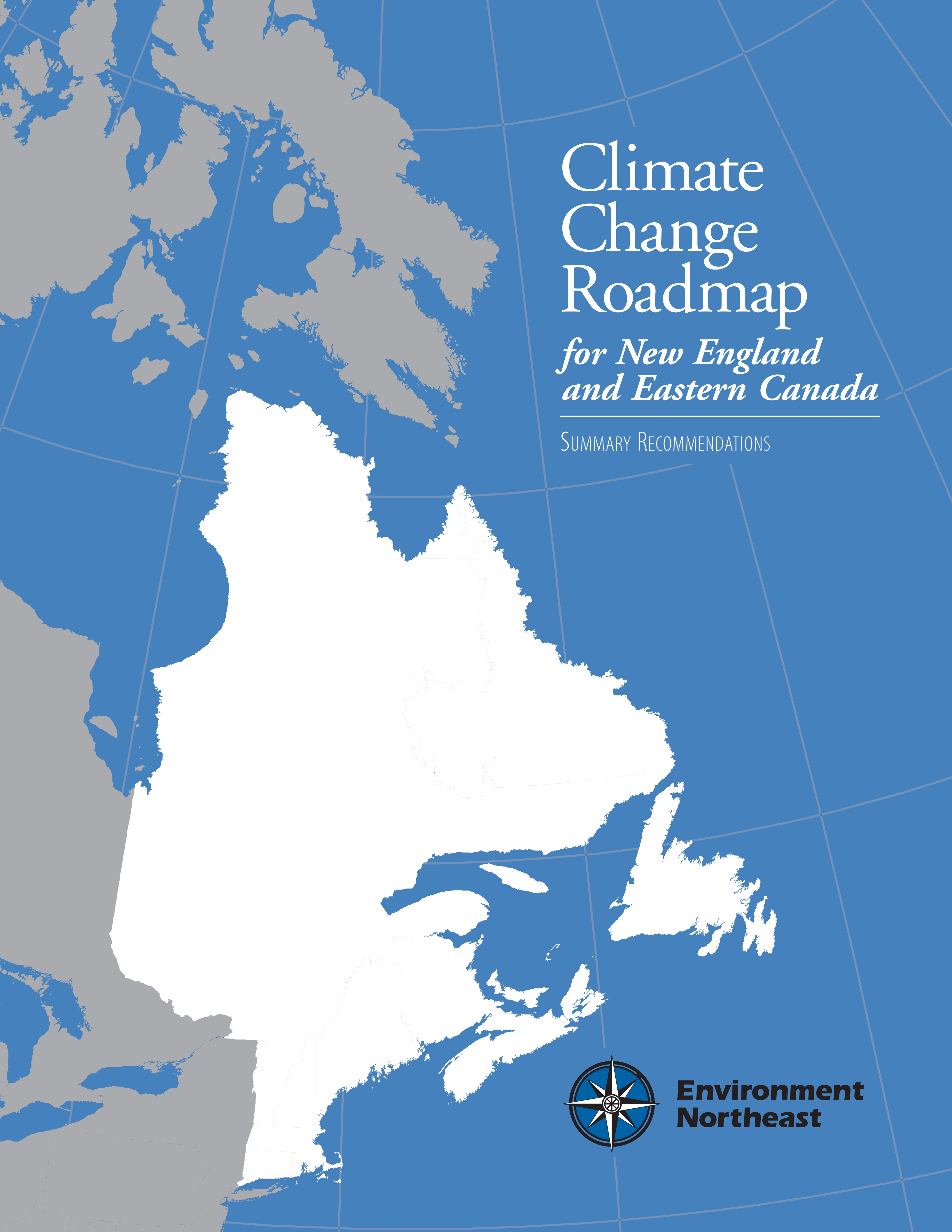
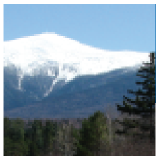


Climate Change Roadmap

for New England and Eastern Canada

SUMMARY RECOMMENDATIONS

Environment Northeast



Acknowledgments

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Environment Northeast works with a wide network of experts on matters of energy, transportation and sequestration policy. We called upon many of our friends in this network to find the most current data, share information about precedents and case studies, and review our ideas about policy recommendations. In addition to those listed above, we want to offer special thanks to Doug Baston, Ellen Baum, Joe Chaisson, Sue Coakley, Andrew deLaski, Brad Gentry, Alec Giffen, Fred Gordon, Arnulf Grubler, Howard Herzog, Lloyd Irland, Joe Kruger, Sarah Murdoch, Bill Prindle, Sarah Wade and Steve Winkleman.

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Any errors, omissions or opinions expressed in this report are the responsibility of Environment Northeast alone.

About Us

Environment Northeast is a nonprofit research and advocacy organization focusing on the Northeastern United States and Eastern Canada. Our mission is to address large-scale environmental challenges that threaten regional ecosystems, human health, or the management of significant natural resources. We use policy analysis, collaborative problem solving, and advocacy to advance the environmental and economic sustainability of the region.

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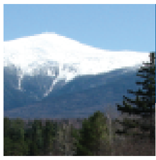

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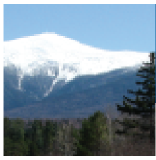


Preface

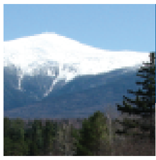
Global warming and other impacts of a changing climate are increasingly evident around the world, including in the United States and Canada. As with most complex issues, our economic and environmental future will be better served by embracing the challenge of climate change directly rather than continuing along the current path of argument, uncertainty, inaction and delay.

In 2001, the New England states and Eastern Canadian provinces provided needed leadership on the issue of climate change when the governors and premiers officially endorsed the need to work together to reduce greenhouse gas emissions throughout the region. Since issuing that resolution, states and provinces have taken some important steps toward meeting their mid-term target of reducing greenhouse gas emissions to 10% below 1990 levels in 2020 and their long-term target of 75 to 85% reductions from current levels. Many have developed climate change action plans and the region is the focus of international attention for the work undertaken to design and implement the Regional Greenhouse Gas Initiative, the first multi-state carbon cap-and-trade system proposed in North America. Yet much more must be done to put this region on the path towards meaningful emission reductions.

Environment Northeast has prepared the Climate Change Roadmap for New England and Eastern Canada to encourage and guide approaches to reducing emissions of greenhouse gas pollutants. The Summary Recommendations of the full Climate Change Roadmap are presented here. We focus on practical solutions that states and provinces can adopt now to combat climate change. The remedies we suggest are intended to help lead us towards more competitive, efficient and productive economies and improved public health.

Our hope is that the Climate Change Roadmap will serve as a valuable aide as the region navigates the path to a more sustainable and economically robust future.

Daniel L. Sosland
Executive Director



Introduction

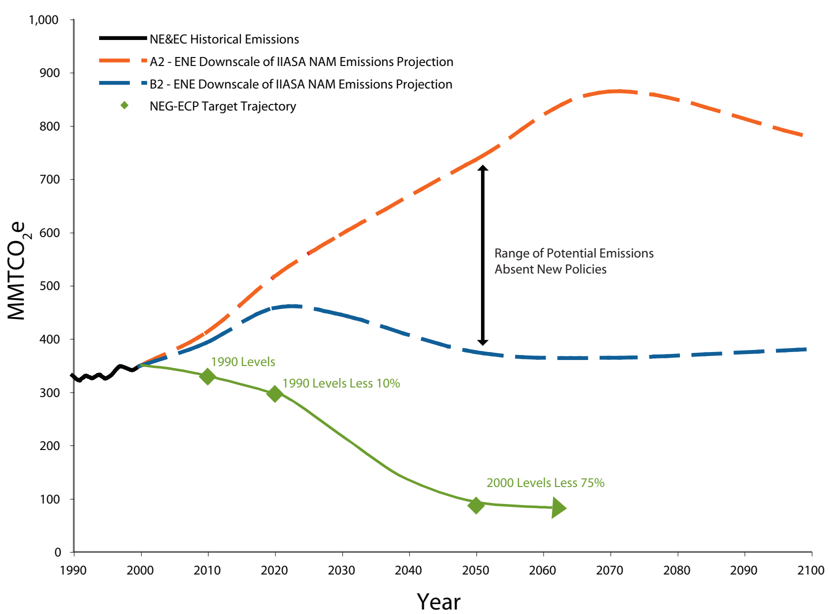
Acting collectively at the 2001 Conference of New England Governors and Eastern Canadian Premiers (NEG-ECP), the 11 states and provinces of this region (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont and New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island and Quebec) memorialized their concern about climate change. They set a near-term target of reducing greenhouse gas (GHG) emissions to 1990 levels by the year 2010, a mid-term target of reducing emissions to 10% below 1990 levels by 2020, and a long-term goal of reducing emissions by 75 to 85%.

The total emissions of GHGs inventoried from the New England and Eastern Canada (NE-EC) region in 2000 was approximately 345 million metric tons of CO_2 equivalent (MMTCO_2e). A 75% reduction from this level would result in annual emissions at 86 MMTCO_2e.

Environment Northeast has prepared the Climate Change Roadmap for New England and Eastern Canada as a guide to reaching this 75% reduction target by the year 2050. Our focus is on solutions —policies and programs that can make a significant impact and be decided and implemented by the states and provinces of the region, regardless of federal action.

The following figure presents a range of potential emissions projected to occur in the absense of new climate policies, and illustrates the emissions trajectory the region needs to be on to achieve the long-term targets. The emissions reductions necessary to meet these targets are significant and will require policy and planning changes in all sectors of the economy.

Figure 1: Projections of Business as Usual Regional Emissions versus the NEG-ECP Targets



Source: ENE analysis of IIASA/IPCC results, from Riahi, K. et al, 2006, IIASA draft paper, and personal communication with A. Grubler

Introduction

Climate Action at the State and Provincial Level

Developing and implementing climate action policies in the states and provinces offers certain advantages. States and provinces have a stronger self-interest than the federal government in promoting indigenous energy resources, making the local economy more competitive by increasing energy efficiency, and improving local air quality and human health. Advancing new or innovative policies and programs can move faster in the states than at the federal level. Regulators, politicians and the media at the state and provincial level are acutely sensitive to opportunities for new business development and improving economic competitiveness and are more responsive to the concerns of local constituents. The policy and technology changes that best promote long-term state and provincial self-interests and create new industries and jobs of the future are the same changes that will reduce GHG emissions.

Collective Action among States and Provinces

There is significant value in states and provinces acting collectively to address climate change. Cooperating on a regional level makes possible new initiatives by sharing costs and other resources that would be too great for any one jurisdiction acting alone. A regional approach is the most rational way to deal with issues that cross jurisdictional boundaries. Also, a regional approach enables market-based solutions to function in a larger marketplace, fostering greater opportunities for financial return and greater competition, driving down costs of implementing the solutions. Coordinating the development and implementation of policies that reduce GHG emissions will help to ensure uniformity of standards and procedures, improving the efficiency of doing business across state and provincial boundaries and lowering costs for businesses and consumers. It makes climate actions more affordable and politically palatable. Together, NE-EC states and provinces can implement climate change policies that will create stronger and more stable economies and position their businesses and consumers to prosper in a world where GHG emissions are dramatically reduced and widely regulated.

The Road Ahead

Our destination as a region is to emit one quarter of current GHG emission levels by 2050 while maintaining our quality of life and strengthening our state and provincial economies.

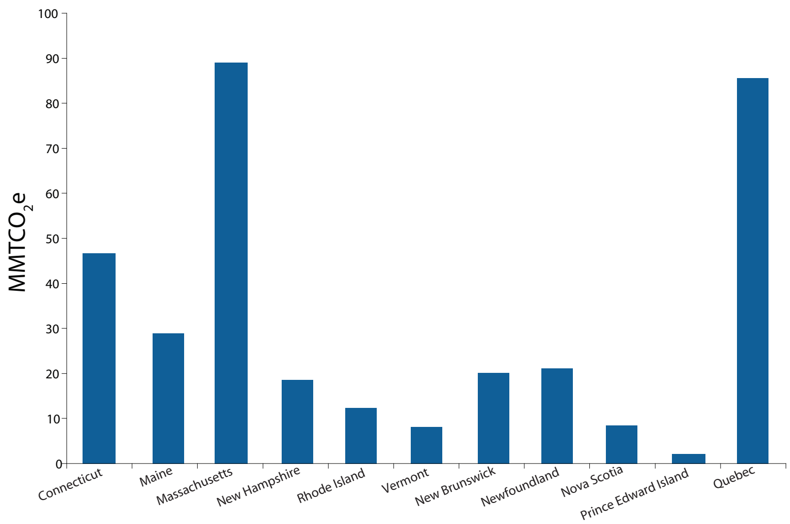
This destination is based on the modeling and analysis of the Intergovernmental Panel on Climate Change (IPCC), and from the long-term goal set out by the NEG-ECP to reduce GHGs from 2001 levels by 75 to 85%. This target is consistent with a consensus forming among governments, academics, and key stakeholders:

- We must constrain global warming to the “lowest rate feasible” in order to limit “severe disruption” to natural ecosystems that may be caused by climate change.
- IPCC modeling indicates that the lowest rate feasible would be an increase of 1^{o} to 2^{o} Celsius by the year 2100.
- The 1^{o} to 2^{o} Celsius rise corresponds with an assumed concentration of 450 parts per million (ppm) CO_2 in the atmosphere—the most optimistic projection among numerous scenarios.
- IPCC modeling indicates that keeping CO_2 concentrations at or below 450 ppm would require global CO_2 emission reductions of roughly 50% from 2001 levels by mid-century.
- To achieve the global reductions target, developed countries like the United States and Canada need to be on a path to emit approximately one-quarter of their current GHG emissions by mid-century.

Introduction

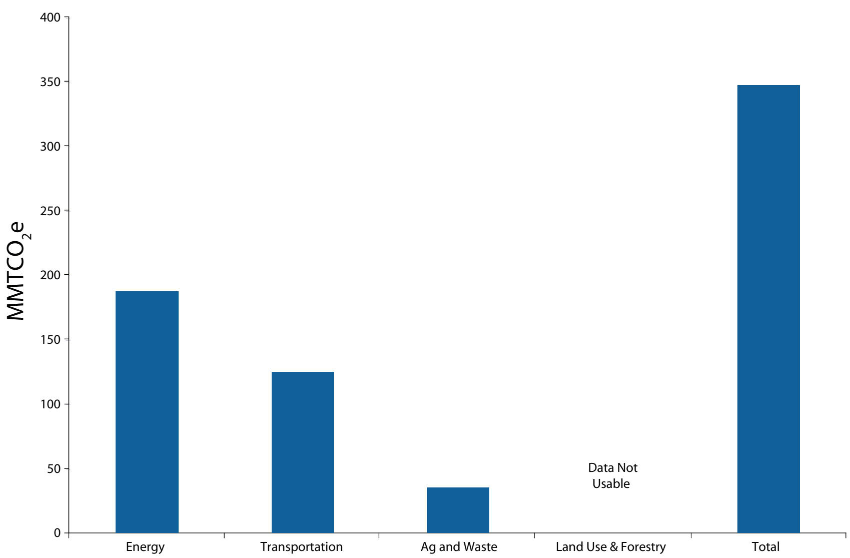
To better understand the road we will travel, we must understand our starting point. The year 2000 is our proxy for "current" levels, and is the reference point from which we propose to measure our progress going forward. From 1990 to 2000, the total GHG for the region increased from 329 to 346 MMTCO_2e, an increase of 5%.* Figures 2 and 3 present inventories of GHG emissions by state and province and by economic sector for the year 2000.

Figure 2: Annual GHG Emissions in New England and Eastern Canada, by State/Province, in 2000



Source: Eastern Canada data from Natural Resources Canada; New England data from NESCAUM and EPA State Inventory Tool.

Figure 3: Annual GHG Emissions in New England and Eastern Canada, by Sector, in 2000



Source: Eastern Canada data from Natural Resources Canada; New England data from NESCAUM and EPA State Inventory Tool.

Reaching the long-term target will be challenging, but it is achievable. It is also consistent with steps needed to keep the regional economy competitive while providing improvements in public health. It will require progress on all fronts, coming from new technology developments and changes in the policy framework. The Climate Change Roadmap identifies ten priority solutions, with 28 specific implementation recommendations, as outlined in Table 1, for reducing emissions (or increasing carbon storage) to meet the long-term targets.

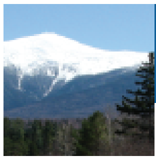
*This inventory data and these figures do not include land use inventories because the methodology for reporting land use changes is not well developed and not consistently reported between the jurisdictions.

Introduction

Table 1: Ten Priorities for Climate Change Action in New England and Eastern Canada
(priorities highlighted in blue)

		Priorities and Pathways	*ACTIONS IMPLICATED* Legislation, Regulation	Direct Financial Support, Incentives	Research, Education, Training
	Energy				
PRIORITY	1	Invest in Energy Efficiency Resources			
	1.1	Reform Utility Planning and Procurement	X		
	1.2	Establish Minimum Investment Levels for Energy Efficiency Programs	X	X	X
	1.3	Align Utility Revenue Incentives with Promotion of Efficiency	X	X	
PRIORITY	2	Increase Energy Efficiency of Buildings			
	2.1	Adopt and Enforce Latest Building Energy Codes	X		X
	2.2	Promote Use of Energy Performance Standards to Exceed Building Energy Codes	X	X	X
	2.3	Provide Operations & Maintenance Training		X	X
PRIORITY	3	Increase Energy Efficiency of Appliances			
	3.1	Set Minimum Efficiency Standards for Consumer Appliances and Equipment	X		
	3.2	Require Government Procurement of High-Efficiency Models	X		X
PRIORITY	4	Reduce Emissions from Large Stationary Sources			
	4.1	Implement a Greenhouse Gas Cap-and-Trade Program	X		
	4.2	Improve Greenhouse Gas Inventories and Registries			X
PRIORITY	5	Commercialize and Deploy No-Carbon and Low-Carbon Energy Sources			
	5.1	Commercialize and Deploy More Renewable Energy	X	X	X
	5.2	Promote Clean, High-Efficiency Fossil Electric Generation	X		X
	5.3	Improve Grid Access for Clean Distributed Generation	X		
	5.4	Establish Environmental and Safety Standards for Permitting New Power Plants	X		
	5.5	Provide Public Support for Clean Energy System Commercialization and Deployment	X	X	X
	Transportation				
PRIORITY	6	Transition to No-Carbon or Low-Carbon Transportation Fuels			
	6.1	Establish a Declining Net Greenhouse Gas Fuel Standard	X		
	6.2	Explore Pathways to Develop Low–Greenhouse Gas Biofuels in the Region	X	X	X
	6.3	Explore the Expansion of Electric Mobility Infrastructure		X	X
PRIORITY	7	Reduce Greenhouse Gas Emissions from Light-Duty Vehicles			
	7.1	Implement Emission Standards for all Light-Duty Vehicles	X		
	7.2	Improve Fuel Economy Standards in the U.S. and Canada	X		
	7.3	Reduce Vehicle Miles Traveled (VMT)	X	X	X
PRIORITY	8	Reduce Emissions from Heavy-Duty Vehicles			
	8.1	Reduce Black Carbon Emissions from In-Use Diesel Engines	X	X	
	8.2	Promote Improved Efficiency of Heavy-Duty Vehicles		X	X
	8.3	Improve the Efficiency of the Region's Freight Transportation System		X	X
	Sequestration				
PRIORITY	9	Sequester Carbon in Terrestrial Sinks			
	9.1	Improve Inventory and Accounting Tools to Better Quantify and Track Forest Carbon	X		X
	9.2	Promote Forest Management Strategies That Sequester Additional Carbon		X	X
	9.3	Minimize Carbon Loss from Land Conversion	X	X	
PRIORITY	10	Capture and Store Carbon Dioxide from Energy and Industrial Sources			
	10.1	Build a Regional Framework for Long-Term Carbon Capture and Storage	X	X	X

The numbering of priorities and pathways in Table 1 can be used to cross-reference more detailed discussion in the full Climate Change Roadmap at www.env-ne.org.



Some recommendations contemplate implementation through legislation, regulation or regulatory orders. Others are best advanced by means of financial incentives or programs to conduct additional research, education or training. Many recommendations will only succeed if there is action taken along all three paths.

Specific solutions to achieve these ten priorities are recommended based on their qualities of:

- being suitable for individual or collective action by states or provinces;
- maximizing economic savings and/or development while achieving GHG reductions;
- maximizing the use of market mechanisms and performance standards;
- building on established precedent or analogous success stories;
- reflecting the economy, legal framework, natural resources, infrastructure and culture of the region;
- addressing or achieving the largest GHG emission reductions available to the region.

Quantification of Emissions Reductions

We will succeed if we have contributions from all sectors of the economy, from all sources of GHG emissions and from all consumers of the products and services responsible for those GHG emissions. The policy recommendations described in this report cover all sectors of the economy and, if implemented together, will interact to support the common goal of reducing emissions. For instance, a cap-and-trade program for the electric sector is complemented by regulations requiring additional renewable energy, incentives for combined heat and power, and expanded investments in energy efficiency. The reductions in GHGs of these policies working together will be reflected in the overarching carbon cap regulating total emissions from the sector. In the case of the transportation sector, the GHG reductions from a requirement to reduce vehicle emissions on a tons-per-mile basis (*i.e.,* the California GHG Emission Standards for Vehicles) are heavily impacted by the number of miles vehicles are traveling (VMT) and the life-cycle emissions associated with the fuels being used. The recommended policies are designed to reinforce each other and ensure that we are using energy efficiently while reducing the emissions associated with creating that energy. It is therefore hard to accurately calculate the impacts of any single policy on total emissions without understanding how the other policies are working or being implemented.

As to whether these measures can succeed in meeting our long-term targets, we are able to provide a partial answer at this time. First, our analysis of these ten priorities suggests that by 2020, the recommended implementation pathways could reduce annual GHG emissions in the region by 35 to 40 $MMTCO_2e$ below current levels. Such reductions would meet or exceed the NEG-ECP mid-term target (of 10% below 1990 levels) and put us on the right trajectory to meet the long-term 75% reduction target.

Most emissions reductions are best calculated as a change in emissions from a business as usual trajectory. Yet, as Figure 1 shows, business as usual is also very hard to predict. Different assumptions about future scenarios deliver a very wide range of outcomes.

We know that a cap-and-trade program for the electric sector and major industrial sources, as proposed in this report, could deliver emissions reductions from business as usual levels in the range of 45 to 50 $MMTCO_2e$ by 2020. However, decisions about the actual design, sources covered, timing, and level of the cap will drive this outcome, and programs such as the proposed Regional Greenhouse Gas Initiative (RGGI) are not aggressive enough or broad enough to achieve this large a reduction without an expansion over time. Electric sector policies such as energy efficiency and requirements for additional renewables will assist in achieving the cap, and could each deliver in excess of 20 $MMTCO_2e$ if enacted on their own by 2020. Policies that promote high-efficiency fossil sources like combined heat and power would reduce emissions in the electric sector and from thermal sources and, if enacted alone, could reduce emissions by 10 to 15 $MMTCO_2e$ by 2020. Programs to increase energy efficiency from the natural gas and fuel oil sectors could add another 5 and 6 $MMTCO_2e$ of reductions, respectively.

The transportation sector policies also interact with each other in significant ways and we have not attempted to quantify the potential emissions reductions associated with changes in development patterns and driving habits. A fuels standard that would reduce the net life-cycle GHG emissions from transportation fuels could reduce emissions by 3 to 4 $MMTCO_2e$ by 2020. The California GHG Emission Standards for Vehicles, which require reductions in emissions on a tons per mile basis, could achieve reductions around 16 $MMTCO_2e$ by 2020. These estimates assume that all states and provinces enact the recommended policies.

