North Country Council, Inc.

Regional Commission & Economic Development District

Northern Forest Center

Energy in the Northern Forest Region:

A Situation Analysis

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Table of Contents

1. Introduction

1.1. Purpose and Approach

Synapse Energy Economics, Inc., has prepared this paper on energy issues as input to the Northern Forest Sustainable Economy Initiative (the "Initiative"). This Section 1 provides an overview of the key points made in the rest of the paper. In Section 2, we present some basic facts about energy production and use in the Northern Forest ("NF") region. Section 3 discusses the key energy issues, challenges and opportunities that should be considered in charting a path towards the Initiative's goal of a healthy economy.[1] Section 4 offers recommendations for further research on energy issues and how they influence the NF region's economy, while Section 5 summarizes our conclusions. The remaining sections provide a glossary, background data, and references.

Where possible, we have disaggregated data on energy and the economy for the 34-county NF region. However, due to the manner in which energy statistics are collected, this was rarely possible given the time constraints on this effort. Where it was not, we have provided state-level data and commented on the likely similarities and differences between the NF region and the balance of the four NF states (Maine, New Hampshire, Vermont and New York). Issue discussion are based on that data and our experience and professional judgment.

This report is not an energy plan nor an technical analysis of energy data and potential. Rather, it seeks to highlight and explain certain key energy-related issues and understandings that decision makers and policy influencers should keep in mind when grappling with the question of how to build a sustainable economy—sustainable for the long haul—in the NF region.

We wish to thank the following people for their assistance in preparing this report: Curt Grimm, Joseph Short, Andrea Colnes, all of the Northern Forest Center, and Sarah A. Savage of the University of New Hampshire's Carsey Institute.

1.2. A Vision for the Northern Forest Economy

Past work of the Northern Forest Center ("Center") has identified three traits of a healthy economy for the NF region:

- ❖ Strong, diverse local economies that provide good jobs, attract investment and enable people to create and buy local goods and services.
- ❖ A revitalized forest manufacturing sector recognized worldwide for ecologically sound practices, innovative products and skilled craftsmanship.
- ❖ World-class tourism and recreation rooted in experiences of a spectacular natural landscape and the region's unique stories, history, cultures, arts and traditions.

The Center's 2005 regional strategy document goes on to single out "[i]ncrease the energy self-sufficiency of the Northern Forest by expanding renewable energy generation" as a strategy for achieving these outcomes. (Northern Forest Center 2005) As we will see below, progress *towards*

[1] The Northern Forest Center has stated that "A shared vision for the future of the Northern Forest has emerged from the past decade and a half of dialogue, research and community activism. People from different states, political parties, professions and walks of life have come together time and again to address the region's needs and they have found common cause in a vision of the Northern Forest that provides: Healthy Communities[,] Healthy Economies[,] Healthy Ecosystems[, and a] Healthy Region."

energy independence for the NF region can and will help improve the health of its economy, energy independence cannot stand alone as *the* way to deliver an adequate, safe, reliable, reasonably priced, and sustainable supply of energy for a healthy NF economy. In this report, we will show how a "360 degree" view of energy-economy interactions can provide a wider context for economic planning.

1.3. Key Planning Observations

- The NF region has several commercial scale, indigenous and renewable energy resources: hydropower, biomass in various forms, wind and solar energy. Essentially all other energy sources are imported. Most of the hydroelectric output exported with little benefit to the region because the dams are owned by outside entities.

- While current production is quite large, the potential for *additions* to hydroelectric capacity is small. Surging wind power development has met strong backlash is a few areas and succeeded well in others. The total potential is significant compared to the electric use in the NF region and can also form an economic export.

- Woody biomass is widely used for direct heat and in a few plants for electric generation. New high efficiency, clean technologies for both heat and electricity applications. Other forms of biomass production show promise as well, including short rotation woody crops and grasses.

- Transportation energy needs and the resulting air pollution and costs are the single largest energy issue in the NF region, have not been adequately addressed to date, and will require innovative solutions to make headway. Virtually all transportation fuel used in the NF region is imported fossil fuel. The biggest levers for addressing that need are likely to be vehicle efficiency and travel demand management. However, biodiesel (a diesel-like fuel made from agricultural products or waste cooking oil) and methanol (made from agricultural products or wood) are now tiny contributors, but show promise as indigenous fuels for the future and have other desirable characteristics.

- We estimate that for 2006 petroleum products purchases for fuel in the NF region caused an outflow of about $4.8 billion dollars and that the outflow for purchases of natural gas used in the NF region is about $1.1 billion dollars. The total of these estimates is $5.9 billion dollars. To put this in scale, the contribution to Gross State Product from the entire agriculture, forestry, fishing and hunting sectors in the four states combined was $5.75 billion dollars in 2004.

- A recent study by Synapse Energy Economics estimated that a reasonable, but steady program to capture just the readily available electric energy efficiency in New England would net the regional economy an estimated $180 million (2001 dollars) per year and increase employment by an average of about 1350 jobs. A similar program to develop renewable energy would net the regional economy an estimated $600 million (2001 dollars) per year and increase employment by an average of almost 1200 jobs. The NF region could readily achieve economic benefits from similar actions.

- All four states in the NF region have established state-level policies and programs to promote development of renewable electricity generation and energy efficiency for electric and natural gas uses. But few, if any, programs and resources are devoted to promoting energy efficiency or renewable energy use in transportation or non-electric uses in residences or businesses.

- Climate change (and other environmental) issues will become increasingly important for both forest health and tourism over the coming decades. Climate change concerns will likely dominate energy policy making starting sometime in the next decade.
- "Green" practices, communities and vendors are likely to become more important to destination and buying decisions of consumers, tourists and businesses.
- High and volatile prices for fossil fuels and electricity, along with possible supply disruptions and increasing environmental constraints and costs may be expected to last for many years.
- Construction of major liquefied natural gas ("LNG") terminals in Northeast U.S. and Canadian