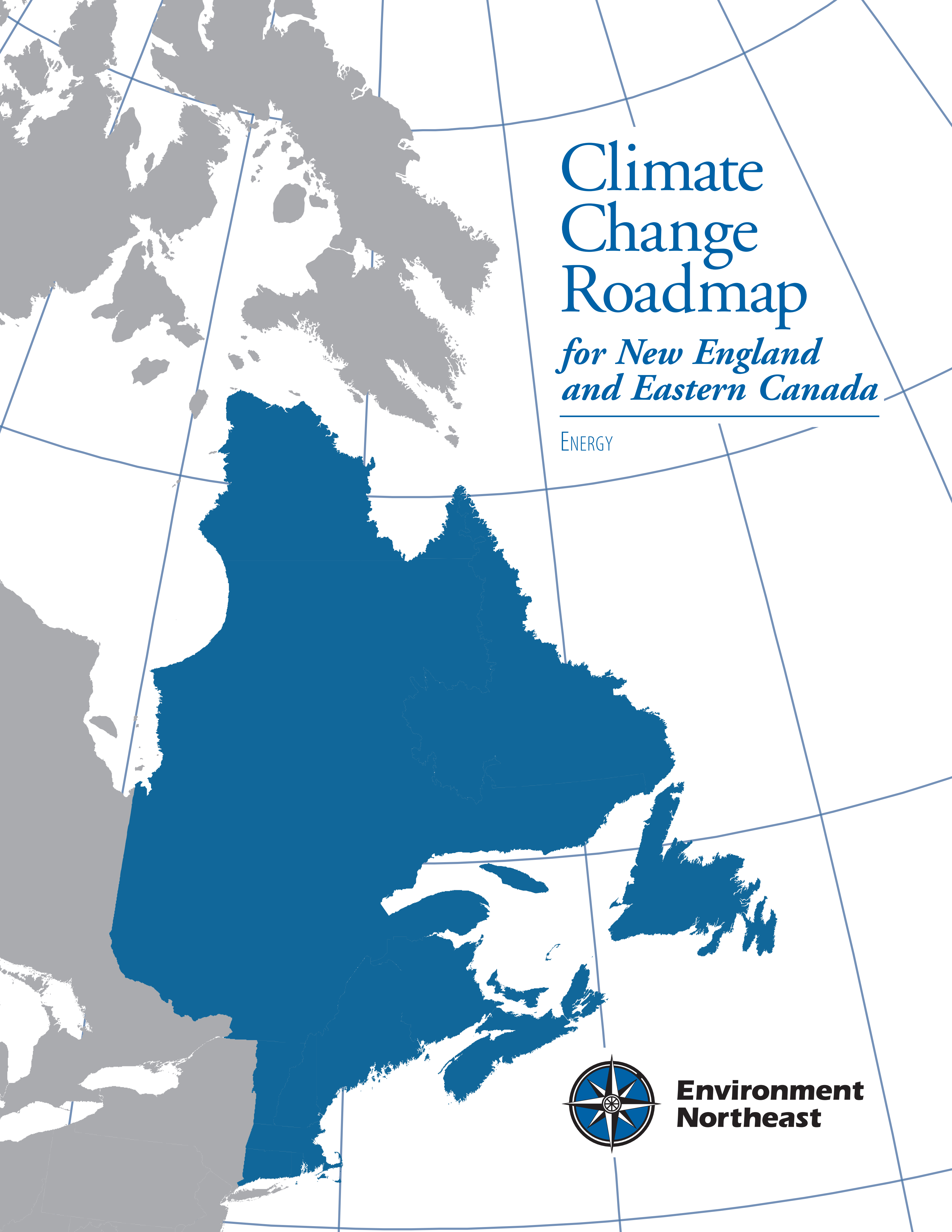
Climate Change Roadmap

for New England and Eastern Canada

Energy



Environment Northeast

Chapter 1: Energy

Introduction

In this chapter, we review the most promising opportunities to reduce greenhouse gases from stationary energy sources in the region of New England and Eastern Canada. Here we include electric power plants, industrial boilers, heating and cooling systems for commercial buildings, and home furnaces and distinguish stationary energy sources from mobile energy sources of GHGs such as cars and trucks.

Of the many available opportunities to advance these goals, we have organized the recommendations for new policies and programs of this chapter according to the following five priorities:

- Priority 1 – Invest in energy efficiency resources
- Priority 2 – Increase energy efficiency of buildings
- Priority 3 – Increase the efficiency of appliances and commercial equipment
- Priority 4 – Reduce emissions from large stationary sources
- Priority 5 – Commercialize and deploy no-carbon and low-carbon energy sources

The first three of these priorities can be loosely categorized as “demand side” measures, since they are designed to influence consumer demand (or “consumption”) of energy. The last two priorities may be categorized as “supply side” measures, reflecting the fact that they primarily affect how energy suppliers produce and distribute energy to consumers.

Before discussing these priorities in more detail, it is useful to lay out some basic information that may help to put subsequent policy discussions in context.

Energy as a Source of Greenhouse Gases

We see in Table 1.1 evidence that stationary energy applications are responsible for more than half of the total GHGs emitted in New England and the Eastern Canadian provinces. Reducing these emissions must be a top priority for policy makers because they constitute such a large fraction of the total GHG emissions in the region.

Table 1.1: Stationary Energy Contribution to Total GHG Emissions

	1990		2000	
GHG from Energy*	$MMTCO_2e$	contribution to total GHG emissions	$MMTCO_2e$	contribution to total GHG emissions
6 New England States	110	56%	112	54%
5 Eastern Canadian Provinces	74	55%	71	51%
TOTAL REGION	184	56%	183	53%

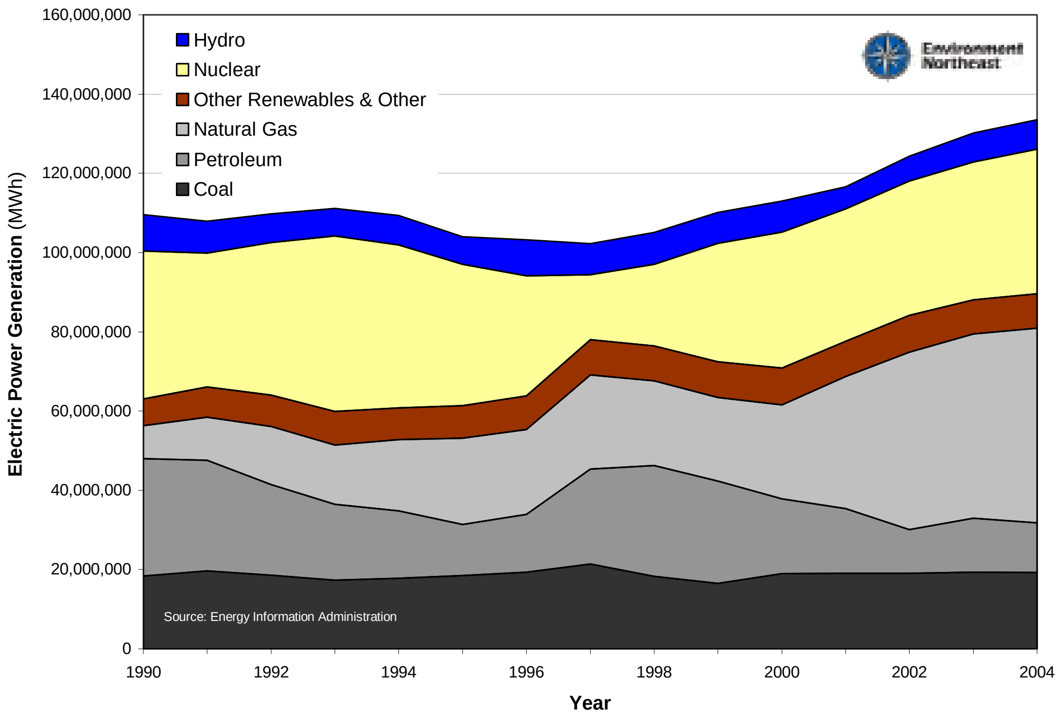
Note: * This table includes industrial process gases that may be contained in the NESCAUM/EPA and Natural Resources Canada GHG inventories of industrial GHGs even though these gases are not technically associated with the production or consumption of energy.

Approximately one-third of the region's energy GHGs are emitted during the generation of electricity. The remaining two-thirds of GHG emissions are emitted during the combustion of oil, natural gas, and biomass used to heat and cool homes and businesses and for industrial uses.[1]

Energy Consumption and Supply

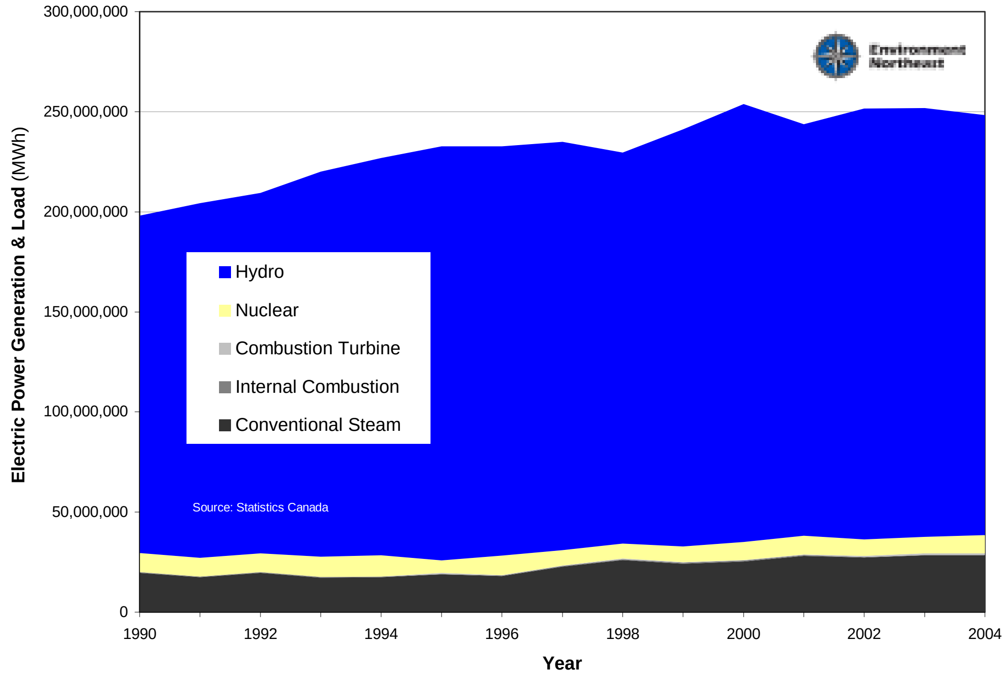
The first order of business is to understand how much energy we are using, and what quantity of fuels and technology types we are using to make energy. Starting with the existing electric generation mix in the region, Figures 1.1 and 1.2 illustrate the amount of low-carbon and no-carbon generation coming from hydro, nuclear and other renewable resources compared to the relatively high-carbon emitters such as natural gas, petroleum (oil) and coal since 1990. In Canada, official databases report the fossil generators by technology rather than fuel type, but it is adequate for our purposes to know that combustion turbines, internal combustion and conventional steam are mostly burning coal and oil. From these figures, we see that, without factoring in exports and imports, New England is making and consuming roughly 130 million MWh of electricity per year, and Eastern Canada is making and consuming approximately 250 million MWh per year.

Figure 1.1: Annual Electric Generation in New England by Fuel Type



[1] It is also worth noting that these sources of energy are responsible for a large portion of the region's acid-rain-causing sulfur dioxide, smog-causing nitrogen oxides, fine particulates, and mercury.

Figure 1.2: Annual Electric Generation in Eastern Canada by Generation Type



As we will discuss more under the first three (demand side) priorities in this chapter, we rely on numerous studies about the region's potential cost-effective energy efficiency opportunities to support the proposition that states and provinces in the region can keep local economies growing and maintain our present quality of life while keeping the amount of electric energy we consume constant for most of the next decade. It is feasible to actually reduce this consumption ("load") a bit more every year from 2020 through 2050. Leveling and then gradual reduction in load growth is shown in Figures 1.3 and 1.4 by the green dotted line. If we do not increase the efficiency with which we use electricity, load growth of 1.3% for New England and 1.2% for Eastern Canada is projected for each year.

Figure 1.3: New England Electric Power Consumption Targets

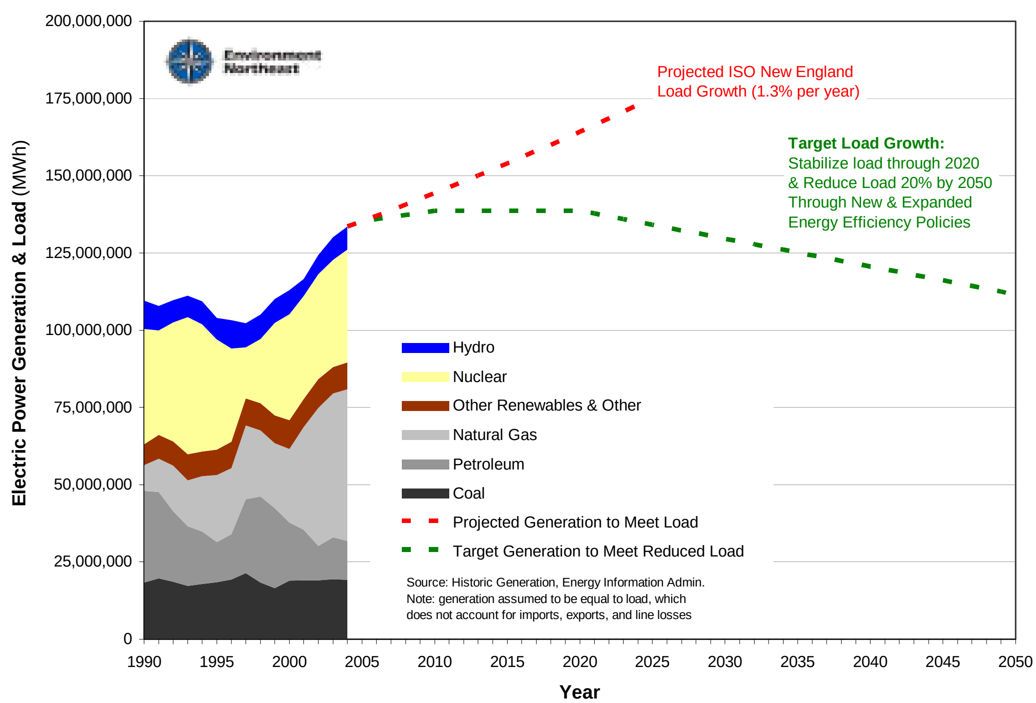
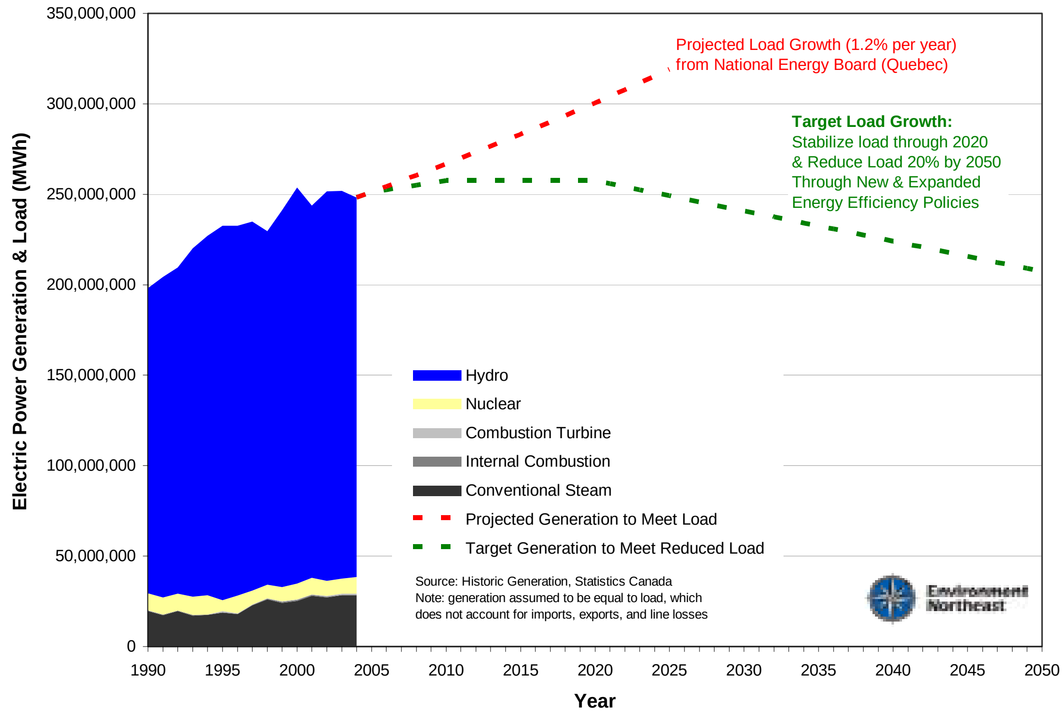
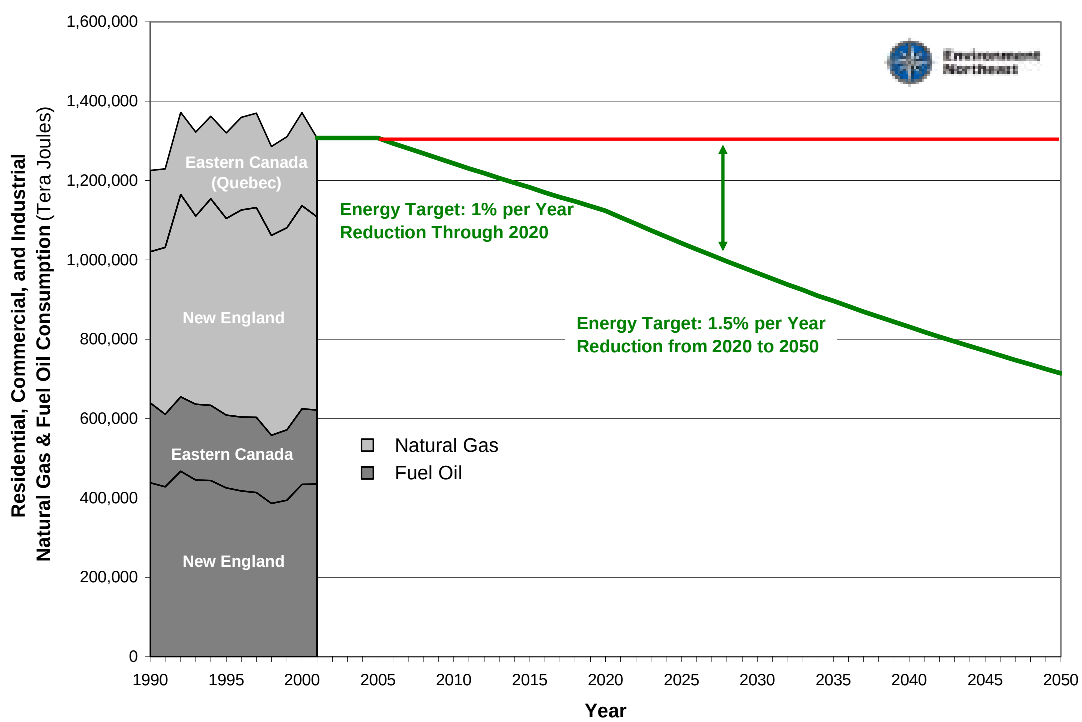


Figure 1.4: Eastern Canadian Electric Power Consumption Targets



In addition to electricity, consumers in the NE-EC region use other kinds of energy for such stationary applications as heating, cooling, and manufacturing. As Figure 1.5 illustrates, for most of the past decade the region has consumed in the vicinity of 1.3 million tera joules of natural gas and fuel oil each year in the residential, commercial and industrial sectors. (A tera joule is 1 trillion joules, or the equivalent of about 275 MWh). Figure 1.5 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.

Figure 1.5: New England and Eastern Canadian Energy Consumption Targets for Natural Gas and Fuel Oil in the Residential, Commercial, and Industrial Sectors

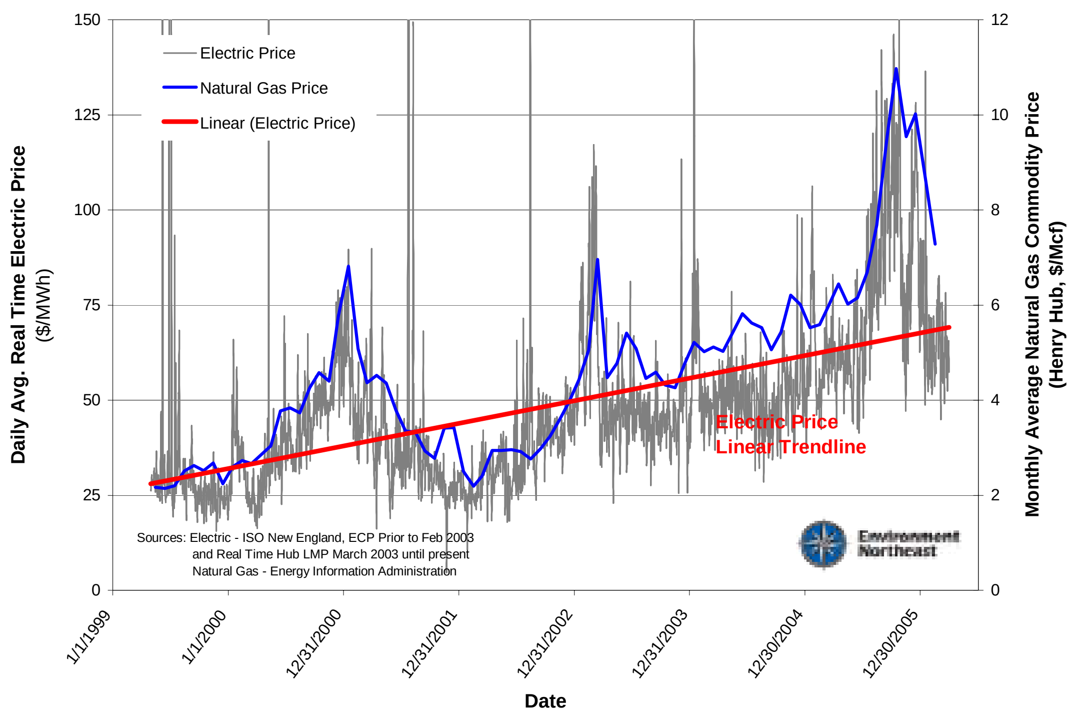


These are aggressive targets. However, we think the following discussion of energy costs and energy expenditures in the region demonstrate the opportunity we face to invest in energy efficiency, save money, and achieve our targets.

Energy Costs and Expenditures

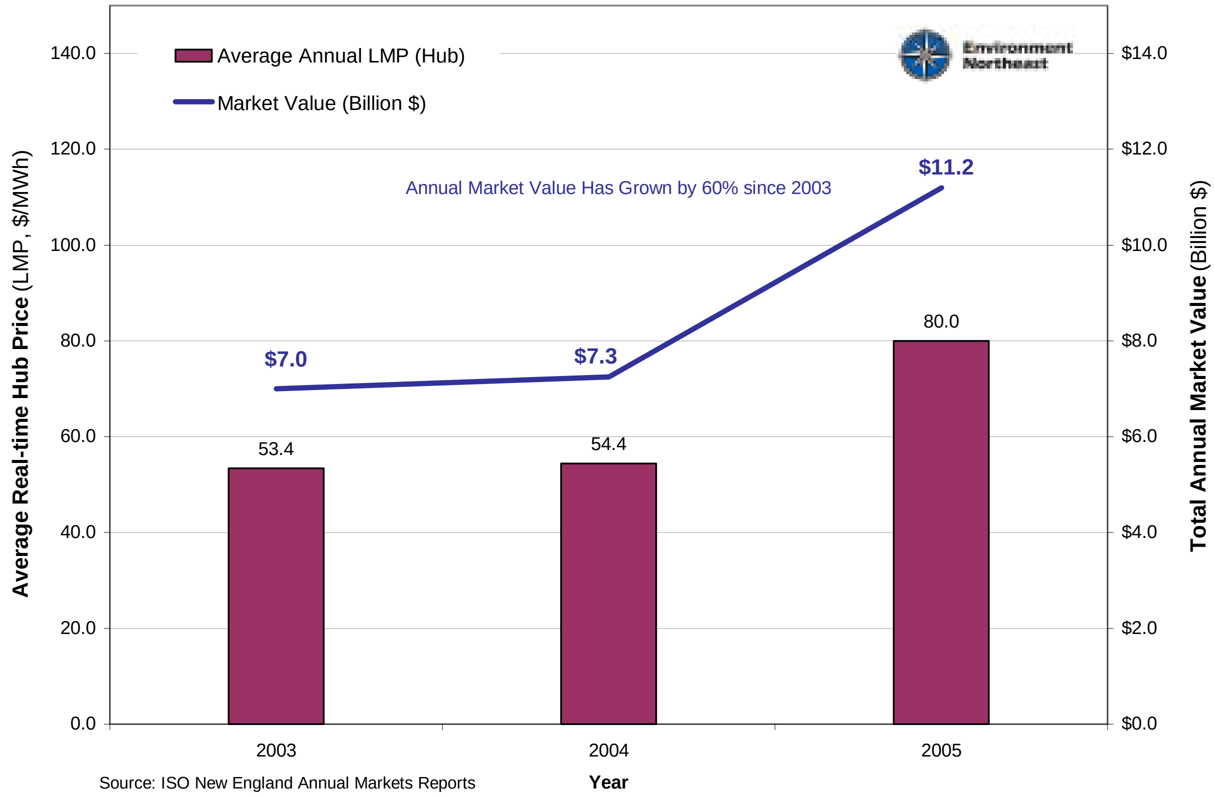
As Figure 1.6 shows, the wholesale prices of electricity and natural gas in New England have climbed steadily during the past seven years.

Figure 1.6: New England Natural Gas Commodity Costs and Wholesale Electric Prices
The wholesale price of electric power, shown in grey, closely tracks the price of natural gas, shown in blue; with the red line illustrating the linear trend of electric power prices over the last seven years.



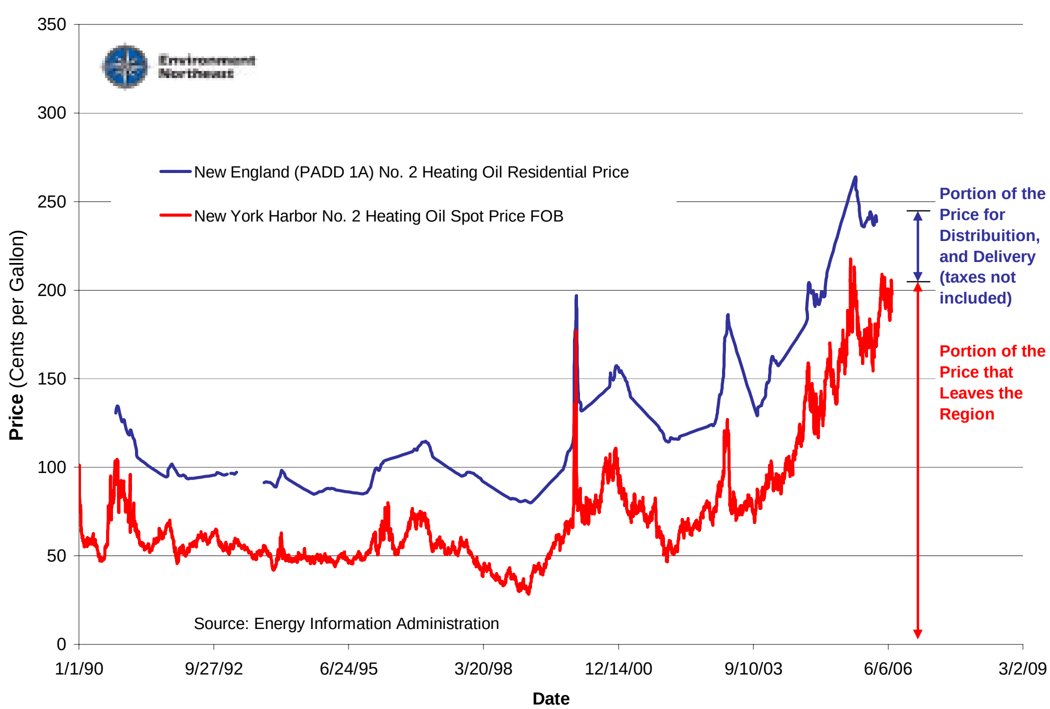
In 2004, the annual average spot market price for electric generation in New England was $54/MWh. In 2005, that average price jumped to $80/MWh.

Figure 1.7: The Annual Average Generation Price and Total Size of the Wholesale Electric Power Market in New England (ISO New England)



A similar trend is underway for fuel oil (heating oil), the other major energy commodity used in the region. The residential price of home heating oil has moved from $1/gallon through most of the 1990s to $2.50 in the winter of 2005-2006.

Figure 1.8: Commodity Costs and Delivered Residential Costs for Fuel Oil (Heating Oil) in the Northeast



Figures 1.9, 1.10 and 1.11 indicate the impact these rising commodity prices and rising consumption have had on electric power generators and on residential, commercial and industrial consumers of natural gas and fuel oil. (Data on expenditure trends for electricity generation and natural gas were not readily available for all of Eastern Canada and therefore are not reflected below).

In sum, Figures 1.9-1.11 show that from 1999 to 2005:

- expenditures for electric power generators (in New England) quadrupled;
- expenditures for natural gas (in New England) doubled;
- expenditures for fuel oil across the region more than doubled.

Figure 1.9: Fossil Fuel Expenditures by New England Electric Power Generators

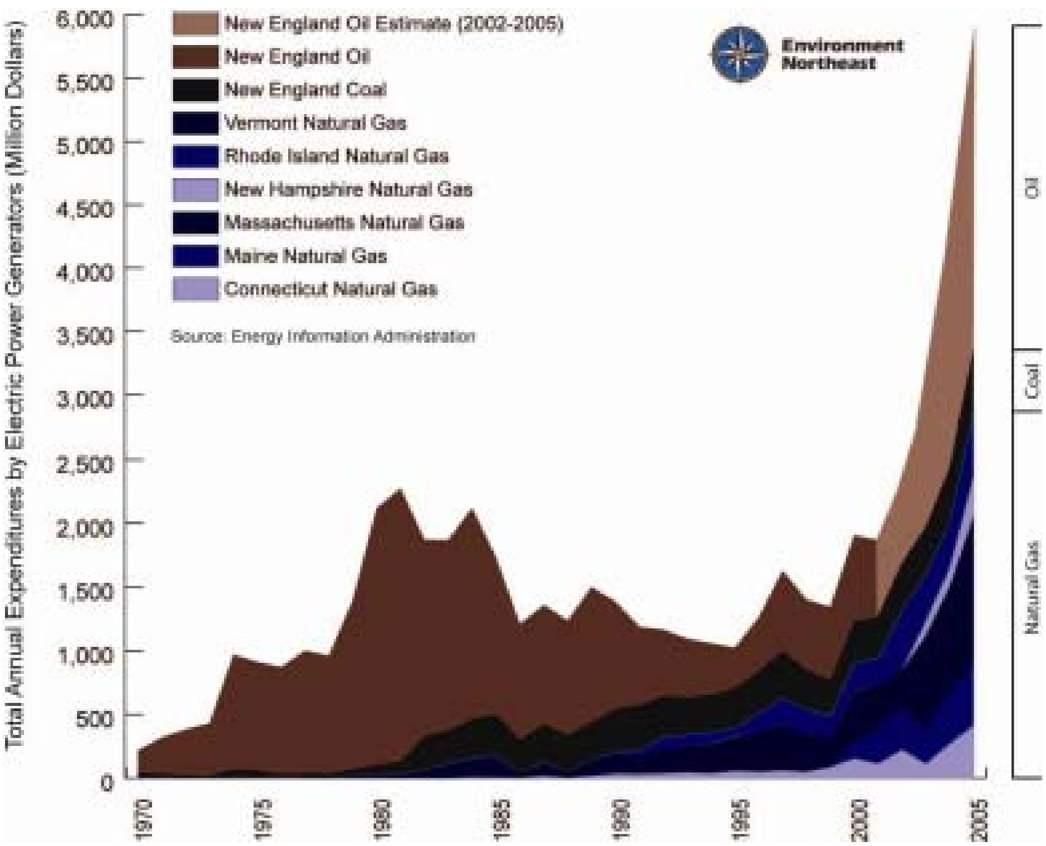


Figure 1.10: Residential, Commercial, and Industrial Expenditures on Natural Gas in New England (commodity only)

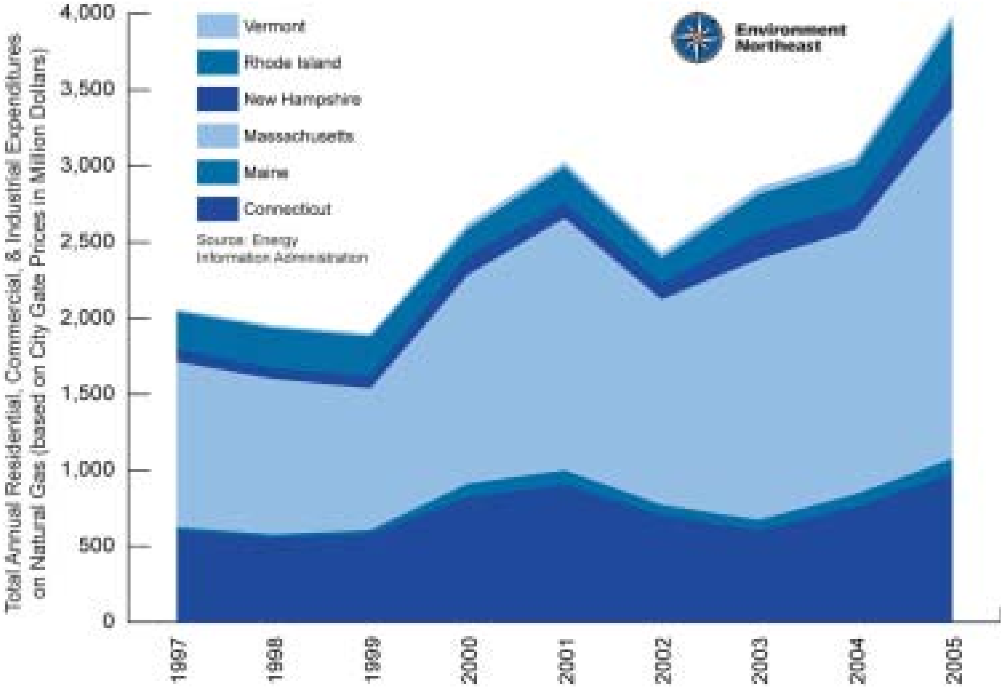
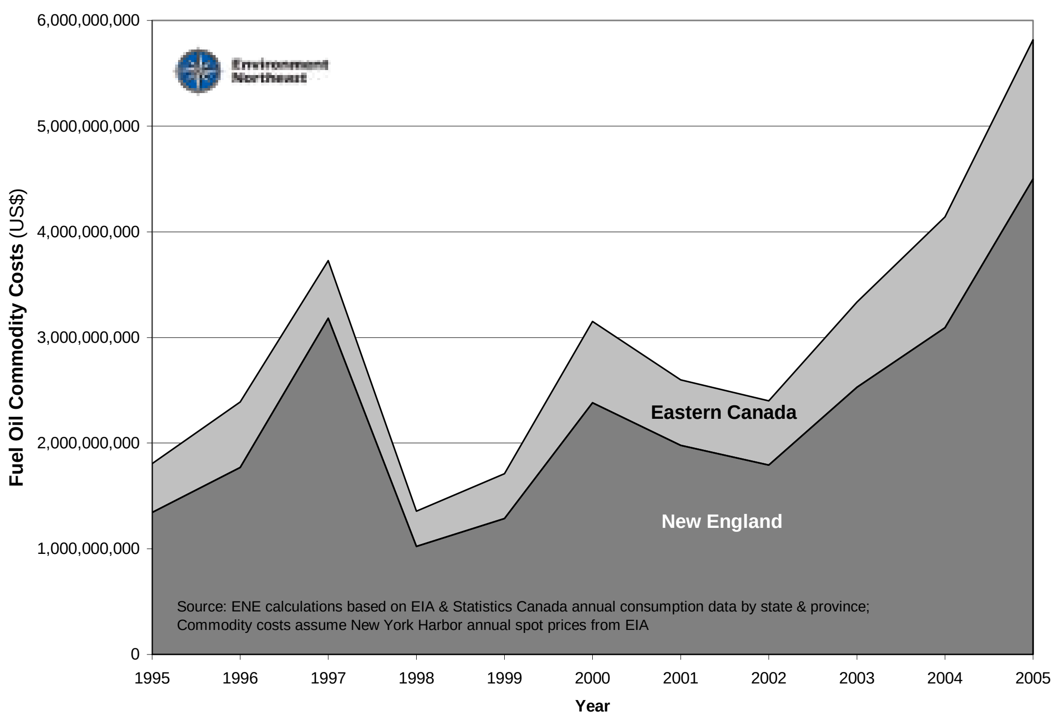
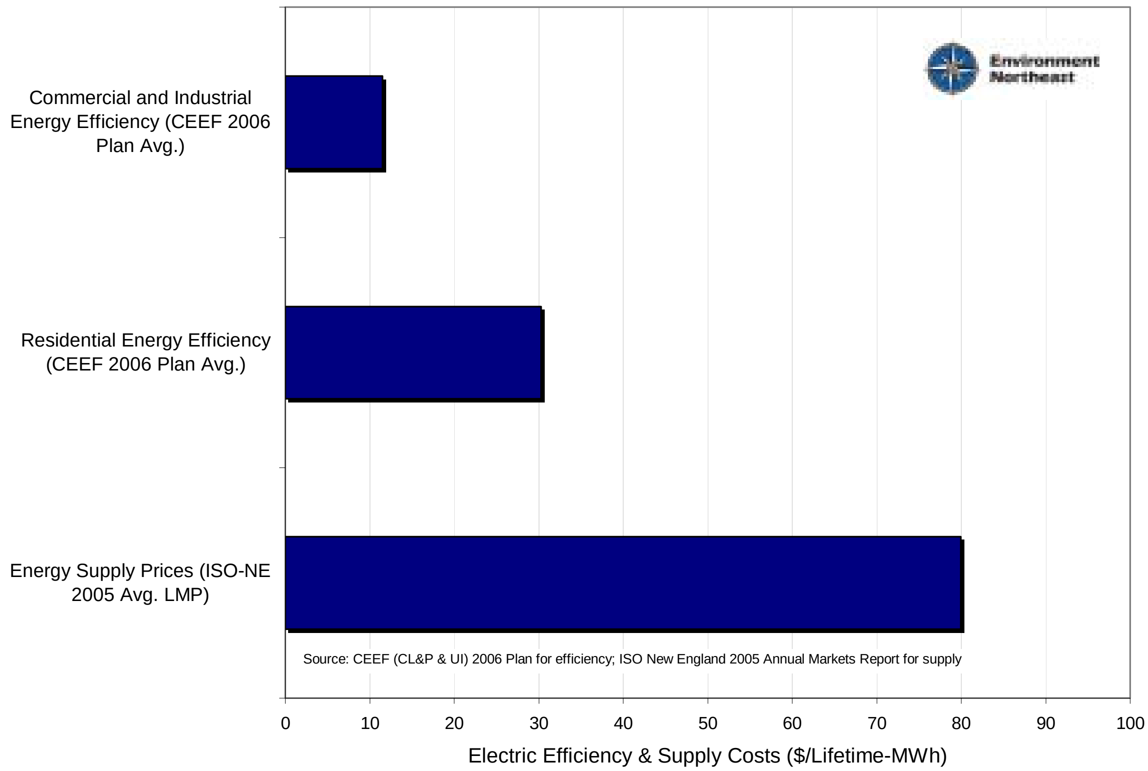


Figure 1.11: Total Expenditures in New England and Eastern Canada on Fuel Oil
New England consumption is for residential, commercial, and industrial use and Eastern Canadian consumption is all sales of light fuel oil



The dramatic rise in commodity costs and expenditures for conventional supplies of energy has ignited a search for cheaper alternatives. Fortunately for the region's businesses and consumers, at least one alternative has emerged that is cheaper and also helps achieve GHG emission targets. Using electricity supply as an illustration, Figure 1.12 shows that on average, energy efficiency projects can be purchased (or invested in) for no more than $30/Lifetime-MWh. Commercial sector efficiency projects can be purchased for less than $15/Lifetime-MWh. By comparison, purchasing an equivalent amount of conventional electric energy has lately cost about $80/MWh. These energy efficiency investments translate into energy savings or benefits that exceed costs by at least four times. This presents a very large opportunity to save consumers money and reduce GHG emissions while maintaining all the same functionality that consumers demand.

Figure 1.12: Electric Supply Costs vs. Efficiency Investment Costs



We have recounted the rise in energy costs here to highlight the opportunity climate change action advocates and policy makers have in the energy sector.