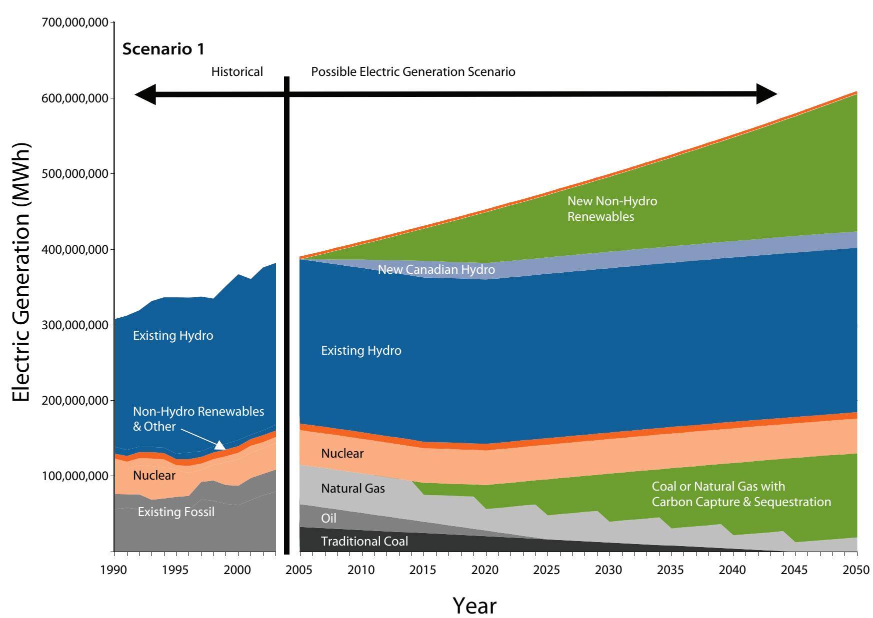
Modeling Assessment and Energy & Emissions Scenarios

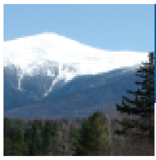
Comprehensive, economy-wide modeling (showing all the interactions of individual recommendations) would be required to assess the full long-term impacts of the suite of polices discussed in the ten priorities, but is not within scope of this report.

By way of illustration, we are able to generate hypothetical scenarios of how the electric sector might change, and how electric sector GHG emissions would be impacted, if we assume the implementation of certain new policies and market responses. In the full report of the Climate Change Roadmap, we present five representative scenarios for the electric sector. Each of the five scenarios meets or exceeds the emissions targets while varying assumptions about energy consumption and technology mixes that would be driven by the policies recommended in the Climate Change Roadmap.

Figure 4 represents one such scenario, illustrating what could happen if electric sector energy consumption continued growing. In order to achieve the long-term GHG targets with this level of energy consumption, tremendous quantities of new renewable energy generation and new fossil generation with CO_2 capture and sequestration must be added every year through 2050.

Figure 4: Electric Sector Supply—Roadmap Scenario 1

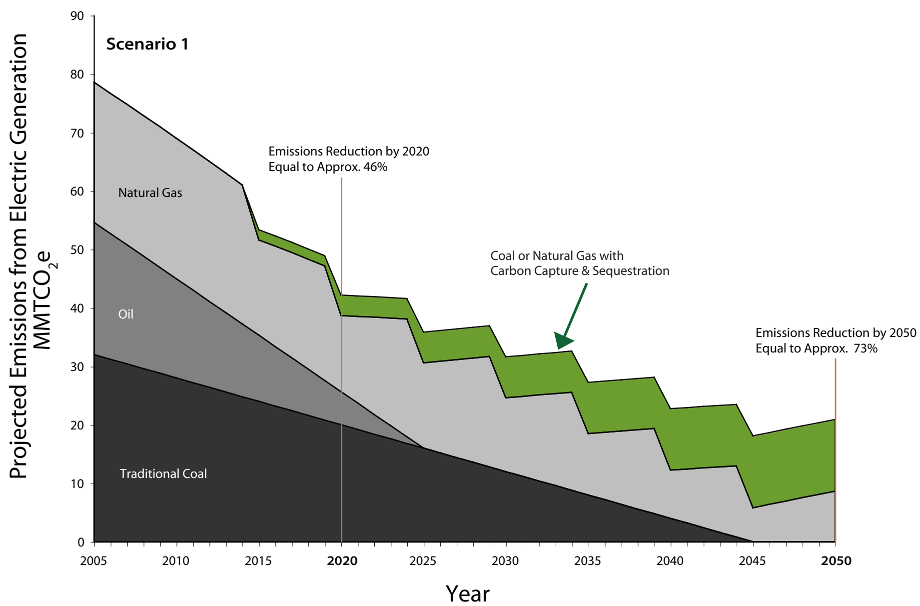




Specific assumptions factored into this scenario are that: (1) electric load grows at a rate of 1.0% per year through 2050; (2) new renewables increase by 1% per year to 15% in 2020, then increase by 0.25% per year for a total increase of 22.5% in 2050; (3) regional output of hydro increases by 10% due to Hydro-Quebec expansion plans; (4) existing hydro output remains constant; (5) existing nuclear capacity is replaced with the same quantity of new nuclear capacity; (6) natural gas makes up the difference between other sources and electric load (demand); (7) oil-fired generation is phased out over 20 years; (8) traditional coal generation is phased out over 40 years; (9) new coal or natural gas with carbon capture and sequestration adds 2,500 MW every five years starting in 2015.

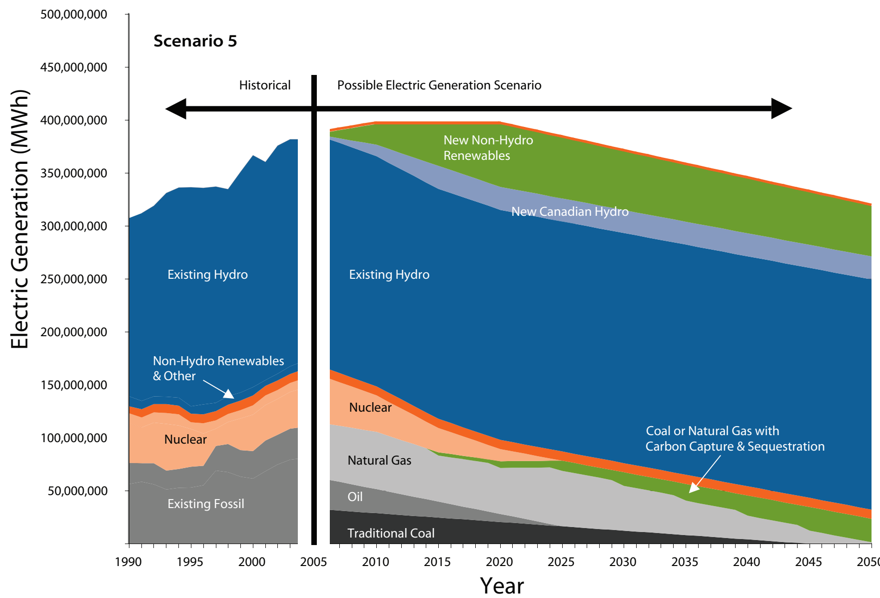
The resulting electric consumption and energy supply mix would deliver emissions associated with the remaining fossil fuel generation, as shown in Figure 6. (Note: certain other energy sources, such as hydro and other renewables, may have GHG emissions associated with them that are not included here.)

Figure 5: Projected Emissions—Roadmap Scenario 1



An alternative scenario, presented in Figure 6, illustrates what would happen if we assume that the region enacts policies to significantly increase the efficiency with which we consume electricity. We expect this level of demand reduction would be achieved at a financial savings to the region and assume the main drivers would be improvements in electrical equipment, building design and construction practices. This scenario does not assume significant behavioral changes.

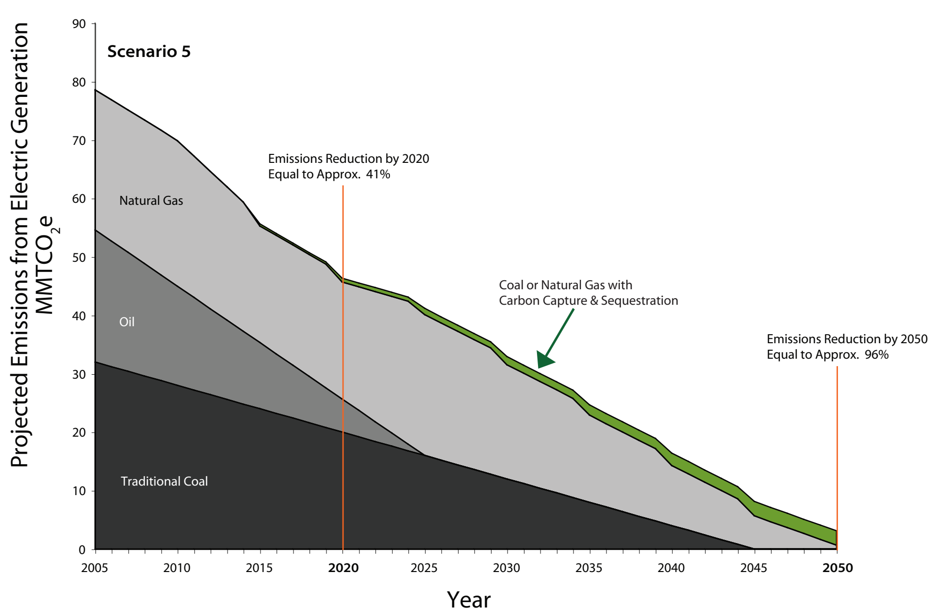
Figure 6: Electric Sector Supply—Roadmap Scenario 5

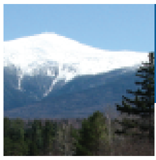


Specific assumptions factored into this scenario are that: (1) electric load stabilizes between 2010 and 2020 and declines from 0% to 20% between 2020 and 2050; (2) new renewables increase by 1% per year and then hold constant at 15% from 2020 on; (3) regional output of hydro increases by 10% due to Hydro-Quebec expansion plans; (4) existing hydro output remains constant; (5) existing nuclear is phased out over 20 years; (6) natural gas makes up the difference between other sources and electric load (demand); (7) oil-fired generation is phased out over 20 years; (8) traditional coal generation is phased out over 40 years; (9) new coal or natural gas with carbon capture and sequestration adds 500 MW every five years starting in 2015.

The resulting electric consumption and energy supply mix would deliver the following emissions from fossil fuel generation, as shown in Figure 7.

Figure 7: Projected Emissions—Roadmap Scenario 5





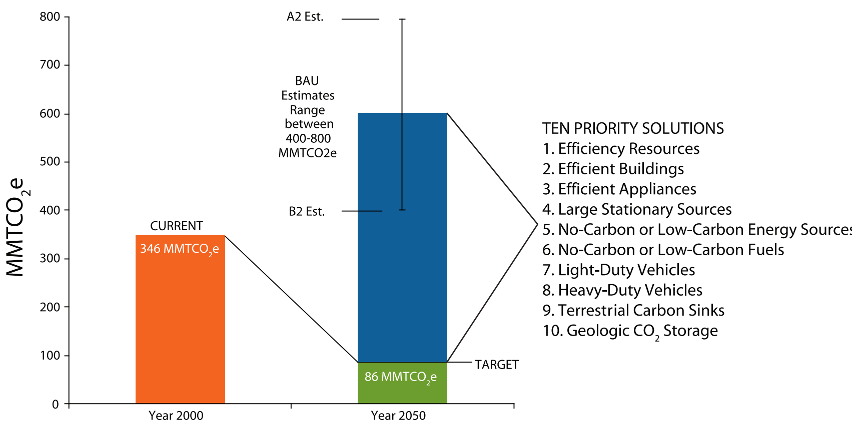
Introduction

The key finding from these scenarios is that energy efficiency and reduced load growth are absolutely critical to achieving GHG emissions targets. With aggressive energy efficiency policies and programs, the region can achieve deep reductions in emissions relying on modest levels of new renewables, some natural gas, and small quantities of coal or natural gas that incorporate carbon capture and sequestration.

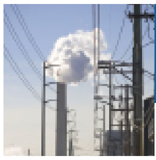
In all cases, emissions drop quickly in the early years due to energy efficiency gains and deployment of renewables. However, if renewable projects are developed on a slightly delayed timeline, long-term emissions reduction targets can still be achieved. These scenarios also imply that the electric system is well integrated across boundaries and grids, and that existing hydro power from Canada would provide an important portion of the total supply mix.

Figure 8 illustrates the relative magnitude of the challenge, including how current (Year 2000) emissions compare both to 2050 emission levels under a 75% reduction target and to a range of business as usual (BAU) scenarios. It also indicates where our ten priority solutions for climate action will deliver these 75% GHG reductions.

Figure 8: Regional GHG Emissions Levels—Current, Target, and Estimated Business as Usual Range



The full presentation of the Climate Change Roadmap, available at www.env-ne.org, analyzes the region's major sources of GHG emissions, discusses the rationale for certain policy and program solutions, and provides detailed descriptions and examples of implementation pathways. It concludes that this region can meet its mid-term and long-term GHG emission targets by adopting and implementing policy changes at the state and provincial level. We present here the Summary Recommendations, highlighting the main features of the ten priority solutions and the implementation pathways for states and provinces in the region. We hope that the Climate Change Roadmap will help chart a course forward and foster a robust discussion. The next step is providing policy makers, stakeholders and the media in the region sufficient information about climate change solutions to point us in the right direction and to compel us, individually and collectively, to take action.



Energy

Under the heading of Energy, we identify the most promising opportunities to reduce greenhouse gases from stationary energy sources in the region. Stationary energy sources include electric power plants, industrial boilers, plus heating and cooling systems for commercial buildings and residential homes.

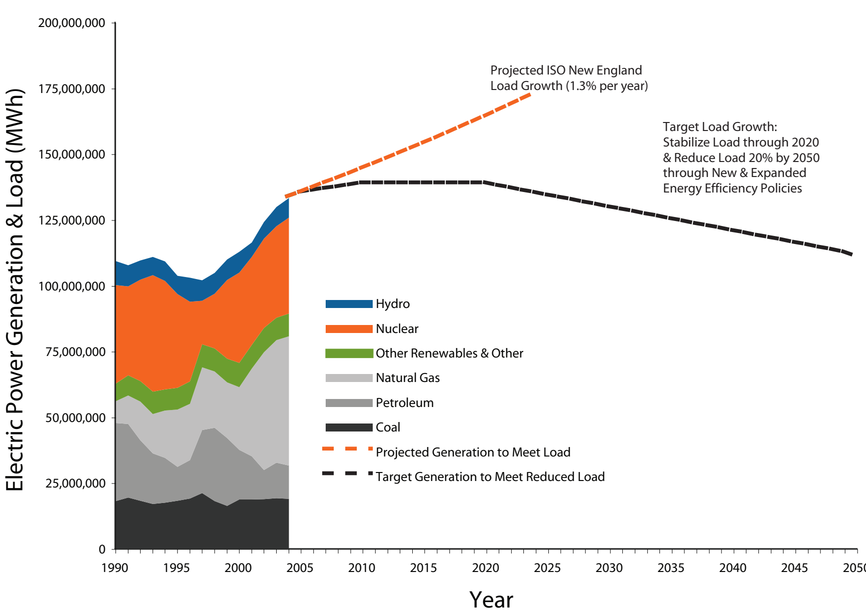
Stationary energy applications are responsible for more than half of the total GHGs emitted in New England and the Eastern Canadian provinces. One-third of this comes from electric power generation, and the remaining two-thirds is emitted during the combustion of oil, natural gas, coal or biomass used to heat and cool homes and businesses and for industrial uses.

Data on the electric generation in the region (without factoring in exports and imports) suggests that New England is making and consuming roughly 130 million megawatt-hours (MWh) of electricity per year, and the Eastern Canadian provinces are making and consuming approximately 250 million MWh per year.

The following figures show the amount of low-carbon and no-carbon generation coming from hydro, other renewable resources and nuclear power compared to the relatively high-carbon emitters such as natural gas, petroleum (oil) and coal (indicated as Combustion or Steam types in the Canadian data), and also reflect the targets of reduced consumption we think achievable over the coming decades.

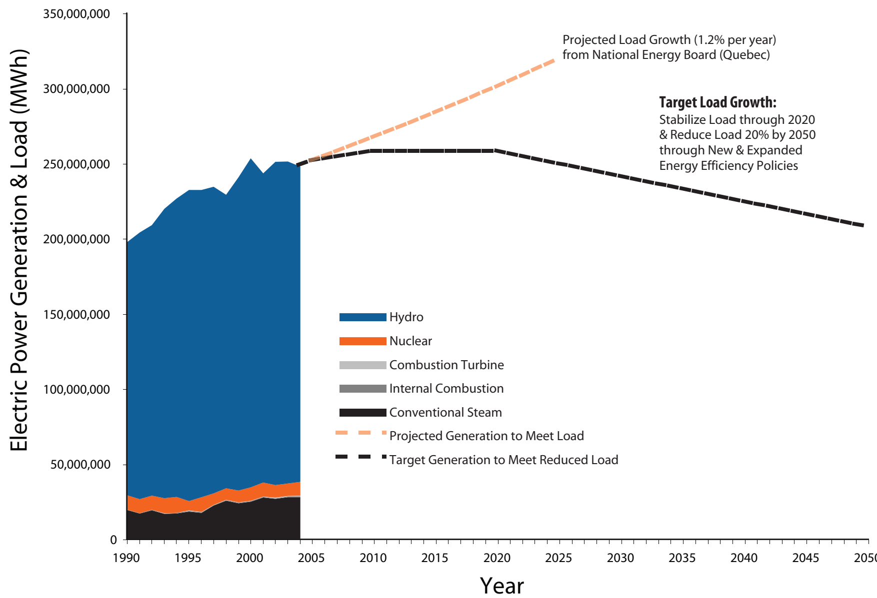
We rely on numerous studies about the region's potential cost-effective energy efficiency to support the proposition that states and provinces in the region can keep local economies growing and maintain their quality of life while keeping the amount of electric energy they consume ("load") constant for most of the next decade. This is called "zero load growth." We further believe it is feasible to reduce this load a bit more every year from 2020 through 2050. This leveling and then gradual reduction in load growth is shown by the black dotted line in Figures 9 and 10. If we do not find a way to increase the efficiency with which we use electricity, the load is projected to grow as shown with the red dotted lines.

Figure 9: New England Electric Power Consumption Targets



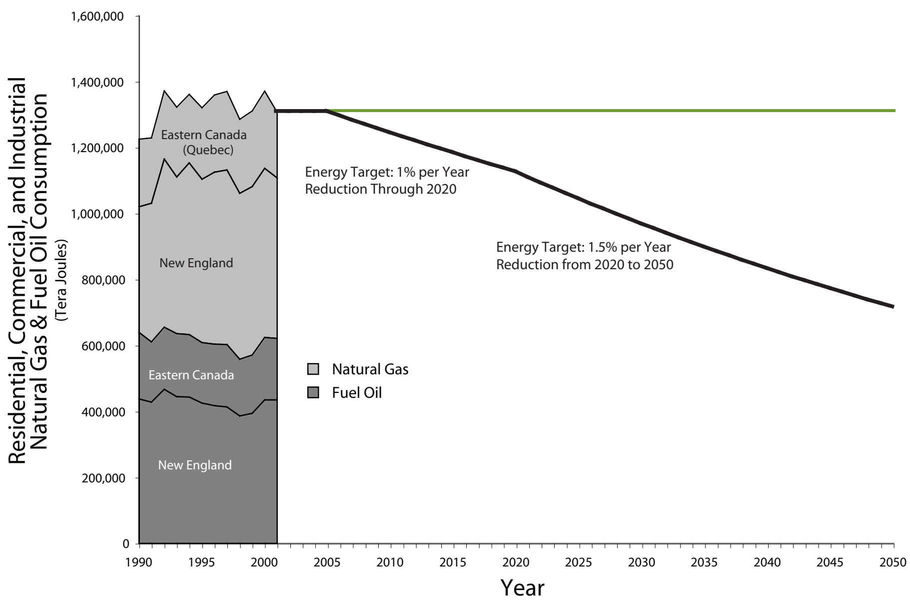
Source: Historic generation, EIA. Note: generation assumed to be equal to load, which does not account for imports, exports, and line losses

Figure 10: Eastern Canadian Electric Power Consumption Targets



Source: Historic Generation, Statistics Canada. Note: generation assumed to be equal to load, which does not account for imports, exports, and line losses

Figure 11: New England & Eastern Canadian Energy Consumption Targets for Natural Gas and Fuel Oil in the Residential, Commercial, and Industrial Sectors

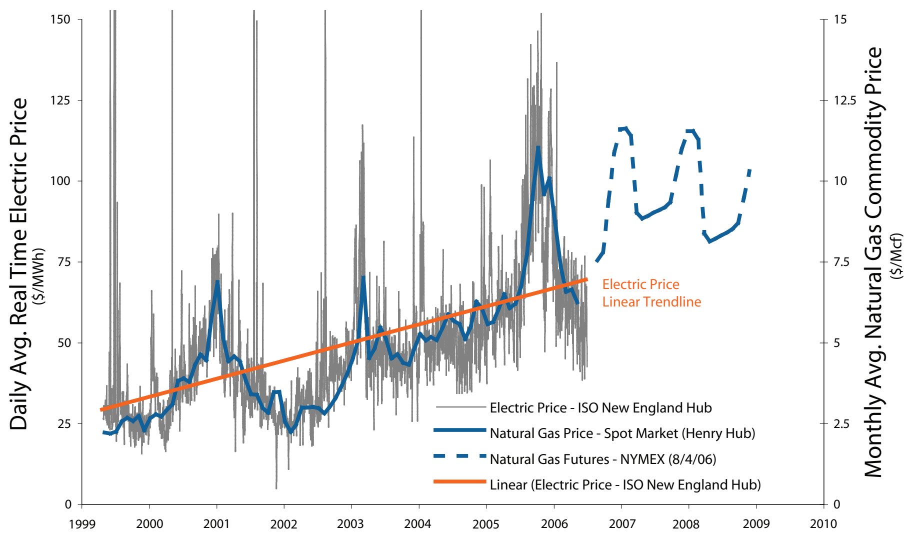


Source: Eastern Canada data from Statistics Canada, Canada Energy Consumption database; New England data from EIA Energy Consumption database.

As Figure 11 illustrates, for most of the past decade the region has consumed approximately 1.3 million tera joules of natural gas and fuel oil each year for heating, cooling and manufacturing in the residential, commercial and industrial sectors. (A tera joule is 1 trillion joules, or the equivalent of about 275 MWh). This figure also plots a target for reducing this consumption by 1% per year until 2020, and then by a further 1.5% per year from 2020 to 2050.

We have confidence that these consumption targets are achievable because as energy prices rise, the cost savings for energy efficiency also rise, making efficiency policies and efficiency products and services more popular and cost-effective. The cost trends in Figure 12 show that we are in the midst of a steady climb in energy prices. Similar price increases can be shown for home heating oil and other fossil fuels.

Figure 12: New England Natural Gas Commodity Costs and Wholesale Electric Prices



Sources: Electric—ISO-New England; ECP (prior to February 2003) and Real Time Hub LMP (March 2003 until present). Natural gas—EIA and NYMEX.

By mid-century, we must have an energy system that is cleaner and lower cost than the one we rely upon today. It must also improve our standard of living while using much less energy to get the job done. Our goal for 2050 is to develop a system of energy supply and demand that emits just one-quarter of the amount of GHG currently emitted from the energy sector. Absent some very compelling reason, every energy-related policy, program, investment or procurement decision should advance this goal. We have confidence that this goal is achievable.

First, there has not been a better time in recent history to motivate businesses, politicians and regulators to promote energy efficiency and clean energy alternatives. The economics of the energy efficiency measures we propose here save money for participating consumers and utility ratepayers collectively, and keep that money in the local economy where it can be reinvested.

Second, high and volatile energy prices, together with over-dependence on imported energy, are strong motivators for us to increase local energy supplies.

Third, the solutions that allow us to capture this opportunity are increasingly well defined. For example, numerous studies have explored the potential and mechanics for implementing energy efficiency programs. Some of these programs have been operating for more than a decade, have demonstrated cost-effectiveness, and have shed light on how they could be improved.

Fourth, many of the solutions now available to us rely on emerging energy technology that has matured in the last decade. From wind energy to carbon capture and sequestration, from LED lights to 90% efficient furnaces, from hybrid cars to biofuels, we see advances in technology and commercial enterprise that are poised to succeed in the new paradigm of energy costs.

