, such as furniture or construction lumber, sequester carbon for long periods of time, as long as the timber is produced as a result of certified sustainable harvesting practices. Wood products are also much less energy-intensive to create than materials such as steel, plastic, aluminum, and concrete.	**Unanimous Consent** Support a voluntary education program to encourage individual and business consumers to buy durable wood products. State government should lead by example by increasing the amount of durable wood products purchased. **Expected GHG Reductions in 2010 and 2020** The measures have not been quantified. **Expected Cost per Ton GHG** The expected cost has not been quantified.
42. Support Economically Viable Landfill Gas-to-Energy Projects	**Unanimous Consent** Support installation of 18.5 MW of landfill gas-to-energy projects.

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Policy Action	Proposal Definition, Status
Landfills naturally create methane gas (a GHG) as a by-product. Rather than being released into the air or burned off (flared), methane can be captured and used as a fuel to produce energy.	**Expected GHG Reductions in 2010 and 2020** These are included in waste and electricity sector reference cases. **Expected Cost per Ton GHG** This cost has not been estimated. **Other Major Issues** The total estimated amount of generation is based on IPM modeling analysis. The waste emissions baseline (for 2000–2020) was adjusted to account for methane reductions from increased gas-to-energy estimated in the electricity reference-case analysis.
43. Increase Recycling and Source Reduction to 40 Percent This would cover programs to reduce the amount of waste being put in landfills and/or waste-to-energy facilities, thereby reducing the amount of generated methane and CO_2, and emissions associated with producing virgin materials.	**Unanimous Consent** • Provide funding to increase education about and enforcement of recycling requirements and programs. • Support adoption of "pay-as-you-throw" programs for residential waste and, possibly, for small nonresidential waste through funding; if recycling levels are not increased sufficiently, implement by legislative mandates. • Increase composting of source-separated organics by providing funding and other assistance. • Provide funding to increase small business recycling. • Support recycling markets with additional funding to Connecticut's Environmental Preferable Purchasing program (through the DAS). • Provide increased funding to expand electronics recycling. • Increase "producer responsibility" with legislative mandates. **Expected GHG Reductions** • 2010 = 0.91 $MMTCO_2e$ • 2020 = 0.97 $MMTCO_2e$ **Expected Cost per Ton GHG** The expected cost would equal \$4 to \$5/$MTCO_2e$. It is estimated that the program would cost \$4.1 million per year in State funding (see appendix to Chapter 3.4). **Other Major Issues** Some of the potential ancillary benefits of this program include decreased raw materials acquisition (fossil fuel energy and other emissions and changes in forest carbon sequestration); decreased manufacturing (fossil fuel energy emissions) and transportation-related emissions; reduced need for new disposal facilities, avoiding land use and siting issues, waste transportation issues, other pollutants from waste combustion, generation of ash residue which requires handling, transportation, and disposal, and reduced toxicity of the waste stream. Consideration was given to the impact of GHG on resource-recovery facilities compared with disposal of waste out-of-state.
44. Voluntary Carbon Offset Program Encourage pilot efforts on carbon offsets (i.e., emissions reductions by sources not covered	**Unanimous Consent** The State should encourage voluntary programs on carbon offsets.

Table ES.5
Summary of Connecticut Climate Change Stakeholder Dialogue Recommendations

Policy Action	Proposal Definition, Status
under specific recommendations from the stakeholders and outside the state or the country).	**Expected GHG Reductions in 2010 and 2020** The measures have not been estimated **Expected Cost per Ton GHG** The cost has not been estimated.
Electricity Generation	
45. Renewable Energy Strategy (RES) RES is a group of options designed to promote renewable energy.	**Unanimous Consent** Promote the development of renewable energy in Connecticut and in the region as a long-term GHG emissions-reduction strategy, and encourage the renewable industry in Connecticut. The RES consists of a number of policy components described in items 46, 47, and 48. **Expected GHG Reductions (from combining Recommendations 46 through 48)** IPM quantified reductions: • 2010 = 0.0 $MMTCO_2e$ (within State) 0.09 $MMTCO_2e$ (within region) • 2020 = 1.33 $MMTCO_2e$ (within State), 2.02 $MMTCO_2e$ (within region) **Expected Total Cost** The expected total program and policy costs through 2020 is $253.91 million. Total cost changes by component are as follows: • Power expenditures: –$17.51 million • Renewable premium: $138.32 million • State production tax credit: $133.10 million **Expected Cost (In-State) per Ton GHG (Region)** The expected cost is $22.39/$MTCO_2e$ ($82.10/MTCe)
46. Renewable Portfolio Standard (RPS) The RPS mandates that a certain minimum percentage of annual electricity production come from renewable energy sources. Sources of qualifying renewable energy are delineated in the legislation, as are the increasing percentage requirements over time.	**Unanimous Consent** Consider increasing the RPS in the future, based on its actual performance. Data from future State and stakeholder experience with the RPS will be analyzed to determine the design. **Expected GHG Reductions** This is calculated in Recommendation 45 based on an extension of the current RPS to 8% in 2011 and up to 20% in 2020. **Expected Cost per Ton GHG** This is calculated in Recommendation 45 based on an extension of the current RPS to 8% in 2011 and up to 20% in 2020.
47. Government Green Power Purchase State government and universities are required to replace an increasing share of electricity with renewable energy, or to pay a premium on electricity to support investment in renewable energy generation capacity.	**Unanimous Consent** Increase the State's purchase of Class I renewables to 20% in 2010, 50% in 2020, and 100% in 2050. **Expected GHG Reductions/Cost** This is calculated under the RES. **Expected Cost per Ton GHG** This is calculated under the RES.
48. Production Tax Credit (PTC)	**Unanimous Consent**

Table ES.5
Summary of Connecticut Climate Change Stakeholder Dialogue Recommendations

Policy Action	Proposal Definition, Status
Create a financial incentive for qualifying renewable energy production with a per-kWh tax credit.	Explore a PTC ($0.018/kWh for 10 years) for new Class I renewable projects in Connecticut that are not covered by the federal renewable PTC (i.e., fuel cells, solar, landfill gas, biomass, hydrogen, and small hydro). This would be a potential mechanism to achieve RPS and promote development of in-state renewables in light of future information on the availability of and competition for biomass resources. **Expected GHG Reductions** This is calculated under the RES. **Expected Cost per Ton GHG** This is calculated under the RES.
49. Green Power Option Allow ratepayers to choose electricity derived from renewable energy sources.	**Unanimous Consent** Establish and launch a green power option for all ratepayers and default customers pursuant to SB 733 by January 1, 2004. The green offering(s) targets recommended by the renewable energy subcommittee are as follows: 3–4% by 2010; 5–10% by 2020; and 11–20% by 2050. The targets are over and above the RPS requirements. **Expected GHG Reductions** • 2010 = 0.43 $MMTCO_2e$ • 2020 = 0.81 $MMTCO_2e$ **Expected Total Cost** • 2010 = $14.49 million • 2020 = $17.76 million **Expected Cost per Ton GHG** • In 2010 = $33.69/$MTCO_2e$ ($123.55/MTCe) • In 2020 = $21.92/$MTCO_2e$ ($80.39/MTCe)
50. Green Tags The benefits of renewable energy— zero emissions of GHG and other pollutants—can be purchased via certificates called “green tags,” which track the generation and sale of renewable energy, even when produced outside the local utility grid.	**Unanimous Consent** To meet the RPS and State government green power purchase, allow purchase of green power generated in New England as well as Delaware, Maryland, New Jersey, New York, and Pennsylvania, assuming they have compatible certificate markets and mechanisms. **Expected GHG Reductions in 2010 and 2020** This has not been estimated. **Expected Cost per Ton GHG** This has not been estimated. **Other Major Issues** Green tags are a design mechanism that is necessary to allow out-of-state electricity purchases to count towards the RPS and for the implementation of a green power option. This option is specified in the design of the RPS (no. 46 above).
51. Restore the Clean Energy Fund This fund provides incentives for new renewable electricity generation capacity and pilot projects.	**Unanimous Consent** This effort will restore the Clean Energy Fund to the previously planned funding level ($29 million annually). Note that DPUC abstained from voting due to pending regulations. The business-as-usual scenario assumes funding will total $13 million in the

Table ES.5
Summary of Connecticut Climate Change Stakeholder Dialogue Recommendations

Policy Action	Proposal Definition, Status
	first year and $20 million in subsequent years. **Expected GHG Reductions in 2010 and 2020** This has not been estimated. **Expected Cost per Ton GHG** This has not been estimated. **Expected Total Cost** This program requires $16 million in 2004 and $9 million annually from 2005 to 2010.
52. Energy Efficiency and CHP This measure will implement demand-side programs that will reduce electricity demand through a variety of programs for the AFW and RCI sectors. It will also reduce barriers and implement a program to increase clean CHP in Connecticut.	**Unanimous Consent** All measures identified and assessed by the RCI and the AFW working groups that result in electricity demand reductions are included in this EE package for the IPM model run. These measures include • Appliance standards • Appliance-swapping program • HPWH replacement program • Bulk purchasing of appliances • Mandatory upgrades to commercial and residential building code • Energy efficiency and energy improvement mortgages • Weatherization program • Energy Star homes program • High-performance schools and State-funded buildings • High-performance commercial buildings • Shared savings program for government buildings and benchmarking • Training of building operators • Green campus initiative • Benchmarking and tracking program for municipal buildings • Third-party load management • CHP • Restoration of the Conservation and Load Management Fund • Installation of centralized manure digesters • An urban tree-planting program. **Expected GHG Reductions** IPM results: • 2010 = 0.25 $MMTCO_2e$ (within state), 1.17 $MMTCO_2e$ (within region) (only emission reductions associated with reduced electricity demand) • 2020 = 4.90 $MMTCO_2e$ (within state), 3.86 $MMTCO_2e$ (within region) (only emission reductions associated with reduced electricity demand) **Expected Total Cost** The expected total program and policy costs through 2020 is –$481.26 million. Total cost changes by component: • Power expenditures: –$1,108.26 million • Renewable premium: –$10.56 million • Efficiency programs: $637.55 million

Table ES.5
Summary of Connecticut Climate Change Stakeholder Dialogue Recommendations

Policy Action	Proposal Definition, Status
	Expected Cost (In-State) per Ton GHG (Region) The expected cost is –$18.17/MTCO$_2$e (–$66.61/MTCe)
53. Regional Cap-and-Trade Program Cap-and-trade programs set limits on industry emissions at particular levels over particular time periods within a specified geographic area. They allow flexibility by covered entities in sources and methods of reduction, as well as trading credits between those required to comply with caps or standards and other flexibility mechanisms, such as emissions offsets.	**Unanimous Consent** Connecticut should work with other northeastern states through continued participation in the Regional Greenhouse Gas Initiative or the New England Governors Association process to develop a regional cap-and-trade program for the electricity generation sector. These processes should use existing NEG targets as applied to the electricity generation sector as a starting point for recommended cap levels and timing (1990 emission levels by 2010 and 10% below 1990 levels by 2020). Given the results of advanced modeling by IPM in Connecticut predicting substantial loss of emissions benefits due to offsetting increases in emissions (i.e., "leakage") inside and outside the region (in Pennsylvania and the eastern interconnect region), the State should design a program at the broadest possible geographical level covering the widest range of potential sources and develop policy mechanisms to control offsetting emissions (such as a generation performance standard, offsets, or other approaches). In addition, the State should support development of an effective federal cap-and-trade program for electricity generation. **Expected GHG Reductions** This has been estimated but not adopted. **Expected Cost per Ton GHG** This cost has been estimated but not adopted.
Cross-Cutting Recommendations	
54. Public Education Initiative Information and education is an important tool for implementing GHG plans and programs, because it alerts the public and key parties to the need for action and the availability of programs and services.	**Unanimous Consent** Connecticut should support measures to foster a broad awareness of climate change issues (including co-benefit issues such as clean air and public health) and their impact among Connecticut's citizens and to engage citizens in simple actions to reduce GHG emissions. The measures, detailed below, are cross-cutting and provide a foundation for the implementation of all of the mitigation actions proposed in this report. The measures seek to integrate with and build on existing outreach efforts on climate change and co-benefits issues in Connecticut. The following overarching actions are recommended to ensure success of the specific education and outreach measures proposed below: 1. Include the Commissioners of Education and Higher Education on the Governor's Steering Committee on climate change. 2. Establish an ongoing climate change education committee to develop a broad awareness of climate change issues and to implement the education and outreach measures proposed in this report. Participation in the committee should be open to interested parties from all sectors, including State agencies, educators, community-based organizations, businesses and institutions, municipalities, and universities. The work of the committee should include: a. Initiatives to implement the education and outreach

Table ES.5
Summary of Connecticut Climate Change Stakeholder Dialogue Recommendations

Policy Action	Proposal Definition, Status
	measures proposed below b. Education and marketing of the GHG mitigation actions in this report c. Coordination of the agencies and organizations involved in climate change education in Connecticut d. Identification of existing resources and programs to implement climate change education measures e. Identification of additional needs and supplemental funding sources for climate change education measures (e.g., eligibility for climate change education funding under renewables and energy conservation funds, corporations, foundations f. Development of a clearinghouse for Connecticut climate change information and education resources (perhaps on www.ctclimatechange.com).
55. Emissions Inventory and Registry Inventory, reporting, and registry systems are important tools for implementation of GHG plans because they provide a means of measuring and tracking success and of cooperating across sectors, programs, and jurisdictions.	**Unanimous Consent** Connecticut should create appropriate tools for an effective inventory, reporting system, and registry of State emissions that together support the State's target, action plan, and regional leadership role—including mutual recognition by other jurisdictions. Connecticut should explore working with the NEG/ECP on this effort. Development of such a system may include the following actions: • Creating an annual statewide GHG emissions inventory and related State inventories • Mandatory reporting of GHG emissions by appropriate sources • Developing a voluntary GHG emissions registry. • Working with other states and regions on consistent and mutually recognized approaches for inventory and reporting.

CHAPTER 1

HISTORY OF CONNECTICUT CLIMATE ACTIONS

By the Connecticut Climate Change Coordinating Committee[1]

New England Governors/Eastern Canadian Premiers Climate Change Action Plan

The New England states and the eastern Canadian provinces have a long history of working together to address and resolve environmental issues. Starting in the 1980s, the New England governors (NEG) and eastern Canadian premiers (ECP) recognized the harmful effects of acid rain on the region's forests and the negative impact on its economy. The NEG/ECP passed a joint resolution calling for the elimination of emissions contributing to those effects. As a result, states and provinces acted to reduce emissions of nitrogen oxides (NO_x) and sulfur oxides (SO_x). Those steps later served as a model for regional and federal action.

In 2000, the NEG/ECP, citing findings in the United Nations Intergovernmental Panel on Climate Change Third Assessment Report, commenced regional discussions on global warming and its environmental impact. In March 2001, the NEG/ECP, collaborating with the province of New Brunswick, held a climate change workshop in that province. Connecticut Governor John Rowland co-chaired the workshop, which presented findings on the scientific certainty that climate change is already occurring and that a significant human signature is contributing to the observed changes. Officials from government, academia, and industry in Canada and the United States developed strategic recommendations from the presentations. The well-attended workshop provided momentum for the development of a framework for a climate change action plan. In August 2001, the NEG/ECP submitted a climate change action plan[2] at their annual meeting in Westbrook, Connecticut, where Governor Rowland and the other NEG/ECP members signed it.

The vision of the Climate Change Action Plan is to reduce greenhouse gas (GHG) emissions to a level that stabilizes the earth's climate and eliminates the negative impact of climate change. The plan outlines important short- and mid-term goals for measuring progress toward the long-term objective based on environmental needs (not feasibility). The plan also specifies nine action items the states and provinces should undertake. Those goals and action items are detailed in Table 1.1. The plan further provides a recalibration mechanism. Starting in 2005, and continuing

[1] For a list of the Connecticut Climate Change Coordinating Committee members, see Chapter 2, which describes the dialogue process.
[2] http://www.negc.org/documents/NEG-ECP%20CCAP.PDF

every five years thereafter, progress in achieving the goals will be evaluated. The goals will be adjusted, if necessary, and future emission goals may be established.

Table 1.1
2001 NEG/ECP Climate Change Action Plan and Related Resolutions

Regional Goals of Climate Change Action Plan

Short-term: Reduce regional GHG emissions to 1990 levels by 2010.

Mid-term: Reduce regional GHG emissions to at least 10% below 1990 levels by 2020.

Long-term: Reduce regional GHG emissions sufficiently to eliminate any dangerous threat to the climate (current science suggests that this level is 75% to 85% below 2001 levels).

Action Item 1 – Establishment of a Regional Standardized GHG Emissions Inventory

Goal: Each jurisdiction should establish a standardized inventory beginning with 1999 GHG emissions levels, reported every three years.

Action Item 2 – Establishment of a Plan for Reducing GHG Emissions and Conserving Energy

Goal: Each jurisdiction should create a plan articulating measures for achieving GHG reductions in view of the regional short and mid-term targets.

Action Item 3 – Promotion of Public Awareness

Goal: By 2005, make the public aware of the problems and impact of climate change and what actions they can take at home and at work to reduce the release of GHGs. The public should also be made cognizant of adaptive measures they can accomplish.

Action Item 4 – Need for State and Provincial Governments to Lead by Example

Goal: Reduce end-use emissions of GHGs through improved energy efficiency and lower carbon fuels within the public sector by 25% by 2012, as measured from an established baseline.

Action Item 5 - Reduction of GHGs From the Electricity Sector

Goal: Reduce the amount of CO_2 emitted per MWh of electricity use within the region by 20% of current emission rate by 2025.

Action Item 6 - Reduction of the Total Energy Demand Through Conservation

Goal: By 2025, increase the amount of energy saved through conservation programs (as measured in tons of GHG emissions) within the region by 20% using programs designed to encourage residential, commercial, and industrial energy conservation.

Action Item 7 - Reduction and/or Adaptation of Negative Social, Economic, and Environmental Impact of Climate Change

Goal: Broaden the understanding of forecast effects on climate and plan the adaptation to these changes, where possible. In addition, seek climate adaptation options that do not increase GHG emissions further.

Action Item 8 - Reduction in the Transportation Sector's Growth in GHG Emissions

Goal: Slow the growth rate of transportation emissions in the near future, better understand the impact of transportation programs and projects on total emissions, and seek ways to reduce these emissions. Work with federal officials to improve the energy efficiency of vehicles for sale to the public.

Action Item 9 - Creation of a Regional Emissions Registry and Exploration of a Trading Mechanism

Goal: To create a uniform, coordinated basis for emissions banking and trading.

Resolution 27-7 (August 2002)

Encourage and promote climate change proposals focused on LED traffic lights; partnerships with regional colleges and universities for emissions-reduction programs; purchase of high-efficiency and low-emission office equipment; and use of clean, energy efficient vehicles in state and provincial fleets.

Resolution 28-7 (September 2003)

Evaluate "smart growth" approaches to land-use and development and seek recommendations for implementation. Continue to develop the administration, tracking, and reporting framework for a voluntary regional GHG registry. Work to develop voluntary partnerships with cities, towns, and businesses to increase the efficacy of NEG/ECP's climate change work.

The goals and results outlined in the plan are for the New England and eastern Canada region in aggregate and may not be achieved in equal measure by each jurisdiction. It is recognized that differences in emissions characteristics and inventories, social and political systems, economic profiles (including transportation, utility, and industrial infrastructures), and resources will lead to different approaches among the jurisdictions in contributing to the regional goals. However, each jurisdiction in the region has committed to participate in achieving the regional goals and will work with the other states and provinces in the region on this important effort.

Designing a Connecticut Process

The State of Connecticut, in partnership with the Emily Hall Tremaine Foundation and the Rockefeller Brothers Fund, convened a summit on behalf of a Governor's Steering Committee[3] to establish a State process for developing a climate change action plan. The summit met October 2 to 4, 2002, at the Pocantico Conference Center of the Rockefeller Brothers Fund in Tarrytown, New York. Participants from 13 State agencies[4] assembled to establish a participatory process to develop an innovative and responsible plan to address climate change.

Jonathan Raab, Ph.D., facilitated the summit, which included presentations by Bill Moomaw, Ph.D., professor of international environmental policy education at the Fletcher School of Law and Diplomacy at Tufts University; Sonia Hamel, director of air policy and planning for the Massachusetts Office of Environmental Affairs; and Janet Keller, chief of strategic planning and policy for the Rhode Island Department of Environmental Management. Participants discussed the basic structure of an action plan, including a GHG emissions inventory, baselines, targets, GHG reduction options, and an implementation plan.

Speakers from Massachusetts and Rhode Island presented their states' efforts to establish action plans, which were considered within the design of Connecticut's process. The key challenges raised by the Massachusetts and Rhode Island speakers included stakeholder management, fundraising, human resources, and maintaining continuity. The summit participants established three Connecticut climate change goals for 2003:

1. Publish and distribute a report summarizing Connecticut's actions on climate change.[5]

[3] Arthur H. Diedrick (Chairman of the Connecticut Clean Energy Fund), Donald W. Downes (Chairman of the Department of Public Utility Control), Arthur J. Rocque, Jr. (Commissioner of the Department of Environmental Protection), Barbara Waters (Commissioner of the Department of Administrative Services), James F. Byrnes (Commissioner of the Department of Transportation), and John A. Mengacci (Undersecretary of the Office of Policy and Management)

[4] Connecticut Clean Energy Fund, Connecticut Department of Administrative Services, Connecticut Department of Agriculture, Connecticut Department of Environmental Protection, Connecticut Department of Public Utility Control, Connecticut Department of Public Works, Connecticut Department of Revenue Services, Connecticut Department of Transportation, Connecticut Innovations, Connecticut Siting Council, Connecticut Global Fuel Cell Center at the University of Connecticut, Institute for Sustainable Energy at Eastern Connecticut State University, and the Office of Policy and Management.

[5] For more detailed information on this event and Connecticut's actions on climate change, see the report entitled Leading by Example: Connecticut Collaborates to Reduce Greenhouse Gas Emissions. Pocantico Paper No. 6, by the Governor's Steering Committee. Available at: www.ctclimatechange.com/rbf_rept.html.

2. Update a GHG emissions inventory for 1990–2000.[6]
3. Coordinate a process to identify actions to reduce Connecticut's GHG emissions.

The results of the third goal are reflected in this report.

Connecticut's GHG Inventory

Connecticut has quantified its emissions contributing to global climate change by completing GHG emissions inventories for 1990 through 2000. *Connecticut Greenhouse Gas Inventory 1990–2000* (August 2003) was developed by NESCAUM using the State GHG Inventory Tool, an Excel-based software package produced by the State and Local Climate Change Program of the U.S. Environmental Protection Agency (EPA).[7] The inventory summarizes Connecticut's emissions of the six major GHGs covered in national inventories: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The inventory also incorporates information from all major emissions sources in Connecticut: fossil and biomass fuel combustion, industrial production processes, gas and oil activities, landfills and wastewater treatment, agricultural sources, and land-use changes and forestry. To make the inventory comparable to the U.S. national GHG inventory and inventories from other industrialized countries, GHG quantities are expressed in million metric tons of CO_2 equivalent ($MMTCO_2e$), which is derived from the relative global warming potential of each of these gases.

Table 1.2 summarizes Connecticut's GHG emissions from 1990 through 2000 as developed by NESCAUM. The stakeholders used this inventory as a basis for establishing baseline emissions. Upon review of the NESCAUM inventory data, the stakeholders made adjustments to some of the historical data. The most significant adjustment was for the transportation sector (see Chapter 3 for sector-specific adjustments). In 2000, the State emitted 48.485 $MMTCO_2e$ of GHGs, approximately 9 percent more than in 1990. As shown in Figure 1.1, about 90 percent of the total emissions in 2000 came from the combustion of fossil fuels—oil, gas, and coal—to power the State's cars and factories, heat and cool its homes and buildings, and generate electricity. Municipal solid waste management was responsible for about 6 percent of total emissions. Industrial processes and agriculture contributed less than 2 percent and 1 percent, respectively. Carbon stored in forests and soils offset about 4 percent of Connecticut's annual GHG emissions, resulting in net GHG emissions (total emissions minus carbon sequestered) of 46.45 $MMTCO_2e$ in 2000.

[6] *Connecticut Greenhouse Gas Inventory 1990–2000.* (2003). Connecticut**:** Northeast States for Coordinated Air Use Management, Connecticut Clean Energy Fund, and Connecticut Department of Environmental Protection. Available at: www.ctclimatechange.com.

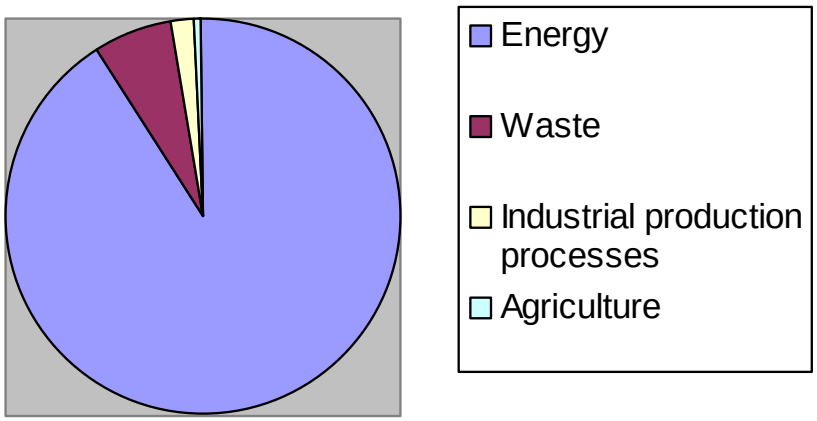
[7] Produced by Northeast States for Coordinated Air Use Management (NESCAUM) and the Connecticut Department of Environmental Protection, with support from the Connecticut Clean Energy Fund. The Inventory Tool incorporates revisions to EPA's guidelines for estimating GHG emissions up through November 2002. The *Connecticut Greenhouse Gas Inventory 1990–2000* (August 2003) uses all revised modules of the Inventory Tool issued through May 30, 2003.

Table 1.2
Connecticut GHG Emissions: 1990–2000

Emissions ($MMTCO_2e$)	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Energy	**40.270**	**39.518**	**39.476**	**38.582**	**37.656**	**37.578**	**41.002**	**44.130**	**43.748**	**44.133**	**44.159**
CO_2 from fossil fuel combustion	38.882	38.081	38.179	37.083	36.166	36.063	39.505	42.679	42.318	42.722	42.853
Stationary combustion	0.201	0.203	0.217	0.215	0.210	0.230	0.236	0.214	0.204	0.199	0.223
Mobile combustion	0.680	0.708	0.719	0.744	0.744	0.752	0.731	0.712	0.703	0.693	0.676
Coal mining	–	–	–	–	–	–	–	–	–	–	–
Natural gas and oil systems	0.508	0.526	0.361	0.540	0.536	0.533	0.530	0.525	0.523	0.520	0.408
Industrial processes	**0.314**	**0.325**	**0.311**	**0.397**	**0.419**	**0.528**	**0.634**	**0.700**	**0.740**	**0.772**	**0.840**
Agriculture	**0.330**	**0.321**	**0.335**	**0.344**	**0.350**	**0.336**	**0.313**	**0.307**	**0.335**	**0.329**	**0.326**
Enteric fermentation	0.124	0.121	0.124	0.121	0.121	0.120	0.110	0.106	0.109	0.107	0.109
Manure management	0.046	0.045	0.044	0.047	0.047	0.046	0.044	0.042	0.045	0.044	0.042
Rice cultivation	–	–	–	–	–	–	–	–	–	–	–
Agricultural soil management	0.160	0.155	0.167	0.176	0.182	0.170	0.159	0.159	0.181	0.178	0.175
Burning of agricultural crop waste	–	–	–	–	–	–	–	–	–	–	–
Forest management and land-use change	**(2.719)**	**(2.650)**	**(2.658)**	**(2.069)**	**(2.039)**	**(2.058)**	**(2.052)**	**(2.015)**	**(2.009)**	**(2.035)**	**(2.035)**
Waste	3.499	3.598	3.598	3.590	3.689	3.662	3.245	3.312	3.230	3.130	3.159
Municipal solid waste	3.239	3.337	3.337	3.329	3.425	3.400	2.983	3.049	2.966	2.863	2.883
Wastewater	0.260	0.262	0.261	0.261	0.264	0.262	0.262	0.263	0.264	0.267	0.277
Gross emissions	**44.414**	**43.762**	**43.720**	**42.914**	**42.115**	**42.103**	**45.194**	**48.450**	**48.053**	**48.364**	**48.485**
Sinks	**(2.719)**	**(2.650)**	**(2.658)**	**(2.069)**	**(2.039)**	**(2.058)**	**(2.052)**	**(2.015)**	**(2.009)**	**(2.035)**	**(2.035)**
Net emissions	**41.695**	**41.112**	**41.063**	**40.844**	**40.076**	**40.045**	**43.142**	**46.435**	**46.044**	**46.329**	**46.450**

Source: *Connecticut GHG Inventory 1990–2000*, August 2003.

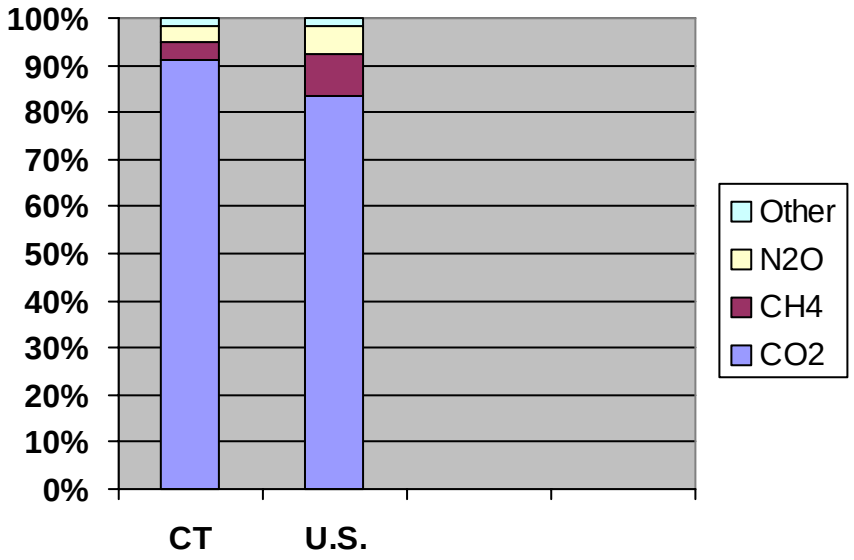
Figure 1.1
GHG Emissions by Sector, 2000



Another breakdown of the State's GHG emissions in 2000 is shown in Figure 1.2. CO_2, largely from fossil fuel combustion, accounted for more than 90 percent of the emissions. The contribution of the major GHGs to Connecticut's GHG emissions profile is similar to national figures.

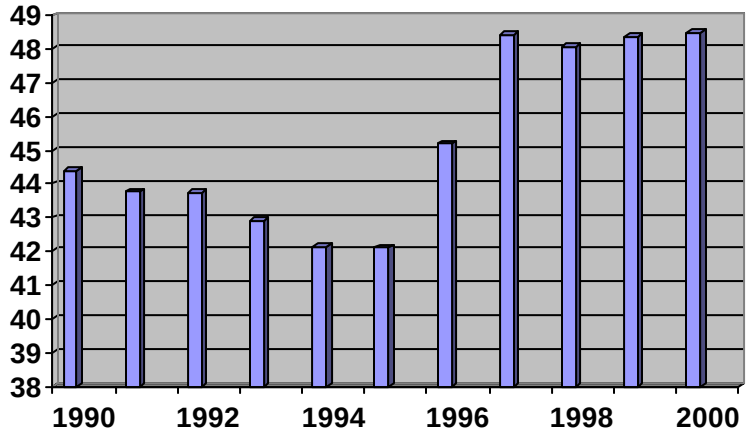
Figures 1.3 and 1.4 show the State's GHG emissions trend between 1990 and 2000. Connecticut GHG emissions declined about 5 percent through the first half of the decade, most likely as a

Figure 1.2
Breakdown of Connecticut and U.S. GHG Emissions by Type of Gas, 2000



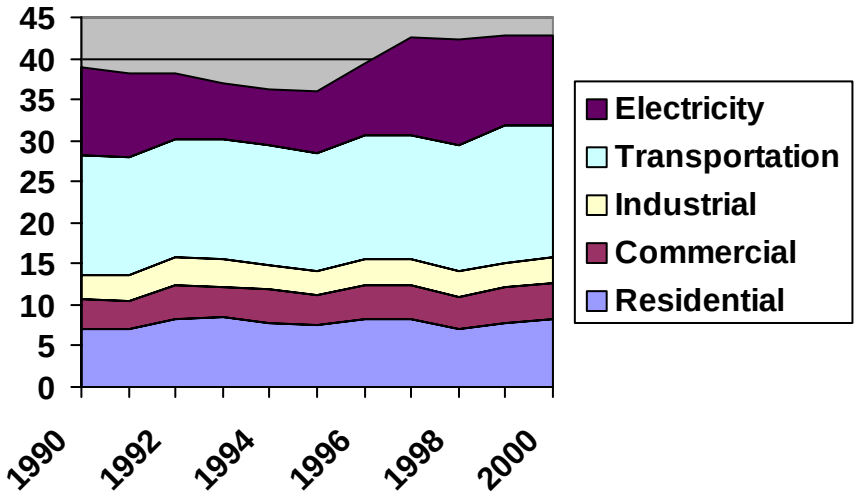
result of a shift in the utility fuel mix used in electric power generation, a shift in waste management practices from landfilling to waste-to-energy, a recession in the early part of the decade, and a slight decline in population. Gross GHG emissions, however, increased by more than 15 percent in the second half of the decade, again partly a result of changes in fuel mix, the economy, and the population.

Figure 1.3
Total Connecticut GHG Emissions, 1990–2000
(MMTCO_2 equivalent)



CO_2 emissions from fossil fuel combustion result from stationary sources (i.e., power plants, industrial facilities, and home heating systems) and from mobile sources, such as motor vehicles. Transportation accounts for approximately 40 percent of CO_2 emissions annually. Primary energy consumption in the residential (R) and commercial/industrial (CI) sectors is

Figure1.4
CO_2 Emissions from Fossil Fuel Combustion, 1990–2000
(MMT)



approximately 20 percent and 10 percent, respectively. The electric utility sector contributes between 18 and 30 percent of the CO_2 emissions from fossil fuel combustion. The great fluctuation in electric utility CO_2 emissions stems from the changing fuel mix used to produce electricity in Connecticut.

Connecticut Climate Change Actions

The State of Connecticut has a tradition of climate change leadership. Even before its landmark 1990 Global Warming Act, the State had numerous pieces of energy-related legislation on the books, for which the concern about global warming was one of several driving forces. From the late 1970s through the 1990s, the State passed more than 20 environmentally related laws that ranged in scope from allowing towns and cities to exempt solar collectors from property taxes to providing low-cost loans for energy efficiency and renewable energy improvements to RCI sectors. (Table A.1.1 in the chapter appendix provides a comprehensive look at those efforts.)

The Global Warming Act of 1990 was the direct result of an intense heat wave in 1988 and media accounts of James Hansen of the Goddard Institute for Spaceflight Studies, who indicated that the heat wave might be an early "fingerprint" of enhanced climate change. Although no single weather event can indicate a long-term shift in climate, legislation to mitigate potential climate problems was introduced in the 1989 session. For a number of reasons, the legislation failed to pass that year. Supporters reintroduced the legislation in 1990; it not only passed but also received the greatest number of co-sponsors[8] of any bill enacted that year. One key to the legislation's success was that a team of legislators from both political parties drafted it, resulting in bipartisan support. Among other actions, the Connecticut law

- required revisions to State building codes;
- required the State to purchase energy efficient vehicles and appliances;
- authorized the Connecticut Department of Environmental Planning (DEP) commissioner to require applicants for air-discharge permits to provide for tree or turf grass planting to offset carbon emissions;
- required the Connecticut Office of Policy and Management (OPM) to develop a comprehensive energy plan to decrease dependence on fossil fuels by promoting energy conservation, solar energy, and other alternative energy sources in the design of all new State buildings as well as home energy efficiency; and
- investigated ways to increase the occupancy levels of vehicles.

Reducing GHG emissions in Connecticut to 1990 levels and lower will require aggressive action by all sectors of society, including its businesses and institutions, colleges and universities, nongovernmental organizations (NGOs), and local governments. All sectors will play a vital role in focusing attention on climate change in Connecticut and implementing the GHG mitigation actions proposed in this plan.

[8] Chief co-sponsors were Mary Mushinski, James Fleming, Joel Gordes, David Anderson, and Mike Meotti.

Connecticut businesses have shown leadership in the development of cleaner and renewable energy technologies, such as fuel cells, gas turbines, and the American wind turbine. In addition, many Connecticut businesses and industries have embraced cost-effective measures to reduce GHG emissions voluntarily. Those activities include energy conservation and efficiency, fuel switching and renewable energy purchases, the development of cleaner technologies and the application of cleaner industrial processes, the use of cleaner and more efficient vehicle fleets, carbon sequestration (through improved agriculture and forestry practices as well as participation in voluntary offset projects), and participation in public outreach and awareness. Some companies have joined partnerships or voluntary programs to reduce pollution and emissions and increase corporate stewardship.

Seventeen of the State's colleges and universities have formally committed to making an inventory of GHG emissions on campus and taking actions to reduce emissions. A number of colleges are purchasing renewable energy; many are improving the energy efficiency of lighting, heating, ventilation, and cooling systems and computers and appliances. Connecticut's colleges and universities have also embraced new cleaner technologies, such as solar photovoltaics (i.e., direct conversion of sunlight into electricity), fuel cells, and geothermal heating systems. Some colleges are incorporating green building design standards into new construction and renovations.

NGOs have been strong supporters of climate change initiatives in Connecticut. Their support is invaluable in engaging public involvement in understanding the wide spectrum of issues linked to climate change. State and regional nonprofit organizations have acted as catalysts for grassroots action, corporate stewardship, and public policy initiatives. The combined efforts of many NGOs are helping to educate the public about climate change, assist the State's businesses and institutions, provide resources to municipalities, promote leadership among faith-based communities, build partnerships, and focus the attention of policy makers. Foundations are supporting much of this work through grants.

Seven Connecticut municipalities and one regional planning organization are participating in the international Cities for Climate Protection program. These jurisdictions have shown leadership by passing resolutions to inventory and reduce GHG emissions from municipal operations. Many other municipalities have begun to save money through energy efficient measures, such as the installation of light-emitting diode (LED) traffic lights, purchasing Energy Star office equipment, performing energy benchmarking and efficiency upgrades at schools and other public buildings, improving public transit options, and increasing the efficiency of municipal fleets. Several have participated in the utility-sponsored Community-Based Program, which coordinates all conservation and load management programs in selected cities and towns.

State initiatives include the planning and development of statewide GHG mitigation measures as well as the implementation of GHG reduction actions in State operations. Some actions are embodied in State statutes and regulations; others are informal programs or policies. The State has implemented energy performance standards for State buildings and is promoting green building design on major capital projects, purchasing environmentally preferable products ranging from computers to lighting, providing certain tax incentives for clean fuels, and beginning to perform energy benchmarking on State buildings to improve efficiencies. In

addition, the State is increasing its use of electronic media, resulting in a commensurate reduction in paper consumption.

The Connecticut treasurer has taken a leadership role among institutional investors by addressing climate change issues with companies in which the State pension fund invests. For example, shareholder resolutions have been filed with a number of companies. In November 2003, Connecticut co-chaired the Institutional Investor Summit on Climate Risk at the United Nations, which developed a set of principles to advise investors on climate risk.

CHAPTER 1 APPENDIX

Table A.1.1
Record of Past Legislation

Legislation	Highlights
Global Warming	
*PA 90-219: An Act Concerning Global Warming	This legislation • required State buildings to reduce energy use by 15% by 1995, 30% by 2000, and 50% by 2010; • required the Department of Administrative Services to purchase energy efficient appliances; • required revision of the State Building Code to incorporate optimum energy efficiency; • required the State to purchase energy-efficient vehicles and consider the use of alternative fuels; • authorized the DEP Commissioner to require applicants for air-discharge permits to provide for tree or turf-grass planting to offset carbon emissions; • required OPM to develop a comprehensive energy plan to decrease dependence on fossil fuels by promoting energy conservation, solar energy, and other alternative energy sources when designing new State buildings and promoting home energy efficiency; • established a group to institute more stringent standards for any use of electric resistance heating; • requested recommendations for disincentives to free parking, including urban and suburban employment centers, off-peak transit services, and urban center loop shuttles; • investigated ways to increase vehicle occupancy levels and promote mass transit; and • required OPM to conduct a study of telecommuting.
PA 91-395: An Act Concerning Global Climate Change	This legislation included provisions to mitigate suburban sprawl, including promotion of cluster development. It reaffirmed the development of solar subdivisions as outlined in previous legislation, PA 81-334.
Energy Tax Incentives	
PA 76-109: An Act Providing Property Tax Exemption for Solar Energy Systems	This legislation allowed towns the local option to provide a 15-year property tax exemption for solar systems. It defined an existing exemption to also include windmills and waterwheels that provide for the collection, transfer, storage, and use of incident solar energy for water heating, space heating, or cooling It also called for establishing standards by the Commissioner of Planning and Energy Policy.
PA 79-547: An Act Providing a Sales Tax Exemption for Solar Energy Systems	This legislation extended the sales tax exemption, previously available only to solar collectors, to all component parts of a solar energy system.
PA 80-406: An Act Concerning the Property Tax Exemption for Buildings	This legislation • recognized passive solar systems as eligible solar heating and

Table A.1.1
Record of Past Legislation

Legislation	Highlights
Equipped with a Passive Solar System	cooling equipment and extended the property tax exemption for identifiable portions; • provided a sales tax exemption on alternative energy systems, except wood stoves; • provided exemption from the corporation profits tax for individually owned companies involved in the manufacture, research, and development of alternative energy systems whose gross annual revenues did not exceed $100 million; and • exempted virtually all forms of taxes on alternative energy products.
Energy Loans	
*PA 79-509: An Act Concerning Authorization of State Bonds for Loans for Energy Conservation Measures	This legislation established the Energy Conservation Loan Fund and authorized bonding for a revolving fund to provide residential loans for low- and middle-income people (The loan amounts in the original legislation were from $400 to $3,000 for energy conservation only. Revisions to the legislation apply the loan to both conservation and alternative energy devices and increase the loan limit to $15,000.) Interest rates have varied over time from 0% to 9.75% depending on income, family size and statistical metropolitan sample area (SMSA). Terms are for up to 10 years. In 1982, a decision mandated that the electric and gas utilities pay into the fund to provide the interest rate buydown from State bonding rates.
PA 79-520: An Act Concerning Industrial Loans for Renewable Energy and Energy Conservation Projects	This legislation • recognized the need in the State for the development and use of indigenous and renewable energy sources that are not subject to rapid cost increases and uncertain availability due to unstable foreign governments and other causes, • recognized that financial assistance by the Connecticut Development Authority would encourage business and industry to construct industrial facilities using renewable energy, and • declared itself to be a "guiding policy of the DED."
PA 80-345: An Act Concerning Loans by the Connecticut Development Authority for Renewable Energy and Energy Conservation Projects	This legislation reaffirmed the intent of PA 79-420.
*PA 95-288: AAC The Connecticut Critical Industries Development Account	This legislation established an economic development program to provide financing for Connecticut-built products, particularly technologies such as renewable energy sources, advanced aeroderivative gas turbines (some using gasified biomass), and fuel cells.

Table A.1.1
Record of Past Legislation

Legislation	Highlights
	It also provided a fund into which any person or entity (insurance pension fund) can contribute and receive a modest tax credit on the front end. Loans can be made to eligible projects that use Connecticut-built products meeting due diligence and are at or below market rates. The loan repayments are returned to the original investors.
Planning and Zoning/Land Use	
PA 78-314: An Act Concerning the Inclusion of Energy Considerations in Local Planning and Zoning Functions	This is the first Connecticut statute to tie energy considerations to land-use statutes. It added language encouraging energy efficient patterns of development, the use of solar and other renewable forms of energy, and energy conservation.
PA 81-334: An Act Concerning Passive Solar Design for Subdivisions	This legislation stated that planning and zoning commissions must require developers to demonstrate that they have considered passive solar design features in new subdivisions and encourage energy efficient patterns of development and land use. It also stated that the regulations must require planning and zoning commissions to consider techniques including the following: • house orientation • street and lot layout • vegetation • natural and man-made topographical features • protection of solar access within the development. In return, developers are allowed density bonuses or lower performance standards on roads within the subdivisions as well as allowance or cluster developments. The legislation reaffirmed and made explicit that the requirement to consider the above techniques was mandatory in Public Act 88-263.
State Buildings	
PA 79-462: An Act Concerning the Use of Renewable Energy in New State Buildings and Establishing a Program to Maximize Efficiency of Energy Use in State-Owned and Leased Buildings	This legislation required renewable energy resources to be used in new State buildings planned in the statewide bank capital facility plan. For the first year, 5% of all new floor space must be heated, cooled, or provided with domestic hot water using renewable resources. Any of these energy applications must provide at least 30% of the total load to fulfill the legislation. Each year for the next nine years, the percentage of floor space served by renewable resources must increase by 5% until 50% of all new floor space uses renewable sources. System selection is subject to lifecycle cost analysis procedures (see PA 79-496). Selection of the system may be overwritten if

Table A.1.1
Record of Past Legislation

Legislation	Highlights
	the selection will cause an undue economic hardship to the State.
PA 79-496: An Act to Establish and Attain Energy Performance Goals in State Buildings	This legislation require that new construction or the renovation of any existing structure more than 10,000 square feet is used or funded by the State meet energy performance goals to be formulated by OPM's Energy Division. The goals be the minimum practical achievable on a lifecycle cost basis and make maximum use of renewable energy resources. Each design proposal include at least two alternate energy systems for heating, cooling, and domestic hot water; at least one system use a renewable energy source. Consideration was to be given to maximize exposure to the sun for use of active and passive solar energy systems. The retrofit program was to have begun in 1982 under the auspices of the Department of Administrative Services. Called for the development and publication of guidelines for an energy efficiency maintenance program applicable to all agencies. Reporting to the Governor and the general assembly was required on the preceding year's activities that met the energy performance goals.
PA 90-130: An Act Establishing a Shared Energy Savings Program	The legislation was formulated to overcome barriers presented by the Connecticut budgeting process wherein any savings realized by a State agency through energy projects. It mandated that at least 50% of the energy savings would remain with the agency and could be used for future energy-related activities
*PA 90-221: AAC Various Administrative Provisions and Reporting Requirements of the DPUC; The Allocation of Economic Benefits of Water Company Land Sold for Open Space and Recreational Purposes, and Energy Efficient Lighting in State Buildings	Section 11 of this law mandated the relamping of bulbs, lighting fixtures, and other retrofits in all State-owned or -leased buildings to achieve a [first-year] savings of $4 million. This money is to be deposited in the State's general fund for the purposes of deficit reduction. These actions are projected to save up to $130 million over the life of the installed equipment.
Restructuring	
*PA 98-2: An Act Concerning Electric Restructuring	Section 25 provided for a renewable portfolio standard (RPS) requiring that power marketers operating in Connecticut provide an increasing proportion of power from Class I and Class II renewable energy resources. Implementation begins with 0.5% Class I and 5.5% Class II resources in the first year, up to a maximum of 6% Class I and 7% Class II by 2009. Section 33 created the Energy Conservation and Load

Table A.1.1
Record of Past Legislation

Legislation	Highlights
	Management Fund, to be administered by the utilities with oversight from an 11-member board comprising business, public sector, and nonprofit interests. A surcharge of 3 mills per kWh is assessed to fund the programs, equating to approximately $85 million. Programs may use buydowns, loans, RD&D grants, and equity positions and encompass commercial, industrial, residential, and governmental sectors. Programs must pass cost-effectiveness tests and are subject to final approval from DPUC. Section 44 established what is now called the Connecticut Clean Energy Fund, administered by Connecticut Innovations, Inc. It was funded initially by an 0.5 mill surcharge per kWh, which rose incrementally to 1 mill over four years. The fund uses grants, direct or equity investments, contracts, and other actions to support R&D, manufacturing, commercialization, deployment, and installation of renewable energy sources. Technologies may include solar energy, wind, ocean thermal, wave and tidal energy, fuel cells, low-emission advanced biomass conversion, and other emerging technologies not involving fossil fuels combustion, nuclear energy, or municipal solid waste. Section 52(e) of this legislation empowered DPUC to decide whether demand-side management or new conventional-distribution capacity would be more cost-effective to meet the demand for electricity for which the increased distribution capacity is proposed.
*PA 03-135: An Act Concerning Revisions to the Electric Restructuring Legislation	This legislation expanded the definition of Class I renewables to include ocean thermal power, wave or tidal power, low-emission advanced renewable energy conversion technologies, and distributed generation (DG). DG generates electricity on a customer's premises using technologies such as fuel cells, photovoltaic systems, and small wind turbines. The legislation reaffirmed the RPS but • reduced the total amount of renewable power that suppliers must obtain, • modified what counts as renewable resources and where it can be produced, and • extended the modified RPS to apply to the services utilities provide to customers who do not choose suppliers. The act extended to utilities other environmental provisions that currently apply to suppliers.
Other	
PA 79-225: An Act Concerning the Use of Sewage as an Alternative Energy Source	This legislation stated that if a municipality's water pollution control authority plans to acquire, construct, or operate a new or additional similar system, it must consider the feasibility of using the collected sewage as an energy source for the generation of electricity or other uses.

Table A.1.1
Record of Past Legislation

Legislation	Highlights
PA 79-606: An Act Requiring Registration of Home Improvement Contractors	This legislation required that each person, *including anyone connected with the installation or improvement of a solar energy system,* whose total cash receipts for a consecutive 12-month period as a home improvement contractor is $1,000 or more register with the Department of Consumer Protection.
PA 80-70: An Act Concerning a Study of a Proposal to Establish a Connecticut Energy Authority	This legislation would have authorized a study to determine the need for a Connecticut Energy Authority for the purpose of developing and implementing new energy technologies and developing and encouraging energy conservation technologies and indigenous renewable energy resources. The study committee was to report to the General Assembly no later than January 7, 1981. If successful, it would have established an entity similar to the New York State Energy Research and Development Authority.
PA 80-108: An Act Concerning Certificates of Occupancy	This legislation eliminated the requirement that a structure must be connected to the electric utility to obtain a certificate of occupancy, as long as the structure otherwise conforms with the requirements of the building and health codes.
PA 81-326: An Act Concerning Solar Energy Devices Installed Within Historic Districts	This legislation stated that an application for a certificate of appropriateness for an exterior architectural feature, such as a solar energy system, may not be denied unless the commission finds that the feature cannot be installed without substantially impairing the historic character and appearance of the district.
*PA 88-57: AAC Conservation and Utility Company Conversion From Oil Heating Systems to Gas or Electric Heating System Conservation Rate Incentive)	This legislation allowed DPUC to provide a 1 to 5% conservation rate incentive on investments by electric or gas utilities operating multiyear energy conservation and load management programs. It provided encouragement to utilities engaged in energy conservation activities.
*PA 91-248: An Act to Encourage the Development and Implementation of Economic Development Programs and Conservation and Load Management Technologies	This legislation mandated a study to investigate the appropriateness of decoupling utility profits from sales. This would have the effect of basing a company's rate of return not largely on kWh sold but on other performance metrics—thereby leveling the playing field for energy conservation and renewable energy sources because under this regulatory system, they may be considered in setting of such returns.

New England Governors/Eastern Canadian Premiers Resolutions

RESOLUTION 27-7
RESOLUTION CONCERNING CLIMATE CHANGE
August 2002

WHEREAS, state and provincial governments are committed to lead by example in implementing climate change and greenhouse gas reduction programs, and have compiled a survey of public sector climate change activities; and

WHEREAS, the Conference's Climate Change Steering Committee is considering climate change proposals in a number of areas, including LED traffic lights, partnerships with colleges and universities on emission reduction programs, purchasing programs for high efficiency-low emission office equipment, and the use of clean, energy efficient vehicles in state/provincial fleets.

NOW, THEREFORE, BE IT RESOLVED THAT the Conference of New England Governors and Eastern Canadian Premiers accept the Climate Change Report outlining the major accomplishments since the adoption of its Climate Change Action Plan and priorities for the coming year as submitted by its Committee on the Environment and its Northeast International Committee on Energy; and

BE IT FURTHER RESOLVED THAT the Committee on the Environment and the Northeast International Committee on Energy be directed to evaluate and recommend options for reducing greenhouse emissions from the electricity sector and increase the amount of energy saved through conservation programs in a cost-effective manner; and

BE IT FURTHER RESOLVED THAT the Conference of New England Governors and Eastern Canadian Premiers continue developing mechanisms to promote cleaner and more efficient vehicles, identify opportunities related to bio-fuels, and explore models of land use and development that could lead to the design of potential incentives and performance-based practices to encourage a reduction in vehicle miles and kilometres traveled; and

BE IT FURTHER RESOLVED THAT the regional inventory and registry initiative focus on building jurisdictional and national capacity and standardized methods to produce a regional inventory, and develop administrative, tracking, and reporting framework for a regional registry; and

BE IT FURTHER RESOLVED THAT the Conference of New England Governors and Eastern Canadian Premiers direct its Committee on the Environment and its Northeast International Committee on Energy, in collaboration with the Commonwealth of Massachusetts, to hold a symposium in the spring of 2003 to explore the current state of understanding of climate change impacts on the natural resource base of New England and Eastern Canada, and present a summary of findings and recommended actions at its 2003 Conference; and

BE IT FURTHER RESOLVED THAT the Conference of New England Governors and Eastern Canadian Premiers identify areas for expanded jurisdictional efforts for the implementation of government climate change programs; and

BE IT FURTHER RESOLVED THAT the Conference of New England Governors and Eastern Canadian Premiers direct its Committee on the Environment and NICE to encourage and promote climate change proposals centred on LED traffic lights, partnerships with colleges and universities within the region on emission reductions programs, purchasing high efficiency-low emission office equipment, and using clean, energy efficient vehicles in state/provincial fleets.

Adopted at the 27th Annual Conference of New England Governors and Eastern Canadian Premiers, August 25–27, 2002.

Bernard Landry
Premier of Québec
Co-Chair

Lincoln Almond
Governor of Rhode Island
Co-Chair

RESOLUTION 28-7
RESOLUTION CONCERNING ENVIRONMENTAL PROJECTS AND ISSUES
September 2003

WHEREAS, air quality in the Northeastern United States and Eastern Canadian Provinces is significantly influenced by transboundary air pollution as a result of major emission sources lying upwind and pollutants transported into the region by prevailing wind patterns; and

WHEREAS, the link between air pollution and public health continues to be of significant concern to the northeast region, and the Conference has successfully developed and supported regional cooperative actions through the NEG/ECP Acid Rain Action Plan to address transboundary air quality issues; and

WHEREAS, energy efficiency, conservation and renewable energy are important components of the strategy to enhance energy security, public health, economic development, environmental protection; and enhanced continental energy independence; and

WHEREAS, diesel engines are a source of several pollutants of concern that adversely impact the environment and public health; and

WHEREAS, the region has achieved a 55% reduction in mercury emissions, exceeding the 2003 goal of the NEG/ECP Mercury Action Plan, and continues to progress toward its 75% reduction target for 2010; and

WHEREAS, the continued implementation of the NEG/ECP Climate Change Action Plan is focusing on developing energy efficient and economically beneficial strategies to reduce greenhouse gas emissions from sources in the northeast and help our region's economy and environment adapt to the impacts of climate change.

NOW, THEREFORE, BE IT RESOLVED THAT the Conference of New England Governors and Eastern Canadian Premiers directs its Committee on the Environment to continue to seek funding from federal agencies in our two countries, to support efforts in the northeast region compatible with the goals and programs of the U.S.–Canada Air Quality Agreement; and

BE IT FURTHER RESOLVED THAT the Conference of New England Governors and Eastern Canadian Premiers commends the successful efforts of its Acid Rain Steering Committee, Mercury Task Force and Climate Change Steering Committee, and accepts their reports and next year's work plans as submitted to the Conference; and

BE IT FURTHER RESOLVED THAT the Conference directs its Committee on the Environment to work with the Northeast International Committee on Energy to review the status of energy efficiency, conservation programs, and the use of renewable energy in the region and report back to the next meeting of the Conference with recommendations to promote energy security, economic development and energy conservation through such programs; and

BE IT FURTHER RESOLVED THAT the Conference of New England Governors and Eastern Canadian Premiers directs its Committee on the Environment and the Northeast International Committee on Energy to:

- Evaluate "smart growth" approaches to land-use and development and seek recommendations for implementation;
- Continue to develop the administration, tracking and reporting framework for a voluntary regional greenhouse gas registry; and
- Work to develop voluntary partnerships with cities, towns, and businesses to increase the efficacy of

RESOLUTION 28-7
RESOLUTION CONCERNING ENVIRONMENTAL PROJECTS AND ISSUES
September 2003

our climate change work.

BE IT FURTHER RESOLVED THAT the Conference of New England Governors and Eastern Canadian Premiers supports reducing emissions in heavy duty diesel vehicles to protect the public health, particularly of our children and citizens with respiratory ailments. The Conference directs its Committee on the Environment

- pursue appropriate options to reduce diesel emissions;
- encourage the early introduction of cleaner diesel fuels in the region;
- promote anti-idling initiatives; and
- enhance education for the public on the benefits of diesel clean-up programs.

Adopted at the 28th Annual Conference of New England Governors and Eastern Canadian Premiers, September 7–9, 2003.

John G. Rowland
Governor of Connecticut
Co-chair

Bernard Lord
Premier of New Brunswick
Co-chair

CHAPTER 2

DIALOGUE AND POLICY RECOMMENDATION PROCESS

Purpose and Goal: Progress Toward or Beyond NEG/ECP Targets

In response to the NEG/ECP Climate Agreement of 2001, the Governor's Steering Committee (GSC) created the Connecticut Climate Change Stakeholder Dialogue (CCSD) to provide stakeholder input to the State's anticipated development of a greenhouse gas (GHG) action plan.

The NEG/ECP agreement calls for individual state and provincial commitments to meet regional targets in addition to taking action on specific regional policy issues. The agreement sets regional GHG targets at 1990 levels by 2010 and 10 percent below 1990 levels by 2020, to be shared by jurisdictions in the transboundary region. It also establishes a long-term target of 75 to 85 percent reductions, consistent with scientific assessments of mitigation needs. NEG/ECP targets were established by top-down assessments of scientific need, not through bottom-up feasibility assessments of actions or policies. The targets will be updated periodically on the basis of scientific developments. The agreement covers six GHGs, including CO_2, N_2O, CH_4, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). It does not cover black carbon; however, Connecticut stakeholders recommended baselines and actions that could include this pollutant in State recommendations.

The GSC asked Connecticut stakeholders to recommend a list of individual climate change mitigation actions that the State could take to make progress toward or beyond NEG/ECP targets. Individual recommendations would be provided on a nonbinding basis to the GSC for consideration; subsequently, the GSC would make recommendations to the Governor. To the extent possible (based on data availability and time), and with the assistance of technical working groups and the Center for Clean Air Policy (CCAP), stakeholders were asked to assess the benefits of actions (GHG reduction potential); their cost-effectiveness (cost per metric ton of GHG removed); and other ancillary costs, benefits, and feasibility issues as appropriate per measure. Assessments were to be conducted on a case-by-case basis using data, methods, and assumptions agreed to by the working groups and stakeholders. Actions with quantifiable reductions would be counted in aggregate toward the NEG/ECP target, and nonquantifiable measures could be included without scoring toward the NEG/ECP target.

The GSC asked CCAP to provide impartial and expert facilitation of the CCSD process and to submit a final report that included recommendations, results of assessments, and stakeholder and public views. The GSC asked CCAP to seek, but not mandate, consensus among stakeholders. CCAP ensured that the dialogue process was implemented according to plan.

Ground Rules

CCAP proposed a set of ground rules for the GSC's and stakeholders' review and input; the final decision was made by the GSC. CCAP based the ground rules on the goals and objectives set initially by the GSC for a process that would have the following characteristics:

- **Informal:** The GSC preferred an informal advisory process that would enhance the flexibility, timeliness, and effectiveness of the dialogue, and produce a broad and aggressive set of recommendations. The dialogue was conducted as an informal advisory discussion.
- **Nonbinding:** The GSC requested a list of policy choices for further consideration, but it did not commit to adopting those measures. Instead, it reserved the right to make its own recommendations to the Governor on the basis of stakeholder and public input and any other information it desired.
- **Inclusive:** Meaningful stakeholder and public input and participation was desired to the extent possible. Although CCAP's initial proposal did not include public participation, the process was restructured to provide public review and input at a number of stages to maximize inclusion of interested parties in all decisions (see discussion of public input mechanisms). As a practical matter, the size of the stakeholder group was limited to facilitate discussion, but technical working group membership was opened to the public and public input meetings were held the night of or the day after stakeholder meetings (see discussion on the roles of stakeholders, technical working groups, and the public).
- **Transparent:** The results of stakeholder decisions, as well as participant views, were to be made public and easily available. The final report, however, would not provide attribution of the views of individual organizations to encourage candor during discussions. All assessments and opinions of stakeholders, technical working groups, and the public were posted on the CCAP website during the dialogue process. The State and CCAP announced stakeholder and working group meetings in advance through CCAP's website, which provided call-in numbers for working group conference calls. The website also featured meeting agendas, presentations, and summaries for public review in advance of and following meetings (See discussion of public input mechanisms).
- **Participatory:** The GSC preferred policy recommendations that were the product of a high level of direct involvement by stakeholders and working groups, instead of a process more dependent on and driven by outside consultants. As a result, CCAP structured a process that was directly based on stakeholder proposals and data. CCAP did not make policy proposals or independent decisions on data sources, methods, or assumptions. The GSC and stakeholders asked CCAP to provide data from other state and regional planning processes to help the stakeholders and working groups formulate actions and assessments. This information included a list of actions considered in other state planning efforts as well as publicly available data on specific measures from those efforts (See later discussion on the decision process).
- **Flexible:** The GSC wanted the ability to adjust the parameters of the process in response to stakeholder feedback and new information. As a result, CCAP provided process review and check-ins with participants at the outset of stakeholder meetings and some technical working group meetings, and it adjusted the process as needed. Stakeholders were provided

opportunities to review and discuss the decision process, the calendar, and ground rules, for example.