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 as well as all utility ratepayers, and keep that money in the local economy where it can be reinvested.

Second, high and volatile energy prices, together with the risks associated with dependence on energy imported to the region, are strong motivators for us to increase local supplies of energy.

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 their 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 geothermal 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 may be poised to take advantage of the new paradigm in energy costs.

Finally, there is the very real possibility of a regulatory framework that places a diminishing cap on the total allowable emissions from some or all parts of the energy sector. Canada's planning for participation in Kyoto contemplates a Large Final Emitter (LFE) cap-and-trade system, 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). It is therefore prudent for stakeholders and policy makers to include in their longer range planning the potential costs of such a framework would place on conventional energy supplies and to look for ways to mitigate these costs by increasing energy efficiency and commercializing cleaner energy supplies.

As attractive as these solutions are, it is clear they will not happen by themselves. Standing in the way are certain market failures, consumer behavior patterns and policies that create disincentives to modernize our energy systems stand in the way. To meet regional GHG targets and capture the associated co-benefits, we must turn from "business as usual" and start a more concerted, strategic commitment to produce cleaner energy and to use energy more efficiently.

By mid-century we should have an energy system that is cleaner and lower cost than the one we rely upon today. Moreover, the region can maintain and improve its standard of living while using energy that emits just one-quarter of the amount of GHGs we emit today. Absent some very compelling reason, every energy-related policy, program, investment or procurement decision should advance one or both of these goals. There are no other options.

There are, however, numerous objectives we can pursue to achieve these goals, the most promising of which we describe and analyze here.

Priority 1: Invest in Energy Efficiency Resources

By: Daniel Sosland, Roger Koontz, Sam Krasnow, Derek Murrow and Michael Stoddard

It is not an exaggeration to suggest that we are in the midst of a growing energy crisis in New England and Eastern Canada, as the previous pages show.

The first component of this crisis involves whether the region has adequate supply resources. Demand for conventional energy supplies (*e.g.*, natural gas, oil and electricity) is growing. Demand for "capacity" to make and move these supplies through our energy infrastructure is also growing. Energy supply and the capacity to produce and deliver them are not keeping pace with growing demand.

The second component of this energy crisis is about cost. As a result of rising demand placed on conventional resources, energy and capacity costs have been volatile and rising quickly. Experts project that these costs will keep rising. As costs rise, manufacturers consider moving operations to parts of the world where the costs are lower. Jobs are put at risk. Individual consumers are forced to spend more of their income on imported energy commodities rather than in the local economy or investing in savings.

The third aspect of the crisis concerns safety and reliability. When either energy supplies or the capacity of our energy infrastructure are stretched too far, energy stops flowing. The immediate effects of extreme events, such as blackouts, are self-evident. But longer term impacts are serious too, and like rising energy costs, they may push businesses away.

A fourth feature of this crisis relates to the environment and fostering sustainable communities. It is generally well understood that the energy sector is one of the largest contributors of harmful emissions such as mercury, air toxics, fine particulate matter and sulfur dioxide, nitrogen oxides and GHGs. If we meet rising demand with conventional resources that generate more of these emissions (such as conventional coal plants), we will give up gains made in protecting human health and ecosystems, and will cripple any chance of meeting climate change targets for the region.

One resource –energy efficiency– satisfies the same functions as conventional energy supply and system capacity, but has obvious benefits:

- It is abundant.
- It costs less.
- It is local.
- It improves safety and reliability of the energy system.
- It reduces emissions of air pollutants and greenhouse gases and makes our economies more sustainable.

Targets

Several credible studies have demonstrated the significant economic and achievable potential for electric energy efficiency opportunities in individual states and provinces of the region, and these studies inform our choice of efficiency targets.[2] The size of the local efficiency resource is very large.

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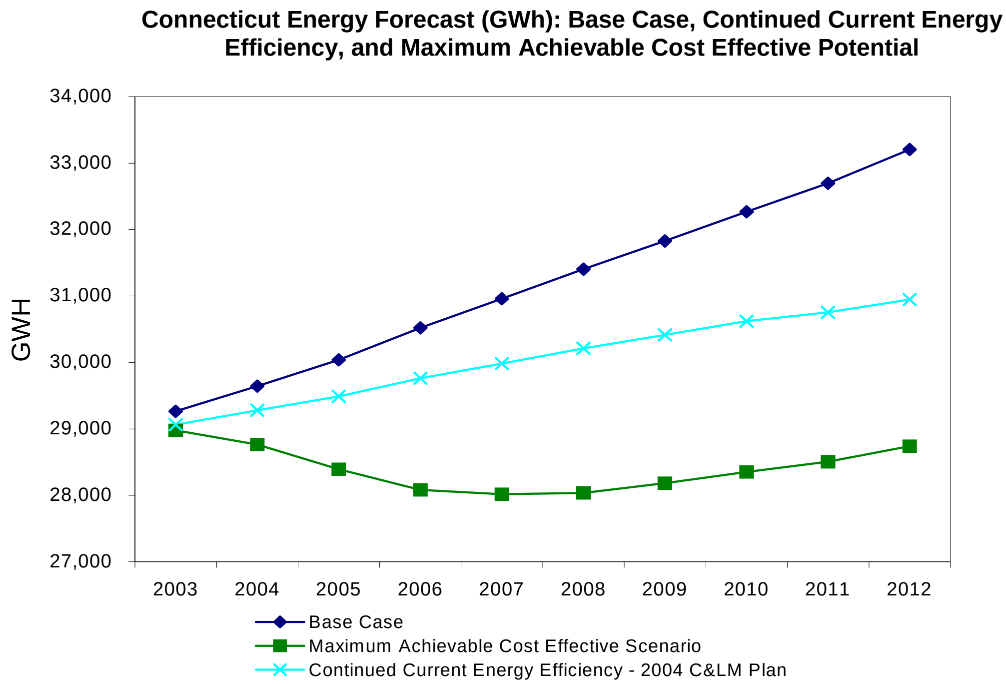
[2] "Electric and Economic Impacts of Maximum Achievable Statewide Efficiency Savings: 2003-2012 – Results and Analysis Summary"; Public Review Draft of May 29, 2002, prepared for the Vermont Department of Public Service by Optimal Energy, Inc.; "The Remaining Electric Energy Efficiency Opportunities in Massachusetts: Final Report," June 7, 2001, prepared for Program Administrators and Massachusetts Division of Energy Resources by RLW Analytics, Inc. and Shel Feldman Management Consulting; "The Achievable Potential For Electric Efficiency Savings In Maine," prepared for the Maine Public Advocate by Optimal Energy and Vermont Energy Investment Corporation, October 22, 2002; *See also*, "California's Secret Energy Surplus: The Potential

Taking just one state as an illustration, a 2004 study concluded that the achievable cost-effective potential for enhanced efficiency investments in Connecticut would reduce demand by 900 MW of peak powerplant capacity and 4.4 million MWh of energy consumption in 2012.[3] This equates to about a 13% reduction in both peak demand and total energy consumption compared to what would happen if Connecticut had no energy efficiency programs. In other words, compared to continuing the historic annual rate of load growth in the region of about 1.2%, enhanced energy efficiency investment could cost-effectively achieve "level load growth."

Figure 1.13: Energy Efficiency Potential – Connecticut[4]

Demand Reduction	Reduction in Electric Use	NPV of Program Savings	Program Cost
Maximum Achievable Potential of 908 MW (13%) by 2012	Maximum Achievable Potential of about 4.47 million MWh (about 13%) by 2012, which eliminates projected load growth	$1.8 Billion total, or $1,228 per household	$82 million - $148 million per year (2003 dollars)



Source: GDS Associates/Quantum Consulting

For Energy Efficiency – Final Report", prepared for The Energy Foundation and The Hewlett Foundation by XENERGY Inc., September 23, 2002; "California Statewide Residential Sector Energy Efficiency Potential Study"; Study ID #SW063; Final Report Volume 1 of 2; Prepared for Rafael Friedmann, Project Manager Pacific Gas & Electric Company San Francisco, California; Principal Investigator: Fred Coito and Mike Rufo; KEMA-XENERGY Inc. Oakland, California; April 2003; Southwest Energy Efficiency Project; "The New Mother Lode: The Potential for More Efficient Electricity Use in the Southwest"; Prepared for Hewlett Foundation Energy Series by Southwest Energy Efficiency Project, November 2002; similar studies were conducted for New Brunswick in the 1990s, and two new studies on technical potential for energy efficiency – one for industrial and manufacturing sector and another for commercial and residential sector -- were announced by the provincial government February 6, 2006.

[3] These results are taken from GDS Associates/Quantum Consulting, *Independent Assessment of Conservation and Energy Efficiency Potential for Connecticut and the Southwest Connecticut Region: Final Report for the Connecticut Energy Conservation Management Board*, Feb. 2004.

[4] *Ibid.*, Figure 1-2.

Definitions: [5]

Technical potential is defined in this study as the complete penetration of all measures analyzed in applications where they were deemed technically feasible from an engineering perspective.

Maximum achievable cost effective potential is defined as the potential for maximum penetration of energy efficient measures that are cost effective according to the Total Resource Cost test, and would be adopted given unlimited funding, and by determining the maximum market penetration that can be achieved with a concerted, sustained campaign involving highly aggressive programs and market interventions.

Total Resource Cost Test measures the net costs of a … program as a resource option based on the total costs of the program … The benefits … are the avoided supply costs, the reduction in transmission, distribution, generation, and capacity costs valued at marginal cost for the periods when there is a load reduction. … The costs in this test are the program costs paid by the utility and the participants plus the increase in supply costs for the periods in which load is increased. Thus all equipment costs, installation, operation and maintenance, cost of removal …, and administration costs, no matter who pays for them, are included in this test.

The Societal Test differs from the TRC test in that it includes the effects of externalities (*e.g.*, environmental, national security), excludes tax credit benefits, and uses a different (societal) discount rate.

Level load growth 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 level load growth through at least 2020.[6] The region should do this for multiple reasons: it will improve our economies; assist businesses and consumers by lowering energy system costs; create jobs; and produce, in a cost-effective way, substantial improvements in air quality and GHG emissions. Over the longer term and by mid-century, the region will need to set targets that likely reduce energy consumption from current levels.

Capturing cost-effective, available efficiency opportunities requires a multi-prong approach. Each of these recommendations is designed to work together and in conjunction with our recommendations in the Buildings and Appliances sections and on the supply side. Integrating supply and demand side policies will produce lower cost, more diverse and more sustainable energy systems that our region requires to meet its environmental needs and compete economically in the future.

With the looming energy crisis making front page news, the time is ripe for stakeholders and policy makers in New England and Eastern Canada to aggressively pursue energy efficiency opportunities. This section describes our recommendations for capturing energy efficiency by:

- reforming utility resource planning and procurement, with all cost-effective efficiency required to be procured first to meet energy and capacity needs for electric and natural gas distribution companies;
- establishing base funding levels for efficiency programs;
- rationalizing utility revenue mechanisms so that efficiency investments are aligned with utility management and profit goals.

[5] GDS Associates / Quantum Consulting p. 1-2, and 9.

[6] A regional goal set in 2001 by governors and premiers for purposes of achieving climate change targets was "By 2025, increase the amount of energy saved through conservation programs (as measured in tons of greenhouse gas emissions) within the region by 20% …." Conference of New England Governors and Eastern Canadian Premiers, "Climate Change Action Plan 2001," August, 2001, p. 14.

1.1 Reform Utility Planning and Procurement

Summary

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 demand energy growth at least-cost to the economy and the environment. The 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, and California has a similar requirement for all utilities.

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 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 also 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.

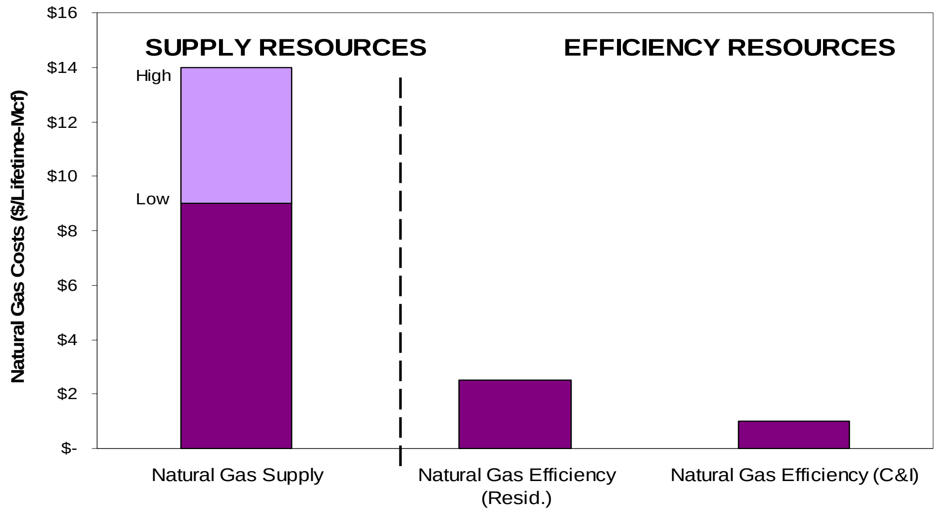
Opportunity

In the supply and distribution of electricity, there are two major markets in the region that are worth billions of dollars. Energy markets are those where utilities contract for or otherwise provide energy to meet their customer energy consumption or loads. Capacity markets are those that focus on the capacity or availability of power plants and the energy distribution infrastructure. When efficiency competes on a level playing field with conventional supplies of energy and capacity, efficiency wins.

As noted in the Introduction of this chapter, the cost to purchase a given quantity of energy efficiency is considerably lower than the cost to procure an equivalent quantity of conventional supply. Electricity generation from the New England spot market cost about $50 per MWh in 2004 and averaged $80/MWh in 2005. By comparison, reductions in consumers' energy consumption through existing state efficiency programs in the region had levelized costs of as little as $9 per MWh for commercial and industrial investments and $10 to $40 per MWh for residential programs.

Similarly, New England natural gas supply cost ranged from about $9 to $14 per Mcf in 2005, while natural gas efficiency programs in the residential sector had levelized costs about one-third as much per Mcf, and projects in the commercial and industrial sector had levelized cost less than one-tenth as much per Mcf.

Figure 1.14: Comparative Cost of Natural Gas Supply versus Energy Efficiency Resources



Source: EIA and ACEEE

In a truly competitive marketplace, the supply of energy efficiency resources should be purchased and exhausted before conventional supply is called upon, especially when the former costs the same or less. But the tradition in utility purchasing has been to let only conventional power supply or natural gas supply compete in the market. That is starting to change, and with this change comes an opportunity to lower electric and natural gas bills and dramatically reduce GHGs from the energy sector.

Utility and Standard Offer Supply: Electricity and Natural Gas Markets

Utilities or distribution companies operate the transmission and distribution system of electric and natural gas grids. Utilities are also responsible for procuring or generating large quantities of energy to meet the needs of end-users. In jurisdictions where markets are not restructured, utilities produce or buy capacity and energy and sell it directly to all customers. In the states that have restructured part of their energy markets to allow competition in the supply of energy, utilities still procure energy for a very large segment of the marketplace because they are statutorily assigned the role of default provider or "provider of last resort." In New England, this default service is often referred to as the "standard offer" or "default" service. Standard offer customers comprise more than 99% of the residential and small business marketplace and a significant portion of the commercial and industrial customer class.

Definitions:

Restructured or **deregulated** markets: Jurisdictions that have opened their markets to competition for electricity or natural gas are sometimes called restructured or deregulated markets. In these markets, a customer is free to buy energy from a competitive supplier.

Standard offer or **default** customers: If the customer does not choose a competitive supplier, the distribution utilities retain an obligation to supply that customer's energy needs as a provider of last resort. In the U.S., these customers are sometimes called standard offer or default customers.

The conventional practice for energy procurement by utilities is to request bids from wholesalers to supply as much energy (electricity or natural gas) and capacity as the utility's customers are projected to consume over a given period of time. The contracting process is typically overseen by a government agency. The contract is awarded to one or more wholesalers who offer the lowest price to provide the necessary amount of resources. The problem is that utilities traditionally only request bids for energy supply or capacity delivered through the grid, excluding energy efficiency and demand response from competing.[7]

Least-cost procurement is a process by which all energy resources are considered by the procuring entity and cost-effective or lower cost efficiency and conservation are purchased first. In most cases, the local distribution utility would be the procuring entity, but it could also be a state or provincial PUC. Under this process, a least-cost plan is developed with input from the government, utilities and consumer or environmental stakeholders. The plan examines ways to meet customer needs with conventional supply (power generation) and demand side resources (energy efficiency, as well as distributed generation, combined heat and power, etc.) with cost being a determining factor along with other energy policy and economic considerations such as air emissions or energy independence. The process would set certain purchasing criteria in addition to cost, such as how clean the resource is, diversification of fuels and other priorities.

The adoption of least-cost procurement is needed to ensure that all cost-effective efficiency (and other demand side resources) are captured in the utility power process so the resulting the savings can be passed onto consumers. Allowing utilities to continue to pass on the costs of procuring increasingly expensive electricity and natural gas hurts our regions' economy and hinders our ability to reduce our GHG emissions.

The logic of requiring least-cost procurement for electricity supply extends equally to natural gas supply. Although no states or provinces in the NE-EC region currently employ least-cost procurement for natural gas utilities serving default customer classes (the Connecticut utility commission is beginning to look at efficiency and supply resources in this framework), the mechanics of implementation and benefits to consumer costs, system reliability, and the environment for least-cost procurement of natural gas would be analogous to those associated with electricity supply.

One illustration of the economic potential for natural gas efficiency can be found by analyzing the Maine Governor's 2005 proposal to reduce natural gas prices in New England by 13% over the next five years through energy efficiency and conservation measures. Specifically, the Governor suggested forming a regional collaboration to reduce natural gas consumption by 1% per year for the next five years.[8] Environment Northeast calculated that the benefit of achieving such a goal would be a savings to the region of more than three-quarters of a billion dollars (net present value), as indicated in Table 1.2.

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[7] The same is generally the case when utilities procure "capacity." Discussion in this section about using energy efficiency and conservation to displace energy supply is also applicable to displacing capacity and related energy services.
[8] Draft Memorandum of Understanding for a New England Heating Fuel and Natural Gas Conservation Initiative, Letters of Gov. John Baldacci, October 13, 2005.

Table 1.2: Estimated Natural Gas Efficiency Investments Required to Reduce Demand by 1% per Year

State	2004 Residential, Commercial, and Industrial Consumption (Mcf)	1% Reduction per Year (Mcf)	Estimate of Efficiency Procurement Cost to Achieve Target ($)	Comparative Cost of First Year Natural Gas Supply ($)	Net Present Value of Natural Gas Supply Savings ($)
Connecticut	166,446,298	1,664,463	$44,441,162	$23,302,482	$156,200,177
Maine	83,010,790	830,108	$22,163,881	$11,621,511	$77,900,802
Massachusetts	433,143,337	4,331,433	$115,649,271	$60,640,067	$406,479,847
New Hampshire	62,748,813	627,488	$16,753,933	$8,784,834	$58,886,114
Rhode Island	72,249,923	722,499	$19,290,729	$10,114,989	$67,802,353
Vermont	8,684,936	86,849	$2,318,878	$1,215,891	$8,150,308
New England	826,284,097	8,262,841	$220,617,854	$115,679,774	$775,419,600

Efficiency Procurement Cost:	26.7	$/ per first year Mcf w/ ~20 year life (based on ACEEE review of VT Gas programs)
	1.3	$/Mcf is the levelized cost over the 20 years of energy savings
Natural Gas Supply Cost:	14 to 11	$/Mcf (NYMEX forward strip plus city gate adder)
	9.0	$/Mcf long-term estimate of city gate prices
Discount Rate Used (NPV):	9%	

Consumption Source: Energy Information Administration

Regional Capacity Markets

Equal treatment of energy efficiency has also made major progress in the regional capacity markets. In New England, the regional electricity grid is overseen by the Independent System Operator (ISO), with the exception of a small service area in northern Maine tied to the New Brunswick grid. In Eastern Canada, there is not a regional grid operator. Each province manages its grid and interconnections to the other provinces.

One job of ISO-New England is to assess the state of the region's electricity supply, reliability standards and capacity adequacy. Historically, ISO has issued special programs or requests for proposals when it believed there to be an imbalance in electricity supply and demand, or a capacity shortfall. For example, it issued a program to address concerns over inadequate supplies in the summer in Southwestern Connecticut. The ISO request for proposals initiated programs to compensate large users who agreed to reduce demand on the electricity grid during hot summer days when brownouts threatened or to add temporary capacity, such as diesel generators.

Example: ISO-New England 2003 Solicitation

In 2003, the Independent System Operator for New England (ISO-NE) solicited bids to ensure grid reliability in Southwest Connecticut where the grid was experiencing a shortfall of transmission and generation capacity.

At the suggestion of the Connecticut Energy Conservation and Management Board (ECMB), ISO-NE established the precedent of inviting "responses for new and incremental quick-start resources, demand response resources capable of 10-minute or 30-minute dispatch response, and for conservation and load management ("C&LM") projects that result in permanent load reductions during on-peak periods. … The ISO recognizes the value of energy efficiency as a component of building competitive markets and ensuring system reliability."[9]

Among the numerous winning bidders, ISO-NE selected a large energy service company, Conservation Services Group (CSG), to supply 3.2 MW of on-peak energy efficiency for a period of four years. CSG proposed to meet the contract primarily by "retrofitting buildings … with power saving lamps and fixtures, … targeting mid-sized to large buildings including multi-family housing projects, schools, warehouses and commercial facilities."[10] The 4 MW energy savings will last for the life of the efficiency measures, which is expected to extend well beyond the four-year contract.

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[9] Carolyn O'Connor, "RFP for Southwest Connecticut Emergency Capability" ISO-NE Correspondence to Connecticut Energy Conservation Management Board, December 4, 2003.

[10] CSG, "For the First Time, Energy Efficiency Contract Awarded to Help Reduce Energy Use," Press Release, April 22, 2004.

Subsequently, ISO began to develop a program for the entire New England region to address concerns about projections of future shortfalls in power supply. This program was first known as LICAP, an acronym for Local Installed Capacity[11] requirements. It originated as a proposal by ISO to provide incentives to add new generating capacity to regions of New England which posed reliability concerns during times of peak demand such as hot summer days. The reliability concerns arise when a region (such as Boston or Southwestern Connecticut) does not have sufficient local generating capacity to meet peak demands and the transmission system serving the area cannot deliver enough additional power to make up the difference. The amount of capacity needed for reliability is determined by several factors including forecast peak demand, a reserve margin for unexpected generating facility outages and the size of the largest system component (generation or transmission) which might be unavailable.

Recently, after long deliberations and a settlement at the Federal Energy Regulatory Commission (FERC), ISO decided to establish a new market, known as the Forward Capacity Market (FCM), which will hold auctions three years in advance for capacity resources necessary to meet the Installed Capacity Requirement (ICR) that will be forecast for each year. It is anticipated that when operational, FCM will be a $4-5 billion market. The program design for implementing the ICR includes an historic provision allowing energy efficiency and other demand side resources to qualify for payments that traditionally have only gone to power generators. This is an enormous opportunity for efficiency to compete with conventional power generation resources.

This new mechanism has the potential to produce substantial new funding for energy efficiency, load management, demand response and distributed generation and to offset the need for new generation facilities. Utilities will be able to bid in the capacity savings from their existing programs for installations which occur after the effective date of FERC approval of the settlement. Presumably, these monies will be used for additional demand-side investments. In addition, energy services companies and large customers will be able to participate in this market.

It should also be noted that in the past two years, Connecticut and Maine adopted legislation that expressly recognizes the potential role demand side resources could play in capacity markets and allows, but does not require, these resources to compete with conventional capacity.[12]

Implementation

Procurement rules governing how utilities meet the energy and capacity needs of customers should be reformed to ensure that conservation and demand response and other distributed resources compete with supply. Utilities should be required to procure all conservation resources that are offered at or below the prices bid for conventional supply or capacity.[13] This mandate should apply in both the electric and natural gas markets. They should also consider using a mix of resources under contracts of varying lengths. Not until the cost of additional conservation resources has risen as high as the cost of conventional supply (of electricity, capacity or natural gas) should additional supply be purchased.

[11] In this context, electric capacity refers to the maximum quantity of energy a generating facility can produce in one hour and is measured in kilowatts or megawatts.

[12] Maine Legislature, Legislative Document 2041, An Act to Enhance Maine's Energy Independence and Security, amending 35-A MRSA Secs. 3210 and 3212, June 2006; Connecticut House Bill 7501, Energy Independence Act, June 2005.

[13] A variation on this approach is to mandate the procurement of a certain minimum target of energy and/or capacity resources (e.g., 1% of base-year electricity sales) plus any additional efficiency resources that satisfy the least-cost criterion.

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."[14]

This policy, now codified in statute by SB 1037 (Kehoe) (2005), has been used by the Public Utilities Commission (PUC) to give direction to the state's large utilities regarding their selection of resources to meet customer's energy needs.[15]

In January 2006, the California PUC and California Energy Commission published the state's *Energy Action Plan II,* in which they identified 15 Key Actions, including the following with regard to procurement:[16]

- require that all cost-effective energy efficiency is integrated into utilities' resource plans on an equal basis with supply-side resource options. . .;
- update and augment, as necessary, utility evaluation, measurement and verification protocols to assure that energy efficiency continues to be fully integrated into resource planning, emission reduction benefits are quantified, and compliance goals are verified.

Example: Rhode Island Standard Offer

On June 23, 2006, the Rhode Island House and Senate unanimously passed "The Comprehensive Energy Conservation, Efficiency, and Affordability Act of 2006" to usher in a new era of energy purchasing using Least-Cost Procurement.

The new law requires that the distribution utility to procure all cost-effective efficiency, distributed generation, demand response, combined heat and power and renewables before more expensive fossil supply. The PUC is required to establish Least-Cost Procurement standards by June 2008. By September 2008, the utility must submit a proposed power procurement plan under these standards to meet RI energy needs in "a manner that is optimally cost-effective, reliable, prudent, and environmentally responsible."

To ensure the effective implementation of the Least-Cost Procurement mandate, the legislature created a new consumer, business and environmental ratepayer council – officially called the "The Rhode Island Energy Efficiency and Resource Management Council." The council's job is to: monitor the least-cost procurement process; provide recommendations to the utility on how much cost-effective efficiency and other resources are available for procurement; make suggestions to the legislature on necessary changes to improve the procurement process; review utility procurement implementation reports; and intervene at the PUC as to whether the utility's "system reliability and efficiency procurement plans" fully pursue all cost-effective efficiency and other resources. The Council is provided funding for consultants and participation in PUC proceeding to ensure ratepayers concerns are well supported and advocated for.

There are challenges to including energy efficiency as a competing resource, such as quantifying energy savings attributable to efficiency programs and managing contributions from numerous smaller distributed resources that must be addressed. However, the benefits of cost savings for consumers, improved grid reliability and energy security and large GHG reductions, make these changes imperative.

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14 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," 8/25/2005.

15 Section 454.5(b)(9) of the Public Utilities Code of California requires each utility to file a procurement plan that demonstrates: "(B) The electrical corporation will create or maintain a diversified procurement portfolio consisting of both short-term and long-term electricity and electricity-related and demand reductions products; (C) The electrical corporation will first meet its unmet resource needs through all available energy efficiency and demand reduction resources that are cost effective, reliable, and feasible."

16 California Energy Commission & Public Utilities Commission, "EAP II: Implementation Roadmap for Energy Policies," October, 2005, p. 3; *See also*, CEC Staff Paper, "Implementing California's Loading Order For Electricity Resources," CEC-400-2005-043, July 2005; and CEC, "2005 Integrated Energy Policy Report (IEPR)," CEC-100-2005-007-CTF, November 2005.

1.2 Establish Minimum Investment Levels for Energy Efficiency Programs

Summary

Each state and province should establish energy efficiency programs to build markets for 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) to energy efficiency programs in each state and province to ensure that a minimum of 2% of total customer spending goes towards energy efficiency (*e.g.*, 3 mills per kilowatt-hour of electricity, 3 cents per Therm of natural gas; and approximately 5 cents per gallon of fuel oil).

Well managed funds set a floor for market penetration of efficiency products and services. Many northeastern states established ratepayer funded energy efficiency funds over the past years. These funds collect a small surcharge on ratepayer bills of 1-3%, and then reinvest these funds 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-$4 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.

To illustrate the potential for region-wide GHG reductions, we note the 2005 results of the Connecticut electricity Conservation and Load Management Fund which saved $550 million and 2.7 million tons of CO_2 (lifetime) with its one-year investment. Similarly, the smaller Vermont Gas Systems' most recent year of efficiency programs is projected to save consumers approximately $8 million and 66,000 tons of CO_2 (lifetime).

Opportunity

As energy prices have risen, states and provinces are beginning to realize the benefits of large-scale energy efficiency programs. Recent performance of energy efficiency programs in the New England states yielded large cost savings to the economy, improved stability of the energy infrastructure, and achieved the largest reductions of GHG of any measure pursued through state policy.

Because efficiency projects are implemented through contractors, equipment suppliers and retail and wholesale sales, they create jobs at a greater rate than any other energy investment.

Relying once again on the Connecticut illustration (which has the most comprehensive data publicly available), we can see that in 2005 the energy efficiency programs in this state, with the largest per capita spending on energy efficiency in the region, made efficiency investments that will return $550 million to in-state consumers over the life of the investments.

Energy efficiency investments deliver other benefits as well. For example, growth in demand for electricity and natural gas requires state, provincial and regional system planners to address the need for additional supply and system capacity to deliver supply from its source to consumers. This growth would normally require new powerplants and other energy infrastructure capacity to be built and paid for over time. Zero load growth through energy efficiency investments would eliminate the need to pay for new supply and capacity while enhancing system reliability, especially during peak demand periods.

Table 1.3 shows the potential financial benefits of a well-funded electric efficiency investment program with independent advisory and oversight functions.

Table 1.3: 2005 Program Results - Connecticut Conservation & Load Management Fund[17]

2005 Program Results - Connecticut Energy Efficiency Fund			
Annual Investment:	$82 million		
Energy Savings:	4,398,000 MWh (Lifetime) ; 318,000 MWh (Year 1)		
Demand Reduction:	135,000 kW		
Economic Benefits:	$550 million in avoided energy bills (Lifetime); $40 million in avoided energy bills (Year 1) Generated $4 in lifetime savings (today's dollars) for every $1 spent Created approximately 1,000 non-utility jobs		
Customer Assistance to:	18,000 low income customers 890 small business customers 3,270 commercial and industrial customers		
Emissions Benefits (Tons):	Pollutant	2005	Lifetime
	CO_2	198,586	2,748,461
	NOx & SOx	The program assists the region meet its goals under the cap and trade programs by reducing demand for electric power	
Awards:	Ranked #1 among U.S. states for cumulative annual energy savings (7.8%) as a percentage of annual total retail sales by American Council for Energy Efficient Economy (ACEEE) *National Scorecard on Utility and Public Benefits of Energy-Efficiency Programs*. (October, 2005). The U.S. national average is only 1.9%.		

Natural gas and fuel oil are critical fuels in the Northeast U.S. and Eastern Canada. A large percentage of powerplants built in New England in the past 10 years are fueled by natural gas. Many homes and businesses in the region rely on natural gas for space and water heating and cooling and industrial processes. In fact, over-reliance on natural gas is a current concern of policymakers in many states. For these reasons, using natural gas efficiently is critical.

For home heating oil, the NE-EC region is unique in North America in the market penetration of home heating oil as a primary fuel for residential and business space and water heating. Some states and provinces in the region have more than 80% market penetration of home heating oil for residential heating purposes, but there is no wide-scale energy efficiency program directing investments toward increased efficiency of oil consumption.

As with electricity, the potential cost-effective savings from increased investments in natural gas (and oil efficiency) are very large, yet fewer states have natural gas efficiency funds than electric funds. In Massachusetts, the Natural Gas Consortium acts on behalf of its member utilities to coordinate a natural gas efficiency fund. Maine recently established a modest fund for its sole natural gas distribution utility. Vermont Gas Systems in the Burlington area has had a robust and comprehensive natural gas efficiency program. Quebec, the only province in the region with significant commercial and residential gas consumption, has an efficiency program operated by Gaz Metro.

[17] Connecticut Energy Conservation and Load Management Board, "Energy Efficiency: Investing in Connecticut's Future – Report of the Energy Conservation Management Board, Year 2005 Programs and Operations," March 1, 2006.

Table 1.4: Vermont Gas Systems Efficiency Program Results

2004 Program Results – Vermont Gas Systems, Inc Demand Side Management Program[18]		
Annual Investment:	$1,122,000 1.8% of Total Revenue (2003)	
Energy Savings:	57,000 Mcf (Annual) 1,168,000 Mcf (20 Year Lifetime)	
Demand Reduction:	480 Mcf Peak Day Savings	
Economic Benefits:	$ 390,000 Saved (Annual) $ 8 million Saved (Lifetime, not discounted)	
Customer Assistance:	Programs open to all customer classes on system 1,640 homes and businesses installed energy efficiency measures	
Emissions reductions (Tons):	Pollutant	2004
	CO_2	3300
	NOx	2.6
	SOx	1.1
Awards:	VGS received the EPA/DOE Energy Star *Leadership in Energy Efficiency* in 2004. In recent years, more than 50% of residential new construction in the utility's service territory has met ENERGY STAR Qualified Home standards.	

Example: Gaz Metro (Quebec) Energy Efficiency Fund

Gaz Metro serves the metropolitan areas of Montreal, Quebec City, Sherbrooke and Three Rivers. Every year, Gaz Metro promotes and provides incentives for more energy efficient gas-using equipment. It also provides an additional $3.3 million (CAD) annually to the separately managed Energy Efficiency Fund, which aims to promote and incent more efficient building envelopes and to introduce innovative, energy efficient services and technologies to the market. The Fund serves 22 different programs divided among residential and commercial/institutional natural gas customers. Programs include:

- high-efficiency furnace incentives;
- new high-efficiency home / commercial building certification (Novoclimat);
- home and commercial building efficiency retrofit incentives;
- solar thermal systems;
- heat reflector panel incentives for hot water radiator systems.[19]

In addition to direct gas savings, studies show that investing in natural gas efficiency helps reduce electric costs, because so many electric generating plants are fueled by natural gas.[20]

From a climate perspective, using natural gas efficiently provides large GHG reduction benefits while producing all of the other economic, consumer and environmental benefits associated with electric efficiency.

As part of the evaluation of the elements of Connecticut's Climate Change Action Plan 2005, Regional Economic Models, Inc. performed an analysis of natural gas and heating oil conservation programs

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[18] Source: Vermont Gas Systems, Inc., "2004 Annual Report: Demand Side Management Programs," 2005, p. EXE-1.

[19] For more information *see* www.gazmet.com and www.fee.qc.ca.

[20] *See*, *e.g.*, Neal Elliot *et al.*, "Impacts of Energy Efficiency and Renewable Energy on Natural Gas Markets," ACEEE, April 2005.

funded from a 3% surcharge on customers.[21] The projected economic benefits to Connecticut for efficiency programs for natural gas and oil funded at a minimum 3% level are summarized in Table 1.5:

Table 1.5: REMI Modeling Results for New Efficiency Programs in Connecticut [22]

Natural Gas Program	**2010**	**2020**
Cumulative Program Costs	$205 Million	$462 Million
Cumulative Program ***Savings*** (Energy Only)	$979 Million	$3,483 Million
Benefit – Cost Ratio	4.8	7.5
Increase in Employment		1,668
Increase in Gross State Product		$1.8 Billion

Fuel Oil Program	**2010**	**2020**
Cumulative Program Costs	$131 Million	$320 Million
Cumulative Program ***Savings*** (Energy Only)	$319 Million	$1,715 Million
Benefit – Cost Ratio	2.4	5.4
Increase in Employment		430
Increase in Gross State Product		$266 Million

Implementation

Program Funding

The backbone of successful efficiency programs is the establishment of a predictable and adequate funding stream to both administer the program and provide the necessary financial incentives. Most programs are supported by modest charges on utility ratepayer bills for electricity and natural gas funds or existing taxes collected on the sale of petroleum products for oil and propane fuels.

Definitions:

Mill: 1/1000th of a dollar (or 1/10th of a cent).

Mill Rate: the number of mills assessed on each unit of energy (*e.g.*, kilowatt-hour) delivered to a customer.

System Benefit Charge (SBC): the charge added to every energy customer's bill to provide funding for any of a number of programs to benefit the system (the transmission and distribution electric grid or gas pipeline) and its customers. The SBC is often expressed as a mill rate, *e.g.*, "3 mills."

Therm: a unit of measure for heat output of natural gas equal to 100,000 British Thermal Units (Btu), which converts to a volume of natural gas equal to just less than 0.1 Mcf.

Mcf: one thousand cubic feet, a unit of measure for a volume of natural gas.

The New England states have opted to collect the core funding for electric efficiency investment programs by a adding a system benefit charge, assessed as a mill rate, to the monthly delivery charge for every kilowatt-hour. By spreading this modest cost among all ratepayers, funding can be aggregated in amounts sufficient to implement critical efficiency programming and deliver cost savings to everyone on the system.

[21] Governor's Steering Committee on Climate Change, February 2005, *Connecticut Climate Change Action Plan 2005*, http://www.ctclimatechange.com/StateActionPlan.html; the funding mechanism has been changed in RB 6777 to be a charge on a per Mcf and per gallon basis, but the program sizes remain similar to those modeled for the state action plan and modeled economic and environmental benefits should remain the same.
[22] *Ibid.*

Table 1.6: Current New England Electric Energy Efficiency Investments 2004-2005[23]

State	CT*	ME*	MA*	NH	RI	VT
Mills/kWh	3.00	1.50	2.50	1.80	2.0	2.50
Budget ($ Million)	61.9	10.6	120.0	16.5	21.7	17.5

* In 2005, Maine's central efficiency program only received $10.6 million of all funds collected by the mill charge. By 2012, the program will receive more than $15 million from full implementation of the 1.5 mill charge. In 2004, Connecticut state government took roughly one-third of the energy efficiency fund to help balance the state budget leaving the fund short of the $87 million that would otherwise have been collected. Similar reductions to the Massachusetts fund were made in 2004.

In the Canadian provinces, efficiency investment funds are collected as part of the transmission and distribution rates recovered by the utilities or may simply be appropriated as part of the legislative budgeting process.

Table 1.7: Current Canadian Electric Energy Efficiency Investments

Province	NB	N/L	NS	PEI	QC
Mills/kWh ($CAD)	0.75		N/A		1.05
Budget ($CAD Million)	11.9		10*	0.5	170

* Includes funding for non-electric efficiency programs. $5 million additional funding proposed in 2006 for electric programs only.

We recommend that each jurisdiction fund system-wide efficiency programs at a minimum investment level. We note that the largest and most successful programs in the region have settled at about 2% of the delivered cost of energy (*e.g.*, electricity and natural gas), and recommend all jurisdictions and all fuel types use this as a guide going forward.

In order to avoid large fluctuations in the total funding available for planners and program administrators to work with, the conventional and most familiar approach is to set the efficiency investment charge at a flat rate per unit sold (or consumed) rather than as a percent of delivered (retail) cost or revenues.

We propose sustained minimum investment levels indicated below be employed in all jurisdictions by the year 2010. To allow time for new programs to get established, an initial Start-up Base level of investment is also suggested, from which funds can gradually be increased to reach the Sustained Investment Level in 2010.

Table 1.8: Proposed Minimum Investment Levels in Energy Efficiency

	Electricity	Natural Gas	Fuel Oil
Start-up Base	1.5 mill/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)

For natural gas utilities, the efficiency assessment should be recovered through distribution rates, and the efficiency services should be made available to all customers in all areas. For fuel oil, the best mechanism for assessing and collecting efficiency investment funds is likely to assess a fee on all distributors of fuel

[23] http://www.neep.org/policy_and_outreach/State_Budgets.pdf

oil. One model for consideration is the carbon tax concept recently introduced by the government of Quebec to be assessed on the sale of all petroleum fuels in the province.

Program Design

Energy efficiency programs are designed to capture cost-effective efficiency opportunities in all customer classes: low-income, residential, commercial, industrial and government users form the core of an effective program design. These programs are targeted to where consumers use energy the most. Examples of "end-uses" that should be addressed by comprehensive programs include:

- providing incentives for the purchase of energy-efficient appliances and heating, air conditioning and lighting devices;
- influencing plans to build or renovate homes, schools or other facilities;
- supporting the installation of more efficient products used in manufacturing such as motors and chillers;
- training for operating and maintaining energy consumption equipment so it runs as specified.

Example: Efficiency Vermont's Business New Construction Program

Efficiency Vermont is an independent agency serving the state as an "energy efficiency utility." Efficiency Vermont's Business New Construction Program is designed to capture cost effective efficiency opportunities during new construction, building additions, and major renovation projects. Efficiency Vermont's business energy services managers identify projects as early as possible in the development process to ensure cost saving efficiency measures can be incorporated into the design phase of the project using computer aided software, where they are the most effective and least expensive to implement.