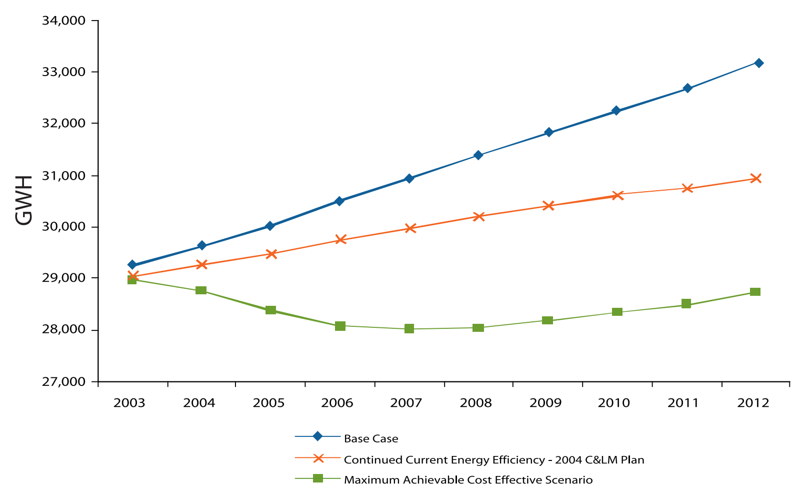
Finally, in the coming years it is likely that a regulatory framework will be implemented to place a diminishing cap on the total allowable emissions from some or all parts of the energy sector. Canada's planning for participation in Kyoto has contemplated carbon regulation through the Large Final Emitter (LFE) program, and most of the New England states have adopted a memorandum of understanding on the implementation of a cap-and-trade system known as the Regional Greenhouse Gas Initiative (RGGI). Prudent planning for businesses, stakeholders and policy makers must consider the financial and investment choices such a framework requires and factor this into their long range planning. A system that regulates carbon emissions from large energy sources will provide economic signals to increase energy efficiency and commercialize cleaner energy supplies over time.

As compelling as these factors are, it is clear that there are certain market failures, consumer behavior patterns and policies that create disincentives to modernize our energy systems. The cost and impacts of our current GHG emissions are not factored into energy polices and planning processes. To meet regional GHG targets and capture the associated co-benefits, we must turn from "business as usual" to start a more concerted, strategic commitment to produce cleaner energy and to use it more efficiently. After review of the "best energy practices" from inside and outside the region and consideration of the specific characteristics of the energy system in New England and Eastern Canada, we identified the following climate action priorities for the energy sector: (1) invest in energy efficiency resources; (2) increase energy efficiency of buildings; (3) increase energy efficiency of appliances and commercial equipment; (4) reduce emissions from large stationary sources; and, (5) commercialize and deploy no-carbon and low-carbon energy sources. These priorities and our recommendations for achieving them are summarized here.

Invest in Energy Efficiency Resources

Investing in energy efficiency will not only dramatically reduce emissions but will also make our energy system less expensive to operate. Zero load growth in the electricity sector is our recommended target for the NE-EC region in the near-term. We should aim to reach this target early in the next decade, and maintain it through at least 2020. We also discuss ways to increase investment levels in efficient use of natural gas and fuel oil and reduce the consumption of these fuels by 1% per year.

Figure 13: Connecticut Zero Load Growth with Maximum Achievable Cost Effective Efficiency

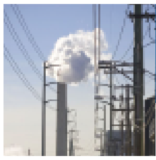


Source: GDS Associates, Inc.

The region should make these investments for multiple reasons, as they will:

- strengthen our economies;
- assist businesses and consumers by lowering energy system costs;
- create jobs;
- produce, in a cost-effective way, substantial GHG emissions reductions and improvements in air quality.

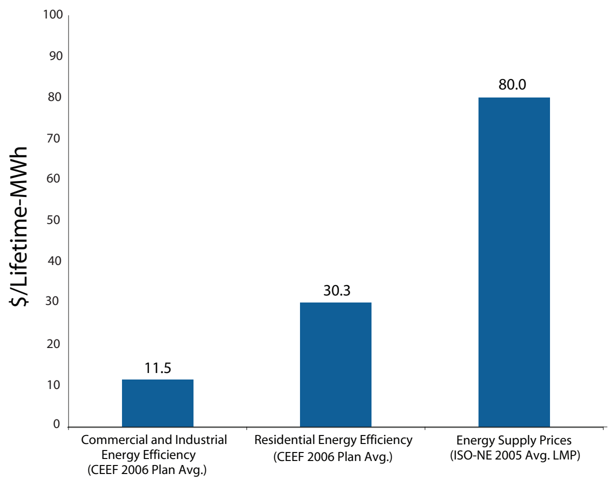
Our vision for investing in energy efficiency includes the following actions: (1) reform utility planning and procurement; (2) establish minimum investment levels for energy efficiency programs; and, (3) align utility revenue incentives with promotion of efficiency.



Reform Utility Planning and Procurement

We recommend that utilities be required to procure all energy efficiency and conservation resources that are available at or below the prices bid for conventional supply or capacity. The general rule should be to meet future capacity and energy needs at least-cost to the economy and the environment. A procurement planning requirement should apply to utilities and providers of last resort in both the electric and natural gas markets. In June 2006, Rhode Island adopted such a least-cost procurement requirement for supplying Standard Offer electricity customers.

Figure 14: Electric Supply Costs vs. Efficiency Investment Costs



Source: CEEF (CL&P & UI) 2006 Plan for efficiency; ISO New England 2005 Annual Markets Report for supply.

Electricity generation from the New England spot market averaged $80/MWh in 2005. By comparison, reductions in energy consumption through existing state efficiency programs in the region costs between $9 and $40 per MWh, a fraction of the cost of conventional electric energy supply. Similar cost advantages exist for energy efficiency in the natural gas markets, and large opportunities are emerging for energy efficiency and other demand side measures to compete in the new capacity markets. Maine and Connecticut have passed laws allowing demand side measures to compete with other sources to satisfy statutory capacity obligations.

Utilities should be required to engage in a planning process for the customers they serve and procure all cost-effective energy efficiency where it is available at a lower cost than supply resources. Energy efficiency should be identified as a first-priority resource in direct competition with supply options. The planning process should lead to the design and selection of a portfolio of resources to minimize financial and environmental risk for their customers.

Example: California Loading Order

"The loading order identifies energy efficiency and demand response as the State's preferred means of meeting growing energy needs. After cost-effective efficiency and demand response, the state relies on renewable sources of power and distributed generation, including combined heat and power applications. To the extent efficiency, demand response, renewable resources, and distributed generation are unable to satisfy increasing energy and capacity needs, clean and efficient fossil-fired generation is supported."[1] This policy, now codified in statute by SB 1037 (Kehoe)(2005), has been used by the Public Utilities Commission to give direction to the state's large utilities regarding their selection of resources to meet customers' energy needs.

Establish Minimum Investment Levels for Energy Efficiency Programs

Each state and province should establish programs to build markets for energy efficiency products and services and capture key cost-saving and GHG reduction opportunities. We recommend establishing minimum and sustained investment funding levels (or increasing existing funding) for programs in each state and province to ensure that a minimum of 2% of total customer spending goes towards energy efficiency.

Well managed funds set a floor for market penetration of efficiency products and services. Many northeastern states established ratepayer funded energy efficiency funds in recent years. These funds collect a small surcharge on ratepayer bills of 1-3% and then reinvest the money in efficiency programs for residential, commercial, industrial and government customers. Lessons drawn from experience with these funds include:

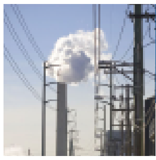
- Well run efficiency funds produce very large benefits, typically returning $2 of value for every $1 invested, (and closer to $3-6 of value per dollar invested in the most successful programs).
- There is tremendous demand for efficiency programs. Many well run programs are oversubscribed, meaning the demand cannot be addressed with current funding levels. This indicates that the services of quality programs, such as incentives to cover the incremental cost of more efficient products or new building design, educational materials tied to investment action, and training, are addressing barriers that exist in the marketplace.
- Successful programs require thoughtful oversight and access to expert advice. Two primary models have been shown to work well: (i) utility administration under regulatory oversight, influenced by a consumer and environmental stakeholder board or (ii) a dedicated efficiency agency.

These spending levels would be supplemented through a least-cost procurement planning process and considered a minimum or "floor" on efficiency investments, resulting in the following investment levels:

	Electricity	Natural Gas	Fuel Oil
Start-up Base Investment	1.5 mills/kWh ($0.0015/kWh)	1.5 cents/Therm ($0.015/Therm)	2 cents/gallon ($0.02/gallon)
Sustained Minimum Investment	3 mills/kWh ($0.003/kWh)	3 cents/Therm ($0.03/Therm)	5 cents/ gallon ($0.05/gallon)

Example: Financial and Climate Benefits of Connecticut Efficiency Programs

The 2005 results of the Connecticut electricity Conservation and Load Management Fund which, using a fund generated by 3 mills/kWh, saved $550 million and 2.7 million tons of CO_2 (lifetime) with its one-year investment of $82,000,000.



Align Utility Revenue Incentives with Promotion of Efficiency

It is time to reform approaches to utility revenue so that incentives are aligned with promoting energy efficiency. Jurisdictions in the region should reform revenue mechanisms that discriminate against energy efficiency. The best approach to accomplish this is to decouple revenues from sales through the adoption of a full sales adjustment clause.

The present formula for compensating utilities for delivery services ties their revenues (and earnings) to the quantity of electricity or gas used by consumers. This sends the wrong economic signal to the utilities with regard to increasing energy efficiency and conservation and reducing greenhouse gas emissions.

Increase Energy Efficiency of Buildings

Understanding buildings—how they are designed, constructed, maintained, financed, and regulated—is critically important to finding the best opportunities for reducing energy consumption and associated GHG emissions. The opportunities are ample, considering:

- The built environment is responsible for 48% of U.S. energy use.
- By 2035, approximately 75% of the United States' aging building stock will be replaced or undergo major renovation.
- The average lifespan of these new or renovated buildings is 50-100 years.
- Best practices in building design and construction techniques now make it cost-effective to design and build new buildings that consume 50% less energy than those built to the latest code.

We recommend three actions to increase the energy efficiency of buildings: (1) adopt and enforce the latest building energy codes; (2) promote use of energy performance standards to exceed building energy codes; and, (3) provide operations and maintenance training.

Adopt and Enforce Latest Building Energy Codes

To maximize savings through the use of building energy codes in the NE-EC region, states and provinces should take the following steps:

- promote uniformity and predictability for code inspectors and building contractors by adopting the latest model codes of the International Energy Conservation Code (IECC) in every jurisdiction and making them mandatory for new construction and major renovations;
- adopt policies in each jurisdiction that automatically update and make effective the latest applicable IECC no later than six months after it is adopted and formally published;
- establish a new inspection mechanism dedicated to energy code compliance (separate from "life safety" inspections) and provide a self-sufficient revenue stream through building permit fees;
- focus on compliance training and technical assistance for inspectors and builders.

The IECC model energy codes for residential and commercial buildings are revised every three years (and occasionally updated with supplements). Of the six New England states, only two are up to date in adopting the 2003 model energy codes for residential buildings, and only three are up to date in adopting the 2003 model energy code for commercial buildings. Canadian provinces choose whether to make the federal model building energy codes mandatory in their jurisdictions, but no provinces in the region have done so. The latest model code update for residential buildings was released for 2006, and the next model code for commercial buildings is expected to be released in 2007.

Compliance with building energy codes is poor. For example, 59% of all New Hampshire communities have no local official prepared to deal with residential or commercial code compliance. According to U.S. Department of Energy reports, it is not uncommon to find more than one-third of new buildings failing to meet local energy code requirements.

Minimum building energy code upgrades and enforcement should be considered a first step towards a longer-term goal of much more aggressive energy performance standards for buildings.

Example: Washington State Energy Inspection Program

In 1994, Washington State adopted a private energy inspector program that requires a certified energy inspector to do a plan review before construction begins and then a subsequent site inspection. Fees for the inspection are based on building size. Local governments choose either their own trained and certified municipal inspectors or select a private energy inspector that is trained and certified by the state. Energy inspectors often become part of the building design and construction team which helps to ensure buildings comply with energy codes in a cost-effective manner.

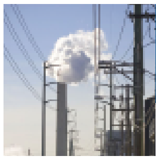
During the past 15 years, building energy codes adopted in various U.S. states have delivered energy savings worth more than $7.4 billion. The Lawrence Berkeley National Laboratory estimates that by updating building codes between 2010 and 2030, as much as 2.2 quads and 3.0 quads can be saved in the U.S. residential and commercial sectors respectively.

Table 2: State and Provincial Building Code Status and Targets

	Residential Today	Commercial Today	Target Residential and Commercial Code for 2007
CT	2003 IECC	2003 IECC	2006 IECC
ME	No Mandatory State Code	2003 IECC/ASHRAE 2001	
MA	1995 MEC	2003 IECC/ASHRAE 1999	
NH	2000 IECC	2003 IECC/ASHRAE 1999	
RI	2003 IECC	2003 IECC/ASHRAE 2001	
VT	2000 IECC	2000 IECC/ASHRAE 1999	
NB	No Mandatory Energy Code	No Mandatory Energy Code	
NFL	No Mandatory Energy Code	No Mandatory Energy Code	
NS	No Mandatory Energy Code	No Mandatory Energy Code	
PEI	No Mandatory Energy Code	No Mandatory Energy Code	
QC	No Mandatory Energy Code	No Mandatory Energy Code	

Promote Use of Energy Performance Standards to Exceed Building Energy Codes

States and provinces should encourage construction of new buildings and major renovations to go above and beyond minimum efficiency levels reflected in building energy codes. This can be accomplished by shifting the focus from meeting codes to use of higher Energy Performance Standards (EPS).



First, we recommend establishing a mandatory EPS for all new construction and major renovations of publicly funded buildings. The EPS for publicly funded construction should be set initially at a target of 30% more energy efficient than the reference case, as the U.S. federal government has done, until 2010, and then move to a higher target of 50% better than the reference case. There are multiple models for determining the reference case, such as setting it at the average new construction efficiency for the region, by building type, or setting it at the level of the latest building energy efficiency code.

Second, we encourage jurisdictions to establish EPS targets and promote their voluntary use in private sector construction and major renovations. A tiered system, setting increasing levels of energy efficiency performance (better than the reference case), could be supported by a tiered rebate system. Building permit fees can generate revenues to pay for the rebates as well as the code inspection. Completion of the final inspection would be rewarded with a small rebate. Certified achievement of increasing tiers of EPS would be rewarded with proportionately larger rebates. Some portion of the building permit fee could be used to train more building energy inspectors and builders to participate in this incentive program.

Efficiency Vermont, a statewide provider of energy efficiency services, estimates that an initial investment in comprehensive energy design for a new commercial building will cost $2–3 per square foot and deliver $0.40 to $1 in cost savings each year. Assuming flat energy prices and discounting the savings, the initial investment in applying high-performance efficiency measures to new construction should be paid back in four years.

Example: High-Efficiency New Construction at Vermont Law School

The new Oakes Hall at Vermont Law School uses 80% less energy for heating and 50% less electricity than the adjacent library building (of comparable size) that was constructed just a few years earlier. This savings was achieved through the use of energy efficient T-8 fluorescent lights with occupancy sensors, structural insulated panels in the walls and roof containing expanded polystyrene (6 inches in the walls, 9 inches in the roof), triple glazed, low-e windows and a heat-recovery system. There was no net increase in initial construction cost due to the energy performance and environmental design.

Provide Operations and Maintenance Training

Each jurisdiction should expand training programs for facility managers so that energy efficient operations and maintenance are widely practiced. States and provinces in the region should implement policies to bring training to facility managers in 100% of publicly owned or operated buildings by the year 2010 and 50% of all privately owned or operated commercial, institutional or industrial buildings by 2015. Industry experts estimate that improved building operations and maintenance (O&M) can deliver between 5% and 20% lower annual utility bills and that these improvements can be achieved at costs that are paid back in less than two years.

Increase Energy Efficiency of Appliances and Commercial Equipment

In this section, we identify and discuss the opportunity to save money for consumers, businesses and government and reduce GHGs at the same time by promoting the purchase of higher efficiency appliances and other energy consuming equipment. Our specific recommendations toward this end are to: (1) set minimum efficiency standards for consumer appliances and equipment; and, (2) require government procurement of high-efficiency models.

Set Minimum Efficiency Standards for Consumer Appliances and Equipment

We recommend that every jurisdiction in the region establish, at an appropriate government agency, the authority to set minimum energy efficiency standards for prescribed energy-using products. New Brunswick, Connecticut and California are examples of jurisdictions that have established such authority.

We further recommend that jurisdictions move ahead in the near-term to establish or update efficiency standards for 11 products, notably including residential furnaces and boilers. By 2020, new minimum standards on these products are projected to save, just in the six New England states, nearly 2 million megawatt-hours of electricity, 500 metric tons of carbon and hundreds of millions of dollars.

Table 3: Sum of Projected Benefits for Efficiency Standards in Six New England States

	2020				2030
	Energy Savings	Summer Peak Capacity Reduction	Value of Bill Savings*	Carbon Reductions	Net Present Value**
Products	**GWh [Million CF]**	**MW**	**$Million**	**1000 MT**	**$Million (2005$)**
Bottle-type water dispensers	13.0	1.8	1.6	2.9	14.0
Commercial boilers ***	[248]	NA	3.2	4.2	35.5
Commercial hot food holding cabinets	18.5	6.1	2.2	4.1	17.4
Compact audio products	88.8	12.3	11.8	19.5	116.3
DVD players and recorders	12.9	1.8	1.7	2.8	14.6
Liquid-immersed distribution transformers	420.5	58.0	50.3	92.2	564.7
Medium voltage dry-type distribution transformers	25.8	3.6	3.1	5.7	36.4
Metal halide lamp fixtures	444.4	145.4	53.1	97.5	584.7
Residential furnaces and residential boilers***, ****	365.2 [2,305.2]	15.8 NA	112.4	154.8	1,240.1
State-regulated incandescent reflector lamps	285.3	70.4	34.1	62.6	342.0
Walk-in refrigerators and freezers	259.9	60.5	31.1	57.0	242.0
Total	**1,934.2**	**375.5**	**304.6**	**503.1**	**3,207.9**
[natural gas]	[2,553.2]				

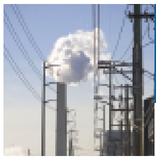
*Value of bill savings is based on energy savings and average state energy prices. This value does not take account of the incremental cost of more efficient products.

** Net present value is the total monetary value of bill savings achieved by products sold under the standards between now and 230 minus the total incremental product.

*** Commercial boilers, and residential boilers and furnaces save natural gas. Gas savings are expressed in cubic feet and enclosed in brackets to distinguish them from electricity savings.

****Residential furnaces and boilers include both natural gas and oil furnaces and boilers as well as furnace fans. Annual savings per unit, incremental cost per unit and pay back period shown here are just for gas furnaces and furnace fans, which are the most common of these products. For these calculations, gas furnace values are enclosed in brackets and listed below furnace fan values.

Source: Nadel, deLaski, *Leading the Way II,* 2006



Implementation of federal standards has achieved massive energy savings and improved product performance without relying on financial incentives from public funds. Yet the federal governments of both the U.S. and Canada have been slow to add to the list of prescribed products and update the standards; on average, it has taken the U.S. DOE eight years to complete rulemakings for prescribed products. States and provinces should lead the way in establishing these standards through a coordinated process.

Table 4: Comparison of Existing Federal Standards with Recommended Standards

Equipment Type	Federal Standards in US and Canada (AFUE)	Recommended State/Provincial Standard
Natural gas and propane furnaces (residential size)	78%	90%
Natural gas and propane hot water boilers	80%	84%
Oil-fired furnaces	78%	83%
Oil-fired hot water boilers	80%	84%
Gas and propane steam boilers	75%	82%
Oil-fired steam boilers	80%	82%
Furnace fan efficiency	none	Electricity use must not exceed 2% of overall furnace site energy use

Source: Nadel, deLaski, *Leading the Way* II, 2006

Require Government Procurement of High-Efficiency Models

State and provincial agencies should adopt the provisions of Section 104 of the new U.S. Energy Policy Act of 2005 and apply it as broadly as possible to publicly funded purchases of appliances and equipment. Section 104 requires U.S. federal agencies to procure Energy Star products or "a product that is designated under the Federal Energy Management Program of the Department of Energy as being among the highest 25% of equivalent products for energy efficiency." It should be mandatory that such products are purchased unless it can be shown by the purchasing officer that the qualifying product would not work adequately or would not be cost-effective, considering energy savings over the life of the product.

Establishing minimum efficiency requirements within the procurement policies governing the use of public dollars is one more way to help transform the markets for more efficient products. It is common for state governments in New England to establish procurement policies that encourage or require agencies to buy Environmentally Preferable Products (EPP). Examples of products that could be added to these EPP policies are refrigerators, furnaces and boilers, air conditioners, lighting, computers and copiers.

Energy

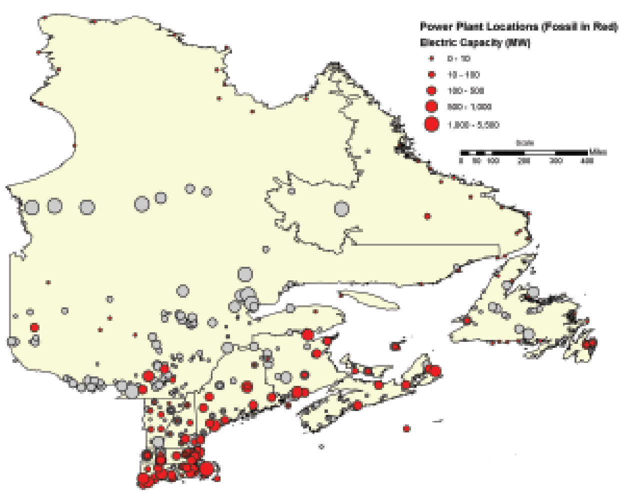
Reduce Emissions from Large Stationary Sources

Large stationary sources of GHG emissions, such as electric generation power plants, are relatively few in number and contribute a very large share of the emissions from all energy sources. These large sources are generally well suited for regulation under market based programs such as a GHG cap-and-trade program. To establish a regulatory framework with which to reduce emissions from large stationary sources, we encourage states and provinces to: (1) implement a GHG cap-and-trade program and (2) improve GHG inventories and registries.

Implement a Greenhouse Gas Cap-and-Trade Program

Cap-and-trade programs, or "tradable emissions" policies, have been adopted and proven successful in reducing or eliminating lead in gasoline, ozone-depleting chemicals (such as chlorofluorocarbons, or CFCs), nitrogen oxides (NO_x) and sulfur dioxide (SO_2). A cap-and-trade program to reduce GHG emissions is currently in operation in the Europe Union and is in the process of being implemented in a limited form by most New England states (Regional Greenhouse Gas Initiative or RGGI). Implementing such programs in New England and Eastern Canada could have significant environmental and economic benefits for the region.

Figure 15: Power Plant Locations

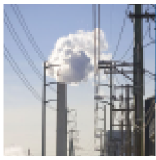


Data Sources: U.S. States. EPA E-Grid. Canadian Provinces, Statistics Canada, Electric Power Generating Stations 2000

A major benefit of the cap-and-trade policy tool is that it provides the market incentives to ensure GHG targets are achieved in the most cost-effective way. The market will identify the lowest cost technologies and reward them accordingly.

In the near term, we recommend the states and provinces work aggressively to implement the carbon cap-and-trade programs that are currently being discussed in both countries. In New England, this means finalizing the rules for RGGI and adopting and implementing RGGI in all six states by 2009. In Canada, it means convincing the federal government to move forward with implementation of an improved Large Final Emitters (LFE) program, or if that fails, exploring establishment of a parallel program to RGGI and/or linking up to RGGI.

Also in the near-term, improvements should be advocated in the program designs in both the LFE and RGGI programs. Notably, the LFE program (or whatever replaces it) in Canada should institute a hard cap, long-term targets, and improvements to the price control mechanisms by avoiding the safety valve mechanism as originally proposed. The RGGI program design should also devise a



mechanism to handle electricity imported from outside participating states (or provinces).