- **Timely:** The GSC requested delivery of a final report in advance of the 2004 legislative session to allow sufficient time to review the report, formulate recommendations to the Governor, and understand its legislative and administrative implications. The final report was delayed from an initial due date of October 31, 2003, to December 31, 2003, to accommodate advanced modeling for the electricity sector, but no further extensions were provided. Many participants in the dialogue noted the ambitious timing of the process and the level of intensity it implied to meet the final deadline.
- **Collegial:** The GSC requested a good-faith process that allowed organizations to set aside existing positions and personal views to collaborate effectively as a group. In response, CCAP structured discussions to be objective (technical and data driven), inclusive, and with shared goals; this was done to provide stakeholders with a safe and substantive environment for addressing sensitive issues. In its role as a stakeholder, the State abided by these same principles (see discussion of roles).
- **Data driven:** The GSC wanted an objective dialogue and specific, implementable recommendations rather than a rhetorical discussion. CCAP proposed, and the GSC agreed, to a dialogue process that was technical in nature and based on expert, objective, and transparent data related to clear assessment criteria (see Appendix 1).
- **Consensus driven:** At the request of the GSC, CCAP developed a process that sought but did not mandate consensus. This approach allowed for the creation of a broad and aggressive set of actions and the inclusion of a broad distribution of stakeholder views in the final report. The GSC requested a process that was nonbinding and advisory to provide the stakeholders and the State with the flexibility to explore options and alternative policy designs that were not supported by an existing consensus.
- **Openly voted:** CCAP proposed a set of voting procedures to stakeholders at the first meeting and adjusted them to address the group's interests. The options included four categories of votes (unanimous consent, supermajority, majority, and minority) and an interactive process that explored alternative policy designs as a part of seeking final consensus (See later discussion of voting).

Roles and Responsibilities of the Parties

The CCSD involved participation of a number of parties, including the State (the GSC), the facilitator (CCAP), stakeholders, five technical working groups, and the public. Roles and responsibilities are described below.

State (Roles: Convening, Advisory)

The State of Connecticut acted in two separate roles during the process: first as the convening authority of the process (and recipient of its results), and second as a stakeholder. The GSC was responsible for the following activities as a convening authority:

- Establish a budget and timeline, including funding of the process and technical support as needed (including advanced modeling).
- Select a facilitator (CCAP).

- Create an oversight group (the GSC) and project coordinator (Connecticut Clean Energy Fund).
- Establish purpose, goals, and project calendar.
- Establish roles and responsibilities of parties with advice from the facilitator.
- Select stakeholders.
- Provide meeting facilities and staff technical support.
- Receive and distribute a final report.
- Establish a process for next steps.
- Provide recommendations to the Governor.

The GSC included the following State officials:

- Arthur H. Diedrick (Chair): Chairman of the Connecticut Clean Energy Fund
- Donald W. Downes: Chairman of the Department of Public Utility Control
- Arthur J. Rocque, Jr.: Commissioner of the Department of Environmental Protection
- Barbara Waters: Commissioner of the Department of Administrative Services
- James F. Byrnes: Commissioner of the Department of Transportation
- John A. Mengacci: Undersecretary of the Office of Policy and Management.

The GSC and State agency staff also acted as stakeholders during the process. Their responsibilities were identical to those of other stakeholders (listed below), including the right to propose and critique policy and to abstain from voting when potential conflicts of interest might exist. In this capacity, the State acted as part of the stakeholder advisory group that provided recommendations to the GSC. The Connecticut agency staff who served as stakeholder representatives or provided technical support to the State were known as the Connecticut Climate Change Coordinating (C4) group. This group included the following participants:

- Bryan Garcia (Co-coordinator): Connecticut Clean Energy Fund
- Chris James (Co-coordinator): Department of Environmental Protection
- Emily Smith: Connecticut Innovations, Inc.
- Connie Mendolia: Department of Environmental Protection
- Chris Nelson: Department of Environmental Protection
- Lynn Stoddard: Department of Environmental Protection
- John Ruckes: Office of Policy and Management
- Barbara Moser: Department of Administrative Services
- Rob Luysterborghs: Department of Public Utility Control
- Michael Chowaniec: Department of Public Utility Control
- David Goldberg: Department of Public Utility Control
- Michael Sanders: Department of Transportation
- Lisa Rivers: Department of Transportation

- David Lepri: Department of Revenue Services.

CCAP (Roles: Facilitation, Advisory)

The GCS asked CCAP to provide the following assistance to the dialogue process:

- Advise the GSC on the dialogue process and technical issues
- Facilitate stakeholder, working group, and public meetings
- Establish meeting agendas and calendars
- CCAP was not under contract to provide technical analysis or policy design, but the GSC did ask CCAP to assist stakeholders and working groups with the following tasks:
  - Providing initial baselines for review by stakeholders and further refinement by working groups and stakeholders
  - Providing a list of potential options from other state processes along with associated policy designs and existing technical data from those measures
  - Drafting policy proposals identified by stakeholders and working groups on their behalf along with results of assessments for stakeholder, working group, and public review
  - Providing alternative policy design options based on actions considered by other states, when requested by stakeholders and technical working groups
  - Providing a list and comparative description of analytical tools for working groups and stakeholders, including advanced models and consultants for electricity sector modeling.
  - Providing a final report to the GSC on October 31, 2003, later extended to December 31, 2003. The GSC requested that final recommendations in the report be available for public review and comment prior to submission.
  - The facilitation and technical support team included the following CCAP staff:
    - Tom Peterson: Project Director, Stakeholder Group Facilitator and Electricity Working Group Facilitator
    - Karen Lawson: Residential, Commercial, and Industrial Working Group Facilitator
    - Jake Schmidt: Agriculture, Forestry, and Waste Working Group Facilitator
    - Steve Winkelman: Transportation Working Group Facilitator
    - Greg Dierkers: Transportation Working Group support
    - Jia Li, Matt Ogonowski: Electricity Working Group support
    - Mac Wubben: Project coordination and technical support
    - Tony Tubiolo: Web management and technical support

Stakeholders (Role: Decisional)

Stakeholders had the sole and final decisional authority in making policy recommendations to the GSC with CCAP facilitation (by Tom Peterson). This included the following responsibilities:

- Attendance at all stakeholder and working group meetings, either directly or through an alternate. In practice, a majority of stakeholders were present at each meeting. The State chose not to deactivate stakeholders on the basis of poor attendance, but a small number did withdraw from the process voluntarily. A majority of stakeholders were present for all votes.

- Provide input on process-related issues to CCAP
- Provide guidance to, and receive recommendations from, technical working groups in making policy recommendations
- Participate as members of at least one technical working group
- Receive guidance from the public in making policy recommendations
- Review and finalize baselines for sectors, including approval of data methods, sources, and assumptions suggested by working groups
- Propose policy actions for further analysis by working groups and further consideration by stakeholders.
- Help working groups and CCAP draft policy actions and designs, including alternative designs where further consensus building was needed
- Establish priorities for technical analysis by working groups
- Provide technical data to technical working groups and CCAP for analysis of potential recommendations
- Review and approve working groups' analysis of potential recommendations, including data methods, sources, and assumptions, and including the selection of an advanced model for electricity sector modeling
- Approve final recommendations with CCAP facilitation
- Stakeholder recommendations and views are included in the discussion of individual recommendations later in this report
- Stakeholders included the following organizations:

City of New Haven
Connecticut Global Fuel Cell Center at the University of Connecticut
Connecticut Business and Industry Association
Connecticut Clean Energy Fund
Connecticut Fund for the Environment
Connecticut League of Conservation Voters
Connecticut Resource Recovery Authority
Department of Administrative Services
Department of Environmental Protection
Department of Public Utility Control
Department of Transportation
Environment Northeast
Fleet Bank
Institute for Sustainable Energy at Eastern Connecticut State University
International Brotherhood of Electrical Workers
Mohegan Tribal Nation
Motor Transport Association of Connecticut
The Nature Conservancy.
Northeast Utilities
Office of Policy and Management
Pitney Bowes
Public Service Enterprise Group
School of Forestry and Environmental Studies at Yale
SmartPower
United Technologies

Working Groups (Roles: Advisory and Technical Support)

Working groups were formed at the first stakeholder meeting and facilitated by CCAP. They were charged with the following advisory and support responsibilities:

- Attendance at all working group meetings, either directly or through an alternate. In practice, a majority were present at all meetings.
- Advising stakeholders on baseline methods, data sources, and assumptions needed to finalize baselines (CCAP provided initial baselines to stakeholders that were referred with stakeholder guidance to working groups for further action)
- Advising stakeholders on potential mitigation options and implications (i.e., benefits, costs, ancillary, and feasibility issues)
- Providing suggested policy designs and analytical recommendations for assessments of each action
- Suggesting alternative policy designs and approaches needed to meet NEG/ECP targets or achieve broad consensus, as needed by stakeholders, with associated data methods, sources, and assumptions
- Assisting with drafting of policy proposals, interim and final analysis of individual measures, and final baselines.

Working groups were organized by sectors as follows: electricity supply, residential/ commercial/industrial (RCI), transportation and land use, agriculture/forestry/waste (AFW), and education. A list of working group participants is included in Appendix 2. Working group comments are summarized in the discussions of individual policy recommendations (Chapter 3).

Public (Role: Advisory)

Meaningful opportunities for public review and input were provided through the following methods:

- Participating in technical working group discussions
- Participating in public review and input meetings and providing suggestions to CCAP via e-mail or letter
- Advising stakeholders on potential options and implications
- Providing relevant data for working groups to use when considering potential policy options
- Reviewing the progress of stakeholders and suggesting alternative policy designs and approaches needed to meet NEG/ECP targets or achieve a broad consensus

A list of public meetings is included in the project calendar (see below and Appendix 4). Public comments are summarized in the report under the discussion of individual recommendations, and a compendium of all public comments was submitted to the State with the final report.

Organizations that participated in technical working groups or public meetings included the following entities:

Alliance of Automobile Manufacturers
American Automobile Association
APX
Archdiocese of Hartford
Argonne National Laboratory
Capital Region Council of Governments
Center for Ecological Technology
Central Connecticut Regional Planning Agency
Clean Energy Group
Clean Water Action
Community Energy
Connecticut Climate Coalition

Connecticut Earth Science Teacher's Association
Connecticut Food Policy Council
Department of Revenue Services
Dominion Power
Don't Waste Connecticut
EMCON/OWT, Inc.
Enabling Technologies, LLC
Environmental Architecture, LLC
Environmental Defense
FANNIE MAE
Farmington River Watershed Association
Fuel Cell Energy
GE Global Research Center
Hydrogen Source
Independent Connecticut Petroleum Association (ICPA)
Interreligious Ecojustice Network
ISO New England
Merit Engineering
Middlesex Clean Air Association
MJ Bradley and Associates
National Renewable Energy Laboratory
Natural Resources Defense Council
New Haven Environmental Justice Network
Northeast Organic Farming Association
NRG Energy
Nuclear Energy Institute
Nuclear Information and Resource Service
NXEGEN
Office of the Connecticut State Treasurer
Phelps Dodge Corporation
Praxair
Proton Energy Systems
Pure Power
Quinnipiac River Association
Reforest the Tropics
Rep. Mary Mushinsky (85th District)
Robinson & Cole
Sierra Club Connecticut Chapter
Sterling Planet
The Retec Group
Toxics Action Center
UK Carbon Trust
University of New Hampshire
Waste Management
Wesleyan University
Ztek Corporation

Calendar

Major Project Milestones

- Request for proposals (RFP) for facilitation services for Connecticut's CCSD
  - November 13, 2002: RFP issued
  - December 11, 2002: RFP deadline for submission
  - December 17, 2002: Interviews with RFP finalists
  - December 23, 2002: Determination of contract award to CCAP.
- February 5, 2003: Connecticut Innovations, Inc., on behalf of the Connecticut Clean Energy Fund, executes a contract with the CCAP to facilitate Connecticut's CCSD
- October 10, 2003: Facilitation contract extension granted pursuant to the request of the GSC
- October 31, 2003: Initial deadline for stakeholder recommendations to the GSC
- December 31, 2003: Final deadline for stakeholder recommendations to the GSC.

GCS Meetings

1. November 6, 2002
2. February 5, 2003: meeting between CCAP and the GSC

3. June 24, 2003
4. September 15, 2003
5. November 17, 2003
6. January 6, 2004: final presentation by CCAP to the GCS.

Stakeholder Meetings

1. April 23, 2003 (process kick-off, review of initial inventory and baselines, long list of policy options)
2. June 9–10, 2003 (review of revised inventory, baselines and options list; establishment of priorities for analysis)
3. August 18, 2003 (review of final inventory, updated baselines, first draft assessments of options and scenarios)
4. October 1 (special stakeholder meeting to approve electricity baseline assumptions for the Integrated Planning Model [IPM])
5. October 15–16, 2003 (identification of consensus actions, review of cross-cutting issues)
6. December 4–5, 2003 (resolution of pending actions, cross-cutting issues).

Working Group Meetings

Electricity Working Group

1. May 21, 2003
2. June 5, 2003
3. June 18, 2003
4. July 9, 2003
5. July 23, 2003
6. July 30, 2003
7. August 13, 2003
8. September 10, 2003
9. September 18, 2003
10. September 24, 2003
11. October 8, 2003
12. November 17, 2003
13. November 19, 2003
14. November 26, 2003
15. December 3, 2003

Agriculture, Forestry, and Waste Working Group

1. May 28, 2003
2. June 5, 2003
3. July 2, 2003
4. July 15, 2003
5. July 31, 2003
6. August 12, 2003
7. September 2, 2003
8. September 12, 2003
9. October 7, 2003
10. November 4, 2003
11. November 18, 2003

Transportation Working Group

1. May 13, 2003
2. May 21, 2003
3. June 4, 2003
4. June 25, 2003
5. July 9, 2003
6. July 18, 2003

7. July 30, 2003
8. August 6, 2003
9. August 27, 2003
10. October 1, 2003
11. October 9, 2003
12. October 22, 2003
13. October 30, 2003
14. November 6, 2003
15. November 19, 2003

Residential, Commercial, and Industrial Working Group

1. May 22, 2003
2. June 3, 2003
3. June 26, 2003
4. July 3, 2003
5. July 10, 2003
6. July 17, 2003
7. July 24, 2003
8. August 7, 2003
9. August 28, 2003
10. September 11, 2003
11. September 17, 2003
12. September 25, 2003
13. October 2, 2003
14. October 23, 2003
15. November 6, 2003
16. November 20, 2003

Education Working Group

1. September 4, 2003
2. September 16, 2003
3. September 23, 2003
4. October 7, 2003
5. October 21, 2003
6. November 4, 2003
7. November 12, 2003
8. November 18, 2003
9. November 25, 2003

Public Meetings

1. June 10, 2003
2. August 18, 2003
3. October 15, 2003
4. December 4, 2003

Decision Process for Recommendations

Stakeholders and working groups engaged in an open, intensive, and stepwise process to develop final baselines and policy recommendations. CCAP designed the process in consultation with stakeholders, working groups, and the GSC. It included the steps described below.

1. Approval of Process by State, With Input From Stakeholders

At the first stakeholder meeting, CCAP provided a proposed project calendar, ground rules, decision criteria, assessment process (for baselines and actions), and voting methods for stakeholder review. On the basis of this input and with GSC approval, CCAP made adjustments to the process before the next stakeholder meeting. At the second stakeholder meeting, these decisions were reviewed and discussed. CCAP and the GSC finalized the process after the second stakeholder meeting, although continuous adjustments were made during the process.

2. Creation of Working Groups

At the first stakeholder meeting, technical working groups were formed, and stakeholders were invited to choose to participate in one or more groups. Working groups followed the same sectoral breakdowns used for inventory and baseline assessments, including:

- Transportation and land use (facilitated by Steve Winkelman, CCAP)
- Electricity supply (facilitated by Tom Peterson, CCAP)
- Residential, commercial, and industrial, including distributed generation and combined heat and power (facilitated by Karen Lawson, CCAP)
- Agriculture, forestry, and waste management (facilitated by Jake Schmidt, CCAP).

At the time of working group formation, CCAP noted that cross-cutting issues could emerge from sector-based discussions during the process. Education, technology, cap-and-trade, and reporting and registry issues were identified as potential issues that would need working group support later in the dialogue process. Ultimately, a working group was formed to generate education recommendations. Technology issues were addressed within working groups, particularly hydrogen issues related to transportation and distributed generation. The electricity working group addressed cap-and-trade issues. Reporting and registry issues were not addressed by a working group; instead, stakeholders partially addressed those issues at the final meeting.

Working groups initially met twice between stakeholder meetings. A number of stakeholders and working group members requested more frequent and regular meetings; in response, CCAP structured regular, weekly (or biweekly) conference calls and/or meetings to allow working groups more intensive participation. This request was based on the challenge of designing and analyzing a large number of potential actions.

3. Creation of Public Input Mechanisms

Following the first stakeholder meeting and at the request of the GSC, CCAP recommended a variety of public participation mechanisms. Results of public input were to be treated with the same standing as working group recommendations for stakeholder review and consideration. Public participation in the dialogue occurred through the following methods:

- **Public meetings:** Meetings were held the night of or day after stakeholder meetings. At each meeting, CCAP's Tom Peterson presented the same materials to the public that had been presented previously to stakeholders. He also provided updates on stakeholder decisions. The public was invited to make additional recommendations or comments at that time. The comments were relayed to stakeholders during their meetings and by written summary to stakeholders and working groups after each public meeting. Meetings lasted three hours.
- **Working group participation:** The State and CCAP announced working group meetings in advance and provided call-in numbers or meeting locations. No limits were placed on public attendance or participation. In practice, a relatively small and regular set of interested parties joined working groups. Comments by the public at those meetings were treated the same as those by working group members. Results of each meeting were summarized and posted to the CCAP website in advance of the next meeting.

- **Continuous website postings and e-mail input:** CCAP maintained a current and comprehensive website with a link for public input (to Mac Wubben, CCAP). Incoming e-mails were distributed to the working groups and their leaders for consideration if they addressed specific working group issues.
- **Review and comment on final recommendations:** Following each stakeholder meeting, the results of stakeholder decisions to narrow or redefine the potential list of policy options were summarized and posted to the website for public review and input. At public meetings, CCAP encouraged public input and recommendations on the same time schedule as stakeholders to ensure its usefulness. At the second-to-last stakeholder meeting, stakeholders identified recommendations that had unanimous support. Those 28 recommendations were summarized and posted for public comment prior to the final stakeholder meeting. At the final stakeholder meeting, stakeholders resolved the outstanding list of 27 potential policy recommendations. After the meeting on December 5, 2003, CCAP summarized results of the final votes in a series of documents that were posted on the CCAP website the following week for a full week of public comment. Those documents were as follows:
  - A list of the names of all 55 measures
  - A summary table of the 55 recommendations with
    - the name of the action;
    - its lay description;
    - its voting status (all but three were unanimous consent, and the remaining three fell one vote short and were categorized as supermajority);
    - summary results of assessments of costs, benefits, and other major issues;
    - stakeholder views; and
    - a summary of public views registered to date for each action.
  - Summary graphs of progress by each working groups, individually and combined, toward the NEG/ECP targets
  - Drafts of report subchapters for each working group, including a summary of baselines and progress graphs; a table of actions and results of benefit and cost assessments; a description of the recommended action; results of assessments of benefits, costs, ancillary and feasibility issues; stakeholder views; and a summary of public views registered to date.

Following the end of the public comment period (December 16, 2003), CCAP incorporated summaries of public comments into the report subchapters for each recommendation and included a compendium of all public comments for the State in the final report. Stakeholder comments received during this period were used to determine whether draft language by CCAP needed technical clarification, but no new stakeholder views were added to the report following the last stakeholder meeting. The final report was submitted to the GSC on December 31, 2003 and posted to state's website (http://www.ctclimatechange.com/) with a notice to stakeholders and working groups. The report was posted to the CCAP website (www.ccap.org/) on January 5, 2004 (due to closure of the CCAP office through the first week of January). The final report, meeting summaries, and associated working group and stakeholder meeting documents can be found on the CCAP website.

4. Review of GHG Inventory and Initial Baselines

Northeastern States for Coordinated Air Use Management (NESCAUM) produced the Connecticut GHG inventory under contract with Connecticut Innovations and on behalf of the Connecticut Clean Energy Fund. Results of the initial inventory were presented at the first stakeholder meeting. A refined version was presented at the second stakeholder meeting; stakeholders to move forward with planning based on those results, which included a clear estimate of 1990 GHG emissions for Connecticut. A final version of the inventory (using the same 1990 index) was provided at the third stakeholder meeting (see the discussion of the history of Connecticut GHG actions and inventory in Chapter 1). CCAP coordinated with NESCAUM and Connecticut DEP on the finalization of the inventory to maintain consistent approaches to the development of initial baselines. NESCAUM presented these at the first and second stakeholder meetings for review and comment by stakeholders.

At the first stakeholder meeting, CCAP provided initial baselines for all sectors and explained analytical methods, data sources, and key assumptions for each sector. CCAP also compared the data to 1990 GHG levels in Connecticut and provided initial estimates of the size of NEG/ECP targets as applied to the State. At this point, CCAP also noted the potential need for advanced modeling to develop electricity baselines (and mitigation analysis) and to address power import and export issues as well as interactions between policy approaches (energy efficiency, renewable energy, caps and standards).

Stakeholders provided general guidance to working groups on baseline development needs, and they referred further refinements to working groups. A refined set of baselines was presented to stakeholders at the next meeting for further review and referred back to working groups for finalization.

For the electricity sector, stakeholders requested that CCAP provide a list of advanced models to use in baseline and mitigation assessments. This task included a comparative analysis of model functions and uses (see CCAP modeling table, Appendix 3). The stakeholders asked CCAP in June to provide a list of potential model vendors for dispatch modeling in the electricity sector. CCAP identified two primary providers: Synapse Consulting and the PROSYM model, and ICF Consulting and the Integrated Planning Model (IPM). CCAP facilitated a series of working group reviews of these models and vendors and asked the stakeholder group to vote on its choice.

In early August, the electricity working group unanimously approved the use of the IPM. Connecticut DEP committed to funding this additional modeling through a $75,000 purchase order that was approved in early September. The delay in approval and funding of the model resulted in GSC's extension of the final report's deadline to December 31, 2003. As a result of the delay in modeling, the electricity sector also adopted a later schedule for policy scenario development.

A special stakeholder meeting was called on October 1, 2003, to ask for stakeholder approval of key baseline assumptions for electricity modeling, including the likelihood of nuclear relicensing, natural gas price forecasts, the likelihood of federal utility legislation, cost and performance of renewable energy policies, and the inclusion of a demand response function (see

the discussion in the electricity recommendations subchapter). Stakeholders approved assumptions for all of these issues by unanimous consent, with the exception of nuclear relicensing, which was decided by majority. Further work on electricity was referred to the electricity working group.

A draft version of the final electricity baseline was presented at the second-to-last stakeholder meeting for review and comment. Final baselines were presented at the final stakeholder meeting and incorporated by CCAP into estimates of progress toward NEG/ECP targets.

5. Development of Potential Mitigation Options ("Long List")

The GSC asked CCAP to help stakeholders identify potential policy options by providing them with a list of GHG actions considered by other state, local, and regional entities (see Appendix 5 for this list). This list was presented at the first stakeholder meeting. CCAP reviewed the list and the definitions of actions with stakeholders and asked for improvements to the framework of actions to ensure its comprehensiveness. Stakeholders were also asked to add potential actions that were missing and potentially applicable to Connecticut. This updated "long list" of potential policy actions was forwarded to the working groups for further consideration of analysis priorities. CCAP was asked to provide simple high, medium, and low rankings of the GHG action potential for the working groups.

6. Development of Initial Priorities for Analysis

At the first working group meetings, participants were asked to review the long list of policy options developed by CCAP along with the GHG rankings. Working groups were asked to suggest additional actions or categories for the list, refine individual actions for stakeholder consideration, and identify potential priorities for initial analysis of benefits and costs. At the second stakeholder meeting, stakeholders reviewed the list again and made additions based on working group input. They also identified initial priority actions for analysis by the working groups. Working groups received the results of these discussions and began the initial assessment process for individual measures.

7. Identification of Preferred Policy Designs for Potential Actions

During the initial phase of analysis of actions, working groups identified key policy design parameters for each action (e.g., levels, timing, and implementation approach). At their third meeting, the results of initial assessments (of benefits and costs) and initial policy design recommendations were provided to stakeholders for review and advice for working groups.

8. Quantification of Benefits (GHG Reduction Potential), Costs (Cost per MMTCO2e removed), Ancillary Costs and Benefits, and Feasibility Issues

Stakeholders and working groups were responsible for proposals and analysis of individual actions. CCAP assisted working groups with assessments by identifying potential tools and methods for analysis, when needed, as well as potential data sources and analytical parameters. Working groups were responsible for finalizing decisions on analytical approaches and providing policy designs and data. CCAP asked working groups to make the methods, sources, and

assumptions transparent when providing data. CCAP recorded these variables in the summaries of action assessments. Stakeholders reviewed assessment results on an ongoing basis as they participated in weekly working group conference calls. Assessments results were also reviewed at the final three stakeholder meetings, along with working group and public comments on actions. A list of assessment criteria is included in Appendix 1.

9. Comparison to NEG Baselines, Goals, and Progress; Identification of New Actions

Following the first round of mitigation options analysis, CCAP provided an estimate of total potential GHG reductions from all potential reductions and graphed this "progress line" in comparison to draft baselines and NEG/ECP targets for 2010 and 2020. Stakeholders, working groups, and the public reviewed this initial summary of potential actions. Because the results fell short of the targets, the stakeholders were asked to identify any additional actions or alternative policy designs that might close the potential gap between the progress line and the targets. This process was repeated at each remaining stakeholder, working group, and public meeting to help stakeholders meet or exceed the NEG/ECP targets. The progress lines were consistently below the targets, but they became closer with each iteration. A final progress line with baselines and targets was produced after the last stakeholder meeting and posted for public comment (see discussion on progress toward targets).

10. Identification of Cross-Cutting Issues

At the third stakeholder meeting, CCAP summarized working group findings related to potentially cross-cutting issues. The group formulated responses to each potential need in the following manner:

- Education issues were referred to a new working group, led by Lynn Stoddard of the Connecticut DEP, with a request that a draft proposal be presented at a later stakeholder meeting (see later discussion of education recommendations).
- Reporting and registry issues were referred for further discussion by stakeholders pending distribution and review of a white paper by CCAP. This paper was available for review prior to the final stakeholder meeting, but not in time for working group review and action. As a result, stakeholders recommended that a short, summary version of this paper be included in final report as a basis for further discussion on the issue (see subchapter on reporting and registry).
- Technology issues were referred to a special workshop on hydrogen and fuel cells, jointly sponsored by Yale University, The Connecticut Clean Energy Fund, and Environment Northeast on September 19, 2003. Recommendations for actions involving these technologies were included in specific recommendations of the transportation and RCI working groups.
- Cap-and-trade issues were referred to the electricity working group for further discussion (see subchapter on electricity and cap-and-trade recommendation).

11. Identification of Actions With Unanimous Consent

At the second-to-last stakeholder meeting, stakeholders reviewed all potential recommendations and assessments by working groups. CCAP reviewed the list of recommendations and related assessments for each action, then asked for clarifying questions on options and statements of opposition. Where no opposition was registered, actions were recorded as final recommendations with "unanimous consent." Where opposition existed, CCAP asked for clarification of the reasons for opposition, then requested proposals for alternative approaches or policy designs.

Following discussion of proposed alternatives, CCAP again asked for clarifying questions and any statements of opposition. Where no opposition was registered, actions were recorded as final recommendations with unanimous consent (28 in total). Where opposition was registered, CCAP asked for clarification of the reasons for opposition and recorded actions as "pending," with specific guidance to working groups for further action. The public was also asked to identify potential alternative design approaches and issues for working group action prior to the next meeting, and feedback was provided to the working groups.

12. Iteration to Consensus Through Alternative Policy Designs

Between the second-to-last and the last stakeholder meetings, working groups focused on resolving pending actions by identifying alternative policy designs and approaches, and finalizing mitigation analysis and baselines. Working groups provided final recommendations for stakeholder consideration at their final meeting.

13. Final Voting (Stakeholders)

At the final stakeholder meeting, stakeholders reviewed the actions agreed to at the last stakeholder meeting and a summary of progress toward the NEG/ECP targets based on consensus and pending actions. CCAP then reviewed the list of pending actions and repeated the voting process used at the previous meeting. Extended discussion was permitted on recommended actions that faced opposition in order to allow alternative design proposals to be made and discussed. Final votes were recorded for all remaining actions (27 in addition to the 28 agreed to at the previous meeting). During these discussions, stakeholders noted priority action areas that could further reduce GHG emissions to meet NEG/ECP goals. Those areas are noted in the discussions of actions in this report.

Of the 55 total recommendations, stakeholders supported 52 by unanimous consent; 3 fell one vote short and were recorded as passing with a supermajority. Final recommendations closed 72.7 percent of the gap toward the 2010 NEG/ECP target and 70.7 percent of the gap toward the 2020 target, not including actions that reduce black carbon emissions. When black carbon reduction actions for transportation are included, stakeholder recommendations closed 75.6 percent of the gap toward the 2010 NEG/ECP target and 80.1 percent of the gap toward the 2020 target.

Connecticut Climate Change

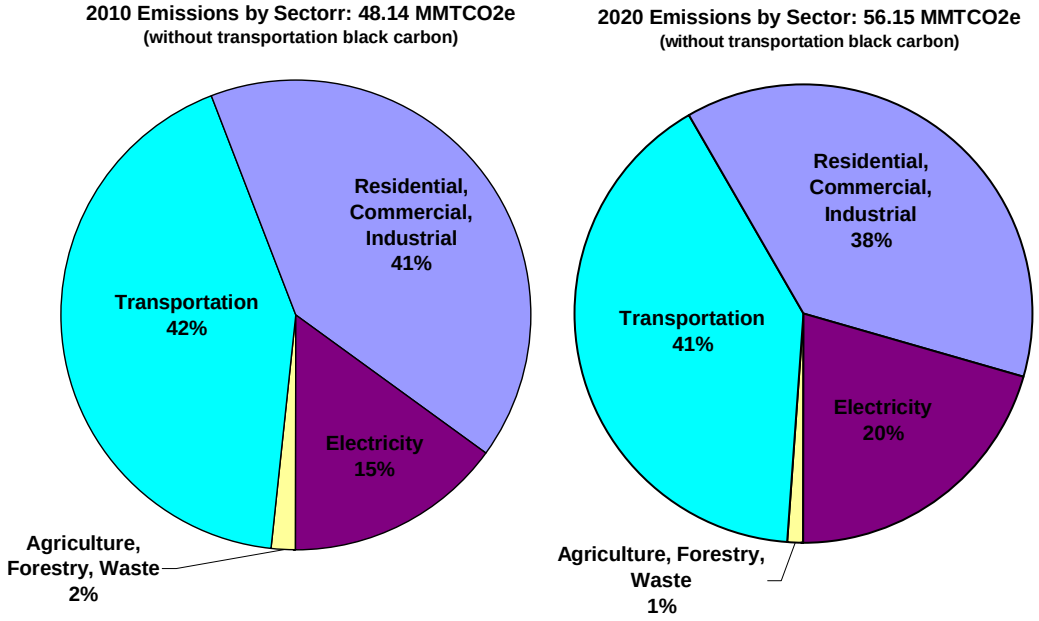
CHAPTER 3

SUMMARY: POLICY RECOMMENDATIONS

Baseline Emissions

Total GHG emissions are projected to increase from 48.14 million metric tons of CO_2 equivalent ($MMTCO_2e$) in 2010 to 56.15 $MMTCO_2e$ in 2020. The transportation sector accounts for about 40 percent of total emissions; the combined residential, commercial, and industrial sector also accounts for about 40 percent of total emissions. Emissions from electricity generation are expected to increase from 15 to 20 percent of total emissions from 2010 to 2020, whereas emissions from agriculture, forestry and waste will remain low (see Figures 3.1 and 3.2).

Figure 3.1
Baseline Emissions by Sector: 2010 and 2020



Two Versions: With and Without Transportation Black Carbon Emissions

Scientists have identified black carbon, a component of particulate matter (PM, or soot), as having a large and fast-acting warming impact on the atmosphere.[1] A new study estimates that black carbon is responsible for about 25 percent of observed global warming from 1880 to 2000.[2] The science of black carbon's global warming potential is still being evaluated. As the data become more precise, they may affect greenhouse gas (GHG) baselines. At that time, the GHG baseline will need to be adjusted using the anticipated process of the New England Governors and Eastern Canadian Premiers (NEG/ECP) (i.e., every three years).

The stakeholder group elected to present transportation GHG savings with and without black carbon emissions and reductions. Thus two versions of the summary graph and summary table are included below, with and without black carbon emissions from the transportation sector, to allow for consistent comparisons with "traditional" GHG inventories and baselines (e.g., with other NEG/ECP studies). In addition the stakeholders developed the following recommendation for NEG/ECP:

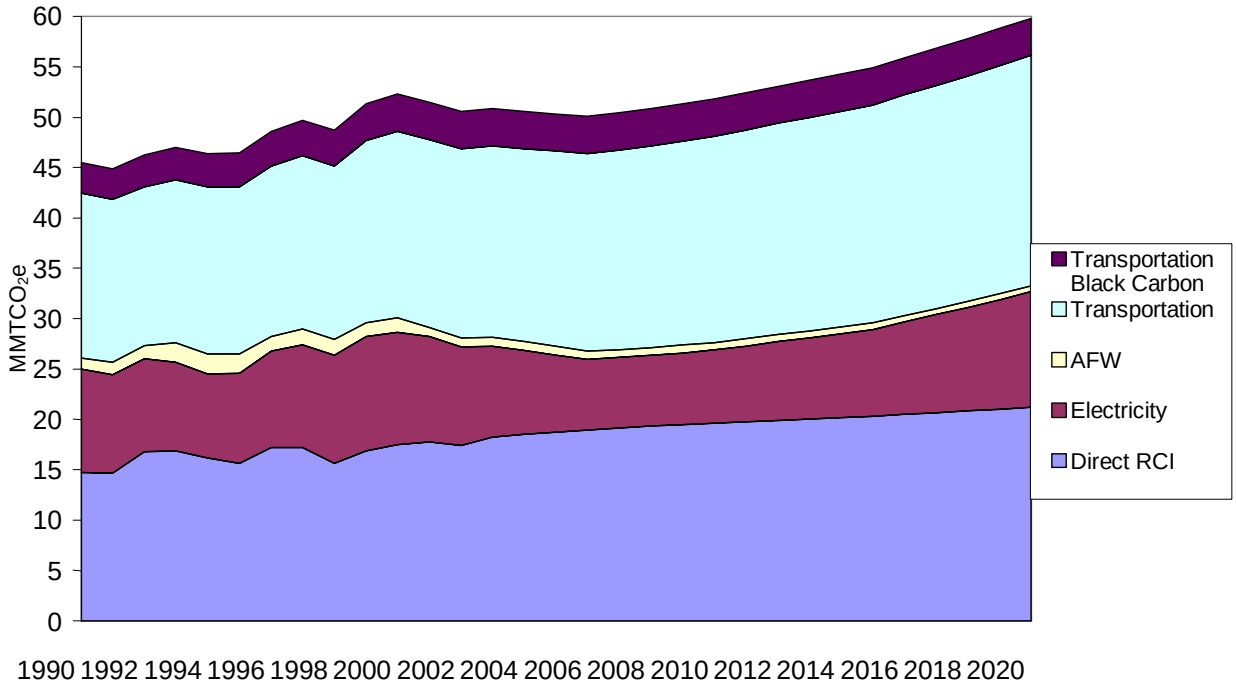
Recommended Action: Connecticut should recommend to the NEG/ECP that black carbon emissions be included in GHG inventories and baselines.

At the final stakeholder meeting, it was noted by several stakeholders that significant black carbon emissions may be generated in other sectors of the economy, such as residential, commercial, and industrial boilers. Appropriate emission factors for nontransportation black carbon sources are still a subject of study. Thus, the summary graph below only includes black carbon from transportation. The stakeholders also developed the following recommendation:

Recommended Action: The State should further develop black carbon emissions baselines and mitigation measures for sources from all sectors.

[1] Jacobson, M.Z. (2002). Control of fossil-fuel particulate black carbon and organic matter, possibly the most effective method of slowing global warming. *Journal of Geophysical Research, 107*(D19), ACH 16, 1-22.
[2] Hansen, J., & Nazarenko, L. (2004). Soot climate forcing via snow and ice albedos. *Proceedings of the National Academy of Sciences, 101*(2), 423–428.

Figure 3.2
Baseline Emissions by Sector



Summary of Connecticut Progress Toward NEG/ECP Targets

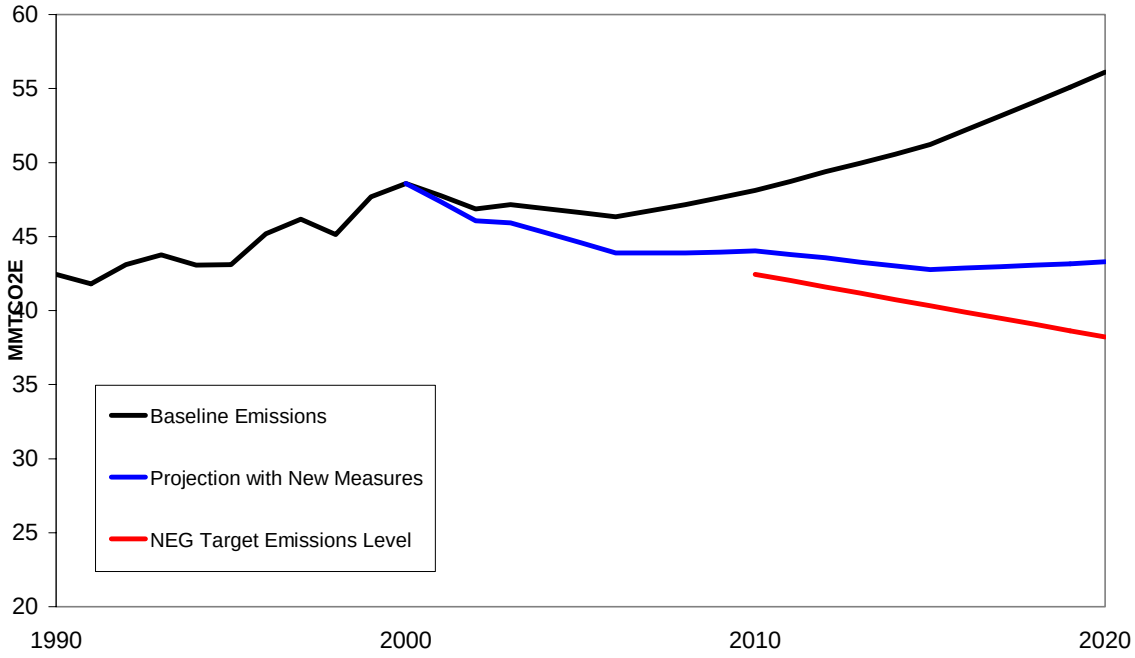
The combined GHG reduction potential of actions recommended by Connecticut stakeholders would achieve 72.7 percent of the 2010 NEG/ECP target and 70.7 percent of the 2020 target for the six GHGs listed in the agreement (Table 3.1). If transportation black carbon is added to the six GHGs in the baseline, the recommendations achieve 75.6 percent of the 2010 NEG/ECP target and 80.1 percent of the 2020 target (Table 3.2).

Progress of mitigation actions was measured against sectoral baselines aggregated to a statewide level (Figures 3.3 and 3.4). The baselines were compared with NEG/ECP targets as applied to Connecticut. (The NEG/ECP agreement does not assign State targets and instead sets a regional target, but it does call for individual State "commitments"). Assessments were not made for progress toward long-term (i.e., post-2020) reduction goals of 75 to 80 percent due to lack of data and of clarity of the target.

The following graphs and tables show emissions and reductions with and without black carbon emissions from the transportation sector.

Baseline and Reductions *Without* Transportation Black Carbon

Figure 3.3
Connecticut All-Sector GHG Reductions: Without Transportation Black Carbon



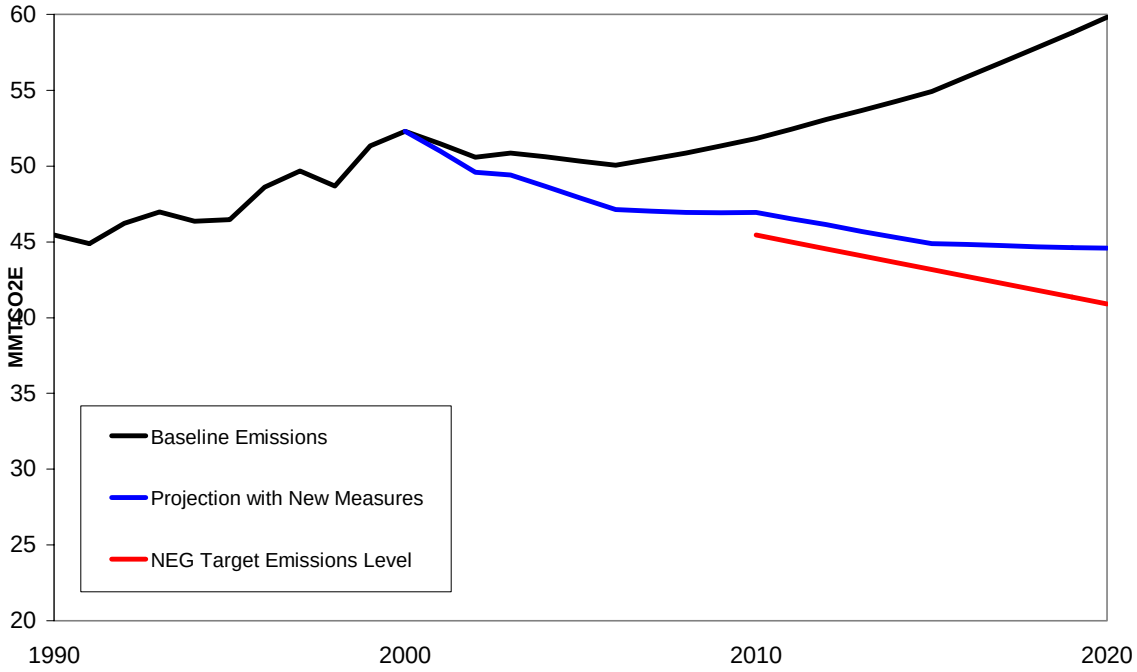
Note: NEG does not necessarily assume equal percentage reductions in each state or sector.

Table 3.1
Summary of Connecticut GHG Reductions
Without Transportation Black Carbon ($MMTCO_2e$)

	2010	2020
NEG/ECP Goal (1990 in 2010, 10% below in 2020)	42.40	38.16
Total $MMTCO_2e$ Baseline, from fuel use	48.14	56.15
Reductions needed to reach NEG/ECP goal	**5.74**	**17.99**
Projected Reductions by Sector		
Transportation	0.36	2.91
Residential, Commercial, Industrial	0.82	1.95
Agriculture, Forestry, Waste	1.21	1.27
Electricity	1.69	6.69
Total $MMTCO_2e$ Savings	**4.18**	**12.72**
% toward NEG goal	*72.7%*	*70.7%*
Additional reductions needed to reach goal	***1.57***	***5.27***

Baseline and Reductions *With* Transportation Black Carbon

Figure 3.4
Connecticut All-Sector GHG Reductions: With Transportation Black Carbon

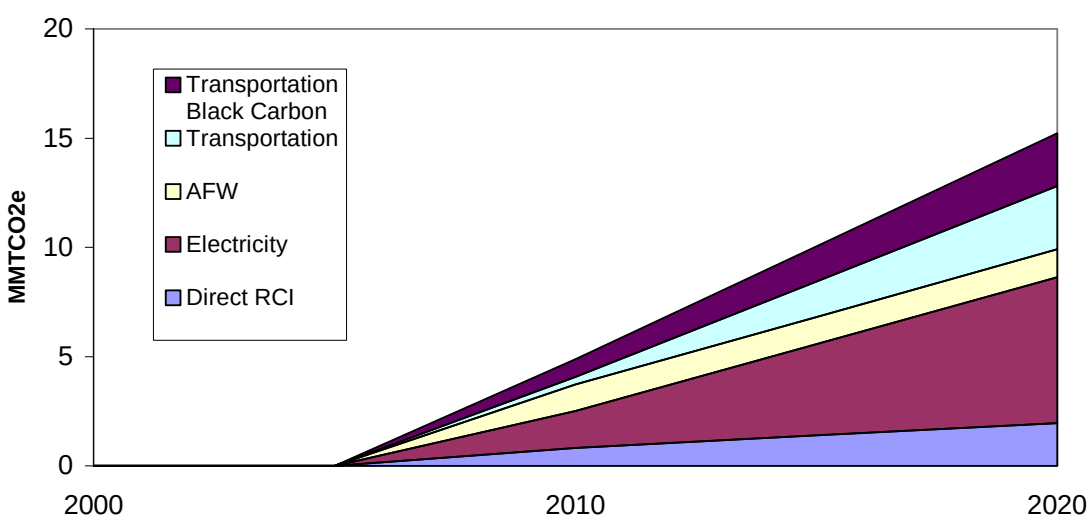


Note: NEG does not necessarily assume equal percentage reductions in each state or sector.

Table 3.2
Summary of Connecticut GHG Reductions
With Transportation Black Carbon ($MMTCO_2e$)

	2010	2020
NEG/ECP Goal (1990 in 2010, 10% below in 2020)	45.40	40.86
Total $MMTCO_2e$ Baseline, from fuel use	51.84	59.85
Reductions needed to reach NEG/ECP goal	**6.44**	**18.99**
Projected Reductions by Sector		
Transportation	1.16	5.31
Residential, Commercial, Industrial	0.82	1.94
Agriculture, Forestry, Waste	1.20	1.28
Electricity	1.69	6.69
Total $MMTCO_2e$ Savings	**4.87**	**15.22**
% toward NEG goal	*75.6%*	*80.1%*
Additional reductions needed to reach goal	***1.57***	***3.77***

Figure 3.5
Emissions Reductions by Sector



Note: For simplicity, this graph assumes a linear progression from 2005 to 2020.
The scale of this graph differs from the scale of the previous graphs for ease of interpretation.

During the stakeholder discussions on progress toward NEG/ECP targets, some stakeholders noted a lack of clarity over the long-term targets, which call for a 75 to 80 percent reduction in GHGs after 2020 but are not specific in timing. At the stakeholder meetings and in some of the written materials distributed to stakeholders, there was discussion about whether to propose a target date for the long-term goal and what that date might be.

The stakeholders shared a consensus that the State should take a leadership role in working within the NEG/ECP process to set an appropriate date for the long-term goal. They noted that establishing a target date for this goal would help policy makers, businesses, and other interested parties focus their research, identify mitigation measures, develop broad strategies, and assess competing options. They also noted that setting a target date for the long-term goal could have an important positive impact on the Connecticut economy. For example, although fuel cells and hydrogen production and infrastructure may not achieve large GHG reductions by 2020, they may be critical to achieving the long-term goal of 75 to 85 percent. The same is true for certain renewable energies and transportation system changes. Setting a tangible target date for the long-term goal accentuates both the importance of the long-term measures and the value of starting soon to develop and promote them.

3.1 TRANSPORTATION AND LAND USE

Contents

- Summary Table of Transportation Recommendations
- Graph of Transportation Baseline and Emissions Reductions
- Baseline Discussion
- Stakeholder Recommendations
- List of Supporting Documents
- Transportation and Land-Use Sources Cited During the Climate Change Stakeholder Dialogue

Stakeholder Recommendations

- California LEV II Standards
- Tailpipe GHG Emissions Reductions (feebates, fleets, tailpipe standards, education)
- Hydrogen Infrastructure Research and Demonstration Program
- Transit, Smart Growth and VMT Reduction Package (includes road pricing pilot and other incentives)
- Multistate Intermodal Freight Initiative
- Clean Diesel and Black Carbon

Summary: Transportation Sector Reductions

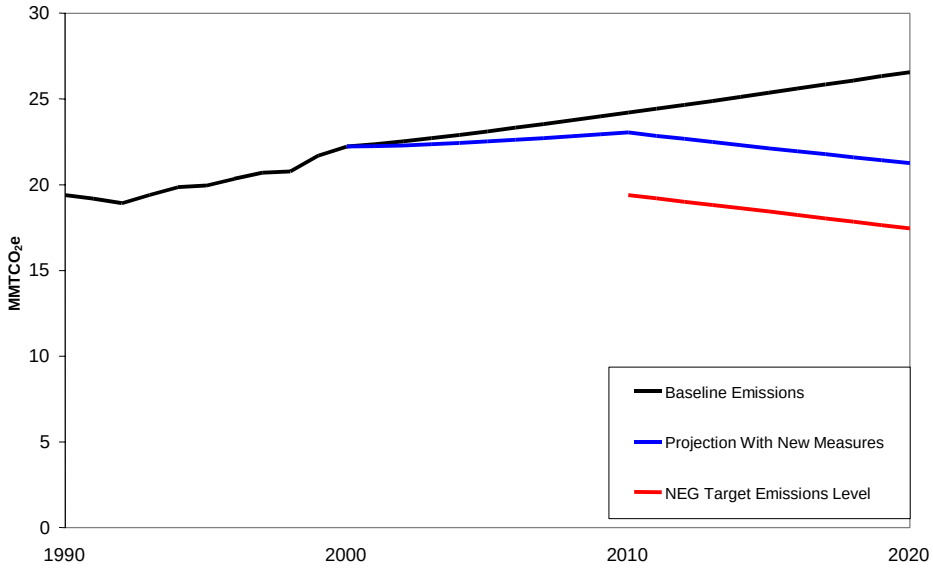
Transportation sector reductions are presented with and without black carbon emissions and reductions to allow consistent comparisons with "traditional" greenhouse gas (GHG) inventories (Tables 3.1.1 and 3.1.2; Figures 3.1.1 and 3.1.2).

Table 3.1.1
Summary of Transportation Sector $MMTCO_2e$ Reductions: With Black Carbon

	2010	2020	Cost
Total $MMTCO_2e$ baseline, from fuel use **(1990 = 19.4)**	24.20	26.56	
Passenger Vehicle GHG Emission Rates			
California LEV II standards	0.04	0.47	*
GHG feebate program	0.01	–	Revenue neutral or revenue positive
Fleet vehicle incentives and initiatives**			Not available
Tailpipe GHG standards (or alternative approach)	0.09	1.81	Not available
Public education initiative**			Not available
Hydrogen infrastructure research and demonstration program***	–	–	Not available
Transit, Smart Growth and VMT Reduction Package			
Transit, smart growth and VMT reduction package (includes road pricing pilot and other incentives)	0.22	0.49	$602/$MTCO_2$ (capital & operating outlays) ($280/$MTCO_2$ when infrastructure, health care and household savings are included)
Freight and Diesel			
Multistate intermodal freight initiative	0.00	0.14	Not available
Clean diesel and black carbon	0.80	2.40	$6–$13/$MTCO_2$
Total $MMTCO_2e$ Savings	**1.16**	**5.31**	
Total $MMTCO_2e$ (net reductions)	23.05	21.25	
% above/below 1990 (19.4 $MMTCO_2$)	*18.8%*	*9.5%*	
NEG/ECP Goal (1990 in 2010, 10% below in 2020)	**19.40**	**17.50**	
Additional reductions needed to reach NEG/ECP goal	*3.65*	*3.79*	

* The report includes some cost estimates, but no total or incremental cost numbers.
** Savings included with tailpipe GHG standards
*** Potential long-term benefits of up to 22 $MMTCO_2e$, assuming low or no GHG emissions from hydrogen production (see Hydrogen Infrastructure Research & Demonstration Program discussion for more details).

Figure 3.1.1
Connecticut GHG Reductions From the Transportation Sector
(With Black Carbon)



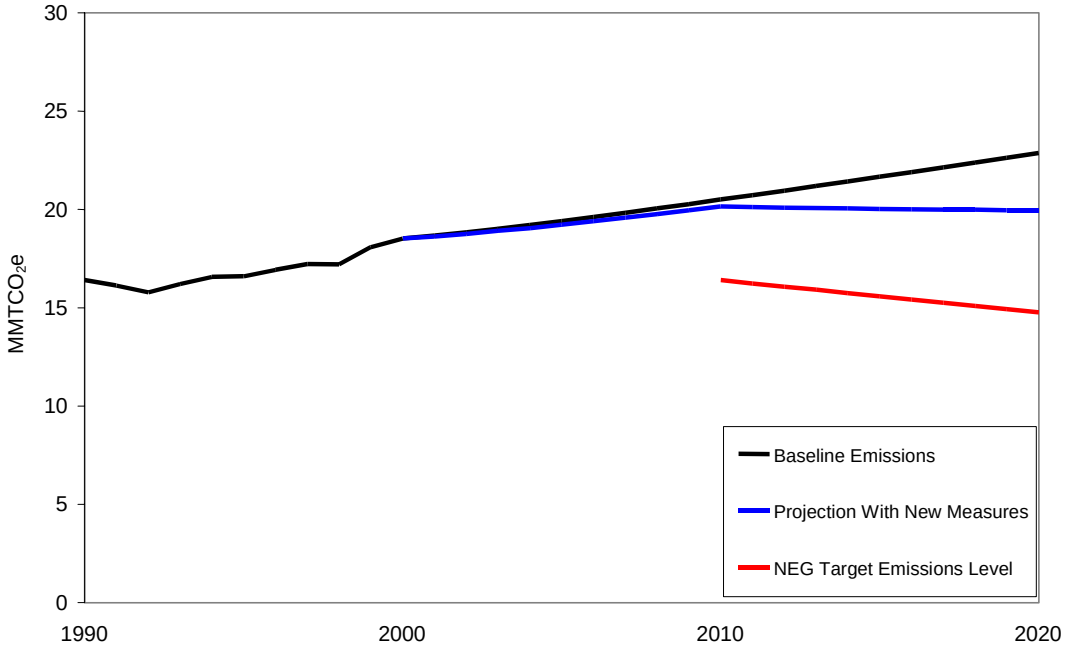
Note: NEG does not necessarily assume equal percentage reductions in each sector.

Table 3.1.2
Summary of Transportation Sector $MMTCO_2e$ Reductions: Without Black Carbon

	2010	2020	Cost
Total $MMTCO_2e$ Baseline, from fuel use **(1990 = 16.4)**	20.50	22.86	
Passenger Vehicle GHG Emission Rates			
California LEV II standards	0.04	0.47	*
GHG feebate program	0.01	–	Revenue neutral or revenue positive
Fleet vehicle incentives and initiatives**			Not available
Tailpipe GHG standards (or alternative approach)	0.09	1.81	Not available
Public education initiative**			Not available
Hydrogen infrastructure research and demonstration program***	–	–	Not available
Develop Packages to Slow/Reduce VMT Growth			
Transit, smart growth and VMT reduction package (includes road-pricing pilot and other incentives)	0.22	0.49	$602/$MTCO_2$ (capital & operating outlays) ($280/$MTCO_2$ when infrastructure, health care and household savings are included)
Freight and Diesel			
Multistate intermodal freight initiative	0.00	0.14	Not available
Clean diesel and black carbon	–	–	
Total $MMTCO_2e$ Savings	**0.36**	**2.91**	
Total $MMTCO_2e$ (net reductions)	20.15	19.95	
% above/below 1990 (16.4 $MMTCO_2$)	*22.8%*	*21.7%*	
NEG/ECP Goal (1990 in 2010, 10% below in 2020)	**16.40**	**14.80**	
Additional reductions needed to reach NEG/ECP goal	*3.75*	*5.19*	

* The report includes some cost estimates, but no total or incremental cost numbers.
** Savings included with tailpipe GHG standards
*** Potential long-term benefits of up to 22 $MMTCO_2e$, assuming low- or no- GHG emissions from hydrogen production (see Hydrogen Infrastructure Research & Demonstration Program discussion for more details).

Figure 3.1.2
Connecticut GHG Reductions From the Transportation Sector
(Without Black Carbon)



Note: NEG does not necessarily assume equal percentage reductions in each sector.

Transportation Sector Baseline

The transportation working group baseline has evolved as new information has become available. The original (May 2003) transportation baseline projected that transportation GHG emissions in the year 2020 would be 5.6 $MMTCO_2e$ above 1990 levels, or 37 percent above 1990 levels. A working group adjustment to the baseline that corrected a disconnect between vehicle miles traveled (VMT) and fuel sales data (October 2003) increased the spread between 1990 and 2020 to 6.5 $MMTCO_2e$, or 40 percent above the adjusted 1990 levels. A final working group adjustment to the baseline to include black carbon emissions (November 2003) increased the spread between 1990 and 2020 to 7.2 $MMTCO_2e$, or 37 percent above the adjusted 1990 levels. Thus, although the absolute baseline is higher and the net differential between 1990 levels increased as a result of those improvements, the total percentage difference between 1990 and 2020 transportation GHG emissions remains the same. This information is summarized in Tables 3.1.3 and 3.1.4.

Table 3.1.3
Summary of Transportation Baseline Adjustments ($MMTCO_2e$)

Baseline	1990	2000	Compared With 1990	2010	Compared With 1990	2020	Compared With 1990
Original (May 2003)	15.2	16.9	111%	18.7	123%	20.8	137%
Adjusted to cue up VMT and fuel sales (October 2003)	16.4	18.5	113%	20.5	125%	22.9	140%
Final adjustment adding back carbon (November	19.4	22.2	114%	24.2	125%	26.6	137%

2003)

Table 3.1.4
Reductions Needed to Meet NEG/ECP Targets ($MMTCO_2e$)

Baseline	2010	2020
Original (5-03)	3.5	5.6
Adjusted (10-03)	4.1	6.5
Final (11-03)	4.8	7.2

The remainder of this discussion touches on the highlights and key assumptions of the baseline adjustments and refers the reader to supporting documents listed at the end of this section. We devote considerable space to discussing black carbon emissions, given the novelty and importance of the issue in climate change policy discussions.

Original Baseline (May 30, 2003)

As detailed in CCAP's memo of May 30, 2003, (see Supporting Document 1) several key factors were used in developing the sector baseline:

- Historical fuel use (Energy Information Administration [EIA] data)
- Projected gasoline use:
  - Based on ConnDOT Master Transportation Plan VMT forecast: 22.2 percent growth from 2000 to 2020
  - EIA assumptions on vehicle efficiency (flat through 2020)
- Projected diesel use
  - Based on historic diesel sales (1.4 percent annual growth)
- Other fuels (less than 10 percent of sector GHG emissions)
  - EIA growth rates.

This approach resulted in the following baseline, which was adopted by the working group on June 4, 2003 (Table 3.1.5).

Table 3.1.5
Original Transportation Baseline ($MMTCO_2e$), May 2003

1990	2000	2000 Compared With 1990	2010	2010 Compared With 1990	2020	2020 Compared With 1990
15.2	16.9	**111%**	18.7	**123%**	20.8	*137%*

Baseline Adjustment to Correct the Disconnect Between VMT and Fuel Sales Data (October 28, 2003)

As detailed in CCAP's memo of October 28, 2003 (see Supporting Document 2) CCAP developed a methodology to correct discrepancies between historic VMT and fuel sales data. In a nutshell, historic fuel sales grew at a rate higher than VMT growth, implying fuel economy trends inconsistent with regional and national trends. CCAP developed a methodology to correct the discrepancy that consists of redistributing regional fuel use to states according to their proportion of VMT. The adjustment is equivalent to deriving fuel use by multiplying VMT by miles per gallon (MPG) for the region (given that VMT and fuel sales data are better aligned

regionally than at the Connecticut level). This formula resulted in the following adjusted baseline, which was adopted by the working group via e-mail polling on October 31, 2003.

Table 3.1.6
Final Transportation Baseline, with Black Carbon ($MMTCO_2e$) November 2003

1990	2000	2000 Compared With 1990	2010	2010 Compared With 1990	2020	2020 Compared With 1990
19.4	22.2	**114%**	24.2	**125%**	26.6	**137%**

Baseline Adjustment to Account for Black Carbon Emissions (November 2003)

The science of black carbon's global warming potential is still being evaluated. As the data become more precise, it is recognized that they may have an effect on GHG baselines. At that point, the GHG baseline will need to be adjusted using the routine process that is expected to be followed by the NEG/ECP (i.e., every three years).

Developing a black carbon baseline requires three steps:

1. Calculate historic black carbon emissions.
2. Develop a forecast of black carbon emissions.
3. Convert black carbon emissions to CO_2-equivalent emissions.

A set of conservative assumptions was used to determine the black carbon baseline; these are summarized below (see Supporting Document 3, Environment Northeast's memo on Diesel Black Carbon Calculations).

Historic Black Carbon Emissions

Black carbon emissions for 1990 and 2000 were calculated by multiplying diesel fuel sales for use in mobile engines by an average black carbon emission factor. The average black carbon emission factor (prepared by Energy and Environmental Analysis, Inc., of Arlington, VA) was based on the latest available data:

- PM emission factors for on-road vehicles uses the U.S. Environmental Protection Agency's (EPA's) PART5 emission factor model
- PM emission factors for all other mobile diesel uses from the EPA's AP-42 "Compilation of Air Pollutant Emission Factors"

The emission factors are for elemental carbon, which is assumed to be a proxy for black carbon. Indirect PM (formed after emission) and direct sulfate emissions are factored out. Elemental carbon is estimated by factoring out the soluble organic fraction of carbon-based PM. The formula resulted in an average emissions factor of 0.0000081987 short tons of black carbon per gallon of diesel fuel.[1]

Projected Black Carbon Emissions

[1] This factor was applied to 1990 diesel fuel (212 million gallons) and 2000 diesel fuel use (257 million gallons) to calculate total black carbon emissions.

Developing an estimate of black carbon reductions requires development of a baseline emissions forecast. In projected black carbon emissions, it is crucial to take into account federal regulations that will reduce black carbon emissions. Specifically, current EPA rules set standards for all new on-road engines that will achieve 90 percent reductions in PM beginning in 2007. Pending EPA rules, which would be phased in between 2008 and 2014, are expected to require similar reductions for all new nonroad engines.

The working group did not have adequate vehicle inventory data or turnover rates to calculate 2020 black carbon emissions with any precision. The working group set out to develop a black carbon forecast that reflected the EPA rules for new diesel vehicles, so that the black carbon policy recommendations would focus on existing on-road and nonroad vehicles. Therefore, the decision was made to use 2000 black carbon emission levels as a proxy for 2020 levels. A few key points underlie this assumption:

- Black carbon emissions from vehicles introduced after 2007 are excluded; therefore, the baseline reflects the 2007 EPA rules for new diesel vehicles.
- The baseline excludes the 32 percent projected growth in diesel use beyond 2000.
- The average life of a diesel engine is assumed to be roughly 30 years. Following EPA's methodology, it is assumed that by 2020 only a small portion of the total diesel fleet will have turned over and been replaced by new, low-emission engines.

If, however, a significant number of vehicles that were on the road in 2000 retire between 2007 and 2020, then the black carbon savings calculated in this report would be overstated, because those vehicles would come under the new EPA rules and black carbon reductions could not be attributed to actions in Connecticut. This uncertainty is assumed to be offset by the assumption of no growth in total consumption of diesel fuel in Connecticut over this time period. With improved data, the State should be able to better determine the extent to which these two tendencies balance out. In the meantime, this work represents the working group's best estimate for future black carbon emissions.