Efficiency Vermont's project managers provide owners, architects, and contractors with key information about energy efficient design and equipment options, including a detailed assessment of the financial benefits and energy savings associated with their implementation. Efficiency Vermont also offers incentives to help reduce slightly higher first costs associated with energy efficient design and high-efficiency equipment purchases. The financial incentives enable more Vermont businesses, municipalities, and institutions to implement the efficiency measures during construction and realize the large associated lifetime energy and cost savings.

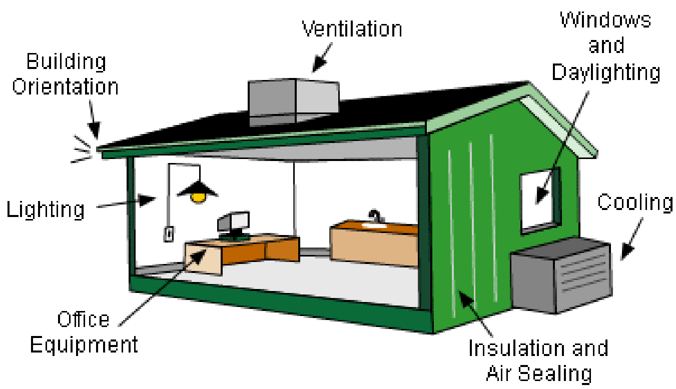
Concrete examples of energy efficient design and equipment options implemented through the Business New Construction Program include:

- Computer Modeling – to identify designs and building materials that to save energy and money
- Passive Daylighting – skylights and south-facing building & window orientation
- High-Efficiency Lighting – super T-8 lamps, T-8s, electronic ballasts, T-5 fluorescents
- Superior Building Insulation – lower heating bill by improving roof and wall efficiency
- Energy Efficiency Windows – triple panes, low-e glazing prevent heat loss
- High Efficiency Equipment – efficient chillers, boilers, and furnaces lower energy use
- Energy Management Controls – to ensure energy is saved when the building is not in use
- Co-Generation Systems – allow efficient combined onsite generation of heat and electricity

In order to ensure success, project managers follow clients through each step of the construction process and provide: 1) smart building design and efficiency equipment choices; 2) an individualized efficiency incentive package for project-specific priorities; 3) assistance to contractors so they can find desired efficiency materials and equipment; and 4) on-site verification of energy savings after construction is completed.

Between 2003 and 2005, the program completed over 350 projects, achieving lifetime electric savings of 475,000 MWh. By coupling $3.6 million in efficiency incentives and $8 million in owner investments with smart design during the construction process, the program has achieved lifetime electric, fossil fuel, and water savings of more than $27.6 million for Vermont businesses, municipalities, and institutions.

Figure 1.15: Typical Energy Efficiency Approaches[24]



Source: Efficiency Vermont

Other valuable efficiency program activities support the development of the energy efficiency marketplace through research and education even while they typically do not "purchase" energy efficiency. Examples of these investments in the development of the efficiency infrastructure and marketplace include:

- research, development and commercialization of high efficiency products or processes;
- market development programs for such products and processes;
- support for energy use assessment, real-time monitoring systems;
- public education regarding conservation.

Energy Efficiency Program Administration

To support thoughtful program design and coordinate the many functions of a high quality efficiency fund, good administration and management oversight is needed. Lessons learned from the last two decades of running energy efficiency programs suggest that the energy efficiency programs of state and provincial government will be more effective if they are complemented by an independent energy efficiency management board. The primary functions of this management board are to bring expert advice and diverse interests into all major planning discussions and to provide oversight to energy efficiency planning and programming.

It is important to note that the management board is an appropriate and effective oversight mechanism for the both administrative models for efficiency programs, *i.e.*, efficiency programs run by the utility as well as efficiency programs run by an independent agency. The "utility model" is currently employed in Connecticut, Rhode Island, Massachusetts, New Hampshire and Quebec, whereas the "independent agency model" is in effect in Vermont and Maine and New Brunswick. Efficiency Vermont is an independent, non-profit organization under contract to the Vermont Public Service Board (VT PSB) with a mandate to deliver effective commercial and residential efficiency program that maximize MWh savings. In 2005, Efficiency Vermont projects delivered 62,000 MWh in annual electricity savings that will save Vermonters more than $44 million dollars over the project lifetime with a budget of $15 million.

24 www.efficiencyvermont.com/pages/Business/BuildingEfficiently/TypicalEnergyEfficiencyAppr/.

The management board should comprise voting members representing a cross section of interests, including relevant government agencies and other key stakeholders (business associations, consumer protection, low income customers, and environment advocates). Financially interested parties, such as distribution utilities, energy suppliers, and energy service providers, should be integrally involved in the work of the management board such as through *ex officio* representation, but should not have voting status to avoid the longstanding conflict of interest problem presented by this situation.

Development of an annual plan is necessary to ensure the most strategic, integrated and cost-effective implementation of energy conservation programs and market transformation initiatives. Such a plan should reflect the entirety of efficiency programming proposals, whether they involve the use of efficiency programming funds or utility procurement strategies.

The management board may be the originator of this plan, and in the case of non-grid delivered energy like fuel oil and propane, may contract with a third-party to develop and implement the efficiency plan. In the event that others, such as the utilities, develop the plan, the management board may play an advisory role.

The key to fostering economic and political success with energy efficiency programs is to ensure the independent management board has reviewed and approved each program and budget proposed in the plan before the program is initiated or funded. This review should include screening for cost-effectiveness and adequacy of resource allocation. Because the opportunity is so large and often un-captured, the review should also examine the potential for programs to save more than one fuel resource. In such cases, costs for joint programs can and should be allocated equitably among the conservation programs. The effective function of the management board is heavily dependent on its ability to retain expert consultants and cover reasonable administrative costs.

Once established, these programs should be the subject of annual plans prepared by the relevant utilities or third-party efficiency service providers, and updated, reviewed and approved by the independent management board. Examples of a functioning board structure are the Connecticut Energy Conservation Management Board and the new Rhode Island Energy Efficiency Resource Council.

While most current efforts focus on electricity efficiency and some natural gas efficiency, the fact is that these kinds of programs can greatly leverage investments and increase market penetration of efficient products and services if all fuels are included in a comprehensive approach. Joint fuel conservation initiatives programs targeted at reducing consumption of more than one fuel resource are critical given the amount of heating oil and propane consumed in our region.

1.3 Align Utility Revenue Incentives with Promotion of Efficiency

Summary

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 the adoption of a full sales adjustment clause, which decouples revenue and cost recovery from sales or consumption.

The present formula for compensating utilities for delivery services ties their revenues (and earnings) to the number of units of electricity (kWh) or gas (Mcf) used by consumers, which sends the wrong economic signal to the utilities with regard to increasing energy efficiency and conservation and reducing greenhouse gas emissions. The use of a sales adjustment mechanism allows the utility to recover its costs and be indifferent to higher or lower energy use.

Opportunity

Traditionally, the formula for compensating utilities for delivery services has tied their revenues (and earnings) to the number of units of electricity (kWh) or gas (Mcf) used by consumers. Unfortunately, this approach sends precisely the wrong economic signal to the utilities with regard to lowering consumers' energy bills and reducing GHG emissions. While they receive more revenue when consumers use more energy, utilities receive less revenue when consumers use less energy. This formula rewards utilities for encouraging consumers to use more energy and penalizes them for helping consumers to use less.

There is growing recognition of the need to reform utility revenue mechanisms by separating energy sales from revenue. Major industrial energy consumers such as Albemarle Corporation, American Chemistry Council, American Forest & Paper Association, American Iron and Steel Institute, Bayer Corporation, The Dow Chemical Company, DuPont, PPG Industries, Rohm and Haas Company, and The Society of the Plastics Industry have embraced policies such as "aligning incentives for utilities' financial health with encouragement of energy efficiency."[25] The American Gas Association (AGA) has indicated its support for sales adjustment mechanisms in order to enable gas utilities to effectively support energy efficiency. The AGA is a national association which primarily represents local gas distribution companies. In a joint statement with the Natural Resources Defense Council (NRDC) to the Nation Association of Regulatory Commissioners, in July 2004, the AGA stated:[26]

> NRDC and AGA agree on the importance of state Public Utility Commissions' consideration of innovative programs that encourage increased total energy efficiency and conservation in ways that will align the interests of state regulators, natural gas utility company customers, utility shareholders, and other stakeholders. Cost-effective opportunities abound to improve the efficiency of buildings and equipment in ways that promote the interests of both individual customers and entire utility systems, while improving environmental quality….
>
> When customers use less natural gas, utility profitability almost always suffers, because recovery of fixed costs is reduced in proportion to the reduction in sales. Thus, conservation may prevent the utility from recovering its authorized fixed costs and earning its state-allowed rate of return. In this important respect, traditional utility rate practices fail to align the interests of utility shareholders with those of utility customers and society as a whole. This need not be the case. Public utility commissions should consider utility rate proposals and other innovative programs that reward utilities for encouraging conservation and managing customer bills to avoid certain negative impacts associated with colder-than-normal weather.

The two primary mechanisms to replace traditional utility revenue approaches are using automatic rate "true-ups" that allow a utility to recover authorized fixed costs without relying on sales volume. Performance-based incentives can be developed that allow utilities to profit by meeting savings and management quality goals independent of sales volumes.

Since the 1980s, states from Connecticut to California have looked for alternative compensation systems.[27] In the mid-1990s, Massachusetts established Performance-Based Regulation (PBR) with Boston Gas Company (now Keyspan) to replace the tradition Cost of Service rate design. Under this plan, the Company's distribution revenue requirement and rates are recalculated annually. A "price-cap" formula takes into account the previous year's rate of inflation and the expected growth in productivity

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[25] Press Release, Solving America's Natural Gas Crisis Through a Balanced Portfolio of Policies: Principles that should guide Congress and the Administration in dealing with the natural gas crisis. *http://www.plasticsindustry.org/membersonly/public/comments/energy/lettertoPresidentandCongess1.3.05.pdf* January 2005.

[26] Joint Statement of the American Gas Association and the Natural Resources Defense Council. Submitted to the National Association of Regulatory Utility Commissioners, at www.aga.org, News page, July 2004.

[27] S. Carter, "Breaking the Consumption Habit: Ratemaking for Efficient Resource Decisions," The Electricity Journal, Dec. 2001.

(a "productivity offset") for the industry. In theory, the price cap model encourages the utility to improve its productivity by promoting efficiency.[28] If the utility improves its productivity by more than the amount anticipated by the productivity offset, it keeps the extra profits. However, if the utility does not achieve the expected productivity gains, it will face a revenue shortfall. In Connecticut, decoupling electric and gas sales from profits was authorized by statute in 2005, but has not yet been implemented.[29] New Hampshire, Rhode Island, and Vermont have no history of piloting decoupling mechanisms and no current plans to do so.[30] Sales adjustment mechanisms have recently been adopted or are under consideration in several states, including Oregon, California and Washington.[31]

Implementation

Jurisdictions in the region should reform revenue mechanisms that discriminate against energy efficiency. The best approach to accomplish this is the adoption of a full sales adjustment clause.

A sales adjustment mechanism is a form of decoupling that is specifically designed to break the link between earnings and sales (*i.e.*, the amount of energy delivered through the system). A sales adjustment mechanism allows for periodic adjustments to customer rates based on the deviation of actual sales from sales projections which are used to determine the underlying rates. This mechanism would only apply to the portion of rates which collect fixed distribution costs through charges based on sales volume (kWh or cubic feet of natural gas).

This mechanism has been demonstrated to work, and it does not have several of the side effects that plague other approaches attempted in the Northeast. For example, unlike Lost Revenue Adjustment mechanisms, the sales adjustment mechanism:

- removes *all* disincentives for utilities to resist energy efficiency measures;
- does not require sophisticated measurement and estimating;
- reduces "gaming" of load forecasting by utilities;
- has low administrative costs and low litigation potential;
- reduces utility revenue volatility.[32]

[28] *See* MCI Telecommunications Corp. v. Department of Telecommunications & Energy, 435 Mass. 144, 147 (2001).
[29] Connecticut Statutes Sec.16-19b (i).
[30] Maine instituted an "Alternative Rate Plan" (ARP) in the mid-1990s to cap Central Maine Power's revenues in a way that rewarded the utility when it achieved energy savings through demand side management programs but the program was not well designed and led to unintended consequences.
[31] *See*, D. Bachrach and S. Carter "Do Portfolio Manages Have an Inherent Conflict-of-Interest with Energy Efficiency?" Natural Resources Defense Council, at pp. 6-9.
[32] These features are summarized from the comparison appearing in Regulatory Assistance Project, "Regulatory Reform: Removing the Disincentives To Utility Investment in Energy Efficiency," *Issuesletter*, September 2005, p. 4.

Example: Oregon Pilot – Sales Adjustment Mechanism

Oregon has carried out a pilot project and a detailed analysis of the sales adjustment mechanism and of other options for achieving decoupling. [33]

The sales adjustment mechanism implemented in Oregon for Northwest Natural has had very positive impacts on the company's activities in promoting the efficient use of natural gas and did not adversely affect its financial performance. The Study finds significant changes in Northwest Natural's activities once it made a corporate decision to seek approval for a decoupling mechanism.[34] These included the following:

- dramatic shifts in its allocation of its advertising budget from promotional advertising to energy conservation and service information;
- a substantial increase in its high-efficiency furnace program performance;
- organizational changes which reduced sales and promotion staff and increased customer assistance staffing.

These changes occurred even though the primary responsibility for administering at least some of its energy efficiency programs, including the High Efficiency Furnace program, shifted to a separate organization, the Energy Trust of Oregon, in 2003.

The financial impact of full decoupling through a sales adjustment clause is to reduce the variability in fixed cost recovery, which contributes to the attractiveness of a company as an investment vehicle. The Oregon Study concluded that the decoupling mechanism did reduce the variability in recovery and appeared to have a positive impact on the stock price, though the period of the study was limited.

After a review of the study and on the basis of a stipulation of parties to the docket, the Oregon PUC extended the pilot decoupling tariff for four years.[35]

A sales adjustment mechanism, as it is applied in Oregon and also in California, would not impose additional fixed charges. The periodic adjustment can be made quarterly, annually or at some other interval, to adjust the charges for fixed cost elements which are collected on a usage basis.

One way to calculate a full decoupling revenue adjustment is with the following simple formula, as laid out in the Oregon study in the context of a natural gas utility:[36]

Margin Adjustment = M * C * (QPCB – QPCA)

M is the dollar per therm margin from the standard tariff;
C is the number of customers to which the program applies;
QPCB is baseline use per customer;
QPCA is actual use per customer.

Example: New Jersey Natural Gas

In December 2005, New Jersey Natural Gas and South Jersey Industries sought rate changes from the state utility board so they could invest in persuading customers to use less gas heading into the high-priced heating season. A gas utility official commented "It's a fundamental shift in how the utility operates. The company's financial well-being will be totally disconnected from how much gas customers use."[37]

In supporting their request, the utilities said the reform would remove their existing incentive to actively ask customers to use more natural gas, as evidenced by their recent efforts to convince homeowners to convert fireplaces to run on gas. If the rate design is changed, the utilities claim they will invest in marketing and mailings encouraging customers how to conserve energy, such as by lowering the setting of water heater thermostats or installing programmable thermostats.

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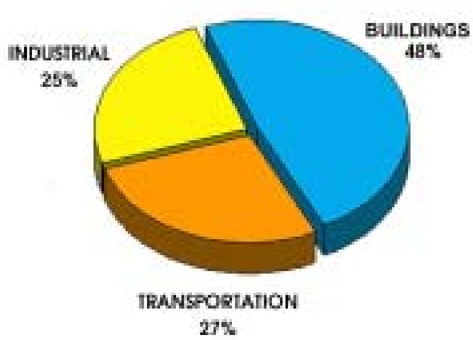
[33] Hansen and Braithwait, "A Review of Distribution Margin Normalization as Approved by the Oregon Public Utility Commission for Northwest Natural," Christensen Associates (March 31, 2005), p. 2.
[34] "A Review of Distribution Margin Normalization as Approved by the Oregon Public Utility Commission for Northwest Natural", Hansen and Braithwait, Christensen Associates (March 31, 2005), p. 34-46.
[35] Oregon PUC, Order No. 05-934 (8/25/2005).
[36] Hansen and Braithwait, p. 65.
[37] "Gas utilities will ask customers to use less," *Star-Ledger*, December 06, 2005.

Priority 2: Increase Energy Efficiency of Buildings

By: Sam Krasnow and Michael Stoddard

The built environment is where 48% of U.S. energy is used, as shown in Figure 1.16. 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.

Figure 1.16: U.S. Energy Consumption, Showing Electricity and Non-Industrial Thermal Use as a Single "Buildings" Sector[37]



Source: Mazria, *Solar Today* (2003)

Two preliminary findings inform our analysis. First, by 2035 approximately 75% of the United States' aging building stock will either be replaced or undergo major renovation.[38] Second, the average lifespan of a new building built today is 50-100 years.[39]

This means there is a large near-term opportunity to reduce the energy use and GHG emissions associated with our region's buildings. This also means that should we miss this opportunity, allowing high energy-use, high-GHG buildings to be built new or significantly renovated over the next three decades, we will lock in a long-term high-GHG building stock legacy that may make it impossible to meet our energy reduction targets.

CO_2 emissions attributable to the building sector have been rising dramatically since 1990. As Figure 1.17 demonstrates, only during the late 1970s and early 1980s, when building energy efficiency was a national priority, did CO_2 emissions from the built environment remain level.

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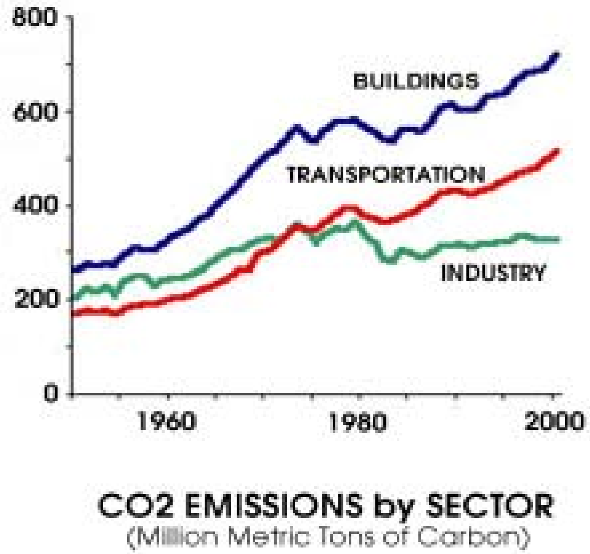
[37] Mazria, E. "It's the Architecture, Stupid!," *Solar Today*, (May/June 2003), pp. 48-51. Note: only the energy use associated with industrial building operations has been allocated to the new "building sector." Energy use attributed to industrial processes remains classified in the industrial sector, which still constitutes 25% of energy use.

[38] Douglas L Steidl, President, American Institute of Architects, August 9, 2005. Presentation sponsored by the Alliance to Save Energy.

[39] American Institute of Architects fact sheet, "Architects and Climate Change," www.aia.org/siteobjects/files/architectsandclimatechange.pdf.

Figure 1.17: U.S. Carbon Dioxide Emissions by Sector



Source: Mazria, Solar Today, (May/June 2003)[40]

Experts in the industry have long recognized two highly leveraged opportunities for influencing building policy and consumer choices. First, the design and construction/renovation phase is the time in the life of the building that the largest, most cost-effective, energy savings can be realized. Second, the operations and management of large buildings is another point of leverage for energy savings in the building sector. Several studies demonstrate that up to 20% energy savings can be accomplished with minimal capital investment.[41]

Once design decisions are made for a new building, a substantial portion of the long-term energy-use for that building has in essence been determined. After this point, it becomes impractical or prohibitively expensive to install or change many heating, cooling and day-lighting efficiency options, leaving only choices about appliances, artificial lighting and some amount of insulation. As demonstrated in Table 1.9, appliances and lighting constitute only 20% of energy use in New England homes.

Table 1.9: Household Energy Consumption in New England (2001)

Space Heating	61%	} **80%**
Electric Air Conditioning	2%	
Water Heating	17%	
Appliances and Lighting	20%	

Source: EIA, *Table CE1-9c (2001)*

Energy saving design measures have been tested and proven successful in thousands of buildings across North American and Europe over the past few decades. A recent report prepared for the Pew Center on Global Climate Change by Oak Ridge National Laboratory, *Towards a Climate-Friendly Built Environment* (2005), highlights many of these measures and estimates the savings they could achieve. The report estimates that by 2010 advances in design and technology measures for building envelopes, equipment and systems integration could lead to 50% reductions in the energy requirements of new buildings

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40 Mazria, E., pp 48-51.

41 *See e.g.*, Federal Energy Management Program "Operations and Maintenance Best Practices Guide, Release 2.0", Chapter 2 (July 2004). http://www.eere.energy.gov/femp/operations_maintenance/om_best_practices_guidebook.cfm and http://www.eere.energy.gov/femp/pdfs/OM_2.pdf.

relative to 2000 at an incremental cost of 0 to 2%.[42] Table 1.10 summarizes design measures and technology improvements and their ability to reduce heating, cooling, hot water and lighting energy use dramatically, as described in more detail in the Pew Center report.

Table 1.10 Efficient Building Design Elements and Savings/Cost Estimates

DESIGN FOCUS	DESIGN DESCRIPTION	SAVINGS / COST EST.
BUILDING ENVELOPE		
Roof	Reflective roof products on the market reflect most of the incident thermal energy that causes an increase in AC loads during the summer months.	20-30 % energy saving on air conditioning. Simple payback period of 1-2 years. [43]
Walls	Effective wall design reduces the amount of uninsulated framing and optimizes the use of insulated materials to minimize heat loss. Design elements include: optimal value engineering, structural insulated panels, and insulated concrete forms.	50% reduction in heat loss[44]
Windows	High-performance windows reduce the loss of energy through all three energy paths: 1) convection–air leakage around the window components; 2) conduction–heat loss through the frame; and 3) radiant energy.	Up to 6 times more efficient than lower-quality windows[45]
Thermal Storage	Increasing the thermal storage of the building through designing phase change materials (PCMs) into the structure reduces energy needed for heating and cooling. Water, salts, organic polymers, stone, and adobe can be used.	15-20% annual heating and cooling savings for residential buildings with PCM wallboard[46]
Insulation	Designing vacuum insulation panels into exterior ceilings, doors, and floors in manufactured homes, floor heating systems, commercial building wall retrofits, and attic hatches and stairs achieves substantial energy savings.[47]	R-value of vacuum insulation is 5-10 times greater than conventional insulation
HOT WATER		
Hot Water	A building design that places the hot water tank closer to the use point(s) saves energy. Designing in a heat pump, a water heating dehumidifier, or a system for heating water with waste heat results in substantial savings.	Integrated system that uses heat pump to meet space heating, air condition, and water heating needs can be 70% more efficient[48]
LIGHTING		
Natural Day-lighting	Large diameter solid core optical durafiber in schools, and commercial, industrial, and public buildings achieves sizable lighting savings by allowing sunlight to reach workspaces. Large south facing windows and light shelves used for passive daylighting reducing electricity use for artificial lighting.	Industrial buildings can achieve 10-20% reductions in artificial lighting, schools 22- 64%, commercial and public buildings 40-50%.[49]

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[42] Pew Center on Global Climate Change, *Towards a Climate-Friendly Built Environment*, prepared by Oak Ridge National Laboratory, June 2005, p. 33.
[43] *Ibid*.., p. 27 citing Miller *et al.* 2004 in *Thermal Performance of the Exterior Envelopes of Buildings, IX*, Proceedings of ASHRAE SP-95 and Akbsari *et al.* 2004 in *ACEEE Summer Study on Energy Efficiency in Buildings*.
[44] *Ibid*., p. 27 using a comparison of whole-wall R-values for standard wall construction and structural insulated panels, *see*, www.ornl.gov.
[45] *Ibid*., p.27
[46] *Ibid*., p.28 citing Khudhair, A.M., M.M. Farid, "A review of energy conservation in building application with thermal storage by latent heat using phase change materials," *Energy Conversion and Management* 45 (2): 263-275, January 2004.
[47] *Ibid.*, p. 71, citing National Association of Home Builders Research Center, Inc., *Accelerating the Adoption of Vacuum Insulation Technology in Home Construction, Renovation, and Remodeling,* December 2002, which states that Vacuum insulation panel applications selected as most promising in the near term are manufactured housing floor panels (489 million sq ft), exterior doors (100 million sq ft), garage doors (33 million sq ft), manufactured housing ceiling panels (489 million sq ft), acoustical ceiling panels (potentially large commercial building market), and attic access panels/stairway insulation (approximately 1 million access panel).
[48] Pew Center on Global Climate Change, p. 32 citing a demonstration supported by DOE, TVA, and industrial partners.
[49] ACTA Press, Sulaiman, Modelling Large Diameter Solid Core Optical Fiber for Passive Daylighting, *From Proceeding* (409) Power and Energy Systems - 2003

Table 1.11 R-Value of Insulation Materials

Type of insulation	R-value
Vermiculite, loose fill	2.1
Fiberglass, blown loose fill	2.2
Perlite, loose fill	2.7
Rock wool, blown loose fill	2.9
Fiberglass, blankets and batts	3.3
Polystyrene boards	3.5
Cellulose, blown loose fill	3.6
Rock wool, batts	3.7
Urea-formaldehyde foam	4.5
Fiberglass, boards	4.5
Urethane foam	5.3

Source: http://www.sizes.com/units/rvalue.htm

The Concept of R-Value

R-Value is a material's resistance to heat-flow.[1] This unit of thermal resistance is used to compare the insulating values of different materials. The higher the R-Value of a material, the greater its ability to insulate and the slower heat flows through it.[1] It is expressed in units of hr-sq ft-°F/Btu and is the inverse of the U-factor.[1]

Technology improvements are helping to make this opportunity possible. Consider, as just one example, the improved efficiency of some new insulation materials compared to conventional insulations.

Despite the tremendous long-term cost savings and environmental advantages of designing energy performance into buildings and adhering to efficient operations and management practices, there are well documented barriers to their adoption. Table 1.12 summarizes several of the main barriers and is drawn largely from the findings in Alliance to Save Energy's July 2005 report *Building on Success: Policies to Reduce Energy Waste in Buildings.*

Table 1.12: Barriers to Improved Energy Efficiency in Buildings

	BARRIER	DESCRIPTION
1.	Tenant-landlord split	Building owners frequently do not pay energy bills and therefore their incentive to invest in energy efficient design or O&M measures is limited.[50]
2.	Information Gap	Knowledge of high-efficiency design techniques and O&M practices is limited.[51]
3.	Supplier / Contractor Gap	While there are some building contractors trained in building science and high-performance energy efficiency, a robust supply has not yet developed.[52]
4.	Risk Aversion	Even if building owners are aware of energy efficient building design techniques they exhibit reluctance to request such design elements because of concern the design elements will cause unforeseen problems.
5.	Higher First Cost	Bias towards minimizing first cost prevents building owners from adopting energy efficiency design measures and O&M practices, even when these elements would pay for themselves over a short time period.
6.	Externality Costs of Energy	Individual energy consumers do no pay the full cost of energy use – increased air pollution, risk of catastrophic climate change, and national security costs are borne by society at large.[53]

(http://www.actapress.com/Content_Of_Proceeding.aspx?ProceedingID=241) , http://www.actapress.com/PaperInfo.aspx?PaperID=15393

50 Alliance to Save Energy, *Building on Success*, 2005, p. 8.

51 *Ibid*., p. 8.

52 Consortium for Energy Efficiency, *Residential Home-Performance Programs National Summary*, 2005, p. 10.

The presence of these barriers means that there is an important role for public policy in ensuring that our built environment is designed and remodeled with energy efficiency in mind. Polices that overcome these barriers to ensure high-performance energy design, improved management of energy use, and the use of more energy efficient building materials have the potential to deliver large energy savings in a cost effective manner.

To minimize the energy use, operating costs and the emissions profile of our region's buildings, we recommend a significant expansion of existing initiatives to increase the energy efficiency of buildings in the NE-EC region. This expansion should focus on three priority recommendations:

- adopt and enforce latest building energy codes;
- promote use of Energy Performance Building Standards to exceed building energy codes;
- provide operations & maintenance training.

2.1 Adopt and Enforce Latest Building Energy Codes

Summary

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

- promote uniformity and predictability for code inspectors and building contractors by adopting the latest IECC building energy codes in every jurisdiction and making them mandatory for new construction;
- adopt policies in each jurisdiction that automatically update the applicable building energy code no later than six months after IECC adopts and formally publishes such updates;
- establish a new inspection mechanism dedicated exclusively to energy code compliance (separate from "life safety" inspections) and provide a self-sufficient revenue stream through building permit fees;
- focus on training and technical assistance for builders.

The International Energy Conservation Code (IECC) model code, which includes chapters on both residential and commercial energy codes is revised every three years (and occasionally updated with limited 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 adopting the 2003 model energy codes for commercial buildings. Canadian provinces choose whether to make the federal model building energy codes mandatory in their jurisdictions, and to date no provinces in the region have done so. In general, each version of the code is more stringent than the previous version.

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. DOE reports, it is not uncommon to find more than one-third of new buildings failing to meet local energy code requirements.

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 projects 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.

Opportunity

Historically, building codes have focused on "life safety" measures by setting standards on proper electrical wiring, plumbing, framing and the like. More recently, an energy component has been added to some states' building codes, setting minimum energy efficiency standards for such building characteristics as insulation, window performance and lighting densities.

[53] Alliance to Save Energy, p. 8.

The energy efficiency provisions in building codes have successfully delivered very large energy savings. Over the past 15 years, building energy codes adopted in various U.S. states have delivered energy savings worth more than $7.4 billion.[54] The American Council for an Energy Efficient Economy (ACEEE) estimates that 0.5 quads of energy were saved in the U.S. in 2000 alone as a result of commercial and residential building codes.[55]

Looking ahead, building codes implemented in participating states have the potential to save even more energy, and reduce significant GHG emissions. The Lawrence Berkeley National Laboratory projects 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.[56]

In the U.S., state building energy codes were first adopted in California in 1974,[57] and subsequently the International Code Council (ICC) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) developed national model energy codes to help all states adopt energy codes. Under current federal law, states can choose to adopt the updated model energy codes, alter the model codes as they see fit, adopt older versions of the model energy code, or decline to adopt an energy code.[58] As a result, a patchwork of energy codes has emerged, with some states lagging far behind in adoption of the more efficient codes. In all, approximately 40 states use some form of these model codes as the basis for their state building energy codes.

The ICC and ASHRAE model energy codes specify a minimum energy performance for items such as ceilings, walls, floors, basement, slab perimeter, and crawl space. The codes constitute a “floor” or minimum standard that all new buildings and major renovations are required to meet.

The ICC issues a new edition of its IECC model code for residential and commercial buildings every three years (and occasionally publishes more limited supplements).[59] The latest full edition of the ICC model residential and commercial energy code is IECC 2006. The ASHRAE model energy code for commercial buildings is published in its entirety every three years in the fall. The latest version available at the time of this writing is ASHRAE 90.1-2004. Specific examples of improvement in the latest version of ASHRAE 90.1 2004 include provisions for 25% reductions in lighting power densities and improved insulation levels and window performance criteria that ensure substantial energy savings.[60] Industry experts estimate that each revision to the code has been approximately five to seven percent more stringent than the previous version, although this is not true in every case.[61]
Tables 1.13 and 1.14 highlight the discrepancies in energy codes in New England. The fact that certain states have not adopted the latest model energy codes represents a lost opportunity for energy savings in the region. Failure to capture these savings places unnecessary demand on electricity, natural gas and home heating oil, pushing up prices for those commodities for everyone in the region.

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54 Alliance to Save Energy, p. 14.
55 *Ibid.*, p. 14.
56 Lawrence Berkeley (Rosenquist), *Energy Efficiency Standards and Codes for Residential/Commercial Equipment and Buildings: Additional Opportunities.* p. 21-22. One quad is 1,000,000,000,000,000 British Thermal Units (Btu), or about the same as 7.2 billion gallons of #2 distillate home heating oil.
57 Loper, Ungar, Weitz, and Misuriello, “Building on Success: Policies to Reduce Energy Waste in Buildings,” Alliance to Save Energy, (July 2005), p. 14.
58 *Ibid.*, p. 14
59 *Ibid.*, p. 15.
60 Alliance to Save Energy, http://www.ase.org/content/article/detail/2032
61 Loper *et al.*, p. 60.

Table 1.13: Residential Energy Code Adoption in the U.S.

Version or Equivalent State Code	States Adopted
2003 IECC	20 States: AK[bc], AR, CA, **CT**, ID, KS, MD, **ME**[b], MT, NE, NM, NV, OH, OR, PA, **RI**, SC, UT, VA, WA
2001 IECC	2 States: NY, TX
2000 IECC	12 States: AL,[b] AZ,[b] DC, DE, FL, GA, KY, LA,[a] NC, **NH**, **VT**, WV
1998 IECC	1 State: OK[b]
95 MEC	5 States: HI,[b] **MA**, MN, NJ, WI
93 MEC	2 States: CO,[b] ND[b]
92 MEC	4 States: IA, IN, MI, TN
PRIOR 92 MEC	1 State: WY[b]
None	4 States: IL, MO, MS,[b] SD[b]

Notes: a Code adopted but not yet effective. Click on the state for more information.
b Code implementation depends upon **voluntary adoption by local jurisdictions**.
c Mandatory for state owned/funded residential buildings.

Source: Building Codes Assistance Project

Table 1.14: Commercial Energy Code Adoption in the US

ASHRAE/IESNA Standard or Equivalent State Code	States Adopted
ASHRAE 04	4 States: GA, IA, OH, WA
2003 IECC	15 States: AR, **CT**, ID, KS, KY, MD, MT, NE, NM, NV, PA, **RI**, SC, UT, VA
2001 IECC	3 States: IL, NY, TX
ASHRAE 01	6 States: AL[c], CA, CO[b], FL, LA, **ME**
2000 IECC	6 States: DC, NC[a], **NH**, **VT**[b], WI, WV
ASHRAE 99	6 States: AZ[bc], DE, **MA**, MI, NJ, OR
ASHRAE 89	6 States: HI, IN, MN, MO[c], ND[b], OK[b]
90A90B	1 State: TN[b]
PRIOR 90A90B	1 State: WY[b]
None	3 States: AK, MS[c], SD[b]

Notes: a Code adopted but not yet effective. Click on the state for more information.
b Code implementation depends upon **voluntary adoption by local jurisdictions**.
c Mandatory for state owned/funded commercial buildings.

Source: Building Codes Assistance Project

Current building codes in the Eastern Canadian provinces are less stringent in terms of energy efficiency than the codes in the New England states. The Canadian Commission on Building and Fire Codes published two model energy codes– the Model National Energy Code for Houses (MNECH) and the Model National Energy Code for Buildings (MNECB). Both were developed in the early 1990s and published in 1997. The primary difference is that the commercial sector's MNECB is more detailed than the residential sector's MNECH with regard to lighting, mechanical systems, and electric power consumption, whereas the MNECH has more detailed restrictions for building envelopes and ensuring they are airtight.[62] The MNECB was developed to ensure the cost of implementing the measures would be less then the lifetime energy savings, so requirements are less stringent in areas that have access to cheap natural gas.[63] A study of the relative efficiency required by the MNECB and ASHRAE 90.1-1999 showed that the U.S. standard, albeit outdated, was 11% more stringent than the MNECB, on average.[64]

Under Canada's Constitution Act, building regulation is the responsibility of provincial and territorial governments, so the provinces choose whether to adopt the MNECB and MNECH. To date, the Province of Ontario and the City of Vancouver are the only major political bodies in Canada to make MNECB requirements mandatory in their building codes.[65]

Table 1.15: State and Provincial Building Code Status and Targets

	Residential Today	Commercial Today	Target Residential and Commercial Code in 2007
CT	2003 IECC	2003 IECC	2006 IECC
ME	No Statewide Code	2003 IECC / ASHRAE 2001	
MA	1995 MEC	2000 IECC / ASHRAE 1999	
NH	2000 IECC	2000 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	
N-L	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	

In New England, a second problem is that the states have idiosyncratic processes for updating their building energy codes. This is one reason that many jurisdictions, once they have established a minimum code, fall behind in updating their codes to maximize energy efficiency of new construction. Today, the code adoption and change processes within the New England states vary greatly.

Table 1.16: Current Practice for Updating Codes[66]

CT	ME	MA	NH	RI	VT
Not more than every 4 years	No set schedule	At least every 5 years	No set schedule	3 year cycle w/ model code updates	Every 3 years

Source: BCAP

In addition to codes becoming outdated and not stringent enough, a third problem concerns code implementation and compliance. Individual agencies responsible for code outreach and enforcement are often understaffed. Where time and resources are limited, code officials tend to focus more on building safety codes and pay less attention to energy efficiency requirements.[67] Limited training and oversight for energy code enforcement can contribute to the problem.[68] According to DOE reports, in some states

[62] Natural Resources Canada, "Introduction to The National Energy Code for Buildings" http://oee.nrcan.gc.ca/english/programs/energycode.cfm#04
[63] *Ibid.*
[64] Hepting, Curt, "Canada's CBIP Versus the United State's LEED[tm]: Building Energy Performance Path Requirements", http://www.esim.ca/2004/documents/proceedings/PA107FINAL.pdf
[65] National Research Council Canada, http://www.nationalcodes.ca/mnecb/index_e.shtml
[66] BCAP, http://www.bcap-energy.org/code_adoption_process_home.php
[67] Loper *et al.*, p. 18.
[68] *Ibid.*

more than one-third of new buildings fail to meet local energy code requirements for windows and air conditioning equipment, which are some of the easiest energy requirements to verify.[69]

Similarly, there is also a need for training and technical assistance for the several thousand home builders in New England. While some large construction companies have extensive resources and repeated experience with energy code requirements, other builders are small outfits who may not have the experience, resources or access to training to stay current with the latest energy codes.

The opportunity presented here is for the states and provinces to adopt stringent energy building codes that meet or exceed the latest ICC/ASHRAE codes and have mechanisms in place to ensure they are adequately enforced and that builders have access to information and training that will facilitate compliance.

Example: Building Code Adoption in Seattle

Seattle has implemented a predictable schedule for updating to its energy code every two years. The City's Department of Planning and Development gathers input from architects, builders, contractors, trade organization, private companies, and energy efficiency experts and develops its updated energy code in a collaborative manner that improves compliance. The transition to more stringent requirements of the most recent code update has gone smoothly because the building operators, builders, and architects were invited to participate in the policymaking process and had advance notice of the changes.[70] Seattle's municipal building energy code takes the form of amendments made to the applicable state requirements. The successful implementation of these tighter standards in the municipal code has often been relied upon by Washington state policymakers during their proceedings to update state standards.[71]

Implementation

Setting and Updating Codes

The large variation in code adoption and change processes illustrated in Table 1.15 highlights the opportunity that exists to improve upon the status quo. The ICC's development process is transparent, with separate steps for proposing and adopting updates. Information about the proposed changes is publicly available six months in advance. Given this transparency, it is reasonable to expect states and provinces to adopt the latest codes no later than six months after ICC adopts and formally publishes them. To ensure ample, predictable lead time for the building and construction industry, the latest ICC codes should then go into effect one year after IECC publication.

Code Enforcement

It is important for the states and provinces to establish a system to effectively enforce the latest energy codes once they are adopted. In most states and provinces, energy waste from construction comes not from imperfect codes but from incomplete implementation of the codes. Consider, for example, the results of a 2002 Northeast Energy Efficiency Partnerships (NEEP)/Peregrine survey that found "59%

[69] *Ibid*., p. 19. It is also worth noting that EPAct 2005 included Section 128, State Building Energy Efficiency Codes Incentives, authorizing U.S. DOE to fund a state that implements a plan "to achieve and document a 90 percent compliance rate" with the 2004 International Energy Conservation Code for residential buildings (or any succeeding version) and the ASHRAE 90.1-2004 Standard for commercial buildings (or any succeeding version).

[70] Personal communication with Harold (Skip) Schick, Senior Manager, Northwest Energy Efficiency Alliance, August 3, 2006.

[71] Personal communication with David Weitz, Executive Director, Building Code Assistance Project, January 27, 2006.

of all New Hampshire communities have no local official prepared to deal with residential or commercial code compliance."[72]

Building inspectors around the country are often asked to take on more responsibility than their resources can cover. Their expertise and ongoing training focus principally on "life safety" and structural engineering issues. Thus, the status quo of compliance and enforcement tends to fall short of the energy efficiency results intended in the code. By way of illustration, consider that in Rhode Island, code inspectors self-reported that less than 30% of them check window U-values, less than 20% check vapor barriers and 0% check ducts for energy efficiency compliance.[73]

Adding a new responsibility to the existing safety inspectors' duties, especially one that is highly technical and time consuming to perform, may not be ideal. Especially in rural areas, adding new building inspectors to handle the load of energy efficiency code compliance for each municipality may be unaffordable or criticized as an unfunded mandate. Given the challenges of simply adding energy efficiency to the responsibilities of the existing building inspection regime, we suggest a new, separate inspection mechanism be considered and given a self-sufficient revenue stream through building permit fees.

