ELECTRIC ENERGY EFFICIENCY AND RENEWABLE ENERGY IN NEW ENGLAND:

An Assessment of Existing Policies and Prospects for the Future

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I. EXECUTIVE SUMMARY

Energy efficiency and renewable energy have many positive effects on the general economy, the environment and energy security in New England. This report explains how, while also quantifying these effects in several new ways. With consistent electric demand growth and persistent concerns about electricity reliability, energy security, air quality, climate change and economic development, there is mounting interest in cost-effective ways to increase deployment of efficiency and renewables. Notably, the New England Governors expressed their interest in this issue in a resolution with the Eastern Canadian Premiers in 2003. Inspired by their interest, the Regulatory Assistance Project produced this report, with modeling and policy assistance from Synapse Energy Economics Inc., and with financial support from the U.S. Environmental Protection Agency.

This report contributes to a growing body of work applying analytical tools to show the value of consumer funded energy efficiency programs and renewable portfolio standards with new rigor. Remaining barriers in the market and in regulation prevent these resources from delivering to consumers their full value, and addressing these barriers is the focus of many recommendations in Section VI of this report.

The centerpiece of this work is economic and environmental modeling performed by Synapse. The economic model, IMPLAN, is widely used for general economic forecasting. IMPLAN tracks specific economic effects from investments in energy efficiency and renewable energy, and reports results in terms of net economic output, jobs, and labor income.

The report also assesses the air quality effects of efficiency and renewable investments with a model Synapse developed for the Ozone Transport Commission. The report also draws valuable conclusions on the influences of energy efficiency and renewable energy on regional energy security.

The modeling done for this report reveals that during 2000-2010, current electric energy efficiency and renewable energy policies may provide close to $6 billion in economic benefits, while creating thousands of jobs and removing millions of tons of pollutants from the region's air. Overall, energy efficiency and renewable energy activity in New England is above the national norm, yet the report finds significant untapped potential for additional beneficial investments.

Findings

Energy efficiency spending in New England supported by ratepayer funds declined through the 1990s as electric restructuring added uncertainty to cost recovery of utility investments. Attention to "system benefits" in the electric restructuring debates focused renewed support for efficiency, and spending has risen in recent years, though spending in constant dollars in 2002 was still less than in 1993. Spending and savings data for 2002 programs are reported in Table ES-1. Figure ES-1 restates information in Table 2, (see page 20) and shows the trend of efficiency spending from 1993-2000.

Table ES-1 reveals that a key strategic value for energy efficiency is its low cost: 2.4 cents per kWh on average across New England, as verified by the prevailing monitoring and verification processes in each state. As natural gas prices increase, pushing New England electric supply alternatives above 4 cents per kWh and higher, the advantages of efficiency as a power system resource are more evident.

Table ES-1

New England Region 2002 Efficiency Program Investments and Savings		
Public Benefit Funds Invested	Lifetime MWh Savings (Estimated)	Cost/kWh
$241,246,000	10,036,148	2.4 cents
Source: State level program reports and interviews with program administrators. See also Appendix D.		

Figure ES-1

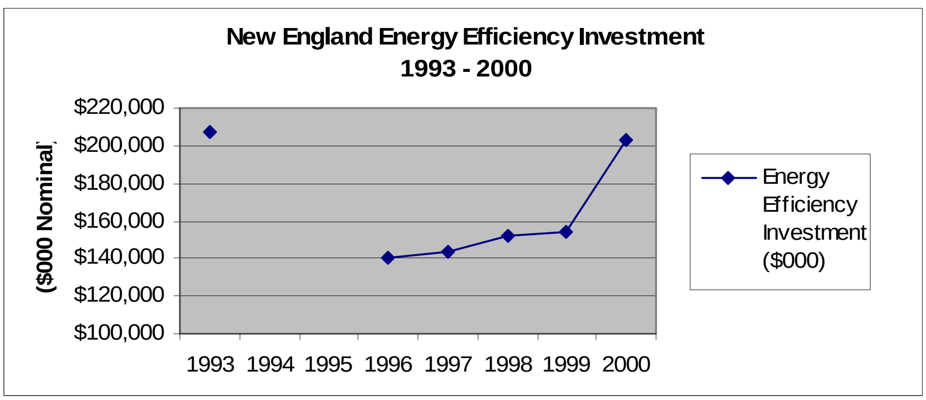
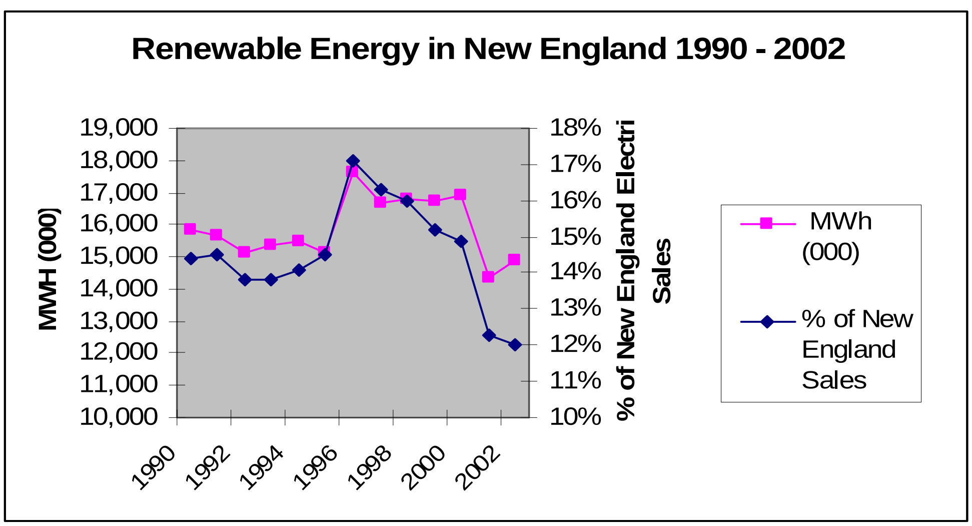


Figure ES-2



Renewable energy production in New England peaked in the 1990s, driven primarily by independent power producers qualifying for long term avoided cost contracts. Aggregate production from these facilities has declined recently as some projects were paid to stop producing due to the high cost of power in these contracts. Figure ES-2 restates information found in Table 1, (see page 20).

The IMPLAN model analysis traces the flow of goods and services, income, and employment among related sectors of the economy. The model computes the eventual sum of all of these purchases cycling through the economy, identifying direct effects, indirect effects, and induced effects. See Appendix C, page 32, for more detail.

Our analysis shows that the combined effects of energy efficiency and renewable energy deployed from 2000 through 2010 and modeled for this project are estimated to produce a positive $6.1 billion for the New England economy. This economic stimulus is accompanied by over 28,000 job-years, and over a $1 billion in wages for those jobs.

Table ES-2

Energy Efficiency Program Impact: Output (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000-2004	429,547	103,243	237,202	769,993
2005-2010	577,262	173,177	480,349	1,230,788
Total	1,006,809	276,420	717,551	2,000,781

Source: IMPLAN runs, Appendix C Table 3.26. Columns and rows may not sum to totals due to round off.

Energy Efficiency Program Impact: Employment (Job-years)

Year	Direct	Indirect	Induced	Total
2000-2004	1,724	1,037	2,337	5,099
2005-2010	3.231	1,707	4,959	9,894
Total	4,955	2,744	7,296	15,533

Source: IMPLAN runs, Appendix C Table 3.27. Columns and rows may not sum to totals due to round off.

Energy Efficiency Program Impact: Labor Income (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000-2004	105,361	40,633	91,653	237,646
2005-2010	188,225	70,163	197,761	456,151
Total	293,586	110,796	289,414	693,797

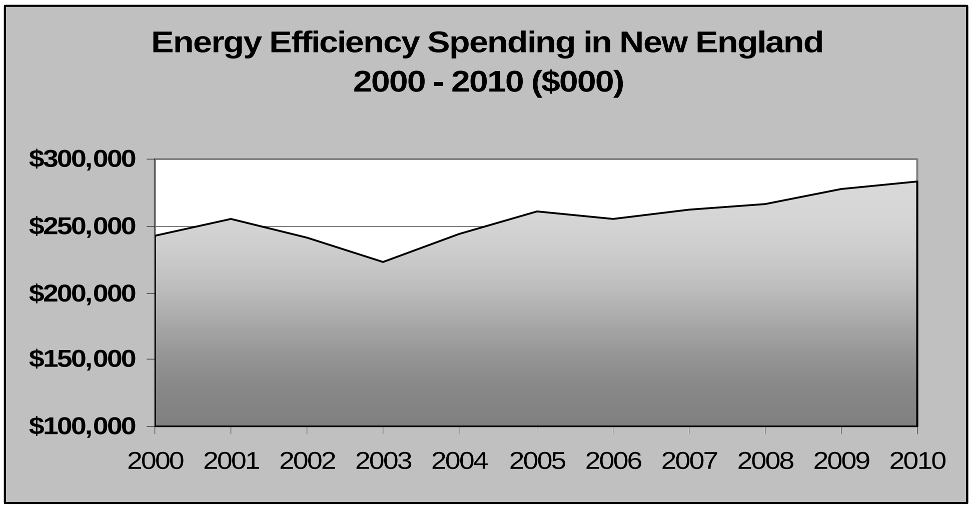
Source: IMPLAN runs, Appendix C Table 3.28. Columns and rows may not sum to totals due to round off.

Energy efficiency measures deployed since 2000 and expected to continue through 2010 will have a significantly positive effect on the economy. The $2.8 billion spent in these programs from 2000 through 2010 is expected to produce a *net* regional economic gain of

$2.0 billion (in constant 2001$). Employment owing to energy efficiency investments is projected to increase by about 1,950 jobs on average at any given time from 2005 - 2010. These results are displayed in Table ES-2. Economic effects are divided among three categories: direct, indirect and induced. This is discussed further in Appendix C.

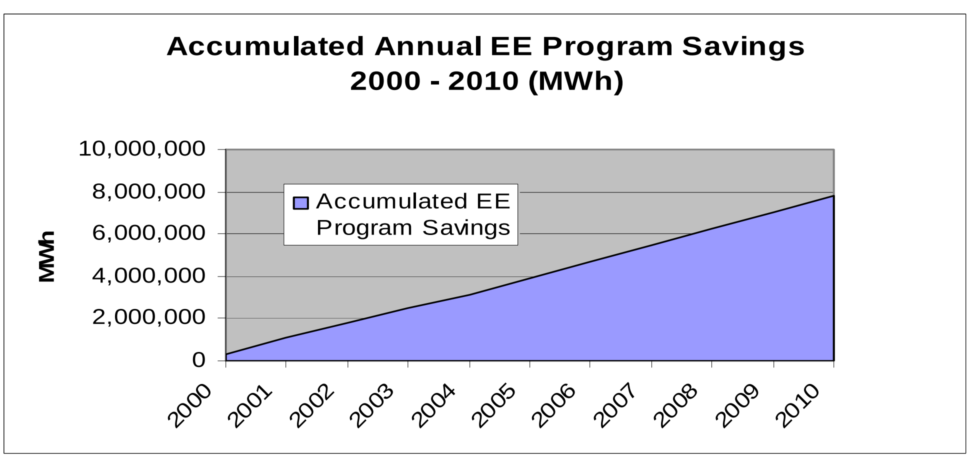
Figure ES-3 shows that annual spending for energy efficiency programs in New England is expected to grow slowly, and in proportion to electric sales growth, if present funding rules remain unchanged. The steady increase through 2010 reflects that efficiency budgets in most states are proportional to utility revenues, which are expected to rise.

Figure ES-3



In 2002, over $240 million was collected in utility rates for electric energy efficiency, and this produced savings at an average cost of 2.4 cents per kWh, much less than the system avoided cost or the cost of alternatives. Savings from efficiency programs accumulate over the lives of the measures, generally 10-15 years. Figure ES-4 shows accumulated savings from programs beginning with 2000 and continuing through 2010.

Figure ES-4

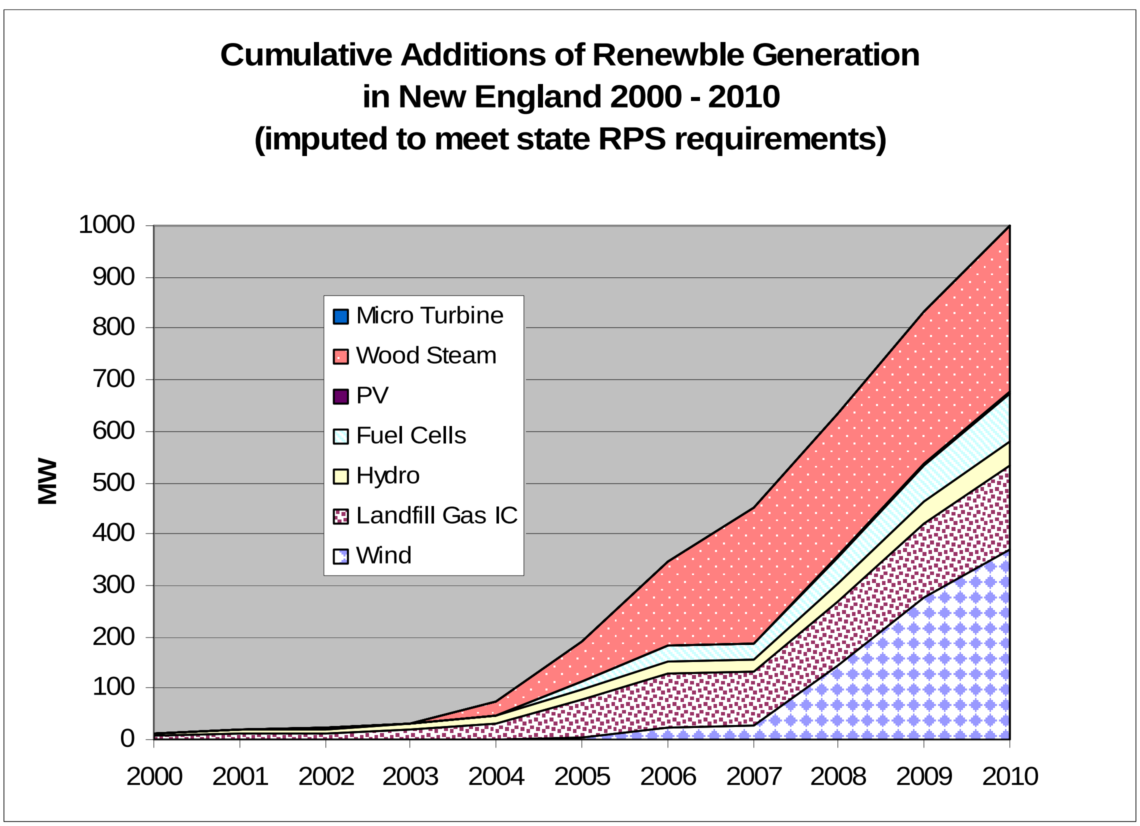


Another moment with Figure ES-4 may be helpful. In each year, efficiency programs produce savings. These savings are added to savings accumulated in previous years. The height of the curve in Figure ES-4 in a year is the accumulated annual amount of energy saved through efficiency programs starting from 2000, and the area under the curve, 44,144,983 MWh, is the total energy saved by 2000-2010 programs during the period.

Renewable energy deployed in New England since 2000 has been modest, almost 73 MW in a system with a peak demand around 25,000 MW, yet economic modeling results are positive. There is a net economic benefit from these investments over the 2000-2010 period of $470 million (Appendix C, Table 3-20). Most of this capacity is landfill gas projects, biomass and hydroelectric re-powering. Wind power remains a significant but almost entirely undeveloped power source in New England.

If New England meets the renewable portfolio standards requirements of its states with generation sited in the region, these economic effects will be quite a bit larger. Based on a plausible scenario, called Phase II in this report and explained in detail on page 28, almost 1,000 MW of renewable generation would be installed in New England from 2000 through 2010. These data are summarized here in Tables ES-3. In this scenario there is a benefit to the regional economy from these investments of nearly $4.1 billion. Employment over the period would increase by 13,197 jobs-years, or an average of around 1,200 jobs over the period. Figure ES-5 shows the renewable generation deployed in New England in the model and reflects data included in Table 7 (see page 29).

Figure ES-5



The report's environmental findings are generated utilizing emission rates developed by Synapse for use by the Ozone Transport Commission. Deployment of energy efficiency and renewable energy potentially avoids emissions of NO_x, SO_2 and CO_2. Because current air quality regulation employs emissions caps on NO_x and SO_2, one of two things happens due to energy efficiency and renewable policies, both favorable. The first possibility is that these investments lead to a reduction in emissions through retirement of emission allowances and fewer emissions or lowering of emissions caps; or emissions levels set under existing emissions caps are achieved in a more cost-effective way.

Table ES-3

Renewable Generator Total Impact: Output (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000 – 2004	166,875	31,833	148,437	347,146
2005-2010	2,133,717	-184,487	1,759,955	3,709,182
Total	2,300,592	-152,654	1,908,392	4,056,328

Source: IMPLAN runs, Appendix C Table 3.23. Columns and rows may not sum to totals due to round off.

Renewable Generator Total Impact: Employment (Job-years)

Year	Direct	Indirect	Induced	Total
2000 – 2004	686.8	242.6	1,503.0	2,432.1
2005-2010	-2,775.9	-2,595.1	16,135.8	10,764.4
Total	-2,089.1	-2,352.5	17,638.8	13,196.5

Source: IMPLAN runs, Appendix C Table 3.24. Columns and rows may not sum to totals due to round off.

Renewable Generator Total Impact: Labor Income (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000 – 2004	30,510	12,196	62,072	104,781
2005-2010	-374,563	-102,595	720,593	243,439
Total	-344,053	-90,399	782,665	348,220

Source: IMPLAN runs, Appendix C, Table 3.25. Columns and rows may not sum to totals due to round off.

There is clear progress in reducing CO_2 emissions from the deployment of energy efficiency and renewable energy. Our projections indicate that due to current energy efficiency programs, 22.5 million tons of CO_2 emissions are avoided from 2000-2010. This is equivalent to roughly 47 million barrels of oil. The nearly 73 MW of renewable generators installed from 2000-2004, will avoid almost 500,000 tons of CO_2 between 2000 and 2010. In the build-out scenario, 9.1 million tons of CO_2 between 2000 and 2010 are avoided. **By 2010, then, New England's existing policies on energy efficiency and renewable energy will have saved 31.6 million tons of CO_2 emissions between 2000 and 2010.** Please see Table ES-4 for a summary of the net emissions reductions for NOx, SO2 and CO2 for the energy efficiency and renewable energy policies modeled in this report. The environmental effects section of this report begins on page 37.

Is this a little or a lot? For purposes of comparison, information being used in the Regional Greenhouse Gas Initiative (RGGI) shows that in 2000, generators in New England greater than 25 MW emitted 45.4 million tons of CO_2. This means that energy efficiency and renewable energy policies modeled in this report reduce CO_2 emissions by roughly 6% during the 2000-2010 timeframe for New England. Note also that in the RGGI discussion, a scenario characterized by a 25% reduction on CO_2 emissions from business as usual results in roughly constant emissions over the 25 year period from 2000 to 2024.

Table ES-4

Potential Emissions Reductions due to Existing, Planned and Imputed Renewable Generation to meet Renewable Portfolio Standards, and current Energy Efficiency Programs maintained, 2000-2010 (tons)

	NO_x	SO_2	CO_2
Renewable Energy	5603	8532	9,163,126
Energy Efficiency	16,436	25,699	22,519,591
Total	22,039	34,231	31,682,717

Energy security is always a vital concern, though it sometimes takes a scare to maintain full policy attention. As a result of the "cold snap" of January 2004, which exposed vulnerabilities in the interactions between gas and electric markets, and heightened concerns for homeland security, energy security is a solid focus now.

This work finds that energy efficiency and renewable energy resources have significant beneficial effects for energy security. These effects include: moderating and reducing influence on the wholesale price of and demand for natural gas; moderating and reducing the wholesale price of electricity in the regional market; moderating and reducing the demand for new capital facilities in the electric market; and enabling the grid to be more resilient to the failure of any single element. A build out in New England of existing RPS requirements would meet nearly 50 percent of expected peak demand growth by 2010, contributing to a more diverse fuel mix.

Ratepayer funded energy efficiency programs in New England have some differences from state to state, but share much in common:

- They serve all customer classes;

- A diverse portfolio of programs is offered, including retrofit of existing buildings, new construction and market transformation;
- Individual utility efforts have often evolved into statewide and regional efforts, reaping benefits of economies of scale, creating a more consistent set of expectations by customers of what energy efficiency programs can do for them, and increasing market penetration of efficiency technologies;
- Programs have received national awards and recognition;
- The states build measurement and evaluation into the programs and use third party contractors to evaluate actual results;
- States that have studied existing efficiency potential have found that there is more cost-effective efficiency available than present funding can support; and
- States are spending to administratively-set efficiency budgets and are not implementing programs to maximize cost-effective efficiency savings.

Renewable Portfolio Standards are prompting the construction of new renewable generation, though it remains to be seen if the supply of new generation will actually match RPS demand.

Since the beginning of the renewable RD&D funds in 1998, over $225 million has been collected in Massachusetts, Connecticut and Rhode Island, and is being applied to technology and market development. This report has not assessed the economic, environmental and security effects of these funds. With significant growth in renewable power in New England, there is an increase in the prospects of businesses manufacturing equipment and supporting this growth locating near this new concentration. Such an effect would add a multiplier to the economic growth factor flowing from RPS and RD&D funds.

Naturally, the actions of the New England states will affect the surrounding regions on both sides of the international border, and vice versa. In Appendix B, this report pays attention to those important interactions.

Data useful for this report was more difficult to gather than expected. Knowledgeable staff were very helpful, but states maintain energy efficiency data in different categories and formats making regional aggregation a challenge. Researchers found conflicting information on carbon goals, current emissions and emissions forecasts, although current policy efforts are likely to help resolve some of the carbon data issues.

Recommendations

The report includes 23 recommendations, beginning on page 46, which are addressed to policymakers, public utility commissions and other stakeholders. **The most important recommendation is to eliminate the incentive for electric companies to sell or deliver**

more electricity. Sales growth presents challenges to reliability and the environment due to the need to fuel that growth with problematic investments.[1]

Other recommendations address opportunities:

- To improve the recognized value for efficiency and renewable energy in wholesale markets;
- To remove barriers to deployment of distributed generation and renewable resources;
- To improve the process for regulators to assure that default service customers are protected to an appropriate extent from market volatility through use of portfolio management practices;
- For improved planning for system resource additions;
- For innovative pricing structures, which will tend to promote energy efficiency;
- For voluntary commitments by leading businesses; and
- For coordination through a new regional state committee (New England State Committee on Electricity), through other stakeholder processes now underway, including the Regional Greenhouse Gas Initiative and the Northeast CHP Initiative, and in local processes, such as those assessing wind siting proposals.

Another set of recommendations addresses stabilizing and maintaining what is working, like the current commitments to energy efficiency by the New England states.

The report identifies further work that would enable the states to establish quantitative goals that enable them to measure progress on a consistent basis. The modeling capability demonstrated here can be extended to measure expected impacts of different policies to meet regional goals.

The authors hope this report will support the New England Governors and their staffs in making choices that will take more complete advantage of the value of energy efficiency and renewable energy for the general economy, the environment and energy security, and in working with the Eastern Canadian Premiers and neighboring states on developing compatible policy outcomes.

[1] In perhaps the clearest state policy statement along these lines, California has adopted a resource loading order. "The loading order calls for optimizing energy efficiency and demand response, meeting new generation needs first by renewable energy resources and DG, then by clean fossil fuel generation, and improving the bulk electricity transmission grid and distribution infrastructure." *Commission Final Report: Integrated Energy Policy Report 2004 Update*, California Energy Commission, Sacramento CA, December 2004. http://www.energy.ca.gov/2004_policy_update/ (May 2, 2005)

II. INTRODUCTION

About this Report, its Value and its Limitations

The objective of this report is a thorough assessment of the effects of several electric energy efficiency and renewable energy policies in New England. The primary intended audience is the Conference of New England Governors and Eastern Canadian Premiers (NEG/ECP), which has taken an interest in these topics, among other energy and environment issues. In its September 9, 2003 resolution, the NEG/ECP called for a deeper investigation of, and recommendations for, ways that energy efficiency and renewable energy can address concerns with energy security, economic development and conservation.[2] In light of the interest of the NEG/ECP and a number of other stakeholders, The Regulatory Assistance Project developed this report to assess the effects of electric energy efficiency and renewable energy policies in New England. Synapse Energy Economics, Inc. provided expertise in energy modeling and interpretation.

The report begins with a historical look at the New England energy market, to explain the origins of current circumstances. The report then summarizes two major policy approaches used by the New England states to increase electric energy efficiency and renewable energy: public benefit funds and renewable portfolio standards (RPS). The project team used actual and projected program expenditures and results to assess the effects of these programs on the New England economy, its environment, and energy security. Projections for energy efficiency are based on continuing existing programs at their planned levels. Projections for renewable energy represent one of an infinite set of possible scenario to meet the growing demand driven by existing provisions of RPS in Massachusetts, Connecticut and Rhode Island.

The data on program costs and achievements used to develop inputs to a macro-economic model, IMPLAN, and to estimate program impacts on several economic outcomes. The data were also applied to sources of potential air emission reductions in New England by year to determine the environmental effects of the EE and RE programs.[3] The results of both of these efforts are presented in Chapter 5, and further detailed in Appendix C. Finally, the data were analyzed for the programmatic effects on energy security in New England.

In preparing this report the project team endeavored to complete all regional data collection and modeling work and to develop as many of the regional perspectives as possible for the governors' use. While state level inputs on energy efficiency and

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[2]Please see Appendix A for the resolution of September 9, 2003, which details the interests of the Governors and Premiers.

[3] The economic impact analysis is performed with constant factor productivity, including labor productivity. The analysis of potential air emission reductions does not assess the effect on those reductions on the current emission caps or vice versa. These two points are discussed further in Appendix C.

renewable policies and performance were critical in this endeavor, these more granular insights are not reported here.

This project examines the likely economic and environmental outcomes if present policies remain unchanged, or change only as planned, through 2010. It does not cover a set of simulations of the future effects of changed policies and levels of commitment to energy efficiency and renewable energy. This report does provide a framework on which such work can proceed. This report also does not model the effects of other important energy policies, such as appliance and building standards and codes[4], federal weatherization programs, non-electric efficiency programs, generation efficiency requirements, state and federal tax incentives for renewable energy, or new renewable energy funds.

Finally, we are aware that the Eastern Canadian Premiers are equally interested in these questions for their provinces. Yet, the geographic scope of this work is limited to the New England states. Acknowledging the integration of the energy economies across the broader North Atlantic region, Appendix B summarizes the electrical connections between New England and surrounding regions.

This report is useful on three distinct levels.

- It provides up-to-date New England regional data on two important policies: electric efficiency public benefit funds and RPS, based on state-specific information.
- It provides recommendations for actions that can improve the value that energy efficiency and renewable energy provide to the citizens of New England.
- It provides analytical insight and detail supported by an economic impact model and an air emissions model which have not been trained on these specific questions before. This analytical approach illuminates questions that are often argued with great heat but too little information.

Context

Any thorough assessment of the energy situation of New England must navigate some distinctive shoals. This region lacks the large hydroelectric resources and indigenous fossil resources of the West. The utilities of the six states have supported economic growth over the last decades through creative energy links with surrounding regions, including the High Voltage DC line to Quebec and the Iroquois Natural Gas and Maritimes Northeast Pipeline, as well as by tapping local renewable generating fuels and energy efficiency opportunities. Pressures from higher energy costs or environmental

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[4] A coordinated legislative effort is underway to adopt a common set of appliance and efficiency standards in the six New England states. See Ned Raynolds and Andrew deLaski, *Energy Efficiency Standards: A Low-Cost, High Leverage Policy for Northeastern States*, Northeast Energy Efficiency Partnerships, Summer 2002 for a description of the significant emissions reductions, energy and capacity savings, and economic benefits these standards are expected to produce.

requirements to take more complete advantage of efficiency and renewable resources are likely to require more attention from policymakers for this potential to be realized.

The last ten years have seen big changes to the New England electric marketplace.

- Five states allow some measure of **retail electric competition**.[5] Many default service issues, affecting customers who "choose not to choose," remain to be resolved.
- Strategies to maintain **resource adequacy**, that is, sufficient capacity to meet established standards for electric reliability, have shifted from reliance on vertically integrated utilities to reliance on a combination of market rules and regulation. This shift influences the full spectrum of market participants. Where before utilities internalized and balanced the risks and opportunities of a portfolio of alternatives, there is now no similar entity bearing that responsibility in any of the competitive states.
- The New England Power Pool, NEPOOL, has evolved, and a **new regional transmission organization, ISO-**New England, is now in place.
- **Generation has become a fiercely competitive business**, with increasingly clean and efficient new power plants, yet also marked by the bankruptcy of some participants and a bursty pace of construction.
- The imperative of **reliability** and the potential for generators to exert sufficient **market power** to affect prices are strong influences in the electricity market. Lessons from the 2003 blackout and new homeland security concerns are still being understood and woven into the design and operations of the electric system.
- **Air quality** remains a challenge for all states, with most facing non-attainment status for several pollutants regulated under the Clean Air Act. While new, cleaner generating sources using natural gas are supplying New England, load growth maintains the need for older, more polluting sources. Meeting Clean Air Act attainment standards gets tougher each year, yet some market participants and consumer advocates express concern about getting too dependent on natural gas as "the fuel of choice." This raises the question of how to fuel future growth.
- **Climate change** has become a significant issue in the region. Two states, Massachusetts and New Hampshire, have instituted mandatory emission limits for multiple pollutants, including CO2, for specific fossil-fuel burning power plants. Meanwhile, a nine-state effort is underway to conceive and develop a carbon cap-and-trade system in the Northeast U.S.
- **Public Benefits**, electric policy goals which may not be served by pure market forces, were identified. Energy efficiency and renewable energy are two

[5] They are: Connecticut, Maine, Massachusetts, New Hampshire and Rhode Island.

prominent public benefit policy areas whose funding, administration and implementation have been reorganized.

In the midst of these changes, load growth continues,[6] natural gas prices are higher[7], and new ozone and carbon controls loom larger. Settlement patterns are turning more rural areas into suburbs, and low density suburbs into higher density areas. These trends portend greater difficulties in siting new energy facilities, even as more are called for. This paper does not address electric system benefits from energy efficiency and renewable energy, which are addressed by several of the footnoted references here.

Modeling Provides Benefits to Policymakers

There are different views on the policy justifications for energy efficiency and renewable energy. It is clear that EE and RE can help meet power needs and potentially reduce emissions while shifting expenditures from fossil fuel purchases to local expenditures. The Conference of New England Governors and the Eastern Canadian Premiers expect that EE and RE will be key strategies used to reach the emission reduction goals described in their Climate Change Action Plan of 2001.[8] However, there remains disagreement about the amount of environmental, economic and security benefits that EE and RE policies can deliver.

More analytical rigor to illuminate this discussion will help. One source of rigor is energy, economic, and environmental modeling. Such models address system planning questions posed by government, the industry, and public interest organizations. Their ability to accurately describe the electric system and forecast its behavior in the future is supported by increasingly powerful computers, as well as generations of experience. In this paper, we will describe the use of one model, IMPLAN, to quantify and forecast a variety of results of two specific EE and RE policies: electric efficiency public benefit funds and RPS.

The benefits of analytical and modeling results are that intuitions and judgments can be tested and compared in a transparent and consistent way. Everyone can see the inputs, the model can be understood, at least by experts of differing philosophy, and the results can inform policy discussions, keeping them in the realm of the probable and possible.

Potential of Energy Efficiency and Renewable Energy

When policymakers set goals to reduce the use of fossil fuels to generate electricity through increased energy efficiency or renewable energy, they need information about the real potential of those resources. That is, what amounts of efficiency and renewable

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[6] *Capacity Energy Load and Transmission Report 2004*, ISO-New England, Holyoke MA. April 2004. Adjusted load rises by 2000 MW from 2004 to 2010.

[7] www.oilenergy.com (March 10, 2001)

[8] *Climate Change Action Plan 2001*, Committee on Environment and Northeast International Committee on Energy of the Conference of New England Governors and Eastern Canadian Premiers, Halifax NS and Boston, MA, August 2001. http://negc.org/documents/NEG-ECP%20CCAP.PDF (May 2, 2005)

energy are technically and cost-effectively available? For an extreme example, it is absurd to expect to meet 100 percent of New England's needs through energy efficiency. But is 20 percent reasonable? Or can demand growth be met with efficiency? Answering these questions requires a "potential" study. This report is not a potential study. However, we offer several observations about the potential of energy efficiency and renewable energy resources in New England.

There have been many efforts to calculate the potential for energy efficiency investments in the region. Most of these have been done for a specific state or utility. Northeast Energy Efficiency Partnerships (NEEP) recently published an efficiency potential study for New England, an ambitious task.[9] NEEP determined the potential for maximum market penetration of energy efficient measures that are cost-effective according to the Total Resource Cost test,[10] and that would be adopted through a concerted, sustained campaign involving highly aggressive programs and market interventions if funding were available. The NEEP study found that from 2004 through 2010, energy efficiency programs are expected to reduce retail electric sales by about 2.8 percent in 2010. Total achievable energy savings potential, however, would reduce sales in 2010 by almost 17 percent.[11] These potential studies do provide a horizon expressing what is possible, so policymakers and implementers can take actions that are more likely to achieve the results they are looking for. The NEEP efficiency potential study will be very useful to the Conference of New England Governors and Eastern Canadian Premiers. The task of modeling the economic and environmental effects of this additional energy efficiency resource is beyond the scope of this report and could be the focus of further work.

The Connecticut Energy Conservation Management Board commissioned a potential study, which it received in 2004. The study found that electric load growth in Connecticut can be eliminated through 2013 with application of a full suite of energy efficiency programs. This resource would cost less than 3¢ per kWh on average.[12]

Analysts generally assess two different types of energy efficiency potential. One level determines all the energy efficiency that is technically feasible and cost-effective when all the benefits to society are considered, regardless of funding constraints. Assessing the efficiency that is technically achievable is useful in the abstract, for planning, and for re-considering program funding, since costs for many technologies will decline as they are commercialized, and energy costs may increase. But program choices in the moment must factor in benefit/cost ratios and funding limitations. So, a second level of analysis often identifies the potential of cost-effective efficiency measures, given funding realities.

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[9] *Economically Achievable Energy Efficiency in New England*, Northeast Energy Efficiency Partnerships, Lexington, MA. November 2004.

[10] Some states use the Total Resource Cost test, while others use different screening tests. A Societal test adds non-electric and non-quantitative factors, such as environmental costs to the evaluation, and can be tailored to the priorities of a given state.

[11] Ibid, Pg. 7.

[12] *Independent Assessment of Conservation and Energy Efficiency Potential for Connecticut and the Southwest Connecticut Region*, Connecticut Energy Conservation Management Board, Hartford CT. June 2004.

To date, studies of achievable or cost-effective energy efficiency potential in the New England region show that considerable resources remain to be tapped by appropriate policies.[13] In the presence of existing caps on energy efficiency spending, either in statute or by regulatory order, the value of these potential studies may be limited to long term planning, however, since consumers in a given state will not be able to see program levels that exceed the cap, even if there is a resource planning justification.

The potential of renewable energy can also be analyzed from two perspectives: what is technically and economically feasible versus limits on what is presently practical due to barriers other than funding. Determining the potential of resources such as solar, wind and methane from landfills, wastewater treatment facilities and farms is a developing science influenced by improving technology.[14] However, regardless of technical potential, the practical potential for RE deployment is influenced by several factors, including siting, financing, and technology development. For example:

- In some parts of the U.S., one barrier to development of renewable energy is the absence of sufficient electric transmission to move the power to load centers from the relatively remote places that wind energy prevails.[15] In New England, this problem is not as acute, owing to the shorter distances and denser settlement of these six states, and smaller prospective wind sites, but neither is the regional interconnection challenge trivial. Siting is particularly vexing right now for wind projects, especially for groups of state-of-the-art units of 1.5 to 2 MW or more, each. Proposals for both off-shore and ridgeline projects are challenging developers, communities, and siting authorities with dilemmas of competing environmental qualities. Offshore wind development obviously comes with a transmission line challenge, and the aesthetic and wildlife issues of ridgeline wind development are exacerbated by the need to site interconnecting power lines. Unlike the Midwest, where wind fits well into its agricultural economy and relatively flat landscape and thousands of machines are in service or under development, New England has yet to find the formula for success for wind.
- Financing is also proving challenging. For most renewable projects to get financing, they need long-term contracts on the order of 10 years for power and renewable energy credits. It is well to remember that RE project developers tend not to be utilities with ratepayer-backed balance sheets, but generation entrepreneurs with no structural link to customer bills. Since a

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[13] See, for example, *The Remaining Electric Energy Efficiency Opportunities in Massachusetts* at http://www.mass.gov/doer/pub_info/e3o.pdf.

[14] For information on the potential of several renewable resources see http://www.eia.doe.gov/emeu/reps/rpmap/rp_contents.html. For a discussion of the potential of wind, biomass and landfill methane in New England, see http://www.ucsusa.org/clean_energy/archive/page.cfm?pageID=168 and http://www.biomasscenter.org/.

See also, *Potential Cost Impacts of a Vermont Renewable Portfolio Standard,* Synapse Energy Economics, Boston MA, June 2003

[15] FERC Notice of Proposed Rulemaking **RM05-4-000**, January 24, 2005**.**

majority of the load in New England is served by default service providers with relatively short-term commitments (well under 10 years), the match between financial security requirements and the duration of sales contracts is strained.[16] Without long-term contracts to assure a return on investment in a reasonable time, consumers will suffer higher prices for renewable power as developers add a risk premium to shorter term deals to supply portfolio standards.[17]

- Technology has achieved significant cost reductions for wind and solar power systems. Improved materials enable greater output at hydroelectric stations as well, but those potential gains are offset by potential reductions in output due to new flow restrictions driven by better understanding the trade-offs between power production and river habitat which may be applied in the federal relicensing process. Biomass gasification and fuel cell systems will be, perhaps, the next to see a quantum leap in capabilities and cost. With technology improvements, however, come new challenges. For example, as wind machines improve, they will be able to be still larger, sweeping even greater areas, making places with lower wind speeds viable for development. Whether siting can keep up with the aesthetic challenges posed by these larger machines is a vexing question.

Why not smaller wind machines?

In Europe, travelers on rural highways and country roads have a good chance of seeing wind machines. Many of these are smaller than the machines being built in the U.S. today. A significant reason for this is government support. Government subsidies or other advantages for these projects are justified as compensating for otherwise unpriced environmental and risk management benefits and serve to meet other policy objectives. A business case supporting smaller projects enables communities to be more supportive of wind, since the scale of development fits the community, which has more of an opportunity to control what happens. Some of the local opposition to wind in New England develops because communities are presented with no option but a project that appears too large.

For fuel cells, which will tend to be located at customers' premises, complementary policies in each state enabling distributed generation will be needed.

Most customers remain unfamiliar with the potential to add generation to an existing building or operation. While adding land fill methane conversion is well understood,

[16] Some states are bidding out default service for a term of three years or less, and current default service providers may cede this responsibility within a few years. This short term horizon makes it difficult for renewable energy providers to get the longer term contracts Wall Street wants to see.

[17] The New York RPS addresses the long term contract issue by creating a central buyer of renewable energy credits, and assigning that role to the state. This approach puts a very stable contacting party on the buying side of the transactions, enabling long term contracts.

methane production for farms or sewage treatment plants is just now being appreciated, for example. Customers may not want to be professional power producers, but they may be able to produce power without much added hassle. As these operators become familiar with the potential to integrate power production, the practical potential of renewable energy deployment will rise.

Three New England states, Connecticut, Massachusetts, and Rhode Island, have in place renewable portfolio standards that call for new capacity. This report examines the effects of one "build-out" scenario for renewable energy in New England through 2010.

Although the Conference of New England Governors and Eastern Canadian Premiers will want to stay aware of studies of potential, this report does not investigate the potential for energy efficiency and renewable energy to meet New England's electrical needs. Accepting that the remaining potential is significant, the report instead examines the portion of that potential we can expect to obtain using several existing energy efficiency and renewable energy policies, as well as the anticipated economic, environmental and energy security impacts of those policies.

III. BACKGROUND: ENERGY EFFICIENCY AND RENEWABLE ENERGY IN NEW ENGLAND

Before the Oil Crises of the 1970s, energy efficiency was a matter of principle or personal choice and was not perceived as a policy issue. "Waste not, want not," and "money to pay the light bill doesn't grow on trees," were common refrains, perhaps a product of traditional "Yankee thriftiness." Power seemed plentiful and likely to decline in cost. Renewable energy came in the form of hydro-electric power, which drove rural electrification, and biomass power produced by pulp and paper businesses, which turned a waste product into a useful by-product. Increasingly larger power stations took advantage of economies of scale. Individual wind projects were so memorable because they were so few. Photovoltaics and fuel cells were reserved for NASA.

The Oil Crises along with growing clean air concerns changed these attitudes, and the Three Mile Island accident (1979) added uncertainty to New England's energy future by precipitating the suspension and ultimate cancellation of construction plans for several thousand megawatts (MW) of nuclear capacity. Gradually increasing requirements for air quality in the 1970s and 1980s further complicated the energy picture.

There followed a series of policy responses intended to regain some balance in New England (and US national) energy policy:

- PURPA - The states set out to implement the Public Utility Regulatory Policy Act (PURPA), passed by Congress in 1978, which directed utilities to allow qualifying independent electric power producers access to the transmission and distribution grid. Utilities were also obligated to buy this power at its avoided cost, a concept that kept public utility commissions (PUCs) busy for quite some time trying to define it. A significant portion of New England's renewable energy was built in response to this policy.
- Planning - As the answers for choosing new electric resources were not as simple as they had previously seemed to be, planning became a priority. States created active energy offices, responsible for preparing state electric plans. The idea of a formal utility resource plan integrating all options that the regulators would review and approve also emerged in the early 1980s.
- Efficiency - These resource plans generally pointed to the merits and potential for energy efficiency to provide value to the overall electric system and its consumers. So, regulators and utilities set themselves to the task of developing a new service: Energy Efficiency Programs. These programs tended to address market barriers that kept consumers and others who make energy decisions from making cost-effective choices. Efficiency programs also tended to conflict with the utility's motivation to build customer demand for electricity.[18]

[18] Known as the "throughput incentive," this motivation is a direct result of how public utility companies make money in a traditionally regulated regime. This effect and potential solutions are discussed well in

Regulators have used a number of strategies to address this conflict, including lost revenue adjustments, revenue caps and incentives for EE performance. Consensus on the perfect solution has not yet emerged.

Throughout this period, there were significant improvements in technology and methods that enabled progress in deployment of energy efficiency and renewable energy. New England states noted economic development benefits using local resources to produce power, and the labor intensive nature of energy efficiency programs.

In the 1990s, the wheel of circumstance spun again.

- With oil prices lower than had been previously predicted, the flaws of PURPA implementation became evident. Power purchase prices were locked in for too long at high prices while fossil fuel prices declined, and there was little or no competitive pressure to select the best projects. Many utilities faced the same problems with their own power commitments. Taken together, the result was higher rates and some significant utility cost disallowances and bankruptcies.
- Power plant technologies emerged that made comparatively clean natural gas a cost-competitive fuel choice for new generating capacity. Pipeline construction enabled a significant and steep growth in natural gas-fired electric capacity in New England. Natural gas represented 9 percent of electricity generation in 1993. In 2003, 38 percent of electricity was produced by natural gas.[19]
- While energy efficiency programs were getting significant financial support in the early 1990s, the move toward retail competition provided a reason for utilities in all six states to reduce commitment to these programs in order to limit utility exposure to "stranded costs," costs that might not be recoverable in the more competitive electric market that policymakers were hoping to create.
- The emphasis on integrated planning diminished in anticipation of greater reliance on market influences in the restructured industry.

The sum of these trends stalled deployment of new renewable electric supplies in New England in the 1990s. Table 1 shows the percentage of electricity generated by hydroelectric and other renewable sources in New England, as a percentage of all New England generation. Notice that deployment peaks in 1996 and declines steadily thereafter, especially due to a policy to promote buying out of expensive PURPA-driven power contracts in conjunction with industry restructuring.

In addition, after peaking in most states in 1993, utility investment in energy efficiency was dramatically cut back. Investment as a percent of revenues continued to decrease in real terms until New England's various state legislatures and/or regulators began to create mechanisms for ratepayer funding of energy efficiency in the late 1990s. By 2000, five

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Profits and Progress through Distributed Resources by David Moskovitz, The Regulatory Assistance Project, Gardiner ME. 2000.

[19] *Electric Power Annual 2003,* US DOE Energy Information Administration, Washington DC, December 2004.

of the six New England states were ranked in the top ten U.S. states for EE program spending as a percent of electricity revenues.[20] However, in real dollars the investments still did not equal those of the early 1990s. Table 2 reports regional energy efficiency spending trends during this same period.

Table 1

Renewable Energy in New England

	MWh	% of Total New England Electricity
1990	15,834,287	14.4%
1991	15,675,099	14.5%
1992	15,128,158	13.8%
1993	15,368,554	13.8%
1994	15,474,091	14.1%
1995	15,123,067	14.5%
1996	17,658,343	17.1%
1997	16,674,369	16.3%
1998	16,777,095	16.0%
1999	16,714,187	15.2%
2000	16,884,215	14.9%
2001	14,330,102	12.3%
2002	14,867,404	12.0%

Source: U.S.DOE EIA 1990-2002 Net Generation by State by Type of Producer by Energy Source (EIA-906). Renewable Energy for this table includes the categories "Hydroelectric" and "Other Renewables." The comparable percentage figure for the U.S. in 2002 was 8.8 percent.

Table 2

Energy Efficiency Spending by Six New England States, 1993-2000

Year	Energy Efficiency Investment ($000)
1993	207,051
1996	139,954
1997	143,592
1998	152,076
1999	153,951
2000	203,457

Note: nominal dollars.
Source: Dan York and Martin Kushler. 2002. *State Scorecard on Utility Public Benefit Energy Efficiency Programs: An Update*. Washington, D.C., ACEEE, December 2002.

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[20] Dan York and Martin Kushler. *State Scorecard on Utility Public Benefit Energy Efficiency Programs: An Update*. Washington, D.C., ACEEE, December 2002.

Today, the electric industry, its regulators and its customers in the New England states are digesting the changes resulting from retail electric competition and other competitive influences to the electric business. Energy efficiency and renewable energy were identified as "public benefits," policy areas that need explicit attention, at least during the transition and perhaps permanently, since it is likely that the full system and social benefits of these programs would not be valued and captured by participants in the new competitive electric markets. Among the most significant changes are:

- Energy efficiency has been partitioned on utility bills and in utility operations and accounts. In Maine and Vermont, the responsibility for base energy efficiency program administration has been designated to new management not affiliated with utilities.
- Renewable energy has been the focus of two new policies, designed to stand in for the effects of no-longer-performed integrated utility resource planning and R&D: the **renewable portfolio standard (RPS)**, and the **research, development and deployment (RD&D) fund**. A portfolio standard requires that all retail sellers include a specified minimum percentage of qualifying renewable energy in the power they sell during a given time period. The RD&D fund collects a small percentage of ratepayer revenue and allocates it to an effort to identify and develop promising renewable technologies, and to deploy these technologies. Some call these "clean energy" funds. See Table 3 for brief funding information concerning these funds. Companies failing to meet the requirement of a state RPS can generally discharge their obligation by paying into the state's RD&D fund.

Table 3

Renewable Energy Funds in New England[21]

	2004 Annual Funding Available
Connecticut Clean Energy Fund	$22 M
Massachusetts Technology Collaborative Renewable Energy Trust	$24 M
Rhode Island Renewable Energy Fund	$3 M

Going forward, policymakers will no doubt grapple with further unexpected events, as well as predictable trends like elevated fossil fuel prices, though states are learning, sometimes fitfully, to defend against policies that over-commit the region's energy economy in any particular direction. The most obvious manifestation of this concern

[21] Navigant Consulting Presentation to Federal Energy Management Program Renewable Working Group, December 15, 2004

today in New England is the challenge to avoid becoming too dependent on natural gas and its price characteristics. In summer 2003, natural gas fired capacity represented approximately 38 percent of all available New England power generation, a steep rise over the previous decade. While the values of environmental quality and resource cost-effectiveness have driven energy efficiency and renewable energy policy for over 20 years, it is apparent that such considerations as energy security, price stability, and system reliability may be additional significant investment drivers in the future if state policies are supportive.

Energy Security

Security of the power grid is very important. The prevailing standard for security in the U.S. enables most electric customers to have no doubt that turning on the light switch will produce light. Yet we know that components in the power grid fail from time to time. Security then, involves a system approach that diminishes to almost zero the effects on customers of a failure of any single system element. This quality is often called, "resilience." And even if a highly unlikely chain of adverse events occurs, the grid should fail "gracefully," in a way controlled by grid operators that affects a defined group of customers without catastrophic or cascading effects, without causing too many key grid elements to fail and with a clear and timely path to recovery.

Reliability and energy security resist quantitative analysis. Even after employing system stability models, as ISO-NE does to test the effects of new power lines and generation outages, the "one day in ten years" planning standard for reliability is only a round representation of the reliability standard system planners strive to achieve. And forecasts should not be confused with predictions. Random events can confound forecasts and often do.

Energy efficiency has restrained growth in electric demand in New England. In 2002 alone, the programs of the three southern New England states saved 161 MW of peak demand, or about 0.6 percent of pool-wide peak that year. Those savings will last an average of eight to twelve years.[22] Additional savings of this magnitude will be obtained year after year with continued commitment to the EE programs.

Energy efficiency has value in peak demand situations. On capacity short days, such as during the January 2004 cold-snap, the capacity value of energy efficiency is very significant. As energy efficiency has avoided hundreds of MW of electric demand that would otherwise have to be built somewhere and consume fossil fuel (inefficiently on peak days), we can conclude that efficiency programs have played an important role in maintaining system reliability, avoiding air pollution, moderating market price volatility and have avoided the need for generating capacity as well as transmission and

[22] Martin Kushler, Dan York, Patti Witte, Five Years In: An Examination of the First Half-Decade of Public Benefits Energy Efficiency Policies, American Council for an Energy-Efficient Economy, Washington DC, April 2004 pg 27.

distribution capacity in some cases.[23] Yet program screening does not credit these values to efficiency programs, and participants have not received compensation for this value, as a generator would receive. On days with thin margins of operating capacity, the substantial value of cumulative energy efficiency programs is particularly evident.

The influence of renewable energy on energy security is more in the realm of fuel diversity. Fuel diversity protects against negative events that affect any one type of source. Nuclear reactors have had very good production in recent years, but experience tells us that safety or maintenance problems can take out thousands of MW suddenly, and for many months. Natural gas has been a reliable, low cost fuel for some time. Recent price increases, coupled with a history of volatility suggest, however, that relying too much on these qualities too far into the future may be a costly mistake. Pollution and economic concerns diminish the prospect for new coal generation in New England, despite its dominance elsewhere. Attributes of renewable energy include a stable and low running cost, and consistent availability independent of fossil fuel markets.

Another positive aspect of renewable energy is that it tends to come in economically smaller blocks of capacity than fossil and nuclear stations of typically 250 - 1000 MW. The ability to add resources in small increments lessens the risk of over- or under-building system capacity. This trait also tends to reduce the influence on system reliability of any single piece of the electric system, leading to an electric grid more resilient to disruptions from natural or human causes.[24]

The mix of New England electricity sources is in the midst of a big change, as the share of natural gas has increased significantly. Please see Appendix E for a further discussion of this trend. Renewable energy represents a strategic alternative – a fuel supply that is already here, and which has demonstrated stable or declining prices.

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[23] Losses to heat on transmission and distribution lines mean that end use efficiency actually displaces 10 to 15% more power at the generating station than the savings of these measures at customers' premises. During peak load hours, these line loss savings are even greater.

[24] *Electrical Energy Security: Assessing Security Risks*, The Regulatory Assistance Project, Gardiner ME, April 2002, and *Electrical Energy Security: Policies for a Resilient Network*, The Regulatory Assistance Project, Gardiner ME, April 2002.

IV. PUBLIC BENEFIT FUNDS AND RENEWABLE PORTFOLIO STANDARDS

Introduction

The Conference of New England Governors and Eastern Canadian Premiers adopted their Climate Change Action Plan in 2001. The Plan set goals to reduce the total demand for electricity by increasing the efficiency of electricity consumption, and to reduce the emissions intensity of generation by improving the efficiency of electricity generation and increasing the contribution of non-emitting sources of generation. If these goals are successfully reached, the region's needs will be met using less electricity, and the electricity that is consumed will produce less greenhouse gas emissions overall and per MWh consumed.

The 2001 Climate Change Action Plan goals dovetailed nicely with several initiatives already underway in the New England states. During the mid- to late-90s, in anticipation of, or in conjunction with, electric industry restructuring, every state in New England took one or more steps to support electric energy efficiency and, in some cases, renewable energy activities. The states have a variety of relevant policy instruments at their disposal, such as regulatory policies affecting electric resource procurement, tax credits, codes and standards, and state procurement practices. This report focuses on two policy approaches expected to have a significant impact on the region's climate change goals. One is the use of ratepayer funds, also known as public benefit funds, set aside to promote energy efficiency and the development of renewable energy sources. The other is the use of renewable portfolio standards, that is, the requirement that renewable or zero-net-emission sources provide an increasing percentage of electricity consumed in a state.

Although both of these approaches serve to meet the goals of the Climate Change Action Plan, they also provide other benefits to states, and their effectiveness may be judged by criteria other than, or in addition to, Greenhouse Gas emission reduction. Both energy efficiency and renewable energy development can increase energy security (or reduce system vulnerability to disruption), promote economic development, create jobs, reduce air pollution, and conserve other valuable resources such as water and fossil fuels. In addition, energy efficiency can improve the competitiveness of the business sector, lower electric bills (increasing consumers' discretionary income) and lower peak demand, further reducing system vulnerability and price volatility as well as the need to build new power facilities in increasingly congested areas of New England.

Public Benefit Funds

During the past eight years, every New England state has enacted measures to assure continued support for public benefit activities that had historically been implemented by traditional vertically integrated electric utilities. All six states created non-bypassable surcharges on electricity sales to pay for electric energy efficiency activities. Three states, Connecticut, Massachusetts and Rhode Island, use the same mechanism to support renewable energy development.

The public benefit funds for efficiency and renewable energy activities in New England have leveraged millions of dollars in federal, state and private investments, in addition to producing the environmental and economic benefits listed above.

Most New England states have chosen not to redirect these public benefit funds for general fund purposes, recognizing the significant short and long-term economic, environmental and reliability benefits of the energy efficiency and renewable investments. In the few instances where these funds have been used for other than their original purpose, energy, demand, and electric bill savings have faltered as programs are curtailed.

Energy efficiency funding has been volatile in the past. This has been primarily due to reductions coincident with the initial uncertainty from retail competition discussions, and, previously, due to regulatory disputes about appropriate budget amounts. When funds are restored, it has taken considerable time to ramp back up to full implementation and participation after significant costs.[25] All New England states experienced this effect in the 1990s. Significant reductions in energy efficiency spending, as reported in Table 2, eliminated significant capacity to accomplish energy efficiency which has taken many years to rebuild.

<u>Energy Efficiency Public Benefit Funds</u>

Ratepayer funded energy efficiency programs in New England have some differences from state to state, but share much in common:

- They serve all customer classes;
- A diverse portfolio of programs is offered, including retrofit, new construction and market transformation;
- Individual utility efforts have sometimes evolved into statewide and regional efforts, reaping benefits of economies of scale, and increasing market penetration of efficiency technologies;
- Programs in New England have received national awards and recognition;
- The states build measurement and evaluation into the programs and use third party contractors to evaluate actual results;
- States that have studied the potential of existing efficiency potential have found that there is more cost-effective efficiency available than present funding can support; and
- States are spending to administratively-set efficiency budgets and are not implementing programs to maximize efficiency savings.

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[25] For a discussion on why energy efficiency capability should be stable, see Paul Chernick, John Plunkett, Jonathan Wallach, *From Here to Efficiency: Securing Demand-Management Resources*, Pennsylvania Energy Office, 1993.

What is Market Transformation?

Market Transformation is a strategy that promotes the manufacture and purchase of energy-efficient products and services. The goal of this strategy is to induce lasting structural and behavioral changes in the marketplace, resulting in increased adoption of energy-efficient technologies.

How does Market Transformation work?

A key aspect of Market Transformation is overcoming market barriers. These market barriers inhibit the manufacture and purchase of energy-efficient products. Some examples of market barriers are:

- Limited availability of energy-efficient products
- Lack of consumer awareness of the products and their benefits
- Resistance to new products in general
- Over-emphasis on first cost vs. operating costs

From Consortium for Energy Efficiency website http://www.cee1.org/cee/mt-primer.php3 (January 27, 2005)

Some of the differences among the states are:

- ♦ Public benefit charges range from $0.0015 to $0.003/kWh.
- ♦ Administrators vary. In Connecticut, Massachusetts, New Hampshire and Rhode Island, utilities administer the programs, usually in collaboration with stakeholders and with oversight by the regulatory agency. In Maine, the Public Utilities Commission is the administrator, and in Vermont, the Public Service Board contracts with an independent administrator supervised like a utility.

Although the costs and benefits of specific programs vary, overall, New England's energy efficiency programs acquire energy savings at a cost much lower than the wholesale cost of electricity plus transmission and distribution costs. Some recent projections of the wholesale cost of power for the New England (not including transmission and line losses) range from about 4 cents per kWh to over 5 cents per kWh over the next ten years,[26] significantly more than EE programs costs of less than 3 ¢/kWh. Table 4 summarizes our findings of efficiency program costs and lifetime savings for the New England region for programs implemented during the year 2002.[27]

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[26] See, for example, New England ISO *Regional Transmission Expansion Plan 2004 (Preliminary version)*, Table 7.18, and U.S. EIA *Annual Energy Outlook*, 2004, Table 66. The latter values, with 2.5% per year inflation adjustment applied, supply the high end of this range; the NE-ISO report supplies the low end of the range.

[27] Comparison of life-cycle costs with system avoided costs should be done with care. With that warning, the Vermont Department of Public in August 2004 released a "base" system avoided cost forecast, which reflects the New England electricity market. Over the average life-cycle of energy efficiency measures installed in 2002 (2003-2014), forecasted annual average system avoided costs range from 4.0 to 5.5 cents

Accumulated savings in the period 2000 – 2010 from programs delivered in those years are expected to be 44,144,963 (See Figure ES-4).

Table 4

New England Region 2002 Efficiency Program Investments and Savings		
Public Benefit Funds Invested	Lifetime MWh Savings (Estimated)	Cost/kWh
$248,740,000	9,360,220	2.7 cents
Source: State level program reports and interviews with program administrators. See Appendix C of this report for details.		

In not one of the New England states is it common practice or policy for the distribution utility to acquire all cost-effective energy efficiency, regardless of the amount budgeted.

Renewable Energy Public Benefit Funds

Three states presently use public benefit funds to support renewable energy development. The charges to ratepayers range from $0.0003 to $0.0010/kWh. The funds are administered by quasi-public agencies in Connecticut and Massachusetts, and by state government in Rhode Island. Over $225 million had been collected through 2003.

Renewable energy public benefit funds are used for grants, investments with royalties flowing back to the state, and other financing mechanisms. These funds are almost always used to leverage significant funds from other sources. The funds may be used to support the direct installation of technologies such as fuel cell, photovoltaic, wind, or low-emission sustainable biomass facilities. However, states also use these funds to meet long-term goals, such as nurturing consumer interest, or building research and manufacturing capability. For a variety of reasons the project team was unable to model the impacts of these funds. As a result, they are not included any further in this report.

Renewable Portfolio Standards

Two states, Massachusetts and Connecticut, have renewable portfolio standard (RPS) that stimulate investment in new renewable resources. They require electricity suppliers to increase the proportion of electricity from renewable sources consumed in each state in time to be considered by this report. See Table 5, below. Maine has also enacted RPS legislation, but it does not presently require an increase in the contribution of renewables to the state's mix, nor does it explicitly credit new renewable sources as a special

per kWh. Clearly, this is significantly more than the cost of energy efficiency in New England. The most recent expectations of higher natural gas costs were not reflected in this forecast. With higher gas costs, latter year avoided costs would be higher since these figures are based on the full costs of a natural gas combined cycle unit. David Lamont, Personal Communication September 16, 2004. http://www.state.vt.us/psd.

category. In 2004, Rhode Island also adopted an RPS to be effective in 2007 designed to attract new renewable resources.

Table 5

CT, RI and MA Renewable Portfolio Standard Requirements

	Connecticut		**Rhode Island**		**Massachusetts**
	Class I +	Class I or II	New +	New or Existing	New Renewables
At end of year					
2003					1.0%
2004	1.0%	3.0%			1.5%
2005	1.5%	3.0%			2.0%
2006	2.0%	3.0%			2.5%
2007	3.5%	3.0%	1.0%	2.0%	3.0%
2008	5.0%	3.0%	1.5%	2.0%	3.5%
2009	6.0%	3.0%	2.0%	2.0%	4.0%
2010	7.0%	3.0%	2.5%	2.0%	5.0%*

Sources: State statutes: CT, Public Act No. 03-135 (Substitute SB 733 of 2003); MA, M.G.L. Ch. 25A, Section 11 (Chapter 164 of the Acts of 1997); RI, G.L. Title 39 Chapter 26 Section 4 (2004-H7375 SubA).
*Massachusetts may choose to forego the 2010 increase

Renewable portfolio requirements increase each year and new generation beyond that which is now known will be needed to satisfy this demand. For this report, two scenarios were studied using both IMPLAN and Synapse's emissions model. In the Phase I scenario, capacity that has already been added, most likely spurred by state RPS policies, was modeled for their economic and environmental effects. This amounts to 73 MW. Table 6.1 displays the types of capacity included in this group of power plants. Please see Table 2.2 in Appendix C for more detail.

Table 6.1

Renewable Capacity added in New England 2000 – 2004 (Phase I additions)	
Wind	1
Landfill Gas	32
Wood Chips	26
Solar	~0
Hydroelectric	13
Fuel Cells	1

Then, in the Phase II scenario, renewable generation projects that are known to be under development are added and these are augmented by an assumed plausible group of projects that would meet the states' RPS requirements with resources somewhere in New England. For purposes of modeling the economic effects of the RPS and to show what the future might look like, Table 6.2 shows the amount of renewable capacity that would have to be added in New England to meet these requirements. By these assumptions, ~~nearly~~ 1000 MW of new renewable energy will be needed in New England to meet 2010 RPS requirements. Please see Tables 2.4, 2.5 and 3.1 in Appendix C for more detail.

Table 6.2

One plausible mix of new renewable capacity (MW), Phase II, added 2000 – 2010 by fuel	
Wind	370
Landfill Gas	163
Wood Chips	323
Solar	6
Hydroelectric	47
Fuel Cells	91
Total	**1000**

Table 7

Renewable Energy in New England, Actuals and Committed from 2000-2005 (Phase I), Added to Meet RPS Requirements (Phase II) 2005-2010

	Phase I Renewable MWh	Actual MWh Renewables in New England	Phase II Renewable MWh	% of Total New England Electricity
2000	42,274	16,884,215	0	14.9%
2001	83,292	14,330,102	0	12.3%
2002	111,189	14,867,404	0	12.0%
2003	158,782		0	
2004	332,072		0	
2005	522,189		779,850	
2006	0		1,615,247	
2007	0		2,579,048	
2008	0		3,332,083	
2009	0		4,100,572	
2010	0		4,844,769	

Table 7 shows the annual energy from new renewables added to the historic data in Table 1. The same data appear in Figure ES-5, and come from known and expected sources, as well as sources imputed for this report to meet New England RPS requirements. For reference purposes, Table 7 includes historic data of total energy from renewable energy in New England, predominantly renewables that pre-date 2000, and the percentage of energy in New England that comes from those renewable sources.

Note that this report does not assume any renewable energy coming from New York. New York is implementing its own RPS, and analysts there expect that around 3700 MW of qualifying renewable capacity will be needed to meet the demand. It would be unwise to expect that New York will have resources to spare, at least during the timeframe covered by this report. Indeed, it is also possible that New England will export renewable energy credits if there is an excess. On the other hand, it is possible that the program in New York will lead to REC prices lower than New England prices. In that event, New York renewable generators may be attracted to the New England market. Renewable energy credits, or RECs, are explained in the text box. Likewise, RPS requirements in the Mid-Atlantic States suggest it is unwise to expect a significant supply of RECs from that region.[28]

Neither is there an assumption here about qualifying renewable energy coming from Eastern Canada or Ontario. There is some prospect that renewable energy from the north can help meet New England's RPS requirements in an economical way.

Because the number of renewable energy credits required depends on total electric sales, a significant increase in energy efficiency investments or sales growth slower than forecast for other reasons would reduce the amount of renewable generation needed to supply the portfolio standards.

Cash flow from REC sales may enable financing for RPS-eligible projects to be as easy or easier than for other generation projects.

Data Issues

Although the New England states are moving in the same general direction when it comes to efficiency and renewable energy activity, data is not tracked consistently from state to state, from year to year, or program to program. The same "parent" utility operating in different states may track different data for essentially the same program for different states. For example, some states require tracking customer costs for some or all energy efficiency programs; others track only program costs. Energy savings may be calculated differently, with some states considering free riders and spillover effects and others, not. Some states report results within months of the year's end. Others do not finalize reports for over a year. If lifetime savings are the important measure for efficiency program incentives, then that is what is reported. Another state may have different performance requirements. These differences may be understandable given the

[28] For a thorough account of RPS policies in the U.S. see http://www.dsireusa.org/ (April 28, 2005)

unique creation and evolution of each state's programs. However, they do pose difficulties for those trying to compare programs and draw regional conclusions and these difficulties could hamper use of this data for regional system plans.

Despite the differences noted above, the options for metrics to measure the effectiveness of traditional energy efficiency activities are well-established. Measuring the impact of market transformation activities, which serve to influence over time the behavior of the many members of the product chain that leads to the consumer, appears to be a less exact, but developing, science. The nature of data regarding the use of renewable energy public benefit funds varied significantly from state to state.

Generation Attributes and Renewable Energy Credits: What's the Difference?

Advocates for renewable energy markets and portfolio standards call for a system to track tradeable renewable energy credits, RECs. Generally, REC systems allow specified generators in a market area to produce unique certificates that can be transferred from the generator to the load server or even to the customer. Generators in this system would be favored by some state policy, like a renewable portfolio standard. This system assures that there is no double-counting of credits, or other misleading or fraudulent practices.

Generation attributes work the same way, but refer to all relevant attributes for all generation in a market system. Such a system might be preferred if non-renewable clean energy resources have value in a market, or if overall environmental quality of the power purchased by a load server or customer is important to report.

New England has a generation attribution system, while the states in the Western U.S. are developing a REC system. The choice is driven by the policy demands of the states in the region.

Documenting compliance with the renewable portfolio standards is important. The NEPOOL Generation Information System (GIS), administered by an independent contractor retained by NEPOOL, is meeting this need. Generation attributes, such as emissions and RPS-eligibility, are tracked by unique certificates for every MWh generated by participating generation facilities. RPS certificates will be "settled" with electricity suppliers in time for compliance filings during the summer after the year in question. The first RPS compliance filings that have consequences in Connecticut and Massachusetts, reporting sources of electricity supplied during 2003, were due in mid-2004. A report on the Massachusetts RPS was published by that state's Department of Energy Resources in February 2005.[29] Briefly, sufficient qualifying credits were available to meet the 1 percent requirement in effect in 2003. The majority of credits (56%) came from landfill gas generation. The report authors forecast some modest shortage in qualifying credits in the early years of the program.

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[29] *Annual RPS Compliance Report for 2003*, Massachusetts Department of Energy Resources, February 15, 2005.

V. PERFORMANCE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY IN NEW ENGLAND

Overview of Analysis

Data on energy efficiency programs and renewable energy deployment since 2000 were used to develop inputs for, an economic input/output computer model, IMPLAN.[30] To assess the air quality effects of these programs, sources that estimate the marginal rate of air pollution were used. Three distinct model runs were performed:

#1 Energy efficiency program investments from 2000 to 2010 with current programs continued at planned funding levels, including any planned changes through 2010;

#2 Renewable energy deployed since 2000, qualifying under and presumably motivated by any of the state renewable portfolio standards in New England – this is called Phase I;

#3 Same as #2, with more renewable energy added to meet existing RPS requirements in Connecticut, Massachusetts and Rhode Island, either from announced projects, or from generic projects in a plausible mix. This is not a forecast of a particular build-out of renewable energy. Rather, this is a plausible scenario, for which we assess the economic, environmental and security effects. This is called Phase II. Energy efficiency inputs for Phase II were the same as those used in Phase I.

The results shown below, and in Appendix C, for economic impacts and the potential air emission reductions represent the projected *net* increases or decreases due to the assumed amount of energy efficiency spending and renewable generation. That is, these outcomes are over and above what would have occurred without these interventions.

The economic impact modeling is subject to certain limitations due to assuming constant values for some input data and use of a non-dynamic input/output (I/O) model.[31] For

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[30] The IMPLAN model analysis traces the flow of goods and services, income, and employment among related sectors of the economy. In an input/output model like IMPLAN, a change in the final demand for a product or service causes that sector to buy other goods and services from other sectors, which in turn purchase inputs from other industries. All of these sectors purchase additional labor, too. The additional employees purchase more goods and services. The job of the model is to compute the eventual sum of all of these purchases cycling through the economy, identifying direct effects, indirect effects, and induced effects.

[31] Among the input data subject to this limitation include marginal fuel mix and emission rates, avoided costs, productivity of existing units, productivity of energy efficiency programs, potential effects of growing local renewable or efficiency businesses, benefits from reduced volatility or clearing prices due to reduced traditional generation and associated fuel demands (including clearing price and volatility reductions for all fossil fuel users), or details of inter-state trade within New England. Due to the static, linear nature of the IMPLAN model, possible changes in industry use of labor, capital, fuel or intermediate

further details about the model and more detailed results, please see the report from Synapse Energy Economics Inc. in Appendix C.[32] The rest of this section focuses on the results of the modeling effort.

Impacts on the Economy

The IMPLAN model was used to assess the effects of construction (renewables), investment (efficiency) and operation on economic output (the sum of all goods and services produced in the New England economy), employment and labor income. These assessments were made by simulating change in the behavior of the regional economy due to energy efficiency and renewable energy programs. As mentioned above, the changes represent the projected *net* increase in economic activity, employment, and labor income due to the energy efficiency and renewable generation activities. Changes in employment are in job-years, the equivalent of one person in one job for one year; changes in economic output and labor income are in 2001 dollars. The model measures direct effects from the investment, as well as indirect and induced effects. Please see Appendix C, Section 3.2 for a useful explanation of these categories.

Energy Efficiency

The economic modeling of the efficiency programs reflected the current level of outlays for those programs, except that where specific changes had already been scheduled, those changes were included. This procedure led to an assumed total expenditure on efficiency programs, for 2000 through 2010, of $2.6 billion (2001 dollars), about $237 million (2001 dollars) per year. In 2002, this represented about 2 percent of total electric sales revenue of $11.8 billion.[33]

From these inputs, the simulation took into account the tradeoffs between reduced purchases of electricity, greater purchasing power of consumers, greater profitability of businesses, reduced business activity in the generation of power, as well as increased spending on efficiency-related goods and services instead of power plant fuel and operating expenses. The net result on the regional economy, summarized in Table 8 was estimated to be an expansion of about $2.0 billion (2001 dollars) or about $180 million (2001 dollars) per year. Employment was projected to increase by 14,994 job years, or an average of about 1350 jobs at a given time. Labor income was projected to increase about $694 million (2001 dollars), an increase of about $60 million (2001 dollars) per year. More detailed data, including annual information for the years 2000-2003, appears in Appendix C in Tables 3.26, 27 and 28.

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goods are also not considered. In particular, the model assumes that productivity of labor and other factor inputs is constant.

[32] Details not found in this report may be available in data files which will be available on the RAP website, or on request from the authors.

[33] From http://www.eia.doe.gov/cneaf/electricity/esr/esr_tabs.html, tables 17, C4 and C5. (April 28, 2005)

Table 8

Projected Net Impact of Energy Efficiency Programs, 2000-2010

	Economic Output	Job-years	Labor Income
Cumulative Results 2000 - 2010	$2.0 Billion	14.994	$694 Million

Modeling energy efficiency reinforces the fact that it represents an alternative to other investments. Changes to energy consumption were matched with avoided fossil fuel use and avoided operation and maintenance costs of generation.

<u>Renewable Energy</u>

Phase I of the economic modeling of RPS reflected the construction costs of the plants that came online in 2000 through 2004, plus the operation and maintenance expenses of those plants through 2010, and their output from the date of installation through 2010. By 2004, the new renewable plants that had come on line totaled about 73 MW of capacity. The amount of output from these plants is assumed to remain constant through 2010, but represents a slowly declining percentage of regional generation, as no new plants are added to the simulation.

From these inputs, the simulation took into account the tradeoffs between reduced purchases of fossil fuel, increased business activity in the generation of renewable power, and decreased business activity in the generation of non-renewable power. The net result on the regional economy was estimated to be an expansion of about $470 million (2001 dollars). Employment was projected to increase by 2,052 job years. Labor income was projected to increase about $79 million (2001 dollars). These gains primarily occur during the construction period (2000 – 2005) of these projects. Annual data, combining the effects from construction and from operation, appear in Appendix C in Tables 3.20, 3.21 and 3.22. A breakdown of results for construction and operation appear in Appendix C in Tables 3.11 through 3.16

Table 9

Phase I Projected Net Economic Impact of Existing Renewable Power Responding to Renewable Portfolio Standards, 2000-2010

	Economic Output	Job-years	Labor Income
Cumulative Results 2000-2010	$470 Million	2,052	$79 Million

A second RPS scenario, Phase II considered the effect of construction of qualifying renewable generation in New England in order to meet annual RPS requirements through 2010. By 2010, nearly 1000 MW of qualifying renewable generation were added in one plausible scenario among an infinite number of possibilities. The net result on the regional economy, summarized in Table 10, on the regional economy is estimated to be an expansion of about $4,056 million (2001 dollars) and averaging over $600 million (2001 dollars) a year from 2005-2010. Employment is projected to increase by 13,197 job-years. Labor income is projected to increase about $348 million (2001 dollars). Annual data, combining the effects from construction and from operation appear in Appendix C in Tables 3.23, 3.24 and 3.25. A breakdown of results for construction and operation appear in Appendix C in Tables 3.11 through 3.13 and tables 3.17 through 3.19.

Table 10

Phase II Projected Net Economic Impact of Existing, Planned and Imputed Renewable Power Responding to Renewable Portfolio Standards, 2000-2010

	Economic Output	Job-years	Labor Income
Cumulative Results 2000-2010	$4,056 Million	13,197	$348 Million

One observation about the renewable energy results concerns the regional output multiplier from the construction of renewable power generation. A large fraction of the outlays for renewable generation are for the generating equipment (wind turbines in particular) and specialized maintenance work. Lacking specific data on whether those funds were spent inside New England or outside the region, we used the IMPLAN model's default percentages for the relevant industries, which reflect a historic pattern of significant expenditures outside the region. *If there were a substantial indigenous renewable generator manufacturing and maintenance industry in New England, then the projected impacts would be larger than those shown here.*

The major investment in renewable generation in Phase II can be expected to cause changes in the economy. Former demands for good and services related to fossil fuels and their transportation and for operation and maintenance on fossil fuel plants will decrease, with a commensurate decrease in jobs and job income.

As noted in Appendix C, page 32, Synapse believes that IMPLAN understates the positive effects of renewable generation operation. Additional refinements to the model, and running it over a longer period of time can address these shortcomings.

Yearly results appear in Appendix C, but are quite variable depending on the generation being added, the generation being avoided and projected fuel costs.

Finally, interactions with the economy from investments in energy efficiency and renewable energy are unlikely to be linear all the time. With more investment comes changes to the surrounding industry, negative changes to the economic contributions from avoided generation types (i.e. fossil fuels), and other dynamic effects. To the extent that changes like these occur together in the region, positive feedback can result in an economic "incubator" and possible development of a "Route 128" type concentration of new businesses. Such simulations are beyond the scope of this report, but merit consideration.

Will the Renewable Build-out Happen?

This work assumes that the state renewable portfolio standards in Connecticut, Massachusetts and Rhode Island will produce actual resources in New England to meet these demands. This outcome may not happen for the following reasons:

- It may be necessary or more cost-effective for load servers to pay alternative compliance costs, especially if barriers to building new units are too formidable, producing a shortage of qualifying credits. This will be influenced by the persistence of the federal production tax credit for wind, and other federal assistance, state incentives, siting costs, pace of technology improvement and cost reductions, and pace of construction to meet new electric demands in New England.

- Significant resources may come from Eastern Canada. Qualifying hydro and wind resources in Canada may under price New England resources. The system of exchanging credits between Eastern Canada and New England will need to be improved and made more seamless to fully realize the potential to import renewable generation attributes.

Presently, a perceived shortage in renewable energy credits compared to demand is causing prices of qualifying credits to approach alternative compliance payments.

Combined Effects

The combined effects of current energy efficiency policies from 2000 through 2010, and a build out of renewable generation in New England to meet state portfolio standards produces the economic results displayed in Table 11. Over $6 billion in benefits to the economy result from these policies, a quite substantial contribution. The policies also yield over 28,000 job-years producing over $1 billion in income, cumulatively. Please see Tables 3.32, 3.33, and 3.34 in Appendix C for category and yearly details of these figures.

Table 11

Combined Impact of Energy Efficiency Programs and Phase II Build Out of Renewable Generation in New England, 2000-2010

	Economic Output	Job-years	Labor Income
Cumulative Results 2000 - 2010	$6.1 Billion	28,190	$1,042 Million

Impacts on the Environment

The effects of energy efficiency and renewable investment were also used to evaluate potential air emission reductions. The marginal emission rates used for year 2000 to 2002 are historical data obtained from the 2002 NEPOOL Marginal Emission Rate Analysis report. For the years 2003 to 2010, projected marginal emissions data from the Emission Reduction Workbook that Synapse developed for the Ozone Transport Commission

(OTC) were applied. The Workbook is a quantitative tool used to estimate emission reductions from a wide variety of energy policies in the Northeast. The Workbook is available from Synapse[34] and from the Ozone Transport Commission. Note that the marginal emission rates of all three pollutants are projected to fall from historical levels during the coming decade, as plant turnover places cleaner plants on the margin for larger percentages of the time. The intent was to identify the potential air emission reductions avoided due to the presence of these efficiency and renewable activities. Further background on the OTC workbook is in Appendix C, Section 4.1.

Note that we refer to these emission reductions as "potential reductions," because many of the oil- and gas-fired steam units that would operate less due to new renewable generation and efficiency currently receive NO_x allowances, and some of them receive SO_2 allowances as well. The extra allowances created by this reduced generation could be traded to other sources, resulting in no reduction in overall system emissions. In fact, if allowance markets are working efficiently, one would expect the industry to emit pollution equal to the capped levels. If that were the case, efficiency and, the new renewable generation would only have the effect of lowering the cost of meeting the emission caps. Alternatively, to maximize the emission reduction potential of efficiency and new renewables, regulators could establish mechanisms to capture and preserve the emission reductions offered by them, such as by lowering emission caps as new, zero-emission generators were added to the system.

Energy Efficiency

The significant actual and expected investments in energy efficiency in the New England grid from 2000 through 2010 are expected to save 38,216,000 MWh. Our estimates of potential emission reductions, in tons, of NO_x, SO_2, and CO_2 from 2000 through 2010 due to these savings are summarized in Table 12:

Table 12

Modeling Results: Emissions Reductions due to Electric Energy Efficiency, 2000-2010 (tons)

	NO_x	SO_2	CO_2
2000-2010 Total	18,147	54,608	18,767,151

The reductions in CO2 emissions would be the equivalent of removing over 3.68 million passenger cars from the road for one year, or a decrease in consumption of 39.5 million barrels of oil.[35]

[34] *OTC Emission Reduction Workbook* http://www.synapse-energy.com/publications.htm#repo. (April 28, 2005)

[35] See http://www.usctcgateway.net/tool/ for translation calculations. (April 28, 2005)

Renewable Energy

Based on the relatively modest amount of new renewable generation added to the New England grid from 2000 through 2004, our Phase I estimates of the potential air emission reductions, in tons, from 2000 though 2010 of NO_x, SO_2, and CO_2 are shown in Table 13.

These are modest figures, representing only four years' worth of new generation, most prior to implementation of RPS requirements, and the impacts are likely to rise as renewable energy driven by the portfolio standards and the renewable energy funds replaces more polluting fuels.

Table 13

Net Emissions Reductions due to Existing Renewable Generation Built for Portfolio Standards (Phase I), 2000-2010 (tons)

	NO_x	SO_2	CO_2
2000-2010 Total	1,248	2,398	1,929,677

Turning to Phase II, the build-out scenario, a significantly greater amount of fossil fuel generation is replaced by qualifying renewable generation, as shown in Table 14. Some renewable generation does involve combustion, so the amount of emissions reductions does depend on the proportions of generation types actually built.

Table 14

Net Emissions Reductions due to Existing, Planned and Phase II Imputed Renewable Generation to meet Portfolio Standards, 2000-2010 (tons)

	NO_x	SO_2	CO_2
2000-2010 Total	5,603	8,532	9,163,126

Combined Effects

The combined effects of current energy efficiency policies from 2000 through 2010, and a build out of renewable generation in New England to meet state portfolio standards produce the environmental results displayed in Table 15. These policies achieve emissions reductions of nearly 31.7 million tons of carbon dioxide, more than 22,000 tons of nitrous oxides, and more than 34,000 tons of sulfur dioxide. Please see Tables 4.1, 4.2, and 4.5 in Appendix C for category and yearly details of these figures.

Table 15

Potential Emissions Reductions due to Existing, Planned and Phase II Imputed Renewable Generation to meet Renewable Portfolio Standards, and current Energy Efficiency Programs maintained, 2000-2010 (tons)

	NO_x	SO_2	CO_2
2000 – 2010 Total	22,038	34,231	31,682,718

Is this a little or a lot? For purposes of comparison, information being used in the Regional Greenhouse Gas Initiative (RGGI) shows that in 2000, generators in New England greater than 25 MW emitted 45.4 million tons of CO_2.[36] If CO_2 emissions rise at the rate of load growth as estimated by ISO-NE, this means that energy efficiency and renewable energy policies modeled in this report reduce CO_2 emissions by roughly 6% during the 2000-2010 timeframe for New England compared with a scenario in which these policies do not exist.

Note also that in the RGGI modeling discussion, a scenario characterized by a 25% reduction in CO_2 emissions from business as usual results in roughly constant emissions over the 25 year period from 2000 to 2024. So to answer the question, existing programs provide significant reductions, but much greater reductions are needed to reach regional goals.

Impacts on Energy Security

An assessment of the energy security effects of energy efficiency and renewable generation is based on data and observations of the New England power market. This section will examine effects on peak electric demand and the implications of reducing the peak, system resilience to component failures and fuel diversity benefits. Challenges related to environmental compliance may also factor into energy security.

One factor common to deployment of both energy efficiency and renewable energy is that they substitute for fossil fuels. For three decades, energy independence has been an interest in national energy policy. Yet over the past fifteen years, the percentage of imported oil used in the U.S. has increased from 50 to 60 percent. National forecasts of fossil fuel supply and demand indicate that business-as-usual will lead to continued increases in imported oil, imported natural gas and even imported coal.[37] Beneficial effects of deployment of energy efficiency and renewable energy in New England are already factored into that trend. Increased deployment of energy efficiency and renewable energy would better insulate the region from any adverse effects from a national increase in energy imports.

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[36] Murrow, Derek K. Presentation to Regional Greenhouse Gas Initiative, October 14, 2004, http://www.rggi.org/docs/murrow_pres_10_14_04.pdf (April 27, 2005)

[37] *Annual Energy Outlook 2004*, US DOE, Energy Information Administration, Washington DC. 2005

The Bid Stack Effect

In New England power suppliers bid to serve the region's load for each hour. The highest bid-price energy needed to serve load in a given hour determines the market clearing price. This price is assigned to all energy purchased in the market that hour. Visually, this can be thought of as a stack of supply bids ordered by price, with only those up to the hourly demand actually selected. The last one selected sets the clearing price, which determines what all bidders actually get paid.

Energy efficiency and some renewable energy supplies have little or no operating cost. Research shows that these resources affect the bid stack by tending to reduce the market clearing price, saving the entire region some money in the cost of the electricity spot market (Wiser). Visually, again, the highest price bid gets pushed off the top of the bid stack by low cost/no cost resources coming in at the bottom.

The bid stack effect of energy efficiency and renewable energy is a mix of financial and longer term security benefits. The economic savings are clear, but some of the cost savings stem from avoiding costs to prematurely expand natural gas infrastructure and associated contractual commitments associated with a path in which gas continues to be the fuel of choice, despite emerging concerns about price.

Energy Efficiency

The 2004 CELT Report from ISO-New England forecasts 1,421 MW of capacity in 2004 accumulated from regional Demand Side Management programs previously implemented. The electric demand for 2004 is forecasted to be 25,846 MW. Without these DSM programs, then, the forecasted peak would be 27,267 MW. While this year the pool is not short of electric capacity, there have been years in recent memory where the regional margin was much smaller and in those years; energy efficiency was part of a safety net that prevented an emergency. Construction of electric capacity is not the regulated activity it once was. Rather, it is the combined judgment of generation companies and the financial institutions that support them that determines the pace of electric generation additions. New England has already seen evidence that this market may lag in responding to both generation shortages and excesses. By dampening the rate of load growth, energy efficiency can contribute to a more responsive generation market by minimizing the magnitude of a shortage or an excess before generators ramp up or ramp down their activities.

Looking at security from a more localized perspective, the electric grid in southwest Connecticut is experiencing very narrow reliability margins. Intensive energy efficiency targeted to this load center (with other local resources) is helping to control demand and enabling existing facilities to maintain a higher probability of providing continuous service.

Targeting energy efficiency at local transmission or distribution hot spots has been done only infrequently in New England. Green Mountain Power applied this strategy for a few years in the vicinity of a Vermont ski area in the late 1990s, and National Grid is now piloting the concept in selected parts of its system.

This strategy has promise in other load centers with similar conditions, though it would be more effective if deployed earlier, before an actual reliability emergency. There remains no structural assurance, however, that where energy efficiency would benefit energy security, it will be applied. While the southwest Connecticut example shows how energy efficiency can work to contribute to cost-effective security solutions, these measures were applied only after reliability conditions in the area reached emergency status and long after the chance to avoid the emergency was lost.

In the alternative, the tariffs and practices of ISO-New England can be modified to more routinely identify opportunities where demand reductions achieved through energy efficiency will produce reliability benefits and to compensate providers of such efficiency in a manner equivalent to the ways pool transmission facilities are financially supported. FERC has supported the southwest Connecticut activities, and has not been given an opportunity to rule on more comprehensive inclusion of reliability-driven energy efficiency in transmission tariffs. This is a significant change from standard procedure, so this initiative could be demonstrated in increasingly less emergent situations identified in the Regional Transmission Expansion Plan in advance of permanent tariff changes.

Another way ISO-New England can help is through its Regional Transmission Expansion Planning process. While the name of this process suggests an emphasis on adding high voltage transmission to solve grid concerns, the process can also support demand side solutions. The results of the plan can be reported to show the amount of efficiency and other demand resources over and above existing plans in a particular area that would address reliability deficiencies. While the ISO is not in a position to judge whether such investment is feasible or economical compared to alternatives, it can present information in a transparent way so market participants and policymakers can see clearly and in a timely way the value to reliability of the choices they have.

Environmental compliance and energy security are not generally thought of at the same time. Yet an initiative to close a group of high-emitting power generators in southwest Connecticut in 2001 raised the concern of the system operator. The potential absence of this capacity to support an area already suffering from thin reliability margins led ISO-New England to raise its concerns in Connecticut, and the generators remain in operation. Leaders in New England are now discussing a carbon cap-and-trade system for the electric sector. Those talks are not sufficiently advanced to speculate on implications for energy security. It is possible, however, that the value of high carbon-emitting power generators will be diminished if such is a system is implemented, and an assessment of any energy security implications as part of the talks would be prudent.

Renewable Energy

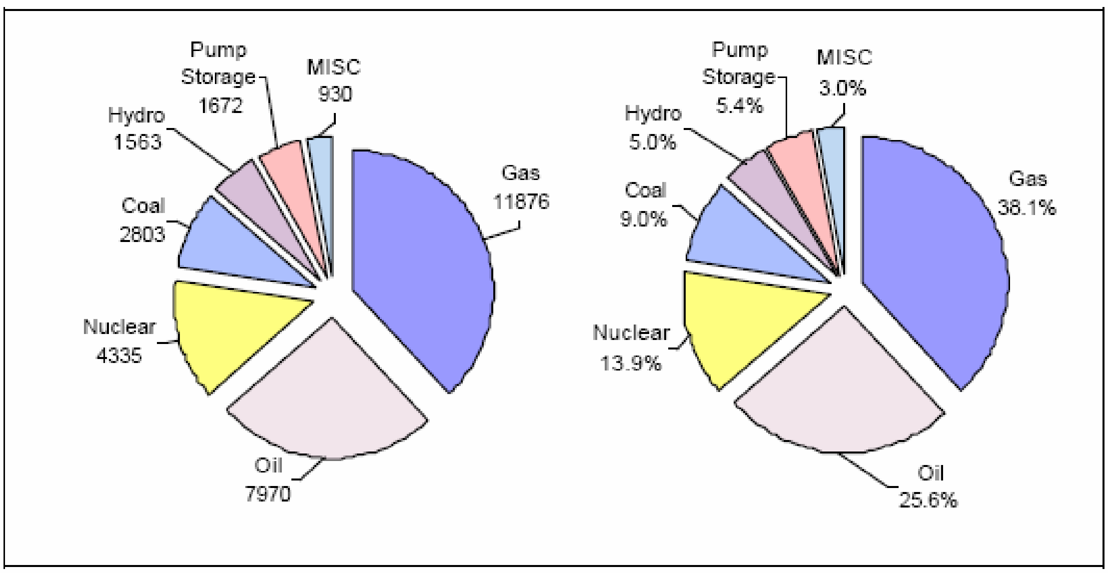
The small amount of renewable energy added since 2000 has had a small effect on energy security. However, with expected additions to the renewable power fleet in New England driven by portfolio standards and renewable funds, more capacity will be built. See Table

5. By 2010, if the RPS of Connecticut, Massachusetts and Rhode Island have their intended effect on construction of new renewable electric generation in New England, this category of sources will have a meaningful effect on energy security.

The influence of renewable energy on energy security continues to be in the realm of fuel diversity, and the smaller size and wider distribution of assets.

Fuel diversity protects against negative events that affect any one source. Every MWh generated by local renewable energy reduces reliance on imported fuels, and associated economic and political uncertainty. In addition, New England's increasing reliance on natural gas, demonstrated in Figure 1, has increased its vulnerability to a wide variety of disruptions. More than 95 percent of new capacity in New England in the last ten years is fueled with natural gas. The proportion of natural gas-fired electricity in New England has jumped from the low teens toward 40 percent. New renewable generation, combined with energy efficiency, is one of the few environmentally sound approaches to moderate this dependence on natural gas and resulting vulnerability.[38]

Figure 1



Energy Sources in New England, Summer 2003.

Source: ISO-New England Regional Transmission Expansion Plan 2003, Figure 3.2.

A positive security aspect of the new renewable energy coming on line is that it tends to come in smaller blocks than traditional generation. This trait tends to reduce the influence on system reliability of any single piece of the electric system, leading to an electric grid

[38] For a perspective from different region of the U.S., see *Cascadia Scorecard: Seven Key Trends Shaping the Northwest, Focus on Energy 2005,* Northwest Environment Watch, Seattle WA. 2005. http://www.northwestwatch.org/scorecard/default.asp (May 1, 2005)

more resilient to disruptions from natural or human causes.[39] A sudden and extended outage at two 1000 MW generators has the potential to result in a more significant disruption to society, than a few outages among dozens of small, geographically dispersed renewable generators.[40]

Renewable power tends to be available in more remote parts of the grid. To a point, added capacity here can have the beneficial effect of balancing loads on the outskirts of the grid, where voltage fluctuations are more likely absent local resources. The system operation benefits of remote generation can be exhausted if too much generation is sited, though such power may have other inherent benefits. In this event some transmission lines may be required to maintain reliability standards. In addition, some renewable generators, such as the McNeil wood-fired station in Burlington VT, are located in congested areas and provide valuable power at critical times, while others, such as hydroelectric units, provide "black start" capability, a very important resource in the event the region is recovering from a blackout.

Despite the value of renewable energy to energy security, barriers to the construction of renewable power may prevent the increase in market share of those sources that the increasing portfolio standards are intended to require. The recommendations in the next section address some of these barriers.

Results

Before moving on to recommendations, it is prudent to pause and assess the information this report develops.

Forecasted load growth in New England from 2001 to 2010, according to Capacity, Energy, Load and Transmission (CELT) reports from ISO-New England, is nearly 3600 MW (24967 to 28565). This includes an estimate by forecasters of the effects of existing energy efficiency programs. This report does not evaluate that estimate and accepts it for the purpose of this section.

Renewable energy built in New England based on the plausible scenario in this report (Phase II) will supply nearly 1000 MW or roughly 28 percent of load growth after existing energy efficiency programs. The effect of renewables from 2005 to 2010 is more

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[39] Electrical Energy Security: Assessing Security Risks, The Regulatory Assistance Project, Gardiner ME, April 2002, and Electrical Energy Security: Policies for a Resilient Network, The Regulatory Assistance Project, Gardiner ME, April 2002.

[40] This effect was actually seen in the mid 1990s when the four operating nuclear power generators in Connecticut were out of service, representing over 3200 MW of capacity. During this period, there were significant increases in NO_x, SO_x and CO_2 from historic levels as fossil fuel generation replaced the nuclear power. Personal Communication, Chris James, Connecticut Department of Environmental Protection, September 2004.

striking. Load growth over that period is forecasted to be 2210 MW. Of that, assuming Phase II capacity is built, roughly 925 MW, or 42% of that will be renewable.[41]

Table 16

	New England Energy Use GWh (1)	Renewable Energy Added in this Report (Phase II) GWh (2)	Actual Renewable Energy GWh (3)	Imputed Renewable Energy GWh (4)	Renewable Energy % in New England GWh (5)
2000	124,886	42	16,884	16,884	13.5%
2001	125,976	83	14,330	14,330	11.4%
2002	127,455	111	14,867	14,867	11.7%
2003	130,778	159		14,915	11.4%
2004	132,522	332		15,088	11.4%
2005	134,085	1302		16,058	12.0%
2006	136,630	2137		16,893	12.4%
2007	138,590	3101		17,857	12.9%
2008	140,700	3854		18,610	13.2%
2009	142,680	4623		19,379	13.6%
2010	144,725	5367		20,123	13.9%

Notes: 1 GWh equals 1000 MWh (1) From ISO-NE CELT Reports for 2001 through 2005. Estimates of future energy use (2005 – 2010) are assumed to include energy efficiency from existing programs. (2) Includes renewable generation already in service, generation judged to be probable, and imputed generation to meet regional RPS. (3) Table 1. (4) For years with historic data (2000 – 2002), that information is applied. For subsequent years, the assumption is that renewable energy added in this report is the sole source of new resources in this category. (5) These are not directly comparable to the percentages in Table 1. They are internally consistent, however, and make the point that renewable energy percentages in New England are essentially maintained with new resources prompted by RPS requirements.

[41] The authors appreciate that reserves of 15-18% beyond load growth are required to maintain reliability. These proportions are offered simply to provide a sense of scale.

The ISO-NE CELT also forecasts energy growth through 2010. The accumulated effects of energy efficiency programs implemented from 2000 through 2010 (7821 GWh, from Table 2.14 in Appendix C) reduce New England wide energy use by over 5% in 2010 (programs implemented prior to 2000 are not considered in this report, but contribute an additional amount). "Potential studies" in multiple states indicate that more efficiency is feasible and cost-effective even at the natural gas prices prevailing when those studies were conducted, which are lower than present prices.

A look at energy from renewable sources, compared with total New England energy requirements show that despite the significant projected increase in production, the proportion from this sector is simply maintained at just under 14 per cent. These data are presented in Table 16. This is due to significant continued expected growth in energy use in New England, despite the savings from energy efficiency.

VI. RECOMMENDATIONS

New England states have stood out among their peers in policies addressing energy efficiency and renewable energy. The rate of investment and deployment of energy efficiency and renewable energy is above the national norm.[42] Yet like most places, the potential for significantly more beneficial investments in each category is large and the policy basis to invest in efficiency and renewables could be stronger still.

Recommendations

Regional Coordination

1. Constitute a regional state committee. (NESCOE)
2. Value fully energy efficiency and renewable energy in wholesale markets.
3. Improve consistency of regional energy efficiency programs.
4. Support the New England Combined Heat and Power Initiative.
5. Make use of the New England Generation Information System
6. Coordinate Renewable RD&D.
7. Adopt consistent appliance and equipment efficiency standards

Regulatory and Policy Actions

8. Decouple utility net income from sales.
9. Maintain support for energy efficiency programs; reconsider budget caps.
10. Implement portfolio management for electric resources.
11. Re-integrate energy efficiency among electric resources.
12. Recognize locational benefits of "smaller" resources.
13. Target energy efficiency at peak loads.
14. Target energy efficiency at demand response customers.
15. Implement dynamic pricing through pilots.
16. Air quality rules should encourage clean distributed generation.
17. Re-engineer distribution planning to highlight high cost places.
18. Institute fair and uniform interconnection rules, business rules, and pre-certified equipment.
19. Establish a stable counter-party for long term renewable power contracts.
20. Support evaluation, monitoring and verification (EM&V) for energy efficiency and renewable energy funds.
21. Recruit businesses as voluntary partners to reduce carbon through EE/RE.

Recommendations for Collaboration

22. Identify and implement best practices for siting wind power.
23. Support Regional Greenhouse Gas Initiative.

[42] Only 16 states have renewable portfolio standards; four of them are in New England. In 2000, five of the six New England states were in the top ten for investments in EE. New England generates a higher percentage of electricity (12%) from hydroelectric and other renewables than the national norm (8.8%).

The recommendations here address this potential, and do not diminish existing accomplishments of efficiency and renewables of the New England states.[43] The Conference of New England Governors and Eastern Canadian Premiers has shown leadership in featuring energy efficiency and renewable energy in its agenda. These recommendations go directly to turning that leadership into results.

Some of these recommendations are straightforward – the responsible entity adopts them or not. Others require more coordination among many entities or states.

Regional Coordination among States

1. Constitute a Regional State Committee – One of the most often uttered ideas at electric policy conferences these days is that electric markets are regional, and that state and federal regulation inevitably come up short in applying the right mix of control and guidance to these markets. To the extent this is so, what should be done? The governors of the New England states are answering this question in their plan to form a **Regional State Committee** (RSC) of the six states to more closely collaborate, where possible, on regional electricity matters.[44] This will be called the New England States Committee on Electricity, or NESCOE. A first recommendation, then, is that NESCOE be constituted as soon as possible. NESCOE can also serve to coordinate at a policy level with counterparts in neighboring regions north and west of New England.

2. Fully Value EE/RE in Wholesale Markets – NESCOE can consider participating in wholesale market policy activity, **advancing energy efficiency and renewable energy solutions in wholesale markets** when it appears the market is not valuing these solutions. NESCOE can advocate for markets to reflect important economic and other societal values and for market rules that do not preempt these resources from contributing value to the grid. In other words, NESCOE would include among its objectives assuring that wholesale markets and regulation tend to lead to investment in the least cost resources, whatever they are. One venue for this is the ISO-NE Regional Transmission Expansion Plan and other ISO-NE Committee activity. Another venue is FERC. Demand

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[43] This section of the report owes a debt of gratitude to the participants in the New England Demand Response Initiative. Many of these recommendations also appear in the report of that group. For a deeper discussion, see The New England Demand Response Initiative, *Dimensions of Demand Response: Capturing Customer Based Resources in New England's Power Systems and Markets* (n.p.: NEDRI, 2003).

[44] Joint petition for declaratory order to form a New England Regional State Committee, June 25, 2004. NESCOE can trace its lineage to work by the National Governors Association and the Federal Energy Regulatory Commission with help from the nation's utility regulators. See: Ethan W. Brown, *Interstate Strategies for Transmission Planning and Expansion* (Washington, D.C.: National Governor's Association Task Force on Electricity Infrastructure, 2002); Federal Energy Regulatory Commission, *Notice of Proposed Rule Making on Standard Market Design*: *Docket RM01-12-000*. (July 31, 2002), 551-554; Federal Energy Regulatory Commission, *White Paper on Wholesale Market Reform*, (Washington, D.C.: July 7, 2003); and National Association of Regulatory Utility Commissioners, *Resolution Regarding Interstate Transmission Planning and Expansion* (Washington, D.C.: NARUC, 2002).

response is already supported in FERC-approved market rules. FERC has been supportive of deploying energy efficiency and distributed generation to address emergent reliability concerns. While some suggest that FERC would not approve a wholesale market rule that provides more routine support to energy efficiency and distributed generation with reliability value, others point out that a credible proposal has not been made.[45] And FERC has been supportive of recommending alternative resources in narrower contexts. States can present FERC with market solutions that make significant use of clean customer resources.

NESCOE can consider improved ways to account for efficiency and renewables in transmission expansion planning in New England.[46] A demonstration of this idea is underway with the market response to provide emergency solutions to the narrow reliability margins in Southwest Connecticut. Energy efficiency resource proposals were welcomed, and ISO-NE selected one. Will it be a one-time event, or a demonstration of a practice that could have wider application that would be reflected in the ISO-NE Regional Transmission Expansion Plan? A standard for regular application of this idea is the Efficient Reliability Rule, explained briefly in the text box.[47]

The Efficient Reliability Rule

Proposed security upgrades and reliability investment decisions that will, by administrative action, impose substantial costs on consumers and other market participants should first be tested by the following standard:

Before flowing costs of a proposed reliability enhancing investments through to all consumers through tariff, uplift or other cost-sharing process, the state PUC, FERC, and the system operator should first require a find that:

1. The relevant market is fully open to demand-side as well as supply-side resources.
2. The proposed investment is the lowest cost, reasonably-available means to correct a remaining market failure.
3. Benefits from the investment will be widespread and thus appropriate for support through broad-based funding.

To ensure that these standards are met, proposed investments should be tested in an open season bid process that is genuinely open to competitive applications from supply, wires, and demand-side resource providers.

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[45] For a longer discussion of ways distributed resources are not sufficiently valued in wholesale markets, see R. Cowart, R. Sedano, F. Weston, *Revealing the Value of Demand Response: Regulatory & Market Options*, EPRI, Palo Alto CA: 2003. 1001638.

[46] A mission statement of another RTO planning effort says it well, “The plan is to consider all market perspectives, including demand-side options, generation location, and transmission expansion.” *Midwest ISO Transmission Expansion Plan 2003*, June 19, 2003, page 6.

[47] Richard Cowart, Efficiency *Reliability: The Critical Role of Demand-Side Resources in Power Systems and Markets*, NARUC, Washington DC, June 2001.

3. <u>Improve consistency in regional EE Programs</u> – NESCOE can support energy efficiency programs in the states by **promoting consistency in common energy efficiency programs among the states**. Consistency means many things. There is already progress with the regional efforts of efficiency administrators working with Northeast Energy Efficiency Partnerships on common programs. Yet there more potential, states can support consistent use of high efficiency equipment, for example.[48] Assuring that data related to energy efficiency programs are comprehensive and are maintained by clearly identified people in a standard way would also be helpful.[49] A model of coordination is the Northwest Power and Conservation Council, in which governor-appointed representatives of 4 states discuss key regional energy issues and oversee a professional staff.

Another facet of consistency is stability. The capacity for doing energy efficiency in a state is fragile – it can be broken quickly with deep funding cuts, and rebuilding it when funding is restored is a slow and costly process. States should consider establishing a clear minimum funding level for energy efficiency to address continuing opportunities like new construction and low income markets, and then manage additional efficiency investments as a tool in resource planning to serve default customers.[50]

4. <u>Support the New England CHP Initiative</u> – NESCOE can consider supporting the work of the **New England Combined Heat and Power Initiative**. A project of the Gas Technologies Institute with support from U.S. DOE, the CHP Initiative is bringing together stakeholders interested in enabling small-scale energy systems throughout the region. While the focus of many participants is on lowering or removing unnecessary regulatory and legal barriers to fossil-fuel fired CHP systems, policy changes supporting CHP and other customer-owned generation will also benefit many renewable energy systems.

5. <u>Make Use of New England GIS</u> – NESCOE can consider seeking preferred status with the New England Generation Information System (GIS). The **New England GIS** is organized by NEPOOL and is intended to account for the generation and environmental attributes of every unit of electricity produced or used in New England. It is the system that supports the recordkeeping and trading needed to efficiently manage RPS obligations and electric product disclosure, among other things. Some information in the GIS is competitively sensitive. State regulators have access to GIS information in formats that are useful to their mission. NESCOE may find that the GIS can provide information that is important to its mission also, while not risking revealing to the marketplace anything proprietary.

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[48] NEDRI 2003 page 91.

[49] Standard information formats would have been helpful in collecting information for this report.

[50] Recent California Public Utility Commission decisions on treating energy efficiency as a resource equivalent with others in the utility process to procure resources to serve retail demand, however, demonstrate this recommendation.

6. Coordinate Renewable RD&D – The states can consider opportunities to **coordinate the efforts of the renewable energy RD&D funds** to produce better overall results. Examples include demonstrating promising technologies, or sharing the burden of developing distinct elements of a promising renewable system. This recommendation does not contemplate pooling or sharing of state RD&D funds.

7. Adopt regionally consistent appliance and equipment standards – States throughout New England are considering new appliance and equipment efficiency standards. These standards are the result of a comprehensive benefit/cost analysis and are found to provide significant savings in the Northeast U.S. The federal standard setting process has bogged down for most products for over a decade. As they have many times before, states are taking the initiative. Connecticut has passed into law a package of standards that represent a thorough assessment of products where more efficient models are readily available, yet inferior models maintain a significant market share. This package of standards removes inferior products from the market with energy savings that far outpace the cost difference. Adopting these standards across a region provides clarity to the equipment manufacturers, while reducing the rate of electric load growth and resulting unnecessary exposure to costs and other risks. After passing standards into law, states should designate an appropriate administrative agency to maintain and update standards.

Regulatory and Policy Actions

A regulatory system with its inherent incentives to utilities and others generally produces inevitable results. The question is: are these the results policymakers intended, or is the design of the process in error, leading participants astray from public policy objectives?

Policies that appear to favor investing in inferior resources tend to reveal the presence of market or regulatory barriers, and provide clues for addressing those barriers. In other words, the regulation machine will produce the results it is designed for. The motivation of regulators and the policymakers who guide them, then, is to make sure that the regulatory machine is tuned to provide the results they are looking for.

8. Decouple utility net income from sales – It is difficult to ask the electric distribution company to sell or deliver fewer units of electricity when its profits (net income, on the income statement) will be cut as a result. Yet because of the convenience of using utilities as a delivery system for efficiency service, this directive is common practice.

Where a utility still has responsibility for energy efficiency programs, regulators can help the utility embrace this challenge and use its customers as a resource. If utility profit is based on numbers of customers, or some other factor independent of sales, earnings can be based more on corporate efficiency and on performance relative to key standards for system performance, or customer relations. Decoupling sales from profits can be a very powerful shift in regulatory incentives.

States should take care that the regulatory process is not unnecessarily spurring electric demand growth and associated needs for power lines and other intrusive facilities, and is providing incentives for utilities to perform well in areas of greatest concern and value to consumers by breaking the link between sales and profits.[51]

9. Maintain support for energy efficiency programs; reconsider budget caps – States should maintain **support for existing energy efficiency efforts** without a sunset. Current programs are offsetting electric capacity needs, either now, or soon and also are avoiding pollution while providing energy savings at prices that are lower than the cost of electric production and delivery (especially with increased natural gas costs). Sustained energy efficiency is as important to service as sustained right-of-way clearing and competent regulation. In the coming years, new opportunities will continue, at the very least from new construction, in influencing purchases of newer, higher efficiency appliances and equipment, and for low-income consumers. This will be especially true and apply to more end uses if fuel prices continue upward and environmental dilemmas intensify. Budget caps for energy efficiency programs may prevent desirable energy efficiency investments in some states. **The use of energy efficiency budget caps should be reconsidered.**[52]

10. Implement Portfolio Management for Electric Resources – A **risk-aware, inclusive comparison of all resources** is essential to protecting ratepayers who buy a regulated service, including both vertically integrated service and standard offer or default service in states with retail electric competition. This means that efficiency and renewable resources should be valued for any risk-management value they provide compared with other generating resources, compared to the construction of new power lines, and they should be procured at levels beyond policy-driven minimums if they contribute to the least-cost combination of resources.[53]

11. Re-integrate Energy Efficiency among Electric Resources – In an effort to assure that energy efficiency was preserved amidst efforts to introduce competition to the electric industry, restructuring efforts partitioned it away from the rest of utility operations. Efficiency is often paid for by a separate line item on consumer bills, and it is administered as a self-contained program with a budget.

Policymakers may have gone too far. As an activity no more or less important than billing, or transmission line maintenance, this separation has drawn undue attention to energy efficiency in state budget proceedings, while limiting its effectiveness as a system resource substitute for power plants and power lines. Re-integrating energy efficiency among electric resources will enable consumers to realize its value and can occur regardless of Energy Efficiency program administrative structure.

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[51] David Moskovitz, *Profits and Profits through Distributed Resources*, The Regulatory Assistance Project, Gardiner ME, 2000. A discussion of why this is particularly important for wire-only companies appears in *Efficient Reliability* by Richard Cowart, RAP, 2001.

[52] California has a system benefit trust that raises funds for energy efficiency. The California PUC has also directed its utilities to procure all cost effective energy efficiency, and energy efficiency is competing with other resources to serve the needs of California electric consumers. The SBC funds act is a floor, not a cap. See Order, California PUC Docket #: R. 01-10-024, January 22, 2004.

[53] Biewald, Bruce, Tim Woolf, Amy Roschelle, William Steinhurst, *Portfolio Management*, The Regulatory Assistance Project, October 2003.

12. Provide Locational Benefits to "Smaller" Resources –Some locations on the electric grid require significantly more investment to maintain reliability. Local alternatives that would avoid or defer these investments merit a close look. Currently, it is not standard practice in most utilities to consider local efficiency or renewable resources as solutions to grid concerns, so there is no way to reward these "smaller" investments for the value of avoiding the larger ones. Utilities should identify high cost parts of their systems as part of their planning processes and they should consider a comprehensive set of measures to control those costs including encouraging local resources. Regulatory changes at both the state and federal levels would be needed to address this deficiency.[54] (See planning recommendation, below for how to identify these higher cost locations.)

13. Target Energy Efficiency at Peak Loads – Key stresses to the electric system occur at times of highest system demands. Energy efficiency program administrators should consider targeting end uses such as heating, ventilating and air conditioning in large commercial buildings that contribute significantly to peak demand at various times of the year. These interventions, which can easily be part of a comprehensive approach to commercial new construction or major retrofit projects, are very cost-effective and they keep fossil-fuel driven peaking generation off the system, especially the most polluting generators, and they provide an energy security buffer for the region.

14. Target Energy Efficiency at Demand Response Customers – ISO-NE offers customers the opportunity to subscribe to demand response programs. Subscribing customers curtail some electric use for a few hours in exchange for market-based compensation. When operating well, this makes customers' resources equivalent to generating resources. Participating demand response customers are likely to be motivated to manage energy costs, and are distinctive candidates to consider energy efficiency programs to further control their energy budgets. Often, there are economies in deploying demand response and energy efficiency together, encouraging best equipment operating and maintenance practices. State energy efficiency program administrators should consider targeting this relatively small group of customers to further reduce peak loads. These customers may also be more likely to be interested in on-site generation, and policies in support of such "distributed" generation should also encourage or require the installation of clean systems. (See Air Quality recommendation, below.)

15. Implement Dynamic Pricing – Average prices have social value, presenting a stable price to consumers even as the underlying electricity market prices are volatile. Any plan to implement mandatory time-of-use rates for all customers would be controversial. Yet an opportunity to signal to some customers to curtail use at expensive times can control total costs to everyone. State regulators should consider ways to present to at least some consumers who stay with the provider of last resort the opportunity to buy a product with

[54] This recommendation is not meant to address the system of locational marginal pricing in the energy market of ISO-NE.

a price structure that signals, at least directionally, the cost of the energy at the time it is used.[55]

16. Air quality rules should encourage clean distributed generation – Distributed generation has come a long way from the wood boilers adjacent to pulp and paper plants that turned sawdust and waste wood into electricity and heat. Almost any customer today can make electricity. The problem is that this is most often done through the use of diesel-fired generators that can be ten to twenty times as polluting as grid-based power. States should adopt air quality rules that encourage clean generation by making permitting easier for clean systems, some of which qualify as renewable systems in some states.

17. Re-engineer distribution planning to highlight high cost places – Distribution engineering planning is a critical gateway for decisions about how to spend millions of ratepayer dollars on reinforcing the system often due to localized changes in demand. By high cost, we mean a high long run marginal cost driven by expensive capital requirements. Local resources offer significant benefits which are generally overlooked, though awareness among regulators and utilities that this is possible is growing. States should highlight the opportunities for distribution companies to solve system problems in high cost locations.

18. Institute fair and uniform interconnection rules, business rules, and pre-certified equipment – States should take steps to assure that its rules concerning distributed generation are fair and comprehensive. For customers interested in on-site generation with a connection to the grid, each approach to interconnect can feel like the first time. Absent a requirement to do so, it is the exceptional utility that has a process in place to address all the issues that routinely come up, for example: standard contracts for power exchanges, standard terms and conditions for insurance and safety procedures, and listing of equipment for which an assessment of compatibility does not have be done every time. Fairness in this context means that neither the utility nor the distributed generator is paying an amount out of scale compared to the value of what is being purchased.

19. Establish a stable counter-party for long term renewable power contracts – States should assure that the default service provider or some other entity is empowered to make a long term commitment (i.e. 10 years) with renewable generators. This will enable some generators to get the financing they need to build. For other developers who can build with shorter term agreements, longer term contracts still help as they will enable consumers to see lower prices while reducing business risks to the supplier.

[55] *NEDRI 2003*, Chapter 3, July 2003.

Selected Recommendations: Organized Temporally

This section contains 21 recommendations, a large number to process. This text box serves to organize these recommendations to show ones that could be implemented quickly, and ones that are likely to take time to accomplish or to develop consensus sufficient to take action.

Nearer Term

Fair and uniform interconnection, business rules, etc. – Underway in some states. Regulatory commissions can initiate generic dockets.

Adopt air quality rules that encourage clean distributed generation – Underway in some states.

Target energy efficiency at peak loads – Already being done to varying degrees within core programs. Southwest Connecticut experience demonstrating this for reliability purpose. Some utilities considering pilots to identify distribution circuits where added efficiency investments can avoid peak-driven investment.

Target energy efficiency at demand response customers – An enhancement of utility service to demand response customers.

Constitute NESCOE – Underway.

Implement RGGI – Recommendations should be available for state action in 2005.

Support the Northeast CHP Initiative – Recommendations will be available in 2005.

Voluntary partnership of leading state businesses - Can be organized quickly.

Longer Term

Decouple utility net income from sales – It takes time to develop a plan to implement this change and see it approved. Critical path is defined, however, by the time it takes to decide to embark on this path. Other recommendations would flow from this, including re-engineering distribution planning,

Portfolio Management – This is a process that utilities and regulators will continue to improve on, once they begin thinking about resource acquisition this way.

Long-term contract counter-party – Requires discussion on ways to do this where retail competition prevails.

Introduce dynamic pricing – Because this can produce winners and losers, finding opportunities to attract volunteers, and testing the practice over time will be preferable.

Wind Power Siting – Local collaboratives and other efforts require more time; offshore siting is new for the U.S. RGGI recommendations may underscore value of wind power.

Re-engineer distribution planning – This policy is the subject of a pilot in Massachusetts. This policy will require some years of evaluation, even after there is a decision to try it. This policy is important to identifying local benefits of distributed resources.

Recommendations to maintain and coordinate efficiency and renewable programs are on-going.

20. Support Evaluation, Monitoring and Verification (EM&V) for Energy Efficiency and Renewable Energy Funds – Long term confidence in the wise use of funds set aside for energy efficiency and renewable energy research, development and deployment will depend on the degree to which the programs prove their effectiveness. Policymakers and implementers must assure that these programs receive ample oversight to produce this proof. While some might blanch at the cost of effective EM&V, these costs should be factored into policymakers' judgment of the value of these programs, as they have been for successful energy efficiency programs over many years.

21. Promote voluntary actions by a Business Environmental Leadership Council - States can organize leading businesses to declare energy and environmental goals, share and recognize success stories, and learn from others. These can be modeled on national partnership programs organized by federal agencies or non-profits.[56]

Collaborative Recommendations

These recommendations are ones in which many must collaborate for success.

22. Developing best practices for siting wind power is proving to be very difficult in many places in New England. Since lots of clean energy can come from these projects, collaborative processes addressing particular projects have emerged in Massachusetts, Maine and Vermont, but these have not yet produced a resolution for the projects, let alone a template that can be applied generally. It is possible that this issue simply needs to play out, and siting authorities will make their decisions based on contentious evidentiary records. Is there nothing else to do?

One recommendation is to assure that the process for siting is sound. This is particularly important for offshore wind projects, where new issues, like the process to secure rights to offshore areas, remain matters of debate. But it is also important for ridgeline projects. Is every view and vista precious, or is it appropriate to develop a fraction of these to secure a measure of the benefits of wind power? Siting authorities may lack clear guidance to decide these questions. State and regional energy planning, with updated siting statutes will help clarify the process, and help all to get a better idea how much indigenous renewable energy New England will likely develop.

Associated transmission facilities for wind projects do not present unique challenges, but they can be formidable. Offshore projects require a submarine cable to come ashore, possibly affecting sensitive shoreline and interacting with people. Ridgeline projects may require a new right-of-way for the interconnecting power line. While formidable, the challenges have been addressed by New England states in other cases.

23. Regional Greenhouse Gas Initiative (RGGI) – Complete the multi-stakeholder effort now underway, RGGI, to control greenhouse gases by developing a capped carbon market for New England and surrounding states.[57] Low-carbon resources, especially energy efficiency and renewable energy, will realize more of their value in the presence of such a system. It will be important that the rules of a system of this kind successfully value low carbon resources in the electricity market and reward investors. Since the concern for carbon is global, a global carbon market would allow the value of low-carbon resources to be reflected anywhere. An effective market-based solution may attract other states interested in controlling carbon to participate.

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[56] See http://www.pewclimate.org/companies_leading_the_way_belc/company_profiles/ (April 15, 2005), http://www.epa.gov/partners/ (April 15, 2005)

[57] http://www.rggi.org/ (April 15, 2005)

Priorities

Of the 23 recommendations, it is a challenge to choose the five that are most important. These address valuing EE and RE, or key barriers.

1. Decouple utility income from sales.
2. Re-engineer distribution planning to identify high cost places.
3. Value fully energy efficiency and renewable energy in wholesale markets.
4. Adopt air quality rules that encourage clean distributed generation.
5. Adopt fair and uniform rules for interconnection, etc.

Important decisions will be affected by:

1. Recommendations of RGGI;
2. Recommendations of NECHPI;
3. Best practices of wind siting.

VII. FURTHER WORK

Data collection for this project produced state level information but the scope of this project only allowed for regional level data to be analyzed and reported. Further work would analyze and report state level data to identify specific state level opportunities, barriers and recommendations pertaining to energy efficiency and renewable energy deployment.

This project is only addressing a subset of the issues that will affect the pace of development of efficiency and renewables. Among the other matters that need attention are:

- Acknowledging the intermittent nature of wind power, how much wind power can system operators manage routinely in a system before it affects the way operators deploy resources for reliability and economic goals.
- This report has identified the policy dilemma of public acceptance of wind siting, but aside from calling attention to the ongoing local collaborative efforts that have taken place, others are encouraged to dig into this challenge more deeply.
- The report does not answer the question of whether all load growth in New England for a period of time can be met by a combination of energy efficiency and renewable energy. For some, this CEO-level goal is an imperative. For others, it is a pipedream. More analysis by states of economic potential and policy barriers is needed to determine appropriate goals.
- The report also does not seek to find the optimal rate of energy efficiency investment, or the optimum level of renewable generation investment in New England. The report also does not evaluate whether current investment rates are close to a level of diminishing economic returns, or could be extended to higher levels with similar winning results. Work by Northeast Energy Efficiency Partnerships does indicate that more energy efficiency would be cost effective.
- Climate change mitigation through a mandatory cap on carbon emissions from electric power generation and a trading system to value carbon credits may disrupt the course of future electric resource investments. This report does not delve into how the degree energy efficiency and renewable energy will be affected. If there is a cap on carbon emissions from generation, the next most important factor affecting what happens next is how the credits are allocated. The Regional Greenhouse Gas Initiative, a stakeholder process with the participants from across the Northeast, will have significant role in answering this question. In order to answer these carbon-related questions well, it will be important to have quantitative goals against which policymakers can measure progress, and a clear idea of the impact of different policies on efforts to meet the goals. The modeling work in this report presents a useful tool that can help policymakers better gauge the expected results of their policy actions.

VIII. ACKNOWLEDGEMENTS

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Catherine Murray at RAP did an incredible job gathering and interpreting data for this project from many, many sources, as the list of acknowledgements demonstrates, and was scrupulous about assuring that data was used properly. Beth Heath of the RAP staff diligently scrubbed that data and improved its quality. Rain Banbury at RAP provided her usual pivotal assistance in the production of this report. We are grateful to our colleagues at RAP who stimulate each other and our readers with ideas on how to improve the deployment of least cost energy resources around the world.

IX. SOURCES

Data regarding electric efficiency program expenditures and savings was taken from the sources below. We used prorating and data from other states to estimate program-level data where such data was not available. Expenditures beyond 2004 are assumed to increase at an inflation rate of 2.5 percent.

- For Connecticut, all data was found in annual reports prepared by the Energy Conservation Management Board for the Connecticut Legislature's Energy and Technology Committee and the Environment Committee. Clarification of data and assistance with estimates came from staff of the utilities administering the programs. The annual reports can be found on the website of the Connecticut Department of Public Utility Control.

- For Massachusetts, the 2000 and 2001 annual reports on the status of energy efficiency activities, prepared by the Division of Energy Resources (DOER), were used to report actual expenses and savings. The annual reports may be found on the DOER website. Preliminary data for 2002 and estimates for 2003 and 2004 were obtained through correspondence with DOER staff.

- For Maine, subtotal and total expense figures for the years 2000-2002 are from EIA Form 861 reports from Maine's three largest distribution utilities, as recorded on the EIA website. Total annual savings figures for those same years reflect the incremental savings reported in the Form 861 reports. Data from 2002 may not include a small amount of non-utility expenditures as program responsibility was transferred to the PUC during the year. Figures for the years 2003-2004 are from Efficiency Maine annual reports and plans, as found on the Maine Public Utility Commission (MPUC) website, and interviews with PUC staff who manage the Efficiency Maine programs. Utility program results, as opposed to the Maine Efficiency program run by the MPUC, are missing for both 2003 and 2004. Efficiency Maine expenditures are approximate for 2003; they were prorated from 10 months of available data. Figures for 2004 expenses are estimated, not actual.

- For New Hampshire, subtotal and total expense figures for the years 2000-2002 are from EIA Form 861 reports from New Hampshire's largest distribution utilities, as recorded on the EIA website. Total annual savings figures for those same years reflect the incremental savings reported in the Form 861 reports. Figures for 2003 were derived from the Core NH Program Quarterly Report on the New Hampshire Public Utility Commission's website. The report covered the period 6/1/02-12/31/03. To be compatible with the utilities' EIA reporting for the same period and eliminate double-counting, the 19 month figures were divided by 19 and multiplied by 12. Annual savings for 2003 were determined by dividing the reported lifetime savings by average lifetime figures supplied by Public Service Company of New Hampshire energy efficiency personnel. When programs with different measure lives were combined for this report (e.g. Energy Star Lighting and Energy Star Appliances), the portion of lifetime savings attributed to each program was divided by the appropriate measure life. Resulting annual savings were then summed. Data for 2004 is based on 2003 expenditure and savings levels.

- For Rhode Island, data for the years 2000-2003 is from the annual Demand Side Management Year End reports filed by Narragansett Electric before the Rhode Island Public Utilities Commission (RIPUC). Program expenses vs. administrative/indirect costs were split 90:10, after conversations with Narragansett Electric staff. Target figures for 2004 are from "Settlement of the Parties in Re: the Narragansett Electric Company, Demand Side Management Programs for 2004" filed with the RIPUC.

- For Vermont, expenses and verified savings for the years 2000, 2001 and 2002 were obtained from the annual reports reflecting adjustments from the savings verification process. Figures for 2003 were found in the Year 2003 Preliminary Annual Report and Annual Energy Savings Claim. Expenses and savings for 2004 were held constant (less inflation) from 2003 levels. All of these reports and plans are submitted to the Vermont Public Service Board. They were obtained for this paper through correspondence with staff of Efficiency Vermont.

Renewable energy information was drawn from ISO-New England and U.S. Energy Information Administration documents.

The RPS build-out scenario represents a plausible future, given many constraints that other writers and the authors found might govern the deployment of the various qualifying energy systems.[58] Renewable generation in this scenario includes:

- ♦ that which was built from 2000 to the present, presumably stimulated by state portfolio standards

- ♦ qualifying generation announced to be built (the authors attempted to verify through interviews and other means that the units included here are likely to be developed – some announced units were not included because they did not meet this criterion in the judgment of the authors)

- ♦ sufficient imputed generation of qualifying fuel types coming into service in each year to meet the cumulative RPS requirements in that year, as judged to be feasible by RAP and Synapse.

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[58] Smith, Douglas C., Karlynn S. Cory, Robert C. Grace, Ryan Wiser, *Massachusetts Renewable Portfolio Standard Cost Analysis Report*, LaCapra Associates, Boston MA, December 21, 2000

Woolf, Tim, David White, Cliff Chen, Anna Sommer, *Potential Cost Impacts of A Vermont Renewable Portfolio Standard,* Synapse Energy Economics, Cambridge MA, September 9, 2003.

Appendix A : RESOLUTION OF THE GOVERNORS AND PREMIERS

28th Annual Conference of the New England Governors and the Eastern Canadian Premiers Groton, CT - September 7 - 9, 2003

RESOLUTION 28-7

RESOLUTION CONCERNING ENVIRONMENTAL PROJECTS AND ISSUES

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

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

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

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

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

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

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

BE IT FURTHER RESOLVED THAT the Conference of New England Governors and Eastern Canadian Premiers commends the successful efforts of its Acid Rain Steering

Committee, Mercury Task Force and Climate Change Steering Committee, and accepts their reports and next year's work plans as submitted to the Conference; and

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

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

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

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

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

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

John G. Rowland Governor of Connecticut Co-chair	Bernard Lord Premier of New Brunswick Co-chair

Appendix B : INTERACTIONS WITH SURROUNDING REGIONS

New England gets the majority of its primary energy from outside the region. In addition to electricity produced in Canada and New York, the gas, coal and oil that fuels most combustion-driven power generation comes from locations across the globe.

Because electric production tends to be less expensive in places closer to primary energy sources, importing some electricity to New England has made sense. While the trend to build nuclear power represented, in part, an effort in self-sufficiency and diversification from fossil fuels, limitations beyond the scope of this report have capped the share nuclear power to roughly 20% of New England electricity.

Electric transmission constraints limit the amount of power that can flow into New England from Canada and New York

There is a group of electric connections between New England and New York. Their transfer limits are controlled more by reliability concerns, rather than physical limits. This means that spare capacity may be held out the market, even when the line is operating a "full capacity" on a given day, to allow for additional power to flow in the event of a sudden outage of a major generation or transmission facility. Power from Quebec and Ontario can reach New England through New York. Table A-1 reports the amount of firm capacity purchases from neighboring systems, reported by NEPOOL.

Table B-1. Net New England Capacity Purchases from Neighboring Systems

	Hydro-Quebec	New Brunswick	New York	Firm Energy Contract*
Winter '00	633	249	127	1500
Summer '00	633	249	127	525
Winter '01	633	324	125	1500
Summer '01	633	324	127	525
Winter '02	280	300	127	0
Summer '02	325	100	127	0
Winter '03	280	225	816	0
Summer '03	280	484	127	0
Winter '04	326	0	-425	0
Summer '04	326	0	127	0

Source: NEPOOL Capacity, Energy, Load and Transmission (CELT) Reports, 2000, 2001, 2002, 2003, 2004.* Capacity Credit for deliveries to New England under the Firm Energy Contract between Hydro-Quebec and NEPOOL, which has since ended.

Additional capacity may have come from these systems in the short term power market.

There are two categories of electric transmission linking Canada and New England. The Maritime Provinces are synchronized electrically with New England, and power lines connect Maine with New Brunswick. The second category reflects the fact that the power grid in Quebec is not synchronized with its surrounding states and provinces. This means power from Quebec must pass through a conversion process to reach New England. There are two converters operating in New England, one in Massachusetts and one in Vermont. Each has a specific amount of power it can handle, 2000 MW in the former, 225 MW in the latter. As with the New York lines, the total amount from Quebec is generally reduced from the physical ratings to protect reliability. In addition, Northwestern Vermont relies on the Vermont converter for electric stability. In other words, the reliability of this part of Vermont relies on some power (100 to 150 MW) flowing from Quebec on this line.

Natural gas pipelines are presently fully capable of delivering product to meet firm demand. The choice of words here is meaningful. Firm gas is delivered to the following users: local gas distribution customers who are not on interruptible contracts; electric power generators with firm gas contracts. According to the Northeast Gas Association, New England pipeline capacity is adequate to serve today's firm gas demand. Upgrades will be needed to serve growth in firm demand, and there is not enough slack capacity during days to support non-firm users, which is fair to gas customers.

Over 4400 MW of natural gas-fired generation in January 2004 was served by fuel contracts that allow the pipeline company to curtail service in favor of firm customers. Since these events are often coincident with winter peaking electric demand, the value of this capacity in the heating season is a matter of some debate.[59]

New York, through its Public Utilities Commission, has created a renewable portfolio standard. The intent of this policy is to increase the percentage of qualifying renewable energy in New York from 19% to 25% by 2013. It is likely that New York will need all the renewable energy credits it can produce for its own needs and few if any will be available for export to New England. Yet the ability for the New York and New England markets to exchange renewable credits should improve. Presently, there is not a seamless exchange of renewable energy credits between New York and New England. If this is not changed, each side of the New England – New York border will essentially have to supply its own renewable energy needs. With a seamless exchange, the most economical renewable sources in the region can serve the regional demand for renewable energy credits.

[59] Final Report on Electricity Supply Conditions in New England during the January 14-16, 2004 "Cold Snap", ISO-New England, pg. 69, October 12, 2004. Over 6000 MW (winter rating) of gas-fired capable generation in New England is either designed for oil back-up, or runs primarily on oil with gas back-up.

Appendix C : Modeling Economic and Environmental Effects of Investments in Energy Efficiency and Renewable Energy

Following is a paper prepared by Synapse Energy Economics, Inc., to document its work and results for this project.

Preliminary Estimates of Economic Impacts and Potential Air Emission Reductions from Renewable Generation & Efficiency Programs in New England:

Phase I Summary

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1.0 INTRODUCTION

1.1 Purpose and Scope

Synapse Energy Economics, Inc., (Synapse) has prepared this analysis to assist The Regulatory Assistance Project (RAP) in analyzing the impact of renewable generation projects and electric energy efficiency programs in New England. The analysis first covers new renewable generation that came on line during the period beginning with January 1, 2000 and ending December 31, 2004, including the effects of both their construction and their operation through the end of the study period at December 31, 2010. This initial analysis also includes the impact of New England electric energy efficiency programs from January 1, 2000, forward to the end of the study period, December 31, 2010. The first analysis for renewable generators is referred to as the "Phase I" analysis in the rest of this report. The Phase I analysis is intended to estimate the impact of certain state policies for renewable generation and electric energy efficiency from 2000 through 2004, but to include the on-going impacts of those policies through 2010.

In the energy efficiency portion of the study, we include the utility programs of the New England states, as well as the non-utility programs of those states that are funded by a system benefit charge (SBC) applicable to retail electricity sales. We include the activities of those programs as reported for each of calendar years 2000 through 2004. In addition, we assume that those programs will continue during the calendar years 2005 through 2010 and operate unchanged at their 2004 levels of expenditures and savings.

A second analysis, called the "Phase II" analysis was performed, as well. The Phase II analysis includes the impact of electric energy efficiency programs from the beginning of 2000 through the end of 2010, but its renewable generation aspect is expanded to include new renewable generation that came or is expected to come on line between January 1, 2005, and December 31, 2010, in addition to renewable generators included in Phase I as a result of New England renewable portfolio standard (RPS) requirements. In addition to specific, announced, RPS-eligible renewable generation units that are expected to come on line during 2005 through 2010, we included an additional amount of new generic renewable units sufficient to meet the requirements of the existing state RPS rules during that period.

We examine those new renewable generators, defined as a project eligible under the renewable generation definition of one or more New England states, entering commercial service on or after January 1, 2000.[60] We assume that those units will operate at current levels through December 31, 2010, except for a few units that ceased operation prior our

[60] We are aware of several projects, especially run-of-river hydro units eligible for the Connecticut RPS, under way in New England to convert or upgrade new or pre-existing generators to provide more renewable power or to convert to production of renewable power for sale in New England markets. Those projects are not included in our study, but an equivalent amount of new generic units are included.

analysis, and report the estimated economic impacts and potential air emission reductions of the study units through that date.

In the energy efficiency portion of the study, we include the utility programs of the New England states, as well as the non-utility programs of those states that are funded by a system benefit charge (SBC) applicable to retail electricity sales. We include the activities of those programs as reported for each of calendar years 2000 through the last year of available data.. In addition, we assume that those programs will continue until 2010. Where savings or expenditure data are not available, we used assumptions derived from the best available information to project future energy efficiency program outlays and achievement through 2010. Our analysis is intended to estimate the impact of certain state policies for renewable generation and electric energy efficiency from 2000 through 2010, including the on-going impacts of those policies through 2010.

1.2 Overview of Methods

Our analysis of economic impacts relied on input data collected from the states as part of this study, as well as Synapse data on the investment and operating costs and operational characteristics of the relevant types of renewable generation. Electric efficiency (EE) program data used in this analysis include annual expenditures by program and annual electric energy savings. Both types of data were derived from efficiency program reports for the six New England states and additional information obtained from Commission and Energy Office staff in the states.

Most of the Synapse data on generic renewable units came from our recent study of renewable generation costs in New England performed for the Vermont Public Service Board. Since the eligible projects are not utility-owned, little public data exists on their construction and operating costs. Generic input data and assumptions were developed to represent hydro, wind, landfill gas, biomass, solar, and fuel cell projects relevant to the study period. Synapse data characterizing the fuel mix of ISO-NE's generation and variable operation and maintenance (O&M) costs were used to model avoided costs.

Economic impacts were estimated using the IMPLAN model. IMPLAN is a widely used input-output economic model, available with data for each state. We used a data set that combined the six states in New England into a single regional economy.

Potential air emission impacts were estimated using Synapse and ISO-NE data that characterizes the marginal emissions of ISO-NE generation. That data was used to estimate the potential air emission reductions each year due to the output of the renewable generation and electric efficiency program savings included in the study.

1.3 Limitations

This study does not address potential changes in various types of input data, including but not limited to marginal fuel mix and emission rates, avoided costs, productivity improvements at existing units, productivity improvements in energy efficiency programs, potential export business (or reduced import business) generated by growing local renewable or efficiency businesses, benefits from reduced volatility or clearing prices due to reduced traditional generation and associated fuel demands (including clearing price and volatility reductions for all fossil fuel users), or details of inter-state trade within New England.

Due to the linear nature of the IMPLAN model, the study does not consider possible changes in industry use of labor, capital, fuel or intermediate goods as demand changes. In particular, the model assumes that productivity of labor and other factor inputs is constant. To the extent that labor productivity continues to increase, reflecting that trend would reduce the labor impacts, both for increased spending on energy efficiency and renewable energy and for reduced output in the electric utility and fossil fuel sectors.

2.0 Data Collection

2.1 Renewable Generation Projects

Renewable Generation Output

We identified existing and planned RPS-eligible generators from the 2003 NEPOOL GIS "GIS Generators" public reports, from "RPS-Qualified New Renewable Generation Units" on the Massachusetts Division of Energy Resources (DOER) website (http://www.mass.gov/doer/rps/approved.htm), from the Maine Public Utility Commission's *CEP Annual Report for Calendar Year 2002*, and from *CT RPS Generator Application* on the Connecticut Department of Public Utility Control's website (http://www.state.ct.us/dpuc/database.htm).

We obtained limited generation data for some units from correspondence with staff at the Massachusetts DOER, who compiled the information from compliance reports, from the Maine PUC's *CEP Annual Report for Calendar Year 2002*, from the EIA Form 906 2002 Monthly Reports, from a report labeled "CT Generation" found on the electricity sector working group page of the CT Climate Change Stakeholder Dialogue at http://www.ccap.org, as well as the EPA EGRID database. For units and years in which generation data was not available, we estimated generation levels using unit capacity as listed in the 2003 Forecast Report of Capacity, Energy, Loads and Transmission (CELT report) and a generic capacity factor. These capacity factor assumptions are listed in Table 2.1. Biomass refers to wood steam generators, LFG refers to landfill gas, PV refers to photovoltaic systems, and MT refers to one biodiesel-based microturbine unit included in our analysis. Our assumptions on wood steam plants are more discussed in "Phase II Analysis" and "Renewable Generation Cost" sections below.

Table 2.1 Capacity Factors

Wind	Hydro	Biomass	Landfill Gas	PV	Fuel Cell	MT
28%	50%	80%	90%	16%	85%	90%

Phase I Analysis

The Phase I analysis includes new renewable generation plants that went on line during the period beginning January 1, 2000 and ending December 31, 2004. Table 2.2 presents specific generation additions each year by fuel. We assume that those renewable generation facilities continue operating until December 31, 2010, except for certain specific facilities that discontinued operation prior to this writing. With the data and assumption for such renewable generation, we estimated the total generation output for the renewable generation in the Phase I analysis shown at Table 2.3. Note that generation by wood steam facilities starting from 2005 is due to one large wood steam unit that started operating December 31, 2004. Also, wind power generation decreased in 2005 to 2010 because two wind facilities stopped operating in 2004.

Table 2.2. Phase I Specific Capacity Additions by Fuel Type (MW)

	2000	2001	2002	2003	2004	Total
LFG	8.7	2.8		5.6	14.7	31.8
Hydro	3.9	3.1	1.9	4.0		12.9
Biomass					25.9	25.9
Wind	0.3	0.7				1.0
NGFC			0.6	0.7		1.3
PV	0.1				0.03	0.14
Total	13.0	6.6	2.5	10.3	40.6	72.9

Table 2.3. Phase I Generation Output by Fuel Type (MWh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LFG	28,735	54,035	70,546	104,536	217,771	230,434	230,434	230,434	230,434	230,434	230,434
Hydro	12,804	28,524	36,323	46,084	102,072	102,072	102,072	102,072	102,072	102,072	102,072
Biomass	0	0	0	0	0	178,031	178,031	178,031	178,031	178,031	178,031
Wind	579	577	1,398	2,196	2,196	1,619	1,619	1,619	1,619	1,619	1,619
PV	156	156	156	156	727	726	726	726	726	726	726
NGFC	0	0	2,766	5,810	9,308	9,308	9,308	9,308	9,308	9,308	9,308
Total	42,274	83,292	111,189	158,782	332,072	522,189	522,189	522,189	522,189	522,189	522,189

Phase II Analysis

Our Phase II analysis differs from the Phase I analysis only in that it includes new renewable generation that will come online between January 1, 2000 and December 31, 2010. This includes both specific new facilities known to us and an additional amount of generic new additions sufficient to meet the existing RPS requirements through 2010.

Several renewable projects that came or will come on line and are eligible for MA RPS in or after 2005 were identified. Table 2.4 presents the capacity additions for Phase II analysis. Information regarding the new renewable projects is obtained from MA DOER's website as follows:

- two wind projects in 2005
- two landfill gas project in 2005
- one biodiesel-based microturbine project in 2005
- one wood steam boiler project in 2005
- six biomass facilities using fluidized bed that are likely to be in operation in 2006 or 2007 are treated as conventional wood steam boilers because data on fluidized bed biomass technologies is not yet readily available in sufficient detail to conduct in-depth economic and environmental analysis.

There are also four biomass facilities (two re-tooled biomass combustion plants with fluidized bed; one bio-oil; and one anaerobic digestion projects) that we identified in MA

DOER's list but did not include in our study due to lack of sufficient data on those technologies such as total capital and O&M costs, details of such costs (e.g. share of generator, building and road construction, installation labor, interconnection-related costs in the total capital costs) and in service date.[61]

In addition to these specific projects, we assumed a sufficient amount of new generic renewable generation plants would come on line after 2004 in order to meet RPS goals in Massachusetts, Connecticut (Class I), and Rhode Island. Such plants were assumed to be divided among wind, solar, landfill gas, run-of-river hydro, fuel cell, and biomass. Table 2.5 presents the generic capacity additions (as well as the capacity of the Phase I units shown in Table 2.2) and Table 2.6 presents their generation output based on specific and generic capacity factor values (including the output of the Phase I units shown in Table 2.3).

As mentioned above, most of the specific biomass projects eligible for Massachusetts RPS use fluidized bed combustor technology, and we are aware that such advanced biomass plants with lower emission will be likely candidates in MA and CT Class I RPS markets in the next five years.[62] Anticipating that advanced biomass technologies would include fluidized bed combustor, fluidized bed gasifier, and the use of those technologies for repowering or retrofitting existing biomass, coal, and natural gas-fired plants, we assume lower emissions for new generic biomass units, consistent with those advanced technologies. However, estimating the capital and operating cost assumptions for those new generic units poses difficulties. Newly built units are likely to be more expensive than new conventional wood steam units, but repowering existing steam units with such technologies is likely to be less expensive. The capital costs of new conventional wood steam units (around $1735/kW) is about the midpoint of the capital costs of new fluidized bed gasifier or high pressure gasification units (around $2500 to $3000/kW) and repowering existing steam plants (around $300 to $600/kW). Therefore, we use $1735/kW as a rough representation for the capital cost of a mix of those new technologies.[63] We applied O&M costs associated with conventional steam plants to all new biomass plants.

[61] These capital and O&M cost details are required to conduct in-depth economic analysis by IMPLAN.

[62] Conventional biomass steam plants are not eligible for MA and CT I RPS due to their stricter standards.

[63] Bob Grace and LaCapra Associates, 2004, *RGGI Renewable Energy Modeling Assumptions* for the cost of advanced biomass technologies; California Energy Commission, 2002, *Biomass Cofirng with Natural Gas in California* and Energy Products of Idaho, 2001, *Repowering Options: Retrofit of Coal-Fired Power Boilers using Fluidized Bed Biomass Gasification* for the cost of biomass co-firing.

Table 2.4. Phase II Specific Capacity Additions by Fuel Type (MW)[64]

Fuel	2000	2001	2002	2003	2004	2005	2006	2007	Total
LFG	8.7	2.8		5.6	14.7	6.3			38.1
Hydro	3.9	3.1	1.9	4.0					12.9
Biomass					25.9	8.6	70.9	100.3	205.7
Wind	0.3	0.7				4.1			5.1
PV	0.1				0.03				0.1
NGFC			0.6	0.7					1.3
BDMT						0.03			0.0
Total	13.0	6.6	2.5	10.3	40.6	19.0	70.9	100.3	263.1

Table 2.5. Combined Phase I and II Capacity Additions by Fuel Type (MW)[65]

Fuel	2005	2006	2007	2008	2009	2010	Total
LFG	34.0	33.0		23.0	15.0	20.0	125.0
Hydro	7.0	2.0		11.0	10.7	3.3	34.0
Biomass	43.0	15.0	1.0	13.0	18.0	27.0	117.0
Wind		20.0	3.0	114.0	134.0	94.0	365.0
PV	0.2	0.4	0.1	1.3	1.2	2.4	5.6
NGFC	15.0	15.0		20.0	20.0	20.0	90.0
Total	99.2	85.4	4.1	182.3	198.9	166.7	736.6

Table 2.6. Combined Phase I and II Generation Output by Fuel (MWh)

Fuel	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LFG	28,735	54,035	70,546	104,536	217,771	532,550	805,545	805,545	987,374	1,105,137	1,262,817
Hydro	12,804	28,524	36,323	46,084	102,072	132,732	141,492	141,492	189,804	236,538	250,992
Biomass	0	0	0	0	0	509,757	895,239	1,851,541	1,942,895	2,068,789	2,258,005
Wind	579	577	1,398	2,196	2,196	4,809	60,682	68,041	348,426	676,335	906,898
PV	156	156	156	156	727	1,007	1,567	1,707	3,535	5,211	8,575
NGFC	0	0	2,766	5,810	9,308	120,998	232,688	232,688	382,016	530,528	679,448
BDMT	0	0	0	0	0	187	223	223	223	223	223
Total	42,274	83,292	111,189	158,782	332,072	1,302,039	2,137,436	3,101,237	3,854,272	4,622,761	5,366,958

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[64] NG(FC) is natural gas-based fuel cells and BD(MT) is biodiesel-based microturbine. Natural gas-based fuel cells are eligible units in some RPS rules. Some such rules encourage NG(FC) units due to their significantly lower NOx and SO2 emissions compared to central power plants and also because they are viewed as a bridge technology to fuel cells that rely on hydrogen, a particularly clean fuel that may be able to be produced and stored from intermittent renewable electricity sources.

[65] No generic BDMT units were included in Phase II, so no assumptions were developed. The BDMT generation in Table 2.6 is from one specific biomass MT unit.

Renewable Generation Costs

We based the capital and operating costs of different renewable generating technologies on estimates from economic analyses of the Massachusetts RPS and proposed renewable standards in New York and Vermont, as well as cost characterizations from EIA, EPA, and Massachusetts Technology Collaborative.[66] These costs were divided into various IMPLAN model sectors representing the different economic activities conducted in the region, such as different types of goods and services produced. We allocated the costs to these categories using capital and O&M cost breakdowns in various studies such as the Department of Energy's Renewable Technology Characterizations, and our professional judgment. Our renewable technology cost estimates and their allocations to different cost categories are shown in Tables 2.7 and 2.8. These costs have been converted to 2001 dollars.

Table 2.7. Capital Cost Assumptions

Fuel	Total Capital Cost (2001$/kW)	Turbine/ Generator Equipment	Building Construction	Road Construction	Intercon-nection	Installation Labor	Other Costs
Wind	1,117	60%	5%	10%	5%	10%	10%
Hydro	2,416	37%	37%	3%	3%	10%	10%
Biomass	1,735	60%	5%	10%	5%	10%	10%
LFG	1,950	65%	5%	0%	5%	15%	10%
PV	5,500	70%	5%	0%	10%	5%	10%
FC	4,424	70%	5%	0%	10%	5%	10%
MT	3,500	61%	5%	0%	5%	15%	14%

[66] Smith, Douglas, Karlynn Cory, Robert Grace, and Ryan Wiser 2000. *Massachusetts Renewable Portfolio Standard Cost Analysis Report*, prepared for the Division of Energy Resources; New York State Department of Public Service, New York State Energy Research and Development Authority, *Sustainable Energy Advantage*; LaCapra Associates 2003, *New York Renewable Portfolio Standard: Cost Study Report*, July; Synapse Energy Economics, Inc., 2003, *Potential Cost Impacts of a Vermont Renewable Portfolio Standard*, prepared for the Vermont Public Service Board; U.S. Energy Information Administration 2004, *Assumptions to the Annual Energy Outlook 2004*; U. S. Environmental Protection Agency, *Catalogue of CHP Technologies*; Massachusetts Technology Collaborative, *Green Building Initiatives: Completed Feasibility Studies*, available at http://www.mtpc.org/RenewableEnergy/green_buildings/green_buildings_projects.htm.

Table 2.8. O&M Cost Assumptions

	Total O&M Cost (2001$/MWh)	Labor	Equipment	Property Taxes	Insurance	Professional Services
Wind	12	60%	12%	15%	1%	12%
Hydro	20	60%	12%	15%	1%	12%
Biomass	33	55%	25%	10%	1%	9%
LFG	15	50%	27%	10%	1%	12%
PV	9	69%	5%	15%	1%	10%
Fuel Cell	3	55%	25%	10%	1%	9%
MT	12	55%	25%	10%	1%	9%

Note: Biomass O&M Cost includes fuel cost component equal to $30/MWh.

Avoided Fuel and O&M Costs

Since assumptions for avoided fuel and avoided O&M costs are used to measure economic impacts of renewable generation and energy efficiency projects, we will summarize their sources here. We estimated the avoided fuel cost from 2000 to 2010, using avoided marginal generation fuel mix and fuel price data. (See Tables 2.9(a) and 2.9(b).) The avoided marginal fuel mix data from the year 2000 to 2003 were provided by NEPOOL. After those years, we assumed the trend in the year 2003's avoided fuel mix continue to 2010.

Table 2.9(a) 2000 to 2003 Marginal Generation by Unit Type (GWh)

	2000	2001	2002	2003
Coal	281	346	303	12
Heavy Oil	1,201	1,594	973	587
Hydro	0	0	0	0
Jet Fuel	0	6	0	0
Light Oil	0	5	0	0
Methane	0	0	0	0
Mix	2,130	563	501	344
Natural Gas	768	1,766	2,555	3,402
Nuclear	0	0	0	0
Trash	0	23	17	4
Wood	12	77	31	20

Source: NEPOOL, February 4, 2005. "Mix" represents units burning multiple fuels.

Table 2.9(b) Summary of Avoided Fuel Cost Components (Nominal $/MWh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Coal	1.03	1.39	1.30	0.05	0.05	0.05	0.05	0.06	0.06	0.05	0.05
Heavy Oil	11.43	13.41	8.47	6.23	7.17	7.12	6.29	5.80	5.62	5.52	5.53
Mix	19.17	4.29	3.98	3.64	4.00	4.14	3.88	3.67	3.60	3.47	3.42
Natural Gas	6.20	10.95	17.94	35.87	37.15	40.42	40.55	39.41	39.09	36.86	35.82
Trash	0.00	0.16	0.12	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Wood	0.06	0.36	0.15	0.10	0.10	0.10	0.10	0.10	0.10	0.09	0.10
Total	37.9	30.6	32.0	45.9	48.5	51.9	50.9	49.1	48.5	46.0	44.9

Delivered fuel prices are New England specific and derived or obtained from several sources. (See Table 2.10.) Wood and trash prices are based on Synapse's RPS study. Natural gas prices from 2005 to 2010 are derived from NYMEX future prices at wellhead level and EIA's assumption on the cost of fuel delivery. Other fuel costs are obtained from EIA's *Annual Energy Outlook 2005* and *Cost and Quality of Fuels for Electric Plants 2001*.

Table 2.10. Delivered Fuel Prices (Nominal Dollars/MMBtu)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Coal	1.53	1.67	1.79	1.84	1.88	1.88	1.95	1.96	1.98	1.83	1.87
Heavy Oil	3.98	3.59	3.81	4.64	5.34	5.30	4.68	4.32	4.18	4.11	4.11
Mix	4.16	3.51	3.86	5.15	5.65	5.84	5.48	5.18	5.08	4.89	4.83
Natural Gas	4.43	3.40	3.94	5.91	6.12	6.65	6.68	6.49	6.44	6.07	5.90
Trash	2.00	2.05	2.08	2.11	2.13	2.13	2.21	2.22	2.25	2.08	2.11
Wood	2.00	2.05	2.08	2.11	2.13	2.13	2.21	2.22	2.25	2.08	2.11

Note: Mix fuel price is assumed to contain 60 % heavy oil and 40% natural gas and to be used for duel fuel generators.

We estimated avoided O&M costs using EIA data assumptions, implicit price deflators and the marginal fuel mix. Because the EIA assumptions are for new units, which typically have lower O&M costs than existing units, our avoided O&M estimates are conservatively low. The nominal dollar amounts are shown in Table 2.11. They were converted to 2001 dollars internally by the IMPLAN model using deflators specific to the industry sector providing each good or service.

Table 2.11 Avoided O&M Costs (Nominal Dollars/MWh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Avoided O&M Cost	2.50	2.40	2.30	2.25	2.20	2.24	2.27	2.31	2.35	2.38	2.42

Renewable Energy Certificate Prices

We obtained spot market prices of RPS-compliant Renewable Energy Certificates (RECs) from Evolution Markets. Spot-market prices for RECs that meet the Massachusetts and Connecticut Class I standards are believed to be significantly higher than the cost premium that an electric supplier would incur for a long-term contract with a renewable generator. However, little information about such contracts is available in New England. Thus, we have used only the spot market prices to estimate the renewable price premium, which likely overstates the actual RPS rate impact. For 2005 and later, we used values in the range of the Evolution Markets REC futures prices for 2004-2006. The values used were $40/MWh for Massachusetts, Rhode Island, and Connecticut (Class I) and $0.75/MWh for Connecticut (Class II) and Maine.

2.2 Electric Energy Efficiency Programs

Electric efficiency (EE) program data used in this analysis includes annual expenditures by program and annual electric energy savings. Both data series were derived from efficiency program reports for the six New England states with additional information obtained from Commission and Energy Office staff in the states.

Expenditures

Table 2.12 shows the New England states' total expenditures by program for each year from 2000 through the last year of available data with the following adjustments or assumptions:

New Hampshire

- Only annual totals were available in 2000, 2001, and 2002; they were pro-rated among the program categories using percentages from 2003, where program detail was available.

Maine

- For 2000 to 2002, and for the sub-class level in 2004, Maine data was prorated using our judgment.

- Annual projected total outlays are available from 2005 to 2009. However, since only annual total outlays are available for C&I programs, they were pro-rated among the C&I program categories using percentages from 2004 where program detail is available.
- 2000-2002 Program expenditures are 20% of those reported by utilities on Form 861, since, according to the PUC, 80-90% of those expenditures were used to pay down earlier CMP Power Partners Program contracts that resulted in minimal new savings. 2003-2010 expenditures also do not include that portion of public benefit funds used to pay down Power Partners contracts, or funds transferred to the Maine General fund in FY 2003 and 2004.

Massachusetts

- Data for 2003 and 2004 was based on state projections.

Connecticut

- Data for 2004 and 2005 was based on state projections.
- Projected annual total expenditures are available from 2006 to 2010. They were pro-rated among program categories using percentage from 2005 where program expenditure detail is available.

Rhode Island

- Data for 2004 and 2005 was based on state projections.

Vermont

- Total expenditures for 2004 and 2005 were based on state projections. They were pro-rated among program categories using percentage from 2003 where program expenditure detail is available.

Projections of program expenditures were made by applying an inflation adjustment to the last year of data or state projections available. New England-wide totals were computed by summing individual program data and projections.

The amounts in Table 2.12 are the nominal dollar values reported in historical years. As explained elsewhere, the projected outlays for later years were held constant in 2001 dollars, but are shown here in nominal dollars to allow comparison with the historical trend. They were converted to 2001 dollars internally by the IMPLAN model using deflators specific to the industry sector providing each good or service. The total outlay over the entire study period is about $2,600,000,000 in 2001 dollars.

Electricity Savings

Table 2.13 shows the annualized electricity savings, at the generation level, delivered by the measures installed during that year from the programs.[67] The actual or projected savings reported by states, except Vermont, are estimated at customer level in their publications. Savings in Vermont are reported at power generation level. We used a nine percent energy loss in transmission and distribution line to adjust the customer level savings to generation level savings.[68]

Table 2.12. Electric Efficiency Program Outlays in New England (000's of Nominal Dollars)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Residential											
New Construction	8,288	12,574	8,961	9,213	10,013	10,599	10,543	10,768	10,998	11,354	11,596
In-Home Services/Retrofit	38,314	47,269	43,317	38,653	39,925	41,710	41,690	42,603	43,538	44,896	45,879
Products and Services	31,942	32,871	27,926	22,879	36,143	41,264	40,620	41,912	42,719	44,653	45,445
Other	4,839	6,335	3,668	6,965	4,140	4,636	4,479	4,543	4,607	4,778	4,861
Subtotal	83,383	99,049	83,872	77,710	90,220	98,209	97,334	99,825	101,862	105,682	107,780
Commercial and Industrial											
New Construction	42,160	40,542	43,468	37,968	46,879	49,873	49,187	50,280	51,337	53,206	54,280
Retrofit/Products and Services	94,096	89,425	79,483	68,239	86,460	90,538	88,715	91,520	93,350	97,274	99,188
Other	7,956	7,329	4,512	12,033	7,016	5,933	5,458	5,518	5,580	5,878	5,942
Subtotal	144,212	137,295	127,463	118,240	140,355	146,344	143,360	147,317	150,266	156,357	159,410
Other	15,664	18,640	29,837	26,683	13,452	16,886	14,688	14,700	14,702	15,807	15,851
Total	243,336	255,065	241,246	222,633	244,027	261,439	255,381	261,842	266,830	277,845	283,041

Actual and projected savings data were obtained from several sources including state agency's reports, correspondence with state agency's staff, one electric utility

[67] The annualized savings of an efficiency measure represents the amount of electricity that the measure saves when in place and operating for a full year.

[68] Nine percent is a national average figure (EIA, February 2005, *Monthly Energy Review*) for annual average transmission and distribution losses. This number is a conservative estimate given that energy efficiency programs reduce marginal generation that contributes to higher than average line loss.

(Narragansett Electric for Maine), third party administrators (Efficiency Vermont and Efficiency Maine), and EIA Form 861 reports (for New Hampshire and Maine). Following adjustments are made to complete energy savings data from 2000 to 2010 in Table 2.13:

- For years when program specific savings data for Residential Sector are not available (for Connecticut for 2000 to 2004 and Maine for 2000 to 2002), they were estimated by applying weighted average $/kWh savings performance of each program from other states.
- For years when program specific savings data for C&I Sector is not available (for Connecticut and Maine), they were estimated to be proportional to available program expenditures because $/MWh performance does not differ significantly among C&I programs unlike residential programs.
- For years when savings data is not available but expenditure data is available (for Connecticut for 2006 to 2010, for Maine for 2005 to 2010, and for Vermont for 2004 to 2005), savings were estimated by adjusting the preceding year's savings by the ratio of each year's expenditures to the preceding year's expenditures, discounted by an inflation rate.
- For years when official projections on expenditures are not available, future program expenditures are projected to increase by a constant inflation rate each year and during those years, savings are held constant.

Table. 2.13. Annualized Electric Efficiency Program Savings (MWh) at Generation Level

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Residential											
New Construction	2,668	3,734	3,916	3,078	4,864	7,066	6,672	6,625	6,579	6,672	6,625
In-Home Services/Retrofit	56,467	57,847	62,680	50,401	47,759	57,846	55,353	55,056	54,766	55,354	55,057
Products and Services	126,630	175,992	143,597	93,176	154,655	194,980	181,229	179,590	177,991	181,231	179,592
Other	3,523	5,769	3,003	842	955	0	0	0	0	0	0
Subtotal	189,288	242,573	213,196	147,496	208,233	269,515	255,178	254,823	253,059	257,620	255,637
Commercial and Industrial											
New Construction	145,480	163,262	144,510	157,674	155,292	178,628	168,181	166,936	165,721	168,182	166,937
Retrofit/Products and Services	313,514	376,556	301,553	304,495	329,336	353,379	332,606	330,131	327,715	332,609	330,134
Other	19,813	38,664	25,074	11,302	19,752	3,279	2,722	2,656	2,591	2,722	2,656
Subtotal	478,807	579,581	471,137	473,471	504,380	553,074	520,803	520,421	516,806	526,103	522,316
Other											
Total	668,095	822,154	684,333	620,967	712,614	822,589	775,981	775,245	769,865	783,723	777,953

Table 2.14 shows the total electric energy savings in each year from the efficiency measures installed in that year and the prior years beginning with 2000. We assume that efficiency measures are installed at a constant pace throughout the year and end their contributions at a constant pace throughout the final year of their measure life. Therefore, we assume only one-half the annualized savings occurs in the installation year and the same amount in the year after the end of the average measure life. So, for example, the savings in 2002 for a program is the annualized savings delivered by the program in 2000 and 2001, plus one-half the annualized savings delivered in 2002.

Table. 2.14. Annual Accumulated Efficiency Program Savings (MWh) at Generation Level

Total New England	2000	2001	2002	2003	2004
Residential					
New Construction	1,334	4,535	8,360	11,858	15,828
In-Home Services/Retrofit	28,234	85,391	145,654	202,194	251,274
Products and Services	63,315	214,626	374,421	492,807	616,723
Other	1,761	6,407	10,793	12,716	13,614
Subtotal	94,644	310,575	538,459	718,806	896,670
Commercial and Industrial					
New Construction	72,740	227,111	380,997	532,089	688,572
Retrofit/Products and Services	156,757	501,793	840,847	1,143,871	1,460,786
Other	9,906	39,145	71,014	89,202	104,729
Subtotal	239,404	768,598	1,293,957	1,766,260	2,255,186
Other	-	-	-	-	-
Total	334,048	1,079,172	1,832,416	2,485,066	3,151,856

Total New England	2005	2006	2007	2008	2009	2010
Residential						
New Construction	21,794	28,663	35,311	41,913	48,539	55,188
In-Home Services/Retrofit	304,077	360,677	415,881	470,792	525,852	581,058
Products and Services	791,540	979,645	1,160,054	1,338,845	1,518,456	1,698,868
Other	14,091	14,091	14,091	14,091	12,330	10,569
Subtotal	1,135,544	1,397,891	1,652,892	1,906,833	2,160,411	2,415,278
Commercial and Industrial						
New Construction	855,533	1,028,937	1,196,495	1,362,823	1,529,775	1,697,335
Retrofit/Products and Services	1,802,144	2,145,137	2,476,505	2,805,428	3,135,591	3,466,962
Other	116,244	119,245	121,934	124,557	127,213	129,902
Subtotal	2,783,913	3,320,851	3,841,463	4,360,077	4,881,532	5,405,741
Other	-	-	-	-	-	-
Total	3,919,457	4,718,742	5,494,355	6,266,910	7,041,942	7,821,019

3.0 ECONOMIC IMPACT METHODS AND RESULTS

3.1 Methods and Assumptions

Impacts on the New England economy from renewable generation and electric energy efficiency programs were estimated using the IMPLAN model configured as a single region containing the six New England states. The IMPLAN (IMpact analysis for PLANning) economic impact model allows us to measure both direct and secondary impacts of expenditures for the various goods and services demanded in the construction and operation of renewable generation plants and the delivery of energy efficiency programs. Data used for this study were developed using data and assumptions described in Section 2, above.

IMPLAN is an input-output (I/O) economic model. It estimates the interactions among the sectors of the regional economy, as well as indirect and induced effects via secondary purchases by those suppliers, as well as household purchases by the employees of all those industries and businesses and purchases by government.

I/O analysis traces the flow of goods and services, income, and employment among related sectors of the economy. In an I/O model, a change in the final demand for a product or service causes that sector to buy other goods and services from other sectors, which in turn purchase inputs from other industries. All of these sectors purchase additional labor, too. The additional employees purchase more goods and services. The job of the model is to compute the eventual sum of all of these purchases cycling through the economy.

IMPLAN (IMpact analysis for PLANning) is one of the most widely used I/O models. Originally developed for the USDA Forest Service in 1979, IMPLAN uses national accounts data and economic survey data from each region to build regional I/O models and forecasts regional economic impact based on those models.

Renewable Generator Construction

The impact on the New England economy of renewable generator construction in the years 2000 through 2010 was estimated using the construction cost data given above and the construction level data shown in Table 3.1. The Installation Labor amounts shown in Table 2.2 were proportionally allocated to the other cost categories listed in that table for allocation economic sectors listed in Table 3.2.

Renewable Generator Operation

Analyzing the impact on the New England economy of renewable generator operation is much more complex that analyzing the impacts of the construction of those units. This task includes modeling reduced purchases of fossil fuels, collection from consumers and payment to generators of the costs for renewable energy credits (RECs), new operation and maintenance (O&M) expense for the renewable generators, and decreased operation and maintenance expense for existing generation. Our approach to representing these events within IMPLAN's modeling structure divides the effects into three pairs of corresponding increases and decreases of outlays in the economy.

Table 3.1. Renewable Generator Construction Level (MW)

Unit Type	2000	2001	2002	2003	2004
Wind	0.32	0.66	--	--	--
Landfill Gas IC	8.7	2.80		5.60	14.68
Run-of-river Hydro	3.88	3.14	1.88	4.00	--
Fuel cells		--	0.6	0.65	--
PV	0.11	--	--	--	0.03
Wood steam	--	--	--	--	25.85
MT	--	--	--	--	--
Total Additions	13.01	6.60	2.48	10.25	40.56
Cumulative Additions	13.01	19.61	22.10	32.35	72.90

Unit Type	2005	2006	2007	2008	2009	2010
Wind	4.08	20.00	3.00	114.00	134.00	94.00
Landfill Gas IC	40.28	33.00	--	23.00	15.00	20.00
Run-of-river Hydro	7.00	2.00	--	11.00	10.70	3.30
Fuel cells	15.00	15.00	--	20.00	20.00	20.00
PV	0.20	0.40	0.10	1.30	1.20	2.40
Wood steam	51.6	85.90	101.30	13.00	18.00	27.00
MT	0.03	--	--	--	--	--
Total Additions	118.19	156.30	104.4	182.3	198.9	166.7
Cumulative Additions	191.09	347.39	451.79	634.09	832.99	999.69

Table 3.2(a). Phase I Renewable Generator Construction Inputs (000's of 2001 Dollars)

Type of Outlay	IMPLAN Sector No.	2000	2001	2002	2003	2004
Turbine Equipment	285	16,024	7211	3689	13,373	47,810
Road Construction	39	1,204	714	284	977	6,681
Commercial Building Construction	38	5,252	3,529	1,964	4,952	5,877
Interconnection and other costs	41	4,826	2,328	1,269	4,156	13,246
Total	--	27,306	13,783	7,206	23,458	73,614

Columns may not sum to Total due to round off.

Table 3.2(b). Phase II--Renewable Generator Construction Inputs (000's of 2001 Dollars)

Type of Outlay	IMPLAN Sector No.	2005	2006	2007	2008	2009	2010
Turbine Equipment	285	167,608	202,097	112,321	203,150	211,131	197,308
Road Construction	39	16,482	24,956	22,393	23,076	26,321	22,152
Commercial Building Construction	38	24,833	24,676	13,466	31,640	32,280	24,304
Interconnection and other costs	41	48,170	57,371	31,457	59,081	61,354	56,727
Total	--	267,093	309,100	179,637	316,946	331,086	300,491

Columns may not sum to Total due to round off.

The first such pair is the increased O&M expense for the new renewable generators, coupled with the decreased O&M expense for the displaced generation. These values are shown in Tables 3.3 and 3.4. For the new renewable units, we include the full O&M cost expressed in $/MWh of output. In contrast, for the displaced generation, we include only the variable O&M expense, as the fixed O&M expenses will not be avoided unless a unit is decommissioned. Thus, the O&M expense per unit output is significantly greater than that for the avoided expense of the displaced generation.

Table 3.3. Renewable Generator O&M Inputs (2001 Dollars per MWh)

Type of Unit	O&M Cost
Wind	12
Land Fill Gas	15
Hydro (run of river)	20
Fuel cells	3
PV	9
Wood steam	3
MT	12

Table 3.4. Displaced Generator O&M Inputs (Nominal Dollars per MWh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Displaced O&M Cost	2.50	2.40	2.30	2.25	2.20	2.24	2.27	2.31	2.35	2.38	2.42

The added O&M costs for new renewables were allocated to IMPLAN sectors as shown in Table 3.5, based on our judgment and the estimated allocations of original construction cost among buildings, roads, and turbine equipment.[69]

Table 3.5. Allocation of Renewable Generator O&M Inputs to IMPLAN Sectors

Sector 43 (Maintenance and Repair of non-residential buildings)	5%
Sector 44 (Maintenance and repair of roads)	15%
Sector 485 (Commercial Machinery Repair)	80%

Avoided O&M costs for displaced generation (not including displaced fuel use) were assigned entirely to Sector 485 (Commercial Machinery Repair) based on our judgment that only generating equipment maintenance would be materially affected by reduced generation at fossil fired units in the short run. In the long run, some units may be retired, leading to greater savings in avoided fixed costs, but omitting them results in a more conservative estimate.

Table 3.6 shows the resulting aggregate inputs to IMPLAN by sector and year to represent changes in O&M expense.[70]

[69] The amounts in this table are the nominal dollar values. They were converted to 2001 dollars internally by the IMPLAN model using deflators specific to the industry sector providing each good or service.

The next group of inputs deals with collection and payment of the cost of renewable energy certificates (RECs). The quantity of REC funds collected (and paid out) each year is assumed to be the product of that year's retail sales (including distribution-only sales in restructured states) and the observed REC premium in each state. For purposes of this analysis, we assume that (1) all REC costs are recouped from retail customers, (2) that this does not result in a change in demand for electricity directly, but, rather, in reduced disposable income for goods and services, and (3) that the funds collected are paid in the same year to the entities that earned the RECs by producing eligible power. We therefore reduce the final demand of households, government, and business entities (called Institutions in IMPLAN) by the dollar amount of the REC premium in each year. This reduction of final demand represents the income effect of an increase in electric retail rates. The household portion of REC payments was allocated among nine income levels, and government amount was split between federal, state and local government, all based on the their relative purchases of electricity in 2001. The reductions were proportional to each entity's share of the sales of electricity.

Table 3.6(a). Phase I and Phase II O&M Expense Inputs (000's of 2001 Dollars)[71]

Type of Outlay	IMPLAN Sector No.	2000	2001	2002	2003	2004
Additional Building Maintenance	43	69	100	109	206	320
Additional Road Maintenance	44	207	301	327	618	961
Additional Machinery Maintenance	485	1,104	1,604	1,746	3,296	5,124
Reduced Variable Machinery Maintenance at Fossil Plants	485	-111	-200	-245	-328	-644

[70] Displaced O&M costs are converted to 2001 dollars internally by IMPLAN using deflators specific to the particular factor inputs allocated as shown in Table 3.5.

[71] The Phase I values for years 2005-2010 are identical to those for year 2004.

Table 3.6(b). Phase II: O&M Expense Inputs (000's of Nominal Dollars)

Type of Outlay	IMPLAN Sector No.	2005	2006	2007	2008	2009	2010
Additional Building Maintenance	43	664	1,003	1,114	1,502	1,876	2,198
Additional Road Maintenance	44	1,991	3,010	3,343	4,506	5,627	6,593
Additional Machinery Maintenance	485	10,617	16,053	17,829	24,032	30,010	35,165
Reduced Variable Machinery Maintenance at Fossil Plants	485	-2,472	-3974	-5,652	-6,893	-8,120	-9,268

We further assumed that the renewables industry is composed 40% of activities matching those in IMPLAN Sector 451 (Management of Companies) and 60% Sector 436 Lessors of Non-financial Intangible Assets.[72] Table 3.7 shows the dollar amounts collected and transferred to the sectors used to represent the incremental portion of the new renewables industry.

In Table 3.7, the small changes in the inputs during the first three years represent mainly variations in the total retail sales of power in Maine. The large jump in 2003 represents the addition of Massachusetts and Connecticut with their much larger loads. In addition, those states set standards for RPS eligibility that were more stringent, leading to a much higher market price for RECs eligible for use in those states.

[72] Our reasoning for selecting these two sectors is that the sale of RECs is essentially the lease of an intangible non-financial asset, namely the right to use the RECs distributed by the NE-ISO GIS, while the business of building and running the generators (aside from the equipment-driven O&M already discussed) is similar to the management of a corporation. We developed the 60/40 split by examining the factor input distribution (the Gross Absorption and Value Added indices) of the two sectors and applying our judgment. The resulting "pseudo-sector" includes small inputs of general goods and services consistent with an office-based business, a modest amount of labor input, and a majority of value added components related to depreciation, dividends, debt service and the like.

Table 3.7(a). Phase I REC Funds Flow Inputs (000's of Nominal Dollars)[73]

Type of Outlay	IMPLAN Sector No.	2000	2001	2002	2003	2004
Final Demand: Institutions	10001-10009, 11001, 12001, 13001	-0.107	-0.142	-0.231	-4,761	-11,752
Final Demand: Management of Corporations	451	0.043	0.057	0.092	1,904	4,701
Final Demand: Lessors of Intang. Non-financial Assets	436	0.064	0.085	0.139	2,857	7,051

Table 3.7(b). Phase I REC Funds Flow Inputs (000's of Nominal Dollars)[74]

Type of Outlay	IMPLAN Sector No.	2005	2006	2007	2008	2009	2010
Final Demand: Institutions	10001-10009, 11001, 12001, 13001	-19,357	-19,776	-20,195	-20,614	-21,034	-21,453
Final Demand: Management of Corporations	451	7,743	7,910	8,078	8,246	8,413	8,581
Final Demand: Lessors of Intang. Non-financial Assets	436	11,614	11,866	12,117	12,369	12,620	12,872

[73] REC costs are converted to 2001 dollars internally by IMPLAN using deflators specific to the particular sectors allocated as shown in Table 3.7.

[74] REC costs are converted to 2001 dollars internally by IMPLAN using deflators specific to the particular sectors allocated as shown in Tables 3.7 and 3.8.

Table 3.8(a). Phase II REC Funds Flow Inputs (000's of Nominal Dollars)

Type of Outlay	IMPLAN Sector No.	2000	2001	2002	2003	2004
Final Demand: Institutions	10001-10009, 11001, 12001, 13001	-0.107	-0.142	-0.231	-4,761	-11,752
Final Demand: Management of Corporations	451	0.043	0.057	0.092	1,904	4,701
Final Demand: Lessors of Intang. Non-financial Assets	436	0.064	0.085	0.139	2,857	7,051

Table 3.8(b). Phase II REC Funds Flow Inputs (000's of Nominal Dollars)[75]

Type of Outlay	IMPLAN Sector No.	2005	2006	2007	2008	2009	2010
Final Demand: Institutions	10001-10009, 11001, 12001, 13001	-50,551	-83,967	-122,519	-152,640	-183,380	-213,148
Final Demand: Management of Corporations	451	20,220	33,587	49,007	61,056	73,352	85,259
Final Demand: Lessors of Intang. Non-financial Assets	436	30,330	50,380	73,511	91,584	110,028	127,889

The last group of adjustments represents the shift of trade in the region from importing fossil fuels (displaced by the new renewable generation) and the corresponding shift in

[75] REC costs are converted to 2001 dollars internally by IMPLAN using deflators specific to the particular sectors allocated as shown in Tables 3.7 and 3.8.

payment of market prices of power (or other negotiated bilateral prices) from the pre-existing wholesale generating entities to those businesses owning the new renewable generation. While the bulk of the wholesale purchase amounts shifted will continue to pay for goods and services similar to those of existing businesses in the power sector, the reduction of money paid for fossil fuels must be re-channeled into a sector more representative of how those funds will be used and not just lost to the economy.

We first developed estimates of the marginal fuel cost per MWh for the region using the marginal fuel mix and the fuel costs discussed above. The amount of renewable generation in each year was multiplied by this unit cost of avoided generation to give the dollars of fossil fuel purchases avoided each year.

The next step was to split those dollars among the affected fuels (at the producer or refiner) and their delivery costs. This resulted in a target dollar amount of reduced demand for the relevant model sectors as shown in Table 3.9. This allocation was made separately for each fuel in the marginal fuel mix.

- Avoided coal purchases (delivered) were split between coal fuel and rail transport based on their 2001 factor inputs in the power sector. In other words, we made the simplifying assumptions that all coal used in the region is delivered by rail.
- Avoide©d oil purchases were split between oil and gas extraction (well production) output, refinery output, and truck transportation in the same manner. Here, the simplifying assumption was that all oil is delivered by truck.
- Wood fuel purchases--a small part of the avoided fuel purchases--were split in the same way between the logging industry and trucking.
- Natural gas purchases were split between oil and gas extraction and pipeline transport, also using 2001 power sector input factors.

Finally, we represented the total of these reductions as an increase in demand for Sector 436 (Lessors of Intangible Non-financial Assets). That sector was used in this part of the analysis, rather than a split between Sectors 436 and 451 (Management of Corporations), as we did in the REC transfer, to represent the fact that such firms are large users of leveraged capital investments, and that a relatively large portion of their costs therefore occurs in Value Added categories. Sector 436 has a factor input structure consistent with that assumption.[76] This makes the direct employment and induced impacts more conservative than they would be if the transfer were allocated to almost any other sector.

Energy Efficiency Programs

Efficiency program expenditures were allocated among the IMPLAN industrial sectors using the percentages shown in Tables 3.10. Ten percent of each program's expenditures were allocated to Sector 450 (Miscellaneous Technical and Professional Services) to

[76] Payments to lessors of intangible non-financial assets are converted to 2001 dollars internally by IMPLAN using deflators specific to that particular factor input.

represent program management, marketing, design and evaluation costs. The remainder was allocated to relevant IMPLAN sectors based on our experience and judgment.

To address the source of the funds spent in the above programs, we reduced final demand in households, government and businesses by the amount of the EE outlays in each year. The residential program outlays shown in the table above were allocated among the household income categories according to their level of purchases from the power sector in 2001. The remaining program outlays were allocated among the federal government, state and local governments, and business entities according to their level of purchases from the power sector in 2001.

Table 3.9(a). Avoided Fossil Fuel Funds Flow Inputs (000's of 2001 Dollars)[77]

Type of Outlay	IMPLAN Sector No.	2000	2001	2002	2003	2004
Logging	14	-1	-16	-24	-31	-46
Wholesale Trade*	390	-1,332	-3,374	-6,071	-11,308	-22,777
Rail Transport	392	-9	-34	-65	-66	-70
Water Transport	393	-45	-108	-164	-224	-364
Trucking	394	-33	-105	-165	-219	-341
Pipeline Transport	396	-204	-531	-1,183	-2,911	-6,592
Lessors of Intangible Non-financial Assets	436	1,624	4,169	7,672	14,759	30,189

** All fossil fuel purchases are assumed to be imports, which are represented in the Wholesale Trade Sector.*

[77] Phase I values for years 2005-2010 are identical to those for 2004.

Table 3.9(b). Phase II: Avoided Fossil Fuel Funds Flow Inputs (000's of 2001 Dollars)

Type of Outlay	IMPLAN Sector No.	2005	2006	2007	2008	2009	2010
Logging	14	-100	-189	-310	-463	-643	-847
Wholesale Trade*	390	-70,140	-145,194	-248,719	-374,321	-515,839	-674,608
Rail Transport	392	-84	-108	-143	-186	-233	-288
Water Transport	393	-902	-1,677	-2,699	-3,908	-5,300	-6,881
Trucking	394	-812	-1,507	-2,433	-3,549	-4,842	-6,312
Pipeline Transport	396	-21,972	-46,765	-81,062	-122,591	-168,799	-220,086
Lessors of Intangible Non-financial Assets	436	94,010	195,449	325,366	505,018	695,656	909,023

** All fossil fuel purchases are assumed to be imports, which are represented in the Wholesale Trade Sector.*

Table 3.10. Allocation of Efficiency Program Outlays (% of Program Total)

Sector/Program	Allocation
Residential	
New Construction	
ME, VT, NH	10% 450, 80% 33, 10% 34
MA, RI, CT	10% 450, 50% 33, 40% 34
New England	weighted average of above by population
In Home Services/Retrofit	20% 450 (half program overhead, half audit-type work) 20% 486 30% 42 5% each to 278, 277, 325, 226, 330, 331
Products and Services	
	Same as In Home but apply retail margin to the product sectors
Commercial and Industrial	
New Construction	20% 450 (half overhead, half extra technology challenge) 40% 37 40% 38
Retrofit/Products and Services	20% 450 (same as above) 20% 485 30% 43 5% each to 276, 277, 278, 325, 326, 334

To represent the reduction in operation and maintenance expenses associated with a reduced level of fossil fuel generation, we reduced final demand in the electric power sector each year by the variable operation and maintenance costs associated with the avoided generation. We further adjusted the use of fossil fuels (and transportation to deliver them) so that the makeup of changes in fuel and transportation inputs used by that sector corresponded to the marginal generation fuel mix for New England. These adjustments were performed in the same manner as for renewable operations impacts, described above.

Finally, we gave to households, government and businesses, in the manner indicated above, their shares of the avoided operation and maintenance costs and the avoided fuel and transportation costs.

Table 3.10a. IMPLAN Sectors Used in Allocation of Efficiency Program Outlays

IMPLAN Sector	Industry
33	New Residential Single Family Construction
34	New Residential Multi-Family Construction
35	Residential additions
37	New Manufacturing buildings
38	New Commercial/Institutional buildings
41	Other new construction
42	Maintenance and repair of residential buildings
43	Maintenance and repair of non-residential buildings
276	C&I fans and blowers manufacturing
277	Heating manufacturing exc. warm air furnaces
278	AC, Refrigeration manufacturing, warm air furnaces
325	Light bulbs manufacturing
326	Lighting fixtures manufacturing
330	Household refrigeration manufacturing
331	Household laundry manufacturing
334	Motor and generator manufacturing
450	Misc. professional and technical services
485	Commercial machinery repair and maintenance
486	Household goods repair and maintenance

3.2 Economic Impact Results

In modeling the eleven year period from 2000 through 2010, our analysis assumes that existing efficiency programs continue to perform at 2003 levels, producing additional investments and new, increased savings each year. In a few instances, planned changes to those efficiency programs were also reflected. For renewable energy, the Phase I analysis assumes the generating plants that came online during 2000 through 2003 continue operating through 2010, but that no new renewable generating plants are added. The Phase II analysis added new renewable generation as explained above.

The economic impacts (and potential emission reductions) presented below represent the projected *net* increases or decreases due to the assumed amount of energy efficiency spending and renewable generation.

IMPLAN economic impact results are divided into three categories: direct, indirect, and induced.

Direct impacts are the outlays for specific goods and service purchased. This includes the construction and O&M costs incurred for the actual renewable generators and the goods and services purchased to operate efficiency programs. For renewable generators, this includes generator equipment itself, access road construction, construction of on-site buildings, and costs of interconnecting with the electric transmission system. For efficiency programs, direct costs include incremental cost of more efficient equipment and building construction, installation labor, and program overhead costs.

These direct purchases are made from specific industries, but those industries, in turn, make further purchases from other segments of the economy. For instance, road construction requires the purchase of crushed stone (from the mining sector), asphalt (from the petroleum products sector), paving machinery and heavy trucks (from the manufacturing sector), and various types of professional, such as surveying and equipment maintenance. Each of those industries also makes further purchases to meet its needs. The fraction of all of those purchases that are made inside the local region are called indirect purchases and needs to be computed and added to the direct impact. All those indirect purchases are included in IMPLAN's indirect impact total.

Lastly, each of the sectors providing the direct and indirect goods and services used employs labor and various fractions of the purchase costs go to labor, profits (and dividends), rents, and taxes. Those outlays for labor and so on also result in further purchases of goods and services by households and government. These are called induced impacts.

For each issue examined in this study, the tables below indicate the direct, indirect and induced economic impacts and the total impact for the years 2000 through 2010, plus the total for the eleven years. Three types of impacts are reported: change in regional output (the sum of all goods and services produced in the New England economy), change in employment, and change in labor income. All dollar amounts are in 2001 dollars, but totals are *not* discounted over time. Employment impacts are in job-years, i.e., one permanent job created in 2000 will result in eleven job-years over the study period.

The direct expenditures we derived are set out in Section 3.1 of this report. IMPLAN reports those amounts as its reported amount of direct impact on output in dollars. The direct impact on employment and labor income are derived using IMPLAN's regional factor input database. The indirect impact on output in dollars is derived by IMPLAN using its I/O matrix for the region, and the indirect impacts on labor and labor income are, again, derived using IMPLAN's regional factor inputs, this time applied to the indirect output change. Induced output changes are the result of spending by households and government using wages, proprietor's income, and taxes. The induced output changes flow from the sum of direct and indirect output changes driven by IMPLAN's database of historical data. Induced employment and labor income changes are computed in the same way as for direct and indirect activity.

Renewable Generator Construction Economic Impact Results

Construction of each renewable generator considered in this study required the expenditure money on the generator itself, civil works (mainly roads), buildings, and electric system interconnection improvements. The estimated amounts for each year are shown in Table 3.2. Those amounts were specified as inputs to IMPLAN and are restated by IMPLAN as its direct impact amount for the economic output. These impacts occur *only* in the year of construction and are not repeated.

It is worth noting that the moderate regional output multiplier seen here ($4,178,719/$1,839,720 = 2.27) is driven in large part by the fraction of the total expenditures on generating equipment that IMPLAN's database indicates would be purchased in New England. This fraction is the regional purchase coefficient or RPC and, in this case, is 69.8%. This is actually the value for turbine-type generator equipment in general and could differ either up or down from the actual, depending on how New England's wind generator industry develops. The employment and labor income multipliers are somewhat larger, 3.21 and 2.75, respectively.

Table 3.11. Renewable Generator Construction Impact: Output (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	27,306	7,479	23,013	57,798
2001	13,783	3,969	12,144	29,896
2002	7,206	2,089	6,416	15,711
2003	23,458	6,509	20,026	49,993
2004	73,614	23,281	70,453	167,348
Phase I Total 2000-2004	145,367	43,327	132,052	320,746
2005	257,093	81,195	246,743	585,031
2006	309,100	97,495	295,857	702,452
2007	179,637	57,313	172,903	409,853
2008	316,946	100,507	305,229	722,681
2009	331,086	105,115	319,001	755,202
2010	300,491	94,633	287,630	682,754
Phase II Total 2000-2010	1,839,720	579,585	1,759,415	4,178,719

Source: IMPLAN runs. Columns and rows may not sum may not to totals due to round off.

Table 3.12. Renewable Generator Construction Impact: Employment (Job-years)

Year	Direct	Indirect	Induced	Total
2000	161.8	63.3	240.9	466.0
2001	90.0	34.3	127.3	251.6
2002	48.2	18.2	67.3	133.6
2003	143.1	55.5	209.7	408.2
2004	410.1	184.9	734.6	1,329.5
Phase I Total 2000-2004	853.2	356.2	1,379.8	2,588.9
2005	1,441.4	649.0	2,572.8	4,663.1
2006	1,719.2	774.6	3,084.5	5,578.3
2007	1,032.0	455.0	1,803.7	3,290.6
2008	1,806.0	804.8	3,183.4	5,794.1
2009	1,892.9	841.1	3,327.3	6,061.3
2010	1,669.3	752.3	2,998.5	5,420.2
Phase II Total 2000-2010	10,414.0	4,633.0	18,350.0	33,396.5

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.13. Renewable Generator Construction Impact: Labor Income (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	8,248	3,037	9,693	20,979
2001	4,525	1,623	5,112	11,260
2002	2,414	857	2,700	5,972
2003	7,263	2,650	8,433	18,347
2004	22,040	9,231	29,744	61,015
Phase I Total 2000-2004	44,490	17,398	55,682	117,573
2005	77,405	32,316	104,163	213,885
2006	92,461	38,689	124,904	256,055
2007	55,034	22,679	72,979	150,692
2008	96,605	40,006	128,836	265,448
2009	101.164	41,815	134,646	277,626
2010	89,822	37,577	121,431	248,830
Phase II Total 2000-2010	556,981	230,480	742,641	1,530,109

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Renewable Generator Operation Economic Impact Results

Estimating the operational impact of the renewable generators considered in this study required us to characterize the impact of RECs on retail consumption, outlays for repair and maintenance associated with both the new and displaced generation, and the shift of dollars from fossil fuel imported into the region to other uses. The estimated amounts and IMPLAN sectors for those input changes are shown for each year in Tables 3.14, 3.15 and 3.16. Those amounts were specified as inputs to IMPLAN and are restated by IMPLAN as its direct impact amount for the economic output as shown in the impact tables below. These impacts occur in each year of operation and are shown here accumulated across all the units operating in a given year, based on their reported output.

The impact on output is positive in most years. The direct impact on employment is negative, and the observed employment and labor income increases, where they exist, are due to shifts in the makeup of factor inputs for the region, rather than an additional stimulus, alone. The major investments in renewable generation in Phase II can be expected to cause significant changes in the demands in the economy. Former demands for goods and services related to fossil fuels and their transportation and for operation and maintenance on fossil fuel plants will decrease. It is to be expected that jobs and job income associated with filling these demands will also decrease. [78]

Two particular issues should be kept in mind in interpreting the economic impacts of renewable generation operation, in addition to the caveats discussed in Section 1.3 of this report:

- The O&M assumptions are conservative. We have included the *complete* cost of renewable O&M while only crediting the economy in the model with the *variable* part of the fossil fuel O&M. With investments of this magnitude in renewable generation, it is possible that some fossil fuel generators will be decommissioned or new units deferred. Were the economy credited with the full O&M cost savings from such decommissioned or deferred generators, the results of the simulation would be more positive.
- Our use of IMPLANs sectors to represent shifts in factor demands, while a reasonable adaptation given the model's structure, may understate the positive effects of renewable generation operation. This understatement could occur because we use the wholesale trade and bulk transportation sectors to remove demand associated with the decreased demand for fossil fuels and their transportation. Fossil fuel demand is largely supplied from sources outside the New England, so the appropriate way to model its reduction is to use sectors for

[78] This simulation uses fossil fuel price forecasts from the New York Mercantile Exchange (NYMEX) and the Energy Information Administration. These forecasts show nominal fossil fuel prices declining from 2005-2010. During such a period of declining fossil fuel prices, a simulation of the economic impact of renewable generation will not produce as positive results as would such a forecast in times of price increases in fossil fuels. Use of a forecast for prices of fossil fuels that reflected price increases over time show a more positive impact of renewable generation.

> which a decrease in demand has relatively little direct and indirect (but not necessarily induced) impact on the local economy. Wholesale trade and bulk transportation, although providing a way to decrease demand without having all of that decrease effect the local economy, do have some job and labor income impacts on the local economy, set at the average for all goods sold at wholesale in the region. The IMPLAN model structure is removing those jobs and income even though it is not certain that the changes associated with reduced demands for imported fossil fuel and fuel transportation will have such extensive impacts on the local economy.[79]

It is also useful to remember that the renewable generation operation can only exist as renewable generator construction occurs. When we combine the renewable construction impacts with the renewable operation impacts to compute the total renewable impacts, the impacts on output, employment and labor income are all positive. Since there is no reason to believe that renewable generator construction will stop at the end of the study period, one can anticipate continued positive effects.

In the simulation, imports of fossil fuel are first converted into value added within the region. Second, retail purchases are reduced (due to REC collections), but a corresponding amount is placed into the economy in a high-Value Added sector. For these reasons, the *multipliers* (but not the actual impact estimates) shown in this data may not be subject to the same type of interpretation found in economic impact studies of new demand or new output and should be used cautiously.

Phase I: Renewable Generator Operation Economic Impact Results

In Phase I of this study we considered the impact of renewable generators which came on line in 2000-2004. Their construction impacts in 2000-2004 were shown in the previous section. Those generators built in 2000-2004 have continuing impacts in operating costs through the end of the study period. The operating impacts shown for each of the years 2005 through 2010 are identical to those obtained in 2004 and are shown as one combined total for those years.

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[79] It is interesting to note, for example, that in 2010, the last year of the forecast, wholesale trade and pipeline transportation together lost 4,520.1 job years and $360,958,770 in labor income. These two sectors, whose job and income losses are overestimated by our simulation, represent 63% of the reported job year losses and 86% of the labor income losses in 2010.

Table 3.14. Renewable Generator Operation Impact: Output (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	1,269	-28	1,107	2,349
2001	1,805	-558	1,211	2,459
2002	1,938	-1,491	694	1,141
2003	5,828	-2,873	4,720	7,675
2004	10,668	-6,544	8,653	12,776
Sub-Total	21,508	-11,494	16,385	26,400
2005-2010	81,972	-39,426	80,340	122,886
Total	103,480	-50,920	96,725	149,286

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.15. Renewable Generator Operation Impact: Employment (Job-years)

Year	Direct	Indirect	Induced	Total
2000	3.5	-0.7	10.3	13.1
2001	-4.5	-5.7	9.3	-0.9
2002	-20.3	-14.4	1.1	-33.6
2003	-41.7	-28.5	37.1	-33.1
2004	-103.4	-64.3	65.4	-102.3
Sub-Total	-166.4	-113.6	123.2	-156.8
2005-2010	-673.2	-390.6	684.0	-379.8
Total	-839.6	-504.2	807.2	-536.6

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.16. Renewable Generator Operation Impact: Labor Income (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	-89	-32	447	326
2001	-804	-265	459	-610
2002	-2,043	-669	203	-2,509
2003	-3,415	-1,303	1,865	-2,853
2004	-7,629	-2,933	3,416	-7,146
Sub-Total	-13,980	-5,202	6,390	-12,792
2005-2010	-41,130	-17,652	32,772	-26,010
Total	-55,110	-22,854	39,162	-38,802

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Phase II: Renewable Generator Operation Economic Impact Results

In Phase I of this study we considered the impact of renewable generators which came on line in 2000-2004. In Phase II we include the renewable generators which we think will come on line in 2005-2010. As was the case in Phase I, each generator placed into service has continuing operation impacts throughout the study period. The following tables show the operating impacts of these generators in 2000-2010.

Table 3.17. Renewable Generator Operation Impact: Output (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	1,269	-28	1,107	2,349
2001	1,805	-558	1,211	2,459
2002	1,938	-1,491	694	1,141
2003	5,828	-2,873	4,720	7,675
2004	10,668	-6,544	8,653	12,776
Sub Total	21,508	-11,494	16,385	26,400
2005	31,435	-22,761	27,503	36,175
2006	49,637	-49,373	35,308	35,572
2007	64,581	-88,288	33,001	9,294
2008	81,719	-133,478	25,976	-25,783
2009	98,454	-184,572	14,434	-71,684
2010	113,538	-242,273	-3,630	-132,365
Total	460,872	-732,239	148,977	-122,391

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.18. Renewable Generator Operation Impact: Employment (Job-years)

Year	Direct	Indirect	Induced	Total
2000	3.5	-0.7	10.3	13.1
2001	-4.5	-5.7	9.3	-0.9
2002	-20.3	-14.4	1.1	-33.6
2003	-41.7	-28.5	37.1	-33.1
2004	-103.4	-64.3	65.4	-102.3
Sub Total	-166.4	-113.6	123.2	-156.8
2005	-397.8	-221.5	208.1	-411.2
2006	-854.7	-475.8	207.0	-1,123.5
2007	-1,537.0	-844.0	69.7	-2,311.3
2008	-2,290.7	-1,272.7	-138.8	-3,702.2
2009	-3,144.7	-1,756.4	-411.1	-5,312.3
2010	-4,111.8	-2,301.5	-769.3	-7,182.7
Total	-12,503.1	-6,985.5	-711.2	-20,200.0

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.19. Renewable Generator Operation Impact: Labor Income (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	-89	-32	447	326
2001	-804	-265	459	-610
2002	-2,043	-669	203	-2,509
2003	-3,415	-1,303	1,865	-2,853
2004	-7,629	-2,933	3,416	-7,146
Sub Total	-13,980	-5,202	6,390	-12,792
2005	-25,304	-10,067	10,983	-24,388
2006	-57,659	-21,735	13,479	-65,915
2007	-105,887	-38,670	11,350	-133,208
2008	-163,827	-58,449	6,878	-215,398
2009	-229,726	-80,785	276	-310,235
2010	-304,651	-105,971	-9,332	-419,953
Total	-901,034	-320,879	40,024	-1,181,889

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Renewable Generator Total Economic Impact Results

The following tables combine the estimated construction and operational impacts for the renewable generators considered in this study.

Phase I:

Table 3.20. Renewable Generator Total Impact: Output (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	28,575	7,451	24,120	60,147
2001	15,588	3,411	13,355	32,355
2002	9,144	598	7,110	16,852
2003	29,286	3,636	24,746	57,668
2004	84,282	16,737	79,106	180,124
Sub-Total	166,875	31,833	148,437	347,146
2005-2010	81,972	-39,426	80,340	122,886
Total	248,847	-7,593	228,777	470,032

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.21. Renewable Generator Total Impact: Employment (Job-years)

Year	Direct	Indirect	Induced	Total
2000	165.3	62.6	251.2	479.1
2001	85.5	28.6	136.6	250.7
2002	27.9	3.8	68.4	100.0
2003	101.4	27.0	246.8	375.1
2004	306.7	120.6	800.0	1,227.2
Sub-Total	686.8	242.6	1,503.0	2,432.1
2005-2010	-673.2	-390.6	684.0	-379.8
Total	13.6	-148.0	2,187.0	2,052.3

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.22. Renewable Generator Total Impact: Labor Income (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	8,159	3,005	10,140	21,305
2001	3,721	1,358	5,571	10,650
2002	371	188	2,903	3,463
2003	3,848	1,347	10,298	15,494
2004	14,411	6,298	33,160	53,869
Sub-Total	30,510	12,196	62,072	104,781
2005-2010	-41,130	-17,652	32,772	-26,010
Total	-10,620	-5,456	94,844	78,771

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Phase II:

Table 3.23. Renewable Generator Total Impact: Output (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	28,575	7,451	24,120	60,147
2001	15,588	3,411	13,355	32,355
2002	9,144	598	7,110	16,852
2003	29,286	3,636	24,746	57,668
2004	84,282	16,737	79,106	180,124
Sub Total	166,875	31,833	148,437	347,146
2005	288,528	58,434	274,246	621,206
2006	358,737	48,122	331,165	738,024
2007	244,218	-30,975	205,904	419,147
2008	398,665	-32,971	331,205	696,898
2009	429,540	-79,457	333,435	683,518
2010	414,029	-147,640	284,000	550,389
2005-2010	2,133,717	-184,487	1,759,955	3,709,182
Total	2,300,592	-152,654	1,908,392	4,056,328

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.24. Renewable Generator Total Impact: Employment (Job-years)

Year	Direct	Indirect	Induced	Total
2000	165.3	62.6	251.2	479.1
2001	85.5	28.6	136.6	250.7
2002	27.9	3.8	68.4	100.0
2003	101.4	27.0	246.8	375.1
2004	306.7	120.6	800.0	1,227.2
Sub Total	686.8	242.6	1,503.0	2,432.1
2005	1,043.6	427.5	2,780.9	4,251.9
2006	864.5	298.8	3,291.5	4,454.8
2007	-505.0	-389.0	1,873.4	979.3
2008	-484.7	-467.9	3,044.6	2,091.9
2009	-1,251.8	-915.3	2,916.2	749.0
2010	-2,442.5	-1,549.2	2,229.2	-1,762.5
2005-2010	-2,775.9	-2,595.1	16,135.8	10,764.4
Total	-2,089.1	-2,352.5	17,638.8	13,196.5

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.25. Renewable Generator Total Impact: Labor Income (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	8,159	3,005	10,140	21,305
2001	3,721	1,358	5,571	10,650
2002	371	188	2,903	3,463
2003	3,848	1,347	10,298	15,494
2004	14,411	6,298	33,160	53,869
Sub Total	30,510	12,196	62,072	104,781
2005	52,101	22,249	115,146	189,497
2006	34,802	16,954	138,383	190,140
2007	-50,853	-15,991	84,329	17,484
2008	-67,222	-18,443	135,714	50,050
2009	-128,562	-38,970	134,922	-32,609
2010	-214,829	-68,394	112,099	-171,123
2005-2010	-374,563	-102,595	720,593	243,439
Total	-344,053	-90,399	782,665	348,220

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Energy Efficiency Program Economic Impact Results

To estimate the economic impact of the EE programs considered in this study, we relied on historical data and estimates of program savings and costs. We allocated the costs to various relevant economic sectors and reduced final demand for electricity by the variable operation and maintenance associated with the avoided fossil fuel generation.

We reflected the payment of EE costs by electric consumers as a reduction in their expenditures on other goods and services. We also adjusted demand for fuels and bulk transportation to reflect the shift of dollars from fossil fuel imported into the region to other uses. The avoided operation and maintenance costs and avoided fuel costs were given to households, government, and businesses.

The estimated outlays and savings and the relevant IMPLAN sectors for those input changes are shown in the tables above. Those amounts were specified as inputs to IMPLAN and are restated by IMPLAN as its direct impact amount for the economic output as shown in the impact tables below. These impacts occur in each year of program operation and are shown here accumulated across all programs operating, based on their reported and projected savings.

Table 3.26. Energy Efficiency Program Impact: Output (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	99,775	22,936	55,884	178,595
2001	93,775	22,127	48,641	164,709
2002	87,917	20,624	47,271	155,812
2003	74,690	16,544	34,380	125,614
2004	73,224	21,012	51,026	145,262
Sub-Total	429,547	103,243	237,202	769,993
2005-2010	577,262	173,177	480,349	1,230,788
Total	1,006,809	276,420	717,551	2,000,781

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.27. Energy Efficiency Program Impact: Employment (Job-years)

Year	Direct	Indirect	Induced	Total
2000	384.4	230.1	554.3	1,168.8
2001	311.3	224.4	477.1	1,012.9
2002	311.1	207.1	467.2	985.4
2003	262.7	167.1	330.5	760.3
2004	454.9	208.7	507.9	1,171.6
Sub-Total	1,724.4	1,037.4	2,337.0	5,099.0
2005-2010	3,230.8	1,705.8	4,958.3	9,894.9
Total	4,955.2	2,743.2	7,295.3	14,993.9

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.28. Energy Efficiency Program Impact: Labor Income (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	24,454	9,110	21,805	55,369
2001	21,586	8,753	18,674	49,013
2002	20,796	8,150	18,335	47,281
2003	15,966	6,393	12,851	35,210
2004	22,559	8,227	19,988	50,773
Sub-Total	105,361	40,633	91,653	237,646
2005-2010	188,225	70,163	197,761	456,151
Total	293,586	110,796	289,414	693,797

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Combined Economic Impact Results

The following tables show the sum of the impacts from the three analyses above: renewable generation construction, renewable generation operation, and electric efficiency programs.

The values are simply the sums of the impacts of those three analyses. This is implies that the effects are linear: $2 million spent in a certain way will have twice the impact of $1 million spent that way. As the economy responds to changes in inputs and consumption, the flow through effects are not always linear. For example, when electric demand is reduced, it is not the average plant that is throttled back, but the marginal plant, usually an oil or natural gas generator. (We have explicitly adjusted for that particular non-linearity in this study, as explained above.) But as deeper and deeper reductions are made, coal plants may be run less, and their avoided costs differ from those of oil and gas plants. As another example, if sufficient business develops in a region for, say, manufacturing or maintenance of wind generators, a local industry may develop changing the amount that is imported or the industry may become more efficient through economies of scale, reducing the unit costs. Such effects are possible, especially in the later years of this study where the impacts are largest, but are beyond the scope of this study.

Phase I:

Table 3.29. Combined Impact: Output (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	128,350	30,387	80,004	238,742
2001	109,529	25,538	61,996	197,064
2002	97,061	21,222	54,381	172,664
2003	103,976	20,180	59,126	183,282
2004	157,506	37,749	130,132	325,387
Sub-Total	596,422	135,076	385,639	1,117,139
2005-2010	659,234	133,751	560,689	1,353,674
Total	1,255,656	268,827	946,328	2,470,813

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.30. Combined Impact: Employment (Job-years)

Year	Direct	Indirect	Induced	Total
2000	549.7	292.7	805.5	1,647.9
2001	396.8	253.0	613.7	1,263.6
2002	339.0	210.9	535.6	1,085.4
2003	364.1	194.1	577.3	1,135.4
2004	761.6	329.3	1,307.9	2,398.8
Sub-Total	2,411.2	1,280.0	3,840.0	7,531.1
2005-2010	2,557.6	1,315.2	5,642.3	9,515.1
Total	4,968.8	2,595.2	9,482.3	17,046.2

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.31. Combined Impact: Labor Income (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	32,613	12,115	31,945	76,674
2001	25,307	10,111	24,245	59,663
2002	21,167	8,338	21,238	50,744
2003	19,814	7,740	23,149	50,704
2004	36,970	14,525	53,148	104,642
Sub-Total	135,871	52,829	153,725	342,427
2005-2010	147,095	52,511	230,533	430,141
Total	282,966	105,340	384,258	772,568

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Phase II:

Table 3.32. Combined Impact: Output (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	128,350	30,387	80,004	238,742
2001	109,529	25,538	61,996	197,064
2002	97,061	21,222	54,381	172,664
2003	103,976	20,180	59,126	183,282
2004	157,506	37,749	130,132	325,387
Sub Total	596,422	135,076	385,639	1,117,139
2005	365,474	79,915	325,083	770,469
2006	456,544	77,842	415,344	949,730
2007	343,236	-1,000	290,825	633,061
2008	497,916	-2,911	416,315	911,319
2009	531,650	-48,610	420,830	903,870
2010	516,159	-116,546	371,907	771,521
2005-2010	2,710,979	-11,310	2,240,304	4,939,970
Total	3,307,401	123,766	2,625,943	6,057,109

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.33. Combined Impact: Employment (Job-years)

Year	Direct	Indirect	Induced	Total
2000	549.7	292.7	805.5	1,647.9
2001	396.8	253.0	613.7	1,263.6
2002	339.0	210.9	535.6	1,085.4
2003	364.1	194.1	577.3	1,135.4
2004	761.6	329.3	1,307.9	2,398.8
Sub Total	2,411.2	1,280.0	3,840.0	7,531.1
2005	1,540.6	640.1	3,282.5	5,463.2
2006	1,400.0	591.4	4,164.6	6,156.0
2007	37.8	-94.0	2,754.2	2,697.9
2008	57.5	-172.0	3,927.7	3,813.1
2009	-695.5	-611.7	3,823.3	2,516.0
2010	-1,885.5	-1,243.1	3,141.8	13.1
2005-2010	454.9	-889.3	21,094.1	20,659.3
Total	2,866.1	390.7	24,934.1	28,190.4

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

Table 3.34. Combined Impact: Labor Income (000's of 2001 Dollars)

Year	Direct	Indirect	Induced	Total
2000	32,613	12,115	31,945	76,674
2001	25,307	10,111	24,245	59,663
2002	21,167	8,338	21,238	50,744
2003	19,814	7,740	23,149	50,704
2004	36,970	14,525	53,148	104,642
Sub Total	135,871	52,829	153,725	342,427
2005	74,867	30,555	134,844	240,267
2006	67,350	29,069	173,257	269,678
2007	-18,081	-3,776	119,517	97,659
2008	-34,427	-6,187	170,997	130,385
2009	-94,978	-26,393	171,172	49,803
2010	-181,069	-55,700	148,567	-88,202
2005-2010	-186,338	-32,432	918,354	699,590
Total	-50,467	20,397	1,072,079	1,042,017

Source: IMPLAN runs. Columns and rows may not sum to totals due to round off.

4.0 AIR QUALITY IMPACT METHODS AND RESULTS

The potential emission reduction results presented below represent projections of the potential *net* increases or decreases due to the assumed amount of energy efficiency spending and renewable generation.

4.1 Potential Impact of Renewable Generation

Table 4.1 and 4.2 presents potential displaced and reduced NO_X, SO_2, and CO_2 emissions due to the renewable generating units covered in this study. They present the results for Phase I and Phase II, respectively. Potential displaced emissions represent how many emissions from centralized power plants renewable generation units displace. Estimates of potential reduced emissions present net emissions reductions by incorporating increased emissions from certain renewable energy sources, such as biomass, biodiesel, and natural gas fuel cells. In other words, the left side of the table presents the avoided emissions from reduced operation of the traditional generating fleet as a result of the Phase I renewable generation, while the right side of the table shows the net effect of those same avoided emissions, but with the emissions of combustion-type renewables added back in.

Table 4.1 Phase I Analysis: Potential Displaced Emissions and Net Reduction in Emissions due to New Renewable Generation (tons)

Potential Displaced Emissions				Potential Net Emission Reduction			
	NOx	**SO2**	**CO2**	**Year**	**NOx**	**SO2**	**CO2**
2000	39	130	31,281	**2000**	39	130	31,281
2001	69	205	57,919	**2001**	69	205	57,919
2002	63	185	74,739	**2002**	63	185	73,169
2003	57	153	93,000	**2003**	57	153	89,703
2004	120	320	169,543	**2004**	119	320	164,261
2005	187	448	262,203	**2005**	155	442	256,921
2006	212	272	264,608	**2006**	180	266	259,326
2007	172	230	259,530	**2007**	140	224	254,248
2008	164	187	253,498	**2008**	132	181	248,216
2009	177	167	252,635	**2009**	145	162	247,353
2010	183	134	252,562	**2010**	150	128	247,280
Total	1,443	2,432	1,971,518	**Total**	1,248	2,398	1,929,677

Table 4.2 Phase II Analysis: Potential Displaced Emissions and Net Reduction in Emissions due to New Renewable Generation (tons)

Potential Displaced Emissions				Potential Net Emission Reduction			
Year	**NOx**	**SO2**	**CO2**	**Year**	**NOx**	**SO2**	**CO2**
2000	39	130	31,281	**2000**	39	130	31,281
2001	69	205	57,919	**2001**	69	205	57,919
2002	63	185	74,739	**2002**	63	185	73,169
2003	57	153	93,000	**2003**	57	153	89,703
2004	120	320	169,543	**2004**	119	320	164,261
2005	467	1,118	653,807	**2005**	372	1,101	585,110
2006	870	1,115	1,083,215	**2006**	704	1,085	951,128
2007	1,022	1,368	1,541,462	**2007**	683	1,308	1,409,375
2008	1,211	1,381	1,871,554	**2008**	853	1,317	1,654,723
2009	1,567	1,487	2,237,004	**2009**	1,184	1,419	1,935,893
2010	1,878	1,382	2,596,187	**2010**	1,459	1,307	2,210,564
Total	7,362	8,844	10,409,712	**Total**	5,603	8,532	9,163,126

In order to estimate net emission reductions, seasonal load characteristics of different renewable units were first identified. Base-load characteristics were used for biomass, biodiesel, landfill gas, and fuel cell units. For other renewable units, such as photovoltaic, wind, run-of-river hydro units, fuel-specific seasonal load characteristics are used. These data is obtained from the Emission Reduction Workbook that Synapse developed for the Ozone Transport Commission (OTC Workbook).[80] The Workbook is a quantitative tool used to estimate emission reductions from a wide variety of energy policies in the Northeast.[81]

Secondly, annual total generation was allocated among four ozone-related seasons for each fuel type unit according to the renewable units' load characteristics. The four seasons are; (1) Ozone Season Weekday; (2) Ozone Season Night/Weekend; (3) Non-Ozone Season Weekday; and (4) Non-Ozone Night/Weekend. The Ozone Season starts in May and ends in September. The weekday is from 7:00 AM. to 10:59 PM, Monday through Friday.

Thirdly, displaced emissions for each season were estimated through multiplying historical and projected seasonal marginal emission rates (Lbs/MWh) by seasonal

[80] Seasonal load characteristics for run-of-river hydro units are not included in OTC Workbook, and thus were developed for this study.

[81] The tool was developed by evaluating system marginal emission rates in the three northeastern power pools with the PROSYM/PROMOD dispatch model. The emission rates developed in this modeling were embedded in a spreadsheet designed to allow the user to evaluate displaced emissions from renewable energy and energy efficiency programs implemented in these regions. See: http://www.synapse-energy.com/publications.htm#repo.

renewable generation (MWh) for each fuel type unit. The total of displaced emissions by all renewable generation units is shown at Tables 4.1 and 4.2. Seasonal marginal emission rates are shown at Table 4.3. The seasonal marginal emission rates from 2000 to 2003 are historical data obtained from the 2003 NEPOOL Marginal Emission Rate Analysis (MEA) report and the emission rates from 2004 to 2010 are projected rates obtained from Synapse's OTC Workbook. Note that the marginal emission rates of all three pollutants are projected to fall from historical levels during the coming decade, as plant turnover places cleaner plants on the margin for larger percentages of the time. Also note that MEA's emission rates were adjusted according to OTC Workbook's ozone-related time periods.

Table 4.3 Historical and Projected Seasonal Marginal Emission Rates (Lbs./MWh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ozone Season Weekday											
NOx	1.98	1.85	1.33	0.73	0.50	0.70	0.80	0.70	0.70	0.70	0.70
SO2	6.53	5.19	3.49	2.23	0.90	1.30	1.10	1.00	0.80	0.60	0.40
CO2	1,540	1,424	1,382	1,175	920	980	1,030	1,010	980	980	980
Ozone Season Night/Weekend											
NOx	1.80	1.50	0.80	0.29	0.80	0.60	0.60	0.50	0.50	0.60	0.70
SO2	6.00	4.40	2.00	0.59	2.40	1.60	0.90	0.80	0.50	0.50	0.50
CO2	1,505	1,340	1,171	974	1,090	1,010	1,000	970	920	920	960
Non-Ozone Season Weekday											
NOx	1.80	1.69	1.44	0.89	0.40	0.40	0.90	0.60	0.60	0.70	0.70
SO2	6.25	5.09	4.66	2.28	0.80	0.70	0.50	0.40	0.40	0.50	0.40
CO2	1,460	1,404	1,506	1,256	920	890	950	940	940	950	950
Non-Ozone Season Night/Weekend											
NOx	1.80	1.60	1.00	0.86	1.10	1.10	0.90	0.80	0.70	0.70	0.70
SO2	5.90	5.00	3.00	2.39	3.30	3.00	1.60	1.30	1.10	0.90	0.70
CO2	1,440	1,393	1,300	1,236	1,130	1,120	1,070	1,050	1,030	1,010	980

Data source: ISO New England Inc., December, 2004 NEPOOL Marginal Emission Rate Analysis; OTC Workbook Version 2.1

Finally, total emissions from certain renewable units, such as biomass, biodiesel, and fuel cell were estimated and applied to the total displaced emissions for estimating net emission reductions. Table 4.4 presents emission rates from those renewable generation units. The results of net emission reductions each year are shown at Tables 4.1 and 4.2, as explained above.

Table 4.4 Emissions from Generation Units

	NOx (Lbs./MWh)	SO2 (Lbs/MWh)	CO2 (Lbs./MWh)
Fuel Cell (Natural Gas)	0.03	0.006	1135
Biodiesel Micro-turbine	1.2		330
Biomass	0.36	0.06	--

Data Source: GRI and NREL 2003; Meidensha 2003; Barrett Consulting Associates, Inc. 2004; Massachusetts Division of Energy Resources (DOER), "Renewable Portfolio Standard Advisory Rulings"

Renewable generation projects selected for our Phase I analysis are projected to displace approximately 1,440 tons of NOx, 2,430 tons of SO2, and 1,970,000 tons of CO2 during the period between 2000 and 2010. Net emission reductions, after accounting for the emissions from certain of the renewable units, are projected to be approximately 1,250 tons of NOx, 2,400 tons of SO2, and 1,930,000 tons of CO2. Net SO2, NOx, and CO2 emission reductions were smaller than the traditional generation emissions avoided by 13%, 1%, and 2%, respectively. The difference between displaced and reduced emissions is most significant for NOx, because of one large biomass plant that became on line on December 31, 2004.

Renewable generation projects selected for Phase II analysis are projected to displace significantly larger amounts of emissions than the Phase I plants, which assumed no new RPS plants came on line after 2004. Displaced emissions in our Phase II analysis are approximately 7,360 tons of NOx, 8,840 tons of SO2, and 10,400,000 tons of CO2 during the period between 2000 and 2010. Net emission reductions are approximately 5,600 tons of NOx, 8,500 tons of SO2, and 9,160,000 tons of CO2. Net NOx, SO2, and CO2 emission reductions were smaller than the traditional generation emissions avoided by 24%, 4% and 12%, respectively. The difference between displaced and reduced emissions is most significant for NOx because a large number of biomass plants were included in Phase II analysis, while the difference in CO2 emission savings was due mainly to inclusion of a number of natural gas fuel cell units. Overall, net emission reductions in Phase II are approximately 4 to 5 times larger than the reductions achieved in Phase I.

Finally note that we refer to these emission reductions as "potential reductions," because many of the oil- and gas-fired steam units that would operate less with new renewable generation currently receive NO_x allowances, and some of them receive SO_2 allowances as well. The extra allowances created by this reduced generation could be traded to other sources, resulting in no reduction in overall system emissions. In fact, if allowance markets are working efficiently, one would expect the industry to emit pollution equal to the capped levels. In this scenario, the new renewable generation would have the effect of lowering the cost of meeting the emission caps. Alternatively, regulators could establish mechanisms to capture and preserve the emission reductions offered by new renewables, such as by lowering emission caps as new, zero-emission generators were added to the system.

4.2 Potential Impact of Electric Efficiency Programs

Table 4.5 presents the potential NO_X, SO_2, and CO_2 emission reductions from year 2000 through 2010 due to energy efficiency programs covered in this study. Unlike renewable generation, displaced emissions equal to reduced emissions in energy efficiency programs. Aside from this difference, displaced emissions were estimated in a manner similar to that used for renewable units: first by allocating cumulative annual savings among ozone-related four seasons based on the typical load characteristics of the aggregated utility DSM programs and then by multiplying historical and projected seasonal marginal emission rates (Lbs/MWh) by seasonal savings (MWh). The quantity of energy savings is given in Table 2.14, and the marginal emission rates in Table 4.3.

In comparison to the impacts of renewable generating units, energy efficiency programs offer significantly larger potential reductions for two reasons: (1) efficiency programs avoid significantly larger quantity of power generation than renewable generation units; and (2) efficiency programs do not emit pollution unlike some types of renewable generation units.

In total, the efficiency programs in our analysis are estimated to reduce significantly larger amount of emissions than renewable energy projects. Reductions achieved during the period between 2000 and 2010 are approximately 16,400 tons of NOx, 25,700 tons of SO2, and 22,520,000 tons of CO2. These figures are around 11 to 13 times greater (depending on which pollutant is considered) than the emission reductions of renewable generating projects under the Phase I analysis and 2 to 3 times those under the Phase II analysis.

Table 4.5 Potential Emission Reductions from Energy Efficiency Programs (Tons)

Year	NOx	SO2	CO2
2000	308	1,036	247,777
2001	907	2,689	753,694
2002	1,109	3,267	1,259,509
2003	924	2,508	1,473,060
2004	1,015	2,572	1,565,527
2005	1,301	2,951	1,926,805
2006	1,949	2,270	2,371,640
2007	1,797	2,247	2,712,014
2008	1,980	2,112	3,030,051
2009	2,408	2,162	3,401,962
2010	2,737	1,885	3,777,552
Total	16,436	25,699	22,519,591

Data source: Synapse calculations using for 200-2003 ISO New England Inc., December 2004, 2002 NEPOOL Marginal Emission Rate Analysis, page 9; and for 2004 through 2010: Synapse OTC Workbook Version 2.1, as well as the sources discussed in Section 2.2 of this report.

4.3 Potential Impact of Combined Renewable Generation and Electric Efficiency Programs

Table 4.6 presents the potential NOx, SO2, and CO2 emissions reduction that combines impact of renewable generation and energy efficiency programs. The Phase I analysis in Table 4.6 indicates the potential emissions reduction by renewable generation under Phase I analysis and by all energy efficiency programs, as discussed above. This resulted in reducing approximately 17,700 tons of NOx, 28,000 tons of SO2, and 24,450,000 tons of CO2 during the period from 2000 through 2010. The Phase II analysis in Table 4.6 presents the potential emissions reduction by renewable generation under Phase II analysis and by the energy efficiency programs as we discussed above. This resulted in reducing approximately 22,000 tons of NOx, 34,000 tons of SO2, and 31,680,000 tons of CO2 during the period from 2000 through 2010. Overall, renewable generation under Phase II analysis and the energy efficiency programs combined reduces 25% more NOx potential emission reduction, 22% more SO2 potential emission reduction, and 30% more CO2 potential emission reduction than renewable generation under Phase I analysis and the energy efficiency programs combined. Note these additional emission reductions are contributed by renewable generation that came or will come on line after December 31, 2004.

Table 4.6 Potential Net Reduction in Emissions from New Renewable Generation and Energy Efficiency Programs (Tons)

Phase I Analysis				Phase II Analysis			
Year	**NOx**	**SO2**	**CO2**	**Year**	**NOx**	**SO2**	**CO2**
2000	347	1,166	279,058	**2000**	347	1,166	279,058
2001	976	2,895	811,614	**2001**	976	2,895	811,614
2002	1,172	3,452	1,332,678	**2002**	1,172	3,452	1,332,678
2003	981	2,661	1,562,763	**2003**	981	2,661	1,562,763
2004	1,134	2,892	1,729,788	**2004**	1,134	2,892	1,729,788
2005	1,456	3,394	2,183,726	**2005**	1,674	4,052	2,511,915
2006	2,129	2,536	2,630,966	**2006**	2,653	3,355	3,322,768
2007	1,936	2,472	2,966,262	**2007**	2,479	3,555	4,121,389
2008	2,112	2,293	3,278,267	**2008**	2,834	3,429	4,684,774
2009	2,553	2,324	3,649,315	**2009**	3,592	3,581	5,337,856
2010	2,888	2,013	4,024,832	**2010**	4,196	3,192	5,988,116
Total	17,684	28,097	24,449,269	**Total**	22,038	34,231	31,682,718

Appendix D : ENERGY EFFICIENCY SPENDING AND SAVINGS, 2000 – 2010

Table D-1 Annual Expenditures by Energy Efficiency Program: Thousands of Nominal Dollars

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total New England Residential											
New Construction	8,288	12,574	8,961	9,213	10,013	10,599	10,543	10,768	10,998	11,354	11,596
In-Home Services/ Retrofit	38,314	47,269	43,317	38,653	39,925	41,710	41,690	42,603	43,538	44,896	45,879
Products and Services	31,942	32,871	27,926	22,879	36,143	41,264	40,620	41,912	42,719	44,653	45,445
Other	4,839	6,335	3,668	6,965	4,140	4,636	4,479	4,543	4,607	4,778	4,861
Subtotal	83,383	99,049	83,872	77,710	90,220	98,209	97,334	99,825	101,862	105,682	107,780
Commercial and Industrial											
New Construction	42,160	40,542	43,468	37,968	46,879	49,873	49,187	50,280	51,337	53,206	54,280
Retrofit/Products and Services	94,096	89,425	79,483	68,239	86,460	90,538	88,715	91,520	93,350	97,274	99,188
Other	7,956	7,329	4,512	12,033	7,016	5,933	5,458	5,518	5,580	5,878	5,942
Subtotal	144,212	137,295	127,463	118,240	140,355	146,344	143,360	147,317	150,266	156,357	159,410
Other	15,664	18,640	29,837	26,683	13,452	16,886	14,688	14,700	14,702	15,807	15,851
Total	243,336	255,065	241,246	222,633	244,027	261,439	255,381	261,842	266,830	277,845	283,041

This table aggregates actual and expected spending for energy efficiency programs in the New England states for each year from 2000 through 2010. Present spending policies are continued through the period.

Table D-2 Annual Savings by Program at Generation Level

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total New England Residential											
New Construction	54,239	67,727	72,964	51,838	89,974	113,685	109,743	109,273	108,814	109,743	109,273
In-Home Services/ Retrofit	837,689	795,224	913,690	684,669	660,171	759,945	735,019	732,048	729,150	735,023	732,052
Products and Services	1,558,891	1,971,193	1,633,748	1,017,804	1,398,169	1,799,057	1,661,552	1,645,164	1,629,175	1,661,572	1,645,184
Other	31,436	57,327	40,302	10,714	9,704	-	-	-	-	-	-
Subtotal	2,482,256	2,798,405	2,660,703	1,765,025	2,158,019	2,779,630	2,638,826	2,637,088	2,619,629	2,665,956	2,646,127
Commercial and Industrial											
New Construction	2,415,906	2,740,167	2,349,363	2,533,995	2,513,592	2,873,349	2,711,751	2,692,491	2,673,700	2,711,774	2,692,514
Retrofit/Products and Services	4,825,298	5,926,729	4,629,189	4,718,221	4,889,563	5,260,173	4,938,871	4,900,577	4,863,217	4,938,918	4,900,623
Other	291,904	608,192	396,898	185,759	305,516	50,720	42,104	41,077	40,075	42,105	41,078
Subtotal	7,533,108	9,275,088	7,375,449	7,437,976	7,708,670	8,466,467	7,967,113	7,962,573	7,906,693	8,051,218	7,992,635
Total	10,015,364	12,073,493	10,036,153	9,203,001	9,866,689	11,246,097	10,605,940	10,599,661	10,526,321	10,717,174	10,638,761

This table aggregates actual and expected energy savings from energy efficiency programs in the New England states for each year from 2000 through 2010. Present program policies are continued through the period.

Appendix E : WHY NATURAL GAS DEPENDENCE RAISES CONCERNS

Natural gas has fueled nearly all of the new generation installed in New England for over a decade. It now fuels almost 40 percent of the region's electricity. This remarkable trend is a result of low gas costs; increased pipeline delivery capacity; power generation technology that is also low cost, relatively straight-forward to site, and reliable to operate; and an air emissions profile that is as clean as any fossil fuel-driven system can presently offer. As with many good things, too much reliance on natural gas as a power generation fuel leads to concerns. In this case, the concerns are about security and price.

Energy Security

ISO-NE is the reliability coordinator for New England. This means the ISO is responsible for maintaining national reliability standards. This includes assuring that they identify significant ways the grid can fail and design system operation defenses.

ISO-NE's consultant, Levitan, made the following observations about natural gas that relate to the security of New England's electric grid.[82]

- Natural gas as a fuel for electric power represents an increasing fraction of New England's fuel mix. There has been significant construction of gas-powered generation in recent years, though the pace has slowed.
- Natural gas flows into New England through five major pipeline systems: Tennessee, Algonquin, Iroquois, Maritimes/Northeast, and Portland.
- Disruption of natural gas supplies at certain places can interrupt gas flows to multiple power generators, a potentially more significant effect than the dropping out of service of any single power source in New England.
  - The effects of a disruption on a pipeline system may be ameliorated by existing interconnections among the gas pipelines and the fact that incremental pipeline compression capacity increases deliverability.
  - However, there remain vulnerable pipeline system elements which can simultaneously affect multiple electric generators.
- Some natural gas generators' fuel supply contracts allow for the gas to be diverted to customers with firm contracts. (While assuring that local gas companies have sufficient gas to meet critical obligations is a very important public objective, it is important that the electric system account for the somewhat diminished level of firm capacity that is available from a generator with such a contract.)

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[82] *Steady-State and Transient Analysis of New England's Interstate Pipeline Delivery Capability, 2001-2005***,** Levitan & Associates, Boston MA, February 2002. This report includes recommendations to ISO-NE that would shore up the natural gas system and the electric generators it serves.

- ♦ Some dual fuel (natural gas and oil) generators do not maintain on-site oil supplies to the maximum extent necessary to assure reliable operation, making them more vulnerable than they could be to shutdowns in tight gas markets.

In addition to infrastructure vulnerabilities, and the occasional lack of firm contracts or back-up plans, there are other factors that increase or diminish the security risk of natural gas dependence. Natural gas gets to New England from four distinct geographic sources: the US Gulf coast, Western Canada and Western U.S., the Canadian Maritimes, and off-Continent via LNG (liquefied natural gas) ships. This source diversity serves New England well in terms of both supply and price risk management. However, as New England increases its dependence on natural gas for electricity generation, it competes with critical uses, such for home heating, and competes with other regions of the country and the world as they add new natural gas generation and rely increasingly on harder to reach supplies in North America and liquefied natural gas abroad..

Renewable energy and energy efficiency can serve to take pressure off the natural gas system by providing more energy from non-gas fuels, and by relieving some of the pressure on natural gas operating and contracting practices caused by growth in electric use, especially in the winter when contention for firm natural gas is most extreme.[83]

Cost

Increased demand for natural gas in the U.S. and abroad in the last decade has lead research economists to try to understand if this trend would increase market prices, and if so, how reducing demand through use of alternative energy resources and efficiency would ameliorate that price increase. Four recent studies were reviewed for insights helpful to policymakers. [84]

Increase in Price

At this writing, a sustained increase in natural gas prices appears to have occurred. After years of prices ranging roughly between $2.00 and $3.00 per million BTU, natural gas prices seem to have settled in a rough range of $4.50 to $7.00 per million BTU with increased volatility in prices the norm through the year. Researchers generally agree that basic supply-demand relationships are at work.

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[83] Further recommendations are included in the *Interim Report on Electric Supply Conditions in New England during the January 14-16, 2004 "Cold Snap"* ISO – New England Market Monitoring Department, Holyoke MA, May 10, 2004.

[84] Ryan Wiser, Mark Bollinger, Matthew St. Clair, *Putting Downward Pressure on Natural Gas Prices: The Impact of Renewable Energy and Energy Efficiency*, Lawrence Berkeley National Laboratory, Berkeley, CA, 2004.

R. Neal Elliott, Anna Monis Shipley, Steve Nadel, Elizabeth Brown, *Natural Gas Price Effects of Energy Efficiency and Renewable Energy Practices and Policies*, ACEEE, Washington D.C., December 2003.

Balancing Natural Gas Policy – Fueling the Demands of a Growing Economy, National Petroleum Council, Washington DC, September 25, 2003. (NPC 2003)

John A. "Skip" Laitner, *The Impact of Efficiency Technologies on Natural Gas Prices: A Review of the Theory and Recent Modeling Activities*, US EPA, Washington DC, July 2004.

The ubiquitous nature of electricity in society and the fact that New England now gets nearly 40 percent of its electricity from natural gas-fired sources should signal policymakers, well beyond the energy sector, that this trend could have serious negative effects on the general economy. No less an authority than Alan Greenspan saw fit to call attention to this concern at a 2003 Congressional hearing.[85]

Mitigation Potential

Researchers also generally agree that steps to reduce natural gas demand will have a beneficial effect on consumer costs of energy and the general economy. Literature published in the last two years endeavors to take that hypothesis and value it with analytical rigor. Some work may be seen as marketing efforts by advocates of distinct alternative resources to take advantage of an opportunity to increase market share at the expense of gas. Fortunately, much of this work, including the work referenced here, stands well on its merits, based on solid analysis and peer review. Therefore, this body of work will help policymakers determine how to value the potential of natural gas alternatives to reduce natural gas prices.

Review of results

The ACEEE report concludes that by 2008 the wholesale price of gas could be reduced by 22 percent using energy efficiency and renewable energy strategies. Deployed over five years, the strategies would reduce overall gas consumption nationwide by 4.1 percent and electric consumption by 3.2 percent, while increasing renewable energy by 4 percent. Net savings over five years to retail gas customers, electric customers, and electric power generators would total $104 billion. To achieve these savings, ACEEE postulated investment of $30 billion in electric energy efficiency (two-thirds), renewable energy (one-quarter), and gas efficiency (the rest). Gas efficiency obviously reduces gas consumption, but most of the gas consumption savings come from electric efficiency and renewable energy displacing the need for gas-fired generation.

The ACEEE report has a national sweep, but it also takes some snapshots of distinct regions. While the report does not examine New England individually, it does examine New York. The report finds that increasing renewable energy in New York by 3.8 percent over current levels over four years would displace sufficient gas to lower wholesale gas prices in New York City by 2 percent. A similar scale effect could be postulated for New England, which has similar circumstances.

The National Petroleum Council, an advisory group to the U.S. Secretary of Energy, provides recommendations designed to accomplish a market balance that avoids high and volatile prices. Efficiency gains in electric demand intensity and gas efficiency are

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[85] Alan Greenspan, Testimony before the Committee on Energy and Commerce, US House of Representatives, June 10, 2003.
http://www.federalreserve.gov/boarddocs/testimony/2003/20030610/default.htm (September 15, 2004)

integral to its recommendations.[86] More generally, the NPC urges that inherent conflicts in markets and regulation and between public and private interests that persist today be removed or minimized. One of their recommendations on this point is consistent with a recommendation here: decouple utility net income from sales.

The LBNL report distills the methods and conclusions of several modeling studies, including the ACEEE work, and combines them with its own analysis. It concludes that "[r]esults presented in this paper suggest that resource diversification, and in particular increased investments in RE and EE, have the potential to alleviate the threat of high natural gas prices over the short and long term." However, they expect that the long-term price impact will be less significant than shorter-term impacts. The authors summarized the reports they reviewed as indicating that "each 1 percent reduction in national gas demand could lead to a long-term average wellhead price reduction of 0.75 percent to 2.5 percent, with some of the models predicting even more aggressive price reductions." They also found the models predict that natural gas price reductions would offset any increases in electricity costs due to the EE and RE investments. However, the LBNL team was careful to point out throughout the report that the ability to accurately model these dynamics, especially the supply curve for natural gas, is presently very limited. A reduction in natural gas "appears likely to lead" to a decrease in the wellhead price of gas.

The LBNL report includes some useful insights for policymakers. The authors note that lower gas prices could be characterized as a shifting of wealth from producers to consumers. Although benefits to consumers may or may not be a priority, that shift may have other important implications such as reducing imports (especially of liquefied natural gas), preserving U.S. manufacturing jobs (in sectors relying on natural gas as a fuel or a feedstock), or assisting farmers (due to use of natural gas in fertilizers). The authors also note that if natural gas prices get too high, new coal units may be built instead of natural gas units, and the EE and RE interventions in some regions would be competing with coal production, with different economic and social results. The authors suggested that policymakers "might view reduced gas prices as a positive secondary effect of increased RE and EE deployment," rather than as an end in itself.

The fourth study, by Laitner, is also a review of other works, as well as a test of the logic that a demand reduction in electricity that has a cost is likely to produce positive benefits. He concludes that there is evidence to "support the potential of energy efficiency technology investments as 'vital near-term and long-term mechanisms for moderating price levels and reducing volatility (of energy prices).'" He also indicates that "cost-effective energy efficiency investments can lower energy prices and increase overall economic activity."

[86] NPC 2003 FINDING 2: Greater energy efficiency and conservation are vital near-term and long-term mechanisms for moderating price levels and reducing volatility.

Implications for New England

Natural gas is a national commodity market, and becoming an international market, but there are distinct regional markets driven by local deliverability and demand.[87] There appears to be consensus among researchers that state and regional efforts to develop alternatives to natural gas will contribute to lower and more stable prices and availability with less need to construct new pipeline and liquefied natural gas facilities.

It is also worth noting that while at this writing, 100 new coal-fired generation facilities have been proposed in the U.S.;[88] none of these are in New England or New York. The practical fuel alternatives to natural gas in New England are fewer than elsewhere. This reality spotlights efficiency and renewables as prime solutions to the policy challenge of managing the region's current level of dependence on natural gas for electric generation.

[87] Greenspan

[88] http://www.netl.doe.gov/coal/refshelf/New%20Coal%20Plants%20(3-30-05).pdf (April 12, 2005)