Conversion of Black Carbon Emissions to CO_2-Equivalent Emissions

The CO_2-equivalent impact of black carbon emissions was calculated according to the recent research of Mark Jacobson.[2] Jacobson ran a climate model incorporating a wide range of mechanisms by which black carbon emissions affect climate. He included runs that reduced global emissions of individual climate-forcing pollutants emissions to zero—including fossil fuel black carbon, methane (CH_4), and CO_2. Each run provides a resulting global temperature reduction curve, which in turn allows the warming effects of each scenario to be compared.[3]

The details of Jacobson's calculations can be found in Environment Northeast's memo on Diesel Black Carbon Calculations, Supporting Document 3.

[2] Jacobson, M.Z. (2002). Control of fossil-fuel particulate black carbon and organic matter, possibly the most effective method of slowing global warming. *Journal of Geophysical Research, 107*(D19), ACH 16, 1-22.

[3] Although many aspects of the impact of black carbon air pollution on climate remain uncertain, other leading climate scientists (e.g., James Hansen) have measured atmospheric conditions driven by black carbon aerosols that generally support Jacobson's modeling-based estimates of the magnitude of black carbon climate impact.

The conversion of black carbon emissions to CO_2-equivalent emissions resulted in the following range of emission levels:

3.0 to 7.0 MMTCO$_2$e in 1990
3.7 to 8.5 MMTCO2e in 2000
3.7 to 8.5 MMTCO2e in 2010 and 2020

For the baseline, the working group made a conservative assumption and used the lower end of the range, namely 3.0 MMTCO$_2$e in 1990 and 3.7 MMTCO$_2$e in 2000, 2010, and 2020.

Supporting Documents

- CCAP Transportation Baseline Memo (5-30-03) (Document 1)
- CCAP Transportation Baseline Memo (10-28-03) (Document 2)
- Environment Northeast's memo on Diesel Black Carbon Calculations (10-22-03) (Document 3)

California LEV II Standards for Light-Duty Vehicles[4]

Recommended Action: Adopt LEV II standards in Connecticut.

The California Low Emission Vehicle II (LEV II) program establishes strict emission standards for all new cars sold in California as well as for any other state that adopts the program. The standards address nonmethane organic gas (NMOG), a precursor of ozone pollution in the lower atmosphere; nitrogen oxides (NO_x); and carbon monoxide (CO).

The LEV II Smart Growth Strawman Proposal, prepared by the Connecticut Fund for the Environment, is the primary source of information on LEV II recommendations, costs, and benefits (see Supporting Document 4).

The LEV II program consists of two complementary components: the low-emission vehicle (LEV) requirement and the advanced technology vehicle program. Under the California standards, 90 percent of a manufacturer's vehicle fleet is required to meet strict baseline emissions standards. The emission standards for LEVs are much lower than the corresponding federal standards and can be achieved through the application of conventional pollution-control technology to the internal combustion engine. The remaining 10 percent of the vehicle fleet must be lower emitting than LEV standards, which qualify for credits under the advanced technology component of the program.[5] The advanced technology components of the LEV II standards are summarized in Table 3.1.7.

Table 3.1.7
Advanced Technology Requirements of the LEV II Emissions Program, 2005–2008

Category	Vehicle Type	Examples	% of Total Fleet	% of Total Alternative Compliance
Gold	Pure ZEVs	Electric vehicles and fuel cells	2	250 total fuel cell vehicles by 2008
Silver	Advanced technology PZEVs	Hybrid Electric and Compressed Natural Gas vehicles	2	3
Bronze	PZEVs	Super Ultra Low Emissions Vehicle or SULEV (internal combustion)	6	6

[4] The LEV II strawman proposal, prepared by Connecticut Fund for the Environment, is the primary source of information on LEV II recommendations, costs and benefits. Significant portions of this section are excerpted verbatim from the LEVII strawman proposal (see Supporting Document 4).

[5] The LEV II advanced-technology vehicle program consists of three categories of vehicles: gold, silver and bronze. The path likely to be followed by Connecticut would require that 6 percent of the total vehicle fleet satisfy the bronze standard, consisting of ultra-clean partial zero-emission vehicles, or PZEVs. Those PZEVs would consist of conventional internal combustion vehicles that are 90 percent cleaner than normal LEVs (and that produce zero evaporative emissions). Two percent of the vehicle fleet would have to meet the silver standard, consisting of advanced technology (AT) PZEVs (such as the hybrid-electric vehicle). Finally, automakers can satisfy the gold standard, 2 percent, true-zero-emission vehicle by offering either battery-electric or fuel cell vehicles. If they choose the fuel cell path, they would offer 250 hydrogen fuel cell vehicles for sale anywhere in the country by 2008.

Connecticut may elect to adopt the California standards either legislatively or administratively. Section 22a-174g of the Connecticut General Statutes authorizes the Commissioner of Environmental Protection to adopt regulations implementing California's motor vehicle emissions standards on the Connecticut Department of Environmental Protection's (DEP's) own initiative. Such standards may be adopted either by emulation or by reference to the relevant California regulations. In addition to the authority granted by § 177 of the Clean Air Act, the Connecticut General Assembly retains its inherent power to adopt any legislation that is necessary to protect the health and welfare of the citizens of the State.

Implementation could begin as early as model year 2007 if Connecticut acts during the 2004 session. Under LEV II, auto dealers in Connecticut, beginning with the model year 2007, would be required to sell new vehicles that are certified to California emissions standards.

Result of Assessments for 2010, 2020, and Beyond

Estimated GHG emissions reductions:
0.04 MMTCO$_2$e in 2010
0.47 MMTCO$_2$e in 2020

GHG savings were calculated using the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model Version 1.5a, developed by Argonne National Laboratory.[6] GHG savings are based on "ZEV Scenario Two: Advanced Technology with Minimum Compliance" from the Connecticut Fund for the Environment report *The Drive for Cleaner Air in Connecticut*.[7] This scenario assumes the following penetration rates by 2020:

- ZEV 5 percent (battery electric vehicles through 2009, transitioning to hydrogen fuel cell vehicles between 2010 and 2013, with hydrogen from natural gas)
- AT PZEV 9 percent (hybrid electric vehicles)
- PZEV 2 percent (conventional internal combustion engines with advanced emissions-control technology, SULEV)

Life-cycle GHG savings were reduced by 20 percent to reflect the portion that are direct tailpipe emissions (per GREET).

Estimated Costs

Baseline LEV II vehicles are currently being sold at the same price as their non-LEV II-certified counterparts; manufacturers' costs for compliance are less than $100 per vehicle. A consumer premium exists for hybrid vehicles, currently around $3,000. The California Air Resources Board developed consumer cost estimates for advanced technology PZEVs (Table 3.1.8).

[6] Available at: http://greet.anl.gov.
[7] Connecticut Fund for the Environment. September 2003. *The Drive for Cleaner Air in Connecticut.* Available at: www.cfenv.org.

Table 3.1.8
Advanced Technology PZEVs
(Incremental Consumer Costs)

	Year	Amount
Stage I	**(2003–2005)**	**$3,300**
Stage II	**(2006–2008)**	**$1,500**
Stage III	**(2009–2011)**	**$700**

Source: California Environmental Protection Agency, Air Resources Board, Staff Report: Initial Statement of Reasons: 2003 Proposed Amendments to the California Zero Emission Vehicle Program Regulations, January 10, 2003.

Ancillary Benefits

Adoption of LEV II standards in Connecticut is calculated to reduce toxic pollutants (acetaldehyde, 1,3-butadiene, formaldehyde, and benzene) by 104 tons in 2020.[8]

Stakeholder Views

The stakeholders unanimously agreed to recommend adoption of LEV II in Connecticut (referred to as "unanimous consent" in the summary tables).

Public Views

Public comments were received calling for the adoption of LEVII standards (often referred to as the California standards) for all vehicles sold in Connecticut.

The Alliance of Automobile Manufacturers (AAM), as an observer of the transportation and land-use working group, presented an alternative analysis for LEV II compliance in Connecticut showing lower levels of lifecycle GHG reductions (i.e., 0.2 $MMTCO_2e$ in 2020, equivalent to direct emissions of 0.16 $MMTCO_2e$). The AAM noted that their estimate was an upper-bound estimate, and the organization questioned the assumption that hybrid electric vehicles (HEVs) and fuel cell electric vehicles (FCEVs) vehicles will not be sold in Connecticut without adoption of LEV II standards.

Cross-Cutting Issues

Connecticut's adoption of LEV II will bring a better regional balance and strengthen regional demand for the sale of LEVs, because Massachusetts, New York, and Vermont have already adopted California emissions standards.

Supporting Documents

- LEV II Strawman Proposal (Connecticut Fund for the Environment) (Document 4)
- *The Drive for Cleaner Air in Connecticut.* pp. 19–31 (Connecticut Fund for the Environment) (Document 5)

[8] Connecticut Fund for the Environment, *op cit.*

Tailpipe GHG Emission Reductions

Recommended Action: Implement a package of policies and measures to reduce passenger-vehicle (cars and light trucks) GHG emission rates by 33 percent by 2020.

A variety of policy approaches may reduce vehicle tailpipe GHG emission rates. This recommendation consists of a package of four complementary elements (Table 3.1.9).

Table 3.1.9
Recommended Package to Reduce Tailpipe GHG Emission Rates

Complementary Elements	Function
GHG feebate program	• Market tool to influence consumer purchasing decisions • Achieve economies of scale to pull the market (regional)
Fleet vehicle incentives and initiatives	• Government: lead by example • Achieve economies of scale to pull the market
GHG tailpipe standards (or alternative approach)	To influence manufacturer behavior and increase low-GHG vehicle choices for consumers
Public education initiative	To raise public awareness about the benefits of low-GHG vehicles, including available incentives

GHG "Feebates" [9]

A feebate program uses both incentives and disincentives to induce consumer buying practices that reflect the negative externalities associated with the purchase of a motor vehicle, in this case, lifetime emissions of CO_2. Under a feebate system, consumers would be charged a fee on purchases of relatively high-emitting vehicles and would receive a rebate on the purchase of relatively low-emitting vehicles. A feebate program can be designed in several different ways, taking into account the classes of vehicle to be covered, the manner in which the fees and rebates are to be calculated, and the way in which those fees or rebates are to be collected. A feebate system can also be designed to either generate revenue or to be revenue neutral (i.e., rebates disbursed equal the amount of fees collected, less administrative costs). The GHG Feebates Strawman Proposal, prepared by the Connecticut Fund for the Environment, is the primary source of information on feebate recommendations, costs, and benefits (see Supporting Document 6).

Recommendations

- **Establish a single-tier, GHG-based feebate program for all new passenger vehicles sold in Connecticut beginning in 2005.** Although a multi-tiered system (with different fees and rebates for cars than for light trucks) might initially garner more political support, such

[9] The GHG Feebates strawman proposal, prepared by Connecticut Fund for the Environment, is the primary source of information on feebate recommendations, costs and benefits. Significant portions of this section are excerpted verbatim from the GHG Feebates strawman proposal (see Supporting Document 6).

systems inevitably provide perverse incentives and further distort the skewed preexisting market signals. Under a multi-tiered feebate system, a car purchaser could pay a fee, but a consumer who purchases a light truck with a higher emissions rate than the car could receive a rebate. Developing an exemption system for those who need large vehicles for work-related purposes would present significant administrative difficulties, such as determining the percentage of work-related use of the vehicle (as opposed to discretionary and personal use). If a particular vehicle were truly necessary for work, then it would be eligible for certain favorable tax treatment when the purchaser submits his or her federal income tax.

- **The State should design the levels of fees and rebates for vehicles at different emissions levels in a manner that maximizes influence on consumer demand.** Table 3.1.10 lists sample feebate "schedules" to illustrate the potential magnitudes of fees and rebates in Connecticut. See the Feebate Strawman Proposal, Supporting Document 6, for more details.
- **The State should decide whether the feebate program should be designed to generate revenue beyond that required for administering the program and paying the rebates.** Any generated revenues should support public education on low-GHG vehicles and fund other GHG reduction efforts, such as incentives for the use of low-rolling-resistance replacement tires.
- **Design the GHG feebate program to minimize potential leakage.** The feebate system can be administered at several potential collection points. The most likely options include point-of-sale feebate charges or feebates administered at the time of registration. In choosing one of those options, policy makers must be sensitive to possible leakage issues. Leakage would occur if Connecticut residents were to buy high-GHG vehicles in another state to avoid paying the fee, or if out-of-state residents were to buy low-GHG vehicles in Connecticut in order to get the rebate. Both potential problems could be addressed by administering the feebates at the time of registration, rather than at the time of sale. Because the feebate program would apply only to new vehicle purchases, the dealer would likely handle registering the vehicle for in-state purchasers, thus reducing the burden on the purchaser. Consumers who purchase their vehicles out-of-state would bear the burden of registering in Connecticut and paying the fee at that time. Similarly, out-of-state purchasers of vehicles in Connecticut would typically not go through the dealer for registration; consequently, they would not receive the rebate (see the discussion of a regional approach, below).
- **Engage in multistate and regional discussions on establishing a GHG feebate program for the region.** Regional implementation would provide two benefits that could not be achieved if a feebate program were operating only within Connecticut. First, regional implementation would reduce the likelihood of leakage. Second, a regional program would more effectively influence supply-side (i.e., manufacturer) behavior by encouraging demand-side (i.e., consumer) purchases of low-GHG vehicles. Several states in the region, including Maine, Massachusetts, New York, Rhode Island, and Vermont, have considered feebates as a potential GHG reduction strategy. Notwithstanding the desirability of a regional approach, Connecticut should not wait for other states to commit to implementing a feebate program.

1.

Table 3.1.10
Sample Feebate Schedules

Lifecycle CO_2e Emissions (lb/mi)	Lifetime CO_2e Emissions (tons CO_2e)	$28/ton CO_2 Pivot A	$40/ton CO_2 Pivot B	Sample Vehicles
0.30	33	($1,470)	($2,700)	
0.35	37	($1,365)	($2,550)	
0.40	41	($1,260)	($2,400)	
0.45	44	($1,155)	($2,250)	Insight (man.)
0.50	48	($1,050)	($2,100)	'04 Prius
0.55	52	($945)	($1,950)	'03 Prius
0.60	56	($840)	($1,800)	Jetta diesel
0.65	59	($735)	($1,650)	
0.70	63	($630)	($1,500)	Civic HX
0.75	67	($525)	($1,350)	Civic (man.)
0.80	71	($420)	($1,200)	Geo Prizm
0.85	74	($315)	($1,050)	Mini Cooper
0.90	78	($210)	($900)	Sentra
0.95	82	($105)	($750)	Ford Focus
1.00	86	$0	($600)	Camry
1.05	89	$105	($450)	Lancer
1.10	93	$210	($300)	Grand Am
1.15	97	$315	($150)	Malibu
1.20	101	$420	$0	Intrepid
1.25	104	$525	$150	Aztec FWD
1.30	108	$630	$300	Mustang
1.35	112	$735	$450	Odyssey
1.40	116	$840	$600	Highlander
1.45	119	$945	$750	Town Car
1.50	123	$1,050	$900	Dakota
1.60	131	$1,260	$1,200	Trailblazer
1.70	138	$1,470	$1,500	Explorer 4x4
1.80	146	$1,680	$1,800	
1.90	153	$1,890	$2,100	
2.00	161	$2,100	$2,400	Escalade
2.10	168	$2,310	$2,700	Navigator
2.20	176	$2,520	$3,000	
2.30	183	$2,730	$3,300	
2.40	191	$2,940	$3,600	Ferrari 456
2.50	198	$3,150	$3,900	
2.75	217	$3,675	$4,650	Hummer H1
***Estimated* Net Revenue**		**+$125M**	**+$70M**	

Note: CO_2-equivalent emissions include estimated in-use emissions for gasoline and diesel vehicle (calculated using EIA data), average manufacturing emissions estimated at 10.6 tons CO_2-equivalent (based on ACEEE Green Book methodology, 2002), and fuel-cycle emissions of CO_2 and other GHGs (based on DeLucchi, 1997, using revised GWP estimates from IPCC). Gasoline and diesel vehicle CO_2 burdens were calculated separately, but they result in similar numbers, so a single number was used to estimate both, for simplicity. Sample vehicles are based on model year 2002 carbon emission estimates, except where otherwise noted. Estimates assume lifetime mileage of 150,000 miles, with no discounting of future emissions.

Fleet Vehicle Incentives and Initiatives

Within every class of vehicles (e.g., compact car, sedan, station wagon, pickup, SUV, van) there is at least a 25 percent difference in the GHG emission rate between the most and least polluting vehicle in a class. A variety of incentives and initiatives can encourage public and private owners of vehicle fleets to purchase low-GHG vehicles. This approach presents an opportunity for government to lead by example and achieve economies of scale to influence vehicle manufacturers' product offerings.

Recommendations

- **The State should establish a procurement policy to reduce GHG emission rates for its fleet of cars and light trucks, whether owned, leased, or contracted.** Currently, the State runs a fleet of 3,000 cars and 1,200 vans and light trucks. It replaces more one-sixth of the fleet each year and achieves complete fleet turnover every six years.
- **The State should establish a program to encourage municipal and private sector fleets to purchase low-GHG vehicles.** The program could include a public awareness campaign and public recognition awards.
- **Partner with other Northeast states, local governments, and private fleets to develop bulk-purchasing proposals for low-GHG vehicles.** In the Northeast states, more than 1 million light-duty vehicles are owned and operated by private sector and government fleets of 10 or more vehicles—more than 10 percent of all vehicles sold into fleets in the United States. These fleets are estimated to generate purchases of about 100,000 new vehicles each year. Industry experts report that manufacturers require a minimum annual market size of about 25,000 vehicles before they will introduce a new model vehicle to the marketplace. A limiting factor is that market studies indicate that an immediate market exists for only about 12,000 vehicles per year in the United States. Thus, an initial campaign target would be to aggregate an annual purchase of 12,000 or more vehicles to "match" current market potential. A purchase of this magnitude might well draw additional low-GHG vehicles (e.g., advanced hybrids) into the market.
- **The State should work with the Federal government to advance policies that will improve the market for low-GHG vehicles.** For example, EPACT alternative fuel vehicle requirements should be redefined to include hybrid electric vehicles. In addition, Congress should extend the Federal tax deduction for hybrid vehicles beyond the current sunset date. Finally, encouraging use of low-GHG vehicles in Federal fleets could have an important market impact.

GHG Tailpipe Standards for Passenger Vehicles

California is developing regulations to reduce motor vehicle emissions of GHGs. By January 1, 2005, the California Air Resources Board (CARB) is to develop and adopt regulations that achieve "the maximum feasible and cost-effective reduction of GHG emissions" from passenger vehicles and light-duty trucks whose primary use is noncommercial personal transportation.[10] The regulations will go into effect in January 2006 and will apply to motor vehicles manufactured in model year 2009 and thereafter. Criteria to be used in determining "maximum feasible and cost-effective" include ability to be accomplished within the time provided, considering environmental, economic, social, and technological factors, and economy to vehicle owners and operators, considering full life-cycle costs of a vehicle. CARB is required to consider the technical feasibility of the regulations and to consider their impact on the State's economy, including jobs, new and existing businesses, competitiveness, communities significantly affected by air contaminants, and automobile workers, and related businesses in the State. CARB is also to provide flexibility, to the maximum extent feasible, in the means by which people subject to

[10] AB 1493, signed August, 13, 2002 (www.arb.ca.gov/cc/ab1493.pdf).

the regulations may comply. CARB must ensure that any alternative methods for compliance achieve equivalent or greater reduction in GHGs.

Recommendations

- **Connecticut should adopt tailpipe GHG standards once California regulations go into effect.**[11] This regulatory tool will influence manufacturer behavior and increase low-GHG vehicle choices for Connecticut consumers.
- **The State should phase out GHG feebates once GHG tailpipe standards are adopted in Connecticut.** Although GHG feebates might serve as useful complements to regulatory standards, such market signals may be most effective in priming the market for a shift toward low-GHG vehicles.
- **The State should explore alternative approaches to achieving the same GHG reduction as would be achieved by tailpipe GHG emissions regulation.** The California GHG tailpipe standards will likely face a legal challenge from the automobile industry on the basis that the regulations are preempted by federal fuel economy standards. Both California and the automobile industry have expressed confidence that they have a strong legal case. The final verdict will be decided in court in the likely event of a lawsuit. This scenario casts some uncertainty about the potential for Connecticut to reduce tailpipe GHG emission rates through direct regulation. Thus, the recommendation includes a charge to explore alternative approaches to achieving the same GHG reductions (e.g., coordination with other states on an aggressive, regional GHG feebate schedule; enhanced fleet vehicle initiatives; or GHG-based auto insurance or registration fees).

Public Education Initiative

Recommendations

The State should develop an education program to raise public awareness about the benefits of low-GHG vehicles, including available incentives, such as GHG feebates and fleet procurement initiatives, and potential maintenance options, such as the use of low rolling resistance replacement tires and low friction engine oil.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Table 3.1.11 illustrates the impact of the above approaches on GHGs for 2010 and 2020.

[11] California is authorized to implement mobile-source emissions-reduction polices and programs that are more stringent than federal requirements under § 209 of the federal Clean Air Act. Section 177 permits other states to follow suit and adopt the identical policy.

Table 3.1.11 GHG Emissions Reductions ($MMTCO_2e$)		
	2010	**2020**
A. GHG feebate program	0.01	*
B. Fleet vehicle incentives**	–	–
C. GHG tailpipe standards	0.09	1.81
D. Public education**	–	–
Total	**0.10**	**1.81**

* If a GHG feebate program persisted beyond 2009, reductions in 2020 would be 0.05 $MMTCO_2e$.
** Savings included in GHG tailpipe standards.

Key Assumptions

GHG feebate incentives are assumed to be phased out with the introduction of tailpipe GHG standards in model year 2009. If a GHG feebate program persisted beyond 2009, reductions in 2020 would be 0.05 $MMTCO_2e$. No additional savings are assumed for fleet vehicle incentives or educational efforts.

The impact of feebates is calculated on the basis of a \$40/ton CO_2 schedule. The California Energy Commission analysis cited in the New York GHG Task Force Report used a feebate schedule equivalent to approximately \$160 per ton CO_2 and was thus adjusted downward by a factor of four and applied to the Connecticut fleet.[12]

The California GHG Tailpipe standards are not yet finalized; therefore, the exact level of the standards is uncertain. CARB is expected to have a draft staff proposal in May 2004, at which point Connecticut may have a better sense of the expected GHG emissions rates.[13] Thus, the working group relied on two external estimates of the expected level of the California standards: The New York GHG Task Force assumed a 36 percent reduction in GHG emission rates from projected 2008 base levels, and MassPIRG assumed a 30 percent reduction. The working group used an average 33 percent reduction for its calculations,[14,15] which amounts to approximately 280 g CO_2 per mile for passenger cars in 2020, and 373 g CO_2 per mile for light trucks.[16]

The GHG savings were calculated using a vehicle stock turnover model (which accounts for changes in the on-road fleet from both new and old or retired vehicles) developed by Oak Ridge National Laboratory. Baseline GHG emission rates were based on data from the U.S. Department of Energy's *Annual Energy Outlook 2003*.[17] The VMT projection was based on the ConnDOT Master Transportation Plan[18] and adjusted for expected VMT savings (3 percent in 2020) from

[12] Center for Clean Air Policy. April 2003. *Recommendations to Governor Pataki for Reducing New York State Greenhouse Gas Emissions*. pp. 152-155. www.ccap.org/pdf/04-2003_NYGHG_Recommendations.pdf
[13] For information on the development of the California standards, including the results of technical public workshops, see www.arb.ca.gov/cc/cc.htm#Workshops.
[14] Center for Clean Air Policy, *op cit.*
[15] MassPIRG. *Cars and Global Warming.* April 2003. http://masspirg.org/reports/carsglobalwarming03.pdf
[16] The 2008 base values are 424 g CO_2 per mile and 550 g CO_2 per mile for cars and light trucks, respectively.
[17] www.eia.doe.gov/oiaf/aeo/index.html
[18] www.ct.gov/dot/cwp/view.asp?a=1383&q=259760

transit and smart growth policies (see the section on smart growth and transit). Fleet projections were adjusted downward to reflect the penetration of hybrid electric vehicles as a result of LEV II (9 percent in 2020) to avoid double counting (see the section on LEV II, above).

Costs

The GHG feebate program can be designed to be revenue neutral, so that the fees collected cover rebates disbursed as well as program administration and educational initiatives; or, it could be designed to generate excess revenues for investment in other GHG reduction efforts, such as fleet procurement or transit. The working group did not develop cost estimates for the fleet procurement initiatives, tailpipe GHG standards, or educational initiatives.

As discussed above, the California tailpipe standards, by law, are required to be cost-effective to the owner or operator of a vehicle, considering the full life-cycle costs of a vehicle. CARB is also required to consider the potential economic impact of the standards on jobs, businesses and competitiveness, and communities. The flexibility provision, which allows for alternative compliance methods, should further serve to reduce costs. It is expected that cost estimates for the California standards will be available in spring 2004.

Ancillary Benefits

Ancillary benefits from adopting the package of tailpipe GHG emissions-reduction measures include the reduction of criteria and hazardous air pollutants and potential operating cost savings for the State and consumers.

Stakeholder Views

- **GHG feebate program:** A supermajority of stakeholders supported this recommendation. One stakeholder supported a regional GHG feebate but was opposed to Connecticut implementing such a program on its own because of concerns about potential leakage and competitive disadvantage.
- **Fleet vehicle incentives and initiatives:** The stakeholders unanimously agreed to this recommendation.
- **Tailpipe GHG standards (or alternative approach):** The stakeholders unanimously agreed to this recommendation. They noted that Connecticut should consider coordination with other states and that the State should consider complementary or alternative pathways to reducing tailpipe GHG emissions (e.g., a more aggressive, regional GHG feebate schedule.)
- **Public education initiative:** The stakeholders unanimously agreed to this recommendation.

Public Views

Numerous public comments were received calling for Connecticut to implement low-GHG tailpipe emissions standards and/or GHG feebates and to use cleaner vehicles in the State fleet. Many comments included specific requests for more fuel-efficient light trucks (i.e., SUVs) through the elimination of perverse incentives, pricing mechanisms, or charges and for

"greening" the State fleet through incentives and initiatives to reduce GHG emissions from State vehicles, such as alternative-fueled or hybrid vehicles.

Supporting Documents

- GHG Feebate Strawman Proposal (Document 6). This provides more detail on the feebate recommendations considered by the working group. Note that the calculation of GHG benefits from feebates has been updated since the strawman proposal was prepared.
- Memo on Fleet Procurement Policies (Document 7). This is an early draft of the proposal the working group considered.

Hydrogen Infrastructure Research and Development Program

Recommended Action: Develop a comprehensive hydrogen infrastructure research and demonstration program. [19]

Important technical barriers face the transition both to hydrogen as a primary fuel and to systems that would produce hydrogen in a climate-friendly manner. Nonetheless, the potential benefits to economic development, the climate, and clean air are so large that Connecticut should start now to implement a hydrogen research and development program. The recommendations in this section are based on the detailed strawman proposal on hydrogen prepared by Environment Northeast (Supporting Document 8).

Recommendations

Research

- Review existing relevant safety codes and the status of codes under development; assess potential barriers to development of a hydrogen infrastructure.
- Review the state of the industry and relevant involvement of Connecticut businesses and academic institutions.
- Identify the scenarios for transition to hydrogen economy in the Northeast; identify major developments needed to effectuate the most likely scenarios; and identify the implications for Connecticut transportation infrastructure and businesses.
- Identify potential funding sources for demonstration projects.
- Identify related initiatives in the region through NEG-ECP, academic institutions, business associations, and other interested groups.

Demonstration

Create a strategic plan to guide the involvement of State and local governments, educational institutions, businesses, and nongovernmental organizations (NGOs), including a list of near-term pilot and demonstration projects that the State can facilitate through both public and private initiatives. The plan could also serve as a model for other Northeast states and NEG/ECP. The following early actions should be considered:

- Demonstrate the practicality and safety of key hydrogen mobility-system components (e.g., fuel cell vehicles using hydrogen fuel, vehicle fueling stations, and local hydrogen production at fueling stations).

[19] The Hydrogen Transportation Infrastructure strawman proposal, prepared by Environment Northeast, is the primary source of information for the Hydrogen recommendations. Significant portions of this section are excerpted verbatim from the Hydrogen strawman proposal (see Supporting Document 8).

- Demonstrate co-production of hydrogen for local mobility use at an advanced fossil (or biomass) gasification electric-power system in Connecticut, ideally in combination with carbon capture and sequestration.
- Facilitate adoption of the necessary safety codes in appropriate jurisdictions.
- Conduct targeted public education on hydrogen safety.
- Contribute to and participate in national programs to commercialize key technologies (e.g., vehicle-scale fuel cells or improved on-vehicle hydrogen fuel storage systems).
- Identify potential funding sources for priority actions.
- Demonstrate zero-emission production of hydrogen through electrolysis and the use of renewable energy.
- Test hydrogen-fueled vehicle performance in cold-weather environments.

Institutional

In addition to the specific research and development (R&D) actions proposed above, several cross-cutting, institutional measures should be considered to help organize and implement a successful program:

- Establish a strategic R&D advisory council made up of public, private, and nonprofit organizations.
- Encourage State government transportation leaders to be hydrogen and fuel cell champions.
- Support university and industry collaboration through a hydrogen and fuel cell technology incubator. Assess Michigan's NextEnergy Initiative as a potential model.
- Initiate a business development initiative to promote investments in innovation through venture capital, institutional investors, and State economic development authorities.
- Develop a hydrogen education program ranging from introductory information for schoolchildren to higher education scholarships for studies in related energy fields.

Results of Assessments for 2010, 2020, and Beyond

In the time frame of the 2010 and 2020 targets, this report does not provide estimates of the reductions likely to occur from this measure. The potential reductions in the transportation sector that will occur *after* 2020 as a result of hydrogen and fuel cell technologies could be as much 22 $MMTCO_2e$ in Connecticut. This long-term reduction assumes the availability of low-emissions hydrogen (i.e., produced from gasification of fossil fuels together with carbon capture and sequestration, achieving roughly 90 percent improvement in GHG emissions, or renewable energy sources).

Costs

The transportation working group proposes the establishment of a Connecticut "Clean Energy Transportation Fund" that, among other things, would invest in demonstration projects that advance the state of hydrogen production, storage, distribution, and utilization for transportation applications. Although it is premature to estimate costs of a Clean Energy Transportation Fund

or other elements of R&D, the hydrogen program should be designed to prove the value of hydrogen technologies through a diverse portfolio of end-user applications.

Economic Development Benefits

An important ancillary benefit from a hydrogen and fuel program for Connecticut's transportation sector is economic development. Connecticut currently has 35 percent, or 1,300, of the estimated jobs in fuel cell manufacturing, and over $300 million in fuel cell products have been manufactured and shipped from Connecticut.[20] The Connecticut Clean Energy Fund estimates that the State's hydrogen and fuel cell industry in Connecticut could create 33,000 direct and indirect jobs for the transportation sector alone.[21]

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

Public comments were provided in support of cleaner burning fuels, including the use of hydrogen obtained from renewable energy sources to power vehicles.

Supporting Documents

- Hydrogen Transportation Infrastructure Strawman Proposal (Document 8)
- Summary of Hydrogen Fuel Cell Workshop (and list of participants) (Document 9)

[20] Connecticut Clean Energy Fund (CCEF), PricewaterhouseCoopers (PWC), as cited by the CCEF, via personal communication with Bryan Garcia of CCEF, November 2003.
[21] Based on the current employment makeup with the forecast job market in 10 years from PWC.

Transit, Smart Growth, and VMT Reduction Package

Recommended Action: Implement a package of transit improvements and land-use policies and incentives to achieve a 3 percent reduction in VMT below the 2020 baseline.

Passenger VMT in Connecticut is projected to increase by 22.2 percent from 2000 to 2020, according to the ConnDOT's Master Transportation Plan.[22] Implementation of the measures recommended here are estimated to reduce that growth to 19.2 percent.

This package of recommendations is aimed at increasing accessibility and low-GHG travel choices in Connecticut, such as transit (rail and bus), vanpools, walking, and biking. It draws on more detailed, strawman analyses and proposals, which are listed at the end of this section. Notably, the Smart Growth Strawman proposal, prepared by the City of New Haven (Supporting Document 10), is the primary source of information on smart growth recommendations, costs, and benefits. [23]

The recommendations consist of six complementary elements:

1. Double transit ridership by 2020.
2. Consider potential funding mechanisms for new transit investments, such as road pricing and the Transportation Strategy Board fuel tax recommendation.
3. Establish a coordinated, interagency program to promote smart growth in Connecticut:
    a. Establish priority funding areas to target State spending in areas considered appropriate for growth, as established by the State Plan of Conservation and Development (PCD).
    b. Establish additional planning capacity at the State level to coordinate activity between agencies and provide technical support for planning for growth.
    c. Establish an outreach program to regional planning organizations (RPOs) and local planning and zoning commissions to enact smart growth locally through measures such as transportation and infrastructure planning, regulatory reform, transit-oriented development, and housing diversity.
    d. Expand bicycle and pedestrian infrastructure.
4. Redirect at least 25 percent of new development (based on forecast population and employment) to growth-appropriate locations, as indicated by the PCD.
5. Study a potential road-pricing pilot project, prepare a feasibility design study by 2006, and implement the pilot project if it is shown to be effective. Study road pricing's potential impact on equity and sprawl, and consider broad implementation of road pricing in the long term.

[22] www.ct.gov/dot/cwp/view.asp?a=1383&q=259760

[23] Significant portions of this section are excerpted verbatim from the Smart Growth strawman proposal, prepared for the City of New Haven (see Supporting Document 10).

6. Consider complementary VMT reduction incentives, such as commuter choice, location-efficient mortgages, and mileage-based insurance.

Below are the details of the core elements of the recommendation.

Transit

Public transportation is an efficient, low-GHG alternative that is used by some 85,000 Connecticut commuters every day. The working group set a goal to double transit ridership as a means of reducing VMT. ConnDOT performed model runs assuming doubling ridership for rail and bus transit from the 2020 baseline. The agency also analyzed two stand-alone projects: the New Haven-Hartford-Springfield rail service and the Manchester/Vernon-Hartford bus rapid transit service. ConnDOT conducted a bottom-up analysis to cost out the transit investments necessary to achieve a VMT reduction equivalent to doubling transit ridership. A summary of key elements is included below (for details, see "Transit Growth Scenario Assumptions," Supporting Document 11).

Rail Options

- New Haven-Hartford-Springfield rail service
- Direct service to New York City (Penn Station) via enhanced Amtrak
- Enhanced New Haven Line (NHL) service to New York City (Grand Central Terminal)
- Enhanced intrastate service on NHL Mainline; NHL Branch Lines; Shore Line East (SLE); and extended SLE, all via enhanced passenger train service (i.e., Amtrak)

Bus Options

- Manchester/Vernon-Hartford bus rapid transit service
- Statewide extended span of service and service area
- Enhanced express service in Hartford and other markets

Other

- Vanpool enhancements

Potential Funding Sources

The State should consider potential funding mechanisms for new transit investments such as road pricing and the Transportation Strategy Board fuel tax recommendation.

Smart Growth

Residential and commercial development in suburban and exurban areas increases VMT as distances between homes and jobs increase. Low-density development cannot support public transportation, so single-occupancy-vehicles are often the only practical travel option. Since 1970, Connecticut's population has increased by a modest 12 percent, but VMT have increased

by 78 percent. The National Governors Association reports that nationwide, the increase in VMT is attributable to more miles driven by existing drivers, rather than to new drivers.
Since 1999, eight major reports have documented the impact of sprawl on Connecticut's economy, transportation systems, urban infrastructure, environmental resources, and social equity.[24] These studies have put forth recommendations for reducing sprawl by redirecting growth patterns through appropriate constraints, incentives, and long-term planning. As the eight reports demonstrate, the State has much to gain by planning for growth in appropriate areas rather than permitting continued unfettered development. Efficient reuse of existing infrastructure, reinforced funding for existing schools, improved air and water quality, reduced road and sewer extension costs, congestion mitigation, increased access to jobs, and affordable housing are recognized benefits of growth management. Connecticut's commitment to reducing GHG emissions underscores the needs identified by the eight reports and introduces an additional benefit to the already long list. This proposal borrows from the excellent work contained in these eight reports, with emphasis on recommendations that directly address the sprawl–climate change nexus.

The proposal is a measured response. It acknowledges that most new growth will continue to follow current trends. The working group therefore recommends a modest 25 percent penetration of smart growth principles by 2020 manifested by a 25 percent redirection in projected growth (population and employment) from inappropriate to appropriate locations, as defined by the PCD.

Smart Growth Recommendations

Planning, Coordination and Outreach

- Direct the Office of Policy and Management to address climate change and transportation-related GHG emissions in the State PCD.
- Establish additional planning capacity at the State level to coordinate activity between agencies and provide technical support for growth planning in accordance with the PCD.
- Establish an outreach program to RPOs and local planning and zoning commissions to enact smart growth locally through measures such as transportation and infrastructure planning, regulatory reform, transit-oriented development, and housing diversity.

Financial and Regulatory Mechanisms

- Adopt smart growth legislation that requires State agencies to target State economic development, transportation, infrastructure, and school construction spending in areas considered appropriate for growth, as established by the State PCD.

[24] State of Connecticut Blue Ribbon Commission on Property Tax Burdens and Smart Growth Incentives. 2003 *Report*; Myron Orfield et al. 2003. *Connecticut Metropatterns: A Regional Agenda for Community and Prosperity in Connecticut*; Connecticut Regional Institute for the 21st Century. 2003. *Connecticut: Economic Vitality and Land Use*; Regional Plan Association. 2002. *Is Connecticut Sprawling?*; Harvard Design School. 2002. *Promoting Smart Growth in Connecticut*; Connecticut Conference of Municipalities. 2001. *10 Principles of Smart Growth in Connecticut*; Gallis & Associates. 1999. *Connecticut Strategic Economic Framework*; Connecticut Transportation Strategy Board. 2003.*Transportation: A Strategic Investment.*

- Restructure Section 8.23 of the Connecticut General Statutes to promote integration of State, regional and municipal PCDs; the new laws should provide for enforcement "teeth" and a reporting mechanism for inconsistencies.
- Align statewide policies to support smart growth by pursuing reform in areas identified to affect the shape of growth in Connecticut, including open space acquisition (see AFW recommendations), bicycle and pedestrian travel, property tax reform, and building energy codes (see RCI recommendations).
- Establish an oversight group comprising senior staff from all State agencies and NGOs as well as public participants to ensure that the policies and activities of each agency are supportive of smart growth.

Road Pricing

A recent Connecticut report completed an analysis of travel demand mode shifts that would result from a value-pricing toll of $0.20 per mile in the southwest Connecticut corridor.[25] ConnDOT's travel-demand model predicted that this pricing measure alone would create a 6 percent reduction in drive-alone trips, an increase in new rail trips of 72 percent, and an increase in bus use of 25 percent. The results are consistent with the results of the 1994 COMSIS Transportation Control Measure study, which indicated that a highway value toll of $0.10 per mile was expected to reduce VMT by 3.5 percent.

Road Pricing Recommendations

- The State should pursue Federal Highway Administration funds available for studying and implementing a road-pricing pilot project. Existing underutilized HOV lanes in the Hartford area may provide an opportunity for initial study.
- The State should study the impact that road pricing could have on equity and sprawl.
- The State should consider broad implementation of road pricing in the long term.

Complementary VMT Reduction Incentives

The State should consider complementary VMT-reduction incentives, such as commuter choice, location-efficient mortgages, and mileage-based (pay-as-you-drive) insurance.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

GHG emissions reductions:
0.22 MMTCO$_2$e in 2010
0.49 MMTCO$_2$e in 2020

GHG reductions were calculated on the basis of a 3 percent reduction of passenger VMT below the 2020 baseline, assuming a 1.5 percent reduction in 2010. The working group considered several different data sources and calculations in developing the 3 percent estimate:

[25] Southwestern Regional Planning Association (SWERPA). 2002. *Vision 2020; Congestion Mitigation Systems Plan*.

- First, the working group considered the range of VMT savings from metropolitan planning organization smart growth studies from around the country, which ranged from 1 to 14 percent below baseline projections, with most studies falling in the range of about 3 to 10 percent.[26]
- Next, ConnDOT calculated that VMT reduction from doubling transit ridership would result in a VMT reduction of about 1.6 percent in 2020 (425.5 million divided by 26.4 billion).
- Concurrently, ConnDOT calculated that the VMT reduction from redirecting 25 percent of new growth to urban areas would yield a VMT reduction of 0.5 percent. This modeling did not capture VMT reductions from walking, biking, or reduced trip lengths (due to closer origins and destinations).
- Discussions with a national expert on transit and smart growth yielded a rough rule of thumb that VMT reductions from walking and biking are approximately equal to VMT reductions from transit under smart growth scenarios.

Combining all of this information, the working group agreed on 3 percent as a reasonable estimate of VMT reductions from a package including transit, smart growth, and complementary incentives. The working group noted that even greater VMT reductions may be available with the introduction of road pricing on a large scale throughout the State.

Costs

Transit

ConnDOT calculated that the required transit investments would require approximately $1.8 billion in capital expenses and $110 million in annual operating expenses.

Smart Growth

The Transportation Strategy Board estimated a one-time capital cost of $10 million for State assistance in GIS mapping and technical analyses and annual operating costs of $380,000 for State assistance with municipal and regional plan development.

Avoided Infrastructure Costs

To the extent that future growth can be targeted to developed areas, costly infrastructure investments can be avoided. Scarce resources can be used to repair and maintain existing systems rather than extend them into sparsely populated, exurban areas. The Research Institute for Housing America estimated the potential cost savings of smart growth measures nationally could be as much as $250 billion over a 25-year period.[27] If this nationwide estimate is apportioned to Connecticut by population, the savings could approach $2.7 billion by 2025. About 20 percent of the savings are road and land-use savings to State and local governments,

[26] Summarized in Center for Clean Air Policy. 2003. *State and Local Leadership on Transportation and Climate Change.*

[27] Research Institute for Housing America. 2001. *Linking Vision with Capital –Challenges and Opportunities in Financing Smart Growth.* Institute Report No. 01-01. Available at: www.housingamerica.org/docs/RIHA01-01.pdf.

and about 80 percent of the savings are housing, development cost, and utility savings to developers, home buyers, and commercial tenants.

Avoided Health Care Costs

An additional $3.1 million to $40.1 million in annual savings is expected from avoided health care costs due to air pollution reductions (see below).[28] The working group assumes a midpoint of $21.6 million.

Consumer Savings

A 2000 analysis of household transportation expenditures in 28 metropolitan areas found that transportation expenses are greater in low-density areas with few alternatives to the automobile. The study found that families living in low-density areas pay roughly $1,300 more per year in transportation expenses than families in compact, mixed-use areas do.[29] If this savings is assigned to the population shift associated with 25 percent penetration of smart growth measures in Connecticut, it results in decreased transportation expenditures amounting to more than $28 million in 2020. Table 3.1.12 summarizes the costs and benefits annualized over 17 years using a 7 percent discount rate.

This set of smart growth, transit and VMT reduction measures results in an estimated incremental cost of $602 per metric ton of CO_2 direct cost to government (including capital and operating costs) and $280 per metric ton of CO_2 when cost savings are included: infrastructure (pubic and private spending), health care, and household transportation expenditures.

Table 3.1.12
Annualized Costs and Benefits in 2020
(Annualized Over 17 Years With a 7% Discount Rate)

	Present Value	Levelized Annual	Operating	Total Annual
New Haven-Hartford-Springfield rail	$481,000,000	$49,266,518	$48,000,000	$97,266,518
Manchester/Vernon-Hartford BRT	$100,000,000	$10,242,519	$5,000,000	$15,242,519
Rail	$980,920,000	$100,470,920	$19,200,000	$119,670,920
Bus	$225,100,000	$23,055,911	$38,400,000	$61,455,911
Smart growth costs	$10,000,000	$1,024,252	$380,000	$1,404,252
Subtotal: Direct Government Costs				***$295,040,120***
Smart growth benefits (govt.)	($221,429,897)	($22,680,000)		($22,680,000)
Health cost savings (avg.)				($21,600,000)
Household expenditures (2020)				($28,000,000)

[28] Based on McCubbin D, Delucchi M. 1999. *The Health Costs of Motor-Vehicle-Related Air Pollution*. Journal of Transport Economics and Policy. Publication No. UCD-ITS-RP-99-16.
[29] Surface Transportation Policy Project. 2000. *Driven to Spend: The Impact of Sprawl on Household Transportation Expenses*. Available at: www.transact.org/report.asp?id=36.

Subtotal: Cost Savings	***($157,600,000)***
Total Costs (direct costs minus cost savings)	**$137,440,120**

Air Pollution Reductions

In Connecticut, mobile sources are responsible for the lion's share of criteria and hazardous air pollutant emissions. Health effects of these emissions include respiratory diseases, such as asthma and bronchitis; cardiovascular disease; and premature death. Although difficult to quantify, these emissions have real financial and social costs: treatment and hospitalizations for pollution-induced illness, missed work and school days, restricted activity, coping with symptoms of illness, and premature deaths.

A 3 percent reduction in VMT is expected to yield the following reductions in criteria pollutant emissions (Table 3.1.13):

Table 3.1.13
Criteria Pollutant Savings in 2020 From 3% VMT Reduction (tons)

CO	NOx	PM10	SO_2	VOC
18,935	1,226	35	82	1,767

Note: Calculated with ICLEI Clean Air and Climate Protection Software, Torrie Smith Associates, Inc. Based on 2020 fleet-wide passenger vehicle emission factors.

Other Benefits

- *Increased transportation choices to the traveling public.* In addition to fostering quality-of-life improvements, increased travel choices can help relieve traffic congestion, bolster economic development, and aid urban revitalization.
- *Health benefits from increased mobility.* Auto-centric development patterns have decreased mobility among adults and children, reducing opportunities for walking and bike riding. The Surface Transportation Policy Project released a report this year demonstrating a statistically significant correlation between sprawl, obesity, and hypertension. Research suggests that people in compact, mixed-use areas reap benefits from increased opportunities to integrate walking and biking into their everyday routines.[30] Smart growth seeks to encourage centralized, mixed-use communities with well-developed pedestrian and bicycle infrastructure. Given the myriad health costs associated with inactivity, creating opportunities for increased mobility through smart growth has a clear (although unquantified in this analysis) economic value.
- *Additional environmental benefits.* Smart growth measures reduce the environmental impact of development in other ways. Reduced impervious surfaces and improved water detention safeguard water quality. A study of New Jersey's Development and Redevelopment Plan found that compact development would produce 40 percent less water pollution than would

[30] Barbara A. McCann and Reid Ewing. 2003. *Measuring the Health Effects of Sprawl: A National Analysis.* Washington, DC: Surface Transportation Policy Project.

more dispersed development patterns.[31] Urban sprawl is associated with habitat loss and habitat fragmentation, processes that can disrupt the stability of Connecticut's natural ecosystems. Clean up and reuse of brownfield sites is an additional environmental benefit to smart growth.

- *Avoided costs of sprawl* that can be minimized through smart growth policies include: economic loss due to congestion, declining urban centers, disconnect between affordable housing and job location, quality of life impacts.

Stakeholder Views

The stakeholders unanimously agreed to transit and smart growth recommendations.

Public Views

Numerous public comments were received supporting smart growth efforts in Connecticut (e.g., infill development and increased transit). Public comments were received urging the implementation of the recommendations of the Blue Ribbon Commission on Property Tax Burdens and Smart Growth Incentives, including recommendations for growth management decisions and stronger regional planning organizations. Comments included calls for the development of meaningful plans of conservation and development at the State, regional, and municipal levels, including implementation of rail and other public transportation initiatives. Specific requests included the following initiatives:

- Improve mass transit with more frequent service and lower fares.
- Develop long-term plans for controlling sprawl.
- Improve pedestrian and bicycle infrastructure.
- Support brownfield redevelopment.
- Give tax credits for limiting VMT.
- Reduce vehicle trips (which can adversely affect minority communities and those living near high-traffic roads).
- Implement a tax on driving (gasoline, toll, or mileage-based insurance) that would be channeled in its entirety to a dedicated fund to subsidize mass transit, walking, and bicycling.

Supporting Documents

- Smart Growth Strawman Proposal (Document 10). This document provides more detail on the smart growth recommendations considered by the working group.
- Transit Growth Scenario Assumptions (Document 11).
- Modeling results from 25 percent reallocation of new growth (Document 12).

[31] Center for Urban Policy Research. 2001. *Impact Assessment of the New Jersey State Development and Redevelopment Plan*.

Multistate Intermodal Freight Initiative

Recommended Action: Embark upon a multistate intermodal freight initiative.

The Transportation and Land Use working group concluded that Connecticut can do little on its own to foster intermodal freight transportation in the State (see the ConnDOT memo on intermodal freight, Supporting Document 13). Therefore, the stakeholders recommend that Connecticut engage in multistate and regional discussions on opportunities to divert a portion of the projected 70 percent growth in regional truck traffic to rail and barge modes in order to reduce significantly the GHG impact of freight transportation. Because of the structure of today's freight networks, the geographic scope would likely need to go beyond the Northeast (as far south as Virginia and as far north as Halifax, Nova Scotia).

Results of Assessments for 2010, 2020, and Beyond

GHG emissions reductions:

0.00 MMTCO$_2$e in 2010
0.14 MMTCO$_2$e in 2020

Key Assumptions

- The modeling assumes that 5 percent of truck traffic shifts to rail or barge by 2020.
- Beyond 2020, the potential exists for considerable GHG emissions reductions in Connecticut and regionally, due to the creation of a more efficient, integrated, and diverse freight network that has reduced reliance on trucks as the sole means of goods movement.

Costs

Cost estimates will depend on the selection, adoption, and level of implementation for low-GHG freight policies.

Other Benefits

- Reduced traffic congestion and wear-and-tear on infrastructure
- Air pollution reductions
- More efficient delivery of goods
- Redundancy in freight networks for economic and physical security

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Supporting Documents

- ConnDOT Memo on Intermodal Movement of Freight (August 2003) (Document 13).

Clean Diesel and Black Carbon

Recommended Action: Reduce black carbon by establishing a Connecticut clean diesel program.[32]

Scientists have identified black carbon, a component of particulate matter (PM, or soot), as having a large and fast-acting warming impact on the atmosphere.[33] Diesel engines emit roughly half of the black carbon in the United States; the proportion may be lower in Connecticut, depending on black carbon emissions from other sources.[34] Thanks largely to tightening federal standards for new engines, emission-control technology is now available to retrofit or rebuild existing ("in-use") engines for any kind of diesel engine (on-road, nonroad, locomotive, and marine).

The science of black carbon's global warming potential is still evolving, and as it becomes more precise, the calculations herein may need to be adjusted. Every effort was made to use conservative assumptions about the level of black carbon emissions and reductions.

The recommendations herein summarize the strawman proposal on diesel black carbon prepared by Environment Northeast (Supporting Document 14). Refer to the transportation baseline section of this report and Environment Northeast's memo on diesel black carbon calculations (Supporting Document 3) for more information on how the CO_2 equivalency of black carbon was calculated.

The following stakeholder recommendations are based on a conservative set of assumptions, regarding technology integration and black carbon reduction:

- Include black carbon in the Connecticut GHG baseline. See baseline discussion.
- Connecticut should recommend to the NEG/ECP that black carbon emissions be included in GHG inventories and baselines.
- Establish a Connecticut clean diesel program with the following characteristics:
  - Multi-agency program charged with maximizing diesel emission reductions
  - Design and implement programs and supporting regulations
  - Oversee revenue and expenditures earmarked for clean diesel program.

[32] The Diesel Black Carbon Strawman Proposal, prepared by Environment Northeast, is the primary source of information for recommendations, costs and benefits in this section. Significant portions of this section are excerpted verbatim from the Diesel Black Carbon strawman proposal (see Supporting Document 14).
[33] Jacobson M. 2002. Control of fossil-fuel particulate black carbon and organic matter, possibly the most effective method of slowing global warming. *Journal of Geophysical Research* 107(D19): ACH 16, 1-22.
[34] See the introductory section to the report. The stakeholders have recommended that black carbon emissions from other sources, such as residential boilers, be evaluated.

State Procurement

- **Construction contracts** funded by the State should require best available control technology (BACT) and other emissions-mitigation measures for all diesel engines.[35]
- **Connecticut Transit and ConnDOT:** In the next three years, retrofit with BACT or retire early all buses in the Connecticut transit fleets (500 or more buses); all 632 DOT dump trucks and snow removal equipment; and all 131 diesel ground vehicles at Bradley airport.

Incentives

Fuel

Consider the following measures:

- Cut State sales tax on ultra-low-sulfur diesel fuel in order to reduce (or eliminate) the incremental cost of this fuel until its use is federally required in June 2006.
- Raise sales tax for on-road and off-road diesel fuel earmarked through the State Transportation Fund to the clean diesel program for retrofits and early retirements.

Retrofit Emission Controls and Early Retirement/Replacement

Consider the following measures:

- tax incentives for private sector purchase and installation of qualifying diesel emission control technology
- funding from Connecticut Clean Diesel Program to help defray costs of compliance
- federal grants, earmarked fuel tax revenues, enforcement penalties, appropriations, user fees, etc.
- Interstate trucks
- Establishment of a northeast regional program with NEG/ECP and/or Northeastern States for Coordinated Air Use Management (NESCAUM) to create a new incentive system to promote BACT for in-use engines on long-haul, interstate trucks.
- Anti-idling measures
  - Support capital expenditures to reduce truck, locomotive, and marine engine idling through electrification and use of clean auxiliary engines.

Regulatory Support

- Propose legislation directing DEP to establish phased-in emission standards requiring BACT for particulates, black carbon, and NO_x (as verified by EPA or CARB). The legislation would target in-state trucks (garbage, snow removal, dump, and tanker), school buses, transit and intercity buses, and construction equipment and would extend anti-idling rules to locomotive and marine engines.

[35] See the key assumptions for discussion of BACT.

Results of Assessments for 2010, 2020, and Beyond

Black Carbon Baseline

Developing an estimate of black carbon reductions requires development of a baseline emissions forecast. In projected black carbon emissions, it is crucial to take into account federal regulations that will reduce black carbon emissions. Specifically, current EPA rules set standards for all new on-road engines that will achieve 90 percent reductions in PM beginning in 2007. Pending EPA rules are expected to require similar reductions for all new nonroad engines that would be phased in between 2008 and 2014. The working group developed the baseline to reflect the EPA rules for new diesel vehicles, so that the black carbon policy recommendations would focus on existing on-road and nonroad vehicles.

Baseline levels of black carbon are projected to be 3.0 $MMTCO_2e$ in 1990 and 3.7 $MMTCO_2e$ in 2010 and 2020. Refer to the transportation baseline section of this report and Environment Northeast's memo on diesel black carbon calculations (Supporting Document 3) for more information on how the black carbon was determined.

GHG emissions reductions:

0.80 $MMTCO_2e$ in 2010
2.40 $MMTCO_2e$ in 2020

Key Assumptions

- The working group assumed that by 2020, the technical potential will exist to achieve 100 percent penetration of emission-control technology in pre-EPA-rule on-road and nonroad vehicles, which on average would achieve 90 percent lower PM emissions than in 2000.
- As a conservative estimate, penetration rates of 25 percent in 2010 and 75 percent in 2020 were assumed.
- The working group did not "take credit" in its reduction calculations for any purchases of "new" engines that comply with the federal on-road or proposed nonroad rules unless those purchases were made before the end of the engine's useful life as a result of State policies.
- For purposes of this discussion, BACT refers to equipment that is commercially available and achieves the highest amount of emission reductions at practical costs for a given engine type and use. For high-operating-temperature engines beginning with model year 1994, BACT represents the diesel particulate filters (DPFs) that achieve at least 90 percent black carbon reductions. DPFs capture diesel particulates before they are discharged from the tailpipe into the ambient air. For pre-1994 engines and low-operating-temperature engines (in which DPFs may not be practical), the working group assumed the use of alternative controls, including high-performance diesel-oxidation catalysts (DOCs), which oxidize diesel particles to prevent harmful emissions components and achieve better than 50 percent reductions in particulate matter and 25 percent reductions in black carbon. Although standard DOCs remove about 25 percent of particulate matter, they do not remove black carbon or NO_x and thus do not have climate benefits.
- For engines too old to warrant the expense of retrofits or those that cannot be retrofitted, the options are to accelerate early retirement and replacement with new, low-emission engines

(which in the case of a new on-road truck would deliver greater than 99 percent reductions in PM and black carbon) or to minimize operation of those engines through a combination of anti-idling programs, electrification, and clean auxiliary power units. The combination of those measures will give Connecticut the technical potential of achieving 90 percent reductions from present-level black carbon emissions by 2020.

Costs

The working group did not have comprehensive cost data or complete data on the inventory of diesel vehicles operating in Connecticut. However, it was able to develop the following cost estimates. The working group also noted that as technology evolves, emissions-control technology costs are likely to drop. For more details, see the strawman proposal (Supporting Document 14).

- Ultra-low-sulfur diesel fuel (ULSD), which contains less than 30 ppm sulfur, costs anywhere from $0.05 to $0.15 per gallon more than regular diesel. It is a prerequisite for proper operation of most DPF systems. Existing facilities can be used, but use of ULSD requires dedicated shipping and storage facilities so that it is not contaminated by higher sulfur fuels.
- DPF retrofit packages currently cost between $4,500 and $9,000 per unit for an average truck or bus. Transit buses would be on the lower end of this scale. For large construction engines such as front-end loaders, the filters can cost as much as $12,000. The cost varies with the size of the engine and the volume of the purchase.
- Alternative retrofittable controls, such as the recently commercialized Particulate Reactor, cut PM by 50 to 60 percent and cut black carbon by around 25 percent, on average. Costs vary by size of the engine; for a standard transit bus, they would be between $3,000 and $3,500. The units do not require the use of low-sulfur fuel.
- Maintenance for retrofit emission controls is very low. DPFs (in the muffler) should be removed, cleaned, and reinstalled annually.

The following cost estimates were developed for several categories of vehicles.

- Transit Buses (ConnDOT): $1.6 million to $7.0 million
  - 183 “young” Connecticut Transit buses @ $5,000 = $915,000
  - 213 “middle-aged” Connecticut Transit buses @ $3,500 = $745,500
  - Retiring or replacing 107 “old” Connecticut Transit buses after 2007 at $10,000 to $50,000 (partial cost) = $1.07 million to $5.35 million
- Bradley Airport: $0.26 million (131 pieces of equipment @ $2,000 each)
- Construction sector: $3.15 million
  - 225 units @ $4,000 = $900,000
  - 225 units @ $10,000 = $2,225,000
- School Buses: $40 million to $130 million
  - 2,210 units @ $5,000 = $11 million

  - 2,210 units @ $3,500 = $ 7.7 million
  - 2,210 units @ $10,000 to $50,000 (partial cost) = $22 million to $111 million
- Trucks: $98 million to $172 million
  - 6,550 units @ $5,000 = $32.75 million
  - 8,400 units @ $3,500 = $29.4 million
  - 632 ConnDOT plows and dumps @ average $4,250 = $17.5 million
  - 1,850 units @ $10,000 to $50,000 (partial cost) = $18.5 million to $92.5 million
- Locomotives and Marine Engines = N/A
  - Anti-idling measures = free
  - Electrification or clean auxiliary power units = N/A

Perhaps the most uncertain cost component is that of replacement costs for buses and trucks. It is assumed that vehicle replacement would not require the full vehicle purchase price but a partial cost of $10,000 to $50,000 per vehicle.

Accepting the cost assumptions, along with the other projections regarding the cooling impact of black carbon and the penetration rates of retrofits, then the cost of carbon reductions from this measure would be in the range of $6 to $13 per $MTCO_2e$. Using these assumptions, levelized annual costs would range from $13 million to $30 million.[36] Note that the cost assumptions do not include reduced health care costs resulting from lowered PM emissions.

Health Benefits

Health and climate objectives are advanced with immediate effect, including avoidance of: premature death, asthma and asthma attacks, emergency room visits, heart disease, and cancer associated with risk of exposure to diesel toxic emissions. Note that the cost assumptions above do not include reduced health care costs resulting from lowered PM emissions.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation. One stakeholder, who was not present during the final voting, voiced objections to the proposal during working group discussions. This stakeholder commented that:

- Federal law will soon require increased use of ULSD fuel and of very low emission engines.
- Connecticut has a relatively small fleet of commercial motor vehicles, and most of the large trucks that travel on Connecticut highways are from other states.
- The stakeholder raised concerns about the implications for the interstate commerce clause and the potential to put Connecticut businesses at a competitive disadvantage.

[36] Annualized using a 7% discount rate over 17 years.

Public Views

Numerous public comments were provided calling for the adoption and use of cleaner State and private fleets and reduction of diesel vehicle emissions (PM and black carbon). Specific comments discussed the adverse impact on minority communities (due to higher exposure concentrations) from diesel emissions and were in support of efforts to reduce the toxicity of diesel exhaust, including the use of ULSD fuel and PM traps.

Supporting Documents

- Diesel Black Carbon Strawman Proposal (Environment Northeast) (Document 14)
- Environment Northeast's memo on Diesel Black Carbon Calculations (10-22-03) (Document 3)

Transportation and Land-Use Working Group Supporting Documents

Available on the CCAP website, www.ccap.org. Currently available at the direct links below.

1. Memo on Transportation Baseline, CCAP (5-30-03) www.ccap.org/Connecticut/2003-May-30--CT--Transp--Baseline_Dev_Memo.pdf

2. Memo on Transportation Baseline, CCAP (10-28-03), www.ccap.org/Connecticut/2003-Oct-28--CT--Transp--Finalizing_Baseline_Projection_Memo.pdf

3. Diesel Black Carbon Calculations memo, Environment Northeast (10-22-03), www.ccap.org/Connecticut/2003-Oct-24--CT--Transp--Diesel_Black_Carbon--Fact_Sheet.pdf

4. Strawman proposal: LEV II, Connecticut Fund for the Environment (9-30-03), www.ccap.org/Connecticut/2003-Sept-30--CT--Transp--Adoption_of_LEVII_Std_strawman_proposal.pdf

5. Connecticut Fund for the Environment, *The Drive for Cleaner Air in Connecticut*. Pages 19-31. www.cfenv.org/report

6. Strawman proposal: GHG Feebate, Connecticut Fund for the Environment www.ccap.org/Connecticut/2003-Nov-17--CT--Transp--Feebate_Strawman_Proposal.pdf

7. Memo on Fleet Procurement Policies, Environment Northeast www.ccap.org/Connecticut/2003-July-23--CT--Transp--Fleet_Procurement_Memo.pdf

8. Strawman Proposal: Hydrogen Transportation Infrastructure, Environment Northeast www.ccap.org/Connecticut/2003-Nov-17--CT--Transp--Hydrogen_Strawman_Proposal.pdf

9. Summary of Hydrogen Fuel Cell Workshop (and list of participants) www.ccap.org/Connecticut/2003-Sept-19--CT--Hydrogen_Fuel_Cell_Summit_Summary.pdf

10. Strawman proposal: Smart Growth, City of New Haven. This provides more detail on the smart growth recommendations considered by the working group. www.ccap.org/Connecticut/2003-Oct-30--CT--Transp--Smart_Growth_Strawman.pdf

11. Transit Growth Scenario Assumptions, CT Department Of Transportation. www.ccap.org/Connecticut/2003-Oct-29--CT--Transp--Assumptions_to_Transit_Growth_Scenario.pdf

12. Modeling results from 25% reallocation of new growth, CT Department Of Transportation www.ccap.org/Connecticut/2003-Oct--CT--Transp--25_percent_smart_growth_results.pdf

13. Memo on Intermodal Movement of Freight, CT Department Of Transportation (August 2003). www.ccap.org/Connecticut/2003-Aug-15--CT-CCSD--Transp--Intermodal_Movement_of_Freight_GMP.doc

14. Strawman proposal: Diesel Black Carbon, Environment Northeast (10-23-03), www.ccap.org/Connecticut/2003-Oct-24--CT--Transp--Strawman_on_Diesel_Black_Carbon--Full.pdf

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Arizona SB1429 (effective June 1, 2001): Provides hybrid electric vehicles access to high-occupancy vehicle (HOV) lanes at any time, regardless of occupancy. Virginia and Utah have similar laws.