One such model is the private sector energy inspector. Like the practice now used for plumbing inspections, a list of certified building energy efficiency inspectors can be developed. Homebuilders or contractors simply select any certified inspector from the list and get the appropriate approvals through the building permit process. Municipal governments would not need to hire new staff or add to their budget. The benefit of this system is that it develops a private sector that is better equipped to provide timely and affordable certification of compliance with building energy codes.

Example: Washington State Energy Inspection Program

Washington adopted a private energy inspector program after widespread recognition that unique expertise, beyond that held by the average local building safety inspector, is needed to understand the technical aspects of building energy efficiency and ensure that they are actually evaluated.[74] The state 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. The model provides local jurisdictions with the option of either using their own trained and certified municipal inspectors or selecting a private energy inspector that is trained and certified by the state.[75] The system of certification, plan review and site inspection helps to ensure that municipal and private inspectors have the knowledge base and expertise, as well as the mandate, needed to achieve improved energy code compliance. Because of their mandate and their technical expertise, the energy inspectors frequently become part of the building design and construction team. This helps to ensure buildings comply with energy codes in a cost-effective manner. An evaluation of the Washington program determined that this system, established in 1994, has significantly improved code compliance.[76]

The bottom line is that inspectors should be specially trained in building energy performance and conduct thorough inspections – which would include using computer modeling – both before construction and as a follow-up after construction is completed, to ensure energy performance.

[72] NEEP/Peregrine, "2001 Survey of Knowledge, Practices, and the Needs of Energy Code Officials in New Hampshire and Rhode Island", May 1, 2002. www.neep.org/files/2001_RI_NH_Officials_Survey_Report.pdf
[73] NEEP/Peregrine.
[74] Doug Baston, North Atlantic Energy, "Notes for the Utilities Committee," Presented to the Maine Legislature, March 10, 2004.
[75] *Ibid.*
[76] *Ibid.*

It will be important to address the question of where the financial resources come from to pay for this capacity at the local level. A list of options for securing the necessary resources includes:

- mandating certified inspections, and enabling third-party private inspectors to recover their fees directly from the builder/developer on a fee-for-service basis;
- increasing building permit fees collected by the municipal government and redirect a portion of the fees to private inspectors;
- adding utility connection fees to pay for private inspectors; and/or
- retaining a certified inspector on staff of the local municipal government paid for by the government's general revenues.

It is important for energy inspectors to maintain current knowledge of energy codes and performance. Jurisdictions should make sure there are adequate requirements for inspectors to renew their certification and keep up their training levels to ensure that, as the codes and performance standards change, the inspectors will check for and enforce the most up-to-date requirements.

Training and Technical Assistance

Another strategy to ensure compliance is to focus on training and technical assistance for builders, because many builders currently fail to comply with energy codes due to a lack of knowledge. NEEP's 2002 report on New Hampshire and Rhode Island found that energy code officials in the those states rank "lack of builder training" as one of the top three barriers to code compliance.[77] Allocating a sum of money to go to builder training and technical assistance can greatly improve builders' understanding of newly updated energy codes and increase compliance. Massachusetts ran a successful pilot program that provided education and training on code implementation at the project level. It was well-received and increased the participating architects' and engineers' awareness of energy code requirements.[78] Expanding this builder training program to a full state- and province-wide scale, alongside an effective private building inspection system, could dramatically improve building code compliance.

[77] NEEP/Peregrine.
[78] Baston.

2.2 Promote Use of Energy Performance Standards to Exceed Building Energy Codes

Summary

States and provinces should encourage construction of new buildings and major renovations that go above and beyond minimum efficiency levels reflected in building codes. This can be accomplished by shifting the focus from codes to use of 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 for federally owned buildings, 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 setting it at the average new construction efficiency for the region, by building type, or the setting it at the level of the latest building energy efficiency code.

Second, we encourage jurisdictions to establish EPS targets and promote their 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. Fees, such as those gathered for buildling permits or utility service connections, can generate revenues to pay for the rebates as well as the code inspection. Completion of the final inspection will be rewarded with a small rebate. Certified achievement of increasing tiers of EPS will be rewarded with proportionately larger rebates. Some portion of the fees could be used to train more building energy inspectors and design assistance programs.

Energy saving 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. Yet building energy efficiency codes merely establish a “floor,” a minimum level of energy efficiency that new construction must meet or exceed. New policies are needed to promote the use of building materials and practices that will enable buildings to go above and beyond the minimum building code standards.

Efficiency Vermont, an independent agency serving the state as an “energy efficiency utility,” 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. For example, the newly built Oakes Hall at Vermont Law School uses 80% less energy for heating and 59% less electricity than the adjacent library (of comparable size) that was constructed just a few years earlier.

Opportunity

While it is important to ensure that the states and provinces update and enforce minimum building efficiency through energy codes, there remains an important opportunity to reduce GHG emissions and wasted energy by promoting efficiency above and beyond those codes.

Energy saving building design and construction techniques have advanced dramatically in past decades. These advances make it cost-effective to design and build new buildings that consume 50% less energy than buildings built to the latest code using conventional design and materials.

To understand the payback period and financial return associated with new high-performance buildings, consider that the statewide energy program run by Efficiency Vermont 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.[79] Taking the midpoint of these ranges - $2.50 per square foot initial investment and $.70 cost savings each year - an estimated financial return and payback

[79] Efficiency Vermont fact sheet, “Comprehensive Design Solutions,” http://www.efficiencyvermont.com/Docs/compdesignsolutions.pdf

period can be calculated. Even assuming flat energy prices and a 6% discount on energy savings, the initial investment in high-performance efficiency measures would be paid back in four years.

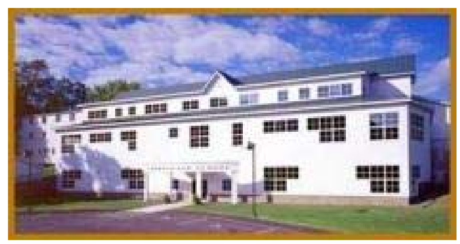
Table 1.17: Typical Financial Return of High Performance Energy Design

First Cost / sq ft	**($2.50)**
Sq Feet	10,000
First Cost	**($25,000)**
Annual Return / sq ft	**$0.70**
Sq Feet	10,000
Nominal Annual Return	**$7,000**
Payback Period	**~4 years**
Cumulative Return after 10 years	**$26,521**
Cumulative Return after 20 years	**$55,289**

While the Efficiency Vermont commercial building example identifies a typical payback period of four years, there are many instances where high-performance energy efficiency can be achieved at no incremental cost. Consider the example of Vermont Law School's Oakes Hall, which was built in 1998.

Example: High-Efficiency New Construction at Vermont Law School

Name:	Oakes Hall, Vermont Law School
Location:	South Royalton, VT
Completed:	August, 1998
Size:	23,500 sq feet
Scope:	New 3-story building (300 people)
Type:	Higher Education
Total Cost:	$3,500,000
Hard Cost:	$115/sq ft



The building uses 80% less energy for heating than the adjacent library building (of comparable size) that was constructed just a few years earlier, and electricity use is 50% less. 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.

Table 1.18: Building Energy Consumption

Annual Purchased Energy Use			
Fuel	**Quantity**	**MMBtu**	**kBtu/ft2**
Electricity	96,000 kWh	328	13.9
Natural Gas	0 kWh	0	0
Fuel Oil (No. 2, diesel)	354 MMBtu	354	15.1
Biomass (wood or other)	0 kWh	0	0
Other	0 kWh	0	0
Unspecified Fuel		-42.1	-1.79
Total Annual Building Energy Consumption			
Fuel		**MMBtu**	**kBtu/ft2**
Total Purchased		639	27.2
Grand Total		639	27.2

Despite the benefits that can be achieved for modest (or even zero) cost, there are several barriers to wide-spread adoption of cost-effective advanced building energy design. One such barrier is the "split incentive," where the person making the design and construction decisions and the ultimate end user have opposing financial interests. This occurs, for example, when a speculative developer is aiming to minimize up-front capital costs and therefore does not choose energy efficient building design, systems or materials. The subsequent buyer of the building will care more about the lifetime costs, especially annual operating costs for energy, but will have missed the opportunity to influence building design decisions.

Even when the client and developer are working in concert, energy efficient building design faces the barrier inherent in bid competitions. Most construction and renovation projects are put out to a competitive bid process. Architects and builders work to put in the lowest possible first-cost bid. They often design the absolute minimum amount of energy efficiency needed to satisfy the building code to keep first costs down. Higher-efficiency building design, materials, and systems typically have slightly higher initial costs. Unless estimated energy operating costs over the life of the building are factored into bid comparisons, designers and builders have little incentive to exceed minimum energy efficiency standards because doing so decreases the likelihood that they will win the bid.

Other barriers to voluntary efficiency improvements include the general inertia of the building design and construction industry, and the reality that many of the more high-efficiency systems and materials are new and unfamiliar. Computer programs, materials and advanced technologies and systems are constantly changing, which makes it challenging for architects and builders to keep up with and implement the newest options.

If these barriers can be overcome, an EPS can save clients (including taxpayers) significant money over the 50- to 100-year lifetime of new buildings and substantially reduce GHG emissions in the process. An EPS also spurs market transformation in the building sector by encouraging architects and builders to develop the habit of using the most efficient design tools, computer programs and their creativity to achieve large energy savings and dramatically improve building performance.

One major advantage of an EPS is that it allows architects, builders and their clients flexibility in choosing how to achieve compliance. An EPS can be met through a long list of design options, building materials and system technologies and thus avoids limiting clients' choices.

The usual solutions proposed to address the first cost of building efficiency measures – a hodge-podge of financial incentives such as tax credits, rebates, low-interest loans, energy efficiency mortgages and low-cost financing – have significant limitations. First, they don't affect the point of most potential impact – the design process. Second, they fail to harness the power of market competition and the ingenuity of the private sector. Third, buildings that are designed poorly from an energy perspective lock building users into a pattern of higher end-use consumption, with the associated impacts air pollution and higher energy costs for many years to come. Financial incentives that are used to perpetuate the status quo of inefficient building practices provide, in essence, a subsidy for a long lasting public harm – high building energy consumption.

Several policies and programs that are now operating in the U.S. and Canada suggest ways in which NE-EC state and provincial governments can do more to overcome these barriers and capture significant energy savings from new construction and major renovation in the building sector.

Implementation

Government Buildings

We recommend adopting an executive order and/or legislation in each state and province to establish a mandatory Energy Performance Standard for all publicly funded buildings.

Some states in the U.S. have mandated that new construction and major renovation exceed an identified reference level of efficiency. There are two competing models for how such a performance standard could be implemented.

One model is to require that new public buildings and major renovation of a certain size exceed the latest IECC/ASHRAE code by a target percentage. For example, Maine requires new state buildings to beat the ASHRAE 90.1-2001 energy code by 20%, providing as follows:

> For each applicable project, building owners subject to this rule shall:
>
> A) Involve consideration of architectural designs and energy systems that show the greatest net benefit over the life of the building by minimizing long-term energy and operating costs.
>
> B) Include an energy-use target that exceeds by at least 20% the energy efficiency standards (ANSI/ASHRAE/IESNA Standard 90.1-2001 hereafter "ASHRAE 90.1") in effect for commercial and institutional buildings. . . .
>
> C) Include a life-cycle cost analysis that explicitly considers cost and benefits over a minimum of thirty (30) years and that explicitly includes the public health and environmental benefits associated with energy-efficient building design and construction, to the extent they can be reasonably quantified.
>
> The energy costs to be included in the life-cycle cost analysis shall include oil, gas, propane and electric.[80]

Similarly, construction of new federal government buildings in the U.S. will soon be required to meet performance standards - 30% less energy use than the most recent IECC and ASHRAE codes - so long as such building design and systems are cost-effective over the full life-cycle of the building.[81]

A second model requires new construction and major renovation projects for public construction to achieve "a minimum delivered energy performance standard" compared to some reference level of energy use. The Governor of New Mexico has ordered that the state adopt this system, mandating that any new building consume no more than half of the average energy use for that building type (as defined by the U.S. DOE).[82] The executive order directs New Mexico's General Services Department, in coordination with other relevant state agencies, to develop criteria and a process for implementing this mandate.

Table 1.19 illustrates what it means to meet a 50% performance standard, based on DOE's average energy consumption by building type.

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[80] 5 Maine Revised Statutes Annotated, Sec. 1764-A, and 18-544 Code of Maine Rules Chapter 60.
[81] EPAct 2005, Sec. 109 (amending 42 U.S.C. 6834(a)).
[82] New Mexico Executive Order 2006-001, January, 2006

Table 1.19

NEW MEXICO ENERGY CONSUMPTION PERFORMANCE STANDARD

Building Type	*1999 U.S. AVERAGE* End-Use Consumption (10^3 Btu/sf)	*NEW MEXICO* End-Use Energy Consumuption Perf. Std. (10^3 Btu/sf)
Education	75.0	37.5
Food Sales	202.2	101.1
Food Service	241.2	120.6
Health Care:		
Inpatient	228.9	114.5
Outpatient	83.3	41.7
Lodging	99.5	49.8
Merchantile:		
Retail (other than mall)	72.1	36.1
Enclosed and Strip Malls	67.5	33.8
Office	90.5	45.3
Public Assembly	81.7	40.9
Public Order and Safety	86.9	43.5
Religious Worship	32.2	16.1
Service	124.4	62.2
Warehouse and Storage	44.0	22.0
Single Family:		
Detached	44.7	22.4
Attached	45.6	22.8
Multi-Family:		
2 to 4 units	56.1	28.1
5 or more units	48.5	24.3
Mobile Homes	72.0	36.0

Commercial Buildings: Data from Table C3. Consumption and Gross energy Intensity for Sum of Major Fuels, EIA, 1999 Commercial Buildings Energy Consumption Survey at www.eia.doe.gov/emeu/cbecs/detailed_tables_1999_html

Residential Buildings: EIA, A Look at Residential Energy Consumption in 2001.

Also of interest, the U.S. Conference of Mayors is backing the "2030 Challenge," the goal of which is to make all buildings completely independent of fossil-fuel energy by 2030. It proposes to establish new energy standards to reduce new buildings fossil fuel energy use by 50%, followed by a new standard every five years, each round reducing building energy fossil fuel consumption by an additional 10 percent. Thus far the mayors of Santa Fe, Albuquerque, Chicago, Miami and Seattle have all ordered 2030 Challenge standards in connection with their targets of achieving carbon neutrality by 2030 for all new city-owned buildings.[83]

By mandating that all publicly funded buildings meet an Energy Performance Standard, a jurisdiction can save significant taxpayer dollars while facilitating high-efficiency practices. This policy requirement would address current barriers to the adoption of high performance building design for this portion of the building stock and jump start a market transformation of best practices in the private sector.

Mindful that modern designs, materials and construction practices can reduce new building energy consumption by 50% compared to the latest building codes and still be cost-effective, we encourage states and provinces to set an EPS at the 50% level. There are advantages and disadvantages to using the most recent building energy code as a reference point, just as there are when using average building type energy consumption as a reference point. The important concept is for the states and provinces to choose a reference point, set the tiers of high-efficiency performance standards, and begin promoting these standards for new construction.

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[83] New Mexico Business Weekly, "New Mexico: 2030 target for fossil fuel independence." *Available at* http://www.msnbc.msn.com/id/13411547/.

The criteria for setting the appropriate level of improvement over and above codes should be that the costs of improved building design and systems are cost-effective over the full life-cycle of the building. It may make sense to start at a 30% target, as the U.S. federal government has done, until 2010. This would allow government clients and architects time to budget these costs, get accustomed to the design and verification software, and familiarize themselves with new building materials and techniques. As soon as possible, we think it reasonable to push publicly funded buildings to reach the higher target of 50% better than the reference case.

Table 1.20 lists case studies of government buildings that have already achieved high energy performance levels.

Table 1.20: Examples of High Performance Government Buildings

Name	Location	Const. Date	Size	High Performance Building Energy Details	Savings
NOAA's Weather Forecast Office	Caribou, ME	Oct-02	8,380 sq ft	Passive daylighting, geothermal heating and cooling, high-efficiency lighting	30% less energy use than typical Weather Forecast Office
EPA New England Regional Laboratory	Chelmsford, MA	Sep-01	70,400 sq ft	High-performance glazings, innovative window-shading photovoltaic system, passive daylighting, high efficiency lighting and mechanical systems	LEED-Gold, Environmental Award from Gov't Services Admin.
Navy's Bremerton Enlisted Quarters	Bremerton, WA	Dec-04	99,800 sq ft	Integrated energy efficiency design. Dual-sensor direct digital controls allow power to each apartment unit to be turned off when the unit is unoccupied.	35% less than ASHRAE 90.1-1999
NREL's Solar Energy Research Lab	Golden, CO	Oct-93	115,000 sq ft	Passive daylighting & heating. Efficient lighting, evaporative cooling, a heat recovery system to pre-condition incoming air, cooling towers for indirect evaporative cooling, window glazing and automatic controls.	30% less than a 10CFR435 federal reference case
NREL's Thermal Test Facility	Golden, CO	Oct-96	10,000 sq ft	South facing for passive daylighting and heating, thermal massing, high insulation levels, energy efficient lighting, high airtightness level	63% less energy than an equivalent code compliant building
NREL's Guard Post Building	Golden, CO	Dec-02	160 sq ft	A roof-integrated 768-watt photovoltaic (PV) system and two wind turbines minimize the amount of electricity drawn from the power line. The building cost less to build b/c the power infrastructure did not need to upgraded.	80% reduced utility costs
STRI Research Station	Bocas del Toro, Panama	Oct-03	7,530 sq ft	Translucent lower roof, along with the partially transparent photovoltaic roof, admits an optimum 5% of daylight into the interior rooms for daylighting. The 38-kW photovoltaic upper roof produces approximately 75% of the building's energy needs, while doubling as the rainwater collector.	More than 75% reduced energy use
Maine PUC Building	Augusta, ME	Retrofits to 1942 Building		Efficient T-8 lighting and electronic ballasts, occupancy sensors, and a solar hot air wall mounted panel system. Close attention to operating practices.	35% reduced energy use
CT DEP Building	Hartford, CT			Efficiency lighting and other measures helped the DEP building score a 90 out of 100 and received EPA's Energy Star label. Energy savings of $300,000 per year benefit taxpayers.	33% less energy use than average building
Medford City Hall	Medford, MA			Retrofits	20% energy savings

Source: U.S. Department of Energy, Federal Energy Management Program, "High Performance Federal Buildings," Available at www.eere.energy.gov/femp/highperformance/

New Construction and Renovation of Private Sector Buildings

We also recommend that each jurisdiction take aggressive steps to promote high-efficiency performance standards in new construction and major renovation of private sector buildings. We propose setting two tiers of performance standards: one that is equivalent to 20% more energy efficient than a reference point, and a second that is 50% more efficient than that reference point and establishing programs to promote the use of these standards.[84]

Numerous programs and incentives currently in use in this region have established the foundation on which this initiative can be built.

For example, the ENERGY STAR Qualified New Home program was established to certify residential construction built to perform better than code. In September 2005, U.S. EPA announced several upgrades to the program, most notably updating the code to the latest (2004) version of the IECC. This voluntary program involves the following components:[85]

- at least 15-20% better energy performance than IECC 2004 (in Maine, New Hampshire and Vermont the target is at least 20% better efficiency, in the other New England states the standard is at least 15% better efficiency);
- proof that some combination of ENERGY STAR qualified products are installed in the house (heating or cooling equipment, windows, appliances, lighting);
- a Thermal Bypass Inspection (to check air and thermal barriers);
- verification and field testing of performance using a certified third-party provider, by one of two methods:
    - a performance path using the Home Energy Rating System (HERS) or
    - a prescriptive path (a Builder Option Package - or BOP).

A HERS rating evaluates a new home's energy efficiency by comparing it to a reference house of identical size and shape that meets the IECC 2004 energy efficiency standards. A HERS rating includes:

- analysis of a home's construction plans to attain technical information such as orientation, shading area, and insulation levels;
- at least one on-site inspection of the home, including:
    - a blower door test (to test the leakiness of the house);
    - a duct test (to test the leakiness of the ducts);
- a computer simulation program to generate the HERS score and the home's estimated annual energy costs.[86]

A BOP approach to verification uses a predetermined list (a "punchlist") of construction specifications unique to each climate zone in the country. The new home must satisfy "performance levels for the

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[84] We note that the energy performance standards in the U.S., when expressed as a percentage improvement over the reference case such as a building code, tend to be a bit lower than their Canadian counterparts. This is likely due to the fact that Canada's model energy building codes are slightly less stringent than those in the U.S. It may be appropriate to use different targets in Canada, such as 25% and 50%, to draw parallels with existing Canadian programs.

[85] ENERGY STAR Qualified Homes National Performance Path Requirements, http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/PerfPathTRK_060206.pdf . In 2005, the province of Ontario announced it was undertaking a pilot project to certify Energy Star Homes built to 40% better energy performance than minimum energy codes in the province.

[86] http://www.energystar.gov/index.cfm?c=new_homes.hm_verification#hers

thermal envelope, insulation, windows, orientation, heating, ventilation and air conditioning (HVAC) system and water heating efficiency for a specific climate zone" in order to meet the standard.[87]

The passage of financial incentives in the Energy Policy Act of 2005 (EPAct 2005) has helped to promote new construction energy performance levels exceeding code. Specifically, the Act offers a tax credit of $2,000 to a contractor building a new home that exceeds by 50% the energy performance of a comparable home (built to minimum IECC 2004 standards).[88] To receive the credit, a certified rater must calculate and attest to the improved energy efficiency using procedures established by the Residential Energy Services Network (RESNET).[89] Similar tax incentives are also available for energy efficiency improvements made to existing homes[90] and for new construction of high-efficiency commercial buildings.[91]

In Canada, very similar tools have been put in place to promote high-efficiency performance standards that exceed the national model energy codes for new homes and commercial buildings.

Part of Canada's strategy to promote higher-efficiency construction in residential housing is R-2000.[92] R-2000 is a collaboration of the federal government's Office of Energy Efficiency and the housing construction industry. It is a voluntary program that employs an energy performance standard that allows builders and their clients flexibility to achieve the standards. A house certified to R-2000 standards typically achieves 40% better energy performance than the same house would if it had been built to meet only the Model National Energy Code for Houses. The program claims to have trained nearly 1,000 builders and certified 10,000 new homes.

The main components of the R-2000 Program are:

- the R-2000 Standard;
- the R-2000 quality assurance process;
- R-2000 home certification;
- training and licensing for builders and R-2000 service providers involved in quality assurance;
- consumer information programs.

Another important part of Canada's efforts to promote more efficient new housing was the Office of Energy Efficiency's EnerGuide for New Houses program. With its counterparts at the provincial level, EnerGuide provided financial incentives to pay for audits and certification. In early 2006 these incentives fell victim to budget cuts, and it is unclear if or when the programs will be restored, or at what level. A remaining federal incentive for higher performance homes can be found in the form of a 10% refund on

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[87] http://www.energystar.gov/index.cfm?c=new_homes.hm_verification#hers; *See also*, http://www.energystar.gov/index.cfm?c=bop.pt_bop_index, for links to the performance specifications applicable in a given state.

[88] EPAct 2005, Sec. 1332, Business credit for new energy efficient homes. Manufactured homes, as opposed to site-built homes, must demonstrate energy efficiency performance at least 30% better than IECC 2004. *See also*, Getting to Fifty (TM), the program being developed by the New Buildings Institute to help users achieve 50% energy efficiency improvement and receive the tax credit. On the web at http://www.advancedbuildings.net/.

[89] Residential Energy Services Network (RESNET) was established to develop a national market for home energy rating systems.

[90] EPAct 2005, Sec. 1333, Credit for energy efficiency improvements to existing homes, gives a 10 % investment tax credit for certain expenditures to improve the building envelope or purchase higher efficiency heating and cooling systems.

[91] EPAct 2005, Sec. 1331, Energy efficient commercial building deduction, allows a deduction of $1.80 per square foot (equal to the added cost of high-efficiency improvements), for new commercial construction that reduces annual energy and power consumption by 50 percent compared to the ASHRAE standard. The deduction would equal the cost of energy efficient property installed during construction, with a maximum deduction of the building.

[92] See http://r2000.chba.ca/What_is_R2000/R2000_program.php.

mortgage loan insurance premiums from the Canada Mortgage and Housing Corporation (CMHC), Canada's national housing agency.[93]

At the provincial level, incentives for higher performance buildings continue to advance improved building design and construction. Quebec's Novoclimat program offers $1,500 - $2,000 for homes built to 25% better energy performance than conventionally built homes. Qualification for grants or loans requires the use of an accredited builder, inspections before and after the work is done, and issuance of a Novoclimat certification. In Nova Scotia, the Department of Energy will reimburse homeowners the full cost ($350) of an energy audit if the house scores as a high-efficiency performer.

For commercial buildings, Canadian contractors and building owners can access several programs that promote energy efficiency performance that is better than the applicable model code.

One such opportunity is the Commercial Building Incentive Program (CBIP) for new commercial and institutional buildings. Using as references the Model National Energy Code for Buildings (MNECB) and the CBIP Technical Guide, owners are eligible to receive twice the incremental design costs, up to $60,000, if they can demonstrate that their building will reduce energy consumption by at least 25% compared to the minimum requirements of the model code.[94] Owners of large buildings must use software packages to demonstrate the 25% savings threshold, while smaller buildings are allowed to use a prescriptive punch-list until the applicable software is released.

There are a large number of computer monitoring tools on the market today that make it relatively easy for architects to design buildings that satisfy a 50% EPS. Existing computer design tools allow the user to simulate and compare major design decisions quickly on the basis of energy performance (and GHG emissions). For example, MIT's Design Advisor is free and available to the public.[95] Users can choose variables from a list of options, such as building size and orientation, window type and glazing, insulation type and thickness, lighting requirement, ventilation needs and loads (number of people, types of use, amount of electrical equipment). The tool calculates total energy use, lighting intensity, first year costs, life-cycle cost and associated CO_2 emissions, and it determines if the building meets ASHRAE standards. By altering their choices among these variables, users can quickly and easily compare the changes in total energy consumption, costs and performance (temperature and lighting). The Design Advisor makes compliance with an EPS fairly easy.

Another program designed to calculate the energy performance of buildings is DOE-2.1E, which predicts the hourly energy use and cost for buildings for given weather, geometric, HVAC and utility rate structure information. It has been used widely for more than two decades to aid building design, analyze retrofit savings opportunities and to develop and test building energy codes in the U.S. and in other countries around the globe. As a joint 2005 report by DOE, the Solar Energy Lab, the University of Strathclyde and National Renewable Energy Laboratory – *Contrasting the Capabilities of Building Energy Performance Simulation Programs* – explains, its use has spread widely as "the private sector has adapted DOE-2.1E by creating more than 20 interfaces that make the program easier to use."[96] Energy-10 Version 1, another popular software tool, automatically calculates the energy impacts of changes to the building envelope and system options (HVAC, lighting, etc.) and estimates full life-cycle costs.[97]

We encourage jurisdictions in the region to consider establishing an aggressive rebate system to help fund and create incentives for the implementation of high-efficiency energy performance standards. Presently, every developer or building owner must pay for a building permit. Usually this is paid at the

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93 http://www.cmhc-schl.gc.ca/en/co/moloin/moloin_008.cfm .

94 http://oee.nrcan.gc.ca/commercial/financial-assistance/new-buildings/how-cbip-works.cfm?attr=20.

95 Design Advisor at http://designadvisor.mit.edu/design; *see also*, Lawrence Berkeley National Laboratory, Radiance program http://radsite.lbl.gov/radiance/ .

96 http://gundog.lbl.gov/dirpubs/BS05/BS05_0231.pdf

97 *Ibid.*

offices of the municipality, and the fee is proportionate to some variable such as total square feet (meters) or total project cost.

Significantly increasing building permit fees, on a sliding scale, could have several benefits. First, the majority of the fee could be rebated to the permit holder after he or she submitted a building design that met a higher efficiency EPS target and a third-party certification that the final building achieved the target. If the permit holder submitted the building design and the final certification but fell short of the target, the program could return a reduced rebate. Second, money collected from the fee could be used to train more building energy inspectors. If the inspectors were on the municipal payroll, the money could help pay their salaries. If the inspectors were private contractors, a portion of the fee could be transferred directly to them. Third, a portion of the fees could be used to support building design assistance programs. A fee schedule that charged more for a very large residence and less for a very small residence would not disadvantage low-income homeowners and would raise awareness among all customers of the need to build more efficient structures.

Example: Aspen, CO Building Permits and Fees

The resort community of Aspen, Colorado has adopted a graduated set of municipal fees charged to homeowners that are used to support local efficiency and renewable energy projects. One component of the Renewable Energy Mitigation Fee (REMF) establishes a requirement that new homes or remodels larger than 5,000 sq. ft. install a 2 kW photovoltaic or equivalent renewable energy system, or, alternatively, the owner can pay a fee. The fee is $5,000 for projects larger than 5,000 sq. ft., and $10,000 for projects larger than 10,000 sq. ft. In less than two years the program raised more than $2 million for local energy efficiency and renewable energy programs. A second component of the fee is assessed on surplus energy consumption for installed luxury electrical systems such as heated driveways, hot tubs and swimming pools. [98]

Finally, to facilitate the widespread adoption of energy efficient design techniques, each state and province should set up an EPS task force composed of builders, architects, building operators, energy efficiency advocates and policy makers. This EPS task force would issue guidance documents to the architectural community that outlined specific strategies, computer programs, designs tools, and best practices that could be used to meet the EPS in new state buildings and major renovation projects.

2.3 Provide Operations and Maintenance Training

Summary

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% - 20% lower annual utility bills and that these improvements can be achieved at costs that are paid back in less than two years.

In the Northeast U.S., one O&M training program is run by the Northeast Energy Efficiency Partnerships, Inc. (NEEP). The 2003 trainings alone saved an estimated 240,000 MMBtu and 118,000 MWh per year.

98 http://www.newrules.org/environment/climateaspen.html.

Opportunity

Industry experts estimate that improved building operations and maintenance (O&M) can deliver between 5% - 20% lower annual utility bills and that these improvements can be achieved at costs that are paid back in less than two years.[99]

In the context of energy efficiency, buildings O&M involves identifying and eliminating wasted electricity use, energy loss from steam, air leaks, uninsulated lines, maladjusted or inoperable controls and poor overall maintenance of buildings' heating, cooling and electrical systems. Employing best practices to building O&M can yield large energy savings without large capital investments.

Improved O&M practices secure these savings through a limited investment in human capital, training and certification of building operators who make adjustments to facility energy systems on a year-round basis.

There are two keys to achieving substantial O&M energy savings. The first is to ensure that building operators are adequately trained and updated so they can identify high-efficiency O&M opportunities. The second is to have management (of the building or the business) that will facilitate the training of the operators and the implementation of proposed measures. It is not uncommon for business managers to be reluctant to approve the use of resources on improving facility O&M, since they are frequently unfamiliar with the technical nature of the issues and their focus is on the core competency of their business. Another typical barrier is the split incentive between building owners and tenants. In buildings where tenants pay their own utility bills, building owners are not financially rewarded for investments in reducing energy consumption in the building and therefore are less likely to pay for training or Building Operator Certification (BOC) for the facility operators or to make small capital expenditures for O&M energy savings.

Implementation

To address these barriers, states and provinces in the region should implement policies to bring training to as many commercial and industrial building owners and operators as possible. We think a reasonable target for such policies is to reach 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.

Policies and programs should focus first on buildings that have a dedicated facility manager or are larger than 100,000 square feet.

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[99] U.S. Environmental Protection Agency and U.S. Department of Energy, "Operations and Maintenance Assessments," prepared by Portland Energy Conservation, Inc., 1999, p. 1.

Example: Building Operator Training

The voluntary Building Operator Certification (BOC) program began in Seattle in 1997 implemented by the Northwest Environmental Education Council (NWEEC). The program is now offered through partner organizations in 17 states and has trained and granted BOC to nearly 1,500 building operators.

In the Northwest, approximately 10% of building operators have participated to date and the Northwest Energy Efficiency Alliance (NEEA) estimates that 40% will have participated by 2010.[100] The Northwest BOC program has a benefit-cost ratio of 7.8 and more than 80% of the BOC trainees report substantial energy savings as well as improved building occupancy comfort.[101]

In the Northeast U.S., the existing BOC program is run by the Northeast Energy Efficiency Partnerships, Inc. (NEEP). The 2003 BOC trainings alone saved an estimated 240,000 MMBtu and 118,000 MWh per year.[102]

The course offerings and certification requirements for the BOC programs are substantial. In the Northeast, the certification requires two days of classes per month for three to four months, project assignments at the operators' home facilities, homework and exams. Course offerings focus on building energy systems, including HVAC and lighting, and techniques in conducting energy audits and preventative maintenance. The benefits of new O&M practices implemented by BOC graduates are illustrated in Table 1.21.

Table 1.21: Benefits of Northeast Building Operator Certification

Resource Saved	2003 Total Savings	Undiscounted Value of 2003 Savings	Energy Savings per Enrollee	$ Savings per Enrollee	Cost per Enrollee	Capital Cost of Adopted O&M Measures	Simple Benefit-Cost Ratio
Electric	61,821	$6,182,100	140,183	$14,018			
	(MWh)		(kWh)				
Natural Gas	103,596	$1,035,960	284,597	$2,349			
	(MMBtu)		(MBtu)		$1,400		
Oil	125,507	$1,574,493	234,912	$3,570			
	(MMBtu)		(MBtu)				
Water	50,124,000	$3,007,440	113,660	$6,820			
	(gallons)						
TOTAL 2003		$11,799,993		$26,757	$1,400		
TOTAL 2003-2008		$58,999,965		$133,787	$1,400	$20,408	6.13

Source: Northeast Energy Efficiency Partnerships, Inc.

In order to bring training to facility managers in all public buildings and half of commercial, institutional and industrial buildings, states and provinces should consider several options.

First, it may make sense to make the training mandatory for facility managers of large public buildings. This could be achieved by legislation or executive order. Leading by example in this way, government could help develop the initial cadre of trainers and fine-tune a curriculum that is best suited to the building types, uses and environment of the local jurisdiction.

Second, policy makers should explore the opportunity to expedite market transformation so that the training can be more accessible to end users. O&M training for energy efficiency could continue to use

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100 ACEEE, *America's Best*, "NEEP, NEEA, and NEEC's Building Operator Certification: Program Overview." http://www.aceee.org/utility/13aboc.pdf.

101 Jane S. Peters, Ph.D. Marjorie R. McRae, Ph.D. of Research Into Action, Inc. Dave Robison, P.E. Stellar Processes, Inc. "Regional Building Operator Certification Venture: Final Market Progress Evaluation Report" Regional Building Operator Certification, No. 7 September 20, 2001 http://www.nwalliance.org/resources/reports/88ES.pdf *and* ACEEE "…Building Operator Certification: Program Overview."

102 NEEP, *Impact and Process Evaluation*, prepared by RLW Analytics, 2005.

the proprietary BOC curriculum but move the delivery of training to private sector providers or educational institutions (such as public universities, community colleges, or vocational schools). Jurisdictions might also choose to develop a modified curriculum that takes less time and costs less and is customized to their local situation. To make the training as accessible as possible, jurisdictions might also consider ways to bring the trainers to the users instead of the other way around as is the current practice.

Finally, developing a curriculum and a cadre of trainers, and making this curriculum accessible to a much larger portion of the region's building managers, may best be advanced through public funding. We urge existing energy efficiency programs to factor this kind of training into their budgets.

Priority 3: Increase the Efficiency of Appliances and Commercial Equipment

By: Michael Stoddard

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 in their homes, schools and businesses.

In 1997, U.S. DOE published a landmark study that highlighted the very large potential for improving efficiency of energy-using products. Table 1.22 illustrates just some of the products that residential and commercial consumers could save money on if they bought the most efficient commercially available models instead of a model of average efficiency.[103]

Table 1.22: Cost-Effective Energy Savings Potentials for Selected End Uses in the Residential and Commercial Buildings Sector

Residential		***Commercial***	
End Use	**Energy Savings Potential***	**End Use**	**Energy Savings Potential***
Fuel Switching (*e.g.,* Clothes Drying)	59%	Space Heating (Electric, Gas and Oil)	48%
Lighting	53%	Space Cooling (Electric and Gas)	48%
Misc. Electric End Uses	33%	Ventilation	48%
Fuel Switching (Cooking)	33%	Misc. Electric End Uses	33%
Refrigeration	33%	Refrigeration	31%
Fuel Switching (Water Heating)	29%	Lighting	25%
Electric Water Heating	28%	Electric Water Heating	20%
Freezers	28%	Gas and Oil Water Heating	10%
Electric Space Heating	25%	Misc. Gas and Oil End Uses	10%
Gas and Oil Water Heating	23%		
Electric Space Cooling	16%		
Gas and Oil Cooking	15%		
Gas Space Heating	11%		
Misc. Gas and Oil Uses	10%		

Note: * Energy-savings potentials are calculated as the percent difference in energy intensity of maximum cost-effective technology and new 1997 technology.

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[103] Eto, Goldman and Nadel, Ratepayer-Funded Energy-Efficiency Programs in a Restructured Electricity Industry: Issues and Options for Regulators and Legislators, Ernest Orlando Lawrence Berkeley National Laboratory and American Council for an Energy-Efficient Economy, 1998, p. 9, quoting Interlaboratory Working Group on Energy-Efficient and Low-Carbon Technologies (IWGELT), *Scenarios of U.S. Carbon Reductions, Potential Impacts of Energy Technologies by 2010 and Beyond*. Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, 1997, p. 3.10.

3.1 Set Minimum Efficiency Standards for Consumer Appliances and Equipment

Summary

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 assigned such authority to state or provincial government. 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.

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. Department of Energy (DOE) eight years to complete rulemakings for prescribed products.

By 2020, new minimum standards on a new list of only 11 near-term candidate products are projected to save, just in the six New England states, nearly 2,000 gigawatt-hours of electricity, 500 metric tons of carbon and hundreds of millions of dollars.

Opportunity

Appliance standards are a policy tool used by state and federal governments. They are regulations prohibiting the sale of new products that do not satisfy minimum energy efficiency standards. By the year 2000, such standards "had already cut U.S. electricity use by 2.5% and U.S. carbon emissions from fossil fuel use by nearly 2%."[104]

By setting minimum energy efficiency standards on energy-using products, sales of inefficient models are phased out and higher efficiency models penetrate the marketplace faster. This results in widespread reductions in energy consumption without the use of public funding, and saves money for both consumers and utility ratepayers while cutting GHG emissions.

> Minimum-efficiency standards make sense when high-efficiency products are readily available or can be readily produced and are cost-effective, but, due to a number of market barriers, many consumers and businesses are purchasing less efficient products.[105]

One challenge to moving more efficient models into the marketplace is that most manufacturers, retailers and consumers are principally concerned with achieving the lowest possible purchase price. They traditionally have been less concerned with finding a model that has the lowest operating cost. For example, manufacturers have long made emergency exit signs illuminated with 40 watt incandescent light bulbs.[106] These lights are turned on full time, costing an average of $30 per year per sign to operate. In recent years many new models of exit signs have been developed that use light emitting diodes (LEDs) and consume as little as 3 watts, more than 90% less energy than the 40 watt bulb. While an LED exit sign recently cost about $20 more than the old models, it saved about $18 each year in avoided energy costs, or about $450 over the 25 year life of the product. Notwithstanding the obvious cost benefit of buying this new technology, retail sellers typically stock their shelves with whatever model sold well last

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[104] Nadel, DeLaski *et al*, *Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards*, ASAP, ACEEE, Jan 2005, p. 7.
[105] *Ibid.*, p. 5.
[106] *Ibid.*, pp.14 and 39.

year, and consumers typically buy what has the lowest sticker price. As a result, market penetration of the environmentally preferable model is delayed.[107]

In 1974, California Governor Ronald Reagan approved the establishment of energy efficiency standards for certain prescribed products as a means to address a mix of market failures.[108] Eventually the U.S. and Canadian federal governments did the same, initially prescribing standards for most basic kitchen appliances, room and central air conditioners, water and space heaters, and clothes washers and dryers, and later adding items such as residential furnaces and boilers. In 2005, 15 more products, including illuminated exit signs, were added to the list of covered products in U.S. federal law.[109] In Canada, the 1992 federal Energy Efficiency Act set initial efficiency standards for "energy using products" and gave government the authority to revise or establish new standards through regulation.[110] The standards are continuously updated, with changes made recently in 2003.[111]

Implementation of federal standards has achieved massive energy savings and improved product performance without relying on financial incentives from public funds. It is estimated that the new list of U.S. appliances for which standards were adopted in 2005 will offset the need for 30,000 MW of power plant capacity by 2020, cut projected U.S. electricity use by about 2% and net energy consumers about $63 billion.[112]

Unfortunately, the federal governments of both the U.S. and Canada have been very slow to add to the list of prescribed products and update the standards, even as there has been an explosion in the number of new electronic devices found in the marketplace and the emergence of high-efficiency models that perform the same work as the inefficient models. On average, it has taken DOE eight years to complete rulemakings for prescribed products. DOE has also been slow to update the standards for products already on the list. Finally, federal standards, while they provide a "floor" for energy performance that reflects average national usage, are not always well suited to advancing region-specific energy needs. For example, the federal energy standard for residential furnaces and boilers in the U.S. reflects what the DOE has found to be cost-effective for an average homeowner in the U.S., regardless of whether the home is located in Mississippi or Maine. As a result, federal standards for home heating systems prescribe a very low level of efficiency and have not been updated since they were first set back in 1987. Canada's standards for furnaces and boilers are the same as those for the U.S. Even though there has been progress with recent setting of both federal and state efficiency standards, significant additional opportunities remain untapped.