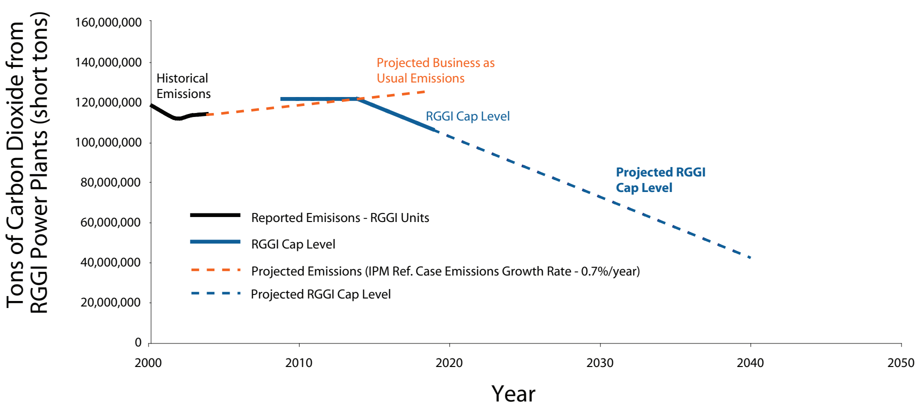
Over the longer term, all jurisdictions in the region will need to expand and improve the cap-and-trade system so that market mechanisms, efficiency, flexibility and fairness are the chief characteristics of our efforts to meet climate objectives. Design features that should ultimately be worked into a long-term GHG cap-and-trade system include:

- regulating all facilities that have capacity to emit over 40,000 tons of CO_2e GHG emissions per year;
- regulating all GHGs officially recognized by the UN Framework Convention on Climate Change as global warming gases;
- setting the cap level to decline from current levels to approximately 75% below current emissions by mid-century (2050);
- distributing allowances by auction to the maximum extent possible;
- allowing a limited quantity of high-quality offsets pursuant to rules and protocols developed by a standing committee of experts, stakeholders, and officials (recognizing that as a matter of policy, most emission reductions in the cap-and-trade system should come from covered facilities operating under the cap, while emissions from other sectors should principally be addressed with their own policies).

As presently conceived, the RGGI program would hold power plant emissions of CO_2 at about 120 million tons for the Northeast U.S. from 2009 until 2014. It would then reduce emissions by 2.5% each year from 2015 through 2018, for a total 10% reduction from the starting point. These reductions, and the potential for further reductions on the same trajectory into the future, are illustrated below.

Ultimately, early regional action is recommended on both sides of the Canada-U.S. border to allow time for learning and increased competitiveness prior to the implementation of federal policies. Regions with cleaner emissions profiles will be more competitive than regions with dirtier profiles once national and/or international programs are implemented.

Figure 16: RGGI Emissions and Cap Levels over Time



Source: RGGI state working group data on regulated facilities; reference case modeling run; and MOU cap levels. Historical emissions from RGGI power plants are over 6% above current emissions but the long-term rate of cap decline should reduce emissions significantly.

Improve GHG Inventories and Registries

Detailed state and provincial inventory data on total GHG emissions by each sector of the economy should be collected annually. The data should be made available to the public on an annual basis. With the exception of land use and forestry emissions, inventory methods are well established and the states and provinces must simply make a practice of reporting regularly and increasing accessibility of data.

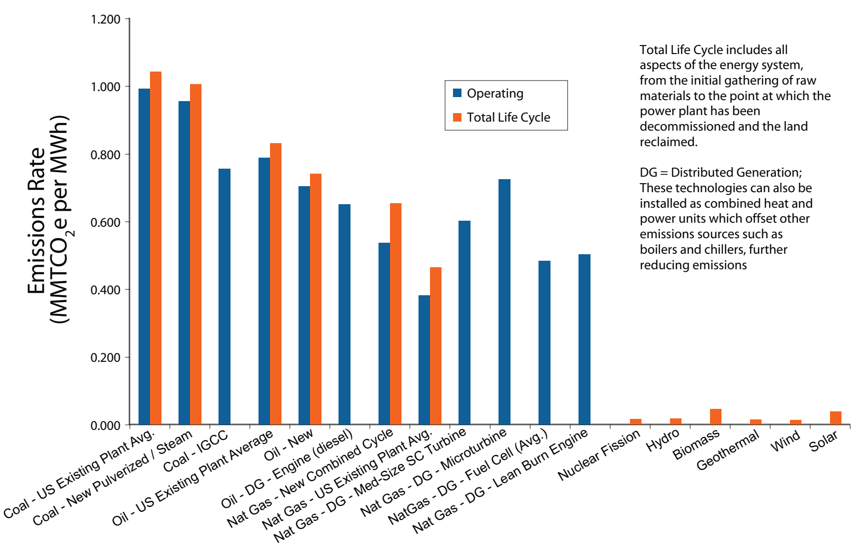
We also recommend that policy makers adopt a comprehensive system to accommodate reporting from specific sources and projects (*e.g.,* voluntary reporting, mandatory reporting, and offsets). The opportunity exists to coordinate the development of a registry across many jurisdictions, from the Northeast U.S., to the Midwest and West, to Canada and/or the Eastern Canadian provinces and this is beginning with the development of the Eastern Climate Registry through Northeast States for Coordinated Air Use Management (NESCAUM). The registry should strive for a high level of standardization regionally and nationally and maximum transparency and accessibility.

The registry should accommodate mandatory reporting from all large stationary sources of GHG emissions in order to allow for the design of high quality cap-and-trade programs.

Commercialize and Deploy No-Carbon and Low-Carbon Energy Sources

In order to achieve 75% GHG reductions from large stationary emitters, the NE-EC region will need to commercialize and deploy energy made from resources that emit little or no GHGs. At the same time, we must avoid building new, long-lasting energy sources that are uncompetitive under a scenario in which carbon emissions are regulated or are otherwise incompatible with long range GHG emission targets and sound environmental policy. Figure 17 illustrates the wide range of GHG emissions for different combinations of fuel types and technologies used in generating electricity.

Figure 17: Comparison of Emissions Rates for Electric Generation Technologies



Sources: Meier et al, 2005; Rubin et al, 2004; and Bluestein, 2003

Figure 18 gives a sense of how much electricity generation each jurisdiction in the region currently receives by type of supply. States or provinces having relatively more coal and oil in their mix will have more work to reach climate change targets than those having more no-carbon and low-carbon supply, although regional trading programs will allow states and provinces to share costs and investment opportunities.

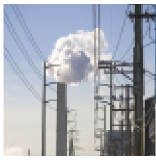
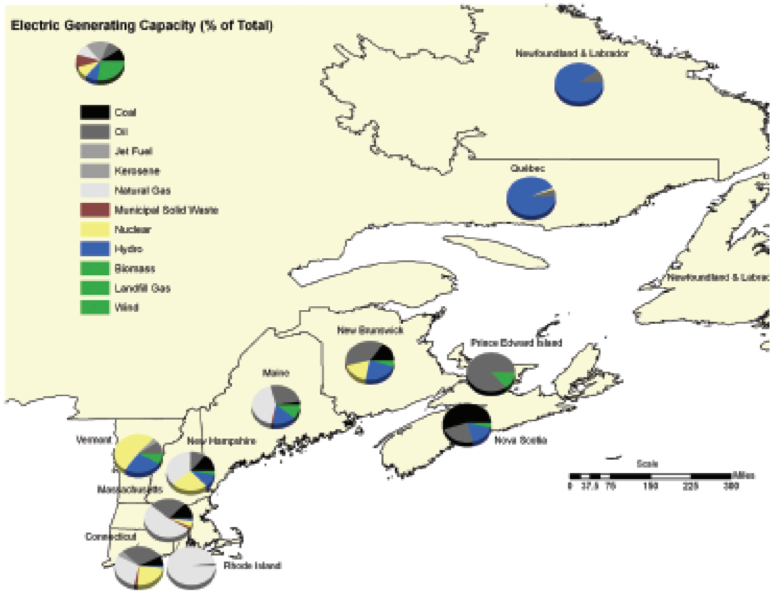


Figure 18: Total Electric Generating Capacity by Fuel Type



Data Sources: U.S. States—EIA Form 860, 2004. Canadian Provinces—Statistics Canada, Electric Power Generating Stations, 2000; Canadian Wind Energy Association.

To commercialize and deploy no-carbon and low-carbon energy sources, we recommend that states and provinces: (1) commercialize and deploy more renewable energy; (2) promote clean, high-efficiency fossil electric generation; (3) improve grid access for clean distributed generation; (4) establish environmental and safety standards for permitting new power plants; and, (5) provide public support for clean energy system commercialization and deployment.

Commercialize and Deploy More Renewable Energy

We recommend setting the Renewable Portfolio Standard or other minimum renewable energy requirements at percentages of electricity load equal to 5% by 2010, 10% by 2015, and 15% by 2020. Technologies eligible for the RPS should only be renewables that are non-commercial or still facing significant market barriers to development at the time facilities are built (we count wind in this category). Using competitive long-term contracts (in the range of 10 years) to purchase renewable power will provide renewable energy developers with the financial certainty needed to obtain investment capital and should be encouraged through the RPS or procurement requirement.

States and provinces must also take steps to address siting of new renewable energy projects. We recommend, for all renewable types, consideration of the general guidelines put forth by the U.S. National Wind Coordinating Committee. These guidelines suggest that the siting application process be characterized by:

- significant public involvement to ensure transparency;
- reasonable time frames in which the application is reviewed and a final decision is made;
- clear decision criteria for siting which (1) list all the factors to be considered in the decision, (2) specify how the factors are to be weighed against one another and (3) set minimum requirements to be met by the project;
- streamlining so that there is maximum coordination between agencies;
- expedited judicial review process;
- advance assessments by siting agencies of preferable geographic locations.

Energy

There is a tremendous renewable energy resource available in the NE-EC region. Modeling indicates that based on cost alone, more than 12,000 MW of new on-shore and off-shore wind would be financially viable New England. Quebec has directed that 3,000 MW of new wind be built, and the Maritime Provinces collectively have established targets or renewable portfolio standards that are already leading to new, sizeable wind projects. The challenge is less about commercializing this technology than about contracting and siting.

Promote Clean, High-Efficiency Fossil Electric Generation

Systems that generate both electricity and useful thermal energy are known as combined heat and power (CHP) (also sometimes referred to as co-generation). CHP systems can achieve efficiencies in the range of 60-90%, while average fossil electric generation efficiency is in the range of 30-40%.

We recommend that states and provinces create additional incentives and mandates for expanded deployment of CHP. They should consider implementing a CHP portfolio standard. Developing and implementing CHP porfolio standards, like those for renewable energy, ideally entails:

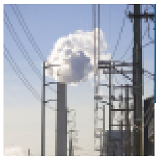
- commissioning a study to determine the market potential for CHP systems in each jurisdiction and using the results to set portfolio requirements;
- increasing the portfolio standard over time, possibly starting in the range of 10% of total load in 2015 and then rising to 15% or more by 2020;
- applying the portfolio standard to all load serving entities;
- making only new CHP facilities eligible to meet the standard;
- setting minimum efficiency levels to ensure energy savings and environmental benefits, with a starting point of 75-80% efficiency that is increased over time to drive innovation and technology improvements.

Large CHP systems should be regulated for GHG emissions under a cap-and-trade system, and smaller systems should be subject to minimum permitting standards for air emissions set by each state that should become stricter over time. Market-based requirements, such as a portfolio standard, would enable regulators and distribution companies to add CHP to the system at low cost as the technology is increasingly cost-effective.

The commercial sector alone has the potential for adding nearly 4,000 MW of new capacity in New England. This represents approximately 13% of New England's total electric capacity. The potential market capacity for added CHP at industrial locations is also significant.

Improve Grid Access for Clean Distributed Generation

Policies and regulations related to the connection of distributed generation to the electricity grid should be improved to promote clean distributed generation. First, we recommend that each jurisdiction ensure clear, consistent, and streamlined procedures for connecting new energy resources to the grid. Second, we recommend reducing or eliminating standby rates for customers with on-site energy resources. If standby rates are retained, they should be based on reasonable assumptions associated with demand for back-up power. Third, electric distribution utilities should be required to provide "net-metering." Net-metering allows on-site generators to sell excess electricity to the grid and to purchase it back when there is a deficit. The limit on net-metering should be raised to 2 MW, so long as it is sized to meet on-site demand and satisfies all interconnection requirements.



Distributed energy resources such as clean and efficient fossil plants, renewable generation, and energy storage technologies place energy sources closer to end users, they reduce the need for expansion of the transmission and distribution grid, and often cut back on the operation of older, dirtier peaking power plants. All of these features help reduce costs and GHG emissions.

Establish Environmental and Safety Standards for Permitting New Power Plants

In this recommendation, we discuss the opportunities and policy tools related to the siting and permitting of new coal, nuclear, biomass and hydro electric power plants in the region.

Coal. The extremely high rate of GHG emissions from coal fired power plants and their 30–50 year lifespan indicate that building new conventional coal fired power plants in the region is completely inconsistent with achieving near and long-term climate change targets. A sensible goal to reflect this point is to ensure that net emissions from all coal fired power plants in the region do not increase over time. We expect carbon cap-and-trade systems to reduce the risk of increasing the region's carbon budget by discouraging new, long-lived, high-emitting plants. Nonetheless, it is prudent to develop permitting rules for possible new coal plants, especially in cases where there is no carbon cap or until such a program is up and running. To prevent these plants from going forward and burdening electricity customers with a legacy of financial liability for carbon costs, coal plant siting or emission rules should incorporate the following restrictions prior to granting a permit or awarding a procurement contract to supply utility (or default service) load:

- A New Coal Unit—must meet or exceed the emissions rate for a natural gas combined cycle power plant from commencement of operation.
- A Coal Unit Re-powered, Refurbished or Replacing an Existing Coal Unit—must demonstrate the legal, technical and economic likelihood that it will achieve, within 10 years of becoming operational, a CO_2 emissions rate equivalent to the emission profile of an Integrated Gasification Combined Cycle (IGCC) unit employing carbon dioxide capture and storage. Demonstration must be specific as to expected locations and economics of CO_2 transportation and storage. Replacement units must not commence operation until an equivalent or greater capacity of old unit(s) ceases operation.
- Existing and New Coal Units—should have permit requirements or fall under emissions control programs that severely limit emissions of sulfur dioxides, nitrogen oxides, and mercury and also require proper handling and disposal of solid and other facility waste.

We also recommend establishing incentives and support for the research, commercialization and deployment of CO_2 capture, transportation, and storage technologies in the region.

Nuclear power. States and provinces should refuse to offer public subsidies or special policy treatment that would give nuclear power a competitive advantage over alternative resources. At the present time, high costs together with the unresolved issues surrounding health impacts, security, and disposal of radioactive waste make developing new nuclear generation unviable. Existing nuclear power plants can and should be phased out as their licenses expire, with their generating capacity replaced primarily by increased investments in energy efficiency and renewables, and some new fossil with carbon capture and sequestration.

Biomass. Biomass power plants have the potential to serve as indigenous sources of sustainable energy supply that may be considered carbon neutral when certain prerequisites are met. To achieve carbon neutrality, these prerequisites include:

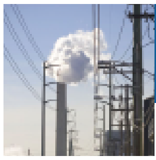
- disqualifying unsustainably harvested biomass and contaminated waste streams such as demolition waste;
- establishing sustainable land management and harvest requirements associated with natural resource and carbon preservation such as certification for forests (*e.g.,* Forest Stewardship Council) or best management practices for agriculture;
- setting best practice air emissions standards for biomass production and combustion;
- establishing waste disposal requirements.

Hydroelectric Power. States and provinces should develop emissions factors for hydro projects and report these emissions in regional and national emissions inventories. Regulatory review and approval of existing and new dams should follow the recommendations laid out by the World Commission on Dams. It is important that any hydropower (re)licensing process recognize the fact that reservoirs for dams can be responsible for significant GHG emissions.

Provide Public Support for Clean Energy System Commercialization and Deployment

Each state or province should provide financial support to the commercialization and development of distributed renewable energy systems, clean and high-efficiency fossil energy systems, energy storage systems, and carbon capture and sequestration systems. To collect funds, a small fee should be assessed on the sale of energy in the state on a carbon content basis. Design and administration of the resulting programs should: (1) include a role for a strong oversight board; (2) function within a long-term energy commercialization strategy; and (3) distribute funds through competitive solicitations and simple grants available to all eligible projects. Incentive or grant levels should be technology specific and set at a level low enough to require significant co-funding by the project owner and conserve public funds, but at a level high enough to stimulate the market and lead to significant project development. Incentives should be focused on production or linked to performance, and incentive levels should decrease over time as technologies are commercialized. This activity would reflect an expansion and improvement on the clean energy funds that exist in states like Connecticut and Massachusetts.

State and provincial funding can provide direct support for research and development and early stage commercialization to help jump start specific innovations and fledgling markets. This investment in research and development and commercialization has the added benefit of developing new businesses and product lines within the region, which should lead to additional economic growth and job opportunities.



Energy

Table 5: Summary of Existing Policies and Programs for Electric Power Supply

Policies & Programs	CT	ME	MA	NH	RI	VT	NB	N-L	NS	PEI	QC
Energy Supply Carbon Trading Program											
Trading Program Proposed	yes	yes	yes	yes	no	yes	yes*	yes*	yes*	yes*	yes*
Entity Administering Program (federal or state)	state	state	state	state	NA	state	federal	federal	federal	federal	federal
Large Electric Generation Sources Covered	yes	yes	partial	yes	NA	yes	yes	yes	yes	yes	yes
Large Industrial Sources Covered	no	no	no	no	NA	no	yes	yes	yes	yes	yes
Start Date	2009	2009	2006	2009	NA	2009	2008	2008	2008	2008	2008
Emissions Reporting & Registry											
Mandatory Emissions Reporting	yes	yes		yes			yes	yes	yes	yes	yes
Renewables											
Production Incentives (federal (fed), state, or both)	fed	fed	fed	fed	fed	both	fed	fed	fed	fed	fed
Mandatory Targets for New Resources	yes	no	yes	no	yes	yes	yes	no	yes	yes	no***
Target Date	2010	2017	2020	NA	2020	2015	2015	NA	2010	2010	2013
Target Percent (% of total load)	7.0%	10.0% **	9.5%	NA	14.0%	~9.4%	10.0%	NA	5.0%	15.0%	+4.0%
Target Capacity (MWs)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3,000 ***
Long-term Power Contracts Available	limited	no	limited	no	no	possible	yes	yes	yes	yes	yes
Renewable Energy Funds or Grants	yes	yes	yes	no	yes	yes					
Tax Exemptions or Credits	yes	no	yes	yes	yes	yes					
Combined Heat & Power											
Portfolio Standard	yes	no	no	no	no	no	no	no	no	no	no
Procurement of Generation / Resources	no	no	no	no	no	no	no	no	no	no	yes****
General Distributed Generation Issues											
Net metering	yes	yes	yes	yes	yes	yes	no	no	yes	yes	pilot
Maximum system size (kW, range related to different technology)	50 or 100	100	60	25	0 - 25	15 - 150			50	100	50
Capacity incentives for distributed generation (yes or no)	yes	no	no	no	no	no	no	no	no	no	no

* The federal LFE proposal laid out in the 2005 Project Green plan was halted by a new government in 2006. Plans to replace or revise the LFE proposal were not public at the time of this writing.

**Maine renewables requirement is dependent on supply being cost competitive, and on how the PUC implements the law

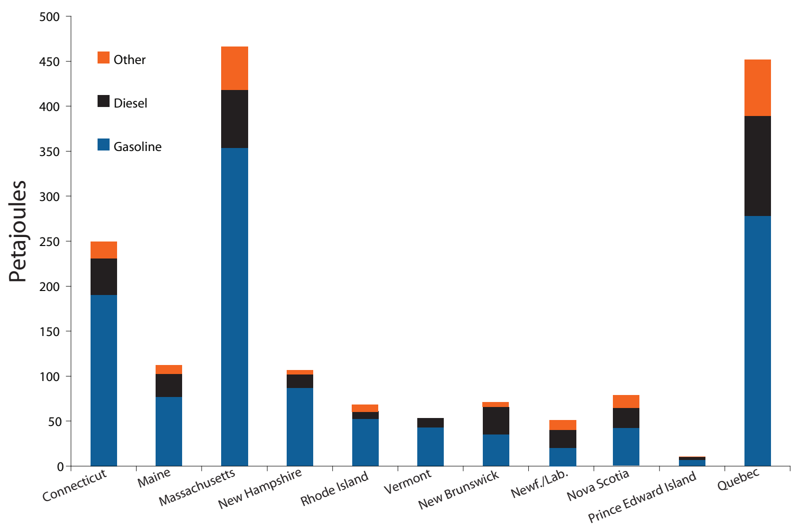
*** Quebec has ordered the procurement of a fixed amount of wind capacity. This figure does not include wind built by or under contact to HQ Production.

**** Approved by order, but not yet implemented.

Transportation

The transportation sector contributes 124 of the 346 $MMTCO_2e$ generated annually in the NE-EC region, or approximately 35% of total GHG emissions. As Figure 19 shows, the challenge for meeting climate targets in the mobile sources sector is to find cleaner alternatives to conventional gasoline and diesel fuel and ways to consume less of it.

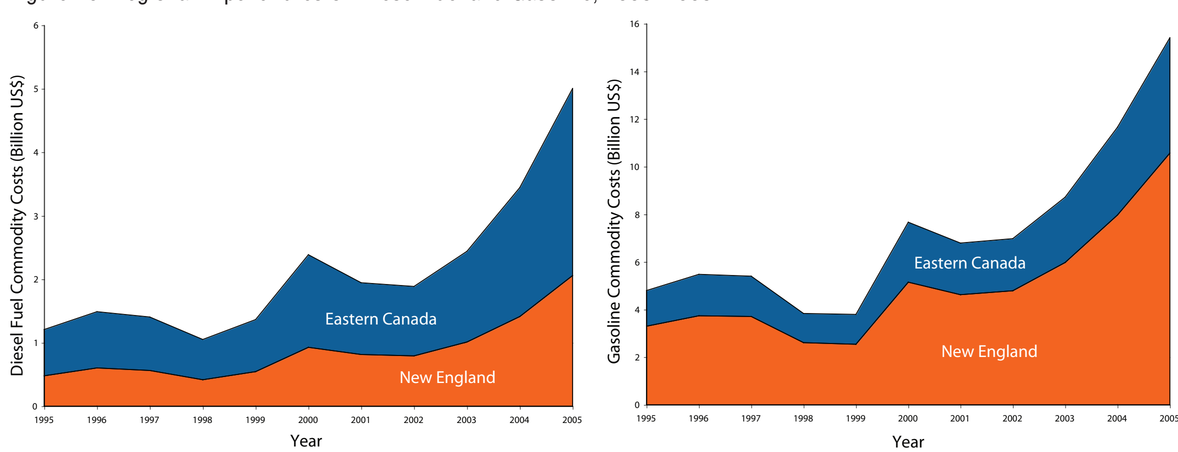
Figure 19: 2001 Transportation Sector Energy Consumption by Fuel and State/Province[4]



Source: Canadian data from the Canada Centre for Energy; New England data from EIA.

Regrettably, the region's growing appetite for both gasoline and diesel fuel is pushing expenditures for these commodities ever higher, as illustrated in Figure 20. With higher expenditures comes a growing opportunity to save money by improving efficiency or finding alternative fuel sources.

Figure 20: Regional Expenditures on Diesel Fuel and Gasoline, 1995–2005



Source: ENE calculations based on EIA & Statistics Canada annual consumption data by state & province; Commodity costs assume New York Harbor annual spot prices from EIA.

Transportation

Transition to No-Carbon or Low-Carbon Transportation Fuels

Nearly 100% of on-road and non-road vehicles currently operate on gasoline or diesel fuel made from petroleum. This situation cannot last. By mid-century, for both climate needs and economic sustainability reasons, our transportation system should:

- have a significant portion of vehicles running on no-carbon or low-carbon energy carriers (*i.e.,* fuels or electricity that emit little or no carbon or other GHGs when viewed from a full-lifecycle perspective);
- have in place the systems, such as fuel or energy storage and delivery infrastructure, as well as road, rail, and port infrastructure, necessary to accommodate the vehicles using these no-carbon and low-carbon energy carriers.