New York Executive Order 111 (January 10, 2001): Requires 50 percent of all new state light-duty vehicle acquisitions to be clean fuel vehicles by 2005, increasing to 100 percent by 2010. Hybrid electric vehicles are eligible under this program.

Connecticut Climate Change

3.2 RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL

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- Encourage Clean Combined Heat and Power
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- Create Natural Gas Conservation Fund
- Identify Measures to Reduce High Global Warming Potential Gases

Supporting Documents

- Information on Pay-As-You-Save (Connecticut DPUC)

- State funding for residential renewable energy applications in US States
- Research on status of natural gas leakage in the State of Connecticut (Connecticut DPUC)

Summary: Residential, Commercial, and Industrial Sectors

Table 3.2.1
Summary of Actions

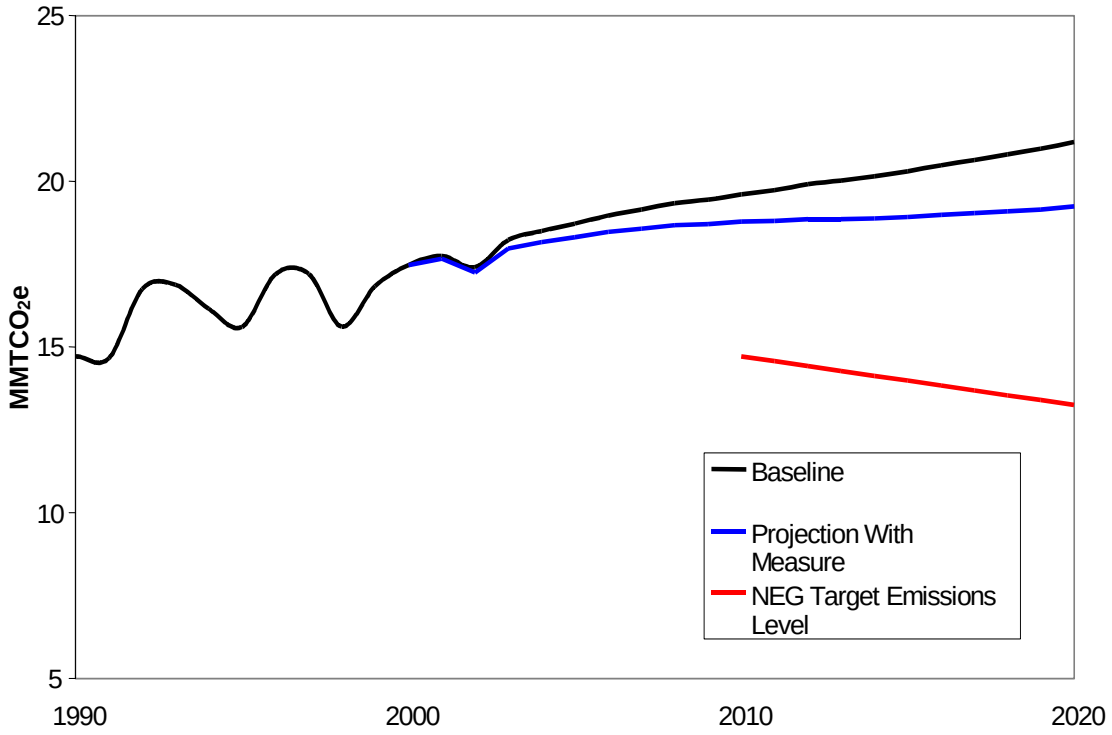
		2010		2020		
	Measure	**$MMTCO_2$ (Indirect)**	**$MMTCO_2$ (Direct)**	**$MMTCO_2$ (Indirect)**	**$MMTCO_2$ (Direct)**	**$/tCO_2$**
1	**Appliances**					
1.1	Appliance standards (R/C)	0.104	<0.001	0.205	<0.001	–106
1.2	Appliance-swapping program (R)	0.016	NA	0.020	NA	–94
1.3	Heat pump water heater replacement program (R)	0.011	NA	0.013	NA	–145
1.4	Bulk-purchasing program of appliances (R/C)	0.023	NA	0.046	NA	–187
2	**Residential Buildings**					
2.1	Mandate upgrades to residential and commercial building energy codes (R/C)	0.009	0.048	0.036	0.176	–177
2.2	Promote EE and energy improvement mortgages	0.001	0.004	0.002	0.012	–33
2.3	Revise current energy conservation loan program	NE	NE	NE	NE	NE
2.4	Weatherization program (R)	0.003	0.003	0.003	0.003	265
2.5	Energy Star Homes Program	0.008	0.009	0.021	0.023	–3
3	**Commercial Buildings**					
3.1	High-performance buildings: schools and other State-funded buildings	0.011	0.006	0.038	0.020	464
3.2	High-performance buildings: privately funded projects	0.012	0.007	0.034	0.018	343
3.3	Shared savings program for government agencies and benchmarking (C)	0.098	0.026	0.160	0.039	NE
3.4	Training building operators (R/C)	0.020	0.011	0.022	0.011	–159
3.5	Green campus initiatives	0.099	0.084	0.106	0.084	NE
3.6	Energy benchmarking, measurement, and tracking program for municipal buildings	0.046	0.073	0.086	0.104	NE
3.7	Fuel switching (oil to biodiesel)	NA	<0.001	NA	<0.001	–123
3.8	Remove current barriers to third-party load-management techniques (C)	0.018		0.033		–34
3.9	State procurement of environmentally preferable services and products	NE	NE	NE	NE	NE
4	**Industry**					
4.1	Review NEDRI recommendations	NE	NE	NE	NE	NE

Table 3.2.1
Summary of Actions

		2010		2020		
	Measure	**$MMTCO_2$ (Indirect)**	**$MMTCO_2$ (Direct)**	**$MMTCO_2$ (Indirect)**	**$MMTCO_2$ (Direct)**	**$/tCO_2$**
4.2	Promote voluntary programs and actions (I)	NE	NE	NE	NE	NE
4.3	Encourage clean combined heat and power (C/I)	0.523	0.009	1.389	0.025	
5	**Comprehensive**					
5.1	Restore Conservation and Load Management Fund	0.279	NA	0.606	NA	–56
5.2	Create heating oil conservation fund (R/C/I)	NA	0.311	NA	0.828	–187
5.3	Create natural gas conservation fund (R/C/I)	NA	0.225	NA	0.601	–303
5.4	Identify measures to reduce high global warming potential gases (R/C/I)	NE	NE	NE	NE	NE
	Total Savings From RCI ($MMTCO_2E$)	**1.28**	**0.82**	**2.82**	**1.94**	
	Percentage of Total Savings	61%	39%	59%	41%	
	Baseline		19.60		21.20	
	NEG/ECP Goal		14.72		13.25	
	Goal Reductions		4.88		7.95	
	Additional Reductions Needed		(4.06)		(6.01)	
	% reductions achieved compared to baseline		**4%**		**9%**	

Note: Indirect emission reductions from reducing electricity demand are measured against the electricity sector baseline.
NE: not estimated
NA: not applicable
R: residential; C: commercial; I: industrial

Figure 3.2.1
Connecticut GHG Reductions From the Residential, Commercial, and Industrial Sector



Note: NEG does not necessarily assume equal percentage reductions in each sector.

Baseline

The GHG baseline for Connecticut's residential, commercial, and industrial (RCI) sectors includes GHG emissions from two source categories:[1]

- *GHG emissions (CO_2, methane, N_2O) from direct combustion of fossil fuels*. Most emissions over the time period are estimated to be from direct combustion of fossil fuels; most direct emissions are attributed to the residential sector. These emissions contribute to 92 percent of the RCI baseline in 2000, 87 percent in 2010, and 83 percent in 2020 (see Table 3.2.2).
- *GHG emissions (methane, HFCs, PFCs, and SF_6) from industrial processes*. Sources of emissions in this category include transmission and distribution of natural gas systems, substitutes for ozone-depleting substances (ODS), semiconductor manufacturing, and electric power transmission and distribution systems. Emissions from industrial processes represent a much smaller but increasing share of emissions relative to the other source category. These emissions contribute to 8 percent of the RCI baseline in 2000, 13 percent in 2010, and 17 percent in 2020.

[1] Black carbon from combustion of diesel fuel oil in the RCI sectors may contribute significantly to the GHG emissions baseline. However, for this analysis, emissions associated with black carbon were not considered because of time limitations. This area warrants further research.

GHG emissions associated with electricity consumption are accounted for in the electricity baseline and are discussed in the electricity chapter (Section 3.3).

Table 3.2.2
Share of RCI Emissions by Source Category

	2000 (%)	2010 (%)	2020 (%)
Direct Emissions			
Residential	48	47	43
Commercial	25	23	23
Industrial	18	17	16
Industrial Process Emissions	**8**	**13**	**17**

For each source category, the data and assumptions used for the preliminary estimate of both historical emissions (1990–2000) and projected emissions (2001–2020) follow.

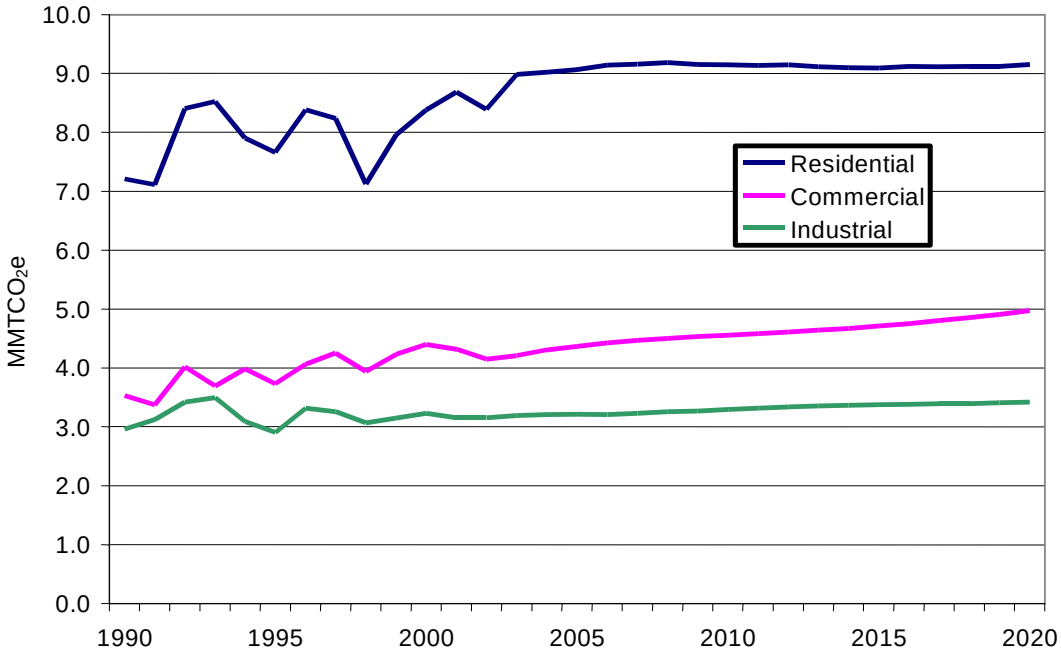
Emissions From Direct Combustion of Fossil Fuels

Direct combustion of fossil fuels refers to coal, oil, and natural gas that are combusted onsite in the residential, commercial, and industrial sector. Figure 3.2.2 shows the baseline for this source category by sector. Most emissions from this source category are from the residential sector, and that trend is expected to continue. Of the residential emissions, roughly 70 percent are attributed to oil use in 2000. The share of oil use in the residential sector is expected to decrease only slightly by 2020. The fuel consumption figures for the commercial and industrial sectors show a relatively even distribution of emissions attributed to the use of oil and natural gas.

- *Historical Emissions (1990-2000)*: The historical emissions for this sector (1990–2000), developed from NESCAUM, are based on EIA State Energy Data Report,[2] which is reported by fuel type, by sector. The EIA state data for industry were adjusted to resolve a reporting error. Coal use for generation of electricity was inadvertently reported under the industrial sector after deregulation in the late 1990s. The coal use reported in the industrial sector from 1998 to 2000 was removed and counted in the electricity sector. Default values from the EPA were used to convert fuel use into emissions.
- *Projected Emissions (2000-2020)*: The forecast is based on the regional growth forecast for different fuel types by sector from EIA's *Annual Energy Outlook* (AEO). Additional detail on the model and its assumptions can be accessed from EIA's report.[3] EIA's *AEO 2003* model is sophisticated, but it forecasts by region rather than by state; thus, it is appropriate, insofar as fuel use in Connecticut is similar to that of the New England region. Default values from the DOE and EPA are used to convert fuel use into emissions.

[2] Available at: www.eia.doe.gov/ emeu/states/main_ct.html.
[3] Available at www.eia.doe.gov/oiaf/aeo/assumption/index.html.

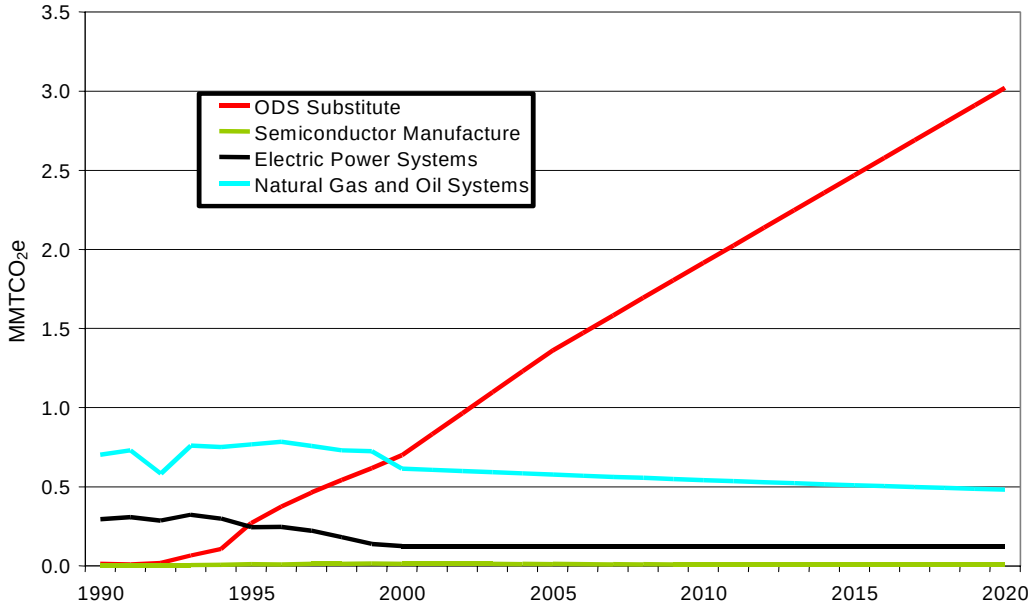
Figure 3.2.2
Emissions From Direct Fossil Fuel Combustion



Industrial Process Emissions

A number of industrial activities result in GHG emissions. In Connecticut, those activities include transmission and distribution of natural gas, ODS substitutes, semiconductor manufacture, and electric power systems. Figure 3.2.3 shows that such emissions are relatively

Figure 3.2.3
Non-CO_2 Emissions in the Industrial Sector



small and are expected to decline by 2020, with one notable exception: ODS substitutes. The GHG emissions from the use of ODS substitutes is expected to increase rapidly over the next few decades as high-global-warming potential (GWP) gases are used to replace ODSs in a number of applications.

Emissions From Natural Gas Systems

Methane (CH_4) is emitted during oil and gas production, storage, transportation, and distribution. Because no oil or gas production takes place in Connecticut, emissions occur solely through gas transmission and distribution. Major CH_4 emission sources from gas transmission pipelines include chronic leaks, fugitive emissions from compressors, compressor exhaust, vents, and pneumatic devices. For gas distribution pipelines, major CH_4 emission sources include chronic leaks, meters, regulators, and mishaps.

- *Historical Emissions 1990–2000*: NESCAUM Connecticut Inventory.
- *Projected Emissions 2001-2020*: GHG emissions were forecast on the basis of the historical growth rate and are expected to decline over the time period.

Emissions From the Use of ODS Substitutes

HFC and PFC emissions result from refrigeration and air conditioning, solvents, foams, aerosols, and fire extinguishing.

- *Historical Emissions 1990–2000:* NESCAUM Connecticut Inventory
- *Projected Emissions 2001–2020:* The forecast presented here assumes that Connecticut's share of national ODS replacement emissions remains constant over time (based on the ratio in the year 2000). Data on national emissions from ODS substitutes are estimated using a complex vintaging model that accounts for equipment turnover, leak rates, charge size, and initial ODS.[4]

Semiconductor Manufacture

The manufacture of semiconductors results in SF_6 emissions. The World Semiconductor Council (WSC) has pledged to reduce PFC emissions from chip manufacture to at least 10 percent below 1995 levels by 2010. More than 90 percent of U.S. semiconductor manufacturing capability is represented by the WSC and its U.S. segment, the Semiconductor Industry Association.

- *Historical Emissions 1990–2000*: NESCAUM Connecticut Inventory
- *Projected Emissions 2001–2020*: It was assumed that Connecticut companies met WSC standard in 2010 and that emissions remain constant thereafter.

SF_6 Emissions From Electricity Systems

[4] The estimates are reported in EPA. (2001). *U.S. High GWP Gas Emissions 1990–2010: Inventories, Projections, and Opportunities for Reductions*. EPA 000-F-97-000. Washington, DC: Office of Air and Radiation.

SF_6 is used as an insulator in electricity transmission and distribution systems (e.g., in circuit breakers, substations, and transmission), and the chemical is leaked into the atmosphere. The EPA has a voluntary program to address those emissions.

- *Historical Emissions 1990–2000*: NESCAUM Connecticut Inventory
- *Projected Emissions 2001–2020*: It was assumed that emissions will remain constant at 2000 levels over time. Emissions decreased roughly 30 percent from 1998 to 1999 and remained at this level in 2000.

Appliance Standards

Recommended Action: Establish efficiency standards for appliances.

The State should set efficiency standards for eight appliances that are commercially available and do not require a federal waiver for state regulation. Those appliances include dry-type transformers, commercial refrigerators and freezers, exit signs, traffic signals, torchière lamps, packaged large A/C units greater than 20 tons, unit heaters, and commercial clothes washers (Table 3.2.3). Appliances at the proposed efficiency level are commercially available.

Table 3.2.3
Summary of Proposed Appliance Standards

Product	Unit Sales in CT	Annual per Unit savings (kWh)	Year Effective	Lifetime
Dry type transformers	254,820	16.6	2005	30.0
Commercial refrigerators and freezers	500	1,542	2005	9.0
Exit signs	4,450	223	2005	2.5
Traffic signals	5,080	431	2005	15.0
Torchiere lamps	107,700	288	2005	10.0
Packaged large AC > 20 tons	150	6,141	2005	15.0
Unit heaters (therm savings)	1,470	268	2006	18.0
Commercial clothes washers	2,880	197	2008	8.0

Source: NEEP, 2003

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Implementing these appliance standards is estimated to reduce GHG emissions by
0.104 MMTCO$_2$e in 2010
0.205 MMTCO$_2$e in 2020

The savings estimates are based on a study by the Northeast Energy Efficiency Partnership (NEEP). NEEP disaggregated a national study by the American Council for an Energy Efficient Economy (ACEEE) and allocated fractions of the estimated energy and peak-demand savings from efficiency standards to individual states by applying state allocation factors. The analysis is static and assumes that equipment sales remain at 2000 levels for all products. In the absence of standards, efficiency levels remain at present levels. In actuality, product sales and efficiency are gradually increasing, even in the absence of standards. Thus, NEEP's study implicitly assumed that those factors counterbalance each other (NEEP, 2003).

The appliance standards will reduce primarily indirect emissions; minor direct emissions savings will come from unit heaters. Estimates are shown in Table 3.2.4.

Table 3.2.4
Estimated Emission Reductions From Improved Appliance Standards

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	<0.001	<0.001
Indirect emissions reductions* ($MMTCO_2e$)	0.104	0.205
Total emission reductions ($MMTCO_2e$)	**0.104**	**0.205**

* Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

Levelized annual costs, based on the NEEP study, were estimated as –$106/$tCO_2$. This estimate accounts for the incremental cost of higher efficiency appliances and the cost savings associated with reduced energy consumption.

Co-benefits were not quantified, but they include (1) reduced hydrofluorocarbon (HFC) and chloroflourocarbon (CFC) emissions due to leaks from commercial refrigerators and freezers and AC and (2) reduced water consumption from commercial clothes washers.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation (referred to as "unanimous consent" in the summary tables). One stakeholder raised concerns regarding regulation of State-specific efficiency standards for large packaged A/C and commercial refrigerators and freezers because these appliances may be regulated at the federal level.

Public Views

None

Appliance-Swapping Program

Recommended Action: Create an appliance-swapping program.

Develop a "pay-as-you-save" program under the Conservation and Load Management Fund to replace old appliances in the residential sector with new Energy Star appliances. Appliances to be covered include Energy Star Tumble Clothes Washer, Energy Star Refrigerator, Energy Star Room A/C (6500 BTU), and Energy Star Dishwasher.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

The appliance-swapping program is estimated to reduce GHG emissions by
0.016 $MMTCO_2e$ in 2010
0.020 $MMTCO_2e$ in 2020

The GHG savings were estimated by multiplying the incremental electricity savings of new Energy Star units compared with old units by the number of units replaced each year by the marginal CO_2 emission factor for regional electricity grid. Assumptions and the estimated savings and costs are shown in Table 3.2.5.

Table 3.2.5
Assumptions for GHG Savings From Appliance-Swapping Program

	Savings Compared With Older Unit (kWh/yr/unit)	Number of Units Replaced Annually	Lifetime*
Energy Star tumble clothes washer	281	3,000	14
Energy Star refrigerator	1,200	3,000	15
Energy Star room AC (6500 BTU)	100	3,000	10
Energy Star dishwasher	186	3,000	10

Source: Savings estimates from DPUC; number of units replaced estimated
*The analysis assumes that savings would only be generated during the first seven years of the equipment life.

The appliance-swapping program will reduce indirect emissions from electricity consumption (Table 3.2.6).

Table 3.2.6
Estimated Emissions Reductions From Appliance-Swapping Program

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	NA	NA
Indirect emissions reductions* ($MMTCO_2e$)	0.016	0.020
Total emission reductions ($MMTCO_2e$)	**0.016**	**0.020**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.
NA: not applicable

Levelized annual costs were estimated to be –$94/$tCO_2$. This estimate is based on the incremental cost of the equipment and the cost savings associated with reduced electricity

consumption. Although not quantified this measure will also reduce the emissions for hydrofluorocarbons (HFCs) and chlorofluorocarbons (CFCs) leaked into the atmosphere from refrigerators and A/C units.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

None

Heat Pump Water Heater Replacement Program

Recommended Action: Create a heat pump water heater (HPWH) replacement program.

Develop a pay-as-you-save program under the Conservation and Load Management Fund (C&LM) to promote the WatterSaver, the next generation of heat pump water heater (HPWH) technology. By utilizing the ambient air, the WatterSaver attains an efficiency rating nearly three times that of the most efficient electric water heaters. This technology is projected to be commercially available in 2004.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Implementing this HPWH Program is estimated to reduce GHG emissions by
0.011 MMTCO$_2$e in 2010
0.013 MMTCO$_2$e in 2020

The GHG emissions were estimated by multiplying the annual electric savings associated with the WatterSaver by the number of units replaced each year by the marginal CO_2 emission factor for the regional electricity grid. The annual electric energy savings for the WatterSaver HPWH is estimated to be 2400kWh/yr/unit, compared with the current state-of-the-art electric hot water heaters. It was estimated that this technology will achieve a 0.5 percent annual market penetration during the first five years following commercialization in 2004, or approximately 1,350 units per year in Connecticut.

The GHG emission reductions from this measure are indirect emissions from decreased electricity consumption (Table 3.2.7).

Table 3.2.7
Estimated Emissions Reductions From Heat Pump Water Heater Replacement Program

	2010	2020
Direct emissions reductions (MMTCO$_2$e)	NA	NA
Indirect emissions reductions* (MMTCO$_2$e)	0.011	0.013
Total emission reductions (MMTCO$_2$e)	**0.011**	**0.013**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.
NA: not applicable.

Levelized annual costs were estimated to be –$145/tCO$_2$. This estimate is based on an approximate incremental installed cost of $500 per unit and the cost savings associated with reduced electricity consumption.

In addition to improving the efficiency of water heating, this appliance has also demonstrated the co-benefit of dehumidifying the space where it is located.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

There was a recommendation to reduce dependence on fossil fuels by heating and cooling houses using ground source heat pumps. To help fund the difference in the initial cost of the efficient heating and cooling systems, there was a suggestion to create a utility company–backed loan to the builder or homeowner that would run with the title of the property and would be repaid as part of the energy bill.

Bulk Purchasing of Appliances

Recommended Action: Create a program for bulk purchasing of appliances.

This program consists of two components:

1. Promote the Consortium for Energy Efficiency's (CEE's) residential-sector bulk-purchasing program in Connecticut along with other states in the region. The program covers apartment-sized refrigerators, large refrigerators, subcompact fluorescents, reflector compact fluorescent lights, dedicated compact flourescent recessed light fixtures, and heat pump water heaters.
2. Promote Pacific Northwest National Laboratory's (PNNL's) commercial-sector bulk-purchasing program in Connecticut and in other states in the region. This program covers unitary rooftop air conditioning products in the 65,000 to 135,000 Btu/h cooling capacity range.

Technology Bulk Procurement is a method for pulling new highly efficient and affordable products into the marketplace through competitive procurements that are backed by large volume buyers.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Implementing this bulk-purchasing program is estimated to reduce GHG emissions by
0.023 MMTCO$_2$e in 2010
0.046 MMTCO$_2$e in 2020

The GHG savings were estimated by multiplying the annual unit savings (kWh) for the appliance by the number of appliances sold annually under the program by the marginal CO_2 emission factor for the regional electricity grid. Data were not available to estimate savings for all appliances under the program. The appliances for which data were available are listed in Table 3.2.8.

Table 3.2.8
Summary of Appliance Data for Bulk-Purchasing Program

Appliance	Unit Savings (kWh)	Appliances Sold Under Program Annually
Apartment-sized refrigerators (14.5 cu ft)	575.0	1,991
Large refrigerators (18.5 cu ft)	435.0	1,991
Subcompact fluorescents	43.8	36,000
Unitary AC	849.0	4,000

Sources: CEE, 2003; PNNL, 2003.

The GHG emission reductions from this measure are indirect emissions from decreased electricity consumption as shown in Table 3.2.9.

Table 3.2.9
Estimated Emissions Reductions From Bulk Purchasing of Appliances

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	NA	NA
Indirect emissions reductions* ($MMTCO_2e$)	0.023	0.046
Total emission reductions ($MMTCO_2e$)	**0.023**	**0.046**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.
NA: not applicable

Levelized annual costs for the residential program were estimated to be –$222/$tCO_2$ and for the commercial program –$187/$tCO_2$. The estimates are based on the incremental cost of the appliance and the savings associated with reduced electricity consumption.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

There was a recommendation to prioritize programs such as improved lighting efficiency.

Upgraded Residential and Commercial Building Energy Codes

Recommended Action: Upgrade residential and commercial building energy codes.[5]

The State should adopt the latest Energy Code from the International Code Council (ICC) by July 2004 and require the automatic adoption of updated revisions within 18 months as they become available for both residential and commercial buildings. Current State law requires the State Building Code (Code) to be updated to incorporate any "necessary" revisions adopted by the ICC. The stated purposes of the Code include conserving energy and facilitating the use of renewable resources.

Conn. Gen. Stat. § 29-252 incorporates energy conservation provisions and is based on the 1996 building code developed by a predecessor of the ICC. The adoption of subsequent revisions in Connecticut has been delayed, in part, by a dispute over whether the International Fire Code should be adopted for certain provisions (mostly unrelated to energy) in place of the existing National Fire Protection Association Code. The State Codes and Standards Committee and the Department of Public Safety are in the process of reviewing and considering updated commercial and residential codes that could be adopted by July 2004.

The most up-to-date revision of the ICC codes, including the International Building Code and the International Energy Conservation Code, occurred in 2003. Many other states, including New Hampshire, New York, Pennsylvania, and Rhode Island, use the ICC codes. Adoption of the updated ICC Building, Energy and Fire codes has been endorsed by key officials of the Department of Public Safety, including the State Building Inspector; the Codes and Standards Committee; and the Coalition for the Adoption of a Unified Code, which includes organizations representing architects and construction trades.

Connecticut can ensure that efficiency standards keep pace with evolving technology by requiring that revisions to the International Energy Conservation Code be adopted (without additional legislative action) within 18 months after they become available. This would not require changing the existing flexibility for adopting more complex building and fire codes.

The State of Connecticut should work with the insurance industry to encourage and enforce increased energy efficiency and mitigation of GHG emissions in commercial, institutional, and residential buildings, through improvements and changes to the State's building codes. The State should encourage the insurance industry to identify changes needed in the building code that will result in reduced fire and safety losses while addressing energy efficiency and conservation (i.e., similar to what was done with torchiere lamps).

[5] The upgrade residential and commercial building energy code strawman proposal, prepared by Environment Northeast, is the primary source of information on the upgraded residential and commercial building code recommendations. Significant portions of this section are excerpted verbatim from the upgrade residential and commercial building codes strawman proposal and the full strawman proposal is available in the RCI Assumptions Document (October 30, 2003).

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Upgrading residential building energy codes as they become available is estimated to reduce GHG emissions by

0.057 MMTCO$_2$e in 2010
0.212 MMTCO$_2$e in 2020

These GHG savings only represent savings associated with upgrading the residential building code. Savings associated with upgrading commercial buildings were not estimated because data were not available. GHG savings for the residential building code upgrade were estimated by multiplying the electricity, gas, and oil savings per household by the number of new homes built that comply with the ICC standard by the appropriate GHG emission factor. Based on a study that looked at upgrading residential building codes in Massachusetts (XENERGY, 2001), it was assumed that upgrading the codes would result in the average home achieving a 1.1 percent savings in electricity and a 13.7 percent or 18.4 percent savings in oil or natural gas, respectively, depending on the home heating fuel. It was assumed that 70 percent of new homes comply with the new standard. It was also assumed that new codes would be developed every three years and adopted by the State within two years.

It is estimated that both direct and indirect emission reductions will be achieved through this measure, as detailed in Table 3.2.10.

Table 3.2.10
Estimated Emissions Reductions From Updated Building Energy Codes

	2010	2020
Direct emissions reductions (MMTCO$_2$e)	0.048	0.176
Indirect emissions reductions* (MMTCO$_2$e)	0.009	0.036
Total emission reductions (MMTCO$_2$e)	**0.057**	**0.212**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

Costs of this measure were not estimated because data were not available. The savings associated with reduced consumption of fossil fuel and electricity were calculated.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

- It was recommended that energy efficiency standards for new buildings and renovations should conform to higher requirements, such as LEEDS standards.
- It was recommended that the State of Connecticut work with the insurance industry to encourage increased energy efficiency and mitigation of GHG emissions resulting from commercial, institutional, and residential buildings, primarily by improvements and changes

to Connecticut building codes, implementation of EE standards for buildings (e.g., similar to those in Europe) in Connecticut, and other standards, and the removal of barriers preventing such efficiencies in existing codes.

Promote Energy Efficient and Energy Improvement Mortgages

Recommended Action: Promote energy efficient and energy improvement mortgages.

This measure is targeted at increasing the awareness of financial products that can encourage people to purchase energy efficient homes and includes the following activities:

- Actively promote EE mortgages (EEMs) in Connecticut. The current EEM allows homebuyers to purchase Energy Star homes that might have cost more than they would have qualified to borrow. In its initial form, the EEM was a straight 2 percent stretch that allowed the buyers of EE homes to qualify for up to 2 percent more debt because of their lowered monthly utility costs.
- Work with the Connecticut Housing and Finance Authority (CHFA), Fannie Mae, and others to develop an energy improvement mortgage (EIM), and then actively promote this product in Connecticut.[6] EIMs target homeowners who purchase existing homes or are making upgrades to their current home. This program would help finance EE improvements on existing homes, such as upgrading to efficient furnaces and adding insulation. Because most of the housing stock in Connecticut was built before 1960, this measure is likely to have a large impact if homeowners take advantage of it. This program has worked best when a home energy rating system (HERS) is available to document the relative efficiency of a home.
- Work with CHFA, Fannie Mae, and others to develop a "smart-commute mortgage," and then actively promote it in Connecticut.
- The State of Connecticut should work with the insurance and banking industries, as well as with home inspectors, to identify safety and EE measures that may mitigate GHG emissions. These measures can be addressed during real estate sales and affect insurance and bank products and services.
- The State should work with the Connecticut home inspectors trade association to provide information on energy efficiency and energy audits. It could develop or collect existing materials that deal with efficient appliances, heating and cooling systems, water heaters, and other home energy savings ideas that inspectors can distribute during home inspections.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Actively promoting EIMs in Connecticut is estimated to reduce GHG emissions of:

0.005 MMTCO$_2$e in 2010

0.014 MMTCO$_2$e in 2020

GHG savings are only estimated for EIMs. GHG savings associated with the EEMs were not estimated because it was assumed that those savings would be accounted for under the Energy Star Homes Program. In other words, promotion of EEMs would lead to an increased

[6] Fannie Mae and Freddie Mac are piloting similar efforts in Alaska, Arkansas, Colorado, Iowa, Louisiana, Mississippi, Vermont, and Wisconsin.

participation in the Energy Star Homes Program. Data on smart-commute mortgages were not available for this exercise; therefore, the estimates below do not include savings associated with that type of product.

GHG savings were estimated by multiplying the electricity, gas, and oil savings per home by the number of new homes participating in the EIM program by the appropriate GHG emission factor (Table 3.2.11). Electricity savings were estimated to be 3 percent whereas fossil fuel savings were estimated to be up to 39 percent, which is based on data from an EIM program administered in Vermont. Participation in the program was estimated to be 0.5 percent of residential resale in Connecticut in the first five years and 1 percent in the subsequent years.

Table 3.2.11
Estimated Emissions Reductions Through Energy Efficiency and Energy Improvement Mortgages

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	0.004	0.012
Indirect emissions reductions* ($MMTCO_2e$)	0.001	0.002
Total emission reductions ($MMTCO_2e$)	**0.005**	**0.014**

* Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

Levelized annual costs for this measure were estimated to be –$33/t CO_2. This estimate is based on the costs associated with the Vermont program and the cost savings associated with the reduced energy consumption.

EIMs represents an untapped tool that could potentially reduce energy consumption and GHG emissions while creating more affordable homes. They could also facilitate community revitalization by helping U.S. consumers access capital; improving the energy efficiency of existing housing stock; and helping communities retain conserved energy dollars in the local economy.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

- This recommendation was supported as a market-oriented program that facilitates consumer choices for energy efficiency. However, it was recommended that an EE mortgage program be coordinated with private sector efforts. For example, with respect to oil-heated residences, the heating oil industry has already initiated marketing efforts to educate consumers on the benefits of upgrading to newly developed, high-efficiency oil heat equipment.
- In implementing this program, it was recommended that all parties involved (e.g., real estate agents, home inspectors, and lenders) ensure the fuel neutrality of the program.

Revise Energy Conservation Loan Program

Recommended Action: Revise the current Energy Conservation Loan Program (ECL).

The State should improve the current ECL program, which provides low-interest loans (with the interest rate based on income) for EE improvements and is run by the Department of Economic and Community Development. The total annual savings from the existing ECL program is approximately 790,533,000 BTUs; the average cost of $875,000/year is based on the past two years. Approximately 70 percent of the money went for "energy saving" measures, 30 percent of the dollars went to energy-related but "non-energy saving" measures.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable):

Emission reductions and cost associated with revising the current Energy Conservation Loan Program have not been estimated.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

None.

Weatherization Program

Recommended Action: Expand weatherization program.

The State should provide funding to double the amount of households served under the Federal Weatherization Assistance Program (WAP), which targets low-income households for comprehensive weatherization. The current WAP program covers between 700 and 1000 housing units per year at a cost of $2,400 to $3,000 per unit.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Expanding the weatherization program is estimated to reduce GHG emissions by
0.006 $MMTCO_2e$ in 2010
0.006 $MMTCO_2e$ in 2020

The GHG savings were estimated by multiplying the electricity and fossil fuel savings per home times the number of homes participating in the program by the appropriate GHG emission factor. The savings were based on an Oak Ridge National Laboratory study (ORNL, 1994) that estimated weatherization savings to be, on average, 13.5 percent, including both electricity and fossil fuel. It was estimated that savings would persist for five years and that an additional 840 homes could be served, compared with the existing program. Estimates for direct and indirect emissions are shown in Table 3.2.12.

Table 3.2.12
Estimated Emissions Reductions Through Weatherization Program

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	0.003	0.003
Indirect emissions reductions* ($MMTCO_2e$)	0.003	0.003
Total emission reductions ($MMTCO_2e$)	**0.006**	**0.006**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

The costs were based on the low-income WAP at a cost of approximately $2,500 per home for an annual average of 700 to 1,000 homes completed over the 2001–2003 period (DSS, 2003). The annual levelized annual costs are estimated to be $265/$tCO_2$. This estimate also accounts for the cost savings associated with reduced energy consumption.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

None

Energy Star Homes Program

Recommended Action: Double participation in the Energy Star Homes Program

This program would expand rebates under the Conservation and Load Management Fund to double participation in the Energy Star Homes program (for new construction only). The current Energy Star homes program targets approximately 15 percent of new homes at an estimated cost of $1,800 to $4,700, depending on the measures implemented. In addition, Connecticut should stay abreast of developments of the United States Green Building Council (USGBC), which is in the early stages of developing a LEED (Leadership in Energy and Environmental Design) standard for residential homes. Although the standard will not be finalized for three to five years, when it is available, Connecticut should review and determine if it should be actively promoted.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Expanding the Energy Star Homes Program is estimated to reduce GHG emissions by
0.018 $MMTCO_2e$ in 2010
0.044 $MMTCO_2e$ in 2020

The GHG savings were estimated by multiplying the average savings of electricity and fossil fuel use for an Energy Star home compared with an average home by the number of new Energy Star homes built by the appropriate GHG emission factor (Table 3.2.12). Energy Star-qualified homes incorporate savings in design and construction and, in Connecticut, use approximately 15 percent less energy for heating, cooling, water heating, lighting, and appliances than a standard home. The number of new homes in Connecticut is expected to be between 8,300 and 8,900 over the next five years.

Table 3.2.12
Estimated Emissions Reductions Through the Energy Star Homes Program

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	0.009	0.023
Indirect emissions reductions* ($MMTCO_2e$)	0.008	0.021
Total emission reductions ($MMTCO_2e$)	**0.018**	**0.044**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

The incremental cost to build Energy Star homes varies greatly; it depends on the house size, the region, and the prevailing construction practices in the region. The average incremental cost is $2,150. A few homes cost more; occasionally, an Energy Star-labeled home can actually be less expensive to build than its non-Energy Star counterpart (i.e., good insulation, high-performance windows, tight infiltration, and elimination of duct leakage can lower the heating and cooling load so much that smaller and less expensive HVAC equipment and more compact duct runs are able to be installed, saving significant first costs) (EPA, 2003). Based on the incremental cost and the cost savings associated with reduced energy consumption, levelized annual costs were estimated to be –$3/$tCO_2$.

Stakeholder Views

The stakeholders unanimously agreed to this measure.

Public Views

It was recommended that efficiency of new and existing buildings be improved (i.e., “green” buildings).

High-Performance Buildings: Schools and Other State-Funded Projects

Recommended Action: Require high-performance buildings for schools and other State-funded projects.

This program would mandate high-performance energy requirements for State-funded buildings, including State facilities and local schools, as follows:

- *New construction and major renovations* of all building projects that receive some State funding (State facilities, local schools, etc.) must meet LEED standards and certify with the U.S. Green Buildings Council (USGBC). Although LEED identifies several building areas, the Energy and Atmosphere and the Indoor Environmental Quality areas have a significant GHG emissions impact. It is anticipated that these areas will be a strong focus for new buildings because they have a good payback and are easy to accomplish. After 2010, the State should consider requiring a higher level of LEED (e.g., silver, gold, or platinum). This requirement can be achieved through legislation, executive order, or the bonding process. The State will also need to provide education and outreach to towns, the Connecticut Department of Education, and others, so that they become familiar with LEED standards as well as the benefits (USGBC, 2003a,b,c).
- *Small construction and renovation projects* that use State funding should also be required to meet a high-performance building standard. Connecticut should not require LEED but should develop standards for small projects and mandate that they be met. This approach would be an alternative to the formal USGBC LEED process, which is often not supported by small project budgets. The Connecticut Department of Public Works (DPW) has begun to develop these standards and may initiate a pilot project in the near future. Some LEED principles could serve as an informal guide. For example, Connecticut could require expert review early in the design process for small projects. This approach can be achieved through legislation, executive order, or the bonding process.
- *Existing State buildings* and space leased to the State should also be required to meet certain energy standards. USGBC is piloting a new program, LEED for existing buildings, which will most likely be final in 2004. This certification program will examine ongoing maintenance and operations of building systems. Optimizing energy efficiency, renewable energy, and continual commissioning are included in the draft checklist. Once final, this program should be evaluated and, if appropriate, be promoted for private and public buildings. Certification with the USGBC could be optional, but the elements of the certification could be adopted independent of the actual certification process. This approach can be achieved through legislation or executive order.

  USGBC is developing a LEED program aimed at tenant space (LEED for Commercial Interiors). It is anticipated that this program may be final by late 2004 at the earliest. This program focuses on the core and shell of buildings. Low-emitting materials and other environmentally preferable products are included in the draft checklist. Once final, this program perhaps should be evaluated and, if appropriate, be promoted for private and public buildings that are leased. Certification with the USGBC could be optional, but the elements

of the certification could be adopted independent of the actual certification process. This approach can be achieved through legislation or executive order.

- *Provide recognition* for projects that go beyond LEED certification. Currently, DEP's Green Circle Award is given for LEED-certified projects.

The State of Connecticut should work with the insurance industry to encourage it to identify green building measures that also decrease risk and liability. The insurance industry can leverage green building measures in their products (e.g., using renewables like solar can reduce fire and safety liability associated with current energy systems).

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Mandating that LEED standards be met for all new State-funded construction and major renovations is estimated to reduce GHG emissions by

0.017 $MMTCO_2e$ in 2010
0.058 $MMTCO_2e$ in 2020

The GHG savings were estimated by multiplying the square footage of new State-funded buildings achieving LEED by the incremental electricity and fossil fuel savings associated with LEED by the appropriate GHG emission factor. The energy savings are based on experience with LEED buildings showing that it is relatively straightforward to achieve 20 to 30 percent reductions compared with the 1989 ICC building code standard. This savings translates into 15 to 25 percent compared with the 1999 or 2001 ICC building code standard (Steven Winters Associates, 2003). It was estimated that approximately 1.5 million square feet of qualifying buildings would be built each year. Emission reductions will include both direct and indirect emission reductions, as shown in Table 3.2.14.

Table 3.2.14
Estimated Emissions Reductions From State-Funded High Performance Buildings

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	0.006	0.020
Indirect emissions reductions* ($MMTCO_2e$)	0.011	0.038
Total emission reductions ($MMTCO_2e$)	**0.017**	**0.058**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

Although many green buildings can be constructed at a cost comparable to or lower than that of conventional buildings, an average of 2 to 7 percent increase in initial costs is estimated (USGBC, 2002). These costs could be recouped in a relatively short time period. Given the incremental cost and the cost savings associated with reduced energy consumption, annual levelized costs for this measure were estimated to be $\$464/tCO_2$.

Numerous co-benefits are associated with implementing LEED. In addition to promoting energy efficiency and renewable energy, LEED promotes sustainable site planning, safeguarding water and water efficiency, conserving materials and resources, and improving indoor environmental quality. In addition to environmental benefits, LEED offers economic benefits, health and safety benefits, and community benefits. Savings associated with these benefits were not quantified.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

- A number of parties recommended that Connecticut support EE standards for new buildings and renovations, such as the LEED standards.
- In addition, a number of parties recommended that Connecticut support the strongest LEED standards possible for EE standards for new buildings and renovations (e.g., LEED silver or LEED gold standards).
- It was recommended that green building practices be incorporated into new construction (especially schools).

High-Performance Buildings: Privately Funded Projects

Recommended Action: Encourage high-performance buildings in privately funded projects.

This recommendation includes the following measures:

- Encourage privately financed new construction and renovation to be high-performance buildings by certifying LEED standards.
- Encourage privately occupied existing buildings and leased space to be high-performing (using future USGBC LEED programs or other programs to be determined).
- Provide tax credits and other financial incentives for green buildings, similar to those offered in New York and Massachusetts.
- Provide awards program to recognize LEED buildings or use other measure to determine high performance.
- Work with lending institutions and insurers to identify incentives that they could offer for high-performance buildings (i.e., preferred rates, utilizing lifecycle costs)
- Encourage municipalities to promote LEED or other high-performance standard for projects within their jurisdiction that require local review.

The State of Connecticut should work with the insurance industry to encourage them to identify green building measures that also decrease risk and liability and to leverage their use in insurance products (e.g., using renewables like solar, could reduce fire and safety liability associated with current energy systems).

Results of Assessments for 2010, 2020, and Beyond (Where Applicable):

Implementing high-performance buildings in the private sector is estimated to reduce GHG emissions by

0.019 MMTCO$_2$e in 2010
0.052 MMTCO$_2$e in 2020

The GHG savings were estimated by multiplying the square footage of new high-performance buildings by the incremental electricity and fossil fuel savings, by the appropriate GHG emission factor. The energy savings are based on experience with LEED buildings showing that it is relatively straightforward to achieve 20 to 30 percent reductions compared with the 1989 ICC building code standard. This savings translates into 15 to 25 percent compared with the 1999 or 2001 ICC building code standard (Steven Winters Associates, 2003). It was estimated that approximately 1.2 million square feet per year would be built under this program. Emission reductions will include both direct and indirect emission reductions, as shown in Table 3.2.15.

Table 3.2.15
Estimated Emissions Reductions From Privately Funded High-Performance Buildings

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	0.007	0.018
Indirect emissions reductions* ($MMTCO_2e$)	0.012	0.034
Total emission reductions ($MMTCO_2e$)	**0.019**	**0.052**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

Although many green buildings can be constructed at a cost comparable to or lower than that of conventional buildings, an average of 2 to 7 percent increase in initial costs is estimated (USGBC, 2002). Those costs could be recouped in a relatively short period of time. Given these incremental costs and the cost savings associated with the reduced energy consumption, annual levelized costs for this measure were estimated to be $\$343/tCO_2$.

Numerous co-benefits are associated with implementing LEED. In addition to promoting energy efficiency and renewable energy, LEED promotes sustainable site planning, safeguarding water and water efficiency, conserving materials and resources, and improving indoor environmental quality. In addition to environmental benefits, LEED promotes economic benefits, health and safety benefits, and community benefits. Savings associated with those benefits were not quantified.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

- A number of parties recommended that Connecticut support EE standards for new buildings and renovations, such as the LEED standards.
- In addition, a number of parties recommended that Connecticut support the strongest LEED standards possible for EE standards for new buildings and renovations (e.g., LEED silver or LEED gold standards).
- It was recommended that the State promote private performance contracting.

Shared Savings Program for Government Agencies

Recommended Action: Revise the shared savings program for government agencies.

The State should revise the program referenced in CGS 16a-37c so that savings are claimed under more controlled terms and the program is workable within the OPM budget. It should then promote its use by State agencies. In addition, the State should review the Federal Energy Management Program (FEMP) Super Energy Savings Performance Contracts program and consider adopting a similar program for Connecticut State agencies. A portion of the savings should go toward the purchase of green power for State agencies.

In addition to the shared savings program, a joint program to provide technical assistance to benchmark all qualifying State facilities in Connecticut over the next 5 years is recommended. This program will provide valuable information to the State during this period of budget crises and cost containment.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Revising the shared savings program is estimated to reduce GHG emissions by
0.124 $MMTCO_2e$ in 2010
0.198 $MMTCO_2e$ in 2020

These savings were based on the assumption that State buildings can reduce energy use by 20 percent in 2010 and 35 percent in 2020. OPM has provided energy use data for State government facilities. The data include annual use by agency for fiscal years 2001 and 2002. State energy consumption was estimated to grow at the same rate as total State energy consumption: 1.1 percent. This measure will result in both direct and indirect emission reductions (Table 3.2.16).

Table 3.2.16
Estimated Emissions Reductions From Government Shared-Savings Programs

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	0.026	0.039
Indirect emissions reductions* ($MMTCO_2e$)	0.098	0.160
Total emission reductions ($MMTCO_2e$)	**0.124**	**0.198**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

- It was recommended that Connecticut should encourage energy efficiency by reducing State government's energy use 25% by 2010.

- It was recommended that the State promote private performance contracting.

Training of Building Operators

Recommended Action: Train building operators to use maintenance approaches that improve energy efficiency.

Ramp up existing Connecticut training programs to serve a larger number of building operators (including maintenance technicians, lead custodians, maintenance foremen, and plant engineers), who typically have little formal training in building efficiency. Currently, Connecticut Light & Power (CL&P) and United Illuminating (UI) offer training courses for building operators that are funded in part by the Conservation & Load Management Fund. Participants pay a fee to enter. Sessions are approximately once per month; maximum participation is 30 students. As a result of the great interest from building operators, the program is oversubscribed. The training includes such topics as where to find and how to use building codes; how to read utility meters and bills; how to maximize heating, ventilation, and air conditioning controls; when to call for help; and how to improve a host of other operation and maintenance techniques.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Implementing this action is estimated to reduce GHG emissions by
0.032 $MMTCO_2e$ in 2010
0.033 $MMTCO_2e$ in 2020

GHG savings were estimated by multiplying the number of students trained per year by the average annual electricity and fossil fuel savings per student by the appropriate GHG emission factor (Table 3.2.16). These average annual energy savings were based on average savings reported from program evaluation (NEEP, 2002), including electricity savings of 238,500 kWh per student, and fossil fuel savings of 930 MMBtu per student. Savings are expected to be generated in the year after training and last for only 5 years.

Table 3.2.16
Estimated Emissions Reductions From Building Operator Training

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	0.011	0.011
Indirect emissions reductions* ($MMTCO_2e$)	0.020	0.022
Total emission reductions ($MMTCO_2e$)	**0.032**	**0.033**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

Levelized annual costs were estimated to be –$159/$tCO_2$, which is based on an estimated cost per student of $1,400 for an eight-course session and the financial savings associated with reduced energy use.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

None.

Green Campus Initiatives

Recommended Action: Promote a "green campus initiative" with Connecticut institutions of higher learning and secondary schools.[7]

Promote a "green campus initiative" with all Connecticut colleges, universities, and private and secondary schools to minimize environmental impact and create "learning labs" for sustainability. This program would develop and support an effective process to promote energy and environmental sustainability with Connecticut educational institutions. The program would provide leadership and resources to engage schools and interest them in taking a comprehensive approach to lowering energy use and cost, reducing GHGs from building systems and transportation, improving water and wastewater management, increasing recycling, reducing the need for hazardous waste disposal, and promoting procurement of environmentally friendly products. The program would use a team-based approach that engaged administrative staff, students, faculty, and technical experts.

The program would be implemented over the course of five years in Connecticut's 48 colleges and universities. The measures could be funded through the Connecticut Conservation and Load Management Fund, the proposed "oil and natural gas conservation fund," or the Connecticut Clean Energy Fund. In addition, financing for comprehensive renovation programs could be made available through performance contracts by energy service companies.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Implementing the green campus program is estimated to reduce GHG emissions by
0.183 MMTCO$_2$e in 2010
0.190 MMTCO$_2$e in 2020

Energy savings (Table 3.2.17) were estimated using the Department of Energy's "Energy Smart Guide to Campus Cost Savings." An average potential cost reduction of 35 percent and 25 percent for electric savings and fossil fuels savings, respectively, was estimated. Savings were calculated using regional-average data for three categories of schools (savings per student), and the number and student enrollment of Connecticut colleges and universities.

The square footage of and actual energy bills for Connecticut colleges and universities are not currently available. Energy-use projections were calculated using DOE regional inventory data on costs per student and applying those values to the "full-time equivalent" student enrollment in

[7] The green campus initiatives strawman proposal, prepared by the Institute for Sustainable Energy, is the primary source of information on the green campus initiatives recommendations, costs, and benefits. Significant portions of this section are excerpted verbatim from the green campus initiative strawman proposal, and the full strawman proposal is available in the RCI Assumptions Document (October 30, 2003).

Connecticut colleges and universities, as provided by the U.S. Department of Education. It was estimated that 20 percent of the market would be enrolled in the program each year.

Table 3.2.17
Estimated Emissions Reductions From Green Campus Initiatives

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	0.084	0.084
Indirect emissions reductions* ($MMTCO_2e$)	0.099	0.106
Total emission reductions ($MMTCO_2e$)	**0.183**	**0.190**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

The program is estimated to include the following costs:

- Program development: $50,000 (first year only)
- Outreach, training, and rollout: $50,000 annually
- GHG and energy inventory of all Connecticut colleges and universities: $250,000
- Administration, benchmarking and action plan development: $1,000,000 annually.

The cost of the energy savings measures were not estimated.

Additional environmental benefits, which were not quantified, will be derived beyond energy conservation by instituting improved recycling, sustainable-purchasing policies, new building design, water conservation, and other activities outlined above. See the section appendix for more details.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

The public was in support of performance contracting.

Energy Measurement, Benchmarking and Tracking Program for Municipal Buildings

Recommended Action: Promote energy measurement, tracking, benchmarking, and strategic planning with municipal facilities.[8]

This program would promote energy measurement, tracking, benchmarking, and strategic planning with municipal facilities, including public schools, to increase their participation in existing and new energy conservation and environmental programs and raise their energy efficiency and Energy Star level. It would involve creating a program that engages communities in developing energy-sustainability plans and implementing those plans by measuring, tracking, and assessing their current efficiency levels. Communities also would use existing energy conservation and environmental programs to improve targeted inefficient municipal facilities.

The program would include the following components:

- Energy and emission inventory and measurement, including benchmarking and ongoing tracking of municipal office buildings and schools
- Identification and ranking of inefficient facilities and development of a strategic plan for improving energy efficiency to Energy Star performance levels
- Prescriptive solutions, such as coordinating participation in existing State, federal, and utility conservation programs; changing local public policy; providing energy education for better understanding of energy, environmental, and cost-reduction issues and options; enhanced energy management and ongoing energy accounting and monitoring to achieve reduction of energy costs in public buildings; addressing difficult environmental issues; and providing energy education for department heads and maintenance staff
- Energy and environmental education programs throughout the public schools.

The proposed program is estimated to be implemented over the next five years. It will target 169 towns incorporating 161 secondary schools, 170 middle or junior high schools, 654 elementary schools, and more than 500 municipal office buildings. Funding for retrofits for electric saving measures could come from the Conservation and Load Management Fund. Funding for retrofits to fossil-fueled building systems should be included in the proposed natural gas and oil conservation funds. Total building renovation for energy performance improvements and building envelope improvements can be financed by municipal bonds, performance contracts, or the proposed pay-as-you-save strategy.

[8] The energy measurement, benchmarking and tracking program for municipal buildings strawman proposal, prepared by the Institute for Sustainable Energy, is the primary source of information on the energy measurement, benchmarking and tracking program recommendations, costs and benefits. Significant portions of this section are excerpted verbatim from the energy measurement, benchmarking and tracking program for municipal buildings strawman proposal and the full strawman proposal is available in the RCI Assumptions Document (October 30, 2003).

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Implementing this program is estimated to reduce GHG emissions by
0.119 MMTCO$_2$e in 2010
0.190 MMTCO$_2$e in 2020

Annual energy savings are estimated to be 20 percent in Year 5 and 35 percent in Year 10 (Table 3.2.18). Savings would be derived from both electric efficiency improvements and fossil fuel equipment upgrades. It was estimated that public schools represent the greatest opportunity for savings in this sector. Savings were estimated using 2003 Connecticut Department of Education data on total schools by type and total students by grade level. The estimate was extrapolated on a cost per student basis using a representative sample of 30 schools benchmarked in 2003. Savings projections were estimated using EPA Energy Star Portfolio Manager Benchmarking and the DOE High-Performance Schools manuals.

A comparable levels of savings can be achieved in the 500 or so Connecticut public buildings, including town office buildings, police stations, fire stations, recreation centers, senior citizens centers, and libraries. However, data for projection are not readily available, so those estimates were not included here.

Table 3.2.18
Estimated Emissions Reductions From Energy Measurement, Benchmarking, and Tracking Program for Municipal Buildings

	2010	2020
Direct emissions reductions (MMTCO$_2$e)	0.073	0.104
Indirect emissions reductions* (MMTCO$_2$e)	0.046	0.086
Total emission reductions (MMTCO$_2$e)	**0.183**	**0.190**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

The estimated annual cost of program administration and outreach to communities is $250,000, including workshops, strategic planning meetings, reporting, and tracking. The estimated cost for benchmarking is $0.005 per square foot. Costs were not estimated for implementing the specific energy saving measures. Co-benefits of this measure were not quantified.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

The public was in support of performance contracting.

Pilot Fuel-Switching Project

Recommended Action: Implement a pilot fuel-switching project.

In Year 1, the State should undertake a pilot project for to B20 biodiesel blend for heating applications at two State facilities (i.e., one State university campus and one State office facility). The pilot facilities will be determined with the assistance of DPW. Assuming the pilot project proves the fuel to be acceptable, the State should begin to require additional State buildings to use B20 in Year 2 and beyond. The State should also consider promoting the use of B20 for heating applications beyond State facilities (e.g., to the general public, private institutions).

The State should also consider promoting biodiesel in marine vehicles, such as boats and ferries provided air quality issues are not a concern and availability is possible. Government-operated marine vehicles could be required to use B20.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

A pilot program to switch from biodiesel is estimated to reduce GHG emissions by
<0.001 MMTCO$_2$e in 2010
<0.001 MMTCO$_2$e in 2020

The GHG savings were estimated by calculating the GHG emissions of two State facilities (assuming heating oil is burned) and subtracting the GHG emissions of two State facilities (assuming B20 is burned) (Table 3.2.19). It was assumed that additional buildings would switch in 2006 and in 2011following positive results of the pilot program.

Table 3.2.19
Estimated Emissions Reductions From Pilot Fuel-Switching Project

	2010	2020
Direct emissions reductions (MMTCO$_2$e)	<0.001	<0.001
Indirect emissions reductions* (MMTCO$_2$e)	NA	NA
Total emission reductions (MMTCO$_2$e)	**<0.001**	**<0.001**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.
NA: not applicable

Annual levelized costs were estimated to be –$123/tCO$_2$, given the incremental cost between biodiesel and heating oil.

Although using biodiesel in transportation emissions has been associated with increased NOx emissions, this is not the case with the stationary application of this fuel.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

- This recommendation was supported as an effective leveraging of the State's resources to promote this fuel; however, it was recommended that the State coordinate its efforts with regional and national developments. A strategy based on Connecticut-specific programs would produce negligible environmental benefit, with significant lost opportunity and competitive disadvantage to Connecticut businesses.
- A number of benefits were outlined: For example, biodiesel can be used immediately by regular diesel engines, with little to no modifications, and biodiesel has significant strategic benefits as a domestic-source fuel.

Remove Current Barriers to Third-Party Load-Management Techniques

Recommended Action: Remove current barriers to third-party load-management techniques.[9]

The State should overcome existing regulatory barriers that prohibit the increased market diffusion of third-party load management for nonintrusive commercial loads.[10] Many regulatory barriers prevent the mass penetration of real-time electric information and load-management services from penetrating the mass commercial markets. Those barriers can be easily overcome but require fundamental structural changes to occur. Recommended changes include:

1. *Integration of information and load management solutions into the local distribution company (LDC) bill.* Allowing customers to select these services through their local utility would facilitate streamlined penetration into the mass commercial markets. They could be included as an optional part of a comprehensive standard-offer generation rate or in some other fashion. This option is viable because real-time energy-use information and proactive load management have significant value to the commodity suppliers or marketers and could reduce customer bills.
2. *Ability of demand resources to participate in the wholesale electric markets.* The wholesale electric generation market today is currently a bid-only market in which dispatching of resources is managed by the independent system operator(s) with no consumer participation. The current emergency-response programs are the only opportunity for loads to participate in the wholesale commodity markets. These programs provide only limited opportunity in instances in which the electricity system is constrained to the point of affecting reliability. Until a robust day-ahead bidding market is developed, consumer participation will be limited, resulting in potential price instability and variability. The development of these markets is critical to the development of a competitive electric industry.
3. *Including an EE component in the alternative transitional standard offer.* Nonintrusive load reductions are implemented when the reductions in specific energy use are not intrusive to occupants; they typically occur without occupant involvement or knowledge that they are taking place. Typical examples of these types of solutions include lighting dimming at slight reductions during peak hours when ambient light levels are high and planned cycling of refrigeration compressors.

[9] The third-party load management techniques strawman proposal, prepared by NXEGEN, is the primary source of information on third-party load management techniques recommendations, costs and benefits. Significant portions of this section are excerpted verbatim from the third-party load management techniques strawman proposal and the full strawman proposal is available in the RCI Assumptions Document (October 30, 2003).