The opportunity presented here is for Northeast states and Eastern Canadian provinces to establish a policy tool they can use now and long into the future to help save operating costs on a wide array of electronic and thermal appliances.

Implementation

The solution we recommend is for every jurisdiction in the region to establish, at an appropriate government agency, the authority to set minimum energy efficiency standards for prescribed energy-

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[107] Nadel, DeLaski, *et al.*, pp. 5-6. Other market barriers to the widespread sale and purchase of higher efficiency models include: limited stocking of efficient products, split incentives (where the purchaser of the product is not the person who pays the energy bill), and lack of consumer awareness.
[108] *Ibid.*, p. 1.
[109] Energy Policy Act of 2005, Sec. 135, Energy Conservation Standards for Additional Products.
[110] Energy Efficiency Act (1992), Sections 20 and 25.
[111] Regulations Amending the Energy Efficiency Regulations, Canada Gazette, Vol. 137, No. 9 — April 23, 2003, Registration SOR/2003-136 10 April, 2003; *see also* Canada Gazette, Vol. 138, No. 7 — February 14, 2004, Regulations Amending the Energy Efficiency Regulations.
[112] Memorandum, "Update on Outcomes on Efficiency Standards in Energy Bill," Andrew DeLaski, Appliance Standards Awareness Project, August 2, 2005.

using products. When the time is right, this authority should be used to add products that are not covered on the list of federally prescribed products, to update all standards on a fixed schedule and to raise the standards beyond federal levels for certain products where there is a compelling state/provincial rationale to do so. Minimum standards do not apply to the sale of "used" products, and they do not require anyone to stop using an existing product to replace it with a new compliant product.

Three provinces in Eastern Canada and all but two of the New England states have established laws and regulations that set standards for energy using products. We note, however, that the Canadian provinces have made a more regular practice (than their U.S. counterparts) of providing power to the relevant government agencies to add new products or update standards without seeking additional legislative authority.[113] Notwithstanding this authority, these provincial laws, which were generally established in the early part of the 1990s, have had little or no updating.

Example: Authority to Set New Efficiency Standards

In 1991, the Province of **New Brunswick** established authority in the Lieutenant-Governor in Council to:

> make regulations: (a) prescribing products or classes of products as prescribed products and prescribing dates after which they will be subject to the application of any or all of the provisions of this Act or the regulations; (b) respecting standards to be met by prescribed products and establishing a date or dates on or after which prescribed products are required to meet those standards;[114]

In 2003 the State of **Connecticut** authorized its Department of Public Utility Control to set standards for new products and to update those standards periodically,

> upon a determination that such efficiency standards (A) would serve to promote energy conservation in the state, (B) would be cost-effective for consumers who purchase and use such new products, and (C) that multiple products are available which meet such standards.[115]

In 2005, the **California** Energy Commission updated its longstanding list of prescribed products subject to minimum energy efficiency standards.[116] This regulatory action, which extended well beyond the list of products already covered by federal legislation, was consistent with the state statute authorizing the Commission to:

> Prescribe, by regulation, standards for minimum levels of operating efficiency … to promote the use of energy efficient appliances whose use … requires a significant amount of energy on a statewide basis. The minimum levels of operating efficiency shall be based on feasible and attainable efficiencies or feasible improved efficiencies which will reduce the electrical energy consumption growth rate. … The standards shall be drawn so that they do not result in any added total costs to the consumer over the designed life of the appliances concerned.[117]

Massachusetts, Rhode Island and Vermont have not provided ongoing standard setting authority to any state agency, but they did recently adopt standards from the latest California list.

Each jurisdiction in the region should also immediately act to adopt standards for products analyzed and recommended in the 2006 study by ACEEE and ASAP as suitable for new state (or provincial) standards, having satisfied these criteria:

- a standard would achieve significant energy savings;
- a standard is known to be very cost-effective for purchasers and users of the product;

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[113] New Brunswick, Regulation 95-70 (May 1995); Nova Scotia, Energy-efficient Appliances Act. 1991, c. 2, s. 1.; Quebec, L.R.Q., c. E-1.2, Loi sur l'efficacité énergétique d'appareils fonctionnant à l'électricité ou aux hydrocarbures (1991, as amended in 2003) and c. E-1.2, r.1, Règlement sur l'efficacité énergétique d'appareils fonctionnant à l'électricité ou aux hydrocarbures.

[114] New Brunswick, c. E-9.11, Energy Efficiency Act 1992, Section 10.

[115] General Statutes of Connecticut, Sec. 16a-48 (d)(3).

[116] The 2006 Appliance Efficiency Regulations, (California Code of Regulations, Title 20, Sections 1601 through 1608) dated January 2006, adopted by the California Energy Commission on October 19, 2005, and approved by the California Office of Administrative Law on December 30, 2005.

[117] Division 15, California Public Resources Code, Section 25402(c)(1).

- products meeting the recommended standards are readily available today;
- a state standard could be implemented at very low cost to the state.[118]

Each jurisdiction should look carefully at the recommended list of products to confirm that their local consumer usage, marketplace and energy costs indicate these four criteria would be met. Going forward, we suggest jurisdictions add new products for coverage in their appliance efficiency standards any time they determine that these four criteria are met and that, regarding the cost-effectiveness for the purchasers/users, the standard under consideration has a simple payback period no more than 20% of the expected life of the product. Thus, for a DVD player or compact audio player with a useful life of five years, a jurisdiction should consider adopting a standard if and when such standard can deliver a simple payback to the consumer in one year or less, and can satisfy the criteria enumerated in the ACEEE study. In the case of DVDs and compact audio players, the simple paybacks are currently projected to be 0.7 and 0.1 years respectively, so both are prime candidates for a standard. Table 1.23 shows the list of top candidate products recommended in the 2006 ACEEE study and projections of their economic and carbon benefits for the six New England states.

Table 1.23: Potential Benefits of New Appliance Standards[119]

Sum of Projected Benefits for Efficiency Standards in Six New England States					
	2020				2030
	Energy Savings	Summer Peak Capacity Reduction	Value of Bill Savings[1]	Carbon Reductions	Net Present Value[2]
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 3	[248]	N/A	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[3,4]	365.2	15.8	112.4	154.8	1,240.1
	[2,305.2]	NA			
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]				

1. 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.
2. Net present value is the total monetary value of bill savings achieved by products sold under the standards between now and 2030 minus the total incremental product.
3. Commercial boilers, pool heaters, and residential boilers and furnaces save natural gas. Gas savings are expressed in cubic feet and enclosed in brackets to distinguish from electricity savings.
4. 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 and DeLaski, *Leading the Way II* (2006)

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118 Nadel, DeLaski *et al.*

119 Nadel and DeLaski, *Leading the Way II*, 2006.

Finally, given that the NE-EC region has longer and colder winters than much of the United States, it is worth focusing special attention to establish standards for furnaces, boilers, and furnace air handlers better suited to this region. In the New England states, this will require receiving a waiver from the U.S. DOE,[120] and showing that the specific use to which these products are put in the region justifies adopting a higher efficiency standard.

Table 1.24: Recommended Furnace and Boiler Standards[121]

Equipment Type	Current Federal Standard 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 and DeLaski, *Leading the Way II* (2006)

To maximize the capture of potential efficiencies and keep up with the pace of technology improvements, it is important that each state or province require periodic reviews to determine if the list of covered products can be expanded and if existing standards should be tightened. We recommend that authorizing language dictate this review occurs no less frequently than every two years. An alternative path for periodic reviews and updates is to peg the standards to the California regulations, much the way states in the Northeast have incorporated California's low emission vehicle standards by reference.

California has dedicated significant resources to studying the market penetration, commercial availability, and consumer paybacks for a wide variety of consumer products. Candidates for minimum energy efficiency standards are subject to lengthy rulemakings, and those for which standards are ultimately set can subsequently be adopted and enforced with minimal investment of time and resources. The California Energy Commission maintains a complete list of product models that satisfy the efficiency standards.[122]

[120] States are authorized to seek a waiver from the federal standard under 42 U.S.C. Section 6297. Massachusetts, Rhode Island, and Vermont have recently started down this path.

[121] Nadel and DeLaski, *Leading the Way II*, 2006, Table 3.8, p. 32; Regulations Amending the Energy Efficiency Regulations, Canada Gazette, Vol. 137, No. 9 — April 23, 2003, Registration SOR/2003-136 10 April, 2003.

[122] http://www.energy.ca.gov/appliances/index.html .

3.2 Require Government Procurement of High-Efficiency Models

Summary

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 another 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). However, these EPP programs are mostly limited to recycled content and waste issues and fall far short of the potential cost savings available from energy efficient products. Significant opportunities exist for states and provinces to reduce GHG emissions, help transform the market for high-efficiency products, and save taxpayer dollars by capturing energy savings from the many other energy consuming products they buy each year. Examples of candidate products that could be added to these EPP policies are refrigerators, furnaces and boilers, air conditioners, lighting, computers and copiers.

Opportunity

As noted in the prior recommendation, appliance and equipment standards serve as a mandatory "floor" below which less efficient models may not be sold (as new) into the marketplace. To make standards politically palatable, policy makers limit the use of this tool for products and efficiency levels that ensure very fast payback times to the consumer and for which there is plentiful choice among commercially available models. As a result, mandatory standards are good at ensuring full market penetration of efficient products that are already available. Standards are less suitable, however, for "raising the bar" to promote newer, even higher-efficiency products that may have longer payback periods or less widespread availability.

Still, it is important to help transform the markets for the use of ever more efficient products. One way to do this is through the public information campaigns and financial incentives provided by statewide energy efficiency programs as described under Priority 1.1. Another avenue is to establish minimum efficiency requirements within the procurement policies governing the use of public dollars.

Many of the products that are appropriate for regulating with minimum efficiency standards are also purchased for use in government office buildings, public housing, public university buildings, and law enforcement and detention facilities.

It is common for states governments in New England to establish procurement policies that encourage or require agencies to buy Environmentally Preferable Products (EPP).[123] However, these EPP programs typically fall short of the energy that could be saved and the impact state purchases could have in transforming the market for high efficiency products. Typically, these procurement policies focus on recycled content of paper. Where they do reference energy efficiency, it is often limited to office computers, copiers and lights.

Significant opportunities exist for states and provinces to save taxpayer dollars by capturing energy savings from the many other energy consuming products they buy each year, including refrigerators, furnaces and boilers, air conditioners and lighting.

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[123] *See, e.g.*, Massachusetts EPP Purchase Program, and Executive Order 438, State Sustainability Program, 2002.

Example: Federal Procurement of Energy Efficient Products

Section 104 of EPAct 2005 – Procurement of Energy Efficient Products – amended the National Energy Policy Act to require 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."

One component of the new federal Procurement rule requires all agency heads to perform "Procurement Planning" by incorporating criteria for energy efficiency into bid specifications for any purchases "involving energy consuming products and systems." This requirement extends to purchases of construction and renovation services. The criteria are to be consistent with the criteria used for rating Energy Star and FEMP designated products.

Another component of the rule allows exceptions if:

- (A) an Energy Star product or FEMP designated product is not cost-effective over the life of the product taking energy cost savings into account; or
- (B) no Energy Star product or FEMP designated product is reasonably available that meets the functional requirements of the agency.[124]

Implementation

Each jurisdiction in the region should capture this opportunity to save taxpayer funds by adopting the provisions of Section 104 of EPAct 2005. Responsible agencies in each state and province should be required to check and post the list of Energy Star qualified models and FEMP designated products in a place easily accessible to procurement officers. It should be mandatory that such products are purchased unless the purchasing officer can show that the qualifying product would not work adequately or would not be cost-effective, considering energy savings over the life of the product.

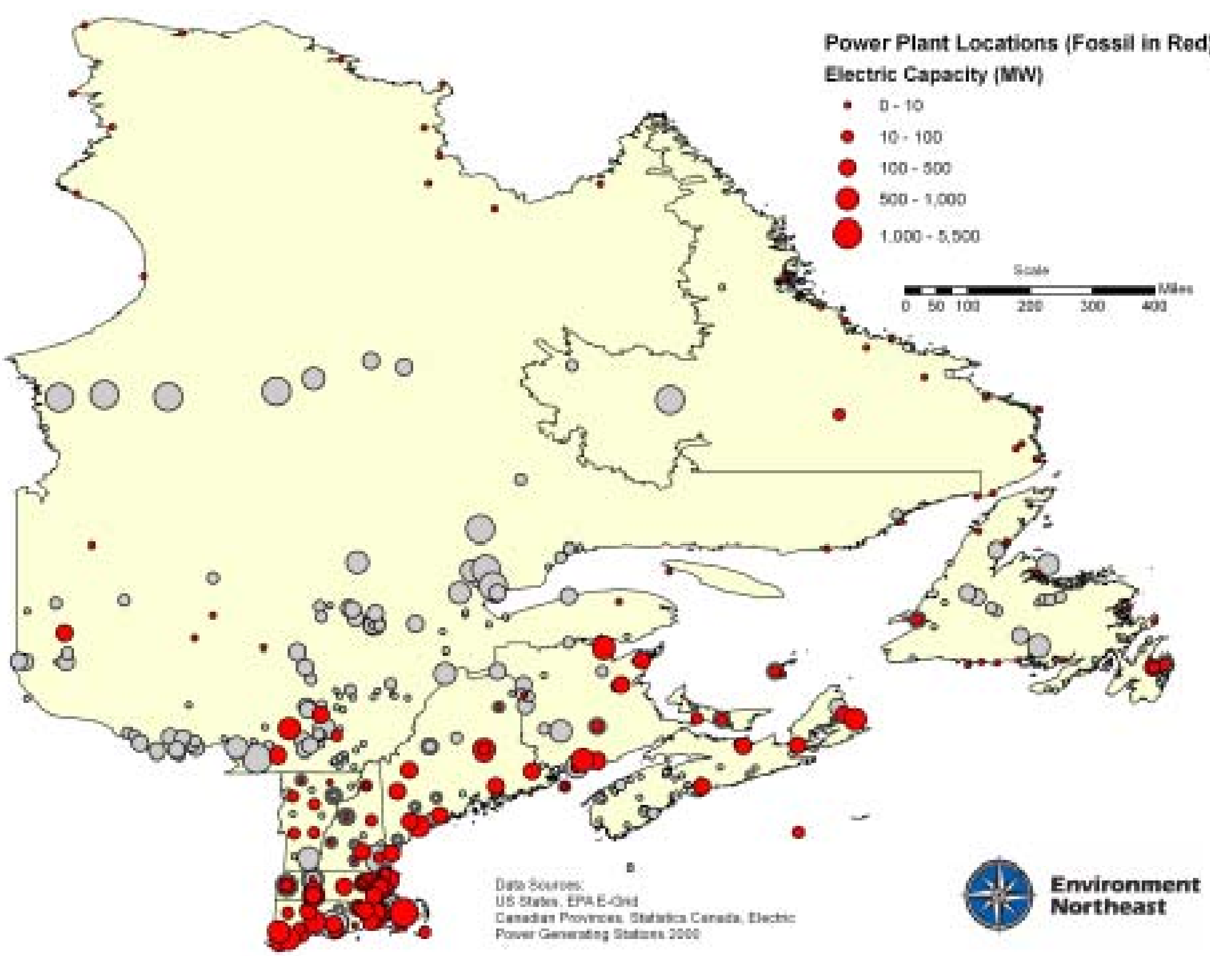
[124] National Energy Conservation Policy Act, Sec. 553(b)(2)

Priority 4: Reduce Emissions from Large Stationary Sources

By: Derek Murrow

Large stationary sources of emissions are suitable for regulation under market based programs such as greenhouse gas cap-and-trade programs, which the region is beginning to implement in the form of the Regional Greenhouse Gas Initiative (RGGI) and the Canadian government may implement in the form of the Large Final Emitters (LFE) program. These kinds of programs are similar to the program developed in Europe to cap emissions from large emitters known as the EU Emissions Trading System (ETS). The facilities that are best suited to this kind of program are large emitters that have the capacity and knowledge to be able to manage their emissions and use a market based system to reduce emissions at the lowest cost. As Figure 1.18 shows, there are many large fossil fueled power plants throughout the NE-EC region that could be regulated and this list would dramatically expand if large industrial and commercial units were added.

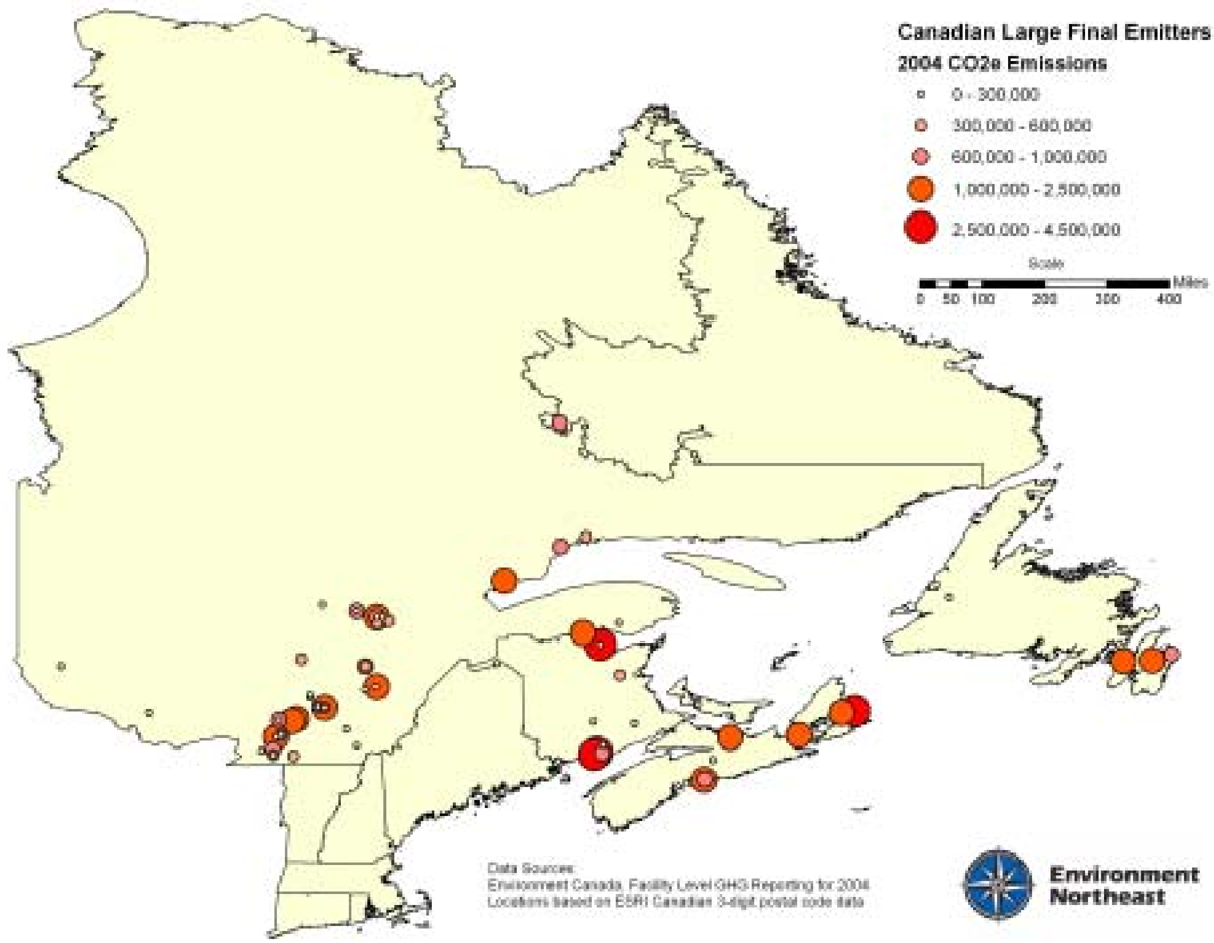
Figure 1.18: Location and Size of Eastern Canadian and New England Electric Power Plants
Fossil fuel fired power plants are shown in red and non-fossil plants in grey. The size of the dot represents the capacity of the power plant in megawatts. Large non-fossil plants are mostly hydro power and nuclear.



Canada has begun to collect data and prepare for implementation of a cap-and-trade program for large industrial emitters (see discussion to follow) and as a part of this effort has required the largest power plants and industrial greenhouse gas (GHG) emitters to report emissions. These facilities, which include the large fossil fueled power plants shown in Figure 1.19, are also suitable for a GHG cap-and-trade program.

All facilities that emit the equivalent of 100,000 metric tons or more of carbon dioxide (in CO_2 equivalent units) per year are required to report emissions in Canada. These facilities, shown in Figure 1.19, are obvious candidates for a cap-and-trade program, but there may be other power plants larger than 10 megawatts that would also be suitable (see Figure 1.18). Similar data is not readily available or required in the New England states.

Figure 1.19: Location and Emissions from Canadian Large Final Emitters Program for 2004 (total GHG emissions in CO_2e)



4.1 Implement a Greenhouse Gas Cap-and-Trade Program

Summary

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 the Regional Greenhouse Gas Initiative (RGGI), and adopting and implementing the Initiative in all six states in 2009. In Canada, it means convincing the federal government to move forward with implementation of the Large Final Emitters (LFE) program, or if that fails, exploring establishment of a parallel program to RGGI and/or linking up to RGGI.

Some near term improvements should be advocated in the program designs in both the LFE and RGGI programs. Notably, the LFE program should be amended to institute a hard cap, long-term targets, and improvements to the price control mechanisms by avoiding a safety valve mechanism. The RGGI program design should 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 any GHG cap-and-trade system include:

- regulating all facilities with the capacity to emit over 40,000 tons of CO_2e GHG emissions per year;
- regulating all GHGs officially recognized by the UNFCC as global warming gases (or aerosols);
- setting the cap level to decline from current levels to approximately 75% below current emissions by mid-century (2050);
- distributing all 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 (most emissions reductions should happen within the regulated sectors).

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 until 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 in Figure 1.23 in this chapter.

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 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.

A major benefit the cap-and-trade policy tool is that it provides the market incentives to answer questions about how GHG targets can be achieved in the most cost-effective way. The market will identify the lowest cost technologies and the system and will reward them accordingly.

Ultimately, early regional action is recommended in 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 and bear less of a financial burden than regions with dirty profiles once national and/or international programs are implemented.

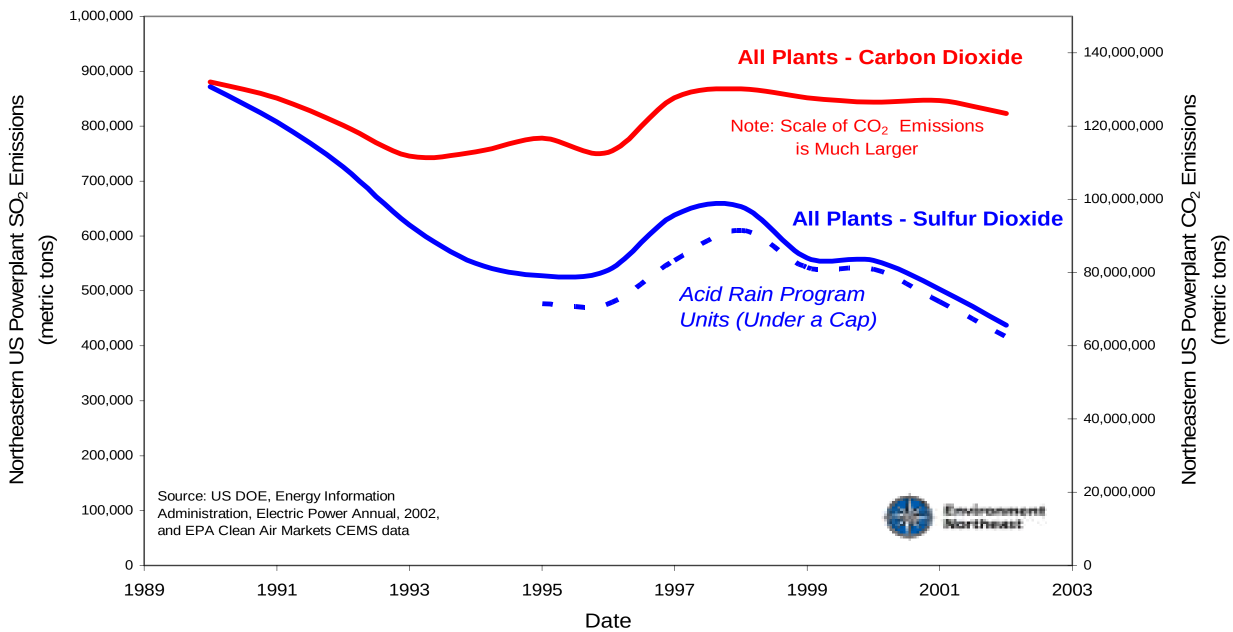
Opportunity

Cap-and-trade programs, or “tradable emissions” policies, have been adopted and tested to control damaging air pollutants at the federal and regional level. Such programs have reduced or eliminated lead in gasoline, ozone-depleting chemicals (such as CFCs), nitrogen oxides (NO_x), a primary component of smog, and sulfur dioxide (SO_2), a leading cause of acid rain.

The most successful and the first large-scale environmental program relying on a cap-and-trade program was implemented in Title IV of the 1990 U.S. Clean Air Act Amendments. The purpose of the program was to cut acid rain levels by reducing SO_2 emissions from electric generating plants to about half their 1980 levels beginning in 1995. Owing to fuel switching and strong advances in new technologies, the program has been a great success; SO_2 emissions have declined faster than anticipated and the cost of reductions has, through the time of this writing, remained significantly lower than predicted.

As can be seen in Figure 1.20, the power plants in the northeastern U.S. have seen SO_2 emissions decline steadily over the last 15 years in response to emission limits, but CO_2 emissions have been relatively stable because no cap-and-trade program exists to address those emissions.

Figure 1.20: Comparison of Historical Sulfur Dioxide and Carbon Dioxide Emissions from Power Plants in the Northeastern United States The requirement to limit sulfur dioxide emissions under the U.S. Clean Air Act, using a cap-and-trade program has led to a decline in those emissions, while carbon dioxide emissions have remained relatively constant.



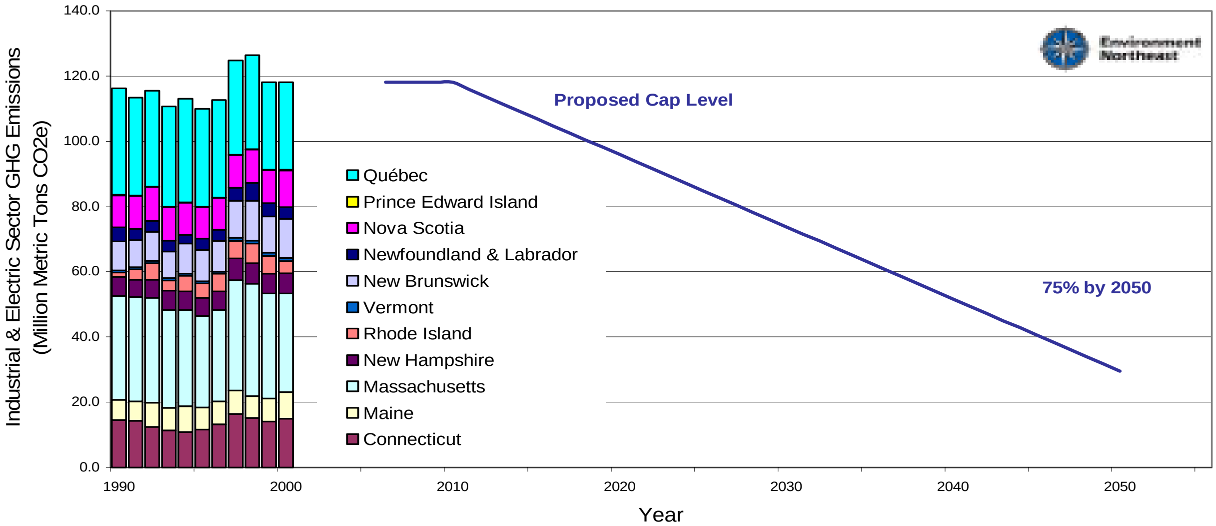
CO_2 and other GHGs are generally uniform pollutants, meaning they have the same atmospheric impact regardless of the location of their source. This makes a cap-and-trade program ideal for the control of GHGs from stationary sources because the focus of the program is on overall emissions into the atmosphere rather than on the need to reduce emissions at specific facilities. In this way, GHGs differ greatly from more localized pollutants, such as mercury and particulate matter, which have direct health impacts on communities and ecosystems located close to the source of pollution.

Cap-and-trade programs are best suited to industries and facilities that have personnel with experience managing commodities and balancing different investment strategies. Large stationary emitters like power plants and industrial boilers are suited to this kind of policy, whereas widely dispersed smaller emitters like home owners or car owners are probably not.

In contrast to a command-and-control policy, where a facility is forced to comply with emissions standards set by the government, this regulatory approach gives facilities the flexibility to apply the lowest-cost methods for reducing pollution. Under this type of program, facilities are able to meet their reduction targets in the most economically efficient manner, as one facility can trade allowances with another and the facility with the lowest cost emissions reduction option will reduce emissions first.

The potential GHG emission reductions from a well designed cap-and-trade program are large. Theoretically, the full New England and Eastern Canadian region could participate in a cap-and-trade program (whether regional, national or international) that regulates all large stationary emissions of GHGs with the goal of reducing emissions to achieve a 75-85% reduction by mid-century. Figure 1.21 presents NE-EC electric sector and industrial emissions as a surrogate for all large point sources and illustrates the change in emissions that a cap-and-trade program should attempt to achieve.

Figure 1.21: New England & Eastern Canadian Electric and Industrial GHG Emissions with a Proposed Rate of Cap Decline for Cap-and-Trade Programs



Some may argue that we have to figure out what energy sources will provide enough energy at low emissions in order to achieve the carbon cap. In fact, the cap-and-trade program should provide the market incentives to answer that question in the most cost-effective way, with the lowest cost technologies that reduce our carbon emissions winning. In addition, the other policies proposed in the energy chapter related to demand and supply side opportunities and frameworks will all be critical to achieving this kind of long term cap and level of emissions reduction. Although Figure 1.21 shows an emissions reduction trajectory for the whole NE-EC region, it is quite likely that the Canadian provinces and the northeastern states would develop separate programs and targets, but allow some trading or interaction between regions.

At the end of this chapter, there is a discussion of how the various policies proposed, including a cap-and-trade program might play out in relation to energy supply sources and electric generation technologies by presenting a number of scenarios. These scenarios illustrate the kinds of energy demand and supply technologies that might be required to meet a 75% reduction by mid-century.

Implementation

In a cap-and-trade program, the government sets a cap on the total amount of a substance (in tons) that can be emitted from a predetermined universe of emitters (such as all electric power plants of a certain size in a designated region). Once that cap is set, a quantity of permits equal to the total tons allowed under the cap is distributed or sold to the regulated facilities. One permit gives the holder license to emit one ton of pollutant. If a facility emits 100 tons of the regulated emission (*e.g.*, CO_2), it must own 100 permits or "allowances." Cleaner sources of electricity, such as natural gas plants, have lower GHG emissions and will thus need fewer allowances to comply with a GHG cap, and dirtier sources, such as older coal plants, will need more allowances to cover their significantly higher emissions.

Recognizing the success of the U.S. SO_2 cap-and-trade program and the generic advantages of cap-and-trade systems as a market-based tool, numerous models are emerging to regulate GHG emissions in this way. The first example appears in the European Union, which has developed the Emissions Trading System (ETS) for large stationary emitters of CO_2. Another GHG cap-and-trade program, proposed but not yet implemented by the Canadian government, is the Large Final Emitters (LFE) System. A third example, developed by states and stakeholders in the Northeast U.S. region is the Regional Greenhouse Gas Initiative (RGGI), which plans to cap CO_2 emissions from the region's large electric power plants. A comparison of these programs is shown Table 1.25.

Table 1.25: Comparison of Design Elements of the European Emissions Trading System (ETS), the Canadian Large Final Emitters (LFE) Program, and the Regional Greenhouse Gas Initiative (RGGI)

Design Elements	European ETS *	Canadian LFE System **	Regional Greenhouse Gas Initiative ***
Emissions Covered:	CO_2, some or all of five other "Kyoto Gases" may be added later	All greenhouse gases	CO_2
Sectors:	Energy (including electric power, oil refineries, coke ovens) Metal ore, iron-and-steel production Minerals (including cement, lime, glass, ceramics) Pulp and Paper	Companies in the mining, manufacturing, oil & gas, and thermal electric sectors	Electric generating units over 25 megawatts in size that burn fossil fuels
Number of Political Jurisdictions:	25 Member States	Canada	8 states in the Northeastern US
Emissions Cap Level:	State allocation/cap has to be in line with the country's Kyoto target (varies by state)	Target reduction of ~45 million metric tons (fixed process emissions are constant and all others must be reduced by ~15% on an intensity basis) from 2008-2012	10% reduction in the region's emisisons from these units by 2018 based on an estimate of 2009 emissions
Number of Regulated Sources:	~11,500 installations	700 companies	~750 generating units (often multiple generating units at one plant)
Allocation of Allowances:	Generally given to polluters based on historic emissions	To be determined	Minimum of 25% to be allocated for consumer benefit or strategic energy purposes; remainder to be determined by states
Project Level Offsets:	Yes	Yes	Yes, but limited in quantity to 3.3% of a generator's total emissions (see price controls below)
Price Controls:	None	$15 per ton price assurance	If average prices in a 12 month period exceed $7 or $10 per ton ($ amount increases over time), the offset % limits and geographic limits are relaxed temporarily

Sources:

* European Commission (http://europa.eu.int/comm/environment/climat/emission.htm); and Kruger and Pfizer, RFF Paper, 2004

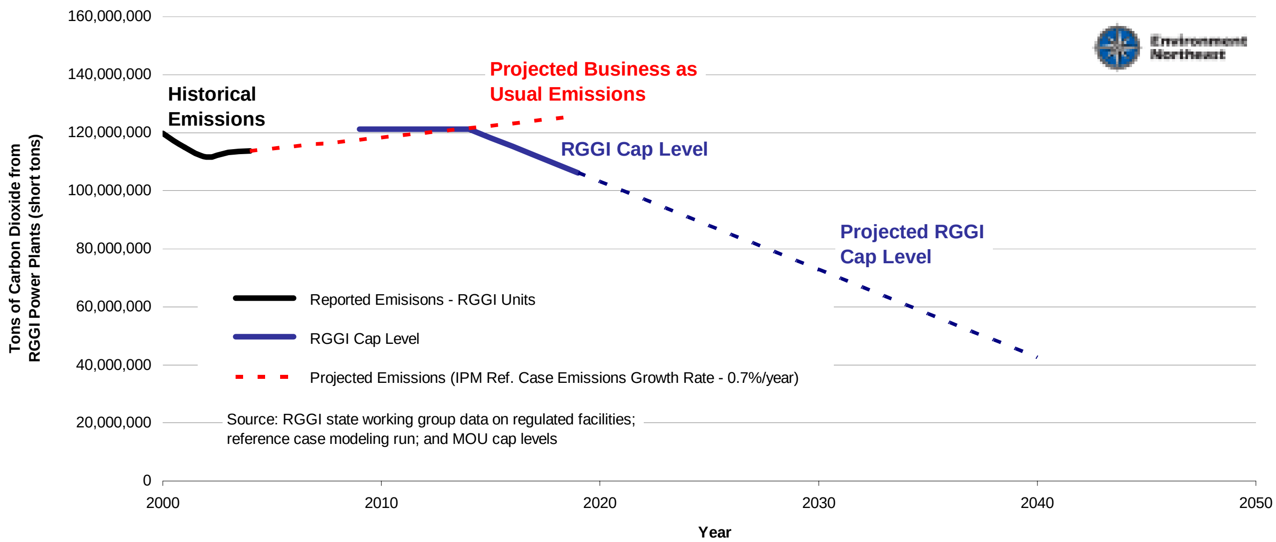
** Project Green, 2005, p 14-18, and Canada Gazette, Part 1, July 16, 2005, p 2489-2502

*** RGGI Memorandum of Agreement, 2005

The RGGI Cap-and-Trade Example

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 until 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 in Figure 1.22, below.

Figure 1.22: RGGI Emissions and Cap Levels over Time
Historical emissions from RGGI power plants are over 6% above current emissions but the long-term rate of cap decline should reduce emissions significantly.



Significant modeling has been conducted examining the impact of RGGI on wholesale electric prices and on consumers' total electric bills. The costs of the program are projected to be very small or even a savings to the region's rate payers. Although wholesale electric prices are predicted to rise slightly, total economic impacts were modeled as positive or essentially neutral. Models indicate that electricity bill impacts would be very modest (especially relative to recent cost increases driven purely by free market forces or relative to the newly imposed Forward Capacity Market plan) or possibly even a savings. The ultimate cost impact will depend on how the allowances or permits are distributed and whether investments in energy efficiency are made at the same time.

Table 1.26: RGGI Wholesale Electric Price and Residential Bill Projections
The projected changes reflect the modeled results if we assume a doubling of the region's investments in energy efficiency from current levels at the same time as implementing the cap-and-trade program.[1]

Projected Wholesale Electric Price Changes

- 2015: 1 to 4%
- 2020: 1.5 to 5.5%

Projected Bill Changes on Residential Customers

- 2015: $2.9 to $16.0 per Year
- 2015 w/ 2X Efficiency Investments: -$30.5 to -$19.7 per Year (savings)
- 2020 $5.5 to $22.4 per Year
- 2020 w/ 2X Efficiency Investments: -$50.2 to -$37.0 per Year (savings)

[1] RGGI modeling results are available on the RGGI program web page at: http://www.rggi.org/documents.htm

The states in the RGGI region and their environmental agencies have existing authority to regulate CO_2 under statutes that call for protection of human health and the environment. In some cases legislative approval will be required to implement aspects of the new regulations. It is our understanding that the Canadian provinces also have the authority to implement new environmental regulations and could develop a similar program to address greenhouse gas emissions from stationary sources.

Given the existing and emerging connections on energy supply between the U.S. and Canada, ideally cap-and-trade systems in the two countries would harmonize design elements as much as possible. Each system could be designed separately while paying attention to coordinating the development of the following elements:

- *Permit or Allowance Measure* -- Allowances issued and traded should be the same unit of measure, ideally one metric ton of carbon dioxide equivalent;
- *Offset Rules* -- Offsets or projects to reduce emissions in sectors not regulated under the carbon cap should have equivalent baselines and requirements and also have the same unit of measure (one metric ton of CO_2e);
- *Rate of Cap Decline* -- The rate of cap decline should be compared and an effort made to achieve the most ambitious and equivalent target in order to allow trading between the two programs (modeling should show similar anticipated allowance prices).

The two proposed cap-and-trade programs have yet to be implemented and there are still design details to be worked out. In addition to striving for compatibility among the systems, both programs should consider the following near-term and longer-term options when finalizing the design of the programs. Some of these are incorporated into the current design proposals and others would represent additions or changes, but we believe a strong program would incorporate ideas such as these.

Design of the Cap-and-Trade System

- *Regulated Units* -- Cap-and-trade programs should start by regulating large stationary emitters, which are well understood by regulators. Concurrently, jurisdictions should establish programs to begin collecting better data on a broader population of stationary emitters so the program can be expanded over time (see GHG registries and mandatory reporting section to follow). The long-term objective should be to regulate all large stationary GHG emissions to achieve a set emissions level per year. GHG emissions from non-regulated energy users and equipment types should be addressed through other policies, such as appliance standards, vehicle standards and other policy tools.
- *Regulated Gases* -- At a minimum, cap-and-trade programs should begin by regulating CO_2. The program should expand quickly to regulate all other GHGs for which data is readily available and the global warming impacts are recognized to be significant. In the NE-EC region, this list should include: CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). To expedite this expansion, jurisdictions in the region should establish mandatory reporting requirements and better data collection for all global warming gases identified by the United Nations Framework Convention on Climate Change (UNFCCC).
- *Emissions Cap Level* -- The cap level should be considered in relation to the total pollution of regulated entities and should be a fixed tonnage cap. The cap should start at a level equivalent to current emissions, stabilize for a short period and then decline at a rate that puts the region on the pathway to a 75-85% reduction in emissions by mid-century.
- *Allocation of Allowances* -- Allowances are a permit to emit a fixed quantity of a regulated substance. Allowances are, in effect, a new currency with value. The monetary value represented by an allowance is created to address a societal problem (climate change) and should be purposefully distributed. We recommend that allowances are auctioned in markets where there is competition on the understanding that costs will be passed on to consumers. Some commercial and industrial companies that sell products internationally may not be able to pass on the carbon cost. Where this

hardship is demonstrated, it may make sense to allocate some limited portion of allowances for free. However, the starting assumptions should be that all allowances will be auctioned off by the regulators and that the regulated entities will have to pay the market rate for the allowances. This concept is also in line with the polluter pays principle. Revenue from the auction should be used to reduce the cost to consumers of the program through direct rebates or investments in energy efficiency programs.