Three actions that will help transition the region to a no-carbon or low-carbon transportation fuels are to: (1) establish a declining net GHG fuel standard; (2) explore pathways to develop low-GHG biofuels in the region; and (3) explore the expansion of electric mobility infrastructure.

Establish a Declining Net GHG Fuel Standard

We recommend that each jurisdiction adopt fuel standards that promote commercialization and deployment of lower carbon transportation fuels on a net GHG basis and displacement of higher-carbon fuels. Implementing this recommendation will entail:

- improving the accounting of the net lifecycle GHG emissions from competing types of fuels;
- developing a certification process by which net GHG emissions factors are assigned to each class of fuel and each production/distribution process;
- instituting a declining average net GHG standard (per unit of energy) for fuels sold in each jurisdiction.

Cellulosic ethanol and synthetic biofuels are two categories of biofuels that hold very high promise although they have not yet been commercialized. Comprehensive lifecycle analysis to date suggests that cellulosic ethanol emits about 52-88% fewer GHG emissions (depending on assumptions and inclusion of land use change) than using an equivalent amount of energy from petroleum-based gasoline. Synthetic fuels, made from a mix of biomass and fossil fuels combined with carbon capture and sequestration, could have significantly higher net GHG benefits than cellulosic ethanol. The net GHG of these two fuels compare very favorably to regular corn ethanol and biodiesel, as Table 6 suggests. Increased production of regular corn ethanol and biodiesel are projected to drive such significant levels of land conversion and other production-related GHGs that they are unlikely to deliver climate benefits.

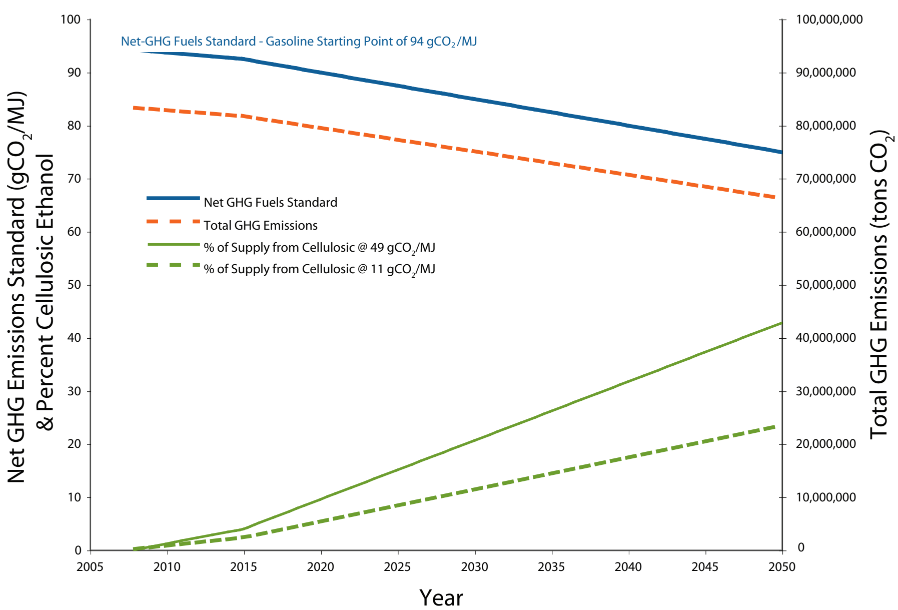
Table 6: Reported GHG Emission Reductions from Biofuels Considering Full Lifecycle and Varying Production

			Net GHG Emissions Reduction (%, with positive equal to lower emissions)		
Boundary	**Source**	**Fuel Type**	**Low**		**High**
References are Gasoline and/or Diesel				0%	
Life Cycle Fuels Analysis (with land use impacts)	Delucci, 2006 Draft	Corn Ethanol	-6%		2%
		Cellulose Ethanol		52%	
		Biodiesel		-53%	
Life Cycle Fuels Analysis (without land use impacts)	Farrell et al, 2006	Corn Ethanol	-2%		13%
		Cellulosic Ethanol		88%	
	Hill et al, 2006	Corn Ethanol		12%	
		Cellulosic Ethanol		High	
		Biodiesel		41%	

Sources: M. Delucci, 2006 Draft, *Lifecycle Analysis of Biofuels—Draft Manuscript;* A. E. Farrell et al, 2006, *Ethanol Can Contribute to Energy and Environmental Goals,* Science V. 311 (506–508); J. Hill et al, 2006, *Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels,* PNAS Vol. 103 No. 30

The projected emissions benefits of the fuel standard for gasoline shown in Figure 21 would be in the range of 3.7 $MMTCO_2e$ by 2020 and 17 $MMTCO_2e$ by 2050. Realistically, a target may need to be set for a 10 to 20 year period and then adjusted as appropriate. Adding standards for other fuels, such as highway diesel fuel and non-road diesel fuel/home heating oil, could allow these benefits to increase significantly, assuming there are fuels available at a lower emissions level per unit of energy that can be substituted for distillate fuels. Displacing petroleum-based fuels has collateral benefits as well, including reducing our reliance on imported oil and providing a significant opportunity to build a new regional biofuels industry.

Figure 21: Increased Demand for Cellulosic Ethanol and Emission Reductions from Net GHG Fuels Standard



Explore Pathways to Develop Low-GHG Biofuels in the Region

We recommend that states and provinces in the region work to commercialize sustainable, low-GHG production of transportation fuels using woody biomass and grasses.

Biofuels made from indigenous supplies of woody biomass have the potential to result in lower lifecycle GHG emissions. The NE-EC region is home to a very significant forest products industry and an abundant supply of woody biomass or biomass by-products (*e.g.,* black liquor). The region should establish an initiative to collaborate on research and development of new biofuel technologies and processing plants and to scope out the path ahead for developing a local biofuels industry and markets for biofuels products. The initial task for this collaborative is to evaluate:

- pathways for converting indigenous biomass resources into useful energy carriers;
- total lifecycle GHG impacts of competing biomass conversion pathways;
- market potential for competing biofuels and related by-products;
- suitability of existing siting and permitting regulations to accommodate new biorefineries and local environmental/community concerns;
- legal and economic potential for biorefineries and/or landowners to receive tradable “offsets” under a regional or federal carbon cap-and-trade regime;
- policy options employed in other states/provinces, and internationally, to help develop a new sustainable biofuels industry.

In addition to instituting a declining fuel GHG standard (described above), states and provinces should consider establishing financial incentives and grants to help develop this industry.

Example: Quebec Biofuels Support

In Quebec, the Climate Action Plan released in June, 2006 proposes to establish a carbon charge or tax on the wholesale sale of all hydrocarbons that is expected to generate about C$200 million. The carbon charge will help net GHG-reducing biofuels compete with higher-carbon conventional fuels, and the proceeds of the charge will go to the so called “Green Fund” that will be used to implement aspects of the Plan, including helping to commercialize biofuel production.[5]

Explore the Expansion of Electric Mobility Infrastructure

Plug-in electric hybrid vehicles could cut GHG emissions by about 50% compared to conventionally powered vehicles. Fully electrified vehicles, including trains, freight carriers, or passenger vehicles, using electricity from low- or no-carbon sources, could theoretically reduce GHGs by 85-100% compared to a conventional gasoline or diesel fueled vehicle, provided the electricity comes from no-carbon or low-carbon sources.

We therefore recommend that states and provinces work together regionally to plan, invest in and build the infrastructure necessary to accommodate increasing electrification of the transportation system.

High-tech businesses and universities located in the NE-EC region should be encouraged to help develop vehicles (and vehicle systems) that make greater use of electricity. The region should develop a list of the issues that need to be addressed for further electrification of the transportation system, and to develop plans and procedures to build and manage the necessary infrastructure. Issues for an initial inquiry could include:

- impact of more electrified transportation on generation capacity;
- capacity of transmission and distribution lines to handle more electrified transportation;
- the impact on load curves and policy options for promoting preferred (off-peak) charging times of electrified vehicles (batteries);
- technical standards and building guidelines for electric vehicle charging devices located at private residences, commercial vendors and public places;
- pros and cons of competing options for distributing electricity to electrified roadways or guideways.

Example: MBTA Silver Line

Construction of the new Silver Line by the Massachusetts Bay Transportation Authority (MBTA) relies on hybrid buses that can switch between electric motors fed from an overhead catenary wire, or on-board regenerative braking, or on-board diesel engines. This is made possible by a dual-mode electric/diesel-electric propulsion system that was placed in the new low-emission, 60-foot-long articulated buses. Another innovative Bus Rapid Transit (BRT) feature of the Silver Line is the establishment of a dedicated right-of-way through the tunnel that connects the city's main train station to the South Boston Waterfront and Logan airport.[6]

Reduce GHG Emissions from Light-Duty Vehicles

Over the past 20 years, GHG emissions from the light-duty vehicle sector, which includes cars, light trucks and SUVs, have increased dramatically despite improvements in engine and drive-train efficiency. This is the result of two factors:

- GHG emissions per mile traveled of the light vehicle fleet has gone up due to the increased use of heavier vehicles, such as light trucks and SUVs, that are less efficient and continue to use gasoline as the primary fuel.
- The number of vehicle miles traveled (VMT) by this fleet has increased substantially due to the rising number of vehicles on the road and the longer distances we travel every year.

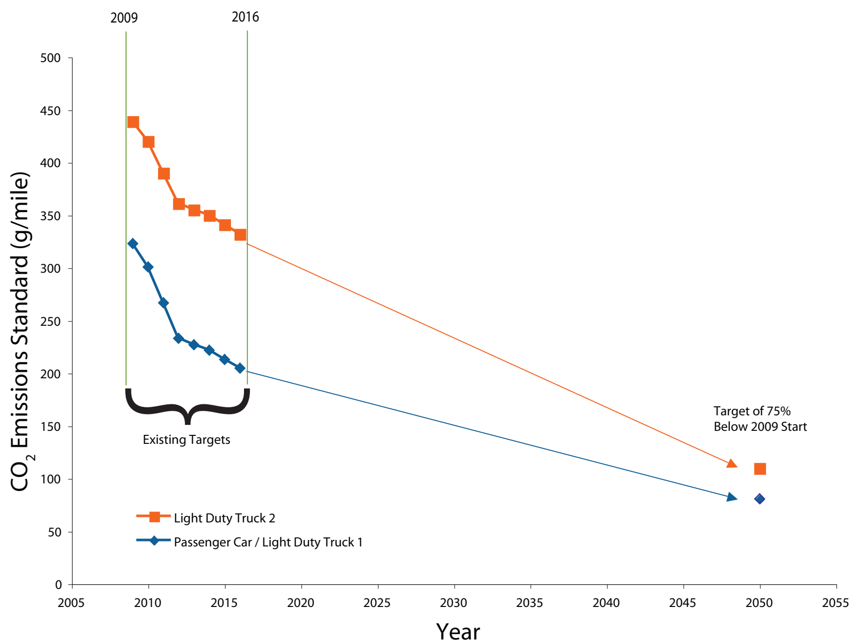
Three actions that will help reduce GHG emissions from light-duty vehicles in the NE-EC region are to: (1) implement emission standards for all light-duty vehicles; (2) improve fuel economy standards in the U.S. and Canada; and, (3) reduce vehicle miles traveled (VMT).

Implement Emission Standards for all Light-Duty Vehicles

New Hampshire and the five Eastern Canadian provinces should establish individual plans for incorporating the California GHG Emission Standards for Vehicles and move forward implementing those plans. States should make clear to courts and federal agencies their interest in adopting California's standards and the arguments that support EPA granting a waiver for the state-based action. Officials in the NE-EC region should work with California state government to ensure that GHG emissions regulations are strengthened over time.

In 2005, all New England states except New Hampshire opted into California's Low Emission Vehicle (LEV II) standards, and were joined by New Jersey, New York, Pennsylvania, Oregon and Washington. Subsequently, California enacted the GHG Emissions Standards for Vehicles directing new regulations to achieve "the maximum feasible and cost-effective reduction of GHG" from light vehicles sold in the state.

Figure 22: Emissions Trajectory from Existing GHG Standards and Potential Target for 2050



Source: 2009-2016 Standards from the California Air Resource Board.

Incorporating off-the-shelf technologies into new cars sold under the standards is expected to result in GHG emission reductions of approximately 34% for new cars and light trucks and 25% for new larger trucks and SUVs by 2016. If timely implemented in every jurisdiction in the NE-EC region, the California GHG Emissions Standards for Vehicles would reduce CO_2 emissions from current levels by 10.3 $MMTCO_2$ by 2020 (from 55.9 to 45.6 $MMTCO_2$). Assuming a price of $2.00 per gallon, these standards will save owners between $300 and $2,200 over the life of their vehicles.

States and provinces also should take steps to help move cleaner cars into the marketplace. Use of procurement policies to require purchases of the cleanest possible cars (*e.g.,* for state or provincial fleets) and financial incentives such as "Feebates" should be considered.

Improve Fuel Economy Standards in the U.S. and Canada

We recommend that states and provinces actively work to support more stringent federal fuel economy standards and that Canada make its standards mandatory and enforceable. Current policies are too modest to make a meaningful impact on the efficiency of these fleets. One of the barriers to improved fuel efficiency in the NE-EC region is the reality that it has been politically difficult to pass significant changes to U.S. Corporate Average Fuel Economy (CAFE) in the federal policy forums. In addition, federal law preempts independent fuel efficiency regulation by state and municipal governments. The Canadian Company Average Fuel Consumption (CAFC) targets in Canada, which are pegged to the CAFE standards, are voluntary. Moreover, Canada has not yet revised the CAFC targets to match the newest CAFE standards for light trucks.

We further suggest that it would improve the effectiveness of the CAFE and the CAFC frameworks if the standards were converted to joules per mile rather than miles per gallon. As we transition away from an economy in which motor gasoline and diesel fuels are the exclusive energy supply for vehicles, switching the measure of efficiency to joules per mile would better enable the system to reflect the different energy content of competing fuels or energy carriers and the efficiency of the various vehicles in which they are consumed.

Transportation

The Carbon Mitigation Initiative has calculated that globally, the transportation sector could reduce emissions by about 1 billion tons per year by doubling the efficiency of all the world's cars from 30 to 60 mpg.

Reduce Vehicle Miles Traveled

States and provinces should develop broad and forward-thinking land use and transportation plans in order to stabilize growth in VMT. Over the longer term, states and provinces should direct investments in transportation and other infrastructure toward areas in or near existing population centers or in designated high-growth areas.

Sprawl is the largest influence on VMT per capita, and most vehicle miles are used for commuting and running errands. Proper regional planning can reduce the need for vehicle use. One goal of "smart growth" policies is to make areas of development more compact. This can be achieved by encouraging "infill" development and redevelopment in existing urban and suburban areas through transfers of development rights, brownfield redevelopment incentives, and urban development programs.

Land use and transportation policies are integrally related and should be aligned to achieve the same goals of minimizing our dependence on car travel, reducing development pressure on remaining open spaces, and revitalizing urban areas. By requiring alternative scenario analyses for Transportation Improvement Plans (TIPs) and Long Range Transportation Plans (LRTPs), many factors that influence development and infrastructure policy decisions can be identified and relevant impacts can be quantified.

Between 2000 and 2003, VMT increased in the NE-EC region by 1.8%. If it continues to grow at this rate, annual VMT for the NE-EC region is projected to increase from 177,000 million to 400,000 million miles by 2050. Various urban and suburban area studies have calculated that a doubling of residential density correlates with 20-30% lower per-capita VMT.

Reduce Emissions from Heavy-Duty Vehicles

Greenhouse gas emissions from heavy-duty vehicles grew by 57% from 1990 to 2003, faster than any other major source.[7] Many important emissions policy solutions for heavy-duty vehicles are better suited for federal rather than state, provincial or regional action. However, there are actions that can be taken locally that help address climate objectives.

We identify three recommendations to reduce emissions from heavy-duty vehicles: (1) reduce black carbon emissions from in-use diesel engines; (2) promote improved efficiency of heavy-duty vehicles; and (3) improve the efficiency of the region's freight transportation system.

Reduce Black Carbon Emissions from In-Use Diesel Engines

Currently, the emissions of fine particulates (PM2.5) from mobile diesel engines in New England and Eastern Canada are just more than 24,500 metric tons per year. PM2.5 that comes from the combustion of fuel in diesel engines is relevant to climate change because the black carbon (or "soot") portion of PM2.5 has a global warming potential (GWP100) of about 600 times that of CO_2.[8] As an aerosol (not a gas), black carbon warms via a different mechanism than GHGs. Its dark color makes it a potent absorber of energy from the sun, which it converts to heat.

The health impacts from the PM2.5 emissions of diesels in New England alone are estimated at more than 16,000 asthma attacks, 1,238 non-fatal heart attacks, and 789 lives cut short (on average, 14 years shorter than normal) each year.

Transportation

Each state and province in the region should establish a 10-year strategic plan to achieve the maximum reduction in health risk from diesel soot. The objective of the plans should be to complement federal regulations by retrofitting aftermarket emission controls onto existing engines. These plans should establish targets for emission reductions and deadlines, recommend legislation or regulations where appropriate, and establish a steady source of funding to help defray the cost of retrofits during the 10-year period. We also recommend adopting anti-idling rules for all on-road vehicles and for those non-road vehicles that have the potential to access idling alternatives such as auxiliary power units or shore power.

By retrofitting existing non-road and on-road diesel engines with emission controls, states and provinces can cut dangerous diesel PM2.5 pollution by between 50–90% per engine. Over the next decade, such cuts could achieve a proportionate reduction in emissions of black carbon. Retrofitting emission controls onto existing ("in-use") engines and implementing an aggressive campaign to eliminate unnecessary engine idling can dramatically cut emissions of PM2.5 and slow warming over the short term by an amount equivalent to reducing 4 $MMTCO_2$.

Promote Improved Efficiency of Heavy-Duty Vehicles

Jurisdictions in the region should establish low-interest loan programs and other financial incentives to promote the purchase and installation of improved engines, vehicles or other equipment that enhances fuel efficiency of heavy-duty vehicles.

Government and industry representatives have identified a menu of steps that freight hauling trucks can implement to improve their fuel efficiency. The common feature of all measures on the menu is that they are cost-effective and have fast paybacks. Taken together, they can reduce GHGs by more than 10 metric tons per vehicle per year.

In the short-term, loan programs or other incentives can expedite deployment of these efficiency measures. In the longer-term, coordinated efforts to promote hybridization could pay large dividends. Next generation heavy-duty vehicles may be capable of increasing fuel efficiency by 100% using hybrid technology. Participants in a public-private partnership studying this opportunity anticipate saving more than 20 million barrels of oil in 2010 and 250 million barrels of oil nationally in 2020, equivalent to approximately 108 $MMTCO_2$ in 2020.

Improve the Efficiency of the Region's Freight Transportation System

We recommend establishing the goal of shifting 10% of truck freight to rail or waterborne modes of transportation by 2015. A first step in understanding how to achieve this goal is to complete the ongoing I-95 Corridor Coalition regional freight transport study and expand it to focus on opportunities to increase waterborne commerce in the region. Shipping via waterborne or rail modes consumes approximately 85-90% less energy per ton-mile compared to trucks. Among the potential benefits of pursuing greater inter-modal activity are reductions in air pollution, traffic congestion and road wear.

Sequestration

As a significant site for carbon storage, forests around the world play an important role in the carbon cycle. Plants and trees convert atmospheric CO_2 and store carbon in their aboveground and belowground biomass through the process of photosynthesis. Belowground, forest soils have been shown to store a significant amount of carbon in their soil organic matter—up to two times as much carbon as found aboveground.[9] Another form of sequestration occurs when carbon dioxide is captured from large energy or industrial sources and stored underground in suitable geologic formations. Our objectives in the area of sequestration are to: (1) sequester carbon in terrestrial sinks; and, (2) capture and store carbon dioxide from energy and industrial sources.

Sequester Carbon in Terrestrial Sinks

Extensive forests in the region, such as those that exist in Northern New England, New Brunswick, Nova Scotia and Quebec, can play a role in both reducing greenhouse gas emissions and storing carbon. Achieving additional sequestration or conserving sequestration capacity beyond business as usual can help bolster the regional forest economy, conserve forest (and farm) lands for a variety of carbon and environmental objectives, help increase the demand for sustainable forest harvest practices and products in the region, and increase market access and revenue streams for landowners producing those goods.

While forests, both passively and actively managed, function as “sinks” for carbon, they are also sources of GHG emissions. Natural biological processes, natural disturbances, and forest management activities (including harvesting and prescribed burning) all result in carbon emissions. When these changes occur, the carbon account balance shifts, resulting in a carbon loss. On the other hand, when sustainable conditions exist—trees continue to grow (and store carbon) at a greater rate than they decay or are harvested—no net carbon is assumed lost from the forest over the long term.

To increase carbon sequestration in terrestrial sinks, we recommend that states and provinces: (1) improve inventory and accounting tools to better quantify and track forest carbon; (2) promote forest management strategies that sequester additional carbon; and, (3) minimize carbon loss from land conversion.

Improve Inventory and Accounting Tools to Better Quantify and Track Forest Carbon

There is a high level of uncertainty about the various estimates of forest carbon stock and sequestration rates for New England’s forests, and estimates for Eastern Canada are difficult to come by. Province-by-province data on forest carbon stock and sequestration rates do not exist and should be developed.

Table 7: Estimated Non-soil Forest Carbon Stocks and Annual Sequestration for NE-EC[10]

Jurisdiction	Forest Land Area	Non-soil Forest Stock			Annual Emissions		
	kha	$MMTCO_2e$			$MMTCO_2e$/yr (low)		$MMTCO_2e$/yr (high)
Connecticut	728	241.6	to	327.1	(1.05)	to	0.98
Maine	7,164	1,807.9	to	2,683.6	4.74	to	(17.55)
Massachusetts	1,274	423.9	to	661.1	(3.89)	to	(13.46)
New Hampshire	1,950	738.1	to	937.2	(9.01)	to	(10.63)
Rhode Island	153	42.3	to	67.8	(0.12)	to	(1.31)
Vermont	1,846	686.9	to	867.0	(16.17)	to	0.59
NE Total	**13,114**	**3.940.8**	**to**	**5,543.8**	**(25.50)**	**to**	**(41.38)**
New Brunswick	6,200	NA		NA	NA		NA
NF/Lab	20,000	NA		NA	NA		NA
Nova Scotia	4,400	NA		NA	NA		NA
PEI	270	NA		NA	NA		NA
Quebec	84,600	NA		NA	NA		NA
EC Total	**115,470**	**NA**		**NA**	**NA**		**NA**

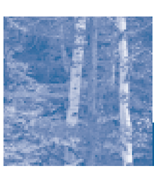
It is important for officials and interested parties in the region to work collaboratively to improve inventory and accounting tools regarding forest carbon. Steps to achieve this include:

- convening an interdisciplinary team to share information and develop an accurate forest carbon inventory by conducting additional research on the carbon impacts of forest practices and land conversion, and forging agreement across jurisdictions as to the most accurate quantification methodology;
- streamlining models for use by foresters and land use planners, and considering the use of financial incentives to increase participation in the use of such models;
- dispatching the best remote sensing technology, using satellite data, to enhance transparency, standardize accounting, and lower costs;
- harmonizing legal instruments such that inventory, accounting and reporting frameworks throughout the region (and continent) are coordinated to best develop a functional, transparent and liquid market for forest-based programs or carbon offsets.

Regional and international agreements on GHG reductions make it clear that an important opportunity exists to help develop technical solutions and shape credible infrastructure to support forest carbon offset markets. In this context, it is important to note that the economic and physical impacts of land conversion on the forest and agriculture sectors are poorly quantified at the present time.

Promote Forest Management Strategies that Sequester Additional Carbon

States and provinces in the region should develop a strategic plan for research around forest carbon sequestration, silvicultural pathways and forest management regimes that can be used to mitigate the region's GHG emissions. A partial list of items meriting further research includes: the storage capacity and economics of biochar, potential effects of "leakage," certification linkages, the role of conservation easements, and carbon accounting protocols for use of durable wood products.



Recent modeling suggests that modified commercial silvicultural practices and forest management regimes (*e.g.*, modified early commercial thinning) can increase the net carbon balance on forested lands compared to business as usual harvesting practices. While the modeling indicates these carbon-friendly practices can capture carbon at a more attractive price than other carbon mitigation measures, we recognize that several important economic variables are not yet well understood. The modeling results can be improved as more work is done to develop practical procedures for implementing and demonstrating modified forestry practices for GHG sequestration and estimating the associated costs.

Establishing new pilot programs to test forest management models is an important next step in demonstrating the commercial and administrative feasibility of forest carbon projects employing modified practices. We further recommend developing programs designed to encourage landowners to sequester additional carbon at the state, provincial or regional level. These programs could serve as a stand-alone driver of modified silvicultural practices or as a bridge to carbon market opportunities that may result with the implementation of carbon cap-and-trade regulations that make forest sequestration projects eligible for tradable offsets that connect with other policies like cap-and-trade programs.

Carbon mitigation regimes, including mandatory and voluntary carbon trading programs, are driving interest in the potential carbon impacts of forestry and land use change. Such a trading program is under discussion in the proposed RGGI cap-and-trade system in the Northeast U.S., and was a component of Canada's proposed "Project Green" plan and Large Final Emitters program (which have been put on hold at the time of this writing).

Carbon-related silvicultural financial incentives have the potential to provide a supplementary stream of funding to landowners who might otherwise be inclined to sell their land for development. Considering that the entire NE-EC has 128 million hectares in managed forestland, we conclude that the potential for added carbon sequestration could be significant even if only modest increases in CO_2 stored per acre are achievable through improved forest practices.

Minimize Carbon Loss from Land Conversion

States and provinces should establish a Carbon Neutral Growth Program to reduce or mitigate land conversion in moderate to large scale residential and commercial development. A companion Carbon Neutral Growth Conservation Fund could be established to invest in carbon offsets achieved through preferred land-use practices or conservation easements.

Local jurisdictions can influence carbon impacts from land conversion by means of zoning and land use regulations, tax programs, and conservation easements. Where development of forest or farmland is proposed, we recommend states, provinces and their municipalities employ the following steps to reduce or mitigate the projected carbon impacts of land conversion:

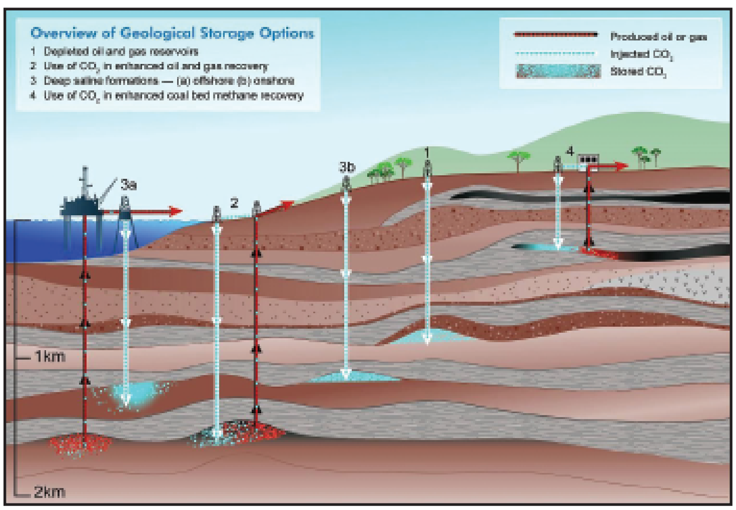
- calculate the difference between the baseline land-use carbon storage potential over a specified time frame and the amount of carbon storage expected to be maintained on-site following development;
- offer developers multiple paths for compliance with carbon mitigation requirements, such as reconfiguring the development plan, purchasing carbon offsets from other projects, paying an alternative compliance fee to an entity that invests it in carbon offsets or a Carbon Neutral Growth Conservation Fund.

The clearing of land for residential development may remove as much as 50-67% of above ground biomass and its associated carbon, while removing 22-25% of soil carbon. In New England the rate of land conversion from rural agriculture and timber land to residential and commercial development is estimated at 1,724 acres (698 hectares) per week, while the Eastern Canadian provinces are estimated to be converting at a rate of 817 acres (331 hectares) per week. In certain parts of the region, conversion of forest and farm land through development threatens the viability of sustainable working forests as well as the loss of carbon.

Capture and Store Carbon Dioxide from Energy and Industrial Sources

Capture and storage of carbon dioxide uses existing technologies that are already employed in various industrial applications and are cost-competitive with many promising climate change mitigation options. Scientists and climate change experts consider carbon dioxide capture and storage (CCS) an important opportunity to reduce GHG emissions. Because this issue is relatively new and undeveloped in the NE-EC region, we offer here a single, multifaceted recommendation as a first step: build a regional framework for long-term carbon capture and storage.

Figure 23: Geologic storage options for CO_2[11]



Build a Regional Framework for Long-Term Carbon Capture and Storage

While large federal programs carry the early burden of researching basic science and economics of CCS, the NE-EC region can focus on its own unique needs and opportunities by creating a framework for long-term sequestration. The region should develop a plan that includes:

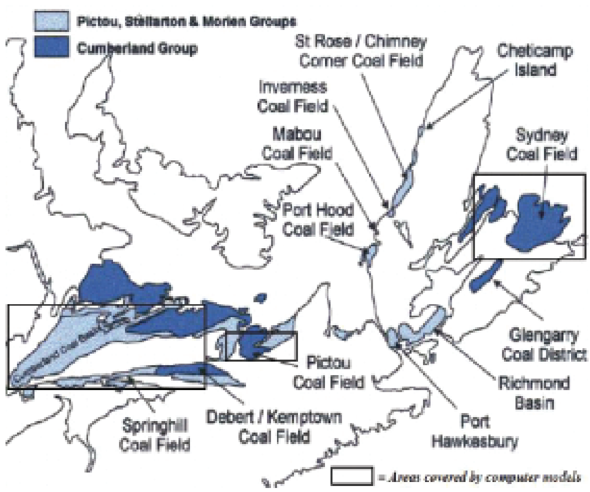
- Regional inventories of sources, potential storage locations, and estimates of storage capacity
- Pilot programs
- Timely adoption of a regulatory framework

Sequestration

Under any future scenario in which carbon emissions are restricted, if states and provinces of the NE-EC region want to preserve the option of building new coal or biomass plants to achieve low-cost fuel diversity and energy independence, then this region will need its own carbon sequestration infrastructure. This infrastructure will include, at a minimum, the capacity to process and transport the CO_2, and ideally would include a place to store the CO_2 within the region. Similarly, any large industrial CO_2 emitters who may be subject to regulatory carbon constraints may want to consider carbon sequestration options.

Preliminary mapping shows significant potential storage sites in the unminable coal seams around Nova Scotia, as well as other underground geologic formations that would require further study off-shore from Rhode Island to Labrador. The capacity of CO_2 that could be safely stored in geologic formations in the region is not yet known.

Figure 24: Potential for CO_2 Storage in Nova Scotia[12]



Source: Hughes, Assessment of Nova Scotia Coalfields (2004)

Endnotes

Energy

1 California Public Utilities Commission, Press Release: "PUC Approves Updated Energy Action Plan To Ensure Long-Term, Environmentally-Sound Energy Supply And Infrastructure At Reasonable Cost To Consumers," August 25, 2005

2 Nadel, deLaski et al, *Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards,* ASAP, ACEEE, Revised March 2006.

3 Source: *Ibid.,* Table 3.8, p. 32; Regulations Amending the Energy Efficiency Regulations; *Canada Gazette,* Vol. 137, No. 9—April 23, 2003, Registration SOR/2003–136 April 10, 2003.

Transportation

4 Source of Data: Canadian Information from Canada Center for Energy and EIA Projections to 2030 for New England.

5 Government of Quebec, *Plan D'action 2006–2012, Le Québec Et Les Changements Climatiques: Un défi pour l'avenir,* June 2006, p. 29.

6 http://www.allaboutsilverline.com/waterfront_service.asp.

7 U.S. Environmental Protection Agency, *Greenhouse Gas Emissions from the U.S. Transportation Sector,* 1990-2003, March 2006 (EPA 420 R 06 003), p. 8.

8 Bond, T. and Haolin, Sun, "Can Reducing Black Carbon Emissions Counteract Global Warming?" *ES&T,* August 2005, p. 5921, estimating GWP100 of 680, from which we have subtracted 80 to account for the reflective organic carbon component; see also Bond, Venkataraman, Masera, "Global atmospheric impacts of residential fuels," *Energy for Sustainable Development,* July 2004.

Sequestration

9 In accordance with other practitioners, inorganic soil carbon is considered inert and thus not included in this report (Heath and Smith 2000).

10 New England data only is from Sampson, Neil, "Terrestrial Carbon Sequestration in the Northeast: Quantities and Costs," DRAFT, March, 2006.

11 IPCC, Working Group III, *Special Report on Carbon Dioxide Capture and Storage: Summary for Policymakers, and Technical Summary,* ISBN 92-9169-119-4, Figure TS-7.

12 Hughes, J.D., *Volume 1: Assessment of Nova Scotia Coalfields for Production of Coalbed Methane and CO_2 Storage in Deep Coal Seams*, Geological Survey of Canada—Calgary, Natural Resources Canada, March, 2004, p. 5.

Extensive additional data, analysis and references are available in the comprehensive Climate Change Roadmap for New England and Eastern Canada at www.env-ne.org.

Appendix

Sources for New England States Data

1 Source: US Energy Information Administration.
2 Source: US Highway Performance Monitoring System.
3 Source: New England States emissions 2002 data.
4 Source: Neil Sampson, 2006.
5 Source: Left estimate from USDA 2003. Right estimate from Neil Sampson, 2006.
6 Source: Left estimate from USDA 2003. Right estimate from Neil Sampson, 2006. Note that this estimate includes emissions from development.
7 Developed using USDA 2005 forest land estimates for 1997-2002 and Sampson 2006 estimate of non-soil forest stock.
8 Source: Neil Sampson, 2006.
9 *Ibid*. Note that possible double counting of agriculture-related soil carbon emissions, though negligible, may exist between these land use change (development) emissions estimates and those given by the historical GHG emissions inventory.

Sources for Eastern Canada Data

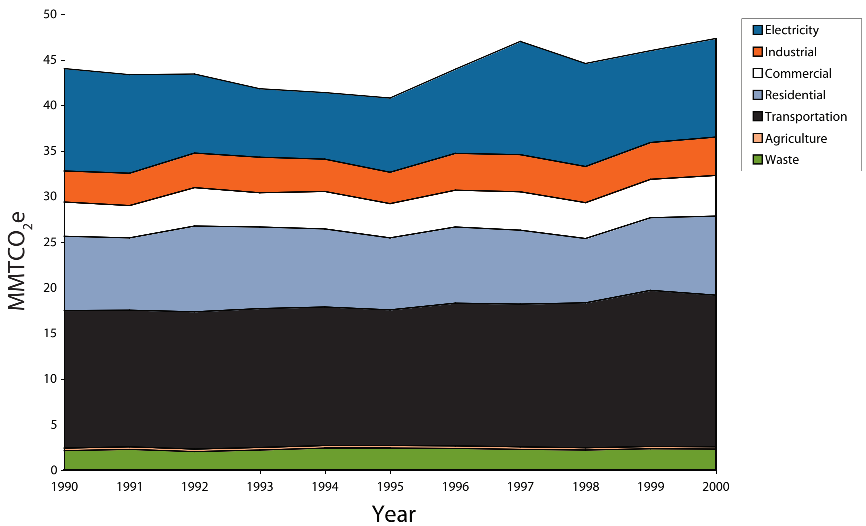
1 Source: Statistics Canada.
2 Source: Statistics Canada.
3 Source: Environment Canada.
4 Source: Natural Resources Canada, 2006.

State Data: Connecticut

Population 3,405,565
Area 4,845 sq. mi. (12,528 sq. km.)
Gross State Product (GSP) (M USD) $160,685

GHG Inventory

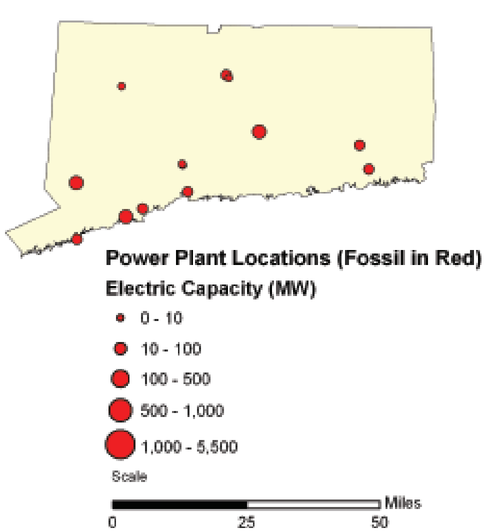
Historical Greenhouse Gas Emissions



Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces
Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because states either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

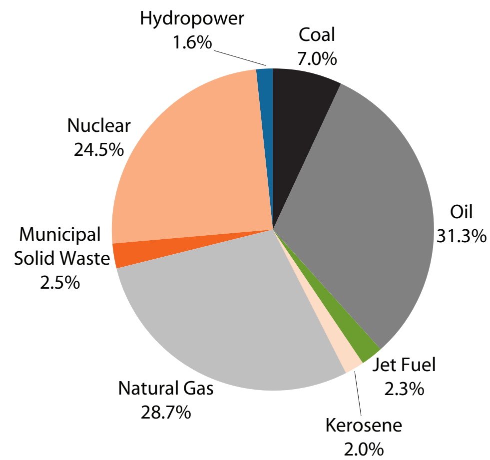
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



Source: EPA E-Grid

Electric Generation Capacity in 2004

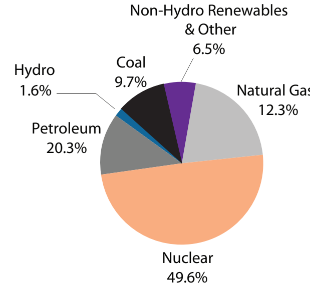


Total Electric Generation Capacity: 8,011 MW
Source: EIA

Total Energy Consumption (2000)[1]

	Total terajoules	Terajoules per capita	Terajoules per GSP
CT	901,698	0.26	5.60
NE-EC	5,952,405	0.25	6.96

Total Electric Generation in 2000



Total Electric Generation: 32,967,570 MWh
Source: EIA

Transportation

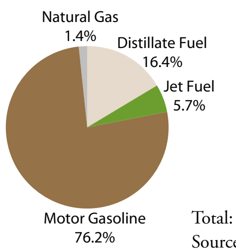
VMT for Light Duty Vehicles (2003)[2]

2000	27,847.45	Million miles
2003	29,427.82	Million miles
Yearly Change	1.89	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	997	Metric tons
Off-road use of diesel	1,049	Metric tons
Total PM 2.5 emissions	2,046	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 249.6 PJ
Source: EIA

Forestry and Land Use Change

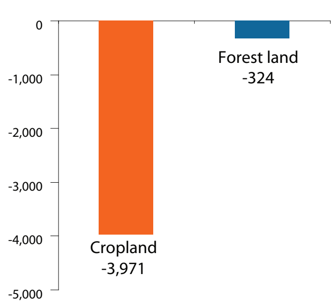
Forest Land Area[4]	Non-soil Forest Stock[5]	Annual Non-soil Forest Emissions[6]
kha	$MMTCO_2e$	$MMTCO_2e$
1,274	423.9 to 661.1	-3.9 to -13.5

Notes: $MMTCO_2e$ = million metric tons carbon dioxide equivalents
Negative numbers indicate sequestration.

Annual Average Emissions from Land Use Change (ha)

Non-soil Forest[7]	Forest Soil[8]	Non-Forest Soil[9]	Total
$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$
5.8	45.4	6.1	57.3

Annual Average Land Use Change, 1997–2002



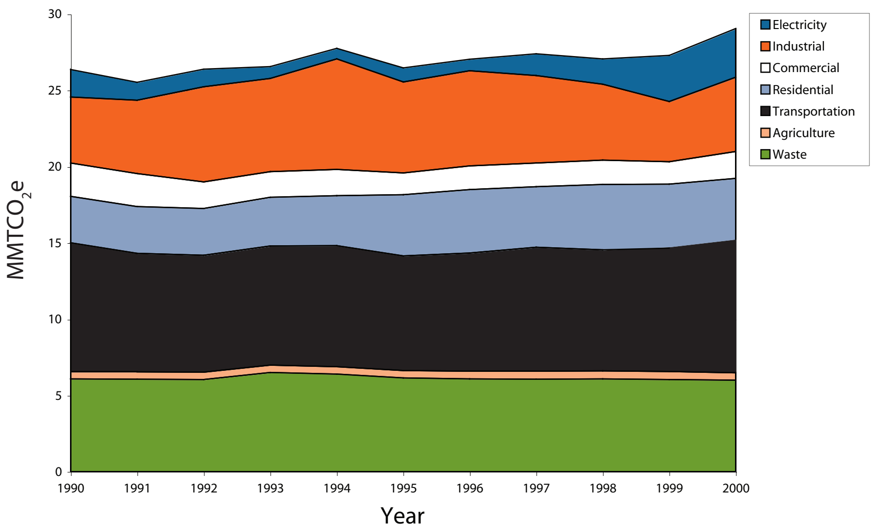
Source: USDA Census of Agriculture and Forest Service

State Data: Maine

Population	1,274,923
Area	30,862 sq. mi. (79,932 sq. km.)
Gross State Product (GSP) (M USD)	$35,662

GHG Inventory

Historical Greenhouse Gas Emissions

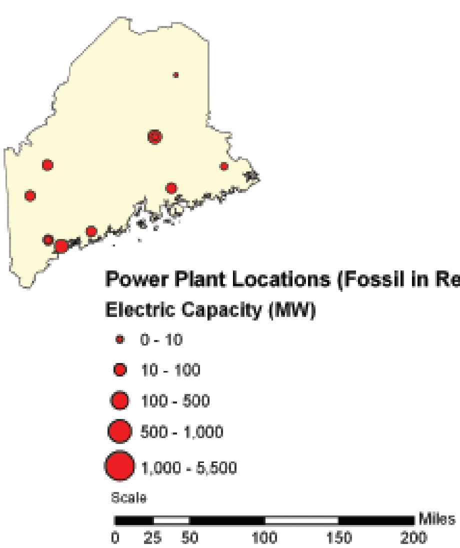


Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces

Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because states either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

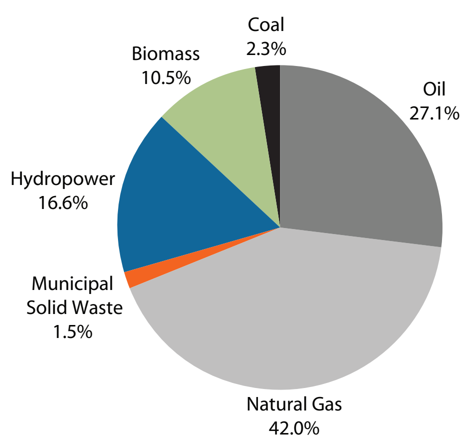
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



Source: EPA E-Grid

Electric Generation Capacity in 2004



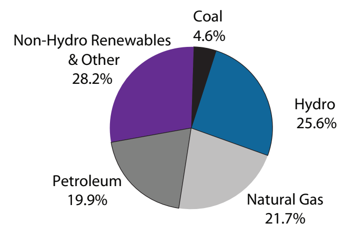
Total Electric Generation Capacity: 4,342 MW

Source: EIA

Total Energy Consumption (2000)[1]

	Total terajoules	Terajoules per capita	Terajoules per GSP
ME	561,678	0.44	15.8
NE-EC	5,952,405	0.25	6.96

Total Electric Generation in 2000



Total Electric Generation:
14,047,947 MWh
Source: EIA

Transportation

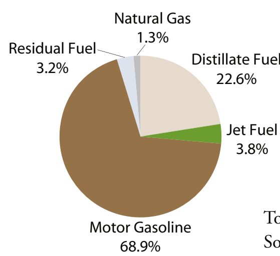
VMT for Light Duty Vehicles (2003)[2]

2000	12,746.22	Million miles
2003	13,490.98	Million miles
Yearly Change	1.95	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	671	Metric tons
Off-road use of diesel	503	Metric tons
Total PM 2.5 emissions	1,174	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 112.2 PJ
Source: EIA

Forestry and Land Use Change

Forest Land Area[4]	Non-soil Forest Stock[5]	Annual Non-soil Forest Emissions[6]
kha	$MMTCO_2e$	$MMTCO_2e$
7,164	1,807.9 to 2,683.6	4.7 to -17.6

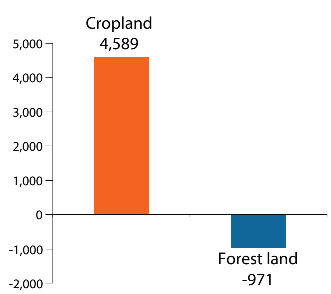
Notes: $MMTCO_2e$ = million metric tons carbon dioxide equivalents

Negative numbers indicate sequestration.

Annual Average Emissions from Land Use Change

Non-soil Forest[7]	Forest Soil[8]	Non-Forest Soil[9]	Total
$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$
0.4	18.4	7.3	26.0

Annual Average Land Use Change, 1997–2002 (ha)



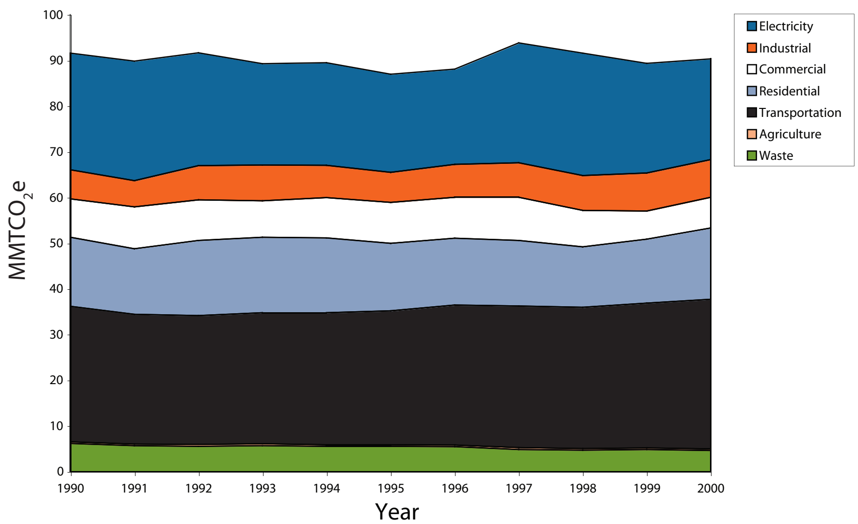
Source: USDA Census of Agriculture and Forest Service

State Data: Massachusetts

Population	6,349,097
Area	7,840 sq. mi. (20,306 sq. km.)
Gross State Product (GSP) (M USD)	$276,786

GHG Inventory

Historical Greenhouse Gas Emissions

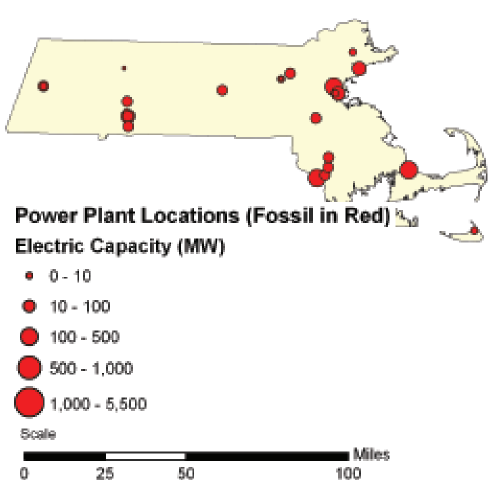


Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces

Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because states either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

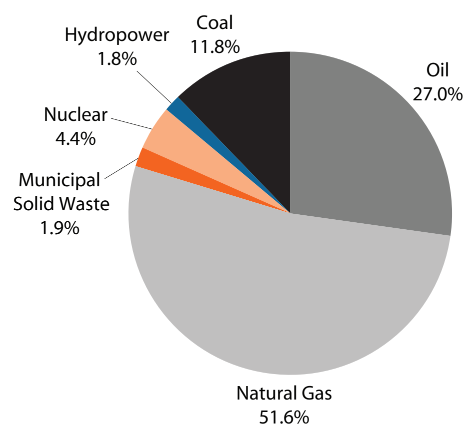
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



Source: EPA E-Grid

Electric Generation Capacity in 2004



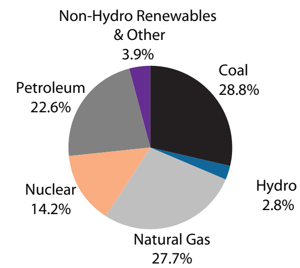
Total Electric Generation Capacity: 15,233 MW

Source: EIA

Total Energy Consumption (2000)[1]

	Total terajoules	Terajoules per capita	Terajoules per GSP
MA	1,632,452	0.26	5.9
NE-EC	5,952,405	0.25	6.96

Total Electric Generation in 2000



Total Electric Generation: 38,697,881 MWh
Source: EIA

Transportation

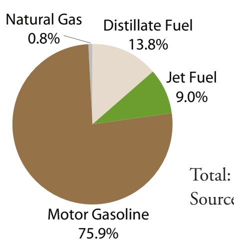
VMT for Light Duty Vehicles (2003)[2]

2000	49,533.22	Million miles
2003	50,595.84	Million miles
Yearly Change	0.72	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	1,514	Metric tons
Off-road use of diesel	3,842	Metric tons
Total PM 2.5 emissions	5,356	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 466.1 PJ
Source: EIA

Forestry and Land Use Change

Forest Land Area[4]	Non-soil Forest Stock[5]	Annual Non-soil Forest Emissions[6]
kha	$MMTCO_2e$	$MMTCO_2e$
7,164	1,807.9 to 2,683.6	4.7 to -17.6

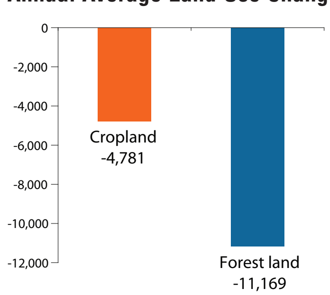
Notes: $MMTCO_2e$ = million metric tons carbon dioxide equivalents

Negative numbers indicate sequestration.