[10] Nonintrusive loads refer to reductions in specific energy use that are not intrusive to occupants and typically occur without occupant involvement or knowledge that they are taking place. Typical examples of these types of solutions include dimming lights during peak hours where ambient light levels are high and planned cycling of refrigeration compressors.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Removing the barriers to third-party load management is estimated to reduce GHG emissions by
0.018 $MMTCO_2e$ by 2010
0.033 $MMTCO_2e$ by 2020

Emission reductions were calculated by multiplying the market potential for reductions by the marginal CO_2 emission rate for the regional electricity grid (Table 3.2.20). The potential nonintrusive commercial load in Connecticut is approximately 4 to 6 percent of the market size, or 100 to 150 MW (NXEGEN, 2003). The relevant market segments include the commercial (office, retail, warehouse), industrial (process, fabrication), and municipal (city buildings, police, fire, library, schools) markets.

Table 3.2.20
Estimated Emissions Reductions Through the Removal of Regulatory Barriers to Third-Party Load Management Techniques

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	NA	NA
Indirect emissions reductions* ($MMTCO_2e$)	0.018	0.033
Total emission reductions ($MMTCO_2e$)	**0.018**	**0.033**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.
NA: not applicable

The current utility emergency-response programs are offering a customer rebate of $500 per KW to participate in real-time monitoring and load-management services. This incentive level is adequate. The incentive is calculated as a percentage of the long-term market benefits that can be derived from the solutions. Annual levelized costs were not estimated for this program.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation. The DPUC reserved judgment on the first and third aspects of the recommendation due to a potential conflict of interest with pending or potential future regulation.

Public Views

None

State Procurement of Environmentally Preferable Services and Products

Recommended Action: Consider increasing preferences for products and services that decrease GHG emissions and/or mitigate climate change impact.

Several policies currently require the State of Connecticut to consider environmentally preferable products, recycled content, and other "green" goods and services. For example, CGS 4a-67h requires Connecticut Department of Administrative Services to establish procedures that promote procurement of environmentally preferable products and services, and an environmental purchasing advisor position was created to develop the program. State agencies should consider increasing preferences for products and services that decrease GHG emissions and/or mitigate the impact of climate change.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Savings and costs were not estimated for this measure.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

- It was recommended that the State of Connecticut consider increasing preferences for products and services that decrease GHG emissions and/or mitigate the impact of climate change. Companies providing both products and services to the State should have a climate change risk assessment and mitigation strategy in place to be eligible to bid on State contracts. These preference arrangements should include insurance and financial institutions.
- It was recommended that State agencies and regulatory bodies overseeing financial and insurance companies based in Connecticut encourage financing of new technologies, products, and services. Consider implementing regulatory incentives, similar to those required by the Community Redevelopment Act, that major banks must meet with regard to encouraging inner-city development and job creation.

New England Demand Response Initiative (NEDRI)

Recommended Action: Review the New England Demand Response Initiative (NEDRI) recommendations.

The State should consider the NEDRI report as a whole. The New England Independent System Operator (NE ISO) and various State DPUCs, wires companies, and various states' DEP worked together to develop a series of recommendations over an 18-month period. The NEDRI report provides a good overview and identifies many measures that can be implemented at the federal and State level. In addition, the Federal Energy Regulatory Commission (FERC) plans to use NEDRI as a model for other state ISOs. The working group cannot recommend the whole package of measures because of time limitations and potential conflict of interest by select stakeholders (e.g., DPUC and DEP cannot prejudge proposals that may come before them).

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Savings and costs were not estimated for this measure.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

None

Promote Voluntary Programs and Actions

Recommended Action: Promote voluntary programs and actions.

The State should strongly promote voluntary programs and actions for the appropriate sectors. State agencies would need to play a coordinating role and devote some resources to this. Partners who have joined these programs could also be supportive by playing a mentoring role. Although some programs already exist at the national level, opportunities to develop additional programs in Connecticut may exist. The Connecticut State government does not necessarily devote resources toward promoting participation in existing national programs.

The following voluntary programs could be included in this measure:

For Municipalities

- Cities for Climate Protection (ICLEI program)
- Rebuild America (DOE program run by Connecticut OPM)

For Business and Industry

- Climate Leaders (EPA program)
- GHG Protocol Initiative (WRI Program)
- Green Power Market Development Group (WRI Program)
- Working 9 to 5 on Climate Change (WRI Program)
- Best Practices Program (DOE)
- Connecticut Sustainable Business Network (Sustainable Step New England program)
- Energy Star Benchmarking (EPA program)
- Negotiated Agreements (These would need to be custom developed with DEP or another regulatory agency with individual companies; they are a policy mechanism.)
- SF_6 Reduction Program (EPA program)

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Savings and costs were not estimated for this measure.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

None

Encourage Clean Combined Heat and Power

Recommended Action: Encourage clean combined heat and power.[11]

The goal of this policy is to push the development of new, clean, combined heat and power (CHP) electricity generation using existing and available technology, which is extremely clean and efficient. The policy consists of two elements:

1. Reducing the current barriers to development of CHP projects (e.g., permitting and interconnection hurdles, standby power rates)
2. Exploring further mechanisms to promote CHP, such as a CHP portfolio standard.

With regard to the second recommendation, the stakeholder group explored one mechanism to promote CHP in Connecticut: mandating that a small but growing percentage of the portfolio of power delivered to Connecticut customers come from clean CHP. In effect, this policy could be considered a third class of power generation within the Connecticut RPS (Class 1 Renewables, Class 2 Renewables, and Class 3 CHP). Under such a measure, a CHP portfolio standard would be developed that mandates that a minimum portion of the electric power sold by suppliers in the State come from clean CHP generation. The power generation should be tracked using the GIS system, with certificates generated for every MWh of production. The certificates could be traded among retail providers of electricity to satisfy the portfolio standard. CHP generation eligible for the portfolio standard would have to meet minimum standards for emissions and efficiency. The portfolio standard would begin with small percentages of power having to be generated by CHP sources and would increase with time.

The following is an outline of a proposed CHP portfolio standard.[12] The stakeholder group agreed to further explore the details of this mechanism, including the start-up date (e.g., postponing until 2007), the required emissions rate to qualify as clean CHP, and the percentage targets required each year.

State Certification and Review (Reducing Barriers to CHP Development)

- Facilities must be certified by DPUC as eligible. (Facility owners are responsible for ensuring and documenting compliance with emissions and efficiency requirements.)

[11] The clean combined heat and power strawman proposal, prepared by Environnment Northeast and United Technologies, is the primary source of information on the clean combined heat and power recommendations. Significant portions of this section are excerpted verbatim from the clean combined heat and power strawman proposal and the full strawman proposal is available in the RCI Assumptions Document (October 30, 2003).

[12] The portfolio standard draws on the current Connecticut RPS policy, the work and recommendations of the European Union for the promotion of cogeneration (http://europa.eu.int/scadplus/leg/en/lvb/l27021.htm), and the proposed framework for a "European CHP Certificate Trading System" presented by Oko-Institute at the ECoCerT workshop in February 2003 (http://www.cogen.org/Downloadables/Presentations/Ecocert/Presentation_Ecocert_Oekoinstitute.pdf).

- The Connecticut Siting Council will expedite review of eligible CHP facilities for interconnection.
- The DEP may expedite review of eligible CHP facilities for permitting.
- Connecticut should request that FERC set standby power prices that promote distributed generation (DG) and CHP construction (economically justified).

Definition of Eligible CHP Facilities

- Facilities must be located in the State of Connecticut.
- Minimum average quarterly system efficiency must be greater than or equal to 70 percent.
  - This is a total efficiency measure based on electricity and useful heat, so ultra-high-efficiency electricity generation that met the 70 percent minimum efficiency would also qualify.
  - The facility owner must document a heat load and the use of that heat to meet the efficiency target.
  - The facility owner must track system efficiency (metering) and document that the heat was used and not dissipated through the use of cooling towers, vents, or exhaust stacks.

Must Meet or Exceed the Following Emissions Requirements (Under Control)

- These emissions numbers may require additional analysis.
- The following emissions rates are per megawatt hour for electricity output alone:
  - NOx less than or equal to 0.15 lbs/MWh
  - SO_2 less than or equal to 0.05 lbs/MWh
  - PM_{10} less than or equal to 0.08 lbs/MWh
  - CO_2 less than or equal to 1350 lbs/MWh.
- Documentation must be completed on a quarterly basis and submitted to DEP and/or DPUC.

Generation of CHP Certificates

- Facilities that are certified by DPUC as being eligible will generate one CHP certificate per MWh of electricity generated.
- The certificates will be the same as the New England GIS certificates for the facility and will be traded and tracked using the GIS system.
- In the same method as renewable certificates, CHP certificates can be generated at the facility even if power is not sold into the grid, as long as approved metering is used.

CHP Portfolio Standard Requirements

- Every retail supplier of electricity will be required to purchase CHP certificates to satisfy the CHP percentage mandated by this portfolio standard.

- GIS certificates can only count toward one of the portfolio standards. Fuel cells, which may qualify for both Class 1 renewables and the CHP standard, would only be allowed to count toward one requirement. No double counting will be permitted.
- The schedule and percentage requirements should begin at 0.50 percent in 2005 and increase at a rate of 0.5 percent per year until they reach 8 percent in 2020; the percentage is based on the portion of total delivered kilowatt hours.
- Failure to meet the portfolio requirements would lead to a payment by the retail supplier equal to $0.02/kWh to the Connecticut Clean Energy Fund for the development of high efficiency, clean CHP systems within the State (money earmarked for this use).

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Implementing the proposed CHP portfolio standard is estimated to reduce GHG emissions by
0.532 MMTCO$_2$e (based on 4 percent CHP in 2010) in 2010
1.414 MMTCO$_2$e (based on 8 percent CHP in 2020) in 2020

Indirect emission reductions were calculated by estimating the amount of electricity the new CHP units generate. It is assumed that the new CHP generation would be offsetting an equivalent amount of electricity from the grid. The amount of total delivered kilowatt hours from new CHP units was estimated by subtracting the delivered kWh from CHP plants built under the Reference Case scenario from the total delivered kWh required by this portfolio standard. To estimate savings, the resulting kWh was multiplied by the marginal CO_2 emission factor for the electricity grid.

The direct emissions reductions were estimated by subtracting the CO_2 emissions generated from the new CHP plants from the CO_2 emissions generated by the business-as-usual (BAU) boilers, which were assumed to be oil fired (Table 3.2.21).

Table 3.2.21
Estimated Emissions Reductions Through Clean Combined Heat and Power Policies

	2010	2020
Direct emissions reductions (MMTCO$_2$e)	0.009	0.025
Indirect emissions reductions* (MMTCO$_2$e)	0.523	1.389
Total emission reductions (MMTCO$_2$e)	**0.532**	**1.414**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.

Costs for this measure have not yet been estimated.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation. The group had considerable discussion and debate regarding the second aspect of this recommendation: the potential mechanism to further promote CHP beyond removing barriers. The stakeholders agreed that a mechanism was necessary, but they did not come to agreement on which mechanism to use. The cost-effectiveness of various approaches should be a key consideration.

Public Views

- This recommendation was supported in concept as potentially offering long-term returns on the State's investment.
- It was recommended that business opportunities for Connecticut-based financial and insurance companies in emerging areas such as carbon credit trading, insuring of delivery risk of carbon credits and permits, and financing of distributed power systems be encouraged.

Restore Conservation and Load Management Fund

Recommended Action: Restore the Conservation and Load Management Fund.

The State should restore full funding ($87 million) to the Conservation and Load Management Fund. BAU assumes $50 million in Years 1 and 2 and $60 million in years beyond that. In addition, the State should consider expanding the fund in light of the findings of a recent Energy Conservation Management Board (ECMB) study. Funds should directed and applied to the intended use for the lifetime of the fund.

The Energy Efficiency and Conservation Potential study (GDS Associates and Quantum Consulting, 2003) highlights specific cost-effective measures that could be implemented within the next 10 years to reduce electricity consumption, assuming available funding from the ECMB. Special attention should be given to EE measures in the Commercial and Industrial (C/I) sectors (e.g., standard retrofit/lost opportunity and C/I incentives and rebates).

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Restoring the Conservation and Load Management Fund to its former level is estimated to reduce GHG emissions by

0.279 MMTCO$_2$e in 2010
0.606 MMTCO$_2$e in 2020

Because the fund targets measures that reduce electricity consumption, the emission reductions are indirect (Table 3.2.22).

Table 3.2.22
Estimated Emissions Reductions Through Restoration of the Conservation and Load Management Fund

	2010	2020
Direct emissions reductions (MMTCO$_2$e)	NA	NA
Indirect emissions reductions* (MMTCO$_2$e)	0.279	0.606
Total emission reductions (MMTCO$_2$e)	**0.279**	**0.606**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.
NA: not applicable

Stakeholder Views

The stakeholders unanimously agreed to this recommendation. The DPUC representative abstained from voting due to pending regulations.

Public Views

- There was a recommendation to prioritize programs such as improved lighting efficiency.

- There was a recommendation to create conservation funds to recycle energy savings into more savings.
- There was a recommendation to use tax policies to encourage fuel efficiency.
- There was a recommendation to reduce Connecticut's energy use by 25% through better efficiency by 2010.

Create Heating Oil Conservation Fund

Recommended Action: Establish a heating oil conservation fund.[13]

The State should establish an annual fund of $20 million for EE investment programs for equipment and buildings that use heating oil. Funds should be directed and applied to the intended use for the lifetime of the fund. The fund's board will report annually on the cost effectiveness of the fund's programs (in terms of $/t$CO_2$ saved).

Current Connecticut "public benefits" EE investment programs are funded through electricity surcharges and do not fund programs that improve the energy efficiency of heating oil consumption (due to equity issues between ratepayer classes). This action would establish new programs that would improve the efficiency of heating oil use in Connecticut.

The program would involve the following measures:

- Creating a heating oil conservation fund and associated conservation programs. The fund would be earmarked for improving efficiency of oil use and would focus on buildings with heating oil service for space and water heating; new construction and building renovation as well as long-lived equipment (e.g., furnaces) that operates on heating oil; and market-based programs that would stimulate EE investments in this area.
- Creating a new oil conservation management board to supervise the program; the board would report annually on the cost-effectiveness of the funds' programs ($/t$CO_2$ saved).
- Ensuring that funds are directed and applied to the intended use for the lifetime of the fund

In addition, the board would work with existing electricity conservation programs to implement fuel-blind programs that address energy efficiency and conservation of all energy sources and building envelopes (10 to 20 percent of funding). The program would be funded at a level of $20 million annually; funding would come from a surcharge on revenues collected by heating oil distributors within the State.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Establishing an oil conservation fund is estimated to reduce GHG emissions by
0.311 MMTCO_2e in 2010
0.828 MMTCO_2e in 2020

The savings for this program were based on the savings and costs of the Conservation Fund of Vermont Gas (Table 3.2.23). For that program, the average cost per first-year million cubic feet

[13] The heating oil conservation fund strawman proposal, prepared by Environment Northeast, is the primary source of information on the heating oil conservation fund recommendations, costs and benefits. Significant portions of this section are excerpted verbatim from the heating oil conservation fund strawman proposal and the full strawman proposal is available in the RCI Assumptions Document (October 30, 2003).

(Mcf) saved (i.e., the first-year savings for a measure that will typically last 20 years) is about $29. Program costs include rebate, audit, and administrative expenses and are higher for commercial programs than for residential programs. The cost per Mcf saved varies depending on the market. For example, savings available in industrial burner upgrades can be much cheaper than adding insulation to an old home.

Table 3.2.23
Estimated Emissions Reductions Through the Heating Oil Conservation Fund

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	0.311	0.828
Indirect emissions reductions* ($MMTCO_2e$)	NA	NA
Total emission reductions ($MMTCO_2e$)	**0.311**	**0.828**

* Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.
NA: not applicable

Stakeholder Views

The stakeholders agreed to this recommendation through supermajority, with one objection. They recommended that this proposal be packaged and implemented together with the proposal for a natural gas conservation fund; however, the funds will be separate and distinct and have their own governance structures. The group engaged in considerable discussion and debate on this measure. The stakeholders struggled to address key concerns they saw with this measure, including (1) the potential for the fund to be diverted, (2) the cost of doing business in the State of Connecticut, and (3) accountability for fund performance. The stakeholders concluded that it was important to recommend this measure because direct emissions (i.e., emissions from onsite combustion of fossil fuels) contribute significantly to the GHG emissions in the State.

Public Views

- Serious concerns were raised about a tax-based oil conservation fund as a means of promoting oil efficiency and conservation because (1) it is simply impossible to insulate a "dedicated fund" from diversion for unrelated purposes, (2) proposals for any new taxes are simply not politically viable in Connecticut's current economic and political environment, (3) proposals for a new tax on heating oil are unwise in the face of Connecticut's longstanding economic challenges and would further threaten Connecticut's businesses and jobs, and (4) a government-administered oil conservation fund threatens to duplicate and undermine conservation and EE efforts already initiated by the oil heat industry.
- There was a recommendation to emphasize the availability of alternatives to achieve the goals of an oil conservation fund, including the recently created National Oil heat Research Alliance (NORA). Through NORA, the oil heat industry has recently launched aggressive marketing efforts to educate consumers on the benefits of upgrading to newly developed, high-efficiency oil heat equipment. A government-administered oil conservation fund in Connecticut, however well-intentioned, would duplicate the industry's efforts and undermine them by diluting the invaluable public relations benefits that industry seeks to earn.
- There was a recommendation to create conservation funds to recycle energy savings into more savings.

- There was a recommendation to use tax policies to encourage fuel efficiency.
- There was a recommendation to reduce Connecticut's energy use by 25% through better efficiency by 2010.

Create Natural Gas Conservation Fund

Recommended Action: Establish a natural gas conservation fund.[14]

Establish an annual fund of $20 million for EE investment programs for equipment and buildings that use natural gas. The funds should be directed and applied to the intended use for the lifetime of the fund. The fund's board will report annually on the cost effectiveness of the Fund's programs (in terms of $/tCO$_2$ saved).

Current Connecticut (Connecticut) "public benefits" EE investment programs are funded through electricity surcharges and do not fund programs that improve the energy efficiency of natural gas consumption (due to equity issues between ratepayer classes). This action would establish new programs that would improve the efficiency of natural gas use in Connecticut. Because the programs would operate in conjunction with electric efficiency programs, joint-fuel and fuel blind initiatives could increase the ability to treat whole buildings regardless of fuel type.

The program would involve the following measures:

- Creating a natural gas conservation fund and associated conservation programs, supervised by a new natural gas conservation management board, with funding from a surcharge on revenues collected by natural gas utilities within the State. The fund would be earmarked for improving efficiency of natural gas use and would focus on buildings with natural gas service for space and water heating; new construction and building renovation as well as long-lived equipment (e.g., furnaces) that operate on heating oil; and market-based programs that would stimulate EE investments in this area.
- Creating a new natural gas conservation management board to supervise the program; the board would report annually on the cost-effectiveness of the funds' programs ($/tCO2 saved).
- Addressing natural gas leaks at large industrial and commercial sites.

In addition, the board would work with existing electricity conservation programs to implement fuel-blind programs that address energy efficiency and conservation of all energy sources and building envelopes (10 to 20 percent of funding). The program would be funded at a level of $20 million annually. Funds would be directed and applied to the intended use for the lifetime of the fund.

[14] The natural gas conservation fund strawman proposal, prepared by Environment Northeast, is the primary source of information on the natural gas conservation fund recommendations, costs and benefits. Significant portions of this section are excerpted verbatim from the natural gas conservation fund strawman proposal and the full strawman proposal is available in the RCI Assumptions Document (October 30, 2003).

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Establishing a natural gas conservation fund is estimated to reduce GHG emissions by
0.225 $MMTCO_2e$ in 2010
0.601 $MMTCO_2e$ in 2020

The savings for this program were based on the savings and costs of the Conservation Fund of Vermont Gas (Table 3.2.24). For that program, the average cost per first-year Mcf saved (i.e., first-year savings for a measure that will typically last 20 years) is about $29. Program costs include rebate, audit, and administrative expenses and are higher for commercial programs than for residential programs. The cost per Mcf saved varies depending on the market. For example, savings available in industrial burner upgrades can be much cheaper than adding insulation to an old home.

Table 3.2.24
Estimated Emissions Reductions Through Natural Gas Conservation Fund

	2010	2020
Direct emissions reductions ($MMTCO_2e$)	0.225	0.601
Indirect emissions reductions* ($MMTCO_2e$)	NA	NA
Total emission reductions ($MMTCO_2e$)	**0.225**	**0.601**

*Estimates of indirect emission reductions (due to decreased electricity consumption from the electricity grid) are based on the marginal grid emission factor for NEPOOL region. See EE Model Run for the interactive effects of all electricity demand-side measures.
NA: not applicable

Stakeholder Views

The stakeholders agreed to this recommendation through supermajority with one objection. They recommended that this proposal be packaged and implemented together with the proposal for an oil conservation fund; however, the funds will be separate and distinct and have their own governance structures. The group engaged in considerable discussion and debate on this measure. The stakeholders struggled to address key concerns they saw with this measure, including (1) the potential for the fund to be diverted, (2) the cost of doing business in the State of Connecticut, and (3) accountability for fund performance. The stakeholders concluded that it was important to recommend this measure because direct emissions (i.e., emissions from onsite combustion of fossil-fuels) contribute significantly to the GHG emissions in the State.

Public Views

- There was a recommendation to create conservation funds to recycle energy savings into more savings.
- There was a recommendation to use tax policies to encourage fuel efficiency.
- There was a recommendation to reduce Connecticut's energy use by 25% through better efficiency by 2010.

Measures to Reduce High Global Warming Potential Gases

Recommended Action: Identify measures to reduce high-global-warming potential gases.

The State should further explore measures to reduce high-global-warming potential (GWP) gases. High-GWP gas emissions are a growing share of emissions from the RCI sector, rising from 8 percent in 2010 to 17 percent in 2020. The largest area for growth is projected to be from ozone-depleting substance (ODS) substitutes. One potentially significant opportunity for reducing high-GWP gas emission is to implement a leak-reduction and -maintenance program at supermarkets. Refrigeration in piping is considerable, and leak rates are estimated to be between 15 and 30 percent. This opportunity should be explored further. In addition, the State should identify other programs and opportunities to reduce emissions associated with ODS substitute use.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Savings and costs were not estimated for this measure.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

There was a recommendation to focus on high-GWP gases.

Next Steps

In addition to the recommendations detailed in the previous section, the stakeholder group identified several next steps for action and research in the RCI sector:

- *Expand and intensify the energy efficiency (EE) package.* Given the analysis to date, EE measures are a cost-effective means of achieving reductions in GHG emissions. One potential option to help Connecticut close the gap between forecasted emissions and the NEG goals would be to expand and intensify the EE package. New research and analysis commissioned by the Energy Conservation Management Board and recommendations by the New England Regional Demand Initiative can serve as good starting points to identify further actions.
- *Identify actions to reduce high-GWP gases.* High-GWP gases are expected to increasingly contribute to statewide GHG emission levels, reaching 3 $MMTCO_2e$ by 2020. As shown in the baseline, most high-GWP gas emissions in Connecticut are estimated to be from the increased use of HFCs as a replacement for ozone-depleting substances (ODSs). The stakeholders group did not have the time to fully investigate measures to reduce high-GWP gases and recommends further research in this area.
- *Conduct further research on the impact of black carbon in the RCI sector.* Scientists have identified black carbon, a component of diesel particulate matter (PM), as having a large and fast-acting warming impact on the atmosphere. During the stakeholder process, the potential GHG emission contribution from black carbon in the transportation sector was explored. The analysis found that the RCI sector was potentially a large source of black carbon emissions. Further research is needed to evaluate the impact of black carbon, include it in the GHG baseline, and identify mitigation actions.
- *Conduct further research to identify actions to reduce heating oil use in Connecticut.* Most direct emissions from the RCI sector are from heating oil use in the residential sector. A number of actions have been recommended targeting improved energy efficiency; however, more work needs to be done to identify opportunities to reduce heating oil consumption in the existing housing stock. Heating oil use in Connecticut, especially for the residential and commercial sectors, is an area demanding further efforts both to reduce the direct emissions impact from CO_2 and to evaluate the possible, even larger impact of black carbon emissions.

RESIDENTIAL, COMMERCIAL, INDUSTRIAL SECTORS

APPENDIX

Pay-As-You-Save[15]

Description of Pay-As-You-Save®

The Pay-As-You-Save™ (PAYS®) system is a market-based system to stimulate consumer installation of energy efficient measures. PAYS enables building owners or tenants to purchase and install money-saving energy efficiency (EE) products with no up-front payment and no debt obligation. Those who benefit from the savings pay for the products through a tariffed charge on their utility bill, but only for as long as they occupy the location where the products are installed. The monthly charge is always lower than the product's estimated savings, and it remains on the bill for that location until all costs are recovered. Like a loan, PAYS allows for payment over time, but unlike a loan, the PAYS obligation ends when occupancy ends or the product fails.

Opportunities for More Energy Efficiency

The PAYS system makes it possible for more customers to participate in the Conservation and Load Management Fund (C&LM) programs (especially those who have not participated in the past) by making it easier, fairer and less risky to purchase and install energy efficient measures.

- *No debt obligation*: Using a tariff, the PAYS system simply requires a customer to pay his or her utility bill. It does not require customers to sign notes accepting new debt obligations, and it allows municipalities to move ahead with projects without voter approval. PAYS allows large companies to install energy efficient measures without affecting their debt-to-equity ratios. It also allows organizations such as hospitals to approve long-range projects without modifying their budgets.
- *A fair system*: Because any savings accrue to the person who pays the utility bill, the PAYS tariff assures that the person who benefits from the measure makes the payments. This system is fair and opens participation to tenants, landlords and developers.
- *Reduced risk*: Savings estimates for all PAYS products are independently certified to be significantly greater than their cost. Combined with the benefits of the PAYS tariff, customers face little or no risk installing energy efficient measures.

Capital for EE Projects

PAYS® eliminates the problem of scarce capital for EE projects.

- *Limitation of incentive funds*: Programs that use incentives require scarce public funds year after year. When these funds are used up, consumers stop investing in energy efficiency.

[15] The information on PAYS was prepared by the Connecticut Department of Public Utility Control.

- *Unlimited source of funds*: Lenders will make unlimited funds available for consumers to purchase EE products if the repayment stream is reliable. PAYS uses the utility collection system, which has a much higher collection rate than any consumer loan.

Utility Role

Utility funds are not required to pay for measures; funds from third-party investors, such as insurance companies or vendors seeking to expand their markets, can be used. Distribution utilities only need to bill and collect the PAYS charges. A third party designated by the Department of Public Utility Control (which could be the utilities themselves) must certify that PAYS products are estimated to save significantly more than the payments and are appropriate.

Incentives

The PAYS system does not use funds from the Conservation and Load Management Fund to provide incentives. Instead, system-benefit funds are used to build the PAYS market infrastructure (e.g., to pay for the product certification system and establish a guarantee fund to reduce the cost of capital). If funding is available, however, policy makers could use incentives to make more measures cost-effective (e.g., in transmission-constrained areas, where long-term transmission savings might not immediately affect retail decisions) to reduce total system costs for all ratepayers.

PAYS Example

The following example of an actual customer illustrates the difference between a PAYS offer and an incentive offer.

New Hampshire Electric Coop's (NHEC's) Business Services program analyzed the EE opportunities for a small franchised retail store in Plymouth. The owner had occupied the approximately 2,000 square foot space for 2 years and had 8 years remaining on a 10-year lease. From October 1998 through September 1999, the store used 3,342 kWh and had an average demand of 13.25 kW (peak demand, 16.49 kW, occurred in July). NHEC staff recommended a complete lighting retrofit.

The cost for converting 32 fluorescent fixtures with magnetic ballasts to an equal number of fixtures with electronic ballasts was $1,862.02. The annual savings were estimated to be $1,525.90. To make the project more attractive, NHEC offered to do the work and provide an incentive of $372.40 (making the simple payback less than one year).

The offer was made near the holiday season. The owner said that he was too busy and cash was too tight. After the holidays, he turned down the project again, alluding to the fact that his landlord would not help him with the cost.

If the PAYS system had been in place, the owner would have been offered this project as a PAYS product (providing the landlord gave him permission to change out the lights at no cost to the landlord). There would have been no incentive, but the customer would have had no up-front, out-of-pocket expenses. The payments would have been structured so that the customer received

savings immediately. He would only have had to make payments as long as the fixtures worked and he remained a tenant in that space.

The fixtures were likely to last for more than 10 years. However, given the robust savings, this project would have been financed over only three years.

Table A3.2.1
Lighting Retrofit Costs

Item	Cost
Project Cost	$1,862.02
Monthly PAYS charge (3 years @ 9.5 percent APR)	$ 59.65
Annual PAYS charge	$ 715.80
Annual lighting cost reduction	$ 1,525.90
	$ 810.10
Net annual customer savings	(53% of gross savings)
Utility program cost reduction	$ 372.40

State Funding for Residential Renewable Energy Applications in the United States

Grants and Incentives for Equipment and Installation

According to DSIRE (2003) and CCAP (2003), states provide the following types of funding for residential renewable energy applications: California's system-benefit fund offers capital cost buydowns for small distributed generation, including solar photovoltaic (PV), wind, renewable fuel cells, and solar thermal electric.

- Massachusetts's system-benefit fund offers incentives for residential PV and solar heating through service providers in the state.
- New Jersey's system-benefit fund offers incentives for fuel cells, PV, small wind, and sustainable biomass technology.
- New York's system-benefit fund budgets $1.3 million (as of February 2002) to encourage installation of grid connected PV by supporting companies that market and install residential grid connected PV.
- New York offers $4 to$5 per watt (up to 15 kW) to eligible installers of approved grid-connected PV systems.
- New York offers incentives for wind turbines on residential property.
- Pennsylvania's system-benefit fund provides grants for solar, PV, landfill gas, wind, biomass, hydro, fuel cell, waste, cogeneration, and solar applications.

Tax Credit or Exemption

- Massachusetts offers a 15 percent state income tax credit for RE systems installed on primary residences ($1,000 maximum credit).
- Massachusetts has a state tax exemption on solar, wind, and heat pump systems and related equipment that is used on the principal residence.
- New York offers a 25 percent personal tax credit for the cost of equipment and installation of PV systems on residential properties.
- Vermont offers a 5 percent sales tax exemption for Renewable Energy (RE) systems that applies to net-metered systems as well as home RE systems not connected to the grid.
- Rhode Island offers a personal tax credit and a 7 percent sales tax refund for PV, solar, hot water, space heating and wind applications.
- Rhode Island provides funds to buy down PV system costs.
- New Jersey offers a 6 percent sales tax exemption for solar and wind equipment.
- Maryland offers a state income tax credit for solar water or PV system.
- California provides a tax credit for purchase and installation of solar energy systems.

Rebates

- Delaware provides rebates for PV, solar water heating, wind turbines, and geothermal heat pumps.
- Maryland provides rebates for residential PV.

Information on Natural Gas Leaks in Connecticut[16]

Interstate Pipelines

Natural gas is transported to Connecticut through the interstate pipelines (Algonquin Gas Transmission, Iroquois Gas Transmission, and Tennessee Gas Pipeline), through large-diameter (16-, 24-, 26-, 30- and 36-inch) buried mainlines, and through small-diameter (4- through 16-inch) buried lateral lines at high pressure (600 psig through 1,440 psig). The pipelines are made of high-strength steel and are coated and cathodically protected (i.e., a slight electrical current is placed on the pipe) to minimize corrosion. Buried pipe joints are made by welding. Transmission pipelines in Connecticut are considered to be modern pipelines.

Only three leaks of any significance have occurred on the mainline and lateral systems (one due to a large mechanical excavator hitting the 4-inch pipe, and two due to material failure). The gas systems are managed using a series of valves and associated fittings throughout the pipeline system. In addition, regulators and meters (and associated fittings) are placed at the transfer points between the interstate pipelines and the local distribution companies (LDCs). Most of these facilities are above ground and may produce small amounts of leakage at times. The most significant cause of leakage is deactivation and evacuation of the pipeline, which occurs in the course of certain types of construction, maintenance, and repairs. To the maximum extent practical, gas is consumed by the LDC, but some amount must be vented.

Local Distribution Companies

General

Local distribution companies in Connecticut (Connecticut Natural Gas [CNG], Southern Connecticut Natural Gas [SCG], Yankee Gas [YES], and the City of Norwich Department of Public Utilities [NOR]) receive gas from the interstate pipelines and transport the gas to customers throughout their franchise area. LDCs typically use small-diameter pipelines (from 2- to 16-inch) operated at lower pressures (0.25 to 99 psi). Few above-ground facilities exist, except for the pipelines at the customer premises, such as the meter and associated piping at the building wall or inside a building.

State of the Art

Some LDC pipes are more than 100 years old. LDC pipes are of two types: state-of-the-art (i.e., made of modern materials, such as coated, cathodically protected steel and plastic) and not state-of-the-art (i.e., pipelines made of materials not currently being installed, such as unprotected steel, cast iron, ductile iron, and copper). State-of-the-art pipe is significantly less likely to leak than non-state-of-the-art pipe.

[16] The information on natural gas leaks in Connecticut was prepared by the Connecticut Department of Public Utility Control.

LDCs are continually increasing the amount of state-of-the-art pipe because that is all they install. Most retirements are of pipes that are not state of the art (Table A3.2.2).

Table A3.2.2
Summary of Progress for State-of-the-Art LDC Pipelines

Company	Mains				Services			
	1984	2002	Increase	Year*	1984	2002	Increase	Year*
Connecticut Natural Gas	49%	74%	26%	2028	50%	81%	32%	2016
Southern Connecticut Natural Gas	40%	59%	19%	2088	32%	61%	29%	2042
Yankee Gas	59%	79%	20%	2042	59%	81%	21%	2029
City of Norwich Department of Public Utilities	28%	60%	32%	2039	22%	61%	39%	2021

*Year in which state-of-the-art pipe reaches 100% at current replacement rate.

Pipe that is not state-of-the-art is replaced on an on-going basis. All three Connecticut gas companies have recently instituted programs to accelerate the replacement of its pipe that is not state-of-the-art. The costs of those programs are currently being funded by ratepayers.

Leakage Surveys and Leak Classification

To protect the public from the potential risks that could be associated with a gas leak, gas companies perform leakage surveys using sophisticated leakage detection equipment. Interstate pipelines usually perform the leakage surveys once a year. LDCs perform leakage survey every 5 years in outlying areas, once a year in urban areas, and multiple times in urban areas where cast iron pipe is present.

LDC gas leaks are classified as Grade 1, 2, or 3. All Grade 1 and Grade 2 leaks are reported to the DPUC on a monthly basis. The leak reports are reviewed and analyzed when received, as well as during comprehensive audits of the gas companies. Typically, interstate pipelines do not grade leaks, but repair them as soon as possible.

- "Grade 1, a leak that represents an existing or probable hazard to persons or property, and requires immediate repair or continuous action until the conditions are no longer hazardous.
- "Grade 2; a leak that is recognized as being non-hazardous at the time of detection, but, requires scheduled repair based on probable future hazard.
- "Grade 3, a leak that is non-hazardous at the time of detection and can be reasonably expected to remain non-hazardous." (ANSI Z380 American National Standard for Gas Transmission and Distribution Piping Systems, 1998)

Unaccounted For

Gas leakage and unaccounted-for gas are two different concepts. "Unaccounted-for" refers to the difference between the measured gas input into the system and the measured sales from the system. Unaccounted-for gas covers the following problems:

- Differences in timing between the time period when input is measured (based on daily readings) and sales are measured (based on monthly readings)
- Meter inaccuracy of the input measures (generally fewer, high accuracy, but large volume)
- Meter inaccuracy of the sales meters (lower accuracy but large numbers of meter, each measuring smaller volumes)
- Inaccuracy due to BTU conversion (pipelines sell gas on a BTU basis, while sales to LDC customers are on an MCF basis
- Theft
- Gas purged through normal maintenance as well as a result of damage to the pipe by outside contractors
- Actual leakage due to pipe failure due to wear and tear.

Connecticut companies have low rates of unaccounted-for gas (Table A3.2.4).

Table A3.2.3
Unaccounted-For Gas in 2000*

Company	Unaccounted-For Gas (%)
Connecticut Natural Gas	0.46
Southern Connecticut Natural Gas	2.46
Yankee	0.96
Norwich	2.87

*GPSU Comprehensive Audit, 2002.

Gas Pipeline Safety Unit Oversight

The Gas Pipeline Safety Unit monitors leakage in several ways. It monitors the total unaccounted-for gas at comprehensive audits; gas company procedures for leakage surveys; and leakage classification and leak repair procedures, including emergency response when necessary.

The Gas Pipeline Safety Unit also is active in DPUC rate cases in reviewing proposed gas company construction programs for replacing pipe and companies' expenses related to proper operation and maintenance of the pipe. When appropriate, changes are made to the company applications. (The UR&R Gas Section is responsible for overseeing meter accuracy, which affects unaccounted-for gas but does not relate to true loss of gas to the environment.) (DPUC 2002; ANSI 1998).

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Connecticut Climate Change

3.3 ELECTRICITY

Contents

- Summary Table of Electricity Sector Recommendations
- Graph of Electricity Sector Baseline and Emissions Reductions
- Inventory and Baseline
- IPM Modeling Discussion

Draft Final Recommendations

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  - Renewable Portfolio Standard (RPS)
  - Government Green Power Purchase
  - Production Tax Credit
- Green Power Option
- Energy Efficiency and Combined Heat and Power
- Regional Cap-and-Trade Program
- Other modeling results

Supporting Documents

- Connecticut Greenhouse Gas Inventory 1990-2000
- IPM Modeling Assumptions Document
- IPM Modeling Results
- Renewable Energy Subcommittee: Renewable Energy Assumptions Document
- ICF Consulting Report: Connecticut GHG Taskforce Electricity Sector Modeling Results (see report appendix 6)

Summary: Electricity Sector Recommendations

The emission reduction measures for the electricity sector and the associated estimated CO_2 reductions are presented in Table 3.3.1. Figure 3.3.1 displays the projected trends in baseline emissions and the emissions that result with the adoption of emission reduction measures.

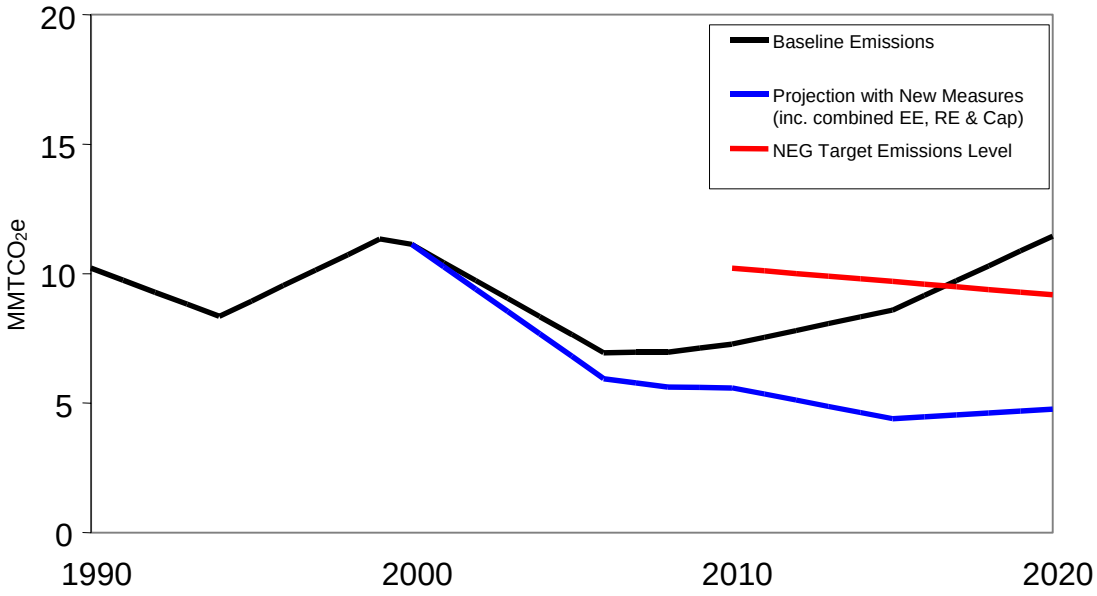
Table 3.3.1: Electricity Sector $MMTCO_2e$ Reductions

	2010	2020	In-State Cost*
Emissions Baseline	7.28	11.46	
PRIORITY MEASURES -- IPM Analysis			
Renewable Energy Strategy (RES) (including regional impact)	0.09	2.02	$22.39 per metric ton CO_2
Energy Efficiency and Combined Heat and Power (including regional impact)	1.17	3.86	–$18.17 per metric ton CO_2
Regional Cap and Trade Program	Estimated but not adopted		
Green Power Option (offline)	0.43	0.81	2010 = $33.69 per metric ton CO_2 2020 = $21.92 per metric ton CO_2
Total $MMTCO_2e$ Savings (with RES and EE)**	**1.69**	**6.69**	
% above/below 1990 (10.2 $MMTCO_2e$)	*-45%*	*-53%*	
NEG/ECP Goal (1990 in 2010, 10% below in 2020)	**10.2**	**9.2**	
Additional reductions needed to reach NEG/ECP	*-4.63*	*-4.43*	

*In-state cost for RES and EE calculated as the ratio of the net present value (using a 7% discount rate) of the estimated total program and policy costs to Connecticut through 2020 to the total cumulative CO_2 reductions in the 10-state region in the same period. Green Power Option cost calculated as the ratio of total costs to Connecticut in specified year to total CO_2 reductions in Connecticut in that year. All cost and price estimates in this chapter are given in Year 2000 dollars.

**Total does not account for interaction between RES and Energy Efficiency Measures.

Figure 3.3.1
Connecticut GHG Reductions From the Electricity Sector



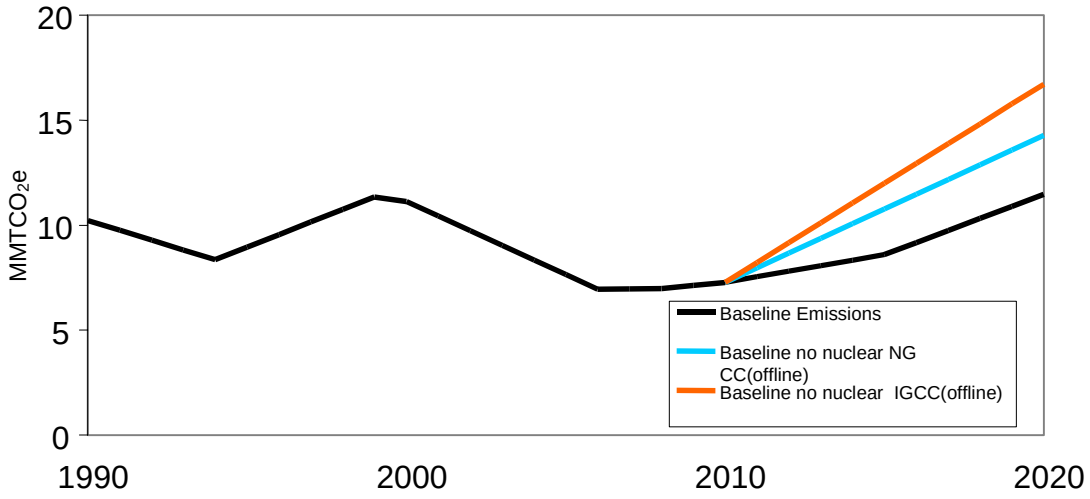
Note: NEG does not necessarily assume equal percentage reductions in each sector.

Electricity Sector Baseline

The final electricity sector baseline is a product of the joint efforts of the Connecticut stakeholders; the electricity, RCI, and AFW working groups; CCAP; and Northeastern States for Coordinated Air Use Management (NESCAUM), with analysis provided by ICF Consulting. CCAP was responsible for developing initial complete baselines (1990–2020), providing input on the development of historical and future baselines, and framing key assumptions for the stakeholders. NESCAUM was tasked with developing the complete historical baseline (1990–2000). The methodology for developing the historical inventory used EIA's *Electric Power Annual* for estimates of emissions (see Document 1 in the section appendix for details). ICF's Integrated Planning Model (IPM; see below for description) provided the baseline for future (2000–2020) electricity sector emissions. During baseline development, the electricity working group provided input into the development of the IPM modeling assumptions, and the stakeholders made the key baseline development decisions. Some of the key decisions confronting the group included treatment of nuclear relicensing, natural gas price assumptions, and resource availability (see the IPM modeling assumptions document, Document 2 in the chapter appendix, for the final modeling inputs).

Stakeholders also expressed an interest in examining what the future baseline might look like in the absence of nuclear relicensing. The graph below demonstrates the potential impact of removing nuclear power from the generation mix. The type of generation capacity used to replace nuclear power determines this new baseline. The impact of substituting all the nuclear generation with generation from the two most likely generation sources, coal-fired integrated gasification combined cycle (IGCC) units and natural gas combined–cycle units, is illustrated in Figure 3.3.2.

Figure 3.3.2
Connecticut Electricity Sector Baseline Without Nuclear Relicensing



The Integrated Planning Model

The impact of options for greenhouse gas (GHG) mitigation in the electricity sector was analyzed using ICF Consulting's Integrated Planning Model (IPM), a detailed, engineering-economic production-costing model. The model uses a linear programming formulation to select investment options and dispatch generating resources by minimizing the net present value of capital and operational costs, given the cost and performance characteristics of available options, electricity demand forecasts, and reliability criteria.

The IPM model can simulate single- or multiple-pollutant reduction constraints under cap-and-trade programs, technology-based standards (e.g., BACT, MACT), or rate-based standards (e.g., lb/mmBtu, lb/MWh), and has been used by the EPA and many private sector clients to analyze alternative approaches for reducing multiple emissions from electricity generation. IPM determines the least-cost means of meeting emissions reduction policy requirements and forecasts allowance prices, compliance costs, and unit dispatch and retrofit decisions for each boiler and generator in the North American Electric Reliability Council (NERC) regions. Because no carbon-scrubbing technology is assumed, CO_2 allowance prices in the electric sector are determined by the increased system costs of building and operating lower carbon-intensive generation as well as existing unit dispatch changes.

IPM forecasts future trends in electricity markets and related environmental variables on the basis of a given algorithm and a set of assumptions input to the model. This type of analysis is extremely useful in determining directionality as well as cause and effect. For any given scenario modeled, however, the use of different assumptions will typically lead to different outputs. In addition, the assumptions input to the model may not reflect the actual future values of the assumed parameters. Actual real-world decisions may differ from optimal economic outputs

determined by IPM due to factors not expressly evaluated in this analysis. The results of IPM modeling should therefore be interpreted accordingly.

IPM Assumptions

The stakeholders selected the IPM model for use in this analysis; the key assumptions input to IPM for the Connecticut analysis were selected through an extensive assumptions-development process. In this process, alternative data sets were considered and final data sets to be used in the analysis were chosen. Although all key assumptions that drove the direction of the analysis were carefully reviewed and selected by the stakeholders, some of the unit-specific data were not reviewed. The assumptions are detailed in the IPM modeling assumptions document dated 10-30-03 (Document 2 in the section appendix). Sources for the assumptions used included the U.S. Energy Information Administration's (EIA) *Annual Energy Outlook* (2003), the U.S. Environmental Protection Agency (EPA), ISO-New England, and ICF- and stakeholder-provided data. The key parameters used in IPM and the specific sources used in this analysis are summarized in Tables 3.3.2 and 3.3.3.

Table 3.3.2
Macroeconomic and Power Market Drivers

Item	Source
CT, NEPOOL Load and Peak Demand Forecast	EIA Annual Energy Outlook 2003 Reference Case (AEO 2003); ISO New England (ISO-NE)
Reserve Margin Assumptions	ISO-NE
Financing for Capital Projects – new builds and retrofits	ICF
Coal supply, minemouth and transportation prices	ICF
Natural Gas Prices	AEO 2003
NEPOOL Transmission (Assumes implementation of Phase I and Phase II capability expansions)	ISO-NE; Electricity Working Group

Table 3.3.3
Greenfield Power Plant and Retrofit Cost and Performance

Item	Source
Greenfield Cost and Performance Characteristics of Conventional (fossil) Generation	EIA AEO 2003
New Build Emissions Profiles	ICF
Firm Builds	ICF; Electricity Working Group
Greenfield Cost and Performance Characteristics, and Resource Availability of Renewable Generation	EIA; Electricity Working Group
Emissions and Control Assumptions	EPA

In the reference case and in all policy cases, this analysis incorporated a renewable portfolio standard (RPS). In such cases, a required amount of renewable generation is specified as a percentage of electric demand, and it is met through the construction and operation of the renewable technologies that were decided on as input assumptions. The reference-case RPS assumptions are shown in Table 3.3.4.

Table 3.3.4
Reference Case Renewable Portfolio Standards

- Reference Case RPS standards modeled to establish regionwide renewable demand. One regionwide REC market was assumed to be in place.

Regional Market	State	Standard in 2005 and Later	Capacity Types
NEPOOL / New York / PJM	**Connecticut (Class I)**	1.5% in 2005 growing to 7% in 2010 and later	Wind, Landfill Gas, Biomass Gasification, Fuel Cells, Solar PV, Hydro (smaller than 5 MW)
	Massachusetts	2% in 2005 growing to 4% in 2009, plus 1% growth/year thereafter	Wind, Landfill Gas, Biomass Gasification, Fuel Cells, Solar PV, Hydro (smaller than 5 MW)
	New York	1% incremental in 2006 growing to 8% incremental in 2013	Wind, Landfill Gas, Biomass Gasification, Fuel Cells, Solar PV, Hydro (smaller than 5 MW)
	New Jersey (Class I)	0.75% in 2005, 1.0% in 2006, 4% in 2012 and later	Wind, Landfill Gas, Biomass Gasification, Fuel Cells, Solar PV, Hydro (smaller than 5 MW)
	Pennsylvania	2% in 2001; increasing 0.5% annually, but only for PECO	Wind, Landfill Gas, Biomass Gasification, Fuel Cells, Solar PV, Hydro (smaller than 5 MW)

IPM results were modeled for representative years over the 2006–2025 analysis period. Results were reported through 2020 to alleviate any end-year anomalies.

Reference Case Results

The reference case was developed to represent a view of the world under "business-as-usual" conditions, against which Connecticut- and region-specific policies could be evaluated. The reference case includes State-level environmental regulations as well as an assumed national three-pollutant (3P) policy that represents some future action, either by regulation or legislation, on national SO_2, NO_x and Hg emissions from power plants. The reference case also includes existing State-level renewable portfolio standards. It was assumed that existing nuclear-generating units would automatically relicense upon reaching the end of the 40-year operating license; no incremental costs were assigned to the relicensing process. Nuclear units were given the option to increase their capacity (i.e., uprate) by a defined amount if such action was deemed economic by the model. The uprate potential and costs used were developed by an EIA study. In the reference case, CO_2 emissions in Connecticut are forecast to be 29 percent below 1990 levels in 2010, but they rise to 12 percent above 1990 levels by 2020. This outcome is primarily the result of the addition of new, coal-fired IGCC capacity in Connecticut and the 10-state region in the 2020 time frame. CO_2 emissions for the 10-state region are forecast to increase by 10 percent and 31 percent above 1990 levels in 2010 and 2020, respectively. Emissions in the 10-state region are forecast to increase by 26 percent from 2006 to 2020, with much of the increase in the 2015–2020 period due to the new coal IGCC builds. If generation from gas-fired combined-cycle units were substituted for all the generation for those plants, emissions in 2020 would increase only 16 percent above 2006 levels. Note that the coal IGCC builds were the outcome of assumed EIA cost and technology inputs and gas price trajectories. The stakeholders

expressed some skepticism regarding the likelihood of significant new coal IGCC builds to meet electricity demand. Although IGCC may be competitive under the 3P scenario analyzed in the reference case, the group thought this economically chosen result was unlikely due to other considerations.

Policy Case Results

Based on stakeholder input, the IPM model was used to estimate the future CO_2 emissions from the electricity sector that would result under six individual scenarios with GHG mitigation measures: renewable energy strategy (RES), energy efficiency and combined heat and power, regional cap-and-trade program, combination run (including RES, regional cap and trade and energy efficiency), combination run without nuclear relicensing, and combination run with high natural gas prices. The last two cases are sensitivity analyses developed from the combination run. The policies modeled in each of these runs in IPM are summarized in Tables 3.3.5 and 3.3.6.

Table 3.3.5
Connecticut State Policies and Program Scenarios

Scenario	Air Regulatory Policy	Renewable Policy	Regional CO_2 Policy	Energy Efficiency Program
Reference	Title IV SO_2 NO_X SIP Call	CT, MA, NY, PA and NJ Standards in Regional Renewable Credit Trading Market (NEPOOL, NY, PJM)	None	None
CT Renewable Strategy	State Multipollutant Regulations Representative 3-Pollutant Policy Covering SO_2, NO_X and Hg	Incremental to Reference: 20% RPS by 2020 (CT), State Agency Purchase Requirement (CT), State Production Tax Credit (CT)		
CT Energy Efficiency Program		Same as Reference		14% Load Reduction by 2020

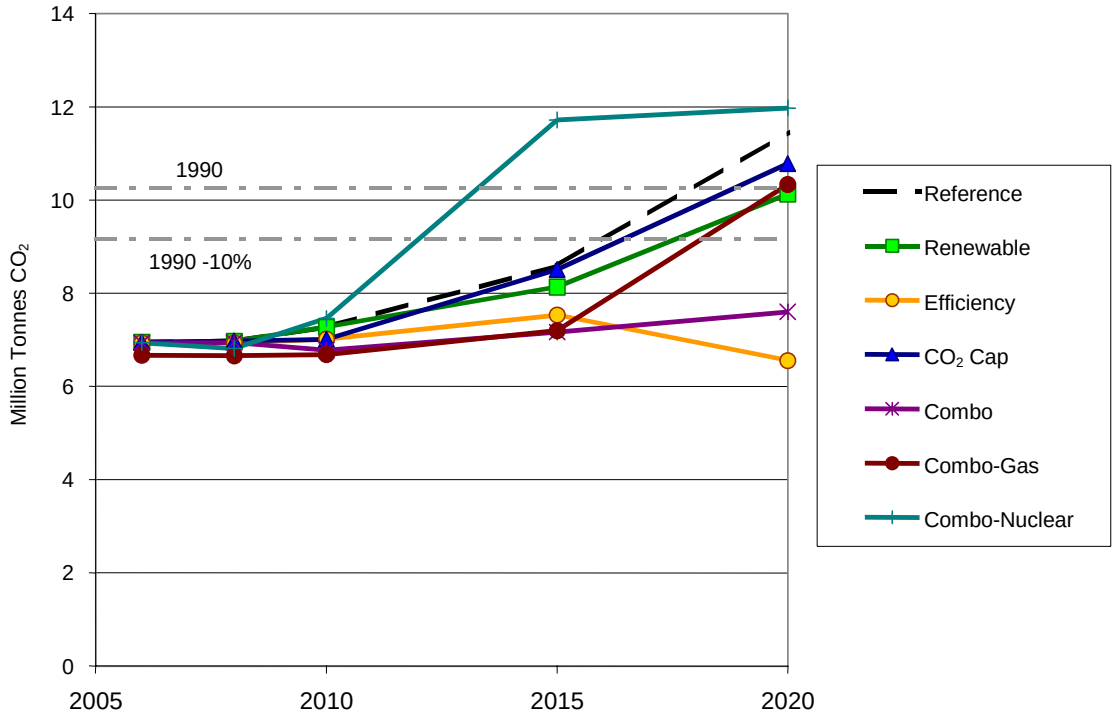
Table 3.3.6
CO_2 Cap-and-Trade Scenarios

Scenario		Renewable Policy	Regional CO_2 Policy	Energy Efficiency Program	
10-state CO_2 Cap and Trade Policy	Title IV SO_2	None	10-state Cap 1990 Levels in 2010 1990-5% in 2015 1990-10% in 2020 (Offsets in 2015, 2020)	None	None
Combination	NO_X SIP Call	Same as Renewable Strategy		Same as CT Energy Efficiency Program	None
Combination: High Gas Price Sensitivity	State Multipollutant Regulations				Henry Hub Prices 50% Higher than Reference Case
Combination: No Nuclear Unit Relicensing Sensitivity	Representative 3-Pollutant Policy Covering SO_2, NO_X and Hg				Nuclear Units Retire at End of Current License Period

The results of the IPM analysis of the electricity sector for the six policy scenarios are presented in Figures 3.3.3–3.3.7.

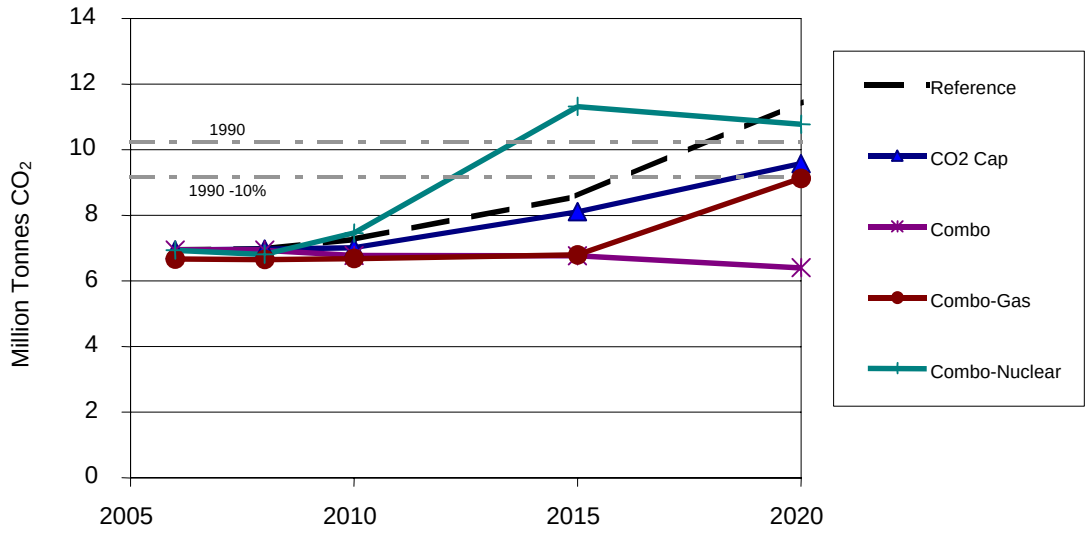
Figure 3.3.3 displays the projected CO_2 emissions in Connecticut. Electricity sector CO_2 emissions decrease below reference-case levels in every scenario except the combination run

Figure 3.3.3
Connecticut CO_2 Emissions Trajectories, On System



without nuclear relicensing case, in which CO_2 emissions increase sharply from 2010 through 2015. The energy efficiency (EE) and combined heat and power case has the greatest impact on reducing electricity sector emissions in Connecticut, and the combination run (including RES, regional cap and trade, and energy efficiency) has the second greatest impact. The remaining three cases produce similar results in 2020. Note that the reductions obtained in the combination run case (which includes a regional cap-and-trade program) are much greater than would be obtained with the cap-and-trade program alone, due to the implementation of EE and renewable energy programs within Connecticut.

Figure 3.3.4
Connecticut CO_2 Emissions Trajectories, With Offsets

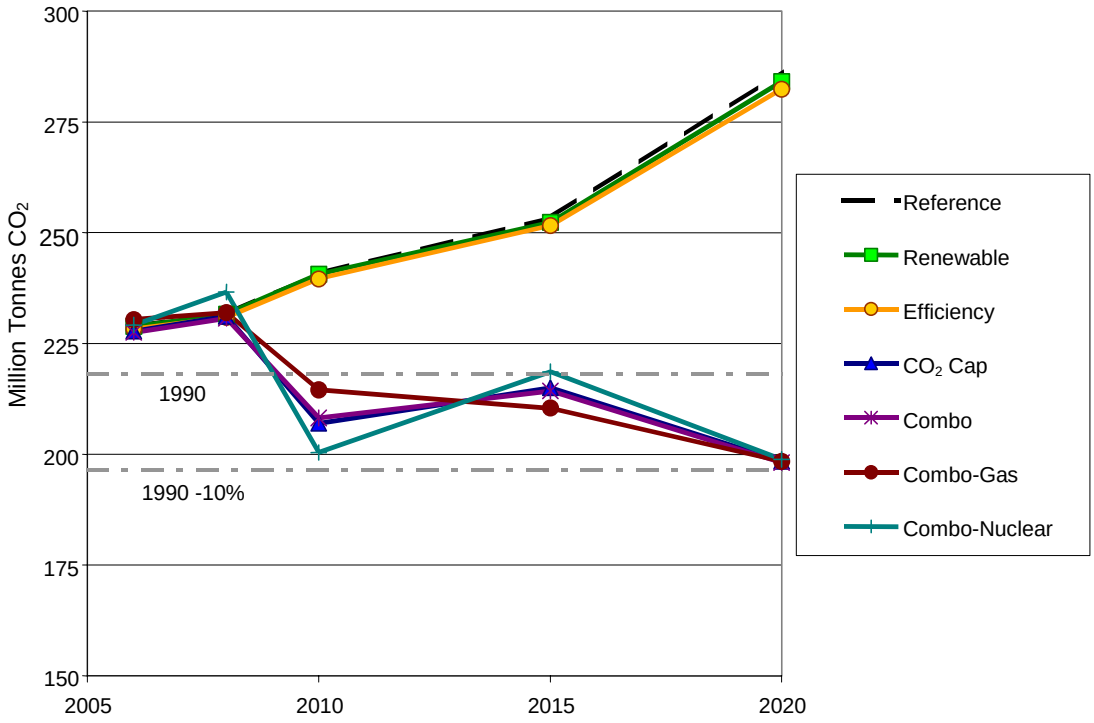


The impact of offsets in the cases that include a regional cap-and-trade program can be seen in Figure 3.3.4. The offsets have a significant impact on emission levels in 2020, lowering emissions in all four scenarios.[1]

The projected CO_2 emissions for the 10-state region are displayed in Figure 3.3.5. It is apparent that the two Connecticut-specific cases (RES and energy efficiency and combined heat and power) have little impact on the 10-state regional CO_2 emissions trajectory. Connecticut accounts for only 7 percent of the electric load and 3 percent of the total CO_2 emissions within the 10-state region, so State-specific actions in Connecticut have a relatively small impact on regional emissions. The four other cases include a regional cap-and-trade program and result in absolute reductions across the 10-state region, reducing emission levels to the 1990 minus 10 percent policy level in 2020.

[1] The quantity and price of offsets available to the electric sector in this analysis were derived by ICF Consulting from EPA methane and High-Global Warming Potential marginal abatement curves and a marginal abatement curve for forestry generated by Ken Richards at Indiana University.