- *Offsets* -- Emissions reduction projects from other sectors should be allowed into the program as an alternative to owning and retiring an emissions allowance. However, the quantity should be limited in order to ensure that most of the reductions in emissions are coming from the regulated sectors. Offsets must consist of actions that are real, surplus, verifiable, permanent and enforceable. Given the administrative complexity of cap-and-trade systems and the importance of minimizing price volatility, the rules and protocols should be developed by project type with common baselines to allow for straightforward review and increased certainty for project developers.
- *Price Controls* -- If price control mechanisms are deemed necessary, they should be simply designed with the price points set high enough that they do not distort the market and should avoid inflation of the cap. Some of the mechanisms that are being implemented or discussed include:
    - Circuit Breaker: If an aggressive rate of cap decline is agreed to, a circuit breaker could be incorporated that would delay the rate of cap decline if the average allowance prices in the previous trading period exceeds a set price point. The price point should increase by the rate of inflation plus the rate of economic growth, with a willingness to invest more in carbon mitigation over time. The result of this mechanism is a potential delay in the rate of emissions reductions if prices are too high.
    - Price Triggers that Expand Offsets: Offsets provide regulated entities with flexibility and an ability to purchase emissions reductions from outside the sector. The quantity of offsets allowed is limited in order to ensure that emissions reductions do in fact happen within the regulated sector. A price based trigger that increases the quantity of offsets allowed if average allowance prices exceed that trigger level can be utilized. (This mechanism is used in RGGI.) The result of this mechanism is a potential transfer of emissions reductions to other sectors, but the same net-emissions.
    - Safety Valve or Price Cap: A hard price cap allows companies to purchase additional allowances beyond the number allocated under the cap at a set price (*i.e.*, it inflates the cap). We think this approach should be avoided, as it offers a potentially unlimited expansion of the cap. While it adds financial certainty, it reduces environmental certainty. If included, this mechanism should be set well above the highest cost policy makers believe is acceptable for program success. The price point should increase by the rate of inflation plus the rate of economic growth, and any money collected by regulators should be used to purchase emissions reductions (offsets) or to assist in making the cap-and-trade program costs decline (energy efficiency investments).
    - Borrowing Safety Valve: A more attractive variation on a safety valve is to allow companies to purchase allowances at a set price in the same manner as a safety valve, but to then reduce the cap level in the subsequent compliance period by the amount purchased. This approach has the effect of inflating the cap at one point in time but potentially reducing it in subsequent periods if allowance prices decline. (Sustained high prices, however, could still lead to an unlimited expansion of the cap.)

Implementing the Cap-and-Trade System

As design elements are worked out, several key steps must be undertaken to assure the cap-and-trade system is effectively implemented. These steps will generate real GHG reductions but will also position the economies of the NE-EC region for participation in the inevitable carbon-constrained system that is being developed at the federal level in both the U.S. and Canada. Early action by the region will allow time for learning and also a lower burden once federal programs are put in place, as regions with cleaner emissions profiles will be more competitive than regions with dirty profiles, once a national program is implemented.

In New England, it is important that Massachusetts and Rhode Island join the RGGI regime immediately in order to drive emissions changes across the region and avoid emissions leakage. It will also be important for RGGI stakeholders and policy makers to continue working to devise a mechanism to handle electricity imported from outside participating states (or provinces). Finally, once the new RGGI system is up and running, it will be important to make an early start on developing Phase 2 of the program, expanding to other GHGs and to other large stationary sources of emissions outside the power plant sector.

The Eastern Canadian provinces can take action to lobby the federal government to implement and improve the LFE program through the inclusion of a hard cap, long-term targets, and improvements to the price control mechanisms by avoiding a safety valve mechanism. We further recommend that the EC provinces begin to actively explore provincial programs that could be modeled on and linked to RGGI, in case the LFE program is not implemented at the federal level. Quebec and the other provinces could be the catalyst for developing a RGGI compatible cap on large stationary industrial emitters that would be a model for the rest of the region and allow trading with the RGGI states.

Over the longer term, all jurisdictions in the region will need to continue working on ways 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. Over time, we envision a cap-and-trade system with the following features:

- *Regulated Sources* -- All facilities with the capacity to emit over 40,000 tons of CO_2e GHG emissions per year (roughly equivalent to a 10 MW natural gas power plant at 90% capacity) should be subject to a cap.
- *Regulated Gases* -- All GHGs officially recognized by the UNFCC as global warming gases (or aerosols) should be factored into and subject to the cap according to their CO_2 equivalence.
- *Cap Level* -- The cap level should decline from current levels to approximately 75% below current emissions by mid-century (2050), with possible changes in the trajectory of the cap allowable if and when price control mechanisms are triggered.
- *Allocation of Allowances* -- The ideal system will distribute all allowances by auction. If initial rules allow some portion of allowances to be given away free, then a timeline should be established for transitioning to a distribution system in which 100% of allowances are eventually auctioned.
- *Offsets* -- It is reasonable to allow a limited quantity of high-quality offsets, and there should be a standing committee of experts, stakeholders and officials tasked with developing rules and protocols for new types of offsets.

4.2 Improve GHG Inventories and Registries

Summary

There are two critical types of data collection tools a jurisdiction needs to measure and manage GHG emissions: (1) a state or provincial inventory that tracks total emissions by sector over time, and (2) a climate registry that is used to compile and track emissions from specific sources or projects.

Detailed state and provincial inventory data should be collected annually on total GHG emissions by each sector of the economy. The data should be made available to the public on an annual basis both digitally and in print. With the exception of land use and forestry emissions (see the Sequestration Chapter), inventory methods are well established and the states and provinces just need to get in the habit of reporting regularly and increasing accessibility of data.

Policy makers should also adopt a comprehensive system that accommodates 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 Northeastern 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 should maximize transparency and accessibility.

Opportunity

In order to develop and manage climate change policies, good data and information on sources and quantities of emissions are needed. Policy makers should invest resources in developing a set of high-quality GHG accounting protocols, a database and reporting platform that is transparent and available to the public, and should coordinate activities across jurisdictions.

There are two critical types of data collection tools a jurisdiction needs to measure and manage emissions: (1) a state or provincial inventory that tracks total emissions by sector over time, and (2) a climate registry that is used to compile and track emissions from specific sources or projects.

All of the states and provinces have developed inventories of total emissions by sector. The data they contain enables policy makers and the public to track performance against state and regional climate goals over time. However, they must be accurate, complete, and the data must be accessible in a timely fashion to provide value in planning and implementing climate action policies.

Climate registries are also needed in each state and province. However, there currently is no standardized approach to compiling and analyzing data that is (or will be) collected under mandatory reporting programs, reporting of emissions through cap-and-trade programs, voluntary reporting programs and for offsets or project-based emissions reduction programs. A number of emissions reporting tools and databases, known as registries, exist and are maintained by state and federal governments and consortiums of other entities.

Existing registries are numerous and have been designed with very different goals in mind. Some examples of government sponsored registries include: U.S. DOE's 1605(b) voluntary reporting program, Canadian Environmental Protection Act Registry, California Climate Action Registry, and Eastern Climate Registry. Consortia of groups such as the World Resources Institute & World Business Council for Sustainable Development GHG Protocol have developed reporting, accounting, and registry tools also. Registries can track and account for many different pieces of information about sources and types of emissions, such as:

- emissions reported voluntarily by companies or entities;
- emissions from specific facilities or units regulated under a policy such as a cap-and-trade program or facilities required to report for public disclosure reasons;
- project based emissions reductions or offsets, including information about whether they qualify for credits under regulatory programs;
- ownership and details of transactions between buyers and sellers of allowances, offsets, etc.

For certain emitters, advancing climate change action objectives will be contingent on wider use of mandatory reporting requirements. Mandatory GHG reporting from large emissions sources has several benefits, including:

- Toxic Release Inventory experience has should that comparison and competition among emitters encourages improvements in efficiency and emissions rates.
- Companies and facilities that report emissions can also benefit from positive publicity if they are in a leadership position. They can better manage and assess carbon related risks and benefits associated with new investments, and potentially receive credit for early action within a regulatory scheme.
- Understanding the characteristics of emitters is critical in designing cap-and-trade programs like RGGI and the LFE program, their future expansion to other sources, or any other policy that sets targets and requirements based on current emissions totals (tons) or rates (tons per unit of energy or unit of industrial output).
- In order to assess progress with programs such as cap-and-trade and understand the changes different technologies and industry sectors are able to achieve, it will be important look at changes in emissions over time and what technologies and investments have facilitated those reductions.

Mandatory reporting for a limited set of facilities and entities is already required within Canada and in a number of Northeastern states, such as Connecticut, New Jersey and Maine.

Implementation

Going forward, detailed state and provincial inventory data should be collected annually on total GHG emissions by each sector of the economy. It is important that the data be made available to the public on an annual basis through the publication of a report and through access to the data in digital (spreadsheet) format.

Second, there is a pressing need for a well designed and coordinated registry for the region. New England does not have such a registry, and it is likely that the Canadian Environmental Protection Act Registry could be made more user-friendly by making more data publicly accessible.

What is needed to make a regional cap-and-trade system run efficiently and fairly is a standardized and rigorous reporting system and registry with the stamp of approval from state and provincial regulators. This could lead to a single system and serve as a potential model for national registries. Policy makers should adopt a comprehensive system that accommodates all mandatory reporting as well as voluntary entity-wide or facility reporting and voluntary or regulator approved project-based emissions reductions (offsets). The opportunity exists to coordinate the development of a registry across many jurisdictions, from the Northeastern 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).

Mandatory reporting requirements in each jurisdiction should have the following features:

- All facilities whose direct emissions are greater than or equal to a set tonnage level such as 40,000 tons of CO_2e GHG emissions per year (roughly equivalent to a 10 MW natural gas power plant at 90% capacity) should report annually.
- An assessment should be completed to identify a reporting threshold for entities with significant transportation emissions and indirect emissions associated with electricity or steam use.
- Reporting should be based on simple fuel use or activity metrics with standardized emissions factors, or actual monitors if available. (In the U.S., most Title V facilities have emissions monitors already in place.)
- Data collection and reporting should be delivered to a centralized database or registry that allows for simple tracking, analysis, and reporting.
- Data should be available to the public.
- The cost of maintaining the registry can be covered by assessing a reporting fee.
- Additional entities should be able to opt-in to the reporting scheme and voluntarily report emissions.

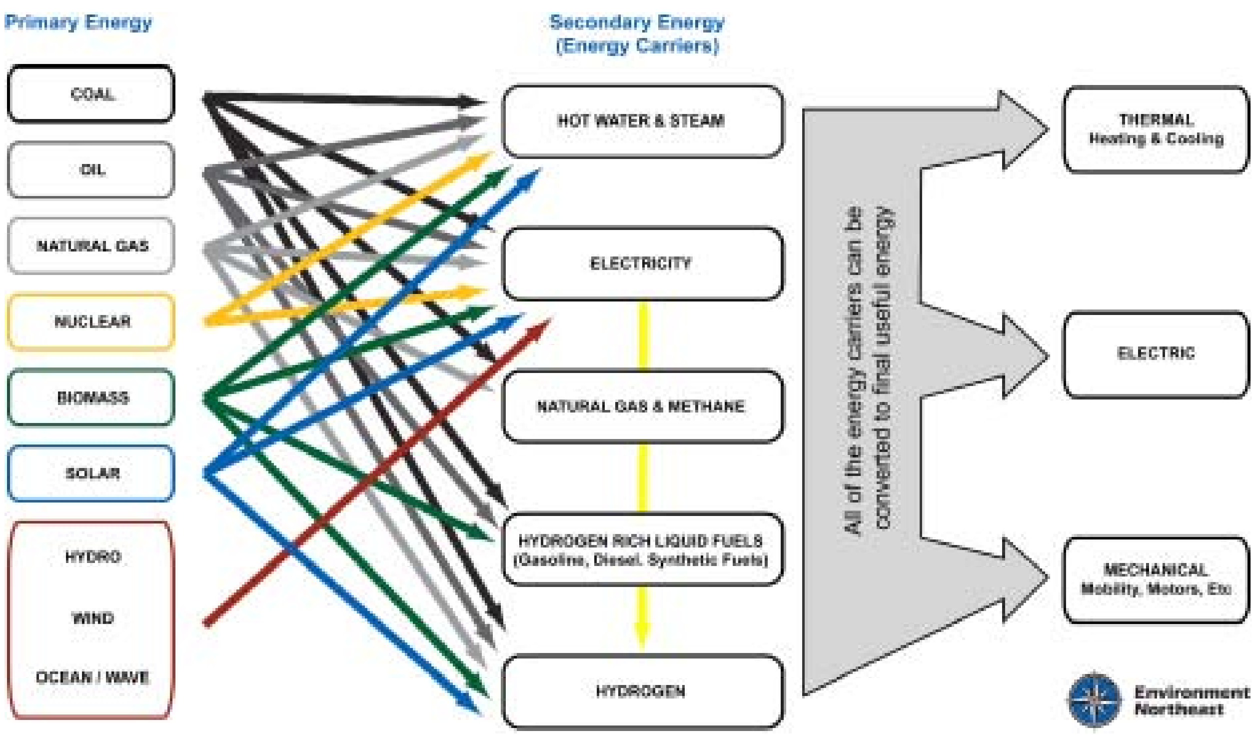
Priority 5: Commercialize and Deploy No-Carbon and Low-Carbon Energy Sources

By: Derek Murrow

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. Existing resources in the NE-EC region that meet this criteria include renewable sources (mostly hydro and biomass, with a growing contribution from wind), aging nuclear power plants and a small portion of very high-efficiency fossil conversion devices. In the future, the energy supply mix for the region will need to reduce its reliance on conventional fossil fuel conversion plants, either by displacing them with new no-carbon or low-carbon plants or by adding carbon capture and sequestration capacity to new or existing plants.

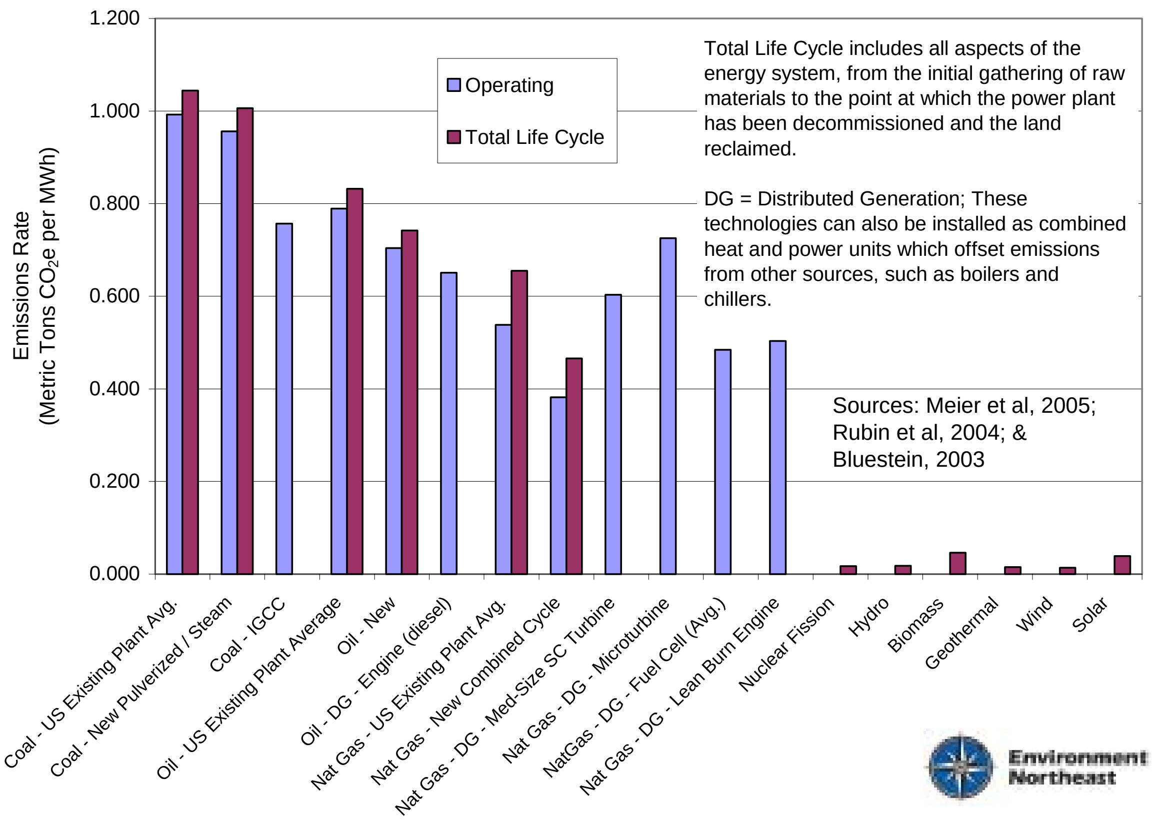
The energy sources and energy carriers available to supply sustainable energy to the region are varied, and there are many pathways that technology developers and policy makers should consider when setting new policy. Figure 1.23 describes most of the energy sources, energy carriers and final energy uses.

Figure 1.23: Sources of Energy, Energy Carriers, and Final Uses
Some energy sources are more easily converted into a variety of fuels or energy carriers, with fossil fuels and biomass being more flexible than nuclear or other renewables. Hydrogen can also be created using electricity, but a primary energy source is always needed. All energy carriers can be used to provide final useful energy.



As discussed under Priority 4, transitioning to a low-carbon energy future will be significantly aided by placing a cap on emissions that declines with time, making low emitting power plants and energy conversion devices more competitive. However, the transition can and should be accelerated by implementing policies that help new technologies enter and grow in the marketplace. As Figure 1.24 illustrates, different electric generation technologies have significantly different emissions profiles. Policies promoting new energy technologies should factor in climate objectives and be designed to promote technologies with the lowest emission profiles.

Figure 1.24: Comparison of Emissions Rates for Electric Generation Technologies



5.1 Commercialize and Deploy More Renewable Energy

Summary

We recommend setting the Renewable Portfolio Standard (RPS) minimum percentages of electricity load to be served from new renewable supply at 5% by 2010, 10% by 2015, and 15% by 2020. Renewable technologies eligible for the RPS should only be renewables that are non-commercial or still facing significant market barriers to development. We also recommend using the procurement of long-term contracts – when used to satisfy capacity or load requirements for utility, default or standard offer energy customers – to buy renewable energy through competitive solicitations. Tax and grant incentives should be used to help increase the competitiveness and deployment of small, distributed renewable energy systems.

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.

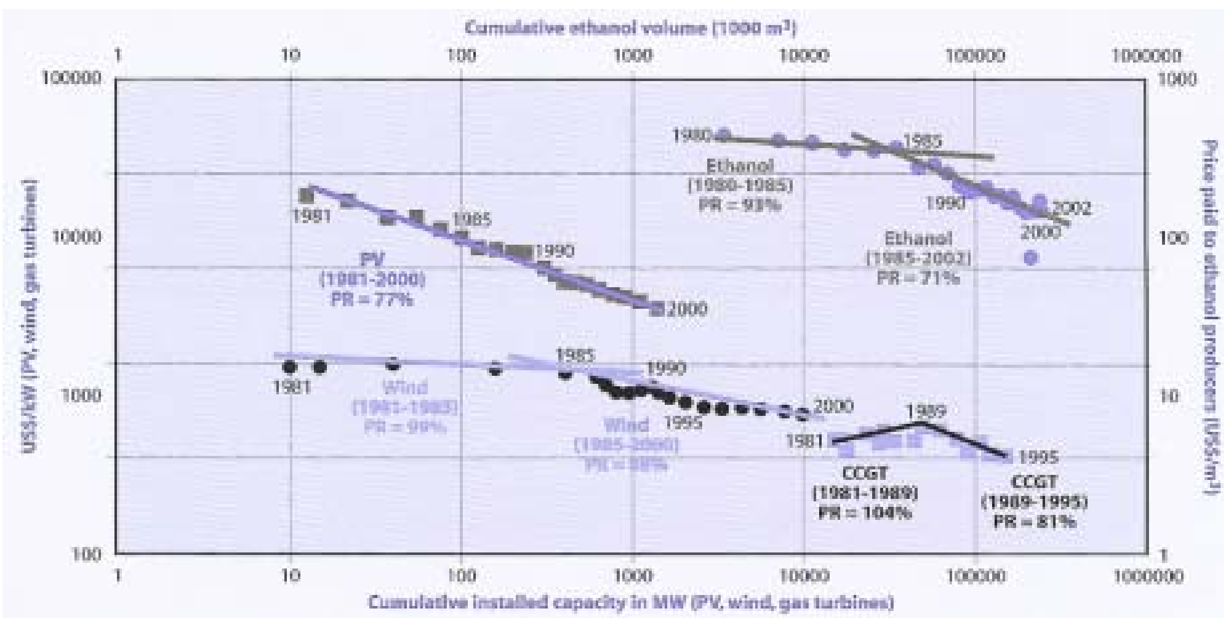
There is a tremendous renewable energy resource available in the NE-EC region. Modeling of financially viable new on-shore and off-shore wind potential in New England alone exceeds 12,000 MW. Quebec has set a target of building 3,500 MW of new wind, and the Maritime Provinces collectively have established targets or renewable portfolio standards that are already leading to new, sizeable wind projects.

Opportunity

There is a tremendous renewable energy resource available in the NE-EC region. However, converting sun, wind, forest biomass or wave energy into usable energy carriers such as electricity, hydrogen or liquid fuels can be expensive. Renewable energy sources ("renewables") are often found in locations that complicate quick and economical development. Also, many renewables rely on the weather, which can put them at a competitive disadvantage in certain markets or applications. The location of the resources and their intermittent nature requires that renewables are combined in an energy system with other energy sources or energy storage for times when the renewable resource is not available.

On the cost side, renewable energy conversion technologies such as wind turbines and photovoltaics traditionally have been considered expensive and non-competitive technology options. However, this is changing. As more renewable technologies are built, they become less expensive as continued innovation and economies of scale play out in manufacturing and distribution. Figure 1.25 from the World Energy Assessment illustrates how wind turbines and photovoltaic costs have declined with increased production. Note especially the "learning," or rate at which prices have been declined for photovoltaics (PV).

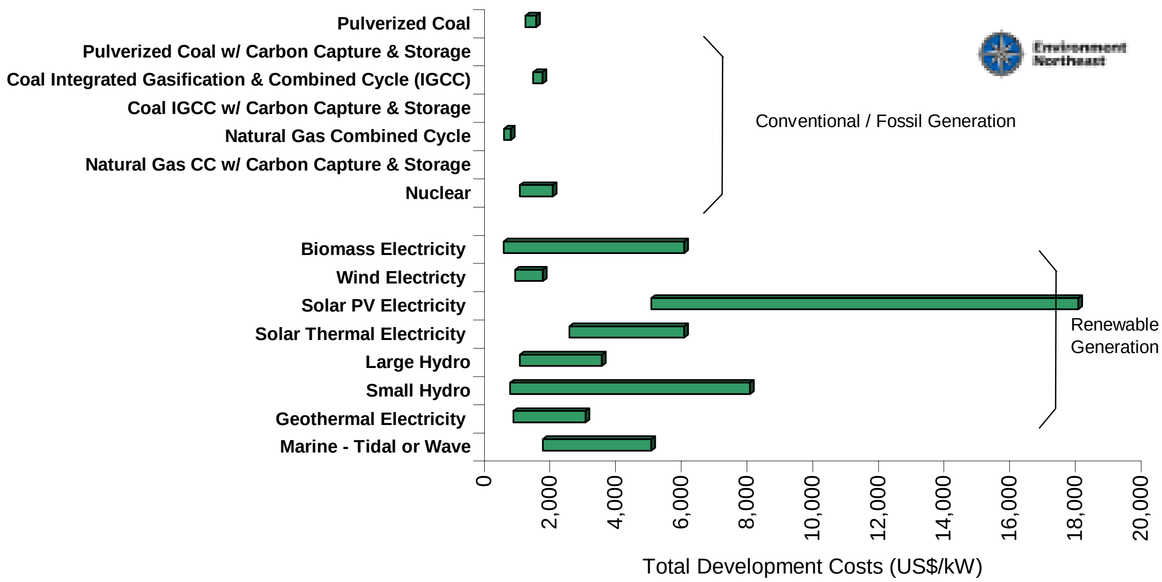
Figure 1.25: Experience Curves for Photovoltaics, Windmills, Gas Turbines and Ethanol Production
As a technology is commercialized and more units are built and sold, the price tends to decline significantly; the rate of learning or decline in price being fastest for photovoltaics (note scale is logarithmic and PR is the price reduction for each cumulative doubling of production).[135]



In some applications, renewable energy technologies are competitive with conventional or fossil technologies today. Figure 1.26 compares the cost of renewable electric generation to other technologies in terms of the cost to develop a kilowatt of capacity.

135 UNDP & WEC, 2004, World Energy Assessment Update, Figure 14.

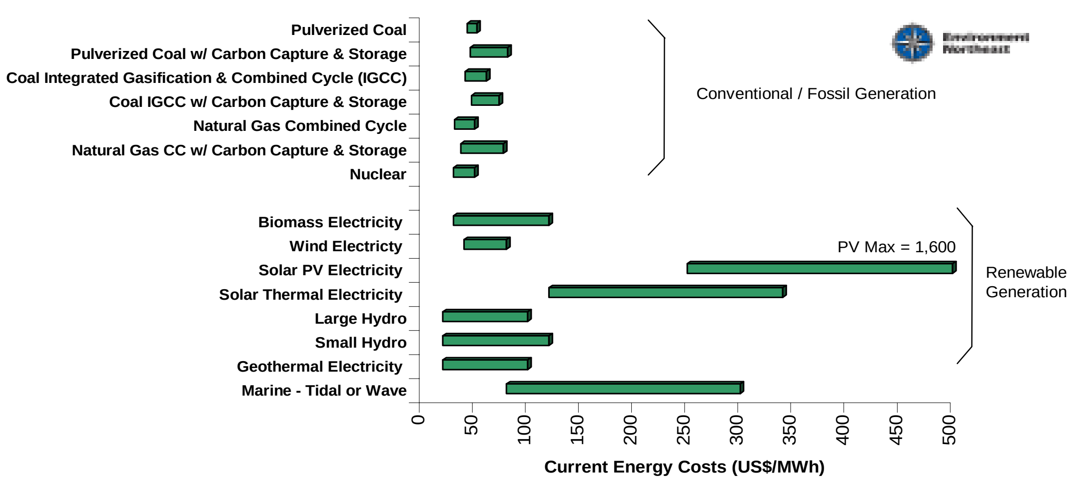
Figure 1.26: Comparison of Construction (Capacity) Costs for Electric Generation Technologies
Note that electric capacity costs would be similar for carbon capture and storage technologies, but cost of energy is different in the subsequent figure



Sources: Coal & Natural Gas: IPCC, 2005, *Special Report on Carbon Dioxide Capture and Storage*, Tables 8.1 and 8.3a
Nuclear: NEA, IEA, & OECD, 2005, *Projected Costs of Generating Electricity - 2005 Update*
Renewables: UNDP & WEC, 2004, W*orld Energy Assessment Update*, Table 7

With rising fossil fuel prices, renewable energy technologies are competitive or close to competitive today. As seen in Figure 1.27, new wind, biomass and hydro power are increasingly competitive in the region today.

Figure 1.27: Comparison of Levelized Energy Costs for Electric Generation Technologies



Sources: Coal & Natural Gas: IPCC, 2005, *Special Report on Carbon Dioxide Capture and Storage*, Tables 8.1 and 8.3a
Nuclear: NEA, IEA, & OECD, 2005, *Projected Costs of Generating Electricity - 2005 Update*
Renewables: UNDP & WEC, 2004, W*orld Energy Assessment Update*, Table 7

There is a general acceptance of the value of increasing renewable energy as part of the region's supply portfolio. Two significant policy initiatives aimed at promoting renewables, the state level Renewable Portfolio Standards (RPS) and the U.S. federal production tax credit (PTC), focus on spurring production of energy from renewables.

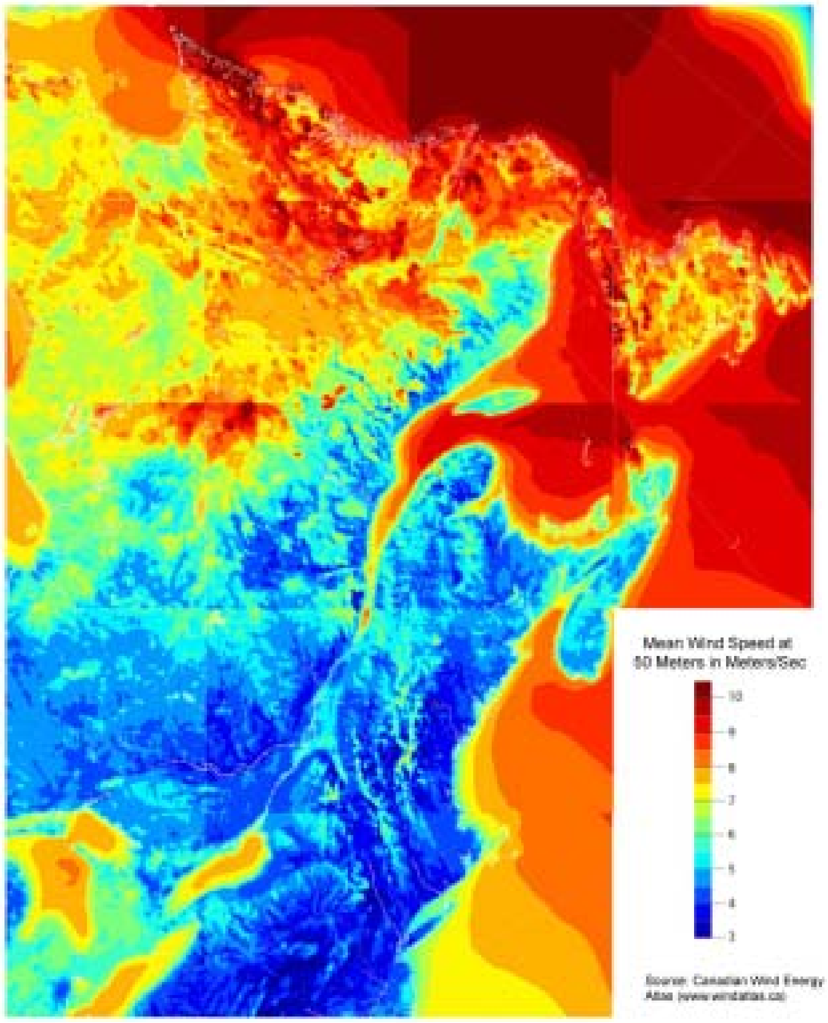
The PTC has made wind energy significantly more attractive to investors, but because it has not been authorized for an extended period it has led to a boom and bust cycle of development as the tax credit is authorized and then runs out.[136] The PTC, in its recent re-authorization, was expanded to cover other renewable energy technologies, but longer term authorization by the federal government would help stabilize the industry. There is little the states can do to remedy this federal policy problem other than put pressure on their representatives in Washington to fund the PTC for longer periods of time.

The Canadian Wind Power Production Incentive (WPPI) is funded over a longer period of time (15 years) with a goal of supporting 4,000 new megawatts of wind nationally. The provinces have little control over this national policy but can encourage the federal government to expand eligibility to other renewable sources and ensure that funding is sustained. Production incentives, such as the PTC, WPPI or an RPS, have been shown in the policy and technology literature to provide the largest amount of clean energy due to their focus on production (actual megawatt-hours of energy being generated and delivered), rather than just capacity (megawatts of potential generation).

Renewable energy resources vary based on geography and natural resources available for harvest. The ability to site facilities and take advantage of those energy resources also has to compete with other land uses such as development or recreation. Figure 1.28 shows which portions of the Northeast have the strongest wind resources.

[136] *See* UCS web page for more on production tax credit trends and implications: http://www.ucsusa.org/clean_energy/clean_energy_policies/update-on-production-tax-credit-for-renewable-energy.html.

Figure 1.28: Wind Resource Map for the Northeast
Light blue, yellow, and red indicate regions with enough wind for grid-scale wind projects to be viable, with the best resources being on ridgelines and high plateaus, offshore, and in Northern Canada.



Other key renewable energy resources such as biomass are limited by the availability of fuel and the distance of transport, with resources being largest in states and provinces that are heavily forested such as northern New England and the Eastern Canadian provinces. Table 1.27 illustrates the technical potential for a number of renewable technologies in the New England states.

Table 1.27: New England Renewable Energy Potential as Compiled for RGGI
The following data were developed by industry experts as reasonable estimates of potential new renewable energy capacity for New England in the next 15 to 20 years.

	Reasonable / Viable Renewable Capacity (MW)					
State	**Onshore Wind** Classes 3 and Up	**Offshore Wind**	**Landfill Gas**	**Biomass**	**Hydroelectric**	**Total**
Connecticut	63	0	22	NA	25	110
Maine	4,129	154	10	NA	174	4,467
Massachusetts	676	3,228	11	NA	59	3,974
New Hampshire	2,143	0	13	NA	25	2,181
Rhode Island	48	231	4	NA	10	293
Vermont	1,292	0	75	NA	90	1,457
Total	8,351	3,613	135		383	12,482

Notes: NA = Not Available, biomass estimates were not made public during the RGGI process, although significant potential exists
Hydro estimates represent efficiency upgrades at existing facilities and new generation at existing dams
Solar energy capacity is limited mostly by cost and not the resource
Source: Sustainable Energy Advantage and LaCapra Associates, 2004, RGGI Renewable Energy Modeling Assumptions

Environment Northeast

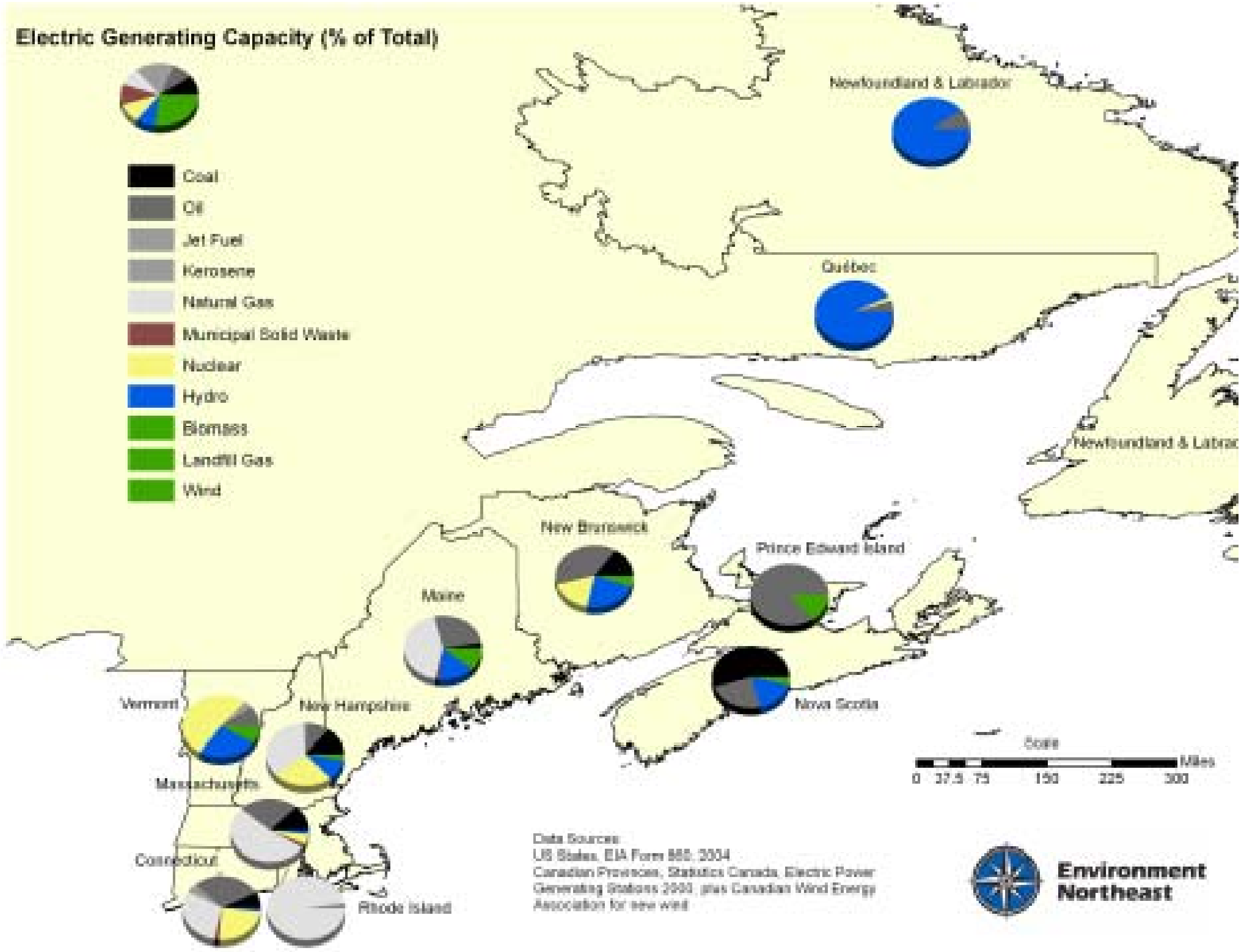
A Renewable Portfolio Standard (RPS) is another tool used to spur the development of renewable energy. However, RPSs have had mixed success in bringing new renewables online quickly. In Texas, where there is a large wind resource and plenty of open land, the development of an RPS catapulted the state to a leadership position, adding over 1,800 MWs between 2000 and 2005.[137] In contrast, RPS policies in Connecticut, Rhode Island and Massachusetts have led to little new development over the past few years, although there are many projects in the development stage. This is likely driven by two primary factors: (1) a lack of long term contracts that allow for bank financing, (2) and permitting hurdles driven primarily by “not in my back yard” opposition to development.

The structure and planning process for utilities procuring energy and the availability of long-term contracts for new development of electric power generation projects appear to be important factors in encouraging renewable development. Using wind (one of the lowest cost renewable resources) as an example, it is interesting to look at how much capacity has been added in the NE-EC region between 2000 and the end of 2005. In New England the number is essentially zero, and in the Eastern Canadian provinces there have been 41 MWs in Nova Scotia, 14 MWs in Prince Edward Island and 212 MWs in Quebec.[138] Other states in the U.S. such as California, New York, and Texas have added 504 MWs, 185MWs, and 1,825 MWs respectively.[139]

Figures 1.29 and 1.30 show the percent of total capacity by generation type in each state and province, followed by the installed and proposed wind generating capacity in the NE-EC region along with the quantity of wind required to meet 100% RPS compliance or the renewables target in that state or province (as an example).