Annual Average Emissions from Land Use Change

Non-soil Forest[7]	Forest Soil[8]	Non-Forest Soil[9]	Total
$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$
5.8	45.4	6.1	57.3

Annual Average Land Use Change, 1997–2002 (ha)



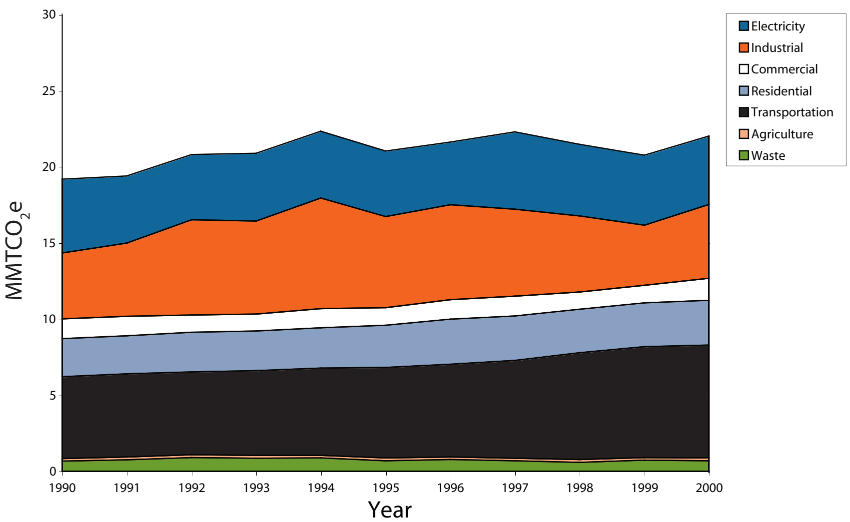
Source: USDA Census of Agriculture and Forest Service

State Data: New Hampshire

Population	1,235,786
Area	8,968 sq. mi. (23,227 sq. km.)
Gross State Product (GSP) (M USD)	$43,584

GHG Inventory

Historical Greenhouse Gas Emissions

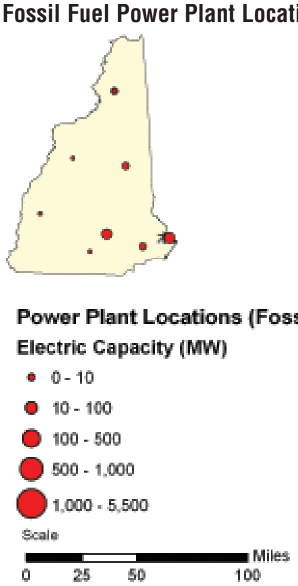


Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces

Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because states either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

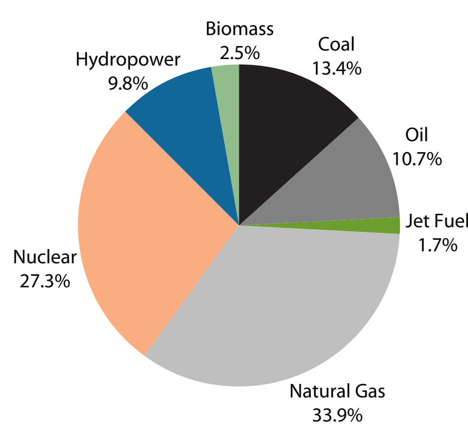
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



Source: EPA E-Grid

Electric Generation Capacity in 2004



Total Electric Generation Capacity: 4,551 MW

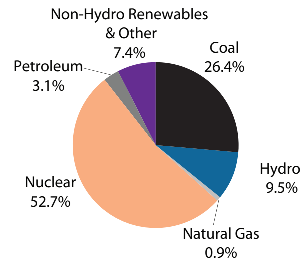
Source: EIA

Appendix

Total Energy Consumption (2000)[1]

	Total terajoules	Terajoules per capita	Terajoules per GSP
NH	346,154	0.28	7.9
NE-EC	5,952,405	0.25	6.96

Total Electric Generation in 2000



Total Electric Generation: 15,031,499 MWh
Source: EIA

Transportation

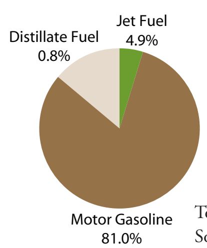
VMT for Light Duty Vehicles (2003)[2]

2000	11,339.76	Million miles
2003	12,234.81	Million miles
Yearly Change	2.63	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	347	Metric tons
Off-road use of diesel	347	Metric tons
Total PM 2.5 emissions	694	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 107.1 PJ
Source: EIA

Forestry and Land Use Change

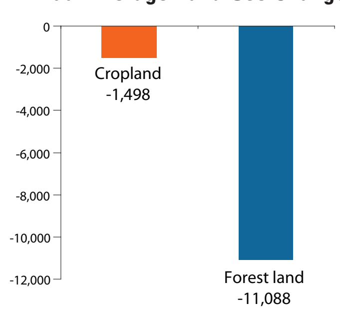
Forest Land Area[4]	Non-soil Forest Stock[5]	Annual Non-soil Forest Emissions[6]
kha	MMTCO2e	MMTCO2e
1,950	738.1 to 937.2	-9.0 to -10.6

Notes: MMTCO2e = million metric tons carbon dioxide equivalents
Negative numbers indicate sequestration.

Annual Average Emissions from Land Use Change (ha)

Non-soil Forest[7]	Forest Soil[8]	Non-Forest Soil[9]	Total
$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$
5.3	15.9	2.0	23.2

Annual Average Land Use Change, 1997–2002



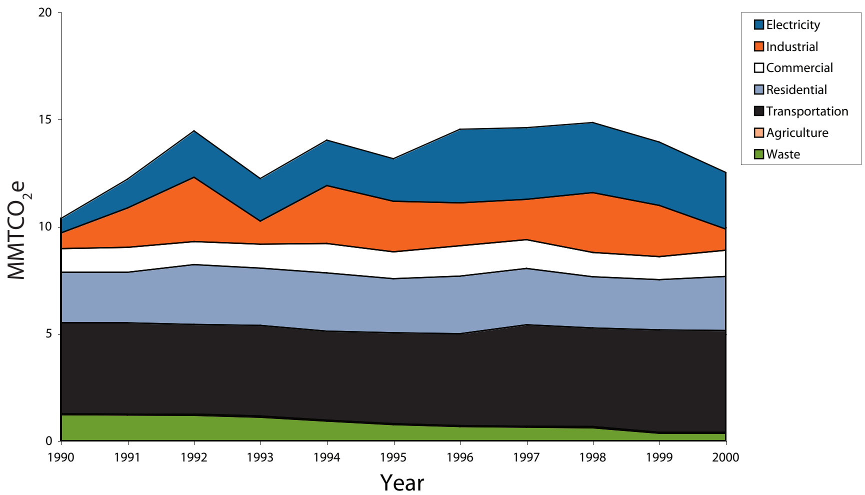
Source: USDA Census of Agriculture and Forest Service

State Data: Rhode Island

Population	1,048,319
Area	1,045 sq. mi. (2,707 sq. km.)
Gross State Product (GSP) (M USD)	$33,835

GHG Inventory

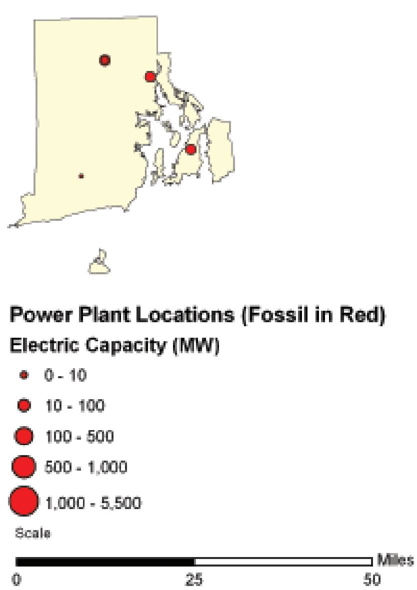
Historical Greenhouse Gas Emissions



Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces
Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because states either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

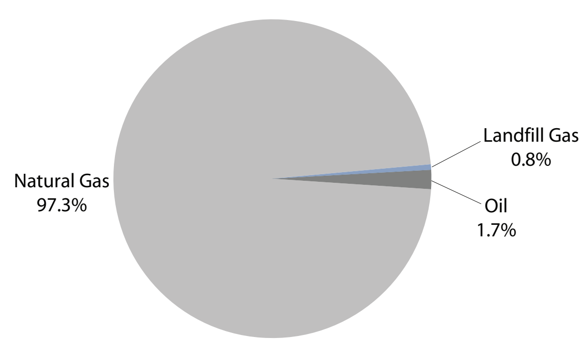
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



Source: EPA E-Grid

Electric Generation Capacity in 2004

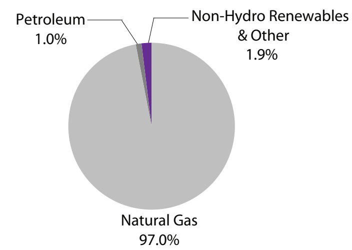


Total Electric Generation Capacity: 2,016 MW
Source: EIA

Total Energy Consumption (2000)[1]

	Total terajoules	Terajoules per capita	Terajoules per GSP
NH	235,479	0.22	7.0
NE-EC	5,952,405	0.25	6.96

Total Electric Generation in 2000



Total Electric Generation:
5,971,545 MWh
Source: EIA

Transportation

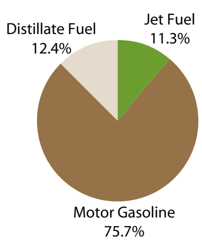
VMT for Light Duty Vehicles (2003)[2]

2000	7,382.12	Million miles
2003	7,590.09	Million miles
Yearly Change	0.94	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	80	Metric tons
Off-road use of diesel	221	Metric tons
Total PM 2.5 emissions	301	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 68.9 PJ
Source: EIA

Forestry and Land Use Change

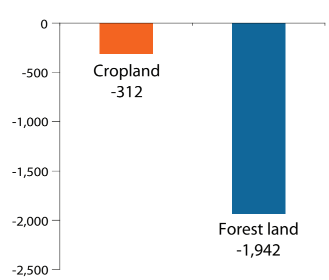
Forest Land Area[4]	Non-soil Forest Stock[5]	Annual Non-soil Forest Emissions[6]
kha	$MMTCO_2e$	$MMTCO_2e$
153	42.3 to 67.8	-0.1 to -1.3

Notes: MMTCO2e = million metric tons carbon dioxide equivalents
Negative numbers indicate sequestration.

Annual Average Emissions from Land Use Change (ha)

Non-soil Forest[7]	Forest Soil[8]	Non-Forest Soil[9]	Total
$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$
0.9	1.8	0.5	3.2

Annual Average Land Use Change, 1997–2002



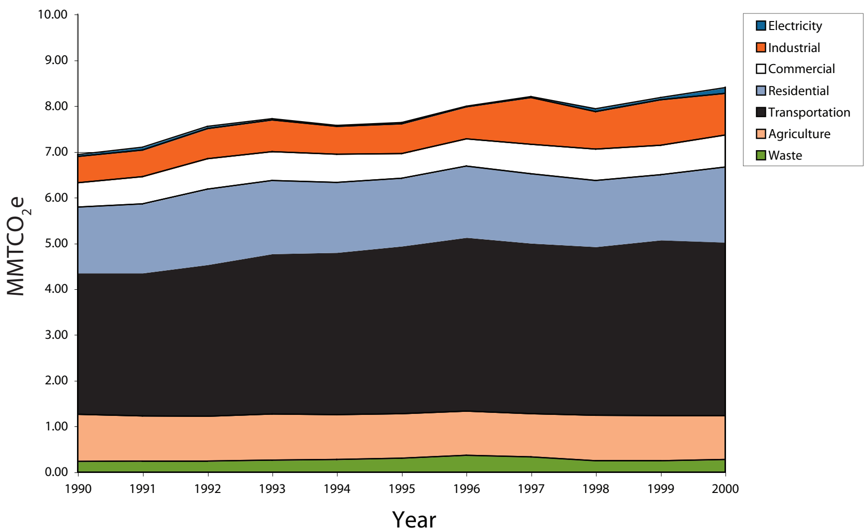
Source: USDA Census of Agriculture and Forest Service

State Data: Vermont

Population	608,827
Area	9,250 sq. mi. (23,957 sq. km.)
Gross State Product (GSP) (M USD)	$17,661

GHG Inventory

Historical Greenhouse Gas Emissions

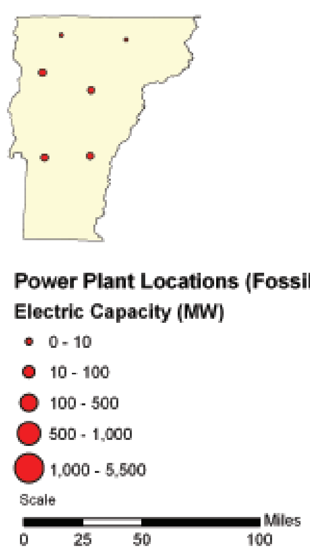


Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces

Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because states either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

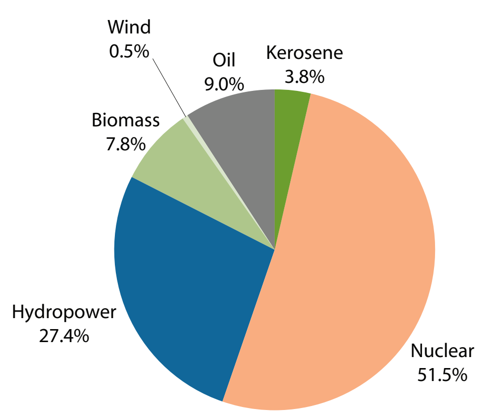
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



Source: EPA E-Grid

Electric Generation Capacity in 2004

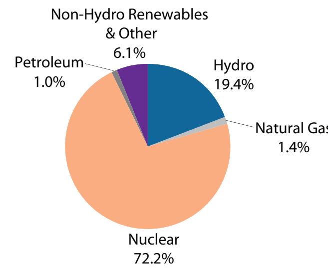


Total Electric Generation Capacity: 1,093 MW
Source: EIA

Total Energy Consumption (2000)[1]

	Total terajoules	Terajoules per capita	Terajoules per GSP
VT	174,162	0.29	9.9
NE-EC	5,952,405	0.25	6.96

Total Electric Generation in 2000



Total Electric Generation: 6,303,014 MWh
Source: EIA

Transportation

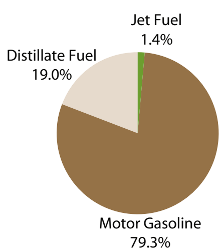
VMT for Light Duty Vehicles (2003)[2]

2000	6,595.78	Million miles
2003	7,526.83	Million miles
Yearly Change	4.71	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	311	Metric tons
Off-road use of diesel	270	Metric tons
Total PM 2.5 emissions	581	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 54.4 PJ
Source: EIA

Forestry and Land Use Change

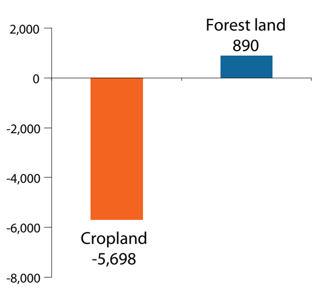
Forest Land Area[4]	Non-soil Forest Stock[5]	Annual Non-soil Forest Emissions[6]
kha	$MMTCO_2e$	$MMTCO_2e$
1,846	686.9 to 867.0	-16.2 to 0.6

Notes: MMTCO2e = million metric tons carbon dioxide equivalents
Negative numbers indicate sequestration.

Annual Average Emissions from Land Use Change (ha)

Non-soil Forest[7]	Forest Soil[8]	Non-Forest Soil[9]	Total
$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$	$MMTCO_2e$
-0.4	4.0	2.9	6.5

Annual Average Land Use Change, 1997–2002



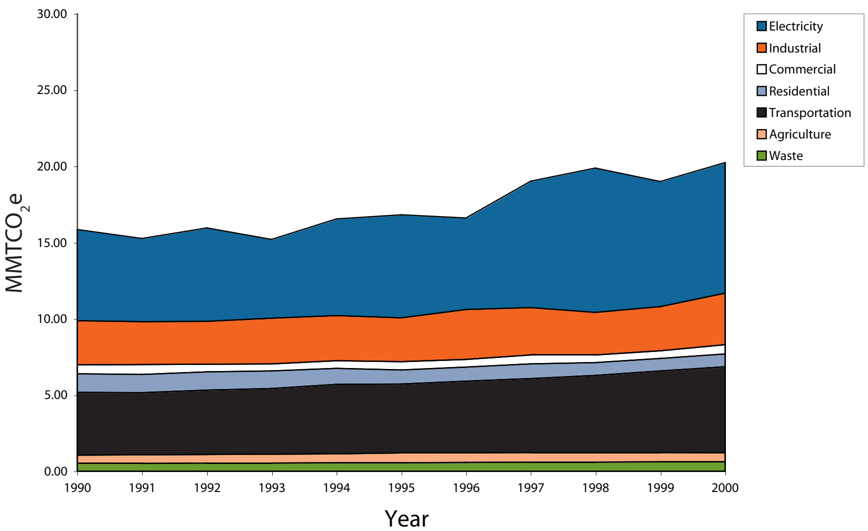
Source: USDA Census of Agriculture and Forest Service

Provincial Data: New Brunswick

Population	751,000
Area	28,185 sq. mi. (73,000 sq. km.)
Gross State Product (GSP) (M USD)	$20,085

GHG Inventory

Historical Greenhouse Gas Emissions

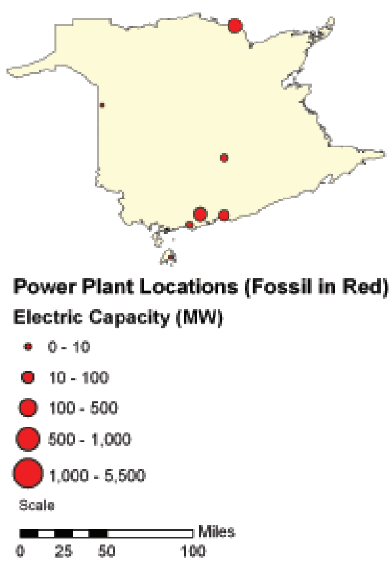


Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces

Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because provinces either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

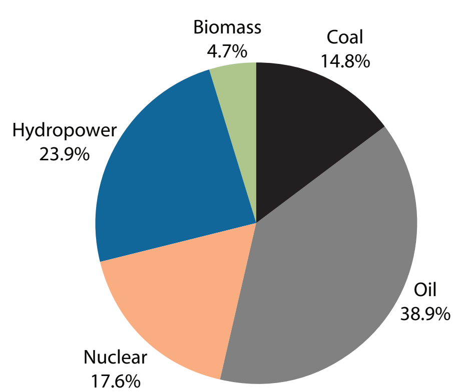
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



Source: Statistics Canada

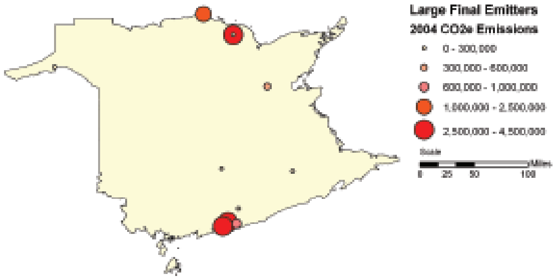
Electric Generation Capacity in 2000



Total Electric Generation Capacity: 3,854 MW

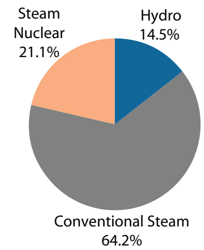
Source: Statistics Canada

Large Final Emitter Locations, 2004 (CO_2e)



Data Sources: Environment Canada, Facility Level GHG Reporting for 2004. Locations based on ESRI Canadian 3-digit postal code data

Total Energy Consumption in 2000[1]



Total Electric Generation: 18,778,156 MWh
Source: Statistics Canada

Total Electric Generation in 2000 (MWh)

	Total terajoules	Terajoules per capita	Terajoules per GSP
NB	228,453	0.30	11.4
NE-EC	5,952,405	0.25	6.96

Transportation

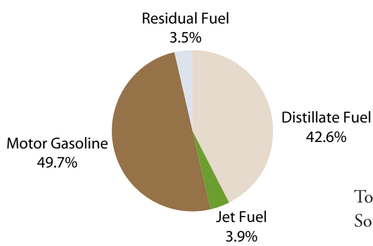
VMT for Light Duty Vehicles (2003)[2]

2000	5,071.51	Million miles
2003	4,781.64	Million miles
Yearly Change	-1.91	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	659	Metric tons
Off-road use of diesel	1,425	Metric tons
Total PM 2.5 emissions	1,569	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 71.2 PJ
Source: OEE

Forestry and Land Use Change

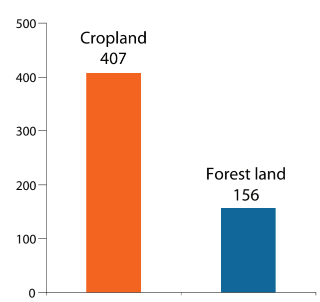
Province-by-province data on forestry and land use change emissions (soil and non-soil) are not available at this time and are not provided here.

Forest Land Area[4]	Non-soil Forest Stock	Annual Non-soil Forest Emissions
kha	$MMTCO_2e$	$MMTCO_2e$
6,200	Not estimated	Not estimated

Notes: $MMTCO_2e$ = million metric tons carbon dioxide equivalents

Annual Average Land Use Change, 1996-2001 (ha)

Source: Cropland from Statistics Canada; forest data from Canada's GHG Inventory estimates

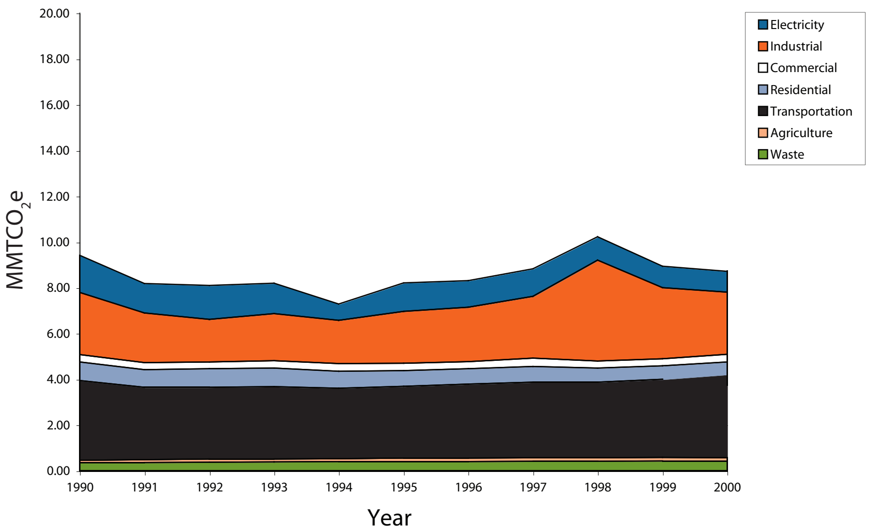


Provincial Data: Newfoundland and Labrador

Population	528,000
Area	154,441 sq. mi. (400,000 sq. km.)
Gross State Product (GSP) (M USD)	$13,922

GHG Inventory

Historical Greenhouse Gas Emissions

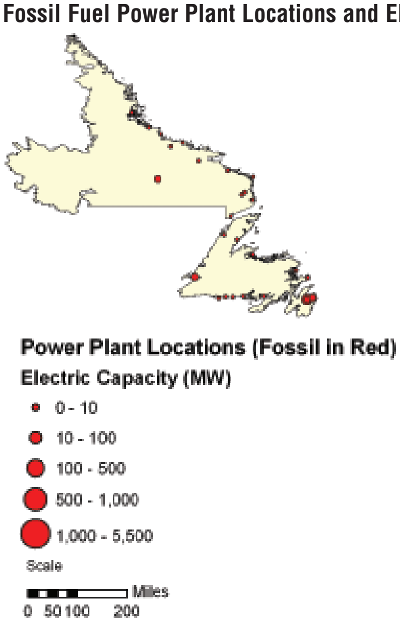


Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces

Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because provinces either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

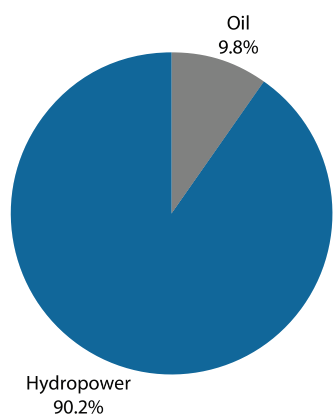
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



Source: Statistics Canada

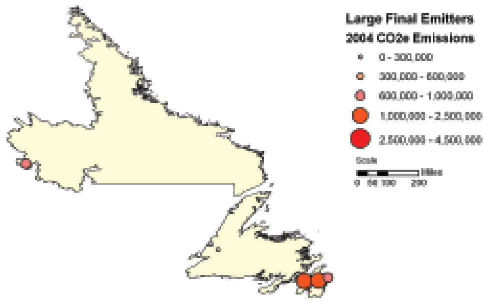
Electric Generation Capacity in 2000



Total Electric Generation Capacity: 7,416 MW

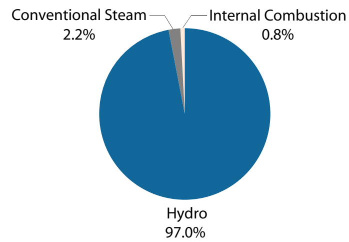
Source: Statistics Canada

Large Final Emitter Locations, 2004 (CO_2e)



Data Sources: Environment Canada, Facility Level GHG Reporting for 2004. Locations based on ESRI Canadian 3-digit postal code data

Total Electric Generation in 2000



Total Electric Generation: 43,597,943 MWh
Source: Statistics Canada

Total Energy Consumption (2000)[1]

	Total terajoules	Terajoules per capita	Terajoules per GSP
NF/L	147,599	0.28	10.6
NE-EC	5,952,405	0.25	6.96

Transportation

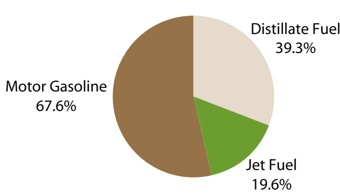
VMT for Light Duty Vehicles (2003)[2]

2000	2,983.51	Million miles
2003	2,183.19	Million miles
Yearly Change	-8.94	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	251	Metric tons
Off-road use of diesel	362	Metric tons
Total PM 2.5 emissions	613	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 51.1 PJ
Source: OEE

Forestry and Land Use Change

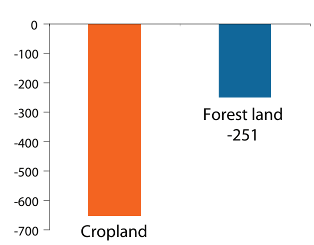
Province-by-province data on forestry and land use change emissions (soil and non-soil) are not available at this time and are not provided here.

Forest Land Area[4]	Non-soil Forest Stock	Annual Non-soil Forest Emissions
kha	$MMTCO_2e$	$MMTCO_2e$
20,000	Not estimated	Not estimated

Notes: $MMTCO_2e$ = million metric tons carbon dioxide equivalents

Annual Average Land Use Change, 1996-2001 (ha)

Source: Cropland from Statistics Canada; forest data from Canada's GHG Inventory estimates

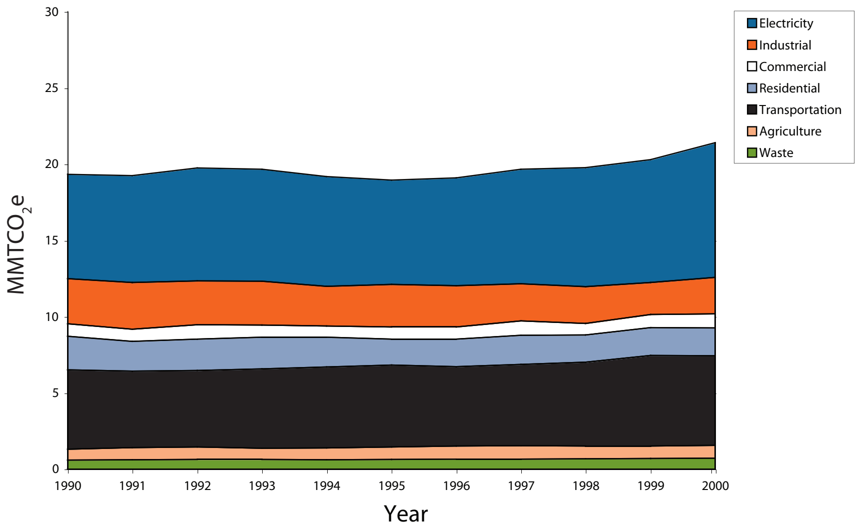


Provincial Data: Nova Scotia

Population	934,000
Area	21,236 sq. mi. (55,000 sq. km.)
Gross State Product (GSP) (M USD)	$24,658

GHG Inventory

Historical Greenhouse Gas Emissions

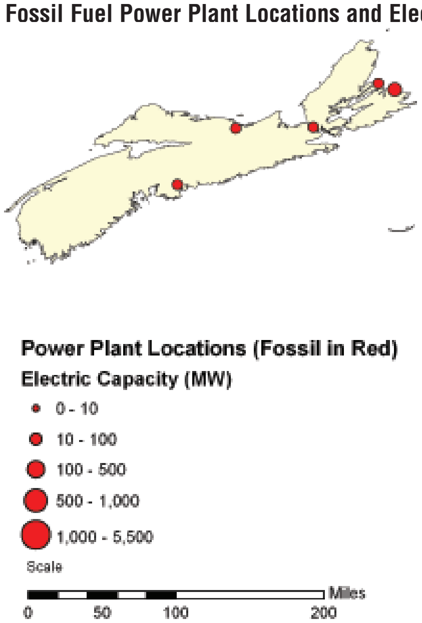


Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces

Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because provinces either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

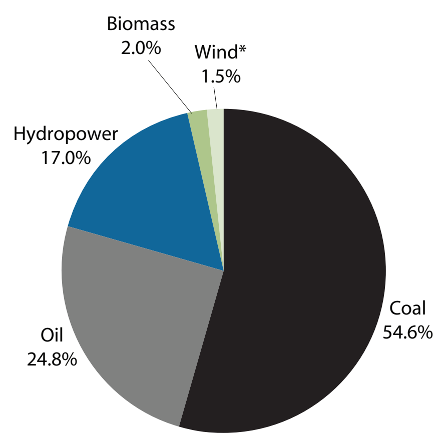
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



Source: Statistics Canada

Electric Generation Capacity in 2000

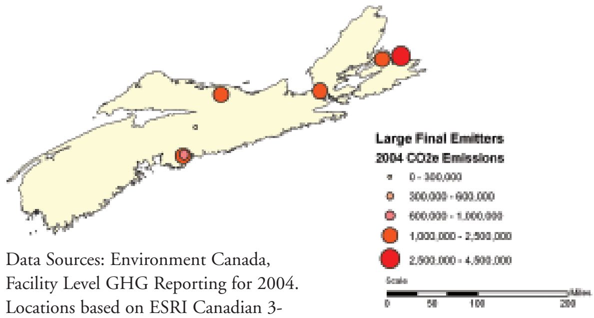


* Wind data through 2005

Total Electric Generation Capacity: 2,344 MW

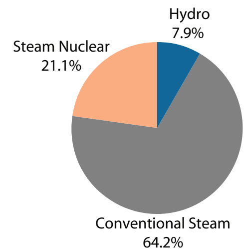
Source: Statistics Canada

Large Final Emitter Locations, 2004 (CO_2e)



Data Sources: Environment Canada, Facility Level GHG Reporting for 2004. Locations based on ESRI Canadian 3-digit postal code data

Total Electric Generation in 2000



Total Electric Generation: 11,605,083 MWh
Source: Statistics Canada

Total Energy Consumption (2000)[1]

	Total terajoules	Terajoules per capita	Terajoules per GSP
NS	203,250	0.22	8.20
NE-EC	5,952,405	0.25	6.96

Transportation

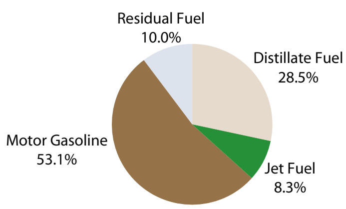
VMT for Light Duty Vehicles (2003)[2]

2000	5,298.24	Million miles
2003	6,184.63	Million miles
Yearly Change	5.58	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	463	Metric tons
Off-road use of diesel	1,106	Metric tons
Total PM 2.5 emissions	1,569	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 78.3 PJ
Source: OEE

Forestry and Land Use Change

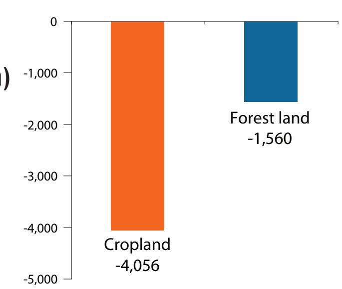
Province-by-province data on forestry and land use change emissions (soil and non-soil) are not available at this time and are not provided here.

Forest Land Area[4]	Non-soil Forest Stock	Annual Non-soil Forest Emissions
kha	$MMTCO_2e$	$MMTCO_2e$
4,400	Not estimated	Not estimated

Notes: $MMTCO_2e$ = million metric tons carbon dioxide equivalents

Annual Average Land Use Change, 1996-2001 (ha)

Source: Cropland from Statistics Canada; forest data from Canada's GHG Inventory estimates

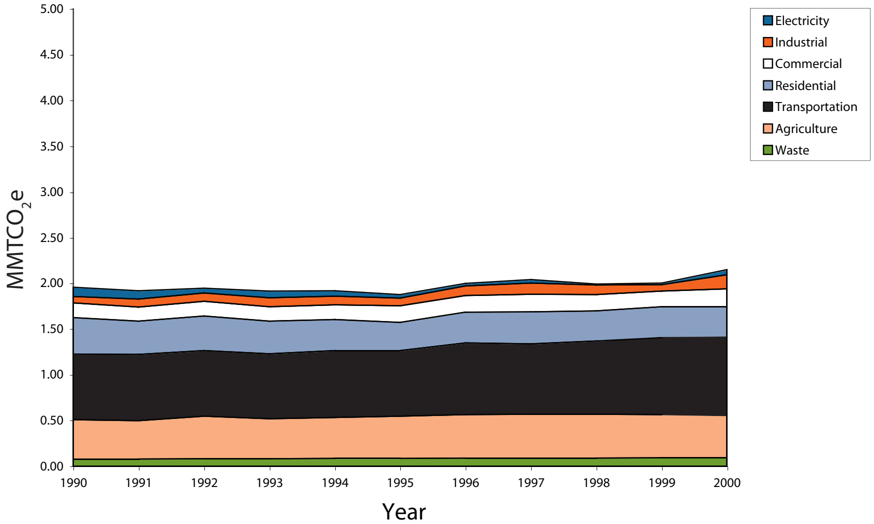


Provincial Data: Prince Edward Island

Population	136,000
Area	2,239 sq. mi. (5,800 sq. km.)
Gross State Product (GSP) (M USD)	$3,366

GHG Inventory

Historical Greenhouse Gas Emissions

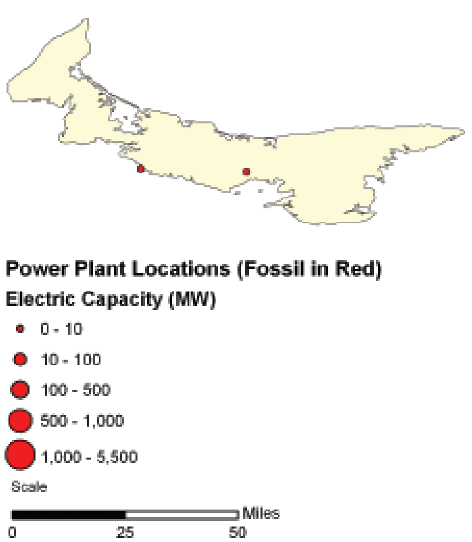


Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces

Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because provinces either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

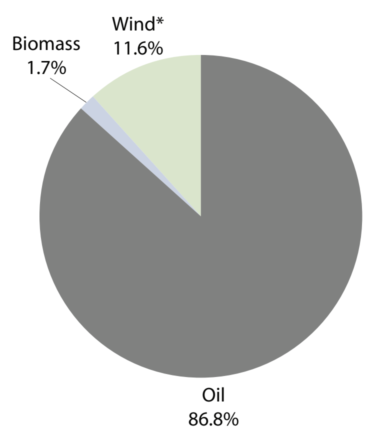
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



Source: Statistics Canada

Electric Generation Capacity in 2000

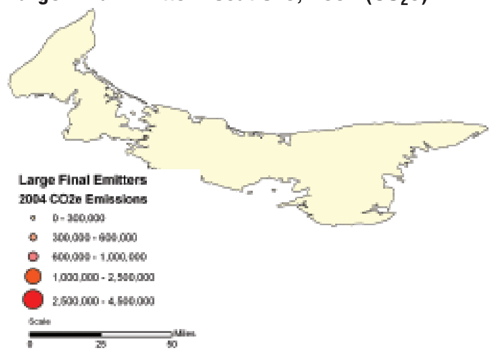


* Wind data through 2005

Total Electric Generation Capacity: 121 MW

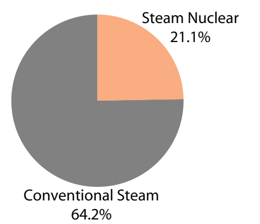
Source: Statistics Canada

Large Final Emitter Locations, 2004 (CO_2e)



Data Sources: Environment Canada, Facility Level GHG Reporting for 2004. Locations based on ESRI Canadian 3-digit postal code data

Total Electric Generation in 2000



Total Electric Generation: 48,081 MWh
Source: Statistics Canada

Total Energy Consumption (2000)[1]

	Total terajoules	Terajoules per capita	Terajoules per GSP
PEI	25,567	0.19	7.6
NE-EC	5,952,405	0.25	6.96

Transportation

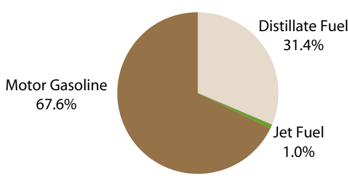
VMT for Light Duty Vehicles (2003)[2]

2000	734.09	Million miles
2003	797.41	Million miles
Yearly Change	2.88	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	152	Metric tons
Off-road use of diesel	441	Metric tons
Total PM 2.5 emissions	592	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 10.5 PJ
Source: OEE

Forestry and Land Use Change

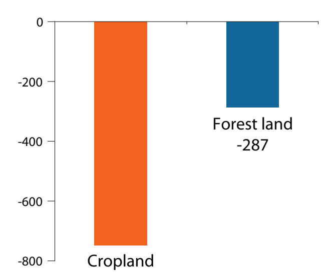
Province-by-province data on forestry and land use change emissions (soil and non-soil) are not available at this time and are not provided here.

Forest Land Area[4]	Non-soil Forest Stock	Annual Non-soil Forest Emissions
kha	$MMTCO_2e$	$MMTCO_2e$
270	Not estimated	Not estimated

Notes: $MMTCO_2e$ = million metric tons carbon dioxide equivalents

Annual Average Land Use Change, 1996-2001 (ha)

Source: Cropland from Statistics Canada; forest data from Canada's GHG Inventory estimates

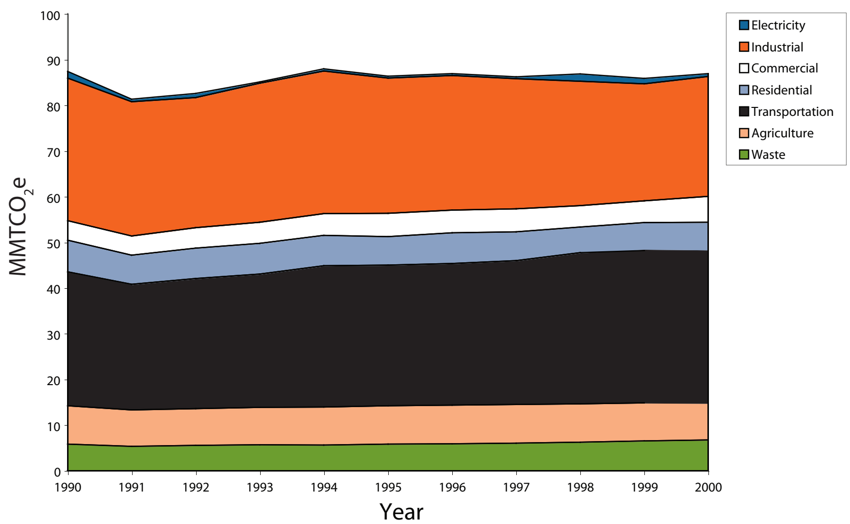


Provincial Data: Quebec

Population	7,357,000
Area	586,875 sq. mi. (1,520,000 sq. km.)
Gross State Product (GSP) (M USD)	$224,928

GHG Inventory

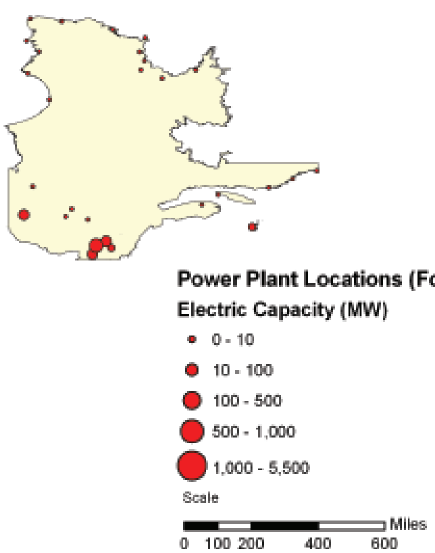
Historical Greenhouse Gas Emissions



Source: NESCAUM and EPA State Inventory Tool for New England and Natural Resources Canada for Eastern Canadian Provinces
Note: Forestry and land use change data are not included in the historical greenhouse gas emissions because provinces either do not report these emissions or do not report them consistently. See the Forestry and Land Use Change section for more information.

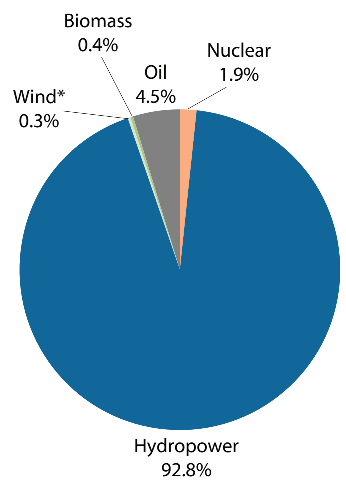
Energy

Fossil Fuel Power Plant Locations and Electric Capacity



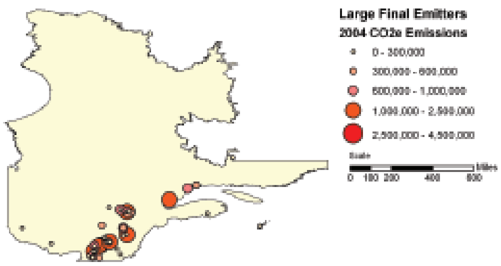
Source: Statistics Canada

Electric Generation Capacity in 2000



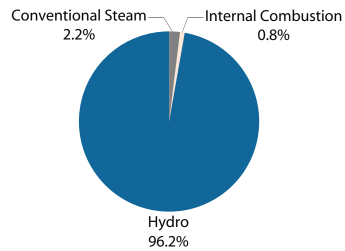
* Wind data through 2005
Total Electric Generation Capacity: 35,376 MW
Source: Statistics Canada

Large Final Emitter Locations, 2004 (CO_2e)



Data Sources: Environment Canada, Facility Level GHG Reporting for 2004. Locations based on ESRI Canadian 3-digit postal code data

Total Electric Generation in 2000



Total Electric Generation: 179,728,120 MWh
Source: Statistics Canada

Total Energy Consumption (2000)[1]

	Total terajoules	Terajoules per capita	Terajoules per GSP
Quebec	1,724,365	0.23	7.7
NE-EC	5,952,405	0.25	6.96

Transportation

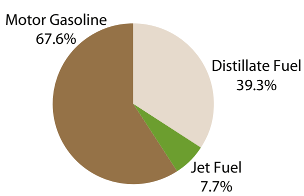
VMT for Light Duty Vehicles (2003)[2]

2000	39,081.69	Million miles
2003	42.874.29	Million miles
Yearly Change	3.23	%

Heavy Duty Vehicles: PM2.5 Emissions from Diesels (2002)[3]

Highway diesel vehicles	4,349	Metric tons
Off-road use of diesel	11,417	Metric tons
Total PM 2.5 emissions	15,767	Metric tons

Energy Consumption from Transportation in 2001 (Petajoules)



Total: 451.9 PJ
Source: OEE

Forestry and Land Use Change

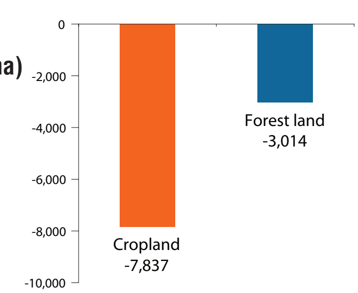
Province-by-province data on forestry and land use change emissions (soil and non-soil) are not available at this time and are not provided here.

Forest Land Area[4]	Non-soil Forest Stock	Annual Non-soil Forest Emissions
kha	$MMTCO_2e$	$MMTCO_2e$
84,600	Not estimated	Not estimated

Notes: $MMTCO_2e$ = million metric tons carbon dioxide equivalents

Annual Average Land Use Change, 1996-2001 (ha)

Source: Cropland from Statistics Canada; forest data from Canada's GHG Inventory estimates



Notes

Environment
Northeast

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