Figure 3.3.5
Ten-State Region CO_2 Emissions Trajectories

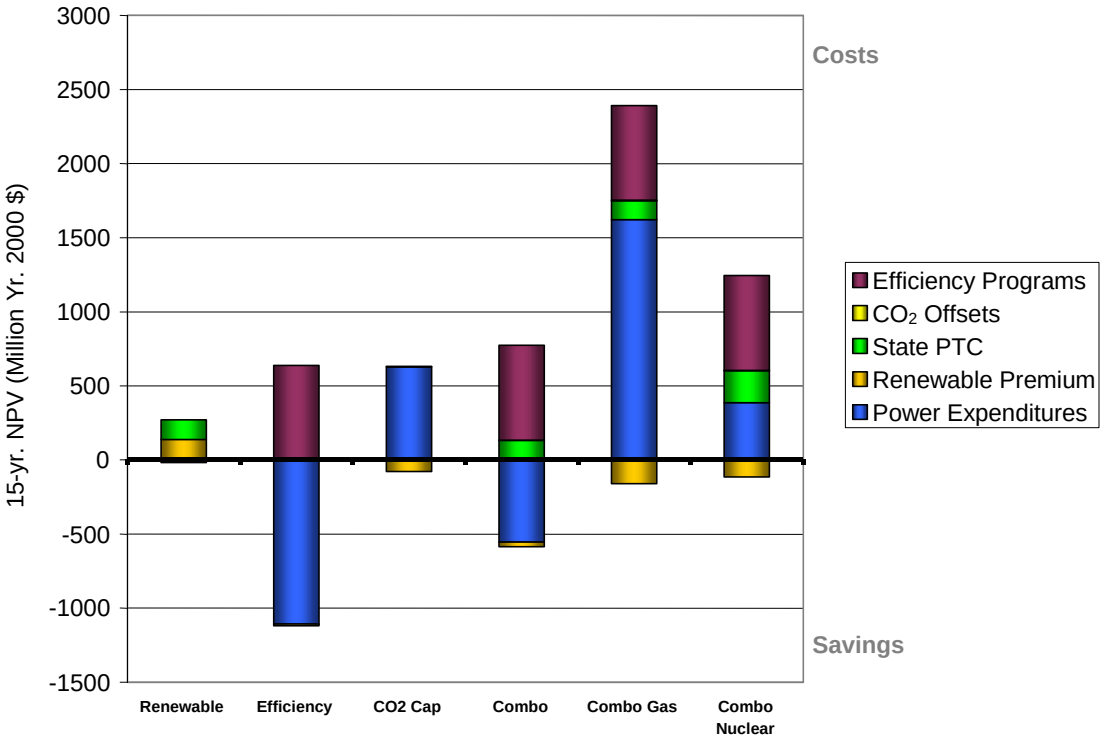


Note: Cases with cap-and-trade programs include impact of offsets.

The total State-level costs of the scenarios analyzed are shown by component in Figure 3.3.6. The following costs (compared with those in the reference case) were included in the estimates: cost of the EE programs;[2] CO_2 offsets purchased off-system; cost of the Connecticut State-level production tax credit for renewables; the renewable premium required to support the level of generation required by the RPS; and changes in wholesale power expenditures. The EE and combined heat and power case leads to a significant decrease in costs, because program costs of $640 million are more than offset by $1.1 billion in savings on power expenditures. The combination run with high natural gas prices case leads to the largest cost increase due to a significant increase in power expenditures in addition to the cost of the EE programs. In the RES case, the introduction of low marginal cost generation slightly reduces wholesale prices, but that is more than offset by the renewable premium and the cost of the State production tax credit, producing a moderate cost increase.

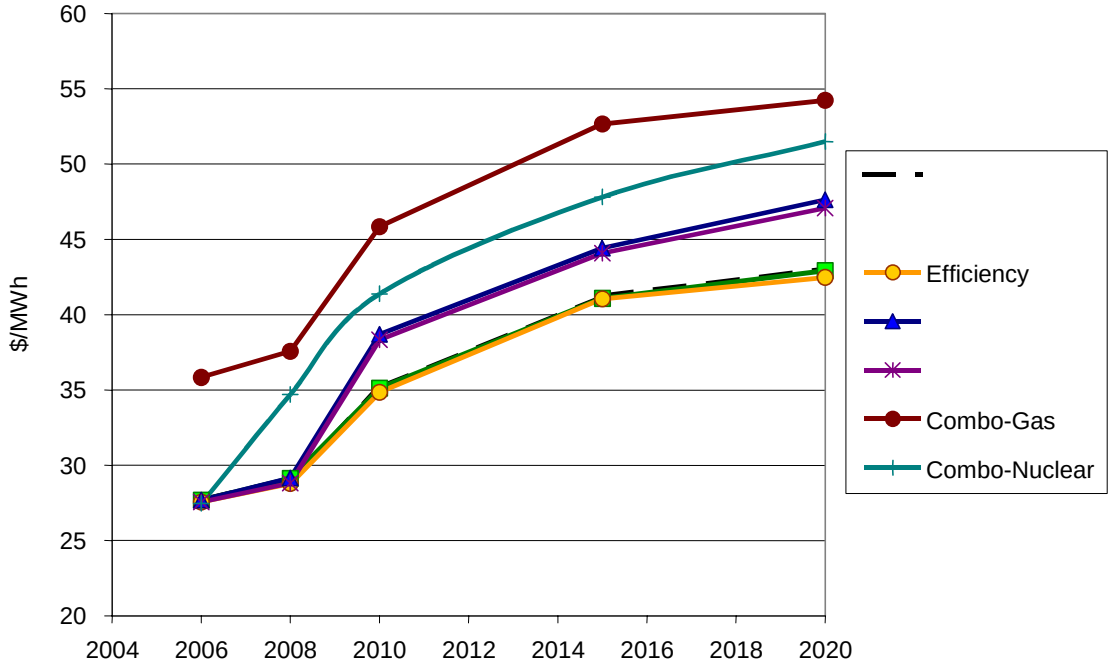
[2] The cost of the EE programs was calculated off-line and was based on the $0.024/kWh average program cost of the Connecticut Conservation and Load Management Fund. Note that IPM does not explicitly account for emissions from standalone steam boilers or the net emissions changes that may occur from the new combined heat and power units that replace them.

Figure 3.3.6
Program and Policy Costs to Connecticut by Component



The wholesale firm power prices in Connecticut are displayed in Figure 3.3.7. The lowest power prices are obtained in the RES case and the EE and combined heat and power case, which follow trajectories similar to the reference case. Prices are $0.46/MWh lower in the latter case. The price trajectories in the regional cap-and-trade case and the combination run (including RES, regional cap and trade and energy efficiency) also follow similar paths. in the regional cap-and-trade program case, wholesale prices reach more than $47/MWh. In the Combination Run case, the implementation of EE and renewable energy programs within Connecticut alleviates pressure on fossil-fired resources, slightly reducing prices. Wholesale prices increase most dramatically under the two sensitivity analyses, the combination run without nuclear relicensing case and the combination run with high natural gas prices case. The combination run without nuclear relicensing case puts upward pressure on power prices under a CO_2 cap as the nuclear capacity in the State and region is replaced with emitting fossil generation. The combination run with high natural gas prices case puts the most upward pressure on allowance prices. In this scenario, fuel switching to gas (the main strategy for compliance under a CO_2 policy) is more expensive due to the higher fuel costs.

Figure 3.3.7
Connecticut Wholesale Firm Power Prices



Detailed Policy Descriptions and Modeling Results

Individual descriptions of each policy case and the associated IPM results are provided in the following sections. The change with respect to the reference case has been estimated for Connecticut CO_2 emissions and other parameters. Estimates of the change in CO_2 emissions for the 10-state region are also provided.

Also included in this chapter are separate discussions of each of the individual measures comprising the RES (RPS, government green power purchase, and production tax credit [PTC]) and a green power option measure. The CO_2 reductions from three of these measures were estimated through off-line calculations (reductions for the PTC were not estimated).

Renewable Energy Strategy (RES)

Recommended Action: Implement the renewable energy strategy (RES).

Promote the development of renewable energy in Connecticut and in the region as a long-term GHG emissions-reduction strategy and encourage the renewable industry in Connecticut. The RES consists of a number of policy components: adoption of an enhanced RPS in the State, purchases of renewable energy by State government, and a PTC. The IPM model was used to quantify the RES.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Implementing this program is estimated to reduce Connecticut's GHG emissions by

0.0 MMTCO$_2$e in 2010
1.33 MMTCO$_2$e in 2020

The estimated emissions reductions from the implementation of the RES in Connecticut for the 10-state region are

0.09 MMTCO$_2$e in 2010
2.02 MMTCO$_2$e in 2020

- Total CO_2 emissions in Connecticut from the electricity sector do not change in 2010, but they will decline by 0.46 MMTCO$_2$e in 2015 and by 1.33 MMTCO$_2$e in 2020. CO_2 emissions therefore decline from reference-case levels by 5.3 percent in 2015 and 11.6 percent in 2020.
- Through 2010, no additional capacity is added in Connecticut. Through 2020, 409 MW of projected fossil-fired capacity in Connecticut would be displaced by the construction of 204 MW of biomass-fired IGCC and additional capacity construction outside the State. The cumulative combined-cycle capacity built decreases from 656 MW to 470 MW, while the coal IGCC falls from 825 MW to 602 MW. The total cumulative capacity added in 2015 increases to 817 MW; the cumulative capacity added through 2020 falls to 1,456 MW, which is 205 MW below the projected capacity in the reference case.
- In 2010, the generation profile in Connecticut does not change. Generation from all fossil sources declines by 8.7 percent in 2015 and 11.7 percent in 2020. Combined-cycle generation decreases by 13.2 percent in 2015 and 6.2 percent in 2020; oil/gas steam-unit generation increases by 120.5 percent in 2015; and coal IGCC generation falls by 27.0 percent in 2020. Total renewable generation increases dramatically by 354.3 percent in 2015 and 250.3 percent in 2020. Generation from biomass IGCC increases from zero to 1,432 GWh in both 2015 and 2020. Biomass IGCC accounts for nearly all the increase in renewable generation, although wind generation increases by 11.1 percent in 2015. Total in-state generation in 2020 decreases by 2.1 percent, and the proportion of generation from renewable sources rises from 1.5 to 5.2 percent.
- The average wholesale electricity price in Connecticut changes only slightly over the forecast period. It does not change in 2010, but it decreases by 0.4 percent (–$0.13 /MWh) in 2015 and 0.2 percent (–$0.09/MWh) in 2020.

- Average wholesale capacity prices increase by less than 0.1 percent in 2010 and then decline by 0.2 percent in both 2015 and 2020.
- Average wholesale firm power prices increase by less than 0.1 percent in 2010; they then decrease by 0.3 percent in 2015 and 0.2 percent in 2020.
- Compared with the reference case, total program and policy costs to Connecticut through 2020 increase by $253.91 million. Total cost changes by component are as follows:
  - Power expenditures: –$17.51 million
  - Renewable premium: $138.32 million
  - State production tax credit: $133.10 million

Renewable Portfolio Standard (RPS)

Recommended Action: Consider increasing the renewable portfolio standard (RPS).

The State should consider increasing the RPS in the future, based on its actual performance. Data from future State and stakeholder experience with the RPS will be analyzed to determine the design.

The recommended RPS Class I renewable energy targets for 2011 to 2020 are shown in Table 3.3.7.

Table 3.3.7
Recommended RPS Class I Renewable Energy Targets

Year	Energy Target (%)
2011	8.0
2012	9.0
2013	10.0
2014	11.0
2015	12.5
2016	14.0
2017	15.5
2018	17.0
2019	18.5
2020	20.0

To meet the RPS and State government green power purchase requirements, Connecticut would allow the purchase of green power generated in New England as well as that generated in Delaware, Maryland, New Jersey, New York, and Pennsylvania, assuming they have compatible certificate markets and mechanisms.

Implementation Pathway

Set a required renewable portion of the total State power mix offered by electricity suppliers for Connecticut ratepayers.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

The group analyzed the RPS in conjunction with other electricity sector measures (i.e., government green power purchase and PTC). The results from that joint quantification are detailed in the section on the RES.

Prior to the IPM analysis, the working group estimated the impact of the RPS in Connecticut. The assumptions behind the method and the results are detailed below.

This isolated bottom-up calculation estimated that Connecticut would achieve the following reductions:

0.53 MMTCO$_2$e in 2010
1.25 MMTCO$_2$e in 2020

Note that the assumptions regarding implementation of the scenario were revised. Thus, the two estimates are not directly comparable, but the bottom-up approach is included for informational purposes. The assumptions underlying the initial quantification and the resulting carbon impact are shown in Table 3.3.8.

Table 3.3.8
RPS Assumptions and Resulting Carbon Impact

	2002	2010	2020
Electricity demand (GWh)	32,907	35,713	39,796
RPS Level			
Class I	1.4%	7%	20%
Class II	0%	3%	3%
RPS Generation (GWh)			
Class I	461	2,500	7,959
Class II	0	1,071	1,194
Marginal CO_2 emissions rate (lbs CO_2/MWh)	1,400	1,300	1,200
MMTCO$_2$e Reduction			
Class I	0.29	1.48	4.34
Class II	0	0.63	0.65
Net impact (I+II x .25) (.25 is due to limited renewable availability)	0.07	0.53	1.25

Extension of the RPS provides multiple benefits, including fuel diversity, energy independence, public health, economic development, and GHG emissions reductions.

The RPS would also require the development and implementation of a green-tag system to certify electricity that is produced using renewable resources. Such certificates facilitate accurate accounting practices and trading.

Stakeholder Views

After revising the language to address uncertainty of availability and performance, The stakeholders unanimously approved this measure (referred to as “unanimous consent” in the summary tables).

Given the uncertainties associated with the RPS, promoting and encouraging the continued long-term deployment of Class I renewable energy resources in the region as an extension of the RPS beyond 2010 will be considered for adoption in the future. Further increases in the magnitude of the RPS will be considered as well. Future State data and stakeholder experience with the RPS will be analyzed to reevaluate assumptions regarding implementation, timing, and levels. It is hoped that the deployment of clean distributed renewable energy through an extension of the RPS will further encourage the long-term development of renewable energy resources in the Northeast and diversify the region's fuel mix, thereby reducing fuel-price volatility, providing secure and reliable sources of energy, and creating economic development opportunities.

Public Views

- Public comments supported broad incentives for wind, photovoltaic power, and other renewables along with hydrogen generated from these sources
- Wide public support exists for the following measures to promote renewable energy:
  - Aim for and incentivize 20 percent renewable energy by 2010.
  - Require a minimum of 20 percent renewable energy by 2020.
- Renewable incentives should match or exceed any incentives given to fossil fuels

Other

New Jersey Governor James McGreevey has directed the New Jersey Board of Public Utilities to implement a set of task force recommendations aimed at promoting the use and development of renewable energy in the State. The recommendations include establishing a statewide program that would allow retail electric customers to select an alternative green power supplier through a sign-up option on utility bills. Other task force recommendations include increasing the State's RPS to 4 percent in 2008; establishing a new long-term RPS of 20 percent for 2020; and providing a check-off option on utility bills that would allow customers to contribute to the New Jersey Clean Energy Program, which promotes renewable energy through rebates and incentives.

New York's Public Service Commission is currently working on establishing an RPS; the goal is to achieve 25 percent renewable energy by 2013 to increase diversity of energy resources and reduce air emissions. The renewable energy level is currently at 17 percent, with an additional 8 percent required to meet the anticipated target. The implementation of the RPS will result in the displacement of about 13 percent of the electric energy derived from oil and gas resources. The task force has assumed that 25 percent of New England's demands for new renewable energy resources will be met by resources available from the New York market.

Government Green Power Purchase

Recommended Action: Implement a government Green Power Purchase program.

The State should increase its purchase of Class I renewable energy to 20 percent in 2010, 50 percent in 2020, and 100 percent in 2050.

To promote and encourage the deployment of renewable energy resources in the region (beyond RPS requirements) by Connecticut businesses, municipalities, institutions, and households, government can "lead by example" by purchasing increasing amounts of renewable energy.[3] The adoption of a portfolio of strategies could yield a zero-cost solution. These strategies include the following measures:

1. *Use energy conservation savings to finance the premium for renewable energy.* A shared savings policy requires the Office of Policy and Management to rebate 50 percent of the energy savings achieved by State agencies. The stakeholders recommend that the 50 percent of the savings received by the State through this measure be earmarked for renewable energy purchases. Clearly demonstrated energy savings (based on comparable kWh numbers from year to year) could substantially finance the State purchase of renewable energy and help it achieve the recommended goals. This strategy is coordinated with the RCI working group and its recommendations for State government energy conservation targets.
2. *Competitive power procurement.* Deregulation offers State government the opportunity to issue a competitive bid in the open market to achieve a reduced rate. Energy savings of 5 to 10 percent can be achieved through a competitive offer. The State could also specify increasing quantities of renewable energy in its mix to achieve the recommended targets.
3. *Supplemental environmental projects.* Supplemental environmental projects (SEPs) can help companies mitigate all or part of the penalties imposed as a result of air pollution violations. SEPs are environmentally beneficial projects administered by the DEP that offer pollution prevention, EE, green energy, and community-based programs. SEPs can reduce the renewable premium, help finance renewable energy projects, and support the purchase of green tags.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Implementing this program is estimated to reduce GHG emissions by
0.08 MMTCO$_2$e in 2010
0.21 MMTCO$_2$e in 2020

The Office of Policy and Management (OPM) has provided annual energy usage data for State government facilities for FYs 2001 and 2002. Data provided by OPM and the Connecticut Siting Council show that State government energy consumption equates to roughly 2 percent of

[3] Renewable energy means Class I from one of the following sources: (1) renewable energy certificates purchased in Delaware, Maryland, New England, New Jersey, New York, and Pennsylvania, (2) green power offerings, or (3) onsite distributed-generation deployment at State facilities.

Connecticut's total, making it an important target for leading by example. Electricity costs represent less than 0.5 percent of the general budget. The market size is estimated to be 650,000,000 kWh, including 34 State agencies and 18 State colleges and universities.

Government procurement has significant positive benefits in spurring market demand. State government's commitment to purchase renewable energy creates opportunities for clean energy technology commercialization, energy reliability and security through distributed generation, and economic development prospects for nascent industries in which Connecticut companies are recognized leaders (e.g., fuel cells).

The assumptions that went into the initial quantification and the resulting carbon impacts are shown in Table 3.3.9:

Table 3.3.9
Government Green Power Purchase Assumptions

	2002	2010	2020
Estimated government demand for electricity (GWh)	647	702	781
Percentage renewable	1%	20%	50%
Estimated renewable electricity demand (GWh)	6	140	391
Marginal CO_2 emissions rate (lbs CO_2/MWh)	1,400	1,300	1,200
$MMTCO_2e$ reduction	0.004	0.08	0.21

This option was also analyzed within the IPM RES scenario. See the summary of the RES scenario for joint quantification estimates.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

There should be a minimum 20 percent government green power purchase by 2010 and 50 percent in 2020.

Production Tax Credit

Recommended Action: Explore a production tax credit (PTC) for new Class I renewable projects.

The State should explore a production tax credit (PTC; equal to $0.018/kWh for 10 years) for new Class I renewable projects in Connecticut that are not covered by the federal renewable PTC (i.e. fuel cells, solar, landfill gas, biomass, hydrogen, and small hydro). This would be a potential mechanism to achieve RPS and promote development of in-state renewables in light of future information on the availability of and competition for biomass resources.

A PTC can encourage the deployment of renewable energy resources in Connecticut; generators in Connecticut should be provided a State PTC to complement the federal PTC. A Connecticut PTC would cover Class I renewable energy resources constructed in Connecticut and not covered by the federal program. Under this policy, projects eligible for the federal PTC (e.g., wind) would not receive State assistance, but ineligible projects (e.g., solar) would. A Connecticut PTC would apply to projects constructed beginning in the year legislation was passed and continue indefinitely. Projects would have to first seek federal assistance; if they did not qualify, they would be eligible for the State tax credit. This policy should ensure that renewables that are close to the margin economically will get built in Connecticut.

The Connecticut PTC would be for the same amount as the federal credit (currently $0.018/kWh). Like the federal PTC, the credit period would be 10 years from the start of service.

Implementation Pathway

Provision of PTC will be handled by the Department of Revenue Services for qualifying projects.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

The PTC was quantified together with two other measures (government green power purchase and RPS) as the RES using the IPM model (see the summary of the RES scenario for joint quantification estimates).

Stakeholder Views

Given the results of the IPM modeling, the stakeholders were initially concerned that the PTC would affect only biomass capacity while failing to encourage development of solar or other renewables in Connecticut. Cautionary language was added to reflect the group's concerns. With this caveat, the group achieved unanimous consent on recommending exploration of the PTC as potential mechanism to achieve RPS and promote development of in-state renewables.

Public Views

None

Green Power Option

Recommended Action: Provide a green power option to ratepayers and default customers.

The State should establish and launch a green power supply option for all ratepayers and default customers pursuant to SB 733 by January 1, 2004. The green offering targets recommended by the renewable energy subcommittee are as follows: 3 to 4 percent by 2010; 5 to 10 percent by 2020; and 11 to 20 percent by 2050. These targets exceed the RPS requirements.

To promote and encourage the deployment of renewable energy resources in the region (beyond RPS requirements), Connecticut ratepayers should be able to choose where their power comes from through one or more green offerings. Several years ago, two competitive power suppliers offered Green-e certified renewable energy products: Green Mountain Energy and the Connecticut Energy Cooperative. At their peak, the two providers were satisfying less than 0.1 percent of the market with a renewable energy product based on the number of ratepayers being served. Currently, no renewable energy offerings are available to Connecticut ratepayers. The implementation of green offerings would therefore provide choices for Connecticut ratepayers while improving the portfolio of renewable energy strategies to support market development and deployment of clean-energy technologies.

The recommended targets for green offerings are as follows:

- 3 to 4 percent by 2010
- 5 to 10 percent by 2020
- 11 to 20 percent by 2050

Note that these targets exceed the RPS requirements. In other words, by 2010, 10 percent of the power supply will come from Class I and Class II renewable energy resources through the RPS, and 3 to 4 percent of ratepayers will be supplied by 100 percent renewable energy (90 percent more than is required by the RPS for this block of customers) through competitive offering(s) explicitly purchased by them.

The program would be administered by the Alternative Transitional Standard Offer Providers Connecticut Light and Power (CL&P) or United Illuminating (UI) and by any competitive power supplier offering green product(s) in the marketplace.

- *Consumer Education and Outreach Program*. Research indicates that a continuous commitment to marketing green offerings contributes to program success. The Consumer Education and Outreach Program, managed by Department of Public Utility Control (DPUC), should set aside a portion of its funding to specifically inform ratepayers about green offerings. Strategic funding efforts by DPUC to capable organizations operating in Connecticut can improve upon the effectiveness and efficiency of education and outreach programs.

- *Connecticut Clean Energy Fund (CEF).* The CEF, through its existing education and outreach initiatives, will provide support for the benefit of Connecticut ratepayers.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

The program is estimated to reduce GHG emissions by
0.43 MMTCO$_2$e in 2010
0.81 MMTCO$_2$e in 2020

The estimates are based on the output of the renewable IPM modeling run. The State energy-use and fossil fuel emissions factors are taken from the run. The impact of the green option is quantified by taking the minimum target level, as determined by the stakeholders for specified years, adjusted for the expected generation source (renewable vs. nonrenewable) and multiplied by the expected emission rate. The range of cost premiums for renewable energy is based on the costs of the generation technologies and fuels (e.g., wind, solar, biomass, landfill gas, fuel cells, hydrogen, etc.), pricing pressures due to limited supplies in the Northeast, and natural gas prices. Cost estimates (Table 3.3.10) are based on projected consumption (kWh) and number of ratepayers as well as on the estimated ranges of cost premiums for renewable energy.

Table 3.3.10
Details of the Green Option Quantification

	2010	2020
Electricity demand (GWh)	32,933	38,560
Fossil fuel generation displaced	2.8%	4%
Fossil (marginal) emission rate (lb CO_2/MWh)	1,035	1,155
Carbon reduction (MMTCO$_2$e)	0.43	0.81
Total cost (millions)	$14.49	$17.76

Stakeholder Views

The stakeholders agreed to this recommendation through unanimous consent.

Public Views

- All consumers should have the option to purchase green power.

Energy Efficiency and Combined Heat and Power

Recommended Action: Implement a package of energy efficiency and combined heat and power (CHP) measures.

All measures identified and assessed by the RCI and AFW working groups that result in electricity demand reductions are included in the EE package for the IPM model run. The measures include appliance standards, an appliance-swapping program, a heat pump and water heater (HPWH) replacement program, bulk purchasing of appliances, mandatory upgrades to commercial and residential building codes, energy efficiency and energy improvement mortgages, a weatherization program, an Energy Star homes program, high-performance schools and State-funded buildings, high-performance commercial buildings, a shared savings program for government buildings and benchmarking, training of building operators, a green campus initiative, a benchmarking and tracking program for municipal buildings, third-party load management, combined heat and power, restoration of the Conservation and Load Management Fund, installation of centralized manure digesters, and an urban tree-planting program.

Implementing this program is estimated to reduce Connecticut's GHG emissions by
0.25 MMTCO$_2$e in 2010
4.90 MMTCO$_2$e in 2020

For the 10-state region, the emissions-reduction estimates are
1.17 MMTCO$_2$e in 2010
3.86 MMTCO$_2$e in 2020

This program includes demand-side reductions made in the RCI and AFW sectors and measures to encourage combined heat and power. The IPM model was used to quantify this package. Demand was assumed to be reduced by 3 percent in 2006, increasing to a 14 percent reduction in 2020. The measures and the costs of implementing them were developed within the stakeholder process.

- Total CO_2 emissions in Connecticut from the electricity sector will decline by 0.25 MMTCO$_2$e in 2010, 1.05 MMTCO$_2$e in 2015, and 4.90 MMTCO$_2$e in 2020. CO_2 emissions therefore decline from reference-case levels by 3.5 percent in 2010, 12.3 percent in 2015, and 42.8 percent in 2020.
- Through 2010, no additional capacity is added in Connecticut. Through 2020, the cumulative combined-cycle capacity built decreases by 484 MW, and the coal IGCC falls from 825 MW to zero. The total additional cumulative capacity projected to be built therefore decreases to only 314 MW in 2015 and 352 MW in 2020. Total projected capacity additions decline due to the decrease in generation levels resulting from increased energy efficiency.
- Generation in Connecticut from combined-cycle units decreases significantly, falling by 1.1 percent in 2010, 27.5 percent in 2015, and 25.3 percent in 2020. Coal IGCC generation falls to zero in 2020; generation from oil/gas steam units falls to zero in 2010, increases by 120.5 percent in 2015, and rises from zero to 244 GWh in 2020. Generation from renewable sources does not change. Total in-state generation falls by 1.7 percent in 2010, 8.6 percent in

2015, and 21.0 percent in 2020; fossil generation decreases by 4.2 percent in 2010, 18.9 percent in 2015, and 43.1 percent in 2020.

- Average wholesale electricity prices in Connecticut decrease slightly: by 0.9 percent (–$0.28 /MWh) in 2010 and 0.3 percent (–$0.12/MWh) in 2015. In 2020, however, wholesale electricity prices increase by 1.3 percent ($0.45/MWh).
- Average wholesale capacity prices decrease by less than 0.1 percent in 2010, 0.6 percent in 2015, and 12.6 percent in 2020.
- Average wholesale firm power prices decrease slightly throughout the forecast period, falling by 0.8 percent in 2010, 0.4 percent in 2015, and 1.3 percent in 2020.
- Compared with the reference case, total program and policy costs to Connecticut through 2020 decrease by $481.26 million. Total cost changes by component are as follows:
  - Power expenditures: –$1,108.26 million
  - Renewable premium: –$10.56 million
  - Efficiency programs: $637.55 million

Public Views

- Energy efficiency should be a priority option.
- There were a number of recommendations to increase efficiency in each sector by 20 percent by 2010.
- Connecticut should reduce its energy consumption by 25 percent through better efficiency by 2010.

Regional Cap-and-Trade Program

Recommended Action: Work with other northeastern states to develop a regional cap-and-trade program.

Connecticut should work with other northeastern states through continued participation in the Regional Greenhouse Gas Initiative (REGGI) and/or the New England Governors Association process to develop a regional cap-and-trade program for the electricity generation sector. These processes should use existing NEG targets as applied to the electricity generation sector as a starting point for recommended cap levels and timing (1990 emission levels by 2010 and 10 percent below 1990 levels by 2020). Given the results of advanced modeling by IPM in Connecticut that predict substantial loss of emissions benefits due to offsetting increases in emissions (i.e., "leakage") inside and outside the region (in Pennsylvania and the eastern interconnect region), Connecticut should design a program covering the broadest possible geographical region and the widest range of potential sources and develop policy mechanisms to control offsetting emissions (such as a generation performance standard, offsets, or other approaches). In addition, Connecticut should support development of an effective federal cap-and-trade program for electricity generation.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

As a first step, the impact of a regional CO_2 emissions cap on power plants, as implemented through a trading system, was modeled using IPM. The cap-and-trade program was defined as follows:

- *Region:* Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont (10 states)
- *Sources:* In the interest of capturing the largest number of sources, include all grid-connected generating units.
- *Cap Size and Timing:* 1990 levels in 2010, 5 percent below 1990 levels in 2015, and 10 percent below 1990 levels in 2020
- *Offsets:* Offsets are phased in: none in 2010, 5 percent in 2015, and 10 percent in 2020.

Leakage of power generation to areas outside the capped region is often a problem in cap-and-trade scenarios. To counteract leakage, a Generation Performance Standard (GPS) may be implemented with the cap. The GPS sets a level of emissions permissible for power imports. By limiting leakage, the performance of the cap-and-trade mechanism may be improved.

The IPM model was used to quantify this measure.

- Total CO_2 emissions in Connecticut from the electricity sector will decline by 0.26 $MMTCO_2e$ in 2010, 0.08 $MMTCO_2e$ in 2015, and 0.68 $MMTCO_2e$ in 2020. CO_2 emissions therefore decline from reference-case levels by 3.5 percent in 2010, 0.9 percent in 2015, and

5.9 percent in 2020. Note that under a regional cap-and-trade system, Connecticut's electricity exports increase, reducing the level of in-State emissions reductions.

- The cumulative capacity added in Connecticut through 2010 totals only 2 MW (of combined-cycle capacity). Through 2020, 1,404 MW of additional combined-cycle capacity is projected to be built in Connecticut. The cumulative combined-cycle capacity built increases from 656 MW to 2060 MW, displacing coal IGCC capacity, which falls from 825 MW in the reference case to zero. The total cumulative capacity added in 2015 increases to 952 MW; the cumulative capacity added through 2020 totals 2,240 MW, which is 579 MW more than the projected capacity in the reference case.
- In 2010, total fossil fuel–based electricity generation in Connecticut decreases by 3.7 percent. Oil/gas steam-unit generation decreases by 87 percent, combined-cycle unit generation falls by 0.2 percent, and coal-unit generation falls by 1.5 percent. Generation from renewable sources does not change. Total generation in 2010 therefore decreases by 1.4 percent, and the percentage of renewable generation increases from 0.8 percent to 0.9 percent. After 2010, generation from combined-cycle units increases significantly, rising by 3.0 percent in 2015 and 123.7 percent in 2020, displacing generation from other fossil units. Coal IGCC generation falls to zero in 2020; generation from gas-combustion turbines decreases by 27.8 percent in 2015 and 3.9 percent in 2020; generation from oil/gas steam units falls to zero in 2015; and coal-fired generation decreases by 1.5 percent in 2010, 2015, and 2020. Generation from renewable sources does not change, except for fuel cell generation, which decreases by 19.0 percent. Total in-state generation increases by only 0.2 percent in 2015 but by 9.5 percent in 2020. The proportion of generation from renewable sources falls to 1.2 percent in 2020.
- Average wholesale electricity prices in Connecticut increase significantly over the forecast period, rising by 8.6 percent ($2.58/MWh) with respect to the reference case in 2010, 9.1 percent ($3.12/MWh) in 2015, and 13.8 percent ($4.84/MWh) in 2020.
- Average wholesale capacity prices increase by 19.5 percent in 2010 and 0.8 percent in 2015; they fall by 3.2 percent in 2020.
- Average wholesale firm power prices increase significantly throughout the forecast period, rising by 10.2 percent in 2010, 7.7 percent in 2015, and 10.6 percent in 2020. Firm power prices increase in 2020 because the increase in wholesale electricity prices outweighs the fall in capacity prices.
- Leakage from the 10-state region occurs in 2010 and after. Net power imports to the 10-state region increase by 314.8 percent in 2010 and 115.3 percent in 2015. In 2020, in the reference case the region is a net power exporter. In the policy case, however, it becomes a net importer in 2020, at which time imports total 22,402 GWh.
- The CO_2 allowance price for the 10-state region increases over the forecast period in the policy case, rising from $7.38/metric ton in 2010 to $9.59/metric ton in 2015 to $12.11/metric ton in 2020.

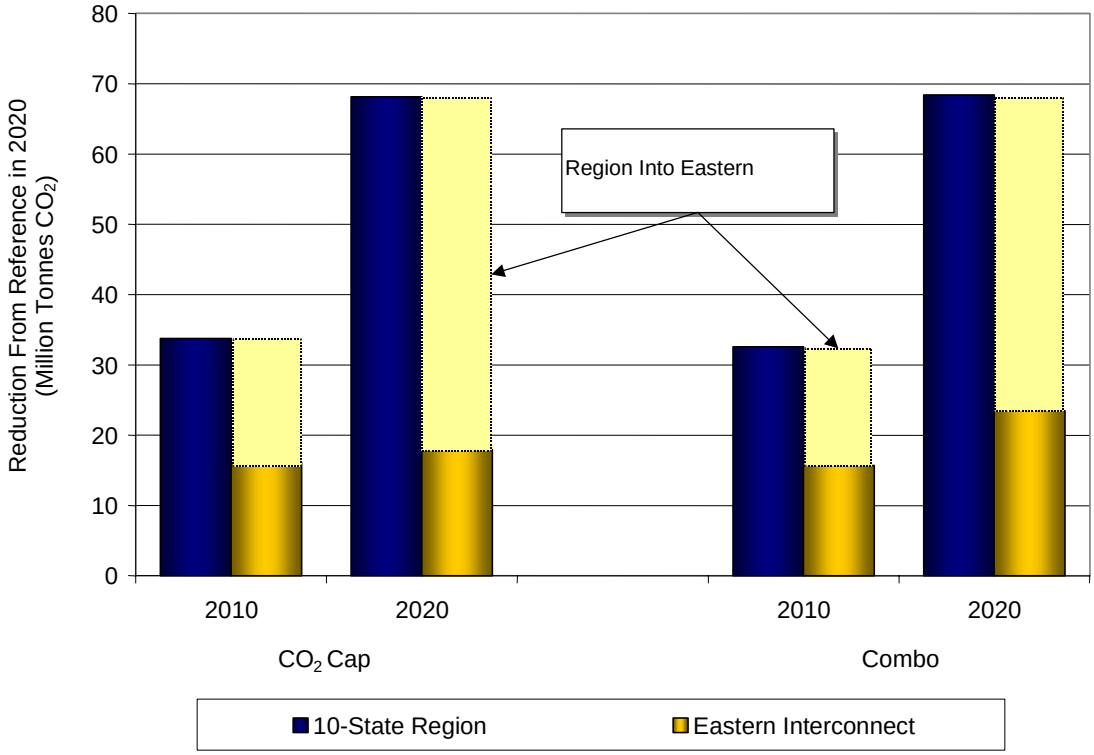
Stakeholder Views

The group unanimously agreed to this revised measure.

The group was particularly concerned with the issue of leakage, which results when the adoption of a cap-and-trade program leads to a rise in imports of electricity into the region or state covered by the cap, in turn increasing emissions outside the region and diminishing the net emission-reduction benefits achieved. Stakeholders also stressed that although cap and trade is effective as a regional policy, it is not very effective as a state policy (in part due to concerns over leakage). Stakeholders felt that Connecticut should therefore avoid implementing a Connecticut-only cap-and-trade program. The group further decided that Connecticut should embrace the REGGI process and should pursue a regional cap-and-trade program with as broad a geographic range (including the REGGI states or even the Eastern Interconnect region) and as many sources as possible. The timing and exact size of the cap should be determined later. It was stated that offsets could have a role in a cap-and-trade program. Given that the inventory has shown that generation in Connecticut is relatively efficient, some stakeholders mentioned that Connecticut is in an ideal position to promote a regional cap-and-trade program. Other stakeholders did not concur with this view. Stakeholders agreed that ongoing discussions of these issues through a cap-and-trade task force should be pursued.

The estimated reductions in CO_2 emissions and costs for this measure were quantified for Connecticut using IPM. A regional cap-and-trade program was estimated to reduce emissions in Connecticut by 0.26 $MMTCO_2e$ in 2010 and 0.68 $MMTCO_2e$ in 2020. Although the emissions reductions appear to be significant, IPM modeling predicted that the emission benefits of a cap-and-trade program in the 10-state region would be substantially reduced due to leakage both within the region (in Pennsylvania) and outside the region (in the eastern interconnect region). By making generation in the 10-state region more expensive relative to generation outside the region (which does not face the CO_2 environmental adder), power imports from areas bordering on the 10-state region increase significantly. Much of this leakage is due to the fact that coal-fired units are the power plant builds of choice outside the 10-state region due to the relative economics of the assumptions used. The IPM results indicate that leakage in the eastern interconnect region would reduce the aggregate emission reductions for the 10-state region by more than 50 percent in 2010 and more than 70 percent in 2020 (Figure 3.3.8). The group was therefore uncomfortable with recommending a regional or statewide cap-and-trade program, and the emission estimates were not included in the statewide reduction totals. The group decided that the report should state that the model results show that significant reductions could potentially be achieved on a regional basis, as long as key concerns (primarily leakage) are properly addressed.

Figure 3.3.8
CO_2 Emission Reductions in the 10-State Region and Eastern Interconnect Region



The group decided that data from IPM runs should be included in the appendix. The group was also concerned that all assumptions used in the analysis be clearly documented.

Public Views

- Many public comments supported a cap-and-trade program, provided that:
  - an auction allocation mechanism is used, and
  - other pollutants associated with fossil fuels are monitored to ensure that generation or pollution is not being concentrated in any area, particularly in minority or economically disadvantaged areas
- Public comments were divided on the question of offsets: Some people favored Connecticut-only offsets; others expressed support for international offsets.
- Offsets should be permanent and contribute to additional reductions beyond those specified by the cap.
- Real reductions should occur immediately under the cap-and-trade approach with offsets used as a long-term tool to meet increasing electricity demand.

Other Modeling Results

Combination Run (including RES, Regional Cap and Trade, and Energy Efficiency)

In this policy scenario, the assumptions of the renewable energy strategy (RES), the regional cap-and-trade program, and the EE and CHP scenarios are modeled together in a single IPM run.

Implementing this program is estimated to reduce Connecticut's GHG emissions by
0.49 MMTCO$_2$e in 2010
3.85 MMTCO$_2$e in 2020

For the 10-state region, the emissions-reduction estimates are
32.58 MMTCO$_2$e in 2010
68.82 MMTCO$_2$e in 2020

The IPM model was used to quantify this measure.

- Total CO_2 emissions in Connecticut from the electricity sector will decline by 0.49 MMTCO$_2$e in 2010, 1.42 MMTCO$_2$e in 2015, and 3.85 MMTCO$_2$e in 2020. CO_2 emissions therefore decline from reference-case levels by 6.8 percent in 2010, 16.5 percent in 2015, and 33.6 percent in 2020.
- Through 2010, no additional capacity is added in Connecticut. Through 2020, the cumulative combined-cycle capacity built increases by 158 MW, while the coal IGCC falls from 825 MW to zero. A total of 204 MW of biomass-fired IGCC capacity is added through 2020. Cumulative fossil-fired capacity therefore decreases by 667 MW, and the total cumulative capacity projected to be built decreases to 784 MW in 2015 and only 1,198 MW in 2020.
- Total generation from all fossil-fired units in Connecticut decreases significantly, by 8.5 percent in 2010, 21.8 percent in 2015, and 26.8 percent in 2020. Generation from combined-cycle units decreases by 7.2 percent in 2010 and 27.8 percent in 2015, but it increases by 15.4 percent in 2020. Combustion turbine generation decreases by 0.4 percent in 2010, 34.1 percent in 2015, and 9.1 percent in 2020; oil/gas steam-unit generation falls to zero in 2010 and 2015; coal generation decreases slightly by 1.5 percent in both 2010 and 2015; and coal IGCC generation falls to zero in 2020. Generation from biomass IGCC increases from zero to 1,432 MW in both 2015 and 2020. Total in-state generation falls by 3.3 percent in 2010, 6.0 percent in 2015, and 9.4 percent in 2020, and the percentage of renewable generation rises to 5.6 percent.
- Average wholesale electricity prices in Connecticut increase by 7.5 percent ($2.25/MWh) in 2010, 8.1 percent ($2.78/MWh) in 2015, and 12.2 percent ($4.25/MWh) in 2020.
- Average wholesale capacity prices increase by 18.9 percent in 2010 and 0.8 percent in 2015, but they decrease by 2.6 percent in 2020.
- Average wholesale firm power prices increase throughout the forecast period, rising by 9.1 percent in 2010, 6.9 percent in 2015, and 9.4 percent in 2020.

- Leakage from the 10-state region occurs in 2010 and after with the implementation of a regional CO_2 cap. Net power imports to the 10-state region increase by 307.0 percent in 2010 and 126.5 percent in 2015. In the reference case, the region is a net power exporter in 2020. In the policy case, however, the region becomes a net importer in 2020, at which time imports total 22,811 GWh.
- The CO_2 allowance price for the 10-state region increases over the forecast period in the policy case, rising from $7.16/metric ton in 2010 to $9.30/metric ton in 2015 to $11.12/metric ton in 2020.

Public Views

None

Combination Run Without Nuclear Relicensing

In this policy scenario, the assumptions of the original combination run were maintained along with the assumption that all nuclear units in the United States retire at the current license expiration date. Therefore, no nuclear relicensing occurs.

Implementing this program is estimated to increase Connecticut's GHG emissions by
0.19 MMTCO$_2$e in 2010
0.52 MMTCO$_2$e in 2020

For the 10-state region, emissions will decrease by
40.41 MMTCO$_2$e in 2010
67.84 MMTCO$_2$e in 2020

The IPM model was used to quantify this measure.

- Total CO_2 emissions in Connecticut from the electricity sector will increase by 0.19 MMTCO$_2$e in 2010, 3.13 MMTCO$_2$e in 2015, and 0.52 MMTCO$_2$e in 2020. CO_2 emissions therefore increase from reference-case levels by 2.6 percent in 2010, 36.4 percent in 2015, and 4.5 percent in 2020.
- Average wholesale electricity prices in Connecticut increase by 14.5 percent ($4.36/MWh) in 2010, 15.5 percent ($5.32/MWh) in 2015, and 23.9 percent ($8.35/MWh).
- Average wholesale capacity prices increase by 37.6 percent in 2010, 18.0 percent in 2015, and 1.3 percent in 2020.
- Average wholesale firm power prices increase throughout the forecast period, rising by 17.8 percent in 2010, 16.0 percent in 2015, and 19.6 percent in 2020.
- Leakage from the 10-state region occurs in 2010 and after. Net power imports to the 10-state region increase by 431.0 percent in 2010 and 105.8 percent in 2015. In the reference case, the region is a net power exporter in 2020. In the policy case, the region becomes a net importer in 2020, at which time imports total 44,393 GWh.

- The CO_2 allowance price for the 10-state region increases over the forecast period in the policy case, rising from $10.45/metric ton in 2010 to $13.60/metric ton in 2015 to $18.94/metric ton in 2020.

Combination Run With High Natural Gas Prices

In this policy scenario, the assumptions of the original combination run were maintained along with the assumption that the gas prices used in the IPM Reference Case (taken from EIA) increase to a level 50 percent above the projected price in each run year. Stakeholders felt that such an analysis was especially important, given the volatility in gas prices over the past few years.

Implementing this program is estimated to decrease Connecticut's GHG emissions by
0.59 MMTCO$_2$e in 2010
1.12 MMTCO$_2$e in 2020

For the 10-state region, emissions will decrease by
26.21 MMTCO$_2$e in 2010
68.21 MMTCO$_2$e in 2020

The IPM model was used to quantify this measure.

- Total CO_2 emissions in Connecticut from the electricity sector will decrease by 0.59 MMTCO$_2$e in 2010, 1.39 MMTCO$_2$e in 2015, and 1.12 MMTCO$_2$e in 2020. CO_2 emissions therefore decrease from reference-case levels by 8.1 percent in 2010, 16.2 percent in 2015, and 9.8 percent in 2020.
- Average wholesale electricity prices in Connecticut increase by 41.6 percent ($12.51/MWh) in 2010, 34.2 percent ($11.68/MWh) in 2015, and 34.8 percent ($12.18/MWh).
- Average wholesale capacity prices decrease by 35.2 percent in 2010, 3.6 percent in 2015, and 12.2 percent in 2020.
- Average wholesale firm power prices increase throughout the forecast period: They grow by 30.5 percent in 2010, 27.7 percent in 2015, and 26.0 percent in 2020.
- Leakage from the 10-state region occurs in 2010 and 2020. Net power imports to the 10-state region increase by 365.3 percent in 2010, then decrease by 28.1 percent in 2015. In the reference case, the region is a net power exporter in 2020. In the policy case, the region becomes a net importer in 2020, at which time imports total 23,691 GWh.
- The CO_2 allowance price for the 10-state region increases over the forecast period in the policy case, rising from $9.69/metric ton in 2010 to $12.60/metric ton in 2015 to $15.99/metric ton in 2020.

Supporting Documents

Connecticut Greenhouse Gas Inventory 1990-2000: Available at: http://www.ctclimatechange.com/pdf/CC_Inventory_Report.pdf

IPM Modeling Assumptions Document: Available at: http://www.ccap.org/Connecticut/2003-Oct-30--CT--Elec--Assumptions_for_Reference_Case-IPM.pdf

IPM Modeling Results: Available at: http://www.ccap.org/Connecticut_Electricity.htm

Renewable Energy Subcommittee: Renewable Energy Assumptions Document: Available at: http://www.ccap.org/Connecticut_Electricity.htm

3.4 AGRICULTURE, FORESTRY, AND WASTE

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Stakeholder Recommendations

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- Increase Recycling and Source Reduction
- Voluntary Carbon Offsets

Supporting Documents

- Electricity Demand Reductions
- Food and Agricultural Policy Strategies Strawman
- Renewable Energy Assumptions Document
- Recycling Strawman Proposal
- Landfill Methane Strawman Proposal
- Forest Sequestration Strawman Proposal
- U.S. Landfill Methane Database
- Summary of Landfill Gas Options

Summary: Agriculture, Forestry, and Waste Sector Reductions

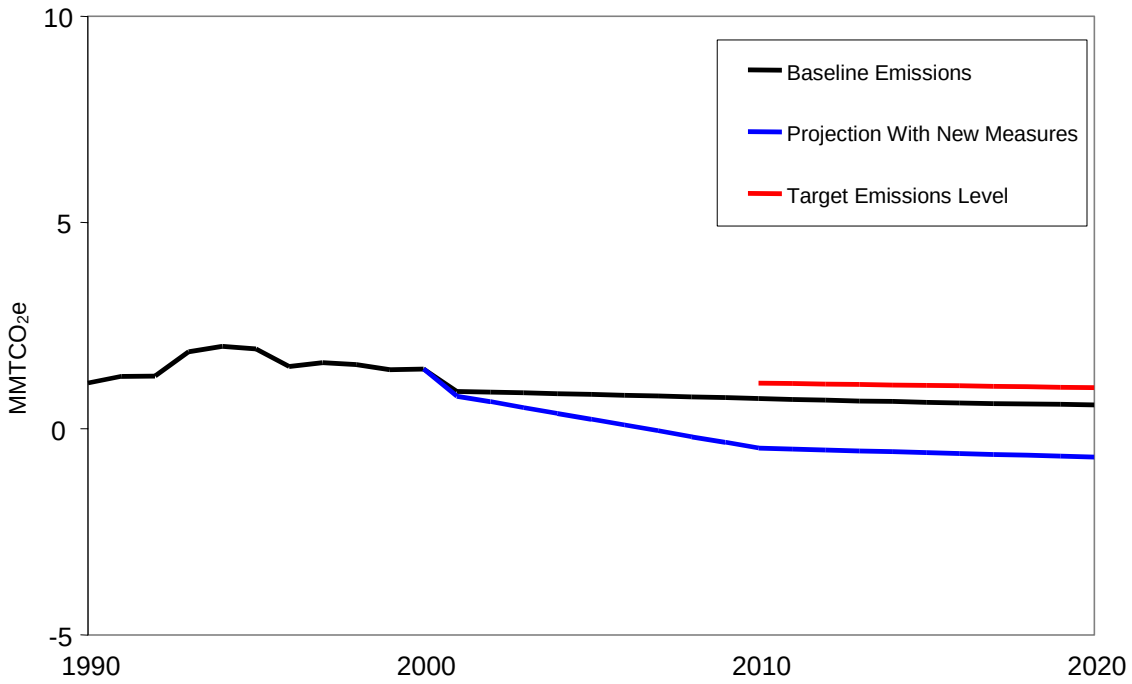
The agriculture, forestry, and waste (AFW) sector reductions are presented in Table 3.4.1.

Table 3.4.1
AFW Sector $MMTCO_2e$ Reductions

	2010		2020		Cost ($/Ton CO_2)
	Direct	Indirect	Direct	Indirect	
Total $MMTCO_2e$ baseline (from fuel use)	0.76			0.63	
Priority Measures: Initial Analysis					
Install centralized manure digesters	0.009	0.008	0.026	0.026	$111.56–$125.78
Ag biomass feedstocks for electricity	Included in electricity			Included in electricity	
On-farm wind production	Included in electricity			Included in electricity	
Reduce nonfarm fertilizer use	0.003		0.006		
Increase purchase of locally grown food*	0.003		0.003		
Research program for forest management and carbon offsets	Not quantified			Not quantified	
Urban tree planting	0.00003	0.0008	0.00007	0.0019	$9,815
Open space and agricultural land preservation	0.283		0.283		$137
Forest products biomass feedstocks for electricity	Included in electricity			Included in electricity	
Promote use of durable wood products	Not quantified		Not quantified		
Economic penetration of landfill gas to-energy (LFGE) through RPS	Included in waste reference case	Included in waste reference case	Included in waste reference case	Included in waste reference case	
Recycling/source reduction*	0.91		0.97		$4-5
Pilot program on carbon offsets	Not quantified		Not quantified		
Total $MMTCO_2e$ Savings*	**1.20**	**0.01**	**1.28**	**0.03**	
Total $MMTCO_2e$ (net reductions)	–0.45		–1.28		
% above/below 1990 (1.11 $MMTCO_2e$)	–140.0%		–216.0%		
NEG/ECP Goal (1990 in 2010, 10% below in 2020)	**1.11**			**1.00**	
Additional Reductions Needed to Reach NEG/ECP	*–1.56*			*–1.00*	

* Includes emissions reductions occurring outside of the State (i.e., lifecycle reductions).

Figure 3.4.1
Connecticut GHG Reductions From AFW Sector



Agriculture, Forestry, and Waste Sector Baseline

GHG emissions for the agriculture, forestry, and waste (AFW) working group are the sum of emissions from (1) agriculture; (2) forest management and land-use change; and (3) waste. The group agreed to use the historical inventory developed by Northeastern States for Coordinated Air Use Management (NESCAUM) with one addition—emissions related to disposing waste out of state (see baseline section for more detail).

In developing the AFW GHG emissions projections from 2000 through 2020, the following key assumptions were made (more details are available in the supporting documents):

- *Agriculture emissions* were assumed to grow at historical rates (1990–2000 levels) through 2020 for each individual factor because no projections were available (i.e., number of dairy cattle, beef cattle, other livestock, and fertilizer use) for the quantity of GHG emissions from enteric fermentation, manure management, and agricultural soil management. No projections were developed for rice cultivation and burning of agricultural waste because neither activity has occurred in the State in the time periods considered and none were expected into the future.
- *Forestry management and land-use sequestration* were assumed to grow at historical rates (1990–2000 levels) through 2020 because no projections were available for liming of agricultural soils, landfilled yard trimmings, and forest carbon flux.[1]

[1] Growth rates for liming of agricultural soils used the rates between 1994 and 1998 because the NESCAUM

- *Waste emissions* were developed from the bottom up using estimates of per capita waste production, population growth, amount of waste recycled or source reduced, and quantity of waste sent to waste-to-energy facilities and landfills. The amount of waste shipped out Connecticut was based on the difference between the amount of waste generated in the State that was not recycled or source reduced and the amount of waste that was sent to existing landfills and resource-recovery facilities in the State. NESCAUM's conversion factors were used to convert total waste landfilled and burned to GHG emissions.

Table 3.4.2 shows the GHG projections agreed to by the AFW working group and stakeholders.

Table 3.4.2
Connecticut Agriculture, Forestry, and Waste GHG Emissions Projections: 2000–2020

	2005	2010	2015	2020
Agriculture	**0.34**	**0.36**	**0.40**	**0.48**
Enteric fermentation	0.10	0.10	0.10	0.09
Manure management	0.04	0.05	0.07	0.12
Agricultural soils	0.19	0.21	0.23	0.26
Rice cultivation	–	–	–	–
Agricultural residue burning	–	–	–	–
Forest Management and Land-Use Change	**(2.01)**	**(2.03)**	**(2.05)**	**(2.07)**
Liming of agricultural soils	0.03	0.03	0.03	0.03
Landfilled yard trimmings	(0.01)	(0.00)	(0.00)	(0.00)
Forest carbon flux	(2.04)	(2.06)	(2.08)	(2.09)
Waste	**2.53**	**2.43**	**2.33**	**2.22**
Municipal solid waste (in-state)	2.23	2.11	1.99	1.86
Municipal solid waste (OOS)	*0.01*	*0.02*	*0.03*	*0.04*
Wastewater	0.29	0.30	0.30	0.31
Total AFW Emissions	**0.85**	**0.76**	**0.67**	**0.63**
(without OOS waste)	0.84	0.74	0.64	0.59

inventory did not contain data before and after that period.

Manure Digesters

Recommended Action: Support the installation of centralized manure digesters.

This program would support the installation of one centralized manure digester by 2010, two by 2015, and three by 2020. Installing anaerobic digesters to process agriculture manure into energy (e.g., heat, hot water, or electricity) reduces GHG emissions from manure storage and can offset GHG emissions from energy use. It also produces digested manure, which can contain valuable nitrogen for crop production.

The group deliberated on a number of implementation approaches for the manure digester option; however, no specific actions were suggested. The electricity working group highlighted a number of options for renewable energy that may assist in implementing this option. The working group discussed options that included funding support from the State and federal government and private developers, technical assistance, supporting removal of transmission barriers, and increasing outreach to farmers and communities about the benefits and costs of manure digesters.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Achieving this level of manure digester installation is estimated to reduce direct (i.e., CH_4 reductions) and indirect GHG emissions (i.e., from electricity reduction) by

0.017 $MMTCO_2e$ by 2010
(0.0087 $MMTCO_2e$ direct and 0.0084 $MMTCO_2e$ indirect)

0.052 $MMTCO_2e$ by 2020
(0.0260 $MMTCO_2e$ direct and 0.0255 $MMTCO_2e$ indirect)

The installation of each centralized manure digester is assumed to use manure from 3,870 cows for a total of 3,870 cows in 2010 and 11,610 in 2020. Table 3.4.3 outlines the key assumptions for direct and indirect emissions reductions used in the analysis of the manure digester program.[2]

Table 3.4.3
Key Assumptions for GHG Analysis (per digester)

Emission Reductions from CH_4 Manure Management ($MMTCO_{2e}$)	Emissions Created Through Transport ($MMTO_2e$)	Net Emissions Reduction ($MMTCO_2e$)	Total Electricity Generated (kWh/yr)
0.007458	0.0012	0.00866	4,469,850.00

[2] Methane reductions from manure management were based on standard assumptions used by NESCAUM in the analysis of the Connecticut GHG emissions inventory. For more details on the assumptions for manure transport, see chapter appendix.

Note: Assumptions about the number of cows and the manure generated from each cow were based on CERC Inc., Connecticut Academy of Science and Engineering (CASE), Connecticut Department of Agriculture, Pines, D., & Day, W. (2003). *An Analysis of Energy Available from Animal Biomass in Connecticut*. Connecticut Department of Agriculture. Methane reductions from manure management were based on standard assumptions used by NESCAUM in the analysis of the Connecticut GHG emissions inventory. For more details on the assumptions for manure transport, see the supporting documents.

The estimated costs of this program are $111.56 to $125.78 per $MTCO_2e$, depending on the type of turbine installed.[3] This analysis was based on the net present value of the estimated GHG benefits of the total energy savings (both direct and indirect) and the net present value of the estimated costs. Table 3.4.4 outlines the key cost assumptions for the analysis.

Table 3.4.4
Capital and Operating Cost Assumptions (Per Digester)

Total Capital Costs (Turbine A)	Total Capital Costs (Turbine B)	Operating costs
$1,800,000	$1,950,000	$74,753

Note: Values are from CERC, et al. (2003).

Implementation of this option could provide ancillary benefits not quantified during the process. Manure digesters provide benefits related to odor control; water quality; potential improvement of farm economics (by supporting generation of additional income); and continuation of farming in the State, which can support both smart growth initiatives and the "increase purchase of locally grown food" option mentioned later in this section. Digesters also provide benefits for manure management by avoiding the potential leakage of excess manure into water bodies (e.g., Long Island Sound).

Stakeholder Views

The stakeholders unanimously agreed to this recommendation (referred to as "unanimous consent" in the summary tables).

Public Views

- No public comments were received.

[3] Both costs and emissions reductions for the cost-effectiveness analysis were discounted at a rate of 7 percent.

Nonfarm Fertilizer Reduction

Recommended Action: Reduce nonfarm fertilizer use.

This program would seek to reduce the amount of nonfarm fertilizer use (e.g., residential and commercial) from today's levels by 7.5 percent in 2010 and 15 percent in 2020. A portion of nitrogen applied to the soil is subsequently emitted as N_2O; therefore, a reduction in the quantity of fertilizer applied can reduce N_2O emissions. This measure would, in part, expand on existing programs to reduce residential and commercial fertilizer use in Connecticut and would include the following elements:

- *Organic Land Care Program.* This program of the Connecticut chapter of the Northeast Organic Farming Association (NOFA) promotes reducing the use of chemical fertilizers and fosters ecological stewardship in designing and maintaining landscapes. The program includes the *Standards for Organic Land Care*, an education and accreditation program for organic land-care professionals, and information and events for citizens.[4]
- *Freedom Lawn Initiative.* This initiative is a voluntary program to decrease the use of pesticides and chemical fertilizers on residential lawns. The Board of Alderman in Milford, Connecticut, passed a resolution in 2002 requesting citizen participation in the program. A local environmental coalition has distributed informational brochures and lawn signs and sponsors a Freedom Lawn competition. At least one street in Milford boasts 100 percent participation in the program.

In addition, a requirement to report nonfarm fertilizer use was considered. Such a measure would help provide better information to track progress toward reducing nonfarm fertilizer use and measure the success of the program. Although the working group initially considered reduction of farm fertilizer use, it was not a priority for analysis as agreed by the stakeholders.

The nonfarm fertilizer reduction program would be implemented within Connecticut but could benefit from regional efforts to reduce nonfarm fertilizer consumption.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Achieving this level of fertilizer reduction is estimated to reduce GHG emissions by
0.003 $MMTCO_2e$ in 2010
0.006 $MMTCO_2e$ in 2020

The amount of fertilizer reduced through this program was based on an estimate of nonfarm fertilizer consumption in Connecticut of 25 million kg.[5] Because no estimates were available for projections of nonfarm fertilizer use, the group chose to use existing consumption data. If nonfarm fertilizer use is projected to decline in the State, the benefits of this program may occur

[4] From the Connecticut NOFA website. For more information, see www.ctnofa.org/programs/landcare.php.
[5] Source: Connecticut Department of Agriculture. Data provided by Rich Meinert, University of Connecticut.

in the reference case instead.[6] These values were converted to nitrogen in order to calculate the GHG emissions; the assumption was that the fertilizer was 15 percent nitrogen. Values were converted to GHG emissions using the standard assumptions of direct and indirect emissions that NESCAUM used in calculating the GHG inventory. The GHG emissions reductions do not include reductions that could occur from other results of the program, such as decreased truck traffic, passenger vehicles, and fertilizer production.

Ancillary benefits of this program include reducing the nutrient runoff into Long Island Sound and other water bodies, increasing the organic content of soil (thus increasing carbon sequestration), reducing GHG emissions (because lawn mowing usually decreases with natural lawn-care methods), and reducing water consumption (because lawn watering usually decreases with natural lawn care methods, increasing biodiversity).

Stakeholder Views

The stakeholders unanimously agreed to this recommendation. There was interest among the stakeholders in understanding the importance of requiring reporting of nonfarm fertilizer. Participants from the AFW working group highlighted that they had considered this to improve data tracking of the option; however, the working group recognized the potential difficulty in collecting such data: Distinguishing between nonfarm and farm fertilizer consumption may be difficult, and the program may require reporting from many sources.

The stakeholders also asked why the working group had chosen a voluntary education approach rather than a mandatory one. The facilitators explained that the working group had considered several potential mandatory approaches, such as a nonfarm fertilizer tax, but it had not raised them with the stakeholders due to the potential difficulty in implementing such an approach. Moreover, a number of initiatives are underway in the State to reduce nonfarm fertilizer use, so the working group focused on building off of those initiatives.

Some stakeholders were concerned that no cost information was available to inform their judgment. However, they recognized the difficulty in developing cost information for such a program and suggested that information on program costs would assist future deliberations on this action.

Public Views

The public provided a number of comments relevant to this specific action, including:

- Develop and implement organic farming classes at State teaching and training institutions.
- Encourage a reduction of farm fertilizer use, as it is a source of nitrous oxide (N_2O), a greenhouse gas.
- Require, beginning in 2004, that all State property be treated organically and that all schools use organic land care practices.

[6] A number of factors may affect the reference case, including the impact of existing programs to reduce nonfarm fertilizer consumption, landscape size (e.g., size of lawns), landscape type (e.g., some plantings require lower fertilizer consumption to retain health, and land use (e.g., retaining natural tree cover instead of plantings could require lower fertilizer use).

Increase Purchase of Locally Grown Food[7]

Recommended Action: Increase the purchase of locally grown food.

This program would seek to increase the amount of food consumed by Connecticut residents from locally grown sources by 10 percent in 2010 and 2020. Food processing, packaging, transportation, and marketing consume 75 to 85 percent of the energy used in the commercial food industry. Food miles—an estimate of the distance food travels from where it is grown to where it is purchased—for conventional produce can equal more than 20 times the distance of locally grown produce.[8] In place of commercial produce markets, Connecticut boasts 65 farmers' markets. The program would be implemented through the following actions:

- Enhance the Connecticut-Grown Program to increase consumer awareness of Connecticut agriculture and promote the regular purchase of Connecticut agricultural products.
- Create an agricultural identity for Connecticut so that residents prefer purchasing a certain type of Connecticut agricultural product (e.g., *Connecticut Blooms*)
- Increase the development of farmers' markets and ensure that participating farmers sell Connecticut-grown products exclusively.
- Encourage and promote the purchase, marketing, and sale of State-grown produce by State institutions and agencies. Potential institutional purchasers include prisons, hospitals, schools, and colleges (e.g., the Connecticut Department of Administrative Services has an agreement with its prime vendor to reserve 25 percent of its contract for local providers).
- Support Senior and WIC Farmers Market Nutrition Programs that enable low-income seniors and mothers to receive coupons redeemable for State-grown produce at State farm stands and farmers' markets.
- Support programs and efforts to facilitate increased access to farmers' markets by low-income households (e.g., funding for wireless EBT machines in farmers' markets for food stamp recipients).
- Facilitate efforts by farmers to develop value-added agricultural products through a through a business development or grant program or general marketing assistance from the Department of Agriculture or other supporting agency. [9]

This program would be implemented within Connecticut, but several components could benefit from regional efforts. Although the actions recommended above would be undertaken within the State, the GHG emissions reductions would occur both within the State and outside because the transport of food crosses several geographic boundaries.

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[7] The letter to the Connecticut Climate Change Stakeholder Process from the Connecticut Food Policy Council, October 10, 2003, prepared for the AFW working group, is the primary source of information on the implementation approaches for this action. Significant portions of this section are excerpted verbatim from this letter.

[8] A study in Iowa demonstrated that locally grown produce traveled an average of 56 miles, whereas conventional produce traveled 1,494 miles. See *Checking the food odometer: Comparing food miles for local versus conventional produce sales to Iowa institutions.* (2003). Ames, IA: Leopold Center for Sustainable Agriculture.

[9] Most of the implementation strategies were originally endorsed by the Connecticut Food Policy Council, Northeast Sustainable Agricultural Working Group, and the Hartford Food Systems. Available at: www.foodpc.state.ct.us/images/Full%20Report.pdf

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Achieving this level of recycling and source reduction is estimated to reduce GHG emissions by

0.003 MMTCO$_2$e in 2010
0.003 MMTCO$_2$e in 2020

The estimates of GHG emissions reductions were based on a study conducted in Iowa that considered the impact of increasing the consumption of locally produced food by 10 percent.[10] The study considered the GHG emissions of transporting food from the conventional system (e.g., national retail and wholesale markets) and a local system (e.g., farmers who market and sell directly to food buyers). Information was not available on the quantity of food currently consumed from local Connecticut sources. The results include the GHG emissions reductions occurring through the entire transportation chain; however, they do not include other potential reductions. For example, a study by the Rodale Institute found that using organic farming practices increased soil carbon content by 15 to 28 percent.[11]

A recent survey found that Connecticut residents believe that locally grown foods are healthy (76 percent) and fresher (88 percent) than non-locally grown or produced foods.[12] Local markets for local agricultural products deliver items to consumers in a cost-effective, resource-efficient way. Some of the ancillary benefits include helping to preserve farmland from energy-intensive development; ensuring the continued economic viability of the small family farm; supporting clean, environmentally sensitive farming practices; helping maintain biodiversity in food plants; and contributing to regional prosperity.

This program can provide a number of ancillary benefits not fully addressed as part of this process, including reduction of air emissions from reduced food transport; support for economic development for Connecticut farms; and pesticide and water pollution, depending on the type of farming practice supported.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation. They deliberated on the need to identify the costs of this approach, although they recognized the potential difficulties in calculating the costs. In addition, the stakeholders highlighted the need to ensure that co-benefits were presented in the final report because it appeared that this approach may have large co-benefits.

[10] More details on the assumptions are available in: *Food, Fuel, and Freeways: An Iowa perspective on how far food travels, fuel usage, and greenhouse gas emissions*. (2001). Ames, Iowa. Leopold Center for Sustainable Agriculture. Available at: www.leopold.iastate.edu/pubinfo/papersspeeches/food_mil.pdf

[11] Rodale Institute, Farming Systems Trial™, 2003. Available at: www.rodaleinstitute.org/bookstore/products/farm_books/main.shtml

[12] Locally Grown - An Agricultural Survey of Connecticut and Massachusetts Residents. (2003). Study conducted for the Quinnebaug-Shetucket Heritage Corridor. Available at: www.workinglandsalliance.org/OtherDocs/Q_Slocallygrown.pdf

Public Views

- Protect the State Department of Agriculture from its proposed elimination for budgetary reasons. A viable Agriculture Department is necessary for the encouragement of local food production, which saves the large amounts of fossil fuel used to transport food thousands of miles from farm to table.
- Several commenters supported increased organic food production and consumption in Connecticut as a strategy to cut down greenhouse gases through decreased need for transportation energy. Production of food for local consumption in home, school and community gardens as well as on small and larger organic farms is especially recommended.
- Support for the proposals to limit chemical fertilizers by greater adoption of organic gardening, farming and land care methods since the reduction of synthetic fertilizer use on and off farm prevents release of greenhouse gases from the manufacturing of these fertilizers and from their incorporation in the soil.
- Beginning in the fall of 2004, all Vo-Ag schools and the University of Connecticut should include organic agriculture methods in the curriculum.

Research on Connecticut Forest Management and Carbon Offsets[13]

Recommended Action: Foster a research program on Connecticut forest management and carbon offsets.

A research program is needed to examine Connecticut's public and private forests and determine how they could be best managed to maximize carbon sequestration and to develop markets for offsets from terrestrial carbon sinks. Land-based carbon sequestration typically involves conserving threatened forest; planting trees and restoring badly degraded agricultural or mineral extraction lands, where without intervention, forests would take decades to establish themselves; improving management of productive forestland; and promoting reduced-impact agriculture. Considering its population density, Connecticut is already heavily forested, and due to various factors, most agricultural land quickly reverts to forest when abandoned. Thus, few opportunities exist to prudently expend significant resources on restoration or planting initiatives in this State.

The State should encourage a research program involving a cooperative team from universities, industry, and the NGO community; the goal would be to conduct research on Connecticut's forest ecosystems and identify the management systems and standards for carbon "sink" offset projects that would maximize sequestration of carbon. Such a program would likely be a multiyear project that could seek funding from a wide range of sources. State funding should be considered, but additional research funds could be secured through foundation support or federal research funds.

It appears that most of the research on measuring carbon stocks and increasing carbon storage in forests has focused on merchantable trees, in large part because forest management research has, since its inception, focused on growing timber and the results of that research are easily convertible to analyzing management for carbon sequestration in merchantable forest products. A much wider range of investigation is possible and necessary in order to answer the many questions that have arisen as a result of concerns with atmospheric CO_2 levels. For example, to maximize carbon absorption and storage, what management methods should be used in forests that will be preserved?

The research project on carbon offsets would also be directly related to potential forest-based carbon offset projects and how to quantify the reductions (see the section on cap-and-trade). The market-based programs would rely on the science and consensus developed through this project (see supporting document six).

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

The GHG benefits and costs of this program were not analyzed because the results would depend on the results of the research and the extent to which they were implemented.

[13] The carbon sequestration straw proposal, prepared by Environment Northeast and The Nature Conservancy, is the primary source of information on this recommendation. Significant portions of this section are excerpted verbatim from the carbon sequestration straw proposal.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation. (See the discussion on pilot carbon offsets, which has implications for the carbon-offset research in this option.)

Public Views

- In- and out-of-country offset projects should be considered.

Urban Tree Planting

Recommended Action: Create an urban tree-planting program.

The State should provide funding and other support to plant 15,000 more sufficiently sized urban trees than is currently planted by 2010 and an additional 20,000 by 2020. Properly planted trees in urban areas can decrease energy use by reducing wind speed in winter and by shading buildings and lowering air temperatures in summer. Improperly planted trees in urban environments can actually increase energy use by shading buildings in winter and adding humidity in summer. Tree effects on wind in summer may or may not be beneficial, depending on air temperature.

To implement this program, Connecticut will need to ensure additional funding for the direct costs of the trees, maintenance, and technical assistance. Limited funding is currently available from the U.S. Forest Service. Connecticut will also need to provide technical assistance to ensure that trees are properly planted (ensuring survival and the largest emissions-reduction potential). The key factors that affect the ability of a tree to provide direct shading of a building include placement relative to buildings and seasonal solar angle; type; species foliage characteristics; height; and crown form, spread, and density.[14]

This program would be implemented within Connecticut, but the GHG emissions reductions would occur both within the State and outside because the resulting reductions in electricity consumption would have an impact on regional electricity emissions.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Achieving this level of urban tree planting is estimated to reduce direct (i.e., home heating oil and natural gas) and indirect (i.e., electricity) GHG emissions by

0.0009 MMTCO$_2$e in 2010
(0.00003 MMTCO$_2$e direct and 0.0008 MMTCO$_2$e indirect)

0.0019 MMTCO$_2$e in 2020
(0.00007 MMTCO$_2$e direct and 0.0019 MMTCO$_2$e indirect)

It is estimated that this program would lead to the following energy demand reductions:

- Electricity savings of 1.7 and 3.72 GWh in 2010 and 2020, respectively
- Home heating oil savings of 1,092 and 2,340 MMBtu in 2010 and 2020, respectively
- Natural gas savings of 693 and 1,485 MMBtu in 2010 and 2020, respectively.

[14] Abdollahi, K., Ning, Z., & Appeaning, A. (Eds.). (2000). *Global climate change and the urban forest.* Baton Rouge, LA: Gulf Coast Regional Climate Change Council.

The GHG estimates mentioned above do not include the emissions reductions resulting from carbon sequestration. Table 3.4.5 outlines the key assumptions used in the analysis of this option.

Table 3.4.5
Key Assumptions for Urban Tree Planting Program

Trees Planted per Year	
2004–2009	2,500
2010–2020	2,000
Tree survival rate (% of planted trees that survive)	80%
Planting and maintenance costs per tree	$200
Energy Savings per Tree	
Cooling savings (kWh)[15]	200
Heating savings (MMBtu)[16]	0.15
Distribution of Connecticut Heating by Fuel Type[17]	
Electricity	14%
Oil	52%
Natural gas	33%
Percentage of Buildings With Air Conditioning[18]	62%

Electricity reductions were converted to GHG emissions using the marginal emissions rate of electricity from the demand-reduction scenario conducted by the electricity working group since the electricity demand reductions from this program were included in that scenario. Home heating oil and natural gas reductions were converted to GHG emissions using emissions factors developed by the RCI working group.

The estimated costs of this program are $9,815 per $MTCO_2e$. This analysis was based on the net present value of the estimated GHG benefits of the total energy savings (both direct and indirect) and the net present value of the estimated costs.[19]

This program would also lead to reductions in other air emissions. A recent study suggested that a similar tree-planting system could lead to reductions of carbon monoxide (CO), nitrous oxide (N_2O), ozone (O_3), particulate matter of 10 microns or less (PM_{10}), and SO_2.[20] In addition,

[15] Studies have shown that a well-placed 25 ft tall tree can produce energy savings from cooling of 100–400 kWh/yr (McPherson & Rowantree, 1993). Value assumed for the analysis in Connecticut assumed electricity savings for both cooling and heating of 200 kWh/yr.
[16] Studies have shown that energy savings from a single tree range from 0.15 to 5.5 MMbtu (Heisler, 1990).
[17] The assumptions for this distribution are identical to the assumptions utilized by the RCI working group.
[18] Data are based on the percentage of homes in New York that have air conditioning—18% central and 44% room (U.S. Energy Information Administration, *Residential Energy Consumption Survey 1997*. Available at: www.eia.doe.gov/emeu/recs/four_states/overview_ny.html). In comparison, the national average is 83% (U.S. Census Bureau, *American Housing Survey for the United States: 2001*. Available at: www.census.gov/hhes/www/housing/ahs/ahs01/tab1a4.htm).
[19] Both costs and emissions reductions for the cost-effectiveness analysis were discounted at a rate of 7 percent.
[20] The study looked at a program to increase new canopy cover of more than 125,000 acres in the New York Metropolitan region. Reductions per day (in metric tons) were estimated as follows: CO, 1.1; NO_2, 4.0; O_3, 10.2; PM_{10}, 5.5; and SO_2, 1.9 (Luley & Bond, 2002. *A Plan to Integrate Management of Urban Trees into Air Quality*

planting programs in urban areas should have few barriers to implementation because many communities are actively pursuing tree-planting programs for reasons other than climate change, such as aesthetics. The group raised some concerns over whether this level of tree planting could be achieved, given that many communities are already making significant efforts to replace their existing forest stock, let alone increase the stock, as envisioned by this program.[21]

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

The public provided a number of comments relevant to this specific action, including the following:

- Investigate urban forest canopy as option for carbon sink.
- The State should promote in-state reforestation.

Planning. Naples, New York.

[21] A survey conducted in 1994 in Connecticut showed that municipalities reported planting 8,000 to 9,000 trees annually. The report concluded that the ratio of plantings to removals was 1.42:1 in 1992 and 1.34:1 in 1993.

Open Space and Agricultural Land Preservation[22]

Recommended Action: Preserve existing forest and agricultural land.

This program would seek to avoid releases of carbon due to conversion of forest and agricultural land to development. When forest and agricultural land is converted carbon is emitted when trees are cut and when the ability of agricultural soil to sequester carbon from the atmosphere is diminished, since forest and agricultural land sequester carbon in plant matter (e.g., trees) and soils. Therefore, avoiding the conversion of this land to development, in conjunction with smart growth measures, preserves the carbon-absorption capacity of existing forest and agricultural lands and enables continued carbon sequestration from the atmosphere. According to one federal study, on average, 8,200 acres per year—4,700 acres of forest and 3,500 acres of agricultural land—are converted to development in Connecticut. This program would be implemented through the following measures (more details are available in Supporting Document 4):

- Open-space conservation and stewardship programs to ensure that future releases of carbon occurring through conversion of forest and grasslands to development are reduced below current levels and are balanced by land-acquisition and -management initiatives
- Acceleration of farmland preservation by expanding the Farmland Preservation Program, including exploring alternative means of funding the program, taking advantage of available federal and other matching funding, and considering additional criteria for selecting land through the program
- Measures to reduce the consumption of land by sprawling development, such as those outlined in the smart growth recommendation
- Possibly other measures, such as impact fees, which would be used to preserve open space on farmlands.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Avoiding this amount of forest and agricultural land conversion is estimated to avoid maximum GHG emissions of

0.283 MMTCO$_2$e in 2010

(forestland of 0.282 MMTCO$_2$e and agricultural land of 0.0013 MMTCO$_2$e)

0.283 MMTCO$_2$e in 2020

(forestland of 0.282 MMTCO$_2$e and agricultural land of 0.0013 MMTCO$_2$e)

Wide ranges of estimates exist for the carbon currently sequestered in forests (see Supporting Document 6). Essentially, the estimates range from 20 to 100 metric tons per acre per year for Connecticut forests. For this analysis, it was assumed that Connecticut forests sequester an

[22] The carbon sequestration straw proposal, prepared by Environment Northeast and The Nature Conservancy, is the primary source of information on this recommendation. Significant portions of this section are excerpted verbatim from the carbon sequestration straw proposal.

average of 60 metric tons per acre. The amount of natural land targeted for preservation is based on the analysis of the Natural Resources Conservation Service (NRCS) of the USDA, which found that from 1982 to 1997, an average of 4,700 acres of forestland was converted to development each year in Connecticut.[23] The quantity of carbon sequestered by agricultural land will depend on the time the land has been under tillage. Estimates range from 0.367 to 0.734 $MTCO_2e$ per acre per year. A conservative estimate of 0.367 $MTCO_2e$ per acre per year was used. The amount of farmland lost was assumed to be 3,500 acres per year, similar to the rate from the NRCS analysis between 1982 and 1987.

With any of the approaches for implementation mentioned above, it is difficult to assess precise carbon emission offsets due to the "leakage" factor—the fact that at least some indeterminable amount of avoided development and resulting emissions will simply be displaced to other communities or states. The leakage factor would make it difficult to impose restrictions or fees on specific development proposals which could be tied to precise carbon impacts. Therefore, statewide open space, agricultural land preservation, and smart growth measures were considered as the most appropriate mechanisms.

These emissions reductions are estimated to cost $137 per $MTCO_2e$.[24] The forestland preservation program is estimated to cost $6,000 per acre across the State, the average amount the DEP has paid for land in the past four years. At that rate, the acquisition of 4,700 acres of forestland would cost a total of $28.2 million per year. For the four and a half years from mid-1998 through 2002, the State of Connecticut bonded approximately $210 million through four open-space programs and initiatives, acquiring outright ownership or conservation restrictions over or assisting towns and nonprofit groups in acquiring approximately 44,000 acres. Annually, the State averaged expenditures of $46.6 million and preserved or helped to preserve an average of 9,777 acres. A significant portion of the land preserved through State funds was done under a matching grant program in which the DEP provided towns and private conservation groups with matching grants, usually 50 percent of the land cost. If such a program were to comprise half of the DEP's efforts, the 4,700 acres could be acquired at a cost of approximately $21.4 million per year.

The cost of the farmland preservation program was based on the historical cost of the Connecticut Farmland Preservation program—$3,000 per acre to purchase the development rights. At that rate, the preservation of 3,500 acres is estimated to cost $10.5 million per year. The Connecticut Department of Agriculture has a goal of preserving 130,000 acres, including 85,000 acres of cropland. This goal will enable Connecticut farms to produce at least 50 percent of milk needs and 70 percent of in-season fresh fruits and vegetables, output that has implications for the support of local farm products mentioned earlier in this section.[25] Development rights have been purchased on a total of 202 farms totaling 28,850 acres—22 percent of the goal.[26]

[23] The estimate is from the Natural Resources Conservation Service of the USDA. The working group recognized the benefit of having a more accurate future projection of land use, but one was not available during the process.
[24] Both costs and emissions reductions for the cost-effectiveness analysis were discounted at a rate of 7 percent.
[25] Connecticut Department of Agriculture (2001). *Connecticut's Farmland Preservation Program, 2001 Annual Report*.
[26] Connecticut Department of Agriculture, *Farmland Preservation Program Summary*, October 14, 2003.

Although the budget crisis that continues to confront Connecticut may preclude such levels of State funding in the immediate future, these figures are in line with what the State has been investing in the recent past and should be the goal for a resumed program as soon as possible.

A program aimed at preserving open space (both forest and agricultural land) provides ancillary benefits, which can further diminish the ratio cost per ton of this approach. These benefits have not been specifically quantified as part of this process, but they were a subject of deliberations during the working group and stakeholder meetings. Benefits of the forestland-preservation program include promoting wildlife habitat, protecting and improving water quality, improving the "livability" of the State, and supporting smart growth initiatives in the State. The agricultural land-preservation program can provide ancillary benefits, including support for economic development (especially in rural parts of the State) by maintaining agricultural capacity, enabling the continued consumption of locally grown agricultural products (which can further enhance and enable the "increase purchase of locally grown food" option mentioned earlier), and supporting smart growth initiatives in the State.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation. The group discussed the size of the program and the funding highlighted, given the current financial situation in the State. Another participant pointed out that this level of funding was similar to what was supported in the past, before the current financial situation. The stakeholders discussed the relevance of the funding level and State budget situation to the timing of the implementation (e.g., may require either a smaller amount of funding in early years or delay in the funding until finances improve).

Public Views

The public provided a number of comments relevant to this specific action:

- Fight sprawl.
- The State should continue with open space acquisition program.
- Preserve small forests.

Promote Use of Durable Wood Products[27]

Promote use of durable wood products.

This program would promote the use of durable wood products over other construction materials through a voluntary education campaign on climate change and what consumers can do to minimize their impacts. This program should encourage individual and business consumers to consider certified-sustainable wood products when buying furniture, building homes, and working on other structures. In addition, the State in its procurement process should lead by example and maximize its purchase of wood products. To ensure that increased use of timber results in a benefit to the environment, wood products should be produced and manufactured as a result of certified-sustainable harvesting practices.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

The GHG benefits and costs of this program were not analyzed because data on the potential increase in durable wood use was unavailable.[28]

The substitution of durable wood products for other materials is beneficial both because of the carbon that wood building materials sequester and because of the energy use they avoid. For example, production of steel, aluminum, plastic, brick, and concrete has high energy requirements compared with wood. The "embodied energy," or the amount of energy used to produce a given material, varies from product to product. Following are estimates of embodied energy for typical building materials:

- Simple sawed wood product: 3 GJ Mg^{-1}
- Plywood: 14 GJ Mg^{-1}
- Steel: 20–25 GJ Mg^{-1}
- Plastic: 60–80 GJ Mg^{-1}
- Aluminum: 190 GJ Mg^{-1}

Most energy used in the manufacture of these materials comes from sources that emit significant GHGs. Unless materials are currently produced using energy from clean renewable or nonfossil sources, products with lower embodied energy are responsible for lower GHG emissions.

In addition, durable wood products, which are used for furniture or construction and have been in use for decades or more, sequester carbon as they sit in a home or office building. Increased use of locally grown and manufactured durable wood products could also be a benefit to the

[27] The carbon sequestration straw proposal, prepared by Environment Northeast and The Nature Conservancy, is the primary source of information on this recommendation. Significant portions of this section are excerpted verbatim from the carbon sequestration straw proposal.

[28] For durable wood products, the benefits would depend on the extent to which the program achieved purchase of durable wood products over other construction materials.

Connecticut timber industry and thereby help prevent the conversion of forestland into commercial or residential use.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation.

Public Views

- No public comments were received.

Landfill Gas Mitigation

Recommended Action: Encourage landfill gas-to-energy (LFGE) projects.

This program would seek to increase the number of landfills in Connecticut that reduce methane and generate electricity through the following actions:

- Encourage the generation of an additional 18.5 MW of electricity from landfill gas-to-energy (LFGE) projects in the State through the Connecticut renewable portfolio standard.
- Support interconnection of these projects by working with the DPUC to ensure that LFGE projects are allowed to connect to the grid (even projects under 1 MW). In addition, work with DPUC and DEP to provide streamlined permitting for these projects.
- Join the EPA Landfill Methane Outreach Program (LMOP) State Partnership Program, which provides assistance with developing regulations and funding opportunities, among other things.

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

In the analysis of the electricity sector reference case, an additional 18.5 MW of landfill gas generation was installed. Therefore, the GHG benefits of this program were included in the electricity- and waste-sector baselines.[29] Although the GHG benefits of this action should not be considered as reductions from the reference case (they are estimated to occur in the electricity sector reference case without additional steps), it is important to note the GHG reductions from this program.

This action is estimated to reduce GHG emissions from direct (i.e., methane reduction) and indirect (i.e., electricity emissions) by

0.447 MMTCO$_2$e in 2010
(0.37 MMTCO$_2$e direct and 0.077 MMTCO$_2$e indirect)

0.452 MMTCO$_2$e in 2020
(0.37 MMTCO$_2$e direct and 0.082 MMTCO$_2$e indirect)

The State provided EPA's LMOP staff with revised data on existing landfills in Connecticut. The LMOP staff reviewed the landfill data and provided a preliminary estimate that 18.5 MW of LFGE potential exists in the State.[30] The electricity working group chose to include all 18.5 MW as potential new LFGE in the IPM modeling (see the electricity sector recommendations for

[29] The GHG impact from the conversion of methane to energy is included in the electricity sector reference case (see the detailed discussion of electricity sector baseline). The GHG impact of methane conversion was calculated outside the electricity sector analysis and accounted for in the waste sector baseline.
[30] See CCAP. (2003, September 2). Revised assumptions for Connecticut landfill gas to energy and flaring option. Memo to the AFW working group.

more details). In 2006, IPM estimated that in the electricity reference case, an additional 18.5 MW of electricity generation from LFGE projects would be installed in Connecticut and that additional LFGE generation would take place in surrounding regions (see electricity sector analysis). The GHG benefits from the conversion of methane were calculated outside the electricity sector analysis using standard assumptions of LMOP staff. Because some of the landfills envisioned currently flare their methane, the landfills currently with flaring were subtracted from the additional benefit of this program to avoid double counting (see Table 3.4.6).

Table 3.4.6
Connecticut Landfill Candidates for Landfill Gas-to-Energy Projects

Landfill	Town	County	WIP (tons)	MW Potential	Existing Flaring*
Branford Landfill	Branford	New Haven	1,340,419	1.0428	No
Bristol Landfill	Bristol	Hartford	599,004	0.4660	No
Enfield Landfill	Enfield	Hartford	1,405,757	1.0937	No
Lebanon Landfill	Lebanon	New London	1,094,990	0.8519	No
Manchester Sanitary Landfill	Manchester	Hartford	5,102,297	3.9696	Yes
NORCAP Regional Landfill	East Windsor	Hartford	2,600,017	2.0228	Yes
North End Disposal Area Landfill	Waterbury	New Haven	5,932,824	4.6157	No
Putnam Landfill	Putnam	Windham	954,606	0.7427	No
Windham Landfill	Windham	Windham	1,500,010	1.1670	No
Windsor-Bloomfield Sanitary Landfill	Windsor	Hartford	3,251,763	2.5299	Yes
Total			**23,781,687**	**18.5022**	
Total Without Existing Flaring			**12,827,610**	**9.9799**	

*Based on analysis conducted by Environment Northeast.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation, as took place during the deliberations on the electricity sector reference case.

Public Views

- No public comments were received.

Recycling and Source Reduction[31]

Recommended Action: Increase recycling and source reduction to 40 percent.

This program would seek to increase source reduction and recycling of municipal solid waste (MSW) to 40 percent by 2010 and to maintain at least 40 percent source reduction and recycling through 2020.[32] This goal would be achieved through implementing the following seven actions (see chapter Supporting Document 4):

1. Increase education and enforcement of recycling requirements and programs (in residential and nonresidential sectors) through increased funding to support ongoing statewide programs.
2. Adopt "Pay as You Throw" (PAYT) programs for residential waste and, possibly, for small nonresidential waste (e.g., small businesses and home businesses) through incentive grants to towns and cities; if recycling levels are not increased sufficiently, implement legislative mandates.
3. Increase composting of source-separated organics (from commercial, industrial, and institutional generators and residential sources) by providing funding and other assistance.
4. Increase small-business recycling by providing funding for outreach and assistance to small businesses.
5. Support recycling markets by providing additional funds to Connecticut's Environmentally Preferable Purchasing program operated by the Department of Administrative Services.
6. Increase electronics recycling by providing funding and other assistance.
7. Increase "producer responsibility" through legislative mandates that are coordinated with regional and national efforts, if possible.

This program would be implemented within Connecticut, but several components could benefit from regional efforts. Although the actions recommended above would be undertaken within the State, the GHG emissions reductions would occur both within the State and outside because recycling and source reduction lower emissions from "mine-to-mouth."

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

Achieving this level of recycling and source reduction is estimated to result in additional reductions of GHG emissions by

0.91 MMTCO$_2$e in 2010

[31] The recycling and source reduction straw proposal, prepared by the Connecticut Department of Environmental Protection, is the primary source of information on this recommendation. Discussions of resource recovery facilities were drawn from draft write-ups prepared by the Connecticut Resource Recovery Facilities Authority. Significant portions of this section are excerpted verbatim from those write-ups.

[32] The Connecticut DEP estimates that the State is currently recycling 23.3 percent of its waste and source reducing 1.3 percent. Analysis conducted by the Connecticut Resources Recovery Authority estimates that the level of recycling and source reduction is significantly higher, 42 percent. Regardless of the absolute percentages, the group agreed that doubling the current level of recycling and source reduction is the important goal.

0.97 MMTCO$_2$e in 2020

Using the waste-generation baseline described earlier in this report, it is estimated that this approach would require recycling or source reduction of an additional 416,000 tons of MSW in 2010 and 443,000 tons in 2020. This waste avoidance was included in EPA's WAste Reduction Model (WARM) using an assumption of mixed recyclables.[33] The WARM model uses life-cycle emission factors to calculate the GHG savings, so a share of those emissions reductions will occur outside the State.

Currently, the waste that is not recycled or source reduced provides sufficient waste to keep Connecticut's existing resource-recovery facilities operating at full capacity. Because the working group considered that no new landfills or waste-to-energy facilities would be built within the State over the time frame considered, should the level of recycling and source reduction proposed above not be achieved, the remaining waste (i.e., the increase not recycled or source reduced) would be shipped to out-of-state landfills or resource-recovery facilities.[34] According to recent studies, shipping waste out of state can result in higher GHG emissions than in-state burning or landfilling, due to the fugitive landfill gas and emissions created by long-haul transport of the waste.[35] Thus, given projected increasing amounts of MSW creation, if all or part of the doubling in recycling and source reduction is not achieved, waste-to-energy could minimize the estimated GHG emissions. For example, if no additional waste were recycled or source reduced and all the excess waste were shipped out of state, GHG emissions of 0.45 MMTCO$_2$e in 2010 and 0.61 MMTCO$_2$e in 2020 would result, which could be avoided by an increase in Connecticut's resource-recovery capacity.

The group discussed the role of new resource-recovery facilities. It had a divergence of views on whether new resource-recovery facilities should be considered even if recycling and source reduction targets are met, or whether such facilities should be considered only if the recycling and source reduction targets are not met or appear unlikely to be met.

The estimated costs of this program are $4 to $5 per MTCO$_2$e. The cost estimates were based upon values by DEP staff indicating that implementing this program could cost $4.1 million per year (see the chapter appendix for detailed estimates).[36] The working group and stakeholders were not able to consider whether this level of funding was sufficient to meet the level or recycling and source-reduction envisioned given time and resource limitations.

The potential ancillary impact of this program includes the following benefits:

[33] The WARM model and details on the key assumptions are available at www.epa.gov/globalwarming/actions/waste/usersguide.htm

[34] The GHG baseline for the waste sector estimates that in absence of this program, approximately 445,000 tons of waste would be shipped out of state in 2010 and 612,000 tons would be shipped in 2020.

[35] See Weitz, K.A., et al. (2002). The impact of municipal solid waste management on greenhouse gas emissions in the United States. *Journal of the Air and Waste Management Association, 52,* 1000–1011, which estimates that every 1 ton of waste burned in a waste-to-energy instead of shipped out of state leads to a reduction in GHG emissions of 1 MMTCO$_2$e. This assumption was used in assessing the benefits of burning waste instead of shipping it out of state.

[36] This estimate does not include estimated costs for the electronics-recycling program.

- Ancillary benefits of recycling include decreases in raw materials acquisition (through fossil fuel energy and other emissions and changes in forest carbon sequestration), manufacturing (fossil fuel energy emissions), and transportation-related emissions.
- Source-reduction and recycling programs avoid the need for new disposal facilities and thus avoids land-use and siting issues; waste transportation issues; other pollutants from waste combustion; and generation of ash residue, which requires handling, transportation, and disposal.
- Electronic recycling and producer responsibility provide co-benefits through reduced toxicity of the waste stream.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation. A number of stakeholders were interested in understanding the costs of such a program; however, the costs presented above were not available in advance of the last stakeholder meeting to inform their deliberations.

Public Views

The public provided a number of comments relevant to this specific action:

- A number of commentors supported eliminating the burning of garbage.
- Promote municipality cooperation to ensure that satisfactory waste solutions are achieved.
- Is there additional waste-to-energy capacity?
- Support a “pay-as-you-throw” policy, but investigate “pay-as-you-make” policy, too.
- Legislative approaches to reduce waste should be investigated.
- Support the recycling program, but the State needs to address the implementation issues.
- A number of commenters supported providing adequate outreach and funding to meet the goal of increasing recycling to 40% by 2010
- Recycling should include refunds for other plastic bottles (e.g., milk and water) and it should be raised to at least 10 or even 20 cents.
- U.S. should adopt a glass bottle recycling program as it exists in Europe.
- Could increase the level of recycling/source reduction to 43%, for example, to assist in meeting the NEG/ECP target.

Voluntary Carbon Offsets

Recommended Action: Encourage voluntary carbon offset programs from agriculture, forestry, and waste reductions.

The State should encourage voluntary programs on carbon offsets (i.e., efforts to reduce GHG emissions by sources not covered by specific recommendations from the stakeholders and outside the State or the country).

Results of Assessments for 2010, 2020, and Beyond (Where Applicable)

The GHG benefits and costs of this program were not analyzed because doing so would depend on the results of the pilot program and the extent to which the pilot program was implemented.

Stakeholder Views

The stakeholders unanimously agreed to this recommendation. They deliberated whether the program should be implemented through rule making or through State encouragement of voluntary efforts. Ultimately, the stakeholders agreed that the State should support this endeavor as a voluntary initiative.

Public Views

- Offsets, if used at all, should be limited only for long range planning.
- Off-sets in a carbon cap-and-trade program should not be permitted, at least not in the near term. Carbon sequestration (protecting land because it can absorb carbon dioxide) should only be allowed if it provides additional CO_2 reductions, permanently protects the land, and is focused on conserving forested land in state.
- Sequestration credits in forests should not be allowed unless it provides additional CO_2 reductions, permanently protects the land, and is focused on conserving forested land in state.

Supporting Documents

1. Electricity Demand Reductions, Available at: www.ccap.org/Connecticut/2003-Nov-03--CT--AFW-Elec--demand_reduction_summary.pdf.
2. Food and Agricultural Policy Strategies Strawman, Available at: www.ccap.org/Connecticut/2003-Oct-10--CT--AFW--strawman_food_and_agriculture_CFPC.pdf.
3. Renewable Energy Assumptions Document, Available at: www.ccap.org/Connecticut/2003-Oct-07--CT--Renewable_Energy_Assumptions_Document.pdf.
4. Recycling strawman Proposal, Available at: www.ccap.org/Connecticut/2003-Oct-06--CT--AFW--Recycling_Strawman_Proposal.pdf.
5. Landfill Methane Strawman Proposal, Available at: www.ccap.org/Connecticut/2003-Oct-06--CT--AFW--Landfill_Methane_Strawman.pdf.
6. Forest Sequestration Strawman Proposal, Available at: www.ccap.org/Connecticut/2003-Oct-06--CT--AFW--Forest_Sequestration_Strawman.pdf
7. U.S. Landfill Methane Database, Available at: www.ccap.org/Connecticut/2003-Sept-22--CT--AFW--Landfill_gas_database-EPA_LMOP.xls.
8. Summary of Landfill Gas Options, Available at: www.ccap.org/Connecticut/2003-Sept-02--CT-CCSD--AFW--Landfill_Gas_Options-Revised.pdf.

APPENDIX
AGRICULTURE, FORESTRY, AND WASTE

GHG Emissions Projections

Table A3.4.1 summarizes the historical GHG inventory for Connecticut, as developed by NESCAUM.

Table A3.4.1
Connecticut Agriculture, Forestry, and Waste GHG Emissions: 1990–2000

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Agriculture	0.330	0.321	0.335	0.344	0.350	0.336	0.313	0.307	0.335	0.329	0.326
Enteric fermentation	0.124	0.121	0.124	0.121	0.121	0.120	0.110	0.106	0.109	0.107	0.109
Manure management	0.046	0.045	0.044	0.047	0.047	0.046	0.044	0.042	0.045	0.044	0.042
Rice cultivation	0.160	0.155	0.167	0.176	0.182	0.170	0.159	0.159	0.181	0.178	0.175
Agricultural soil management	–	–	–	–	–	–	–	–	–	–	–
Burning of agricultural crop waste	–	–	–	–	–	–	–	–	–	–	–
Forest management and land-use change	(2.719)	(2.650)	(2.658)	(2.069)	(2.039)	(2.058)	(2.052)	(2.015)	(2.009)	(2.035)	(2.035)
Waste	3.499	3.598	3.598	3.590	3.689	3.662	3.245	3.312	3.230	3.130	3.159
Municipal solid waste	3.239	3.337	3.337	3.329	3.425	3.400	2.983	3.049	2.966	2.863	2.883
Wastewater	0.260	0.262	0.261	0.261	0.264	0.262	0.262	0.263	0.264	0.267	0.277

Source: NESCAUM, Connecticut GHG Inventory 1990–2000, August, 2003, available at www.ctclimatechange.com/pdf/CC_Inventory_Report.pdf

Agriculture Emissions

Agriculture emissions are the sum of emissions from (1) enteric fermentation, (2) manure management, (3) rice cultivation, (4) agricultural soil management, and (5) burning of agricultural crop waste. The working group was interested in developing emissions projections for agriculture from bottom-up projections of activity; however, no such data were discovered during the course of the project. As a result, the group considered historical growth rates and chose to use rates from 1990 to 2000 as a representation of expected growth rates for emissions for 2001 to 2020. Table A3.4.2 shows the historical GHG growth rates (for different time periods) for enteric fermentation.

Table A3.4.2
Connecticut Enteric Fermentation Historical GHG Emission Growth Rates

	Annual Rate (%)		
Source	**1990–2000**	**1990–1995**	**1995–2000**
Dairy cattle	–1.65	–0.69	–2.60
Beef cattle	–1.07	1.91	–4.67
Other	–0.97	–2.42	0.49

Table A3.4.3 shows the historical GHG growth rates (for different time periods) for manure management.

Table A3.4.3
Connecticut Manure Management Historical GHG Emission Growth Rates

	Annual Rate (%)		
	1990–2000	**1990–1995**	**1995–2000**
N_20			
Dairy cattle	–1.17	–0.07	–2.26
Beef cattle	–15.47	–18.03	–12.82
Swine	21.45	64.16	7.65
Poultry	–2.51	–2.54	–2.48
Other	–	–	–
CH_4			
Dairy cattle	–2.77	–1.93	–3.60
Beef cattle	–0.33	0.29	–0.95
Swine	18.42	33.48	5.05
Poultry	10.26	15.70	5.07
Other	0.15	–0.15	0.44

No rice cultivation or burning of crop residues has historically occurred in the State, and none is assumed to occur in the future. Table A3.4.4 shows the historical GHG growth rates (for different time periods) for agriculture soil management.

Table A3.4.4
Connecticut Agriculture Soil Management Historical GHG Emission Growth Rates

	Annual Rate (%)		
	1990–2000	**1990–1995**	**1995–2000**
Ag Soils-Plant Residues-Legumes			
Residues	–	–	–
Legumes	–6.52	–8.90	–4.07
Ag Soils-Animals			
Indirect N_2O emissions livestock	–1.38	–0.86	–1.90
Indirect N_2O emissions leaching and runoff	1.38	1.90	0.87
Direct N_2O emissions	–0.83	–0.32	–1.35
Ag Soils-Plants-Fertilizer			

Table A3.4.4 Connecticut Agriculture Soil Management Historical GHG Emission Growth Rates			
	Annual Rate (%)		
	1990–2000	1990–1995	1995–2000
Direct	5.33	8.44	4.17
Indirect	5.33	8.44	4.17

Forestry Management and Land Use

Forestry management and land-use sequestration is the sum of sequestration related to (1) liming of agricultural soils, (2) landfilled yard trimmings, and (3) forest carbon flux. The working group sought to use projections of land use and forest cover for estimating GHG emissions for 2001 to 2020; however, no such data were available during the process. In addition, the working group was interested in using revised and more detailed land-use data developed by the University of Connecticut, but those data were not made available in time for use in the evaluation. The working group therefore chose to use historical growth rates from 1990 to 2000 as a representation of future emissions from the forestry sector. Table A3.4.5 shows the historical GHG growth rates for liming of agricultural soils.

Table A3.4.5 Connecticut Liming of Agricultural Soils Historical GHG Emission Growth Rates	
	1994–1998 Annual Rate (%)*
Liming of Agricultural Soils	**14.46**
Limestone	8.38
Dolomite	36.84
*Values are only available for 1994, 1997, and 1998.	

Table A3.4.6 shows the historical GHG growth rates (for different time periods) for landfilled yard trimmings.

Table A3.4.6 Connecticut Landfilled Yard Trimmings Historical GHG Emission Growth Rates			
		Annual Rate (%)	
	1990–2000	1990–1995	1995–2000
Landfilled yard trimmings	–19.65	–22.28	–16.93

Table A3.4.7 shows the historical GHG growth rates (for different time periods) for forest carbon flux.

Table A3.4.7 Connecticut Forest Carbon Flux Historical GHG Emission Growth Rates			
		Annual Rate (%)	
	1990–2000	1990–1995	1995–2000
Forest Carbon Flux	**–2.43**	**–4.80**	**0.00**
Biomass	0.18	0.37	0.00

Table A3.4.7
Connecticut Forest Carbon Flux Historical GHG Emission Growth Rates

	Annual Rate (%)		
	1990–2000	**1990–1995**	**1995–2000**
Forest floor and coarse woody debris	0.05	0.10	0.00
Soils	–0.08	–0.16	0.00
Wood products and landfills	–20.96	–173.16	0.00

Waste Emissions

Waste GHG emissions include in-state emissions from the decomposition of landfilled waste, emissions from waste-to-energy facilities, and methane reductions from flaring or using methane for generating energy. In addition, the stakeholders agreed to include emissions estimates for waste generated within Connecticut but disposed out of state (OOS). Bottom-up waste production was based on projected State population from the U.S. Census Bureau multiplied by per capita waste production beginning in 2001 (the most recent year for data from DEP). The recycling rate was assumed to continue historical trends, and the amount of waste going to resource recovery facilities was assumed constant. In addition, no new resource recovery facilities or landfills were assumed to be built, and the existing landfills were assumed to reach capacity in 2010; therefore, all excess waste (the amount not recycled or source reduced and sent to existing resource recovery facilities or landfills) was assumed to be shipped OOS. The amount of methane captured (for use as an energy source) or flared was increased in the future according to the amount of new landfill gas-to-energy estimated in the electricity sector reference case (see more details in the landfill gas-to-energy discussion below). Table A3.4.8 shows the waste generation and the quantity disposed using various management techniques.

Table A3.4.8
Connecticut Solid Waste Management Data: 2001–2020

	2001	**2010**	**2020**
Waste Generation			
Connecticut MSW generated (tons)	3,351,928	3,342,540	3,559,805
Population	3,409,549	3,400,000	3,621,000
Connecticut MSW generated (tons/person/ year)	0.9831	0.9831	0.9831
Waste Disposal			
Connecticut MSW disposed out of state (tons)	304,339	445,026	611,669
Connecticut MSW disposed at Connecticut RRF	2,118,702	2,118,702	2,118,702
Connecticut MSW disposed at Connecticut landfills	149,023	0	0
Waste Recycled			
Connecticut MSW recycled (includes separated organics composted, tons)	779,764	778,812	829,435
Connecticut MSW recycled (tons/person/year)	0.2288	0.2288	0.2288
% MSW Recycled	23.30%	23.30%	23.30%

All factors were converted to GHG emissions using standard emissions conversions from the EPA beta inventory tool used by NESCAUM in developing the GHG inventory. Table A3.4.9

shows the key assumptions used to convert waste-generation and -disposal data into GHG emissions.

Table A3.4.9
Key Information for Waste GHG Emissions

	2001	2010	2020
Total Emissions From Landfills ($MMTCO_2e$)	**0.9515**	**0.7541**	**0.5008**
Waste in place (WIP); past 30 years	17,710,778	12,534,848	5,895,077
Large versus small landfills rate (% large)	89%	89%	89%
WIP small landfills	1,948,186	1,378,833	648,459
WIP large landfills	15,762,593	11,156,015	5,246,619
MSW methane emissions (short tons)	97,955	87,198	73,399
Total methane flared or recovered	46,079	46,084	46,094
Total industrial methane (short tons)	3,268	2,590	1,720
Total Emissions from Combustion ($MMTCO_2e$)	**1.3593**	**1.3593**	**1.3593**
Waste combusted	2,118,702	2,118,702	2,118,702
Plastics	305,093	305,093	305,093
Synthetic rubber	44,493	44,493	44,493
Synthetic fibers	105,935	105,935	105,935
CO_2 from MSW combustion ($MMTCO_2e$)	1.1408	1.1408	1.1408
N_20 from MSW combustion ($MMTCO_2e$)	0.2185	0.2185	0.2185
Total Connecticut Waste (Landfilled and Combusted)	**2.3108**	**2.1134**	**1.8601**

The ratio of OOS waste sent to landfills versus waste-to-energy facilities was based on the proportion in 2001.[37] The ratio of waste sent to large versus small landfills was based on the national average. Based on a cursory review of where OOS landfilled waste was sent, it was assumed that the large landfills where OOS waste was sent had either methane flaring or capture mechanisms. Table A3.4.10 shows the key data used in developing the GHG emissions data for OOS waste disposal.

Table A3.4.10
Connecticut Out-of-State Waste Management Data: 2001–2020

	2001	2010	2020
Total OOS		**445,026**	**611,669**
Portion OOS waste landfilled	76%	76%	76%
OOS waste landfilled	231,236	338,129	464,743
OOS waste RRF	508,921	106,897	146,925
Total From Landfills ($MMTCO_2e$)	**0.0052**	**0.0206**	**0.0427**
Waste in place (WIP); past 30 years	954,606	3,791,064	7,854,246
Large versus small landfills rate (% large)	89%	89%	89%
WIP small landfills	105,007	417,017	863,967
WIP large landfills	849,599	3,374,047	6,990,279

[37] Connecticut DEP data submitted to the AFW working group.

Table A3.4.10
Connecticut Out-of-State Waste Management Data: 2001–2020

	2001	2010	2020
Methane emissions (short tons CH_4)	63,132	69,026	77,471
Total methane flared or recovered	62,848	67,902	75,142
Total CH_4 MSW (short tons CH_4)	255	1,012	2,096
Total CH_4 industrial (short tons CH4)	18	71	147
Total From Combustion ($MMTCO_2e$)	**0.3265**	**0.0686**	**0.0943**
Waste combusted	508,921	106,897	146,925
Plastics	73,285	15,393	21,157
Synthetic rubber	10,687	2,245	3,085
Synthetic fibers	25,446	5,345	7,346
CO_2 from MSW combustion ($MMTCO_2e$)	0.2740	0.0576	0.0791
N_20 from MSW combustion ($MMTCO_2e$)	0.0525	0.0110	0.0152

Manure Digester Program

During the process, the AFW working group evaluated three mutually exclusive options for the installation of manure digesters on Connecticut farms:

- Centralized digesters: individual farms transport their excess manure to a relatively close single digester
- Digesters on farms with 300 or more cows
- Digesters on farms with 600 or more cows.

This delineation was used because a study previously conducted for the State separately looked at the three options. Table A3.4.11 shows the number of farms on which these digesters would be installed and the number of cows contributing manure to the digesters. Unless noted otherwise, the assumptions were based on CERC Inc., Connecticut Academy of Science and Engineering (CASE), Connecticut Department of Agriculture, Pines, D., & Day, W. (2003), *An Analysis of Energy Available from Animal Biomass in Connecticut*.

Table A3.4.11
Assumed Farms and Cows: 2010 and 2020

	2010		2020	
Project Type	**Farms**	**Cows***	**Farms**	**Cows**
Centralized	1	3,870	3	11,610
300 Cow digesters	10	3,000	20	6,000
600 Cow digesters	7	4,200	14	8,400

*The number of cows required for each digester was taken from CERC Inc., Connecticut Academy of Science and Engineering (CASE), Connecticut Department of Agriculture, Pines, D., & Day, W. (2003). *An Analysis of Energy Available from Animal Biomass in Connecticut*. Connecticut Department of Agriculture.

The penetration rate of the digesters over the time frame was based on initial agreement of the AFW working group and agreed to by the stakeholders. In particular, the stakeholders agreed to recommend the penetration of one centralized digester by 2010, two by 2015, and three by 2020.

Modifications were made to the operating costs for the 300- and 600-cow digesters estimated in CERC (2003).[38] Different turbines were assumed in the analysis. In particular, the cost difference for the centralized digester option depends on whether the device includes a separator and whether other revenue generators other than electricity are available. The 300- and 600-cow options differ by the type of manure management system as well as the type of turbine installed. Table A3.4.12 shows the capital and operating costs assumed in the analysis.

[38] Per suggestion of Richard Meinart, University of Connecticut.

Table A3.4.12
Capital and Operating Costs (Per Digester)

Size	Assumptions	Total Capital Costs (Turbine A)	Total Capital Costs (Turbine B)	Operating costs
Centralized	3,870 cows; 11 farms; within 15 minutes of transport	$1,800,000.00	$1,950,000.00	$74,752.53
300-cow	Plug flow manure slurry technology	$422,000.00	$405,000.00	$45,000.00
300-cow	Liquid fraction mesophilic digester	$433,000.00	$416,000.00	$45,000.00
600-cow	Plug flow manure slurry technology	$588,000.00	$461,000.00	$45,000.00
600-cow	Liquid fraction mesophilic digester	$516,000.00	$444,000.00	$45,000.00

Table A3.4.13 shows the assumptions concerning electricity generation, on-farm electricity consumption, costs of electricity, electricity revenue to farms for selling the electricity, and the total energy savings.

Table A3.4.13
Electricity Generation and Use (Per Digester)

Scenario	Total Electricity Generated (kWh/yr)	Total Electricity Consumption (kW/yr)	Electricity Costs	Electricity Revenue Through Buy-Back	Total Energy Savings
Centralized	4,469,850	720,000	$64,800	$149,994	$214,794
300-cow	346,500	270,000	$24,300	$3,060	$27,360
600-cow	693,000	540,000	$48,600	$6,120	$54,720

Note: Assumes penetration of one-digester per option/scenario.

CERC et al. (2003) assumed that each cow would generate 1,500 to 2,000 kWh electricity per year. Given a 1-month down time, as assumed in the report, that estimate results in electricity generation of 4.5 to 6.06 kWh electricity per cow per day. The USDA AgStar program recommends an assumption of 3.5 kWh per cow per year, which was used for this analysis as agreed by the AFW working group.

To estimate the costs of the program, it is necessary to calculate the net cost of electricity for the farms involved in the program because they consume electricity. For this analysis it was assumed that the on-farm electricity consumption was 900 kWh per cow.[39] Farmers are billed according to Rate 30 or 35, which includes peak demand charges, but a constant cost of $0.09/kWh was assumed instead since this approach was used by CERC et. al (2003). The rate at which electricity was assumed to be sold to the grid was $0.04/kWh.[40] The figure for net electricity savings assumes 11 months of operation.

[39] Based on an average of two farms from the sample, 800 and 1,000 kWh per cow (CERC et al., 2003).
[40] Value from CERC et al. (2003), which notes a monthly rolling average for the past 12 months of $0.040 to 0.045.

Table A3.4.14 shows the key assumptions for the calculation of the GHG emissions savings from this program.

Table A3.4.14
Greenhouse Gas Emissions and Reductions (Per Digester)

Scenario	# of Cows	CH_4 Emission Reductions ($MMTCO_2e$)	Transport Emissions ($MMTO_2e$)	Net Emissions Reduction ($MMTCO_2e$)
Centralized	3870	0.007458	0.0012	0.008660
300-cow	300	0.00058	0.0	0.00058
600-cow	600	0.00116	0.0	0.00116

GHG emissions reductions from the manure methane were based on standard conversions.[41] Because it was assumed that using central digesters would require transporting manure to a centralized location, the AFW working group included an estimate of the GHG emissions related to this activity. The following assumptions were used to derive the GHG emissions from transporting the waste:

- Driving times between farms was assumed to be an average of 15 minutes.[42] An assumption was made about the percentage of each trip that would be on main or minor roads (40 mph vs. 20 mph), yielding average mileage per trip.[43] Each farm had a different average number of trips per day, which was based on the assumption that a 600-cow farm would fill the truck once a day and a 300-cow farm would fill the tank once every two days. Each load would require a round-trip drive, because the digested manure or liquid is returned to the farm. The average miles per day for one centralized digester totaled approximately 67.[44]
- Vehicle efficiency for transport sources for carrying the manure was based on a 6,000-gallon tanker truck, which gets 5.3 mpg.[45] The resulting fuel consumption was multiplied by the emission factor for diesel and multiplied by 330 days, because the digesters are assumed to be under maintenance one month per year.

[41] Intergovernmental Panel on Climate Change, *Good Practice Guidance.*
[42] CERC et al., 2003.
[43] Per suggestion of Richard Meinart, University of Connecticut.
[44] Ibid.
[45] Transportation Energy Data Book 2003.

Landfill Gas-to-Energy Program

Connecticut and Regional Potential

The Connecticut DEP provided the staff of EPA's Landfill Methane Outreach Program (LMOP) with a revised list of Connecticut landfills, including supporting data such as waste-in-place (WIP) information and the opening and closing dates of each landfill. LMOP staff used this information to update the LMOP database and, in turn, provided Connecticut with estimates of landfills that are candidates for landfill gas-to-energy (LFGE) projects.

This analysis considered that a total of 18.5 MW of LFGE projects could be generated in the State. This total was included in the IPM model as the maximum potential LFGE in Connecticut. Likewise, the LMOP staff provided a similar analysis of other states within the region in order to estimate the maximum LFGE potential in regions that are connected to the Connecticut electricity grid. Stakeholders agreed to assumptions on the cost and performance of LFGE through the electricity working group.[46] Table A3.4.15 summarizes the potential LFGE candidates, energy potential, and GHG emissions-reduction potential; however, on-the-ground analysis and assessment will provide greater clarity on which landfills are the best candidates in practice.

Table A3.4.15
Connecticut Landfill Candidates for Landfill Gas-to-Energy Projects

Landfill	Town	County	WIP (tons)	Year Start	Year End	MW Potential	Existing Flaring
Branford	Branford	New Haven	1,340,419	1960	1995	1.0428	No
Bristol	Bristol	Hartford	599,004	1950	1997	0.4660	No
Enfield	Enfield	Hartford	1,405,757	1967	1994	1.0937	No
Lebanon	Lebanon	New London	1,094,990	1971	1993	0.8519	No
Manchester Sanitary	Manchester	Hartford	5,102,297	1952	1997	3.9696	Yes
NORCAP Regional	East Windsor	Hartford	2,600,017	1975	1996	2.0228	Yes
North End Disposal Area	Waterbury	New Haven	5,932,824	1955	1996	4.6157	No
Putnam	Putnam	Windham	954,606	1968	1997	0.7427	No
Windham	Windham	Windham	1,500,010	1946	1996	1.1670	No
Windsor-Bloomfield Sanitary	Windsor	Hartford	3,251,763	1972	1997	2.5299	Yes
Total			**23,781,687**			**18.5022**	
Total without existing flaring			**12,827,610**			**9.9799**	

The emissions impact of electricity generation from LFGE projects was included in the electricity sector analysis. Because the use of methane for energy also leads to GHG reductions from the conversion of methane, offline calculation was conducted on methane conversion by

[46] See electricity chapter for more details on the assumptions for LFGE projects.

assuming that a portion of the landfills that would use LFGE have existing flaring. Therefore, only a portion of the methane conversion (the "total without existing flaring" in Table A3.4.15) was considered additional to what was occurring in the baseline. This quantity was converted to methane using standard LMOP assumptions.

Recycling and Source-Reduction Program[47]

The Connecticut DEP estimated the costs of implementing this program to be $4.5 million per year. Table A3.4.16 shows the breakout of the costs by category of program.

Table A3.4.16
Cost Estimate of the Recycling/Source-Reduction Program

Program	Cost/Year	Comments
DEP staff	$750,000	Based on FY02, includes 5 FTE and some partial staff, salary and overhead
Grants to municipalities	$1,715,000	$5,000/town for recycling coordination; $.25/capita for education and enforcement
Pay as you throw	$50,000	For consulting services to implement PAYT programs with Connecticut towns
Food waste composting: commercial, institutional	$750,000	Pilots, incentives, economic development assistance to food composting businesses
Residential composting	$100,000	For distribution of 5,000 backyard composting bins/year
Small business outreach	$100,000	Partnerships to work with small businesses, chambers, etc.
Workshops for State agencies, municipalities, etc.	$5,000	To increase source reduction and recycling in State agencies and towns
Building material re-use center grants	$50,000	To increase recycling of construction and demolition waste
Source reduction through waste exchange	$50,000	To join Southern New England Waste Exchange
Statewide education campaign	$400,000	For education on PAYT, source reduction, recycling, etc.
Pilots for recycling in public places	$75,000	To promote recycling in parks, malls, fairs, etc.
Integrations with regional recycling programs	$10,000	To join Northeast Recycling Coalition; coordinate on programs, markets, education, etc
Total	**$4,055,000**	

[47] Connecticut DEP and CRRA, *Memo from Connecticut DEP to the AFW working group,* 2003.

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CHAPTER 4

CLIMATE CHANGE EDUCATION AND OUTREACH

The stakeholder group strongly supports measures to foster a broad awareness of climate change issues (including co-benefit issues, such as clean air and public health) and effects among Connecticut's citizens and to engage citizens in simple actions to reduce GHG emissions. The measures, detailed below, are cross-cutting and provide a foundation for the implementation of all the mitigation actions proposed in this report. The measures seek to integrate with and build on existing outreach efforts involving climate change and co-benefit issues in Connecticut.

The following actions are recommended to ensure success of the specific education and outreach measures proposed below:

1. Include the Commissioners of Education and Higher Education on the Governor's Steering Committee on climate change.
2. Establish an ongoing Climate Change Education Committee to develop broad awareness of climate change issues and to implement the education and outreach measures proposed in this report. Participation in the committee should be open to interested parties from all sectors, including State agencies, educators, community-based organizations, businesses and institutions, municipalities, and universities. The work of the committee should include the following components:
   - Implementation of the initiatives to implement the education and outreach measures proposed below
   - Education and marketing of the GHG mitigation actions in this report
   - Coordination of the agencies and organizations involved in climate change education in Connecticut
   - Identification of existing resources and programs to implement climate change education measures
   - Identification of additional needs and supplemental sources of funding for climate change education measures (e.g., eligibility for climate change education funding under renewables and energy conservation funds and from corporations and foundations)
   - Development of a clearinghouse for Connecticut climate change information and education resources (perhaps on www.ctclimatechange.com/).

The climate change education and outreach measures described below focus on the following target audiences:

- Policy makers (includes legislators, executive office, and State agencies)
- Community leaders (includes businesses, institutions, municipalities, and universities and colleges)
- Future generations (includes K-12 education, museums, science centers, curricula for colleges and universities, home schoolers, and education organizations)
- Community-based organizations (includes nonprofit advocacy and education organizations, faith based organizations, foundations)
- The general public.

Measure 1 — Educate policy makers on climate change issues to facilitate implementation of the mitigation actions proposed in this report and other GHG reduction actions.

Implementation Strategies

- Educate policy makers on climate issues and GHG mitigation actions recommended in this report and endorsed by the Governor; promote acceptance and implementation of policies.
- Provide continuous outreach and coordination to implementing State agencies, the executive office, and the legislature, including information sessions on the GHG mitigation actions recommended in this report, updates on progress toward goals, monthly press releases, and collaboration on joint projects and events.
- Educate press secretaries from the executive office and State agencies. Develop relationships to maintain message consistency and coordinate monthly press releases on GHG reductions and events.
- Incorporate input from policy makers to continually develop new climate change mitigation strategies for Connecticut.

Measure 2 — Work with community leaders from businesses, institutions, municipalities, universities, and colleges that have reduced GHG emissions to develop a critical mass of leaders in each sector who are reducing GHG emissions and making it a way of doing business in their communities.

Implementation Strategies

- Identify community leaders with effective GHG reduction programs and form partnerships to showcase successes and mentor to peers (speakers bureau, case studies, etc.).
- Engage associations (e.g., CBIA, SACIA, CCM) and use their meetings to educate their members about climate change and the specific mitigation actions in this report.
- Organize outreach events that focus on "leading by example" and include technical assistance, peer exchange, information on state-of-the-art practices and technologies, and co-benefits and cost savings of GHG mitigation actions.
- Develop statewide climate change recognition programs for community leaders.
- Convene a series of seminars on the financial risks and opportunities related to climate change for Connecticut-based insurance companies and financial institutions.

Measure 3 Integrate climate change issues into curricula and outreach programming for future generations.

Implementation Strategies

- Organize a group of professional educators to identify existing climate change curricula and coordinate with and leverage existing efforts to assemble statewide resources that address climate change problems and solutions.
- Coordinate with the Department of Education to align climate change education resources with Connecticut science frameworks.
- Provide educational resources on climate change to supplement teaching efforts to meet existing State standards for public and private schools and home schoolers.
- Work with existing and developing science centers and museums to help them focus on climate change science and related issues that link with their core missions.
- At universities and colleges, promote research on global climate change and its solutions, integrate global climate change into curricula, and educate students on the problems of global climate change and individual actions (in accordance with Gov. Rowland's October 17, 2003, letter to university presidents).
- Integrate climate change into existing and new education competitions, such as science fairs, the Invention Convention, the Future Problem Solving Program, the Envirothon, and higher education competitions.

Measure 4 Identify community-based organizations involved in outreach on climate change and related issues and expand participation to support all sectors in achieving goals for GHG emissions reductions.

Implementation Strategies

- Identify community-based organizations (e.g., nonprofit advocacy and education organizations, faith-based organizations, and foundations) with expertise in climate change and related issues (e.g., clean air, traffic congestion, smart growth).
- Facilitate peer outreach and education to support an understanding of climate change and related issues and actions within community-based organizations.
- Work with community-based organizations to focus on climate change and related issues that link with their core missions.
- Develop a communication and coordination network of community-based organizations to ensure message consistency, link events, and develop joint projects.
- Assist community-based organizations with organizing their constituencies to support strong climate change actions.

Measure 5: Increase the awareness of the general public of the impact and problems of climate change and engage the general public in actions to reduce GHG emissions in their personal and professional lives.

Implementation Strategies

Connecticut Climate Change Action Plan Rollout and Implementation Updates

- Develop events, outreach to media, and "buzz" around the Governor's acceptance of stakeholder recommendations in this report.
- Declare March (or another month within the legislative session and school year) as Climate Change Awareness Month. Schedule events around a different theme for each week (e.g., transportation, energy efficiency, and renewable energy) and include outreach on GHG mitigation actions and promotion of success stories.
- Coordinate monthly press releases on successful implementation of GHG mitigation actions and GHG reductions. Ensure message consistency and link actions to progress toward goals.

Climate Change Messaging

- Set appropriate evaluation targets to gauge the level of public awareness needed to attain Connecticut's GHG reduction goals.
- Perform initial benchmarking and conduct periodic research on Connecticut public opinion regarding climate change and related topics; the goal is to develop appropriate messaging (including the most effective terms for concepts such as climate change, global warming). Use polling to establish benchmarks on public opinion, gain feedback on outreach measures, and re-evaluate the approach to messaging.
- Focus on positive messages, not negative forecasts.

- Develop a climate change action "brand," marketing line, or logo (similar to "Connecticut Rides" or "Keep America Beautiful") to unify efforts and foster public awareness and engagement.
- Coordinate outreach to promote consistent messaging with all organizations and sectors involved in climate change awareness and education (e.g., nonprofit organizations, State agencies, educators, and municipalities).

Public Information

- Further develop the www.ctclimatechange.com website as a clearinghouse for climate change information, a communication forum for events and success stories, and a resource for progress on plan implementation and total Connecticut GHG reductions.
- Coordinate existing utility outreach to consumers and businesses for message consistency and coordination with action plan strategies.
- Develop disclosure and labeling of electricity-generation fuel mixes to promote consumer awareness of GHG production from electricity generation.
- Develop a plan for adaptation to climate change in Connecticut.
- Incorporate information on co-benefits of GHG reductions in climate change outreach (e.g., clean air, reduced traffic congestion, and healthier communities).
- Provide targeted outreach to key sectors (e.g., faith-based communities, drivers, asthmatics, and outdoor recreation enthusiasts).

Media Outreach

- Work with media to get newspaper editorials, op/ed pieces, and media coverage of climate change issues, action plan strategies, and instances of successful plan implementation.
- Develop public service announcements to raise awareness.
- Develop a documentary about Connecticut climate change.
- Incorporate existing climate change education programs (e.g., the USDA and NASA Global Climate Change programs) into local public access programming.

Stakeholder Views

The stakeholders agreed to all education and outreach measures through unanimous consent.

Public Views

- Public education should be a priority.
- Promote public education on issues through cost-effective media.
- Increase education and funding for education.
- Education is needed, especially for policy makers.

- Promote global warming education in schools.
- Educate buyers on lifecycle car costs.

Participants in the Education Workgroup

Connecticut Department of Environmental Protection, Clean Energy Fund, Connecticut Office of Policy and Management, Connecticut Department of Transportation, Institute for Sustainable Energy, League of Conservation Voters, SmartPower, Clean Water Action, Connecticut Earth Science Teachers Association.

CHAPTER 5

GREENHOUSE GAS REPORTING AND REGISTRY

Recommended Action: Create appropriate tools for an effective inventory, reporting system, and registry of State emissions.

Connecticut should create appropriate tools for an effective inventory, reporting system, and registry of State emissions. The system should support the State's target, action plan, and regional leadership role—including mutual recognition by other jurisdictions. The State should explore working with the NEG/ECP on this effort. Development of such a system may include the following actions:

- Creating an annual statewide GHG emissions inventory and related State inventories
- Instituting mandatory reporting of GHG emissions by appropriate sources
- Developing a voluntary GHG emissions registry
- Working with other states and regions on consistent and mutually recognized approaches for inventory and reporting.

Results of Assessments

Not applicable

Stakeholder Views

Unanimous Consent. As noted earlier, at the third stakeholder meeting CCAP summarized work group findings relating to potentially cross-cutting issues, including education, reporting and registry, technology and hydrogen, and cap and trade. At that time, the group decided to refer reporting and registry issues to further discussion by stakeholders, pending distribution and review of a CCAP white paper. This paper was available for review a week prior to the final stakeholder meeting, but not in time for work group review and action. As a result, stakeholders were uncomfortable with detailed discussion or recommendations. However, stakeholders felt that reporting and registry actions were important for future consideration by the State and recommended that a short, summary version of the paper be included in the final report as a basis for further discussion on the issue.

Public Views

No public comments were received on this issue.

Connecticut Climate Change

APPENDIX 1
DECISION CRITERIA

Proposed Criteria for Assessing and Prioritizing GHG Measures	
Primary Criteria	**Indicators that would be assessed by CCAP to the extent possible using the best available data for each option.**
GHG impact	Total annual GHGs reduced in relevant target years in carbon equivalents. This measure is typically expressed as an average annual level of projected MMTCE reduction in a given year beyond baseline emissions. GHG impact must be quantified in order to aggregate measures toward a numerical target.
Cost-effectiveness	Direct net cost divided by the GHG impact (expressed in dollars per metric ton of carbon equivalent) and is typically expressed in a given year as an average annual value over the life of the action. Costs may be expressed as a range.
Secondary Criteria	**Indicators that would be assessed by CCAP, the working groups, or both when relevant for a particular option using best available data. These effects may not be readily quantifiable.**
Ancillary environmental impact	Environmental impact other than GHG emissions reductions, including public health and ecosystem impact from changes in air quality or other environmental indicators.
Ancillary economic impact	Economic impact other than direct costs or benefits of GHG reduction actions (e.g., economic development, cost savings for other actions).
Equity effects	Extent to which the measure disproportionately affects a population, sector, or region of the State or affects the State's competitive position relative to other states.
Public and political support and concern	Expected support or concern from the general public and policy makers.
Feasibility	Ease of implementation and administration by implementing parties.
Compatibility	Extent to which the measure reinforces or enhances the effectiveness of other policy programs or is required for other measures to work.
Transferability to other States and nations	Ease of duplication of measure in other states or in national and international policies.

APPENDIX 2

Stakeholder Dialogue Participant List [1]

Governor's Steering Committee (GSC)

Arthur H. Diedrick (Chair)—Chairman of the Connecticut Clean Energy Fund
Donald W. Downes—Chairman of the Department of Public Utility Control
Arthur J. Rocque, Jr.—Commissioner of the Department of Environmental Protection
Barbara Waters—Commissioner of the Department of Administrative Services
James F. Byrnes—Commissioner of the Department of Transportation
John A. Mengacci—Undersecretary of the Office of Policy and Management

Climate Change Coordinating Committee (C4)

Bryan Garcia (Co-coordinator)—Connecticut Clean Energy Fund
Chris James (Co-coordinator)—Department of Environmental Protection
Emily Smith—Connecticut Innovations, Inc.
Connie Mendolia—Department of Environmental Protection
Chris Nelson—Department of Environmental Protection
Lynn Stoddard—Department of Environmental Protection
John Ruckes—Office of Policy and Management
Barbara Moser—Department of Administrative Services
Rob Luysterborghs—Department of Public Utility Control
Michael Chowaniec—Department of Public Utility Control
David Goldberg—Department of Public Utility Control
Michael Sanders—Department of Transportation
Lisa Rivers—Department of Transportation
David Lepri—Department of Revenue Services

Facilitator (Center for Clean Air Policy)

Tom Peterson—Project Director, Stakeholder Group Facilitator and Electricity Work Group Facilitator
Mac Wubben—Project Coordination and technical support
Tony Tubiolo—Web management and technical support
Jia Li, Matt Ogonowski—Electricity Work Group Supporters
Steve Winkelman—Transportation Work Group Facilitator
Greg Dierkers—Transportation Work Group Support
Karen Lawson—Residential, Commercial, and Industrial Work Group Facilitator
Jake Schmidt—Agriculture, Forestry, and Waste Work Group Facilitator

[1] We intended to recognize all of those organizations that have in some way been involved in this process for the past year. If your organization is not listed and you participated in this process, we respectfully apologize for not having identified you in this participant list.

Stakeholders

Connecticut Global Fuel Cell Center at Uconn
City of New Haven
Connecticut Business and Industry Association
Connecticut Clean Energy Fund
Connecticut Department of Administrative Services
Connecticut Department of Environmental Protection
Connecticut Department of Public Utility Control
Connecticut Department of Transportation
Connecticut Fund for the Environment
Connecticut League of Conservation Voters
Connecticut Resource Recovery Authority
Environment Northeast
Fleet Bank
Institute for Sustainable Energy at Eastern Connecticut State University (ECSU)
International Brotherhood of Electrical Workers
Mohegan Tribal Nation
Motor Transport Association of Connecticut
The Nature Conservancy
Northeast Utilities
Office of Policy and Management
Pitney Bowes
Public Service Enterprise Group
School of Forestry and Environmental Studies at Yale
SmartPower
United Technologies

Public Participants

Alliance of Automobile Manufacturers
American Automobile Association
APX
Archdiocese of Hartford
Argonne National Laboratory
Capital Region Council of Governments
Center for Ecological Technology
Central Connecticut Regional Planning Agency
Clean Energy Group
Clean Water Action
Community Energy
Connecticut Climate Coalition
Connecticut Earth Science Teacher's Association
Connecticut Food Policy Council
Department of Revenue Services
Dominion Power
Don't Waste Connecticut
EMCON/OWT, Inc.
Enabling Technologies, LLC
Environmental Architecture LLC
Environmental Defense
FANNIE MAE
Farmington River Watershed Association
Fuel Cell Energy
GE Global Research Center
Hydrogen Source
Independent Connecticut Petroleum Association
Interreligious Ecojustice Network
ISO New England
Merit Engineering
Middlesex Clean Air Association
MJ Bradley and Associates
Rep. Mary Mushinsky (85th District)
National Renewable Energy Laboratory
Natural Resources Defense Council
New Haven Environmental Justice Network
Northeast Organic Farming Association
NRG Energy
Nuclear Energy Institute
Nuclear Information and Resource Service
NXEGEN
Office of the Connecticut State Treasurer
Phelps Dodge Corporation
Praxair
Proton Energy Systems
Pure Power
Quinnipiac River Association
Reforest the Tropics
Robinson & Cole
Sierra Club Connecticut Chapter
Sterling Planet
The Retec Group
Toxics Action Center
UK Carbon Trust
University of New Hampshire
Waste Management
Wesleyan University
Ztek Corporation

And the authors of the many letters submitted to the Governor and the GSC over the past year.

Working Group Participants

Transportation and Land Use	
Alliance of Automobile Manufacturers	Greg Dana
Capital Regional Council of Governments	Richard Porth, Sandy Fry
Center for Clean Air Policy	Greg Dierkers, Mac Wubben, Steve Winkelman
Central Connecticut Regional Planning Agency	Carl Stephani
City of New Haven	Madeleine Weil, Mike Piscitelli
CBIA	Eric Brown
Connecticut Clean Energy Fund	Adam Mengacci, Bryan Garcia, Richard Barredo
Connecticut Department of Administrative Services	Barbara Moser
Connecticut Department of Environmental Protection	Bob Kaliszewski
Connecticut Department of Transportation	Michael Sanders
Connecticut Fund for the Environment	Charles Rothenberger, Don Strait
Connecticut League of Conservation Voters	Lori Brown
Connecticut Office of Policy and Management	Daniel Morley, David LeVasseur
Environment Northeast	Dan Sosland, Derek Murrow, Michael Stoddard
Fleet Bank	Helen Sahi
International Brotherhood of Electrical Workers	Jim Fraser
MTA of Connecticut	Michael Riley
Pitney Bowes	Joe Shimsky, Patrice Arita
PSEG	Christine Neely, David Damer
Robinson & Cole LLP	Charles Duffy
The Mohegan Tribe	Norman Richards

Residential, Commercial, and Industrial	
Center for Clean Air Policy	Karen Lawson
City of New Haven	Mike Piscitelli
CBIA	Eric Brown, John Rathgeber
Connecticut Clean Energy Fund	Adam Mengacci, Bryan Garcia
Connecticut Department of Administrative Services	Barbara Moser
Connecticut Department of Environmental Protection	Chris James, Chris Nelson, Connie Mendolia, Lynn Stoddard
Connecticut Department of Public Utility Control	Arthur Marcelynas, David Goldberg, John Buckingham, Michael Chowaniec, Robert Luysterborghs
Connecticut Office of Policy and Management	John Ruckes
Connecticut Treasury	Donald Kirshbaum
Eastern Connecticut State University	Bill Leahy
Environment Northeast	Dan Sosland, Derek Murrow, Michael Stoddard
Fleet Bank	Helen Sahi
International Brotherhood of Electrical Workers	Jim Fraser
Northeast Utilities	Jon Russell
Phelps Dodge Corporation	Adam Weissman
PSEG	Christine Neely
Robinson & Cole LLP	Brian Freeman, Charles Duffy
United Technologies Corporation	Chris Powell, Ellen Quinn

Electricity Generation	
CBIA	Robert Early
Center for Clean Air Policy	Jia Li, Matthew Ogonowski, Mac Wubben, Ned Helme
CERC	Martha Hunt
Clean Water Action	Brooke Suter, Roger Smith
Connecticut Clean Energy Fund	Bryan Garcia, Richard Barredo, Subhash Chandra
Connecticut Department of Environmental Protection	Chris James, Chris Nelson
Connecticut Department of Public Utility Control	Arthur Marcelynas, David Goldberg, John Buckingham, Michael Chowaniec, Robert Luysterborghs
Connecticut Treasury	Donald Kirshbaum
Dominion Power	Chris Funderburk, Dan Weekly, Denny Hicks, Lenny Dupuis
Environment Northeast	Dan Sosland, Derek Murrow, Michael Stoddard
Global Fuel Cell Center, University of Connecticut	Nigel Sammes
ICF Consulting	Christopher MacCracken, Steve Fine
Institute for Sustainable Energy at ECSU	Joel Rinebold
International Brotherhood of Electrical Workers	Frank Carroll, Jim Fraser
ISO New England	Eric Johnson
Merit Engineering, LLP	Paul Popinchalk
MJ Bradley & Associates	Brian Jones, Kristen Vaurio
National Renewable Energy Lab	Laura Vimmerstedt
New Wind Energy	Jeff Keeler
Northeast Utilities	Jon Russell
NRG Energy	Cindy Karlic
Nuclear Energy Institute	Mary Quillian
PSEG	David Damer, Robert Silvestri
Robinson & Cole LLP	Charles Duffy
SmartPower Connecticut	Brian Keane
United Technologies Corporation	Chris Powell, Ellen Quinn

Agriculture, Forestry, and Waste	
American Ref-Fuel	Derek Grasso
Center for Clean Air Policy (Facilitator)	Jake Schmidt
Connecticut Clean Energy Fund	Adam Mengacci, Bryan Garcia, Keith Frame
Connecticut Department of Environmental Protection	Chris James, Connie Mendolia, Don Smith, Lynn Stoddard
Connecticut Resources Recovery Authority	Steven Yates
Environment Northeast	Dan Sosland, Derek Murrow, Michael Stoddard
Fleet Bank	Helen Sahi
Institute for Sustainable Energy at ECSU	Joel Rinebold
PSEG	Christine Neely, David Damer
Reforest the Tropics	Herster Barres
Robinson & Cole, LLP	Charles Duffy
The Nature Conservancy, Connecticut Chapter	David Sutherland, Ellen Hawes, Lize Hanners
University of Connecticut	Linda Drake, Rich Meinert, Stephen Broderick, Tom Morris
Wheelabrator Technology, Inc.	Frank Ferraro
Workplace Fairness	Jiff Martin
Yale University	Brad Gentry

APPENDIX 3
CCAP MODEL MATRIX

	Key Model Features	Modeling Regions	Connecticut Representation	Caps	Carbon Intensity Target	Allowance Allocation			Linkages with Policies & Measures					Sectors Addressed		
						GPS	AU	GF	RPS	SBC	Tax	R&D	Effi. Std.	power	transportation	End-use sectors
I. Electricity Sector Models (and other sector representation)																
PROSYM	Detailed hourly electricity dispatch model that is the most realistic representation of the electricity sector of all the models considered. Can model the entire region including NEPOOL, PJM, NY, and parts of Canada, while modeling the CT load pocket. Can model DG and other new capacity at specific locations in CT and NEPOOL. Will provide the marginal and fixed portions of electricity prices, system costs, and emissions.	NEPOOL (8 regions including CT load pocket), PJM, NY, parts of Canada	Southern CT load pocket and the rest of CT are separate regions within NEPOOL	Indirectly	?	√	Indirectly	√	√	√	√	Manually	√	√		
ICF IPM	Dynamic optimization model that selects investment and dispatch options based on cost and other constraints (e.g., energy markets, emissions.) Investment options are selected by the model given the cost and performance characteristics of available options, forecasts of customer demands for electricity, and reliability criteria. Decisions are made on the basis of minimizing the net present value of capital plus operation costs over the full planning horizon. Detailed transmission capacity represented in IPM.	Nationwide, with 21 electric power markets.	CT is a sub-region within NEPOOL, ready to apply state-specific assumptions and obtain separate outputs.	Yes	√	√	√	√	√	represented by demand redux	√	can represent tech improv	√	√	No	No, except grid-connected DG.

	Key Model Features	Modeling Regions	Connecticut Representation	Caps	Carbon Intensity Target	Allowance Allocation			Linkages with Policies & Measures					Sectors Addressed		
						GPS	AU	GF	RPS	SBC	Tax	R&D	Effi. Std.	power	transportation	End-use sectors
EIA NEMS	NEMS represents the energy markets and their interactions with the U.S. economy. The model represents domestic energy markets by explicitly representing the economic decision making involved in the production, conversion, and consumption of energy products. Where possible, NEMS includes explicit representation of energy technologies and their characteristics. Regional details are included in the model to represent varying costs and availability and energy-consuming characteristics across regions. NEMS consists of energy supply modules (oil and gas, natural gas transmission and distribution, coal, and renewable fuels); an electricity dispatch module; four end-use demand modules (residential, commercial, transportation, and industrial) which provide feedback to the energy supply modules; as well as modules that simulate the macroeconomic impacts of energy/economy interactions. The modularity of the NEMS design provides the flexibility for each component of the U.S. energy system to use the methodology and coverage that is most appropriate.	Nationwide, with NERC power regions	Included in the New England region. State representation is extrapolated based on the regional characteristics and could be benchmarked using state-specific parameters (e.g., population growth rate).	Yes	√	√	√	√	√	√	√	√	√	√	√	√
Tellus NEMS	Same as for NEMS above; except that constraints and assumptions for EE/RE in NEMS are modified to reflect the authors' assessment of the market performance of EE/RE technologies.	Nationwide, with a New England regional model developed for other regional work.	CT is a sub-region within NEPOOL. Tellus did a similar project in RI using both NEMS and LEAP.	Yes	√	√	√	√	√	√	√	√	√	√	√	√

	Key Model Features	Modeling Regions	Connecticut Representation	Caps	Carbon Intensity Target	Allowance Allocation			Linkages with Policies & Measures					Sectors Addressed		
						GPS	AU	GF	RPS	SBC	Tax	R&D	Effi. Std.	power	transportation	End-use sectors
Tellus LEAP	LEAP is a scenario-based energy-environment modeling tool, accounting energy consumption, conversion and production in a given region or economy under a range of alternative assumptions (e.g., population, economic development, technology, price). Using LEAP, scenarios can be built and then compared to assess their energy requirements, social costs and benefits and environmental impacts. LEAP allows for analysis as rich in technological specification and end-use detail. Unlike macroeconomic models, LEAP does not attempt to estimate the impact of energy policies on GDP or employment, nor does it automatically generate optimum or market-equilibrium scenarios, although it can be used to identify least-cost scenarios.	National, regional, local	LEAP has been used in conjunction w/ NEMS to develop GHG mitigation strategy in RI.	Yes	√	?	?	?	√	√	√	√	√	√	√	√
EPA AMIGA	Argonne National Lab's AMIGA (The All Modular Industry Growth Assessment) modeling system is a general equilibrium modeling system of the U.S. economy that covers the period from 1992 through 2030 and includes data of about 300 sectors with detailed technology inputs. It contains the macroeconomic features and is capable of projecting economic growth and calculating the national Gross Domestic Product (GDP), employment, a comprehensive list of consumption goods and services, and trade balance. The AMIGA system includes the Argonne Unit Planning and Compliance model that captures a wide variety of technology characteristics within the electric generating sector. This	Nationwide	No New England regional model developed, but Don Hanson at Argonne National Lab can potential develop the NE model for 2-3 wks with assumption inputs from the group, and be able to run the model in the summer.	Yes	√	?	√	√	√	√	√	√	√	√	√	no	√

	Key Model Features	Modeling Regions	Connecticut Representation	Caps	Carbon Intensity Target	Allowance Allocation			Linkages with Policies & Measures					Sectors Addressed		
						GPS	AU	GF	RPS	SBC	Tax	R&D	Effi. Std.	power	transportation	End-use sectors
	includes a system dispatch routine that allows the retirement and the dispatch of units on the basis of traditional cost criteria as well as the impact of various permit prices on operating costs. Key advantage of AMIGA is the capability to assess the macroeconomic feedback of power sector policy changes (e.g., technology investments, electricity price changes).															
RFF Haiku	The RFF Haiku model is a simulation model of regional electricity markets and interregional electricity trade in both regulated and deregulated markets. Haiku calculates market equilibrium in each of 13 NERC regions. The model uses separate electricity demand curves for each of three sectors of the economy and supply curves that are endogenously determined using fully integrated modules that simulate, among other things, capacity investment and retirement, compliance with emissions regulations, interregional power trading, and coal and natural gas markets.	Nationwide with NERC regions	New England is a power region.	Yes	√	√	√	√	√	√	√	√	√	√	no	represented as demand curves.

	Key Model Features	Modeling Regions	Connecticut Representation	Caps	Carbon Intensity Target	Allowance Allocation			Linkages with Policies & Measures					Sectors Addressed		
						GPS	AU	GF	RPS	SBC	Tax	R&D	Effi. Std.	power	transportation	End-use sectors
MARKAL	The basic components in a MARKAL model are specific types of energy or emission control technology. Each is represented quantitatively by a set of performance and cost characteristics. A menu of both existing and future technologies is input to the model. Both the supply and demand sides are integrated, so that one side responds automatically to changes in the other. The model selects that combination of technologies that minimizes total energy system cost. Unlike some "bottom-up" technical-economic models, MARKAL does not require -- or permit -- an a priori ranking of greenhouse gas abatement measures as an input to the model. The model chooses the preferred technologies and provides the ranking as a result. The model will find the least expensive combination of technologies to meet GHG emissions reduction requirement -- up to the limits of feasibility -- but with each further restriction the total energy system cost will increase. MARKAL has been used to identify least-cost energy systems, identify cost-effective responses to restrictions on emissions, perform prospective analysis of long-term energy balances under different scenarios, evaluate new technologies and priorities for R&D, and evaluate the effects of regulations, taxes, and subsidies.	national, regional and state. NESCAUM is developing the New England version of MARKAL, expecting to complete model development later in the year.	Potentially CT will be one sub-region in the New England MARKAL model. (Unclear how the state-specific characteristics will be reflected.)	Yes	√	√	√	√	√	√	√	√	√	√	√	√

II. Economy-Wide Models

	Key Model Features	Modeling Regions	Connecticut Representation	Caps	Carbon Intensity Target	Allowance Allocation			Linkages with Policies & Measures					Sectors Addressed		
						GPS	AU	GF	RPS	SBC	Tax	R&D	Effi. Std.	power	transportation	End-use sectors
Regional Economic Models (REMI)	REMI POLICY INSIGHT®MODEL has been used for other economic analysis in CT. REMI Policy Insight is the leading forecasting and policy analysis model used by government agencies, consulting firms, nonprofit institutions, universities, and public utilities. The model uses state, county, and primary metropolitan statistical area (PMSA) data from the Bureau of Economic Analysis, Bureau of Labor Statistics, the Department of Energy, the Census Bureau, and other public sources. It enables analysis of the impacts of policies on state economic activity compared to a user-defined or default baseline forecast. In analyzing policy options, the model allows the user to adjust key variables, such as energy price inputs (e.g., changes in electricity prices and fuel prices) and other relevant changes (e.g., raw materials, products, labor, capital, and disposable income) to determine output effects on Gross State Product (GSP), employment, and other macroeconomic variables. Policies can be analyzed for a given sector or sub-sector, the state as a whole, a given county, PMSA, or some combination. REMI and other economy-wide models can provide general guidance on the sensitivity of the state economy to policies. However, models of this type do not always accurately reflect the ability of the economy at large, or sectors within it, to make adjustments to changes.	national, regional, state	Could be designed for CT state. Yale University has a CT version of REMI.	Yes	√	√	√	√	√	√	√	√	√	√	√	√

APPENDIX 4
MASTER CALENDAR

Major Project Milestones

- Request for proposals (RFP) for facilitation services for Connecticut's CCSD
  - November 13, 2002: RFP issued
  - December 11, 2002: RFP deadline for submission
  - December 17, 2002: Interviews with RFP finalists
  - December 23, 2002: Determination of contract award to CCAP.
- February 5, 2003: Connecticut Innovations, Inc., on behalf of the Connecticut Clean Energy Fund, executes a contract with the CCAP to facilitate Connecticut's CCSD
- October 10, 2003: Facilitation contract extension granted pursuant to the request of the GSC
- October 31, 2003: Initial deadline for stakeholder recommendations to the GSC
- December 31, 2003: Final deadline for stakeholder recommendations to the GSC.

GCS Meetings

1. November 6, 2002
2. February 5, 2003: meeting between CCAP and the GSC
3. June 24, 2003
4. September 15, 2003
5. November 17, 2003
6. January 6, 2004: final presentation by CCAP to the GCS.

Stakeholder Meetings

1. April 23, 2003 (process kick-off, review of initial inventory and baselines, long list of policy options)
2. June 9–10, 2003 (review of revised inventory, baselines and options list; establishment of priorities for analysis)
3. August 18, 2003 (review of final inventory, updated baselines, first draft assessments of options and scenarios)
4. October 1 (special stakeholder meeting to approve electricity baseline assumptions for the Integrated Planning Model [IPM])
5. October 15–16, 2003 (identification of consensus actions, review of cross-cutting issues)
6. December 4–5, 2003 (resolution of pending actions, cross-cutting issues).

Working Group Meetings

Transportation Working Group

1. May 13, 2003
2. May 21, 2003
3. June 4, 2003
4. June 25, 2003

5. July 9, 2003
6. July 18, 2003
7. July 30, 2003
8. August 6, 2003
9. August 27, 2003
10. October 1, 2003
11. October 9, 2003
12. October 22, 2003
13. October 30, 2003
14. November 6, 2003
15. November 19, 2003

Residential, Commercial, and Industrial Working Group

1. May 22, 2003
2. June 3, 2003
3. June 26, 2003
4. July 3, 2003
5. July 10, 2003
6. July 17, 2003
7. July 24, 2003
8. August 7, 2003
9. August 28, 2003
10. September 11, 2003
11. September 17, 2003
12. September 25, 2003
13. October 2, 2003
14. October 23, 2003
15. November 6, 2003
16. November 20, 2003

Electricity Working Group

1. May 21, 2003
2. June 5, 2003
3. June 18, 2003
4. July 9, 2003
5. July 23, 2003
6. July 30, 2003
7. August 13, 2003
8. September 10, 2003
9. September 18, 2003
10. September 24, 2003
11. October 8, 2003
12. November 17, 2003
13. November 19, 2003
14. November 26, 2003
15. December 3, 2003

Agriculture, Forestry, and Waste Working Group

1. May 28, 2003
2. June 5, 2003
3. July 2, 2003
4. July 15, 2003
5. July 31, 2003
6. August 12, 2003
7. September 2, 2003
8. September 12, 2003
9. October 7, 2003
10. November 4, 2003
11. November 18, 2003

Education Working Group

1. September 4, 2003
2. September 16, 2003
3. September 23, 2003
4. October 7, 2003
5. October 21, 2003
6. November 4, 2003
7. November 12, 2003
8. November 18, 2003
9. November 25, 2003

Public Meetings

1. June 10, 2003
2. August 18, 2003
3. October 15, 2003
4. December 4, 2003

APPENDIX 5
"LONG LIST" OF GHG ACTIONS CONSIDERED BY OTHER ENTITIES

Transportation and Land-Use Sector GHG Reduction Opportunities	
1	**Passenger Vehicle GHG Emission Rates**
1.1	**Vehicle Technology**
1.1.a	*Implement Tailpipe GHG Emission Standards*—Implement policies to reduce GHG tailpipe emission rates (grams CO_2 -equivalent per mile), such as regulatory standards or an alternative approach.
1.1.b	*Adopt LEV-II*—Adopt California's Low Emission Vehicle II (LEV II) standard for new cars. The LEV II standard addresses non-methane organic gas (NMOG), oxides of nitrogen (NOx), and carbon monoxide (CO).
1.1.c	*Fund R&D on Low-GHG Vehicle Technology (e.g., fuel cell, hybrid electric vehicles)*
1.1.d	*Encourage the use of add-on technologies (e.g., Low Friction Oil, Low Resistance Tires)*
1.2	**Vehicle Operation**
1.2.a	*Enforce Speed Limits (thereby reducing fuel use)*
1.2.b	*Vehicle Maintenance, Driver Training*—To encourage more energy efficient driving habits
1.2.c	*Transportation System Management*—The use of technology, signage and other measures to mitigate traffic congestion
1.3	**Incentives & Disincentives**
1.3.a	*Procurement of Efficient Fleet Vehicles*—Establish incentives and initiatives to encourage acquisition of low-GHG vehicles in public, private and State fleets.
1.3.b	*Feebates (State or regional)*—Under a feebate system, purchasers of high-CO_2-emitting vehicles would pay a fee, while purchasers of low CO_2 emitting vehicles would receive a rebate. Can be designed to be revenue neutral and regional.
1.3.c	*Implement CO_2-based registration fees*
1.3.d	*Provide Tax Credits for Efficient Vehicles*—An incentive for car buyers to purchase a low-GHG emitting vehicle
2	**Slowing VMT Growth**
2.1	**Develop packages to slow VMT growth/reduce VMT—**Increase availability of low-GHG travel choices, such as transit (rail and bus), vanpools, walking and biking. Provide complementary land use polices and incentives to improve the attractiveness of low-GHG travel choices.
2.2	**Land Use and Location Efficiency**
2.2 a	*Review and amend State/local policies that encourage sprawl (e.g., funding, econ. development, property taxes, zoning)*
2.2.b	*Target Infrastructure Funding (transportation, utilities, schools) and development incentives to efficient locations*
2.2.c	*Infill, Brownfield Re-development*
2.2.d	*Transit-Oriented Development*
2.2.e	*Support Smart Growth Planning & Modeling*
2.2.f	*Target Open Space Protection to complement smart growth, infill, etc.*
2.3	**Increase Low-GHG Travel Options**
2.3.a	*Increase/Redirect Transportation Funding for Efficient Modes*
2.3.b	*Improve Transit Service (coverage, frequency, convenience, quality)*

Transportation and Land-Use Sector GHG Reduction Opportunities	
2.3.c	*Expand Transit Infrastructure (rail, bus, BRT)*
2.3.d	*Bike and Pedestrian Infrastructure*
2.3.e	*Transit Marketing and Promotion*
2.3.f	*HOV lanes*
2.3.g	*Initiate a Fix-it-First policy—Earmark transportation funds toward the repair of existing transportation network before funding new transportation infrastructure*
2.3.h	*Transit Prioritization (signal prioritization, HOV lanes)*
2.3.i	*Encourage Telecommute and Live-Near-Your-Work Programs*
2.3.j	*Encourage car sharing initiatives*
2.4	**Incentives & Disincentives—**Establish incentives and initiatives to encourage low-GHG travel behavior including:
2.4.a	*Commuter Choice—Promoting employer-based commuter incentives for transit and carpooling*
2.4.b	*VMT Tax—Tax on the number of miles driven per year per vehicle with revenues targeted towards low-GHG travel alternatives*
2.4.c	*Increased Fuel Tax with Targeted Use of Revenues—A fuel targeted to a low-GHG option such as funding transit, hybrid vehicles, etc with revenues targeted towards low-GHG travel alternatives*
2.4.d	*Pay As You Drive Insurance (PAYD)—Automobile insurance, in which premiums for a vehicle are based on how much it is driven*
2.4.e	*Road Pricing (or tolls) with Targeted Use of Revenues—Use tolls or congestion pricing to fund alternatives to the single occupant vehicle*
2.4.f	*Location-Efficient Mortgages (LEM)—is a discounted mortgage that recognizes the savings available to people who live in location efficient communities, mixed-use communities near public transportation.*
2.4.g	*Parking Pricing or Supply Restrictions—Limit or assess a premium for parking in areas where transit is convenient and highly accessible (e.g., in downtown core, near universities, etc.)*
2.4.h	*Transit Repositioning—Strategies to make transit more competitive in the marketplace*
2.4.i	*Transit Pricing Incentives—To promote transit use (e.g., fare cards, discounts)*
2.4.j	*VMT/GHG Offset Requirements for Large Developments—Require developer to offset automobile emissions attributed to their development (e.g., through tree planting, open space preservation, purchasing emission credits, etc.)*
2.4.k	*Benefits for Low GHG Vehicles (preferential parking, use of HOV lanes)*
3	**Fuel Measures**
3.1	**Set a Low-GHG Fuel Standard (e.g., biodiesel, ethanol)**
3.2	**Low-GHG Fuel for State Fleets (e.g., biodiesel)**
3.3	**Low-GHG Fuel Infrastructure Development (e.g., hydrogen)**—Assess how best to facilitate the development of alternative fuel infrastructure and refueling networks through measures such as pilot projects, research and development, and incentives.
4	**Freight**
4.1	**Vehicle Technology**
4.1.a	*Vehicle Technology Improvements (e.g., aerodynamics)*
4.1.b	*Fund R&D on Low-GHG Vehicle Technology*
4.1.c	*Clean Diesel technologies to reduce Black Carbon -- Provide incentives to accelerate use of lower sulfur diesel, and to accelerate adoption of engine improvements and tailpipe control technology (e.g., particulate traps) to reduce emissions of black carbon (BC).*
4.2	**Vehicle Operation**

Transportation and Land-Use Sector GHG Reduction Opportunities		
	4.2.a	*Improve Freight Logistics e.g., through the use of GIS*
	4.2.b	*Enforce Speed Limits (thereby reducing fuel use)*
	4.2.c	*Improve load efficiency (e.g., reduce empty back-hauls, etc.)*
	4.2.d	*Encourage Anti-Idling Measures (e.g., Truck Stop Electrification, pre-clearance at scale houses, enforcement)*
	4.2 e	*Maintenance and Driver Training—To encourage more energy efficient driving habits*
4.3		**Intermodal Freight Initiatives**
	4.3.a	*Develop and fund a long-term regional infrastructure plan for rail and marine*
	4.3.b	*Remove obstacles to freight rail (e.g., raise bridges, etc.)*
	4.3.c	*Develop intermodal transfer facilities (rail-truck, rail-barge, etc.)*
	4.3 d	*Review and remove policies that disadvantage freight rail (e.g., taxes)*
4.4		**Incentives & Disincentives**
	4.4.a	*Procurement of low-GHG Fleet Vehicles—Establish incentives and initiatives to encourage acquisition of low-GHG vehicles in public, private and State fleets.*
	4.4.b	*Incentives to retire or improve older, more polluting Vehicles*
	4.4.c	*Increased Truck Tolls or Highway User Fees and target revenues to GHG reduction policies*
5		**Intercity Travel: Aviation, High Speed Rail, Bus**
5.1		**Develop and fund high-speed passenger rail (as part of a long term regional transportation plan)**
5.2		**Integrated Aviation, Rail, Bus Networks**
5.3		**Aircraft emissions—more efficient operation of the aircraft and runway management**
5.4		**Airport Ground Equipment (cleaner fuels, i.e., electric, natural gas, etc.)**
6		**Off-Road Vehicles (construction equipment, out-board motors, ATVs, etc)**
6.1		**Incentives for Purchase of Efficient Vehicles/Equipment**
6.2		**Improved Operations, Operator Training—To encourage more energy efficient operating habits**
6.3		**Maintenance Improvements—To ensure the vehicles run at peak efficiency**
6.4		**Increased Use of low-GHG vehicles**
7		**Cross Cutting Issues**
7.1		**Education**—Raise public awareness about the benefits of low-GHG travel options (e.g., hybrids, transit), including available incentives (e.g., tax credits, LEMs).
7.2		**Air Quality Benefits from GHG Plans and (e.g., State Implementation Plan (SIP) credit)**
7.3		**GHG Registry & Emissions Trading**
8		**Other**
8.1		**Provide incentives to promote local agriculture (reduce long-haul freight)**

Residential Sector GHG Reduction Opportunities		
1		**Improve EE of Appliances**
1.1		**Energy Efficiency Appliance Standards**—For appliances not covered under federal standards, the State can set minimum levels of efficiency for specific appliances.
	1.1.a	*Torchiere lamps*
	1.1.b	*Ceiling Fans*
	1.1.c	*Exit Signs*
	1.1.d	*Clothes washers*

Residential Sector GHG Reduction Opportunities		
	1.1.e	*Furnaces?*
	1.1.f	*Other (e.g., wood burning stoves)*
1.2		**Tax Incentives for EE Appliances**
1.3		**Discounts/Rebates on Energy Star Products**
1.4		**Contractor Education: Proper sizing of HVAC—**Proper sizing of air ducts and other components of heating, ventilation and air conditioning systems can significantly reduce the size and energy requirements of furnaces and air conditioning units.
1.5		**Consumer Education: Selection, Alternate appliance choices—**Educate consumers about the lifetime savings achieved over appliance lifetime by appliances that consume less energy.
1.6		**Lawn Mowers, BBQ Grills**
1.7		**Bulk Purchasing Program—**Bulk procurement can reduce the cost of energy efficient appliances or renewable technologies.
1.8		Promote Recycling (appliance)
	1.8.a	*Recycling pick-up program replacement*—Program to collect and recycle old residential appliances, rather than send them to junkyards/landfills.
	1.8.b	*Reduce secondary market for used appliances*—Create incentives for residential customers to discard old appliances when new ones are purchased, rather than selling the old appliance or running both the new and old appliance (e.g. air conditioners or refrigerators). Other states have offered a "bounty" rebate to residents who buy a new window AC unit and turn in the old unit to the state for disposal.
2		**Incentives to Technology Providers**
2.1		**R&D**
2.2		**Incentive to manufacturers (regional)**
3		*Improve EE and SD of Buildings*
3.1		**Improved Building Codes (revisit every 3 years)**—Require buildings to meet the most recent Energy Code efficiency/performance standards established by the International Code Council.
3.2		**Training (builders, code officials, architects etc.) and Enforcement of Building Codes**
3.3		**EPA Energy Star Homes**—This program provides rebates for the purchase of newly constructed homes meeting higher efficiency standards established by the U.S. EPA and DOE Energy Star Program.
3.3		**Voluntary Green Building Design Standards**—Create voluntary high efficiency and sustainable building standards (recycled material, low VOC content, low embodied energy construction materials, etc.) that builders can follow. Buildings meeting the standards can have a "seal of approval" or other type of recognition (e.g., LEED).
3.4		**Mandatory** "Green" Standards for New Construction/ Renovations
3.5		**Energy Efficiency Mortgages—**Energy Efficient Mortgages allow purchasers to borrow a larger mortgage when purchasing an Energy Star home. Energy Improvement Mortgages allow owners to borrow money for energy efficiency improvements on their homes, or to upgrade the energy efficiency of a home before purchasing.
3.6		**Financial incentives for contractors, builders, homeowners**
3.7		**Increased marketing of existing programs**
3.8		**White Roofs and Rooftop Gardens**—Reflect sunlight and shade roofs to reduce air conditioning energy requirements.
3.9		**Landscaping**—Well-planned landscaping with trees for shade and evergreens/hedges to block wind reduce a building's heating and cooling requirements.
3.10		**Education to homeowners**—Educate homeowners energy efficiency and sustainable

Residential Sector GHG Reduction Opportunities		
		design retrofits, renovations and new construction options.
4		**Improve Energy Management**
4.1		**Energy Audits**—Assess a home's energy use, and areas where energy is being wasted.
	4.1.a	*Weatherization*
	4.1.b	*Blower door testing*
4.2		**Training of Building Operators**
4.3		**Efficient Use of Oil and Gas**
	4.3.a	*Building envelope*
	4.3.b	*Heating*
	4.3.c	*DHW*
	4.3.d	*Cooking*
	4.3.e	*Pumping well water*
	4.3.f	*Fuel Switching to less carbon-intensive fuels*
	4.3.g	*"Pay as you save" program*
4.4		**Efficient Use of Electricity**
4.5		**Educate residents/ public/ children**
	4.5.a	*Marketing Programs*
	4.5.b	*Introduce in School Curriculum*
4.6		**Advanced metering**—Provides real or near real-time electricity consumption data. Combined with time-of-use rates, creates incentive for residential electricity load management and conservation.
4.7		**Load Management**—With advanced meters and time-of-use rates in place, residential electricity customers can manage their energy use to reduce consumption during peak daytime rates, thereby saving money.
4.8		**Time-of-Use (TOU) Rates**—Time-of-use rates for electricity, a market mechanism charging customers more during daytime peak periods and less during off-peak periods. Provides incentive for residential customers to save money by shifting some energy consuming tasks (such as laundry) to off-peak periods.
5		**Supply-side Measures**
5.1		**Net-metering**—Allows the electric meters of customers with generating facilities to turn backwards when the generators are producing energy in excess of the customers' demand, enables customers to use their own generation to offset their consumption over a billing period.
5.2		**Encourage Green Power Purchases**
5.3		**Encourage Clean Distributed Generation**
5.4		**Incentives for Renewable Energy Applications**
		See also "Comprehensive Programs"

Commercial Sector GHG Reduction Opportunities		
1		**Improve EE of Equipment and Appliances**
1.1		**EE Equipment and Appliance Standards**—For appliances not covered under federal standards, the State can set minimum levels of efficiency for specific appliances.
	1.1.a	*Unit heaters*
	1.1.b	*Traffic signals*
	1.1.c	*Exit signs*

Commercial Sector GHG Reduction Opportunities		
	1.1.d	*Large packaged A/C*
	1.1.e	*Refrigerators*
	1.1.f	*Freezers*
	1.1.g	*Clothes Washers*
	1.1.h	*Furnaces?*
	1.1.i	*Other*
1.2		**Tax Incentives for EE Equipment and Appliances**
1.3		**Discounts on Energy Star Products**
1.4		**Bulk Purchasing Program—**Bulk procurement can reduce the cost of energy efficient appliances or renewable technologies.
2		**EE Buildings**
2.1		**Improved Building Codes**—Require buildings to meet the most recent Energy Code efficiency/performance standards established by the International Code Council.
2.2		**Training (Builders, Code Officials, Architects etc.) and Enforcement of Building Codes**
2.3		**Voluntary Green Building Design Standards**
2.4		**"Green" Standards for New Construction/ Renovations**
	2.4.a	*Mandatory standards for State buildings*—Construction and renovations receiving any State funding should meet higher energy efficiency/performance standards.
	2.4.b	Mandatory standards for schools—Construction and renovations receiving any State funding should meet higher energy efficiency/performance standards.
2.5		**Tie school bonding to EE improvements**
2.6		**Incentive payment for green buildings—**Provide incentives for privately financed new construction and renovation to meet higher energy efficiency performance standards than standard construction.
2.7		**White Roofs and Rooftop Gardens**
2.8		**State-wide EE Goals and Reporting for Government Buildings—**A program to encourage measurement and tracking of energy consumption, strategic planning and benchmarking against other buildings.
3		**Energy Management**
3.1		**Energy Audits**
3.2		**Building Recommissioning**
3.3		**Training of Building Operators**—Training building operators in how to maximize the efficiency of their buildings will decrease energy use if operators apply what they learned.
3.4		**Efficient Use of Oil and Gas**
	3.4.a	*Building Shell*
	3.4.b	*Heating*
	3.4.c	*DHW*
3.5		**Efficient Use of Electricity**
	3.5.a	*Lighting*
	3.5.b	*A/C*
	3.5.c	*Ventilation*
	3.5.6	*Pumps/motors*
3.6		**Shared Savings Program for Government Agencies**—Allows a State agency to keep a portion of the energy savings realized when the agency makes energy efficiency improvements to a building.
3.7		**Fuel Switching to less carbon-intensive fuels—such as natural gas, biodiesel, etc.**

Commercial Sector GHG Reduction Opportunities	
3.8	**Load Management**
4	**Promote Recycling**
5	**Supply-side measures**
5.1	**Net-metering**
5.2	**Encourage Green Power Purchases**
5.3	**Encourage Clean Distributed Generation (not renewables)**
5.4	**Incentives for Renewable Energy Applications**
5.5	**Encourage Combined Heat and Power: financial incentive, removal of barriers**
	See also "Comprehensive Programs"

Industrial Sector GHG Reduction Opportunities		
1		**Industrial EE, Management, and Conservation**
1.1		**Efficient Use of Oil and Gas**
	1.1.a	*Boilers*
	1.1.b	*Upgrade to steam system*
	1.1.c	*Process-specific equipment*
	1.1.d	*Building Envelope*
1.2		**Efficient Use of Electricity**
	1.2.a	*Pumps*
	1.2.b	*Motors*
	1.2.c	*Lighting*
	1.2.d	*Cooling*
	1.2.e	*Optimization of Compressed air systems*
1.3		**EE process improvements**
1.4		**Shut-it off program (curtailment)**—Financial incentive for industrial electricity customers to cut demand during peak/emergency demand periods for the local utility.
1.5		**Energy Management Training**
1.6		**R&D of new technologies**
1.7		**Financial incentives**—Offer incentive rebates for energy efficiency improvements.
1.8		**Education**
2		*Reduction in Process Gases*
2.1		**Participate in Voluntary Industry-Government Partnerships**
2.2		**Leak Reduction Programs**
2.3		**Process Changes/ Optimization**
2.4		**Capture, Recovery and Recycling of Process Gases**
2.5		**New Equipment**
2.6		**Substitution of High GWP Gases—**Substitute high GWP gases with appropriate substitutes depending on application (e.g., CO_2, ammonia).
2.7		**Participate in Voluntary Industry-Government Partnerships**
3		*Supply Side Measures*
3.1		**Net-metering**
3.2		**Encourage Green Power Purchases**
3.3		**Encourage Clean Distributed Generation**
3.4		**Incentives for Renewable Energy Applications**

3.5	**Encourage Combined Heat and Power**—Combined heat and power is a high efficiency method of distributed generation that utilizes both the steam and electricity produced from the electricity generating process, rather than just the electricity. Efficiency can be 2-3 times that of systems not utilizing the heat produced.
4	**Other programs**
4.1	**Industrial ecology/ by-product synergy**—Programs to link the by-products from one industry with use as the feedstock for other industries.
4.2	
4.3	**Negotiated Agreements**—To promote GHG reductions in particular sectors, a state government may enter into direct voluntary or negotiated agreements with industries or industrial sectors.
4.4	**Cap and Trade**
	See also "Comprehensive Programs"

Comprehensive Programs for Residential, Commercial, and Industrial Sectors GHG Reduction	
1.1	**Mandatory Reporting of Fuel Use, GHG Emissions**
1.2	**State-wide Energy Efficiency/GHG Emission Reduction Goals**
1.3	**Government Agency Requirements and Goals**
1.4	**Public Benefit Funds—**Funds created by a surcharge on electricity, natural gas or oil sales that are used to fund demand side energy efficiency and conservation programs.
1.5	**Negotiated Agreements**
1.6	**Environmentally Friendly Procurement**
1.6.a	*Deploy new EE equipment in State buildings*
1.6.b	*Stream-line incentives to reduce up-front costs*
1.7	**Small-source aggregation**

Electricity Generation Sector GHG Reduction Opportunities	
1.0	**Renewable Energy Policies**
1.1	**Renewable Portfolio Standards (RPS)**—Renewable portfolio standards mandate a certain minimum percentage of annual electricity production or sales come from renewable energy sources. Sources of qualifying renewable energy are delineated in the legislation, as are increased percentage requirements over time. RPS policies typically include wind and solar, and may include biomass, hydrogen (produced with renewable energy), tidal and small hydroelectric generation.
1.1.a	*Green tags within regional power pool*—Green tags are certificates representing the air quality benefits of renewable power. These certificates may be sold separately from the power generated by the renewable energy source, enabling more flexible and cost-effective compliance with renewable portfolio standards.
1.2	**Renewable Energy Public Benefit Fund (PBF)/System Benefit Charge (SBC)**—States generally collect funding as a charge on electricity rates or as a lump-sum payment from utilities, and then redistribute the money to projects such as wind farms, fuel cell deployment programs, and solar energy systems.
1.3	**Wind Turbine on Farm—**Renewable providers pay farmers for rights to place wind turbines on farmland that has appropriate wind resources.
1.4	**Green Power Purchases**
1.4.a	*State Green Power Purchases*—A requirement that State government and universities meet a minimum percent of their power needs with renewable energy. The renewable energy percentage may be set to increase over time.
1.4.b	*Local and University Green Power Purchases*—see 1.5.a

Electricity Generation Sector GHG Reduction Opportunities	
1.4.c	*Green Power Marketing*—Marketing and sales of green power in the competitive marketplace, in which multiple suppliers and service offerings exist.
1.4.d	*Green Pricing*—Green pricing is an optional utility service that allows customers an opportunity to pay a premium (usually per kWh) on their electric bill to cover the extra cost of renewable energy generation and create demand for additional investment.
2.0	**Advanced Low-emitting Technologies**
2.1	**Integrated Gasification Combined Cycle (IGCC)**—Pressurizing coal to produce a mixture of carbon monoxide (CO) and hydrogen (H2), known as synthesis gas (syngas). Syngas is clean-burning (in terms of conventional pollutants). Additional processing with catalysts and separation can create a pure stream of H2 for combustion and CO_2 for capture and sequestration.
2.2	**Carbon Capture and Sequestration (CCS)**—Several technologies allow carbon dioxide to be removed from flue gases for storage in geologic formations or in the ocean.
2.3	**FutureGen**—The Federal Government's IGCC+CCS+H2 production demonstration project.
2.4	**Clean Coal Technologies**—Various new technologies that burn coal more cleanly or efficiently, reducing emissions of conventional pollutants and, in some cases, CO_2.
2.5	**Fuel Cells Incentive Policy**—Use pure hydrogen as energy, or strip hydrogen from fossil fuels. Create electricity without combustion.
2.6	**Biomass Gasification (also in Ag, Forestry, Waste)**—Pressurizing agricultural biomass to produce a synthesis gas for combustion.
2.7	**Biomass Co-firing (also in Ag, Forestry, Waste)**—Combustion of agricultural biomass and fossil fuels together.
3.0	**Other Supply Efficiency Measures**
3.1	**Repowering Old Plants**—Converting old plants to natural gas combined cycle (NGCC) or coal integrated gasification combined cycle (IGCC) technology. Both technologies have the potential to provide efficiency improvements and lower emissions per kWh. Note: this policy does not necessarily produce lower overall emissions.
3.2	**Efficiency Improvements in Existing Plants**—Upgrades to equipment or replacement of parts. Note: this policy does not necessarily produce lower overall emissions.
3.3	**Nuclear Plant Relicensing**—After the first 40 years of operation, nuclear plants can apply for license renewal to operate for up to 20 more years. Nuclear plants that do not relicense result in loss of zero/low-emission baseload generation that must be replaced by other power sources.
3.4	**Nuclear Plant Uprating**—Increasing output from an existing plant, by modifications to turbines and the steam system.
3.5	**Hydrogen**—Hydrogen is a clean burning fuel that may be produced by IGCC and other power sources. The extent to which emissions are lower depend on how it is produced.
4.0	**Distributed Generation (DG)**
4.1	**Combined Heat and Power Incentive Policy (CHP)**—Reduce barriers and implement program to increase clean CHP in the State. CHP is a high efficiency method of DG that utilizes both the steam and electricity produced by the electricity generating process, rather than just the electricity. Efficiency can be 2-3 times that of systems not utilizing the heat produced.
4.2	**Landfill Gas Recovery (also in Ag, Forestry, Waste)**—Capture the methane gas (a high global warming potential GHG that is a natural by-product of landfills) for flaring (burning to convert it to CO_2, a low global warming potential GHG) or for combusting for energy generation.
4.3	**Waste-to-Energy (also in Ag, Forestry, Waste)**—Waste-to-energy facilities produce energy through the combustion of municipal solid waste in specially designed power plants equipped with pollution control equipment to clean emissions.

Electricity Generation Sector GHG Reduction Opportunities	
5.0	**Caps, Standards and Goals**
5.1	**Cap and Trade**—Set a mandatory cap on the amount of CO_2 emitted by the electricity generation sector. Reductions in emissions below cap levels result in tradable credits. Entities polluting at levels higher than permitted by the cap are required to purchase these emission credits.
5.2	**Emission Standards**—Standards that limit emissions on an output basis. A CO_2 emission standard often limits the tons of CO_2 per kWh produced. A generation performance standard, or GPS, is an emission standard covering several pollutants in one policy/regulation, and can include CO_2.
5.3	**Carbon Intensity Targets**—A standard for emissions per unit output or per economic value of the output.
5.4	**GHG Purchase Program**
5.5	**Voluntary CO_2 Targets—**A program in which companies set their own targets and baselines and start to meet these targets. Sometimes a cap or emissions standard. Companies can choose to participate in third party programs (established by government agencies or nongovernmental organizations).
5.6	**CO_2 Tax**—A tax applied upstream to carbon content of fuels or downstream to CO_2 emissions.
6.0	**Grid and Utility Policies**
6.1	**Interconnection Rules**—Standardized rules to enable clean, distributed generation to receive authorization to connect to the local grid.
6.2	**Remove Transmission Barriers**—Transmission pricing and technical issues are often barriers to renewable and other clean distributed generation (DG), as well as power from independent power producers (IPPs)
6.3	**Remove Utility Rate Barriers**
6.4	**Transmission System Upgrading—**Improvements to the efficiency and/or reliability of the transmission system or "grid".
6.4.a	*Reduce Transmission Line Loss*—An efficiency improvement to a transmission system.
6.5	**Net Metering**—Allows the electric meters of customers with generating facilities to turn backwards when the generators are producing energy in excess of the customers' demand, enabling customers to use their own generation to offset their consumption over a billing period. Most/all basic meters are capable of doing this.
6.6	**Load Management**—Programs that create incentives for electricity customers to reduce electricity load from the utility grid in response to emergency and/or market-based price signals.
6.7	**Time-of-use Rates**—Utilities can charge higher prices during peak periods to encourage customers to shift usage to other cheaper cost periods of the day. Similar to telephone rates that vary by the period of day. Requires installation of an advanced meter that tracks consumption during each rate period.
6.8	**Real-time Pricing**—Allow utilities to charge more during the times of the day when demand is greatest—and less when demand is lower. Prices are different from hour to hour and day to day. This would give consumers an incentive to use less energy during times of peak use. Requires installation of real-time meters (a type of advanced meter).
6.9	**Advanced Metering** –In conjunction with communications systems, enables energy providers to offer their customers time-based rates with off-peak discounts, allowing consumers to save on their electricity bills by varying their demand in response to price signals. Can also help determine how much energy is required to run a specific piece of equipment. Real-time meters are a subcategory of advanced meters.
7.0	**Cross-Cutting Electricity Sector Measures**
7.1	**Public Benefit Funds (PBF)/System Benefit Charge (SBC)**—Funds created by a surcharge on electricity, natural gas or oil sales that are used to fund demand side energy efficiency,

Electricity Generation Sector GHG Reduction Opportunities	
	renewable energy, load management and conservation programs.
7.2	**Research, Development and Demonstration (RD&D)**—Policies, programs and incentives that support new research and development of renewable energy, low-emitting energy or energy efficiency technologies.
7.3	**Tax Incentives**—Funds from a state's general budget that go to renewable energy, low-emitting energy or energy efficiency technologies or production. Tax incentives are often credited on a per-kWh generated (or saved) basis.
7.4	**Offset Requirements**—Requirement to offset a given percentage of CO_2 emissions through projects that reduce emissions indirectly, such as afforestation/reforestation or new renewable energy projects.
7.5	**Registry**—Voluntary GHG emissions registry that requires participating entities to separately report direct and indirect emissions or emission reductions. Registries may be used to provide public recognition, baseline protection, and support future emissions trading regimes.
7.6	**Brownfield Re-development**—Policies to encourage or require that new power generation facilities be built on land formerly used for industrial/commercial purposes, rather than on forest or farmland.
7.7	**Environmental Disclosure**—Requirements that power providers disclose emissions on utility bills or in other public reports/venues.
7.8	**Full Cost Accounting**—Ensure that environmental impacts of power production are reflected in the cost of power.
7.9	**Public Education**—Any of a variety of methods, including public service announcements and education in schools, that make the public aware of the GHG emissions that come from fossil-fueled electricity generation and the things people can do to reduce GHG emissions.

Agriculture, Forestry, and Waste Sectors GHG Reduction Opportunities	
1	**Agriculture: Production of Fuels and Electricity**
1.1	**Ethanol production**—Incentives to grow crops and/or create ethanol (for fuel or fuel additive).
1.2	**Biodiesel production**—Incentives to grow crops and/or create biodiesel (for fuel or fuel additive).
1.3	**Install Manure Digesters**—Install anaerobic digesters to process agriculture manure into energy (e.g., heat, hot water, or electricity). Also produces digested manure, which can contain more valuable nitrogen for crop production.
1.3.a	*Use existing technologies on farms >300 cows*
1.3.b	*Use existing technologies on farms >600 cows*
1.3.c	*Install Centralized Digesters*
1.3.e	*Use newly developed technologies*
1.4	**Ag Biomass Feedstocks for Electricity**—Incentives to grow crops or use crop waste for use as a fuel or for co-firing with fossil fuels.
1.5	**On-Farm Wind Production**—Support the development of wind resources on farms (often smaller size installations than commercial wind farms).
2	**Agriculture: Fertilizer, Manure, and Livestock Management**
2.1	**Nutrient Management**—Improve efficiency of fertilizer use. A portion of nitrogen applied to the soil is subsequently emitted as N_2O (a GHG); therefore, a reduction in the quantity of fertilizer applied can reduce N_2O emissions.
2.1.a	*Reduce non-farm fertilizer use—See 2.1*
2.2	**Manure Management**—Improve the handling of manure to reduce methane and N_2O.
2.2.a	*Composting*—Compost manure instead of alternative handling techniques such as slurry or

Agriculture, Forestry, and Waste Sectors GHG Reduction Opportunities	
	stockpiling.
2.2.b	*Change feedstocks*—Alter the feed to animals to lower the manure's nitrogen levels.
2.2.c	*Install Manure Digesters*—Capture methane for use as an energy source (see 1.3 above)
2.3	**Livestock Management**—Alter livestock management practices to reduce methane and N_2O emissions.
3	**Agriculture: Soil Carbon Sequestration**—The following are some measures that increase the amount of carbon contained in soil or prevent carbon from being released from soil.
3.1	**Conservation tillage/No-till**—Practices that utilize less carbon can increase the carbon content of soil; therefore, sequestering carbon from the atmosphere.
3.2	**Reduce summer fallow**—Reducing the amount of land left fallow (vegetation free) can increase the soil carbon content and reduce N_2O emissions.
3.3	**Increase cover crops**—Increasing the use of cover crops can increase the soil carbon content and potentially increase the nitrogen content of soil and reduce fertilizer need (see 2.1).
3.4	**Improve water & nutrient use**—The water content of soil affects the potential for GHG emissions.
3.5	**Rotational grazing/Improve grazing crops**
3.6	**Converting land to grassland, forests, or wetland—**Converting farmland to other types of land can lead to increased sequestration of carbon from the atmosphere.
3.7	**Agricultural Land Preservation**—Preservation of agricultural land can retain ability of land to sequester carbon from the atmosphere.
3.7.a	*Promote "no net loss" of agricultural land*
4	**Agriculture: Energy Use**
4.1	**Conservation tillage/No-till**—Reduces farm fuel consumption and related emissions as well as increasing the amount of carbon sequestered in soil.
4.2	**Convert farm equipment from diesel to LNG (or hybrids)**
4.3	**Nutrient Reduction**—Using less fertilizer can reduce the related production, transportation, and application emissions.
4.4	**Organic Farming**—Utilizing organic farming techniques can reduce the on-farm energy uses (e.g., reduced tractor use) by reduced tillage (see 3.1) and off-farm energy (e.g., reduced transportation of fertilizer and pesticides).
4.5	**Support Local Farming/Buy Local**—Reduces emissions associated with the transport of agricultural products.
5	**Forest carbon sequestration**
5.1	**Afforestation and Reforestation (in-state)**
5.2	**Forest Management**—Forest management programs to protect the productivity of existing forest and reduce or prevent the loss of forest due to fires, storms, diseases, or pests; implementation of reduced-impact logging regimes to minimize the damage to non-harvested trees; actions to increase biomass stocks through activities such as planting, thinning, and fertilizer application; and prolonged rotation periods in harvested forests.
5.3	**Urban Forestry**—Planting urban trees to reduce the consumption of energy for heating and cooling buildings, thereby helping to avoid fossil fuel emissions in the energy sector. Also increases the carbon stock of non-forest land.
5.3.a	*Support tree planting on residential properties*
5.4	**Forest preservation**—Preservation of forestland avoids the loss of carbon sequestered in forestlands.
5.4.a	*Support "no net loss" of existing forests*
5.5	**Promote Use of Wood Products**—Durable wood products/construction sequesters carbon

Agriculture, Forestry, and Waste Sectors GHG Reduction Opportunities	
	for long periods of time, as long as the timber is produced as a result of certified sustainable harvesting practices. Wood products/construction is also much less energy-intensive than other materials.
5.5.a	*State procurement of locally grown wood products*—Incentives or requirements for State government procurement.
6	**Forestry: Energy Production**
6.1	**Forest products biomass feedstocks for electricity**—Incentives to use forest products or forest waste for use as a fuel or for co-firing with fossil fuels.
6.2	**Improve efficiency of wood burning stoves**—Using more efficient wood burning stoves can reduce the need for fuel by increasing the efficiency of burning.
7	**Landfill Gas and Waste Management**
7.1	**Landfill Methane Strategy**
7.1.a	*Flare Landfill Methane*—Combusting it turns methane (a high global-warming-potential gas) into CO_2 (a low global-warming-potential) gas.
7.1.b	*Convert Landfill Methane to Energy*—Landfills naturally create methane gas (a GHG) as a by-product. Rather than being released into the air or burned off (flared), methane can be captured and utilized as a fuel to produce energy.
7.2	**Waste Management Strategy**—The production of less municipal solid waste and or the means by which waste is handled after it is created can reduce GHG emissions.
7.2.a	*Resource Recovery Facility*—Burning waste can reduce the amount of methane generated from waste and can create a source of energy that avoids emissions from other energy sources.
7.2.b	*Recycling/Source Reduction*—Create programs to reduce the amount of waste being put in landfills and/or waste-to-energy facilities, thereby reducing the amount of methane and CO_2 generated. Also, can reduce source emissions by reducing the need for virgin materials.
8	**Wastewater Activities**
8.1	**Energy Efficiency Improvements**—Reducing the amount of energy needed for wastewater facilities.
8.2	**Lower Waste Processing Needs**—Reduce water consumption and waste production.
8.3	**Methane and Biogas Energy Programs**—Capture methane emissions from wastewater facilities for use as a fuel source.
8.3.a	*Install digesters and turbines*—Use captured methane as an energy source for turbines.
8.3.b	*Install fuel cells*—Use captured methane as a source for fuel cells.
9	**Cross-Cutting**
9.1	**Carbon Offsets from AFW Activities (in state and out of state)**—Create a program to reduce GHG emissions from sources not covered by specific recommendations from the Stakeholders and outside the State or the country (i.e., “offsets”).
9.1.a	*Offset CT carbon emissions through pasture reforestation projects in Costa Rica*

APPENDIX 6

MULTISECTOR RESOURCES AND LINKS

Available through the Center for Clean Air Policy's website, www.ccap.org. Also available at the direct links listed below.

American Farmland Trust land-use animations:

- Block Group Housing Density, Connecticut, 1960-2050. Available at: www.ccap.org/Connecticut/2003-June-09--CT-CCSD--AFT-CT-Housing-Density-1960-2050.GIF.
- Block Group Housing Density, New England, 1960-2050. Available at: www.ccap.org/Connecticut/2003-June-09--CT-CCSD--AFT-NE-Housing-Density-1960-2050.GIF.
- Block Group Housing Density, US, 1960-2050. Available at: www.ccap.org/Connecticut/2003-June-09--CT-CCSD--AFT-US-Housing-Density-1960-2050.gif.

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State of Connecticut Climate Change Web site. Available at: www.ctclimatechange.com