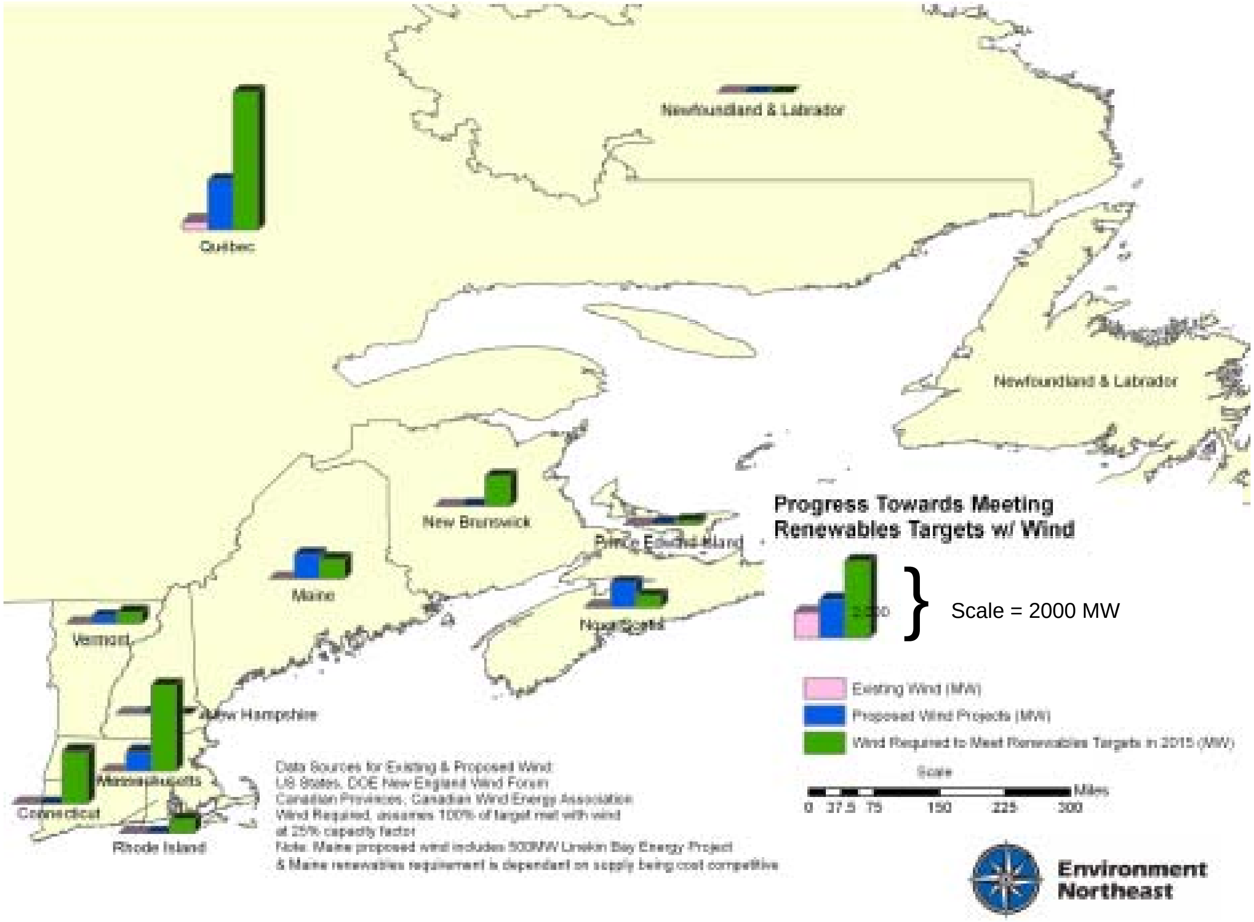
137 American Wind Energy Association, http://www.awea.org/projects/.
138 Canadian Wind Energy Association, http://www.canwea.ca/en/CanadianWindFarms.html.
139 American Wind Energy Association.

Figure 1.29: Total Electric Generating Capacity by Fuel Type
Pie charts indicate the percent of total electric generating capacity by fuel source.



Most, but not all, states and provinces have set targets for new renewables. Wind power is one of the most cost-effective sources of renewable supply, but a lot more needs to be built between now and 2015 to meet the targets set out in various states. There is very little capacity already built, although a lot has been proposed and a lot more is needed to meet the targets. Note that wind is used as an example in Figure 1.30, but in most cases other renewables also qualify and are being built in limited capacity to meet these targets. In addition renewables may be built in one state to satisfy another's requirements.

Figure 1.30: Progress Towards Meeting State and Provincial Renewable Targets with Wind Power



A key difference between New England and the Eastern Canadian provinces appears to be not only the availability of the resource but the fact that there are limited numbers of distribution companies that provide service to the majority of consumers in Eastern Canada. These regulated distribution companies submit supply and demand forecasts and procurement plans for new capacity to regulators and then can issue requests for proposals for specific types of new capacity. The planning process and specific requests for capacity tend to end in concrete contracts between project developers and the distribution companies, allowing projects to be financed and built. These long term contracts are generally not available in New England, although there is potential for a limited quantity in Connecticut (100 MW) and the practice has recently been authorized in Maine. Massachusetts is providing a floor on certificate prices for some developers, and Vermont utilities may provide long term contracts to satisfy their requirements. Still, the New England distribution companies primarily procure electricity supply through short term contracts (less than three years) and the obligation to satisfy the RPS usually goes along with those short term contracts, leaving little opportunity for suppliers to sign long term contracts with renewable projects.

Table 1.28 presents a comparison of energy supply policies in New England and the Eastern Canadian provinces, with the various renewable targets shown for each jurisdiction.

Table 1.28: Comparison of Existing Energy Supply Policies among States and Provinces

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, state, or both)	federal	federal	federal	federal	federal	both	federal	federal	federal	federal	federal
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 diffe	50 or 100	100	60	25	0 to 25	15 to 150			50	100	50
Capacity incentives for distributed generation (yes or	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 dependant 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.

As can be seen in the comparison of RPSs, there should be significant additional demand for renewables, but more projects will be needed than are currently planned. This demand is also illustrated in Table 1.29, which gives a sense of how much more capacity needs to be constructed. Modeling analysis completed for the RGGI process also indicates that RPS requirements from the states participating in RGGI should lead to the development of 10,000 MW of new renewables by 2020.

Table 1.29: RGGI Modeling Results for Renewables.
Existing renewable portfolio standards were built into the RGGI modeling analysis, with the following results indicating what resources were deemed cost-effective and chosen by the model for construction.

	RPS Targets (Incremental %)		IPM Modeling Results (new MWs of Renewables)	
State	**2010**	**2020**	**2010**	**2020**
Connecticut	7.0%	7.0%	74	125
Delaware	None	None	63	108
Massachusetts	4.5%	9.5%	216	807
Maine	None	None	564	1,999
New Hampshire	None	None	327	1,328
New Jersey	4.3%	8.9%	381	868
New York	4.1%	6.4%	1,250	3,275
Rhode Island	2.5%	14.0%	3	4
Vermont	NM	NM	389	1,495
Total			3,267	10,009

Source: RGGI renewable energy modeling assumptions document and IPM reference case results
NM = Not Modeled

Although many projects are on the drawing boards and proposed, as seen in Table 1.29, the requirements for new renewables are not leading to the quantity of new wind power projects in New England that one would hope to see based on the RPS targets. There have been some new landfill gas facilities and upgraded biomass plants, but after several years of having RPS policies in place, the total new renewable capacity developed in New England is still low. Most of the projects on the drawing board in New England are having trouble getting permitted and securing long term contracts that facilitate financing.

Although federal, state/provincial and local governments have long governed the siting and permitting of energy facilities in the U.S. and Canada, siting traditional and renewable facilities today is far more difficult. Not only are government regulations and laws governing siting becoming more complex, there is a greater awareness of the potential effect of projects on the environment and nearby communities. In addition, an emerging trend is that an increasingly informed public is participating more actively in the decision making process, particularly as it relates to siting new generation and transmission facilities. As a result, more communities are resisting the siting of facilities in their neighborhoods based on the so-called “not in my back yard” (NIMBY) effect, which is often cited as a reason for delay in obtaining approvals to construct new facilities. This resistance to new construction could be based on environmental concerns related to emissions and other potential environmental problems associated with large facilities, or it could be related to the negative visual aesthetics a facility would present.

While there has been growth in all types of renewable resources, wind generation is rapidly accelerating because it has proven to be a cost-effective method of generating GHG-friendly electricity, even across different regulatory regimes in both Canada and the U.S.[140] However, siting authorities are recognizing that wind energy technologies and other renewable energy include features that are not always accounted for in existing rules. For example, wind generators have to address siting issues regarding the height, motion, and the arrays in which wind turbines are arranged because of environmental and social impacts. This is complicated by the fact that the jurisdiction over siting energy facilities varies among states/provinces and communities. In some states, the local branch of government (county commissions, planning and zoning boards, or other local government departments) are responsible for conditioning and approving energy facilities, while in other states siting authority is retained at the state level. For instance, both Connecticut and Massachusetts have siting boards or councils that are authorized by state legislation, although the Connecticut Siting Council regulates siting renewable sources greater than 1 MW while the Massachusetts Energy Facilities Board’s requirements apply to generating plants of 100 MW or more and delegates siting of smaller projects to state agencies or local communities.[141]

As a result, some states have begun to develop siting and permitting guidelines for wind facilities and other renewable energy sources which include model ordinances, statutes, and checklists that address specific citing issues such as those related to wind facilities. In the U.S., there are five general siting processes for wind facilities: mandatory, state-level wind statutes; voluntary guidelines for siting within states; model ordinances for local governments to apply and use; local government siting rules; and voluntary checklists and resources for local governments to recommend.[142] In addition, federal agencies have jurisdiction over siting and permitting of facilities when projects are sited on or may affect federal land, federally regulated natural resources or endangered species. Also, U.S. Federal Aviation Administration lighting and safety regulations apply to utility-scale wind energy sites whose turbines are 200 feet or higher.[143]

Siting for wind projects have not, to date, elicited as much opposition as in New England. In part this is because Canada has federal and provincial framework policies to promote renewable energy, which are

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[140] Renewable Energy in Canada, Final Report Submitted by: The Conference Board of Canada September 24, 2003 http://www.conferenceboard.ca/pdfs/Renewable_Energy_Canada.pdf.
[141] National Wind Coordinating Committee and the National Conference of State Legislatures: State Siting and Permitting of Wind Energy Facilities, April 2006.
https://www.nationalwind.org/publications/siting/Siting_Factsheets.pdf.
[142] *Ibid.*
[143] *Ibid.*

supplemented by provincial and municipal level policies regarding use of crown land, transmission and interconnection, environmental, and zoning and permitting to ensure that the signals sent by the framework policies can be acted on in an efficient manner. In addition, Canada's Wind Energy Association is working across Canada to develop wind-friendly policies in each of these areas.[144] (At the same time, it should be noted that some communities and constituencies feel Canada's federal, provincial and municipal policies do not provide adequate opportunities for their voices to be heard on siting of large renewable energy projects.)

In the Eastern Canadian Provinces, lower population densities and larger renewable energy resources, together with a regulatory structure that is still supportive of long-term competitive contracts, have facilitated development of new renewable projects. By contrast, the development of renewable energy in New England presents challenges that have to be addressed through well-crafted and stable policy solutions. Some of the challenges include limited renewable resources, high population densities leading to conflicts over land use, and the lack of long-term contracts. In addition, there have been a number of changes or attempted changes to RPS definitions and criteria that add uncertainty to the market and may be discouraging new development.

Implementation

New renewable energy capacity will be a critical component of achieving the region's energy and climate goals. The resources are not especially expensive, there is a large potential resource waiting to be tapped, and yet in some places requirements for new renewables are not leading to the quantity of projects desired. Renewable policies should: (1) set clear and aggressive targets for renewables; (2) ensure that existing requirements, such as the RPS are delivering their promise by reviewing contracting and procurement processes; (3) investigate and implement policies to support distributed and small-scale renewables; and (4) develop state planning processes to designate suitable development sites that would be eligible for streamlined permitting.

Renewable Portfolio Standards and Procurement Policies

Each state or province should require that electricity suppliers or all load serving entities increase the amount of electricity that comes from renewable sources, with existing RPS requirements brought up to the standards outlined below:

- *Eligible Renewable Energy Sources* -- Eligible sources should limited to those technologies that are not commercially viable today and projects built after 2006 or the start date of the RPS that are powered by wind, solar, geothermal, wave & tidal, generation from landfill gas or manure management or sustainable biomass (see further discussion of biomass in section below). Adjustments to the definitions should be made no more frequently than every 5 years.
- *Target Supply Percentages* -- Minimum percentages of total electricity load should come from new, incremental renewable supply that ramp up to:
    - 5% by 2010
    - 10% by 2015
    - 15% by 2020

  Some jurisdictions may be able to go beyond this if there is significant resource potential or energy storage options are improved.
- *Procurement of Supply* -- For supply purchased to meet standard offer or default service, renewables should be procured through competitive solicitations for long-term contracts (not less than 10 years) for energy or attributes (renewable energy certificates or REC) with regulators weighing the benefits of various contract types to ensure the state receives a fair price and a hedge against rising energy prices (energy plus REC, fixed price for REC, or REC contracts for

[144] Canada Wind Energy Association http://www.canwea.ca/en/faq.html.

differences that are linked to the spot market price). New solicitations should be made on a yearly basis for the incremental additional supply required by the RPS. Tracking should continue to be accomplished using the existing power attribute tracking and trading systems.

- *Power Delivery* -- Renewable resources should be eligible from within the state, regional power pool, or neighboring power pools as long as an equal quantity of power is transferred into the local power pool on a monthly basis. Hourly matching should not be required.

Example: Quebec -- Developing New Wind Quickly and at Large Scale

Quebec has made large scale commitments for new renewables and the projects are being built as planned.

The lowest cost renewable power source is generally wind. As shown in the wind resource map in Figure 1.29, Quebec has very strong wind speeds in much of the province, with significant development potential. The provincial government in Quebec, through Hydro Quebec, has committed to larger and larger targets for wind power leading to project construction at a rapid pace. Hydro Quebec has been issuing competitive requests for proposals and the projects receive long-term contracts for their power output. This is driving significant new development, which is aided by better wind resources, lower population densities, and less opposition to development than in New England.

Quebec Wind Statistics:

Existing:	212 MW
Built in the Past 5 Years:	110 MW
Calls for bids issued:	3,000 MW
New Contracts Awarded (as of 2006):	1000 MW
Total Wind Target (2015):	4,000 MW

Promoting Distributed Renewable Generation

In addition to policies to promote large renewable projects, states and provinces should maximize incentives and programs that assist in the development of small distributed renewable energy systems. These systems, which can be sited near energy demand, avoid transmission and distribution costs and, for technologies such as solar, biomass or ground source heat pumps, they often can be designed to provide energy during periods of peak demand, which reduces system costs for all consumers.

Direct grants are probably best used for distributed renewable systems, as the large grid-scale projects should be adequately supported by well designed RPSs or utility procurement plans. Grants can be structured and funded in a variety of ways – from small societal benefit charges on utility bills to fund clean energy funds or general tax revenue – that are used to pay for set grant amounts for specific system types. Studies looking at the success of grant programs have found that it is important to set the grant level at a point that is not too generous but at a level that provides a catalyst for significant numbers of installations. This funding level may need to be changed with time and may be different for different regions and applications. For this reason we believe developing a knowledgeable energy office or clean energy program to administer grants is the best system. In addition, the energy office or clean energy fund should support commercialization of renewable energy technologies that are new to the market and show significant promise of being competitive over the long-term. (See Priority 5.5 Provide Public Support for Clean Energy System Commercialization and Deployment.)

In order to maximize the quantity of renewable energy technologies developed in the region, the states and provinces should follow the lead of some of the states in the region by making renewable energy equipment and services exempt from most state or provincial taxes.

- *Sales Tax Exemption* -- All renewable energy technologies that are RPS qualified (see previous list) should be exempt from sales tax, including all equipment, materials, and installation costs associated with the project.

- *Property Tax Exemption* -- Small distributed renewable energy systems should be given a property tax exemption in the town or municipality in which they are sited; large systems (>1 MW) or systems used to satisfy the RPS should not be eligible for this exemption (communities willing to host large energy infrastructure should receive the benefit of the additional tax base).

Improve Siting Procedures for Renewables

As demand for wind generation and other renewable resources continues to grow, siting authorities in the U.S. and Canada should ensure that their regulations are structured to promote the development renewable energy facilities. While the details of siting processes will vary widely, the U.S. National Wind Coordinating Committee has suggested several general guidelines to help improve the siting process of wind generation. (The Canada Wind Energy Association has plans to develop a similar set of siting guidelines.) There should be significant public involvement to ensure that the process is transparent while establishing reasonable time frames in which the application for siting is reviewed, hearings are held, public comments are made and reviewed and a final decision is made. In addition, the regulating agency should establish 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. The siting process can also be streamlined so that there is either better coordination between agencies to prevent duplication of permits and delay or developers can obtain all the permits they need from one state agency. If there is a legal challenge to a siting process, there should be an expedited judicial review process in place to ensure that a decision can be made in a timely manner. Finally, since wind power feasibility is highly site-specific, the siting agency could help assess preferable geographic locations in advance.[145] While many of these guidelines are specific to wind, siting agencies should also assess other renewable energy resources and address their specific siting concerns so that as renewable energy becomes more economical and widespread, guidelines for siting them will already be in place.

[145] National Wind Coordinating Committee, Wind Energy Series, January 1997 v. 3 http://www.nationalwind.org/publications/wes/wes03.htm.

5.2 Promote Clean, High-Efficiency Fossil Electric Generation

Summary

States and provinces should create additional incentives and mandates for expanded combined heat and power deployment.

Systems that generate both electricity and useful thermal energy are known as CHP or co-generation systems. Combined heat and power systems can achieve efficiencies in the range of 60-90%, while average fossil electric generation efficiency is in the range of 30-40%. In addition CHP systems can offset boilers or other energy systems that are currently providing thermal energy.

We recommend that states and provinces consider a CHP portfolio standard modeled on, but distinctly separate from, renewable portfolio standards. Developing a CHP portfolio standard 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;
- administering the system through tradable CHP credits that use existing generator attribute tracking systems such as the New England GIS system.

Large CHP systems should be regulated for GHG emissions under a cap-and-trade system, and smaller systems should have to meet minimum permitting standards for air emissions set by each state that should become stricter over time.

There are still barriers to the development of CHP in the form of utility imposed back-up rates, interconnection requirements, and other hurdles. Market-based requirements, such as a portfolio standard, would force regulators and distribution companies to address these hurdles at very low cost as the technology becomes cost-effective.

The commercial sector alone has the potential for adding almost 4,000 MW of new capacity in New England. This represents around 13% of current New England electric capacity and does not reflect potential capacity for industrial locations, which should also be significant.

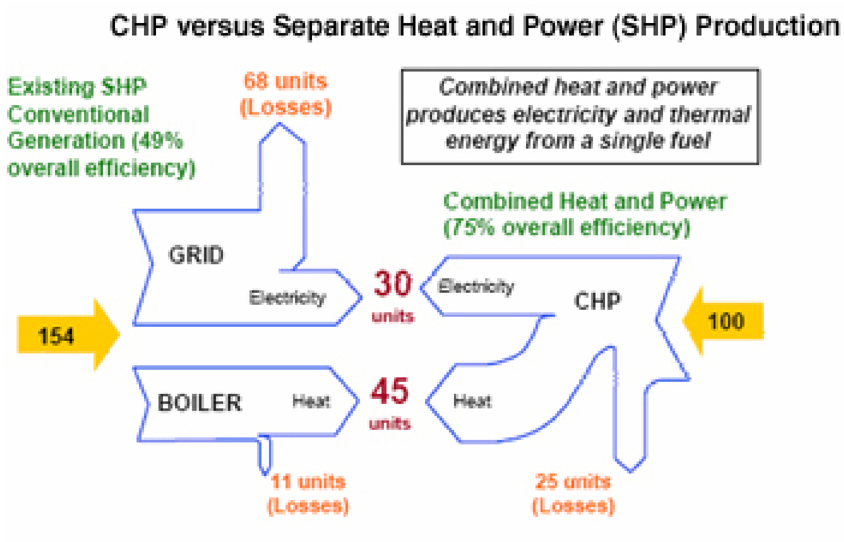
Opportunity

Electric generation from fossil fueled power plants is generally inefficient. Much of the potential energy embodied in the fuel is lost in the form of waste heat or line losses during the transmission of the electricity to the end-user.

There are technologies and generation systems that are significantly more efficient than the average fossil generation systems today. These energy systems use high-efficiency turbines or engines to generate electricity but also harvest the waste heat from the system to provide energy to secondary systems such as: industrial processes, heating and cooling systems, or secondary steam turbines that generate additional electricity.

Systems that generate both electricity and useful thermal energy are known as combined heat and power (CHP) or co-generation systems. Combined heat and power systems can achieve efficiencies in the range of 60-90%, while average fossil electric generation efficiency is in the range of 30-40%. Because the systems are located at the site of the end-user, they have no line losses. In addition CHP systems can offset boilers or other energy systems that are currently providing thermal energy. Figure 1.31 illustrates how a CHP system (on the right) can be used to satisfy the same energy demand as a separate electric plant and boiler with lower total energy consumption and less energy losses.

Figure 1.31: Comparison of the Energy Used from Conventional versus Combined Heat and Power Sources
Because CHP systems can be significantly more efficient than conventional electric generation combined with a boiler (75% vs. 49%), installation of efficient CHP systems can lead to reduced energy use and GHG emissions.[146]



Source: U.S. EPA

The increases in energy efficiency facilitated by CHP systems translate directly into lower consumption of energy and reductions in emissions through reduced fuel combustion. CHP systems can be a useful tool in reducing emissions of greenhouse gases and other air pollutants. In addition, on-site generation using CHP can often be cheaper than purchasing both electricity from the grid and an energy source such as gas and oil for on-site boilers or other equipment.

However, not all CHP systems provide an environmental net-benefit. The characteristics of the electric power and boilers or thermal energy systems they are offsetting are important, as is the total efficiency of the CHP system. New high-efficiency boilers can achieve efficiencies over 90% and have low energy losses. And most importantly, a CHP system that is poorly designed can be inefficient and not properly sized to match the energy demand at the site.

Despite these concerns, overall, there is significant potential for CHP systems to greatly reduce emissions and there is significant market potential for CHP in the commercial and industrial sectors. As Table 1.30 indicates, the commercial sector alone has the potential for adding almost 4,000 MW of new capacity in New England. This represents around 13% of current New England electric capacity and does not reflect potential capacity for industrial locations, which should also be significant.

146 U.S. EPA http://www.epa.gov/chp/what_is_chp.htm.

Table 1.30: Commercial CHP Potential in New England

	CHP Market Potential (MW)						
Sector	Connecticut	Maine	Massachusetts	New Hampshire	Rhode Island	Vermont	New England
Hotels/motels	32.4	15.4	107.7	31.1	10.0	26.0	222.6
Nursing Homes	169.8	31.2	349.8	25.8	53.5	11.9	642.0
Hospitals	115.8	41.3	266.4	23.5	42.8	9.0	498.8
Schools	178.5	70.5	343.3	76.3	39.3	45.2	753.1
Colleges & Universities	48.7	24.2	121.5	13.6	34.7	23.8	266.5
Comm. Laundries	6.2	1.1	15.6	1.5	1.8	0.2	26.4
Car Washes	0.7	0.0	1.5	0.0	0.2	0.0	2.4
Health Clubs/Spas	74.5	17.5	144.4	23.0	14.8	6.1	280.3
Golf Clubs	22.1	3.7	36.0	6.0	4.2	3.3	75.3
Museums	4.2	0.9	21.9	1.4	0.9	0.2	29.5
Correctional Facilities	48.9	8.0	37.1	7.2	5.4	14.7	121.3
Water Treatment	14.9	6.0	36.0	3.9	2.0	0.4	63.2
Restaurants	25.5	7.5	77.8	6.3	9.1	3.6	129.8
Supermarkets	16.4	5.5	23.8	4.0	2.9	2.5	55.1
Refrigerated Warehouses	5.0	3.2	19.9	0.7	0.2	1.1	30.1
Office Buildings	217.6	63.5	357.5	6.2	76.2	28.8	749.8
Total	981	300	1,960	231	298	177	3,946

Source: Resource Dynamics Corp., 2001

With efficient CHP providing significant environmental benefits and also becoming more competitive as energy prices rise, we believe that states and provinces should create additional incentives and mandates for expanded CHP deployment. There are still barriers to the development of CHP in the form of utility imposed back-up rates, interconnection requirements and other hurdles. However, market-based requirements such as a portfolio standard would force regulators and distribution companies to address these hurdles at very low cost as the technology becomes cost-effective.

Implementation

Policies designed to encourage CHP systems should require that the systems receiving policy or financial support meet minimum energy efficiency standards. A minimum standard of 75-80% should be attained, which is better than the 60% minimum currently in place in a number of states. This standard should be assessed by policy makers in relation to the situation in their jurisdiction and raised over time as technologies become more efficient.

CHP systems can also be powered by a range of energy sources ranging from natural gas, oil and coal to landfill methane and digester gas. Larger systems would likely be regulated by a cap-and-trade program for carbon dioxide and possibly other pollutants such as nitrogen oxides and sulfur dioxides. However, small systems should have to meet minimum permitting standards for air emissions set by each state that should become stricter over time.

Increasing the efficiency of existing fossil energy sources will be essential to reducing emissions in the electric, industrial, and commercial sectors. Unlike renewable energy resources, which are only available in some locations, all of the states in the region have significant potential for high-efficiency CHP applications at industrial and commercial sites, large campuses such as universities, hospitals, and airports, and district heating in urban centers.

Policy options that relate to CHP are also discussed as part of other recommendations in this chapter regarding utility procurement, commercialization funding for clean energy systems, and access for distributed generation.

CHP Portfolio Standard

States and provinces should consider a CHP portfolio standard modeled on, but distinctly separate from, renewable portfolio standards. This market based system is likely to be very cost-effective as CHP should be close to competitive with today's sources of electric generation. However, we believe that a portfolio requirement will ensure that the other market barriers such as interconnection standards, backup rates and other hurdles are overcome. The steps and structure of a potential state and provincial CHP portfolio standard could include the following:

- *Assess CHP Market Potential* -- Each state and province or the region as a whole should commission a study to determine the market potential for CHP systems in each jurisdiction. This study should be used to set portfolio requirements.
- *Set Minimum CHP Criteria* -- The portfolio standard should promote new efficient CHP. The standard should set minimum efficiency levels to ensure energy savings and environmental benefits, with a starting point of 75-80% efficiency. The efficiency standard should increase slowly over time to drive innovation and technology improvements, and only new CHP facilities should qualify for the standard.
- *Portfolio Standard Size and Applicability* -- The CHP portfolio standard should be administered based on tradable CHP credits utilizing existing generator attribute tracking systems. (The New England GIS system can track units "behind the meter", while Canadian systems may need to be developed.) The portfolio requirement should apply to all load serving entities (whether utilities, standard offer suppliers, or competitive suppliers). Percentage requirements should slowly increase over time and be set based on the market potential study, but would likely be in the range of 10% of total load served by new CHP by 2015 and 15% or more by 2020.

5.3 Improve Grid Access for Clean Distributed Generation

Summary

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, 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.

Opportunity

Distributed energy resources such as clean and efficient fossil plants, renewable generation, and energy storage technologies all provide benefits to the electricity grid by placing resources closer to the users and avoiding the need for transmission and distribution expansion and the operation of dirty and often older peaking power plants. Because distribution utilities have traditionally been compensated on a rate basis, where their earnings are tied to sales and the quantity of electricity they sell, they have historically been opposed to the addition of distributed resources to the system. Decoupling earnings from sales will significantly change utility incentives and reduce their resistance to these technologies. (See more about utility procurement and decoupling under Priority 1.3.) However, there are additional hurdles to connecting distributed generation that should be removed in order to allow full access to the grid and increased competitiveness.

There are three major hurdles for distributed resources in many states and provinces. They are interconnection standards, the structure and price of utility tariffs, and the ability to participate in net-metering. The status of these policies is outlined in Table 1.27 for each state and province.

Interconnection standards are developed by the distribution company and the regulator as a protocol for the siting and interconnection of new grid-connected energy resources within the electric system. These standards have often been criticized as unnecessarily onerous – a tool for distribution companies to prevent new generation from being connected to the system. Many jurisdictions have recognized this problem and are in the process of improving these standards to simplify and streamline them while ensuring that safety and grid stability concerns are adequately addressed.

The structure of utility tariffs is also viewed as a problem for distributed energy resources and is another mechanism used by distribution companies to prevent new generation from being connected to the system. Distribution companies have often developed rates for entities that have on-site generation, known as standby rates, that are designed to pay for the availability of power should the on-site generation not be available. These rates have often been set under the assumption that all distributed resources could become disabled or unavailable at the same moment during a period of peak demand. This highly unlikely scenario has led to very expensive standby rates. Standby rates can be reduced for distributed energy resources by basing them on more realistic assumptions (*e.g.*, assuming only a small portion of distributed resources would be unavailable at one time). Or as had been done in states like Connecticut, the standby rate can be eliminated, charging customers just the normal rate for energy they use, not energy they might use if their on-site resources are unavailable.

Net-metering allows a company or home owner to generate power on-site and use the electric grid as storage. On-site electricity can be sold into the grid when there is an excess and purchased from the grid if the consumer requires more than they are producing. This mechanism allows the consumer to avoid having to purchase an energy storage system and uses the grid like a battery. It also provides benefits to the grid as a whole, especially for solar applications, as peak power consumption often occurs during peak periods of sunshine. Net-metering has been implemented in most of the New England states, few of the Canadian provinces, and the allowable size of the electric generation is highly variable and generally small.

Implementation

Policies and regulations related to the connection of distributed generation to the electricity grid should be improved to promote clean distributed generation.

Interconnection

Policies should be revised in each state to ensure that a clear, consistent and streamlined procedure exists for connecting new energy resources to the grid. Some jurisdictions have made significant progress in this area, but all should ensure that interconnection standards are fair and safe, while making the siting of new resources predictable and transparent. Different requirements for various sizes will often make sense, with small systems being the least onerous and large systems requiring more analysis and review.

Utility Tariffs

Standby rates should be reduced or eliminated for customers with on-site energy resources, with rates based on reasonable assumptions associated with demand for back-up power.

Net-Metering

Distribution utilities should be required to allow customers to take advantage of net-metering, where generation can be sold into the grid when there is an excess and purchased back when there is a deficit. The size limit on net-metering should be raised to 2 MW, with a requirement that the system be sized to meet on-site demand and satisfy all interconnection requirements, and customers should be able to bank surpluses over a one year period for use in subsequent months.

5.4 Establish Environmental and Safety Standards for Permitting New Power Plants

Summary

Under 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.

- A sensible goal regarding coal is to ensure that net emissions from all coal fired power plants in the region do not increase over time. We largely expect carbon cap-and-trade systems to address the risk of increasing our regional carbon budget with new high-emitting plants that last 30-50 years. Nonetheless, it is prudent to develop permitting rules for possible new 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* – proposed for greenfield sites 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* – is not to commence operation until an equivalent or greater capacity of old unit(s) ceases operation, and 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.
- *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 commercialization and deployment of carbon capture, transportation, and storage technologies.

The high rate of GHG emissions from coal fired power plants, however, and their long 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.

Regarding nuclear power, we discourage the states and provinces from offering public subsidies or special policy treatment that would give nuclear power a competitive advantage over alternative, clean energy 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 the loss of generating capacity replaced primarily by increased investments in energy efficiency and renewables, and some new fossil with carbon capture and sequestration.

Biomass should be promoted as an indigenous source of sustainable energy supply that may be considered carbon neutral, but the states and provinces should determine what limitations or requirements must be placed on biomass energy in order to ensure that it is developed in a sustainable manner. Whether in RPS definitions, cap-and-trade programs, or criteria for financial incentives, we recommend:

- 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 air emissions standards for biomass production and combustion;
- establishing waste disposal requirements.

Summary *(continued)*

States and provinces should work to develop emissions factors for hydro projects and report these emissions in regional and national emissions inventories. We also propose that all regulatory review and approval of existing and new dams follow the recommendations laid out by the World Commission on Dams. It is important that any (re)licensing take cognizance of the fact that reservoirs for dams can be responsible for significant GHG emissions.

Opportunity

Coal

Coal contains the highest concentration of carbon of the major fossil fuels we consume. Coal has potential CO_2 emissions per unit of energy that are about 90% higher than natural gas and 40% higher than oil.

Using coal for our energy supply also has other impacts on the environment. It contains significant quantities of sulfur, mercury, and other impurities. Coal fired power plants are major contributors to smog, acid rain, mercury deposition, solid waste in the form of ash and, in some cases, thermal pollution of nearby water bodies. Finally, mining of coal can lead to acid mine drainage, land subsidence, mountain top removal and huge surface disturbance from open pits.

According to the United Nations Development Program (UNDP) and World Energy Council in their 2000 World Energy Assessment, North American proven reserves of coal, oil and natural gas were reported as 6,065, 193 and 244 Exajoules respectively. The most abundant fossil energy resource in North America is coal and as the World Energy Assessment indicates, North American coal reserves even exceed the oil reserves of the Middle East and North Africa at approximately 4,000 Exajoules. With this energy resource available and oil and natural gas prices climbing, policy makers and the energy industry are attracted to coal as an energy resource. The high rate of GHG emissions from coal fired power plants however and their 30-40 year lifespan indicate that building new conventional coal fired power plants in the region is completely inconsistent with achieving GHG reductions.

The primary technologies being used or contemplated to convert coal into usable energy carriers are the following:

- coal fired boilers with a steam turbine generator;
- coal fired boilers with a steam turbine generator and conventional emissions control technologies (that do not reduce GHG emissions);
- integrated gasification combined cycle (IGCC) power plants that allow for a chemical conversion of coal to synthetic gas for use in a modified gas turbine.

Taken by themselves, each of these technologies emits significant quantities of GHGs. Current coal fired boiler technologies emit about one ton of CO_2 per MWh of electricity generated. New power plants are more efficient, but according to the Intergovernmental Panel on Climate Change's recent *Special Report on Carbon Dioxide Capture and Storage* in which IPCC reviews electric generation and carbon storage technologies, both new pulverized coal plants (boilers) and IGCC plants still have representative emission rates of about 0.8 tons per MWh.[147]

Given its abundance, there will be continued pressure to use coal in delivering future energy needs. From a GHG emissions point of view, the only path for coal to remain a part of our region's energy mix is to consider technologies that address the substantial carbon emissions from all coal generation technologies.

[147] IPCC, *Special Report on Carbon Dioxide Capture and Storage*, 2005, Tables 8.1 and 8.3a.

Research is being devoted to the prospect that CO_2 emitted from power plants and other sources can be separated and captured, transported to a storage location, and placed in isolated storage indefinitely. This process, often referred to as carbon capture and storage (CCS), is ideally suited to coal, given its high carbon content. It is a process that can also be used in conjunction with natural gas power plants, other large industrial emitters, biorefineries and synthetic fuel and hydrogen plants.[148]

There are a number of carbon capture systems available or in development that could be used on coal plants (post-combustion, pre-combustion, and oxyfuel combustion). Of these technologies, pre-combustion capture of CO_2 from IGCC plants is currently the most attractive from a cost, experience and co-benefit perspective. Coal IGCC plants have non-carbon benefits over traditional pulverized coal plants as well. The IGCC gasification process removes traditional pollutants, such as sulfur and mercury more efficiently, reduces and stabilizes solid waste volumes and reduces water use.

Table 1.31, based on the IPCC's *Carbon Dioxide Capture and Storage* report, compares traditional pulverized coal plants to IGCC plants with and without carbon capture and sequestration.

Table 1.31: Representative Characteristics and Performance of Coal Generation with and without Carbon Capture and Sequestration

	New Pulverized Coal Plant			New IGCC Plant		
Performance and Cost Measures	**Without Carbon Capture**	**With Carbon Capture**	**Percent Change**	**Without Carbon Capture**	**With Carbon Capture**	**Percent Change**
Emission rate (kg CO2/MWh)	762	112	-85%	773	108	-86%
Capture energy requirement (% more input per MWh)			31%			19%
Total capital requirement (US$/kW)	1,286	2,096	63%	1,326	1,825	37%
Cost of energy (US$/MWh)	46	73	57%	47	62	33%
Cost of CO2 avoided (US$/tCO2)		41			23	
With capture, transportation, and geologic storage						
Cost of energy(US$/MWh)	46	81	76%	47	73	55%
Cost of CO2 avoided (US$/tCO2)		54			34	
With capture, transportation, and enhanced oil recovery						
Cost of energy(US$/MWh)	46	65	41%	47	58	22%
Cost of CO2 avoided (US$/tCO2)		27			12	

Source: IPCC, 2005, *IPCC Special Report on Carbon Dioxide Capture and Storage*, Tables 8.1 and 8.3a, with representative values or averages of ranges used

Environment Northeast

The performance and cost data shown in this table illustrate why energy companies are interested in developing IGCC plants with captured CO_2 used for enhanced oil recovery. The overall CO_2 emissions rate is very low (86% below a traditional IGCC plant), total cost of energy is up by only 22% to $58/MWh (lower cost than many natural gas plants at the time of this writing), and the cost per ton of

[148] Carbon capture and storage is discussed in some detail in the Sequestration chapter of this report (Chapter 3).

CO_2 avoided could be as low as $12. Geologic storage is more expensive, but all of these costs are likely to decline from today's estimates with technological innovation and learning.

Nuclear

Nuclear power emits no GHGs at the power plant (although some limited amount of energy, often generated from coal, is required to enrich the uranium upstream). While this suggests that there are potential climate change benefits associated with continued and expanded use of nuclear power, they must be considered in the context of large issues that remain unresolved despite many decades of effort.

Among the most important issues are:

- *Cost* -- Existing nuclear power plants generate power at relatively low marginal cost to the region, but are extremely expensive to build, and the financial risk for these investments has been borne by ratepayers and government. The next generation of nuclear plants has not demonstrated the potential for significant cost improvements.
- *Radioactive Storage* -- There is no permanent storage facility for radioactive waste or any agreed upon plan for such storage, causing most waste to be stored on site in the communities where the plant is located.
- *Safety* -- There are safety risks from normal operations as well as from anomalous events such as terrorist attacks. The nuclear power industry is considered so risky in the U.S. that federal legislation, the Price-Anderson Act, is required to provide liability insurance for nuclear power plants.

Until these and other issues are addressed, there is little opportunity to discuss a role for nuclear power in meeting GHG objectives of the region.

Biomass

Biomass used to generate electric power or biofuels (such as biodiesel, ethanol or synthetic fuels) can provide an indigenous source of energy for the region. As discussed more in the Sequestration chapter and also the recommendation on transportation fuels, biomass stores CO_2 during photosynthesis, and then releases CO_2 when it is combusted or otherwise processed to make energy. Historically, policy makers have adopted a convention that assumes the release of CO_2 from this process is cancelled out by the storage (or uptake) of CO_2 in the biomass, assigning zero net CO_2 emissions to energy made from biomass. In fact, however, a full assessment of the net GHG impacts of any given biomass energy source can be very complex, requiring analysis of the full life-cycle impacts of the cultivation, transformation, and utilization of these energy sources. Such analyses have factored in:

- carbon cycle impacts, including emissions from land conversion and the disturbance of carbon in soils, the sustainability of the rate at which biomass is taken off the land, and the long-term implications for carbon dioxide and methane concentrations;
- nitrogen cycle impacts and the implications of NO_x and Nitrous Oxide (N_2O) emissions during combustion as well as the N_2O emissions associated with manufacturing fertilizers;
- fossil fuel use and associated greenhouse gas emissions due to production and transportation;
- the potential for biomass to have negative emissions if coupled with carbon capture and sequestration technologies (See the Sequestration Chapter.).

Several other environmental impacts should be considered in connection with biomass energy sources. These include:

- natural resource impacts, such as soil erosion, changes in soil nutrient levels, water use, fossil fuel consumption in the manufacture and application of fertilizers, fossil fuel use in the transportation and processing of the biomass and final fuel and impacts on biodiversity and habitat;
- non-CO_2 air emissions from the combustion of biomass (such as nitrogen oxides that contribute to ozone, hydrocarbons and particulate matter) and from the use of fossil fuels in making fertilizer and transporting and processing the biomass;
- waste impacts, including possible pollutant content of ash or other biomass waste streams, especially where construction and demolition are used.

While the resource is limited and therefore could supply only a portion of the region's total energy needs, biomass still has a potentially important role to play. To do so, it must develop and operate under clear criteria so that carbon neutrality, overall emissions, and land use impacts are addressed satisfactorily.

Hydro

Hydro power is often viewed as a clean and renewable energy resource. However, as scientific knowledge about the environmental impacts of dams has improved, several concerns have been identified in terms of impacts on ecosystems and also in terms of the increased emissions of greenhouse gases associated with dam construction and hydropower projects.

The most comprehensive assessment of dams and hydro power has been completed by the World Commission on Dams (WCD), an international group of diverse interests brought together to assess the issues associated with large dams. The final report, *Dams and Development: A New Framework for Decision Making*, and the thematic review entitled *Dams and Global Climate Change* both provide important insights on the benefits and problems associated with large dams and hydro power development.

The WCD acknowledges the large benefits of dams in terms of energy supply and economic development. It also enumerates the significant impacts new hydro development can have in terms of people displaced, losses for downstream communities and taxpayers, and impacts on natural environments. The WCD summarizes their environmental findings and lessons in the following manner:

Large dams generally have extensive impacts on rivers, watersheds and aquatic ecosystems. From the WCD Knowledge Base it is clear that large dams have led to:

- loss of forests and wildlife habitat, the loss of species populations and the degradation of upstream catchments areas due to inundation of the reservoir area;
- emissions of greenhouse gases from reservoirs due to the rotting of vegetation and carbon inflows from the basin;
- loss of aquatic biodiversity, upstream and downstream fisheries and the services of downstream floodplains, wetlands and riverine estuarine and adjacent marine ecosystems;
- creation of productive fringing wetland ecosystems with fish and waterfowl habitat opportunities in some reservoirs;
- cumulative impacts on water quality, natural flooding, and species composition where a number of dams are sited on the same river.[149]

[149] WCD, *Dams and Development: A New Framework for Decision Making,* 2000, p. 92-93. For a discussion of potential climate impacts from hydro dams in Quebec and the Northeast generally, *see*, Helios Center, *Restructured Rivers: Hydropower in the Era of Competitive Markets,* prepared for the International Rivers Network, May 2001.

The WCD's review of research on dams and greenhouse gases led them to the following conclusions:

- "The emission of greenhouse gases (GHG) from reservoirs due to rotting vegetation and carbon inflows from the catchment is a recently identified ecosystem impact (on climate) of storage dams."
- "Some values for gross GHG emissions are extremely low and may be 10 times less than the thermal option. Yet in some circumstances the gross emissions can be considerable, and possibly greater than the thermal alternatives. These emissions may change significantly over time as the biomass decays within the reservoir during the first few years of impoundment…"
- "Current understanding of emissions suggests that shallow, warm tropical dams are more likely to be major GHG emitters than deep cold boreal dams." [150]

The WCD report also notes that none of the studies have assessed the net emission of GHG from reservoirs, by measuring the emissions from the basin before and after dam construction. The net emissions from reservoirs are thus unknown and it would be useful to conduct more research to quantify emissions from reservoirs in different regions and environments.

Implementation

We recommend that states and provinces consider adding specific requirements related to the development of new power plants in their jurisdictions.

New Coal Plants and Carbon Sequestration

Carbon cap-and-trade programs should limit the development of new coal facilities, but specific emissions limits should also be applied to new coal plants.

New coal fired power plants sited in the region should have to achieve CO_2 emissions limits that ensure net emissions from all coal fired power plants do not increase over time. The rules should distinguish between re-powering or replacing existing facilities and new facilities to allow for some flexibility for existing owners. For purposes of discussion, we offer the following potential restrictions on the upgrading of existing coal power plants and the development of new coal power plants:

- *A New Coal Unit* – proposed for greenfield sites 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* – is not to commence operation until an equivalent or greater capacity of old unit(s) ceases operation, and 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.
- *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 commercialization and deployment of carbon capture, transportation, and storage technologies. CCS may not be a viable option for all jurisdictions. In the near term there appear to be suitable geologic formations in New York State and parts of Nova Scotia that are under review for geologic sequestration pilot projects (see Sequestration section of this report). These projects could be developed and supported cooperatively by a number of states. Funding for carbon capture and sequestration could be made available through the clean energy

[150] *Ibid.*, p. 75-77

system commercialization program funds discussed under Priority 5.5. Funding should be available to support sequestration research, development, and commercialization at power plants (including natural gas and biomass facilities), and other industrial facilities such as cement production, refineries, and iron and steel production. All of these facilities should also be covered by the regional carbon cap-and-trade program, which will provide an additional incentive for them to reduce emissions and develop carbon capture and sequestration projects.

Nuclear

It is our view that at this time, high costs together with the unresolved issues surrounding health impacts, security and disposal of radioactive waste make developing new nuclear generation unviable. From a public policy perspective, we would discourage the states and provinces from offering public subsidies or special policy treatment that would give nuclear power a competitive advantage over alternative sources of clean energy. To give nuclear power special status and favorable treatment would turn on its head the progress that recently has been made in getting energy resources to compete on a level playing field and holding them economically accountable for as many externality costs (such as carbon emissions) as practical. The excused external costs and the subsidies nuclear power now benefits from remain disproportionate to what other resources are given, and until that is leveled out the ratepayers and citizens will be unfairly burdened by policies designed to favor new nuclear generation. Moreover, it is our view that most of the health, safety and security issues related to existing power plants, the relicensing of those plants, and any new construction are best left to the existing, non-climate related, regulatory frameworks.

As the energy scenarios show at the end of this chapter (1.6), existing nuclear power plants can and should be phased out as their licenses expire, with the loss of generating capacity replaced primarily by increased investments in energy efficiency and renewables, and some new fossil with carbon capture and sequestration.

Biomass

Biomass should be encouraged as a source of sustainable energy supply, but the states and provinces should determine what limitations or requirements should be placed on this energy source in order to ensure that it is developed in a sustainable manner. This will require state and regional research to assess issues relevant to each jurisdiction and develop policy recommendations. Some of the specific features that jurisdictions might consider factoring into their policies on permitting, RPS, or other incentives and grants include:

- defining eligible energy sources (and disqualifying unsustainably harvested biomass and contaminated waste streams such as demolition waste);
- establishing sustainable land management and harvest requirements associated with natural resource preservation such as certification for forests (*e.g.*, Forest Stewardship Council) or best management practices for agriculture and working to have these certification processes also address and examine carbon sequestration trends;
- specific air emissions standards for biomass production and combustion;
- waste disposal requirements.

Hydro

The WCD has proposed a series of recommendations related to planning, construction and operation of dams. These recommendations relate to gaining public acceptance; comprehensive options assessments; addressing existing dams; sustaining rivers and livelihoods; recognizing entitlements and sharing benefits;

ensuring compliance; and sharing rivers for peace, development, and security.[151] State and provincial policymakers and regulators should consider these recommendations and ensure that all regulatory review and approval of existing and new dams follows these guidelines.

Both large and small dams have potential for significant adverse impacts on the local ecosystem and communities.

- Large dams pose significant social, economic and environmental challenges, including emissions of greenhouse gases and should be reviewed and developed in compliance with the recommendations of the World Commission on Dams 2000 report.
- States and provinces should work to develop emissions factors for hydro projects and report these emissions in regional and national emissions inventories.
- New large dams (>10 MW) should have to account for the net emissions of GHG from their reservoirs and states and provinces should consider regulating these emission under carbon cap-and-trade programs.

5.5 Provide Public Support for Clean Energy System Commercialization and Deployment

Summary

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 include a role for a strong oversight board, function within a long-term energy commercialization strategy, and distribute funds based upon 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.

State and provincial funding can provide direct support for research and development (R&D) and early stage commercialization to help jump start specific innovations and fledgling markets. This investment in R&D 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.

Opportunity

Technology Development: Research, Development and Demonstration (RD&D)

The model of technological growth moves from invention to innovation and then to diffusion. Technologies also tend to develop in specific regions or innovation centers that have a need or suitable niche market. States and provinces can facilitate this technological development both by creating policies, such as cap-and-trade programs or portfolio standards that drive innovation. They can also provide direct support for research and development (R&D) and early stage commercialization to help jump start specific innovations. This investment in R&D 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.

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[151] WCD.

The following figure illustrates the development and diffusion of a new technology and the potential support needed to achieve sustained growth and diffusion. Not all support needs to come from the public for this process to succeed, but there is a widely recognized “valley of death” for new technologies between Phases I and II (around point B in Figure 1.32), where significant investments are required to get the product to the point of significant market growth. State funding for clean energy technologies should focus on moving a broad range of technologies from market introduction to the point where they establish a real foothold in the market.

Figure 1.32: Development of Technology from Development to Diffusion

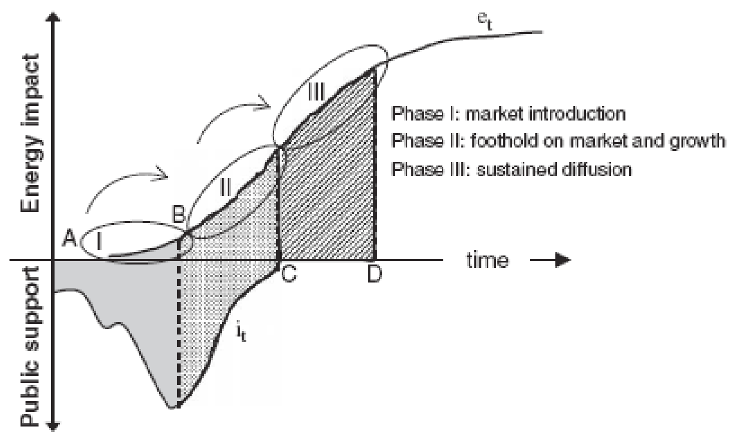


Fig. 1. Illustration of the market diffusion process and the evolution of impacts from public support. Point A: start of public measures and support; Point B: cumulative public support and energy impacts at time point t; Point C: public support seizes as financial breakthrough reached; Point D: large share of potential achieved.

Source: Lund, In Press, 2006

Implementation

In addition to capping greenhouse gas emissions from large stationary emitters and creating a supply push for renewables and high-efficiency fossil such as CHP, there will be a continued need to help fund research, development, and commercialization of new indigenous clean energy systems. Each state or province should collect money from electricity and fossil fuel sales to support 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. These programs should have a strong oversight board, function within a long-term energy commercialization strategy, and distribute funds based upon competitive solicitations and simple grants available to all eligible projects.

- *Collection of Funds* -- In a manner similar to the current System Benefit Charge (SBC) funds collected in some states for renewable program support, a small fee should be assessed on the sale of energy in the state on a carbon content basis and the proceeds used to support the following programmatic activities.
- *Clean Energy Technologies and Programs* -- The following no-carbon and low-carbon energy resources and technologies should receive development and commercialization support (this would likely be an expansion on the programs currently offered by clean energy or SBC funds):
    - Distributed or New Renewable Energy - The programs should develop incentive programs to support the development of large quantities of distributed renewable energy projects (solar electric, solar thermal, small wind, micro hydro, ground source thermal and clean biomass). In addition the programs should support the development and

commercialization of new larger scale renewable energy systems to help them move from a research and development stage to commercialization.

    - Very High-Efficiency Fossil – The programs should support the development and commercialization of very high-efficiency fossil systems such as combined heat and power systems, fuel cells, and micro-turbines with efficiencies greater than 80% (increasing the efficiency requirement over time).
    - Carbon Capture and Sequestration – In states or provinces that have potential carbon storage locations (likely limited by geology – see the Sequestration Chapter, Priority 10) or if there are opportunities for direct biological capture or other technologies, the programs should help to commercialize these technologies that capture and permanently store carbon dioxide.

- *Program Management and Oversight* -- These activities and programs will likely be housed in one or more government agencies depending on the current state or provincial energy structure. The ideal location is likely within an energy planning agency having the knowledge and staff to guide and administer the programs. Programs should be overseen by an independent advisory or oversight board with broad representation and staggered tenures to diminish political influences. A thorough annual report should be completed each year that documents program activities, spending and cost-effectiveness.
- *Strategy Development* -- The program administrator, in cooperation with other state agencies and seeking stakeholder input, should develop a long term technology development and commercialization strategy to set targets and goals for program development.
- *Equal Access and Competitive Solicitations* -- All programs should be run based on a principle of competitive solicitations or equal access to grants in order to eliminate favoritism. Bid specifications should have clear and simple guidelines. If grants are used, they should be open to all eligible projects.
- *Incentive Levels* -- 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. Incentive levels should decrease over time as technologies are commercialized.

Implications of Recommendations – Electricity Scenarios

We have developed a number of electric generation scenarios to depict how the region might achieve 75% emission reductions as envisioned in long-term GHG targets and also in our sector-wide cap-and-trade recommendation.

These scenarios are an attempt to illustrate a series of plausible futures to achieve emissions targets and are not a prediction or attempt to model a future outcome based on economics and a carbon cap. The following five scenarios meet or exceed the emissions targets and represent varying levels of success in reducing demand for electricity and different assumptions about the generation mix that might be available. We describe the five scenarios as:

- Scenario 1: Minimal energy efficiency, very rapid renewables development, rapid carbon sequestration development, and nuclear power generation replaced with new nuclear
- Scenario 2: Aggressive energy efficiency, slower renewables development
- Scenario 3: Modest energy efficiency, rapid renewables development
- Scenario 4: Modest energy efficiency, slower renewables development, rapid carbon sequestration development
- Scenario 5: Aggressive energy efficiency, rapid renewables development

The scenarios illustrate the ways in which both the energy supply and the energy demand policies and goals interact with each other. For each scenario we list the key assumptions made and present two figures. The first figure in each scenario shows the change in sources of electric generation over time. The second shows the projected total emissions associated with that change in generation. Note that emissions from hydro are not accounted for and biomass emissions are assumed to be carbon neutral, with fuel coming from sustainably managed land. The emissions from hydro, especially any new hydro, should be accounted for once an emissions factor is determined.

Scenario 1: Load growth, rapid renewables development, rapid carbon sequestration development, and nuclear power generation replaced with new nuclear

Assumptions:

- ***Electric Load Growth:*** grows at a rate of 1.0% per year through 2050
- ***New Renewables***: Increase by 1% per year to 15% in 2020, then increase by 0.25% per year to 22.5% in 2050
- ***New Hydro:*** Increase regional output of hydro by 10% due to HQ expansion plans
- ***Existing Hydro:*** Output constant
- ***Existing Nuclear:*** Existing nuclear capacity replaced with the same quantity of new capacity
- ***Natural Gas:*** Makes up the difference between other sources and electric load (demand)
- ***Oil-fired Generation:*** Phase out over 20 years
- ***Traditional Coal:*** Phase out over 40 years
- ***New Coal or Natural Gas with Carbon Capture and Sequestration:*** Add 2,500 MW every five years starting in 2015

Figure 1.33: Scenario 1 – Potential Generation Sources to Achieve the Emissions Targets

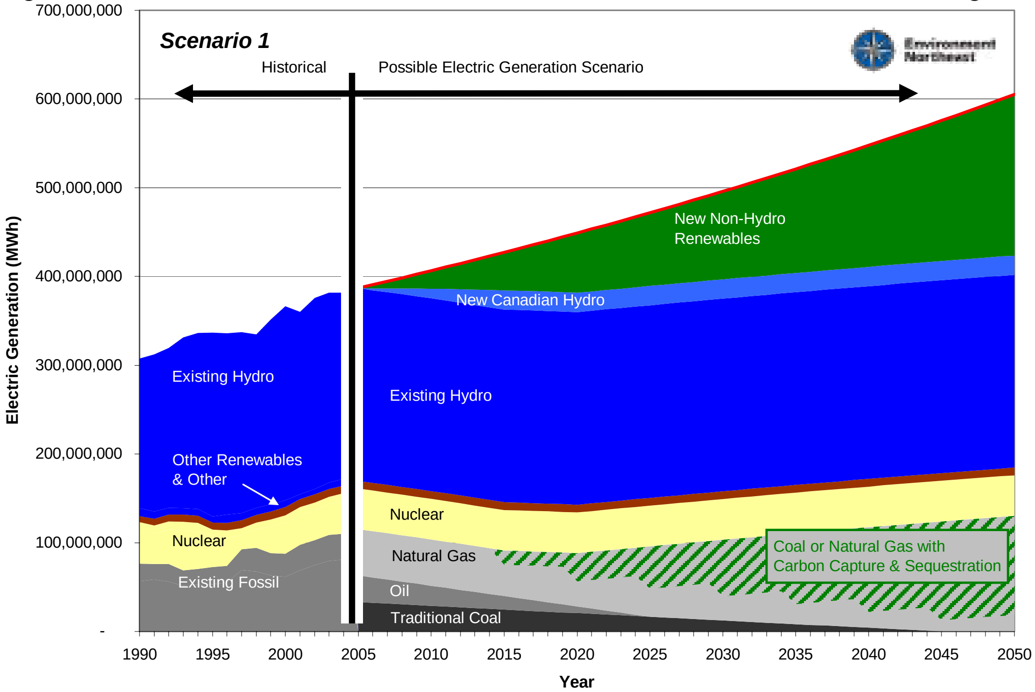
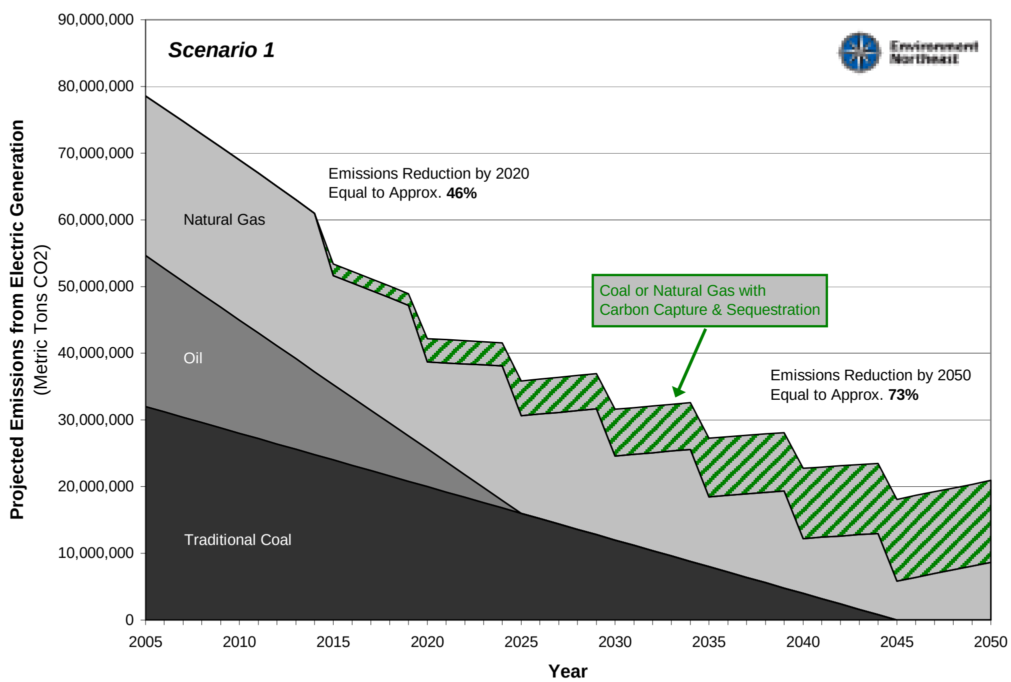


Figure 1.34: Scenario 1 – Projected Emissions from Fossil Generation



Scenario 2: Aggressive energy efficiency, slower renewables development

Assumptions:

- ***Electric Load Growth:*** Stabilize between 2010 and 2020, decline by 20% between 2020 and 2050
- ***New Renewables***: Increase by 0.5% per year and then hold constant at 10% from 2025 on
- ***New Hydro:*** Increase regional output of hydro by 5% due to HQ expansion plans
- ***Existing Hydro:*** Output constant
- ***Existing Nuclear:*** Phase out over 20 years
- ***Natural Gas:*** Makes up the difference between other sources and electric load (demand)
- ***Oil-fired Generation:*** Phase out over 20 years
- ***Traditional Coal:*** Phase out over 40 years
- ***New Coal or Natural Gas with Carbon Capture and Sequestration:*** Add 500 MW every five years starting in 2015

Figure 1.35: Scenario 2 – Potential Generation Sources to Achieve the Emissions Targets

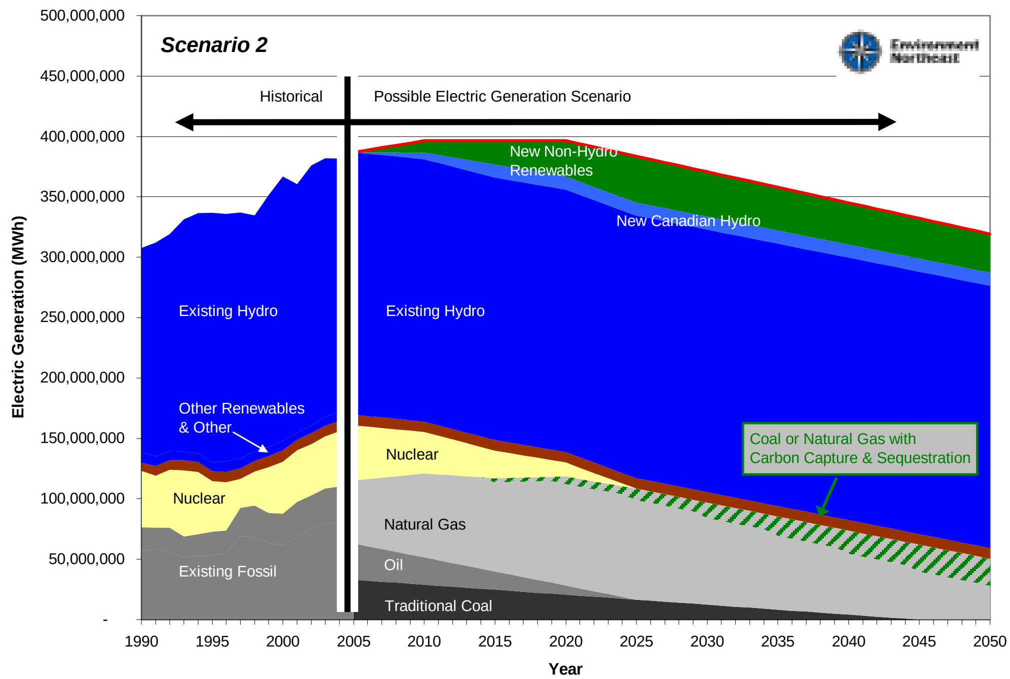
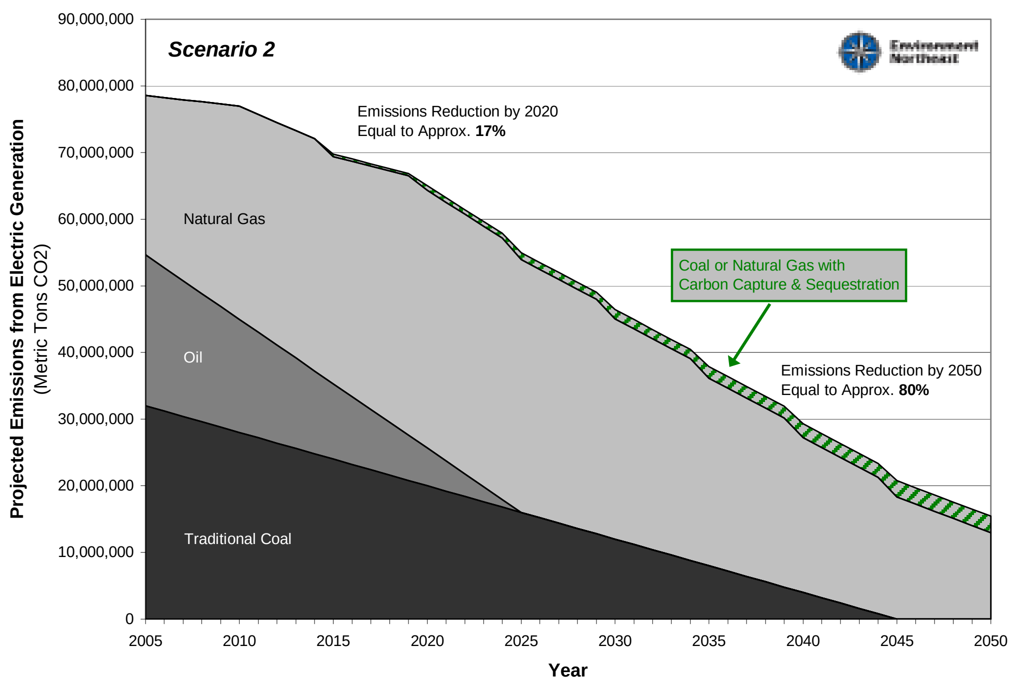


Figure 1.36: Scenario 2 – Projected Emissions from Fossil Generation



Scenario 3: Modest energy efficiency, rapid renewables development

Assumptions:

- ***Electric Load Growth:*** Stabilize between 2010 and 2050
- ***New Renewables***: Increase by 1% per year to 15% in 2020, then increase by 0.25% per year to 22.5% in 2050
- ***New Hydro:*** Increase regional output of hydro by 10% due to HQ expansion plans
- ***Existing Hydro:*** Output constant
- ***Existing Nuclear:*** Phase out over 20 years
- ***Natural Gas:*** Makes up the difference between other sources and electric load (demand)
- ***Oil-fired Generation:*** Phase out over 20 years
- ***Traditional Coal:*** Phase out over 40 years
- ***New Coal or Natural Gas with Carbon Capture and Sequestration:*** Add 500 MW every five years starting in 2015

Figure 1.37: Scenario 3 – Potential Generation Sources to Achieve the Emissions Targets

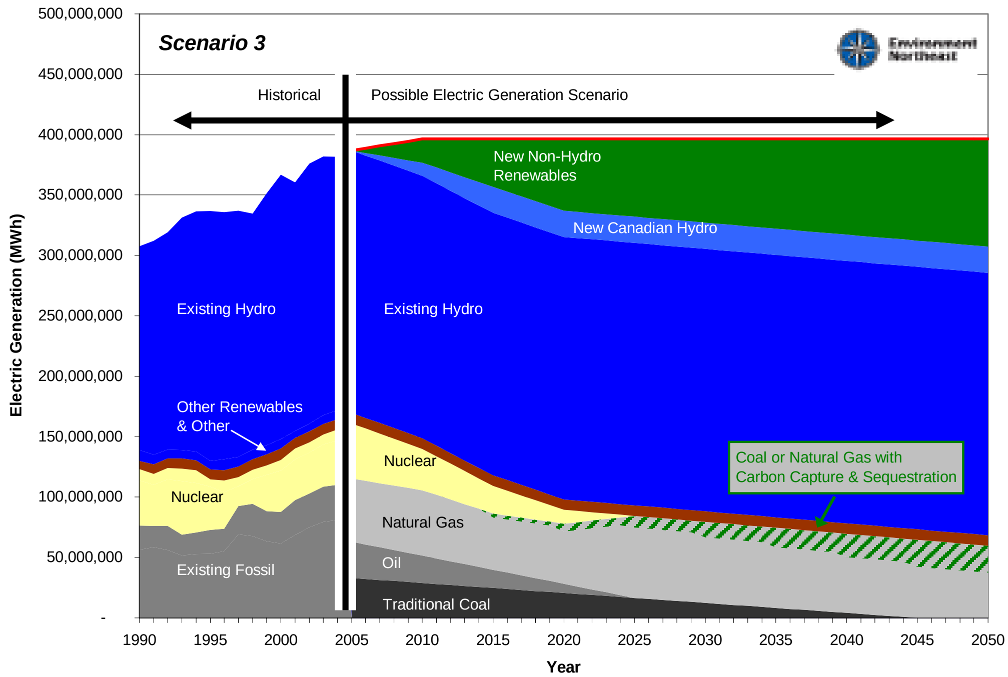
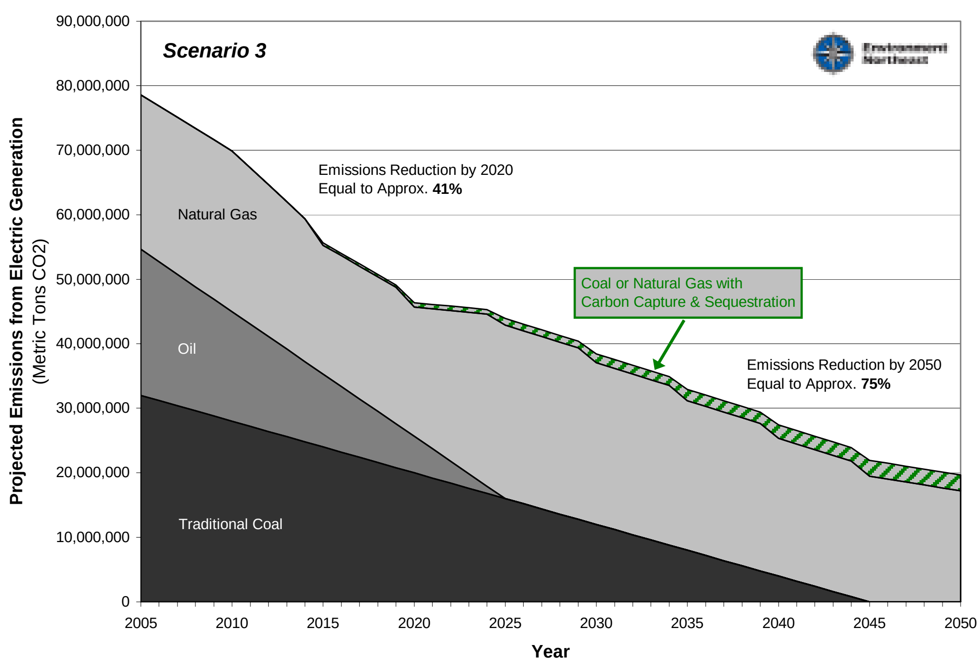


Figure 1.38: Scenario 3 – Projected Emissions from Fossil Generation



Scenario 4: Modest energy efficiency, slower renewables development, rapid carbon sequestration development

Assumptions:

- ***Electric Load Growth:*** Stabilize between 2010 and 2050
- ***New Renewables***: Increase by 0.5% per year and then hold constant at 10% from 2025 on
- ***New Hydro:*** Increase load (demand)
- ***Oil-fired Generation:*** Phase out over 20 years
- ***Traditional Coal:*** Phase out over 40 years
- ***New Coal or Natural Gas with Carbon Capture and Sequestration:*** Add 2,300 MW every five years starting in 2015 regional output of hydro by 5% due to HQ expansion plans
- ***Existing Hydro:*** Output constant
- ***Existing Nuclear:*** Phase out over 20 years
- ***Natural Gas:*** Makes up the difference between other sources and electric

Figure 1.39: Scenario 4 – Potential Generation Sources to Achieve the Emissions Targets

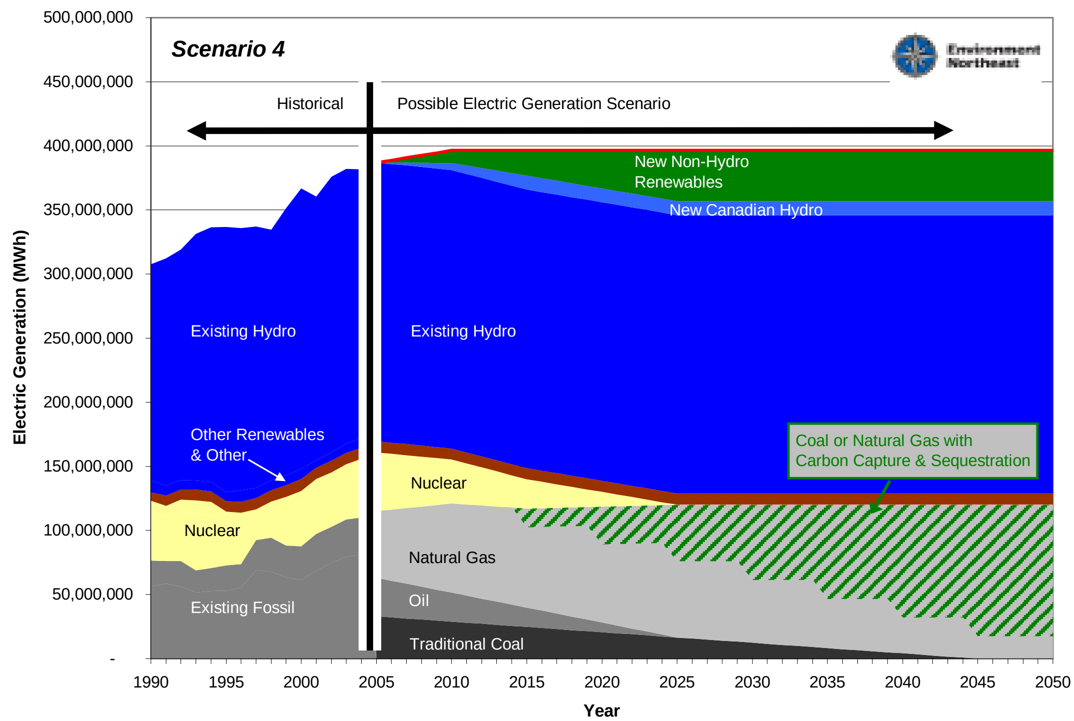
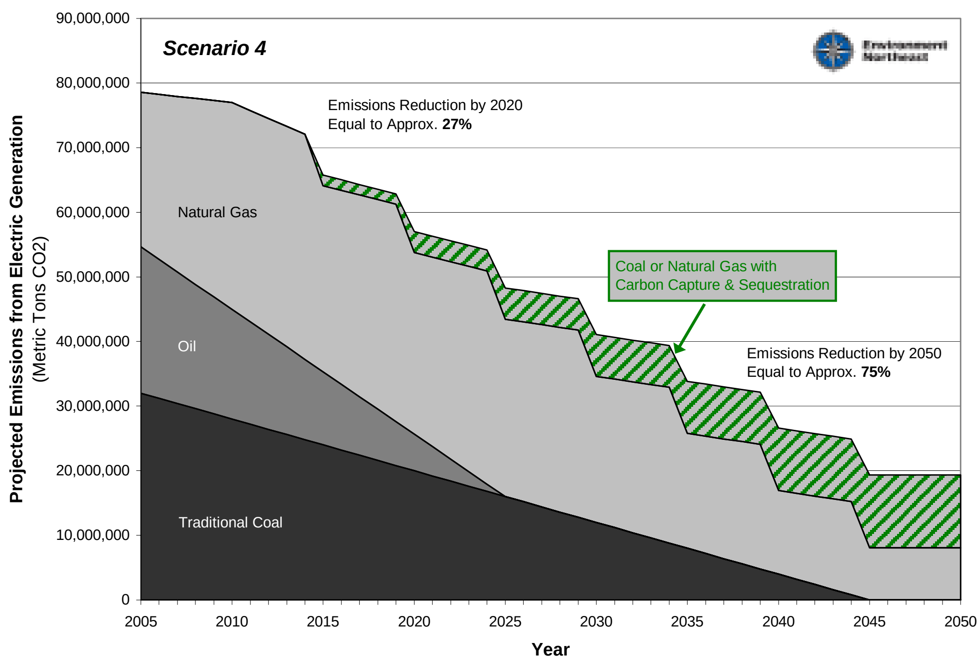


Figure 1.40: Scenario 4 – Projected Emissions from Fossil Generation



Scenario 5: Aggressive energy efficiency, rapid renewables development

Assumptions:

- ***Electric Load Growth:*** Stabilize between 2010 and 2020, decline from 0% to 20% between 2020 and 2050
- ***New Renewables***: Increase by 1% per year and then hold constant at 15% from 2020 on
- ***New Hydro:*** Increase regional output of hydro by 10% due to HQ expansion plans
- ***Existing Hydro:*** Output constant
- ***Existing Nuclear:*** Phase out over 20 years
- ***Natural Gas:*** Makes up the difference between other sources and electric load (demand)
- ***Oil-fired Generation:*** Phase out over 20 years
- ***Traditional Coal:*** Phase out over 40 years
- ***New Coal or Natural Gas with Carbon Capture and Sequestration:*** Add 500 MW every five years starting in 2015

Figure 1.41: Scenario 5 – Potential Generation Sources to Achieve the Emissions Targets

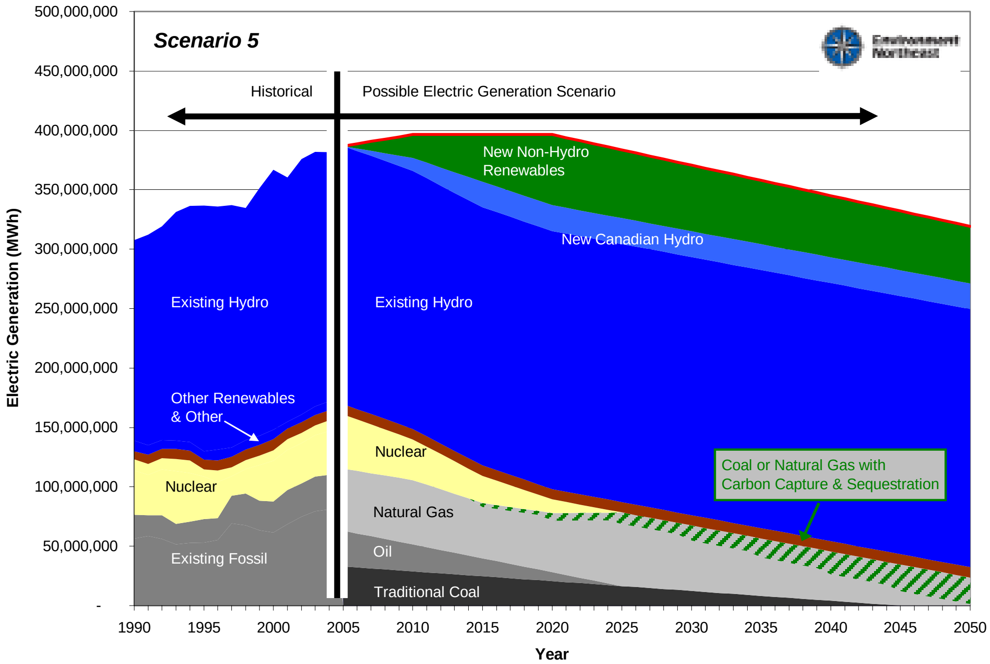
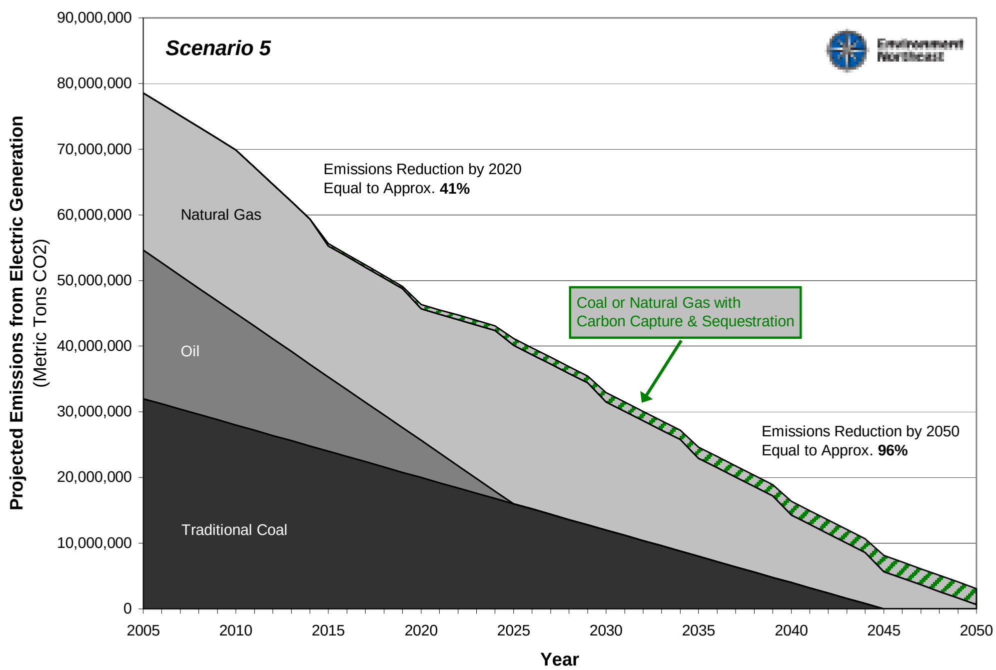


Figure 1.42: Scenario 5 – Projected Emissions from Fossil Generation



The key finding from these scenarios is that energy efficiency and reduced load growth are absolutely critical to achieving the emissions targets. With aggressive efficiency 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 should still be achieved.

In Scenario 5, where load continues to grow on account of only modest investments in energy efficiency, achieving deep reductions requires massive investments in new non-emitting electric generation technologies of all kinds, likely including renewables, fossil with carbon capture and sequestration, and possibly nuclear.

The significant development of carbon sequestration for coal and natural gas requires large technology and infrastructure investments and storage locations, which may or may not be available. If nuclear energy were to overcome its safety, storage, and proliferation problems, it might be able to substitute for some of the generation shown as Coal or Natural Gas with Carbon Capture and Sequestration.

All of the scenarios imply increasing imports of hydro-power from Northern Canada to the other provinces and New England states. This would require a high level of coordination, planning, and some infrastructure development.

The deep reductions in emissions that will be driven by the cap-and-trade program will require the support from many of the other policies in this report. The energy efficiency, renewables, CHP and other policies will all support the cap-and-trade program and help keep program costs down.

1.7 Summary of Recommendations – GHG Benefits

As mentioned above, many of the energy supply policies outlined in this chapter support and would partially fall within the cap-and-trade program proposed. As discussed in the introduction of the report, it is impossible to predict the long-term emissions benefits of a particular policy in relation to business as usual. Business as usual is entirely defined by one's assumptions about the future.

The overall target for the sector should be achieved by mid-century if the cap-and-trade program covers all large stationary sources of emissions and achieves a 75-85% reduction by mid-century. Smaller emitters will need to be governed by energy efficiency programs, building and appliance requirements, and fuel standards in order to achieve the long term targets. The energy efficiency policies proposed in this chapter are grouped by fuel type to present an estimate of the emissions benefits they will deliver. Many of these demand-side efficiency programs complement and interact with each other and it is not possible to break out the benefits of one policy from another.

Table 1.32: GHG Emissions Reduction Estimates for Energy Supply Policies by 2020

GHG Cap-and-trade Programs	45 to 50 Million Metric Tons CO_2e
Other Electric Sector Policies	
(Note: all involve some double counting with the cap-and-trade program, but would achieve these emissions savings in absence of a cap-and-trade program; load and consumption targets are assumed to be achieved by the suite of efficiency policies proposed)	
Renewable Targets & RPS	20 Million Metric Tons CO_2e
CHP Portfolio Standard	10 to 15 Million Metric Tons CO_2e
Elec. Zero Load Growth	22.5 Million Metric Tons CO_2e
Natural Gas Savings of 1% per Year	5 Million Metric Tons CO_2e
Fuel Oil Savings of 1% per Year	6 Million Metric Tons CO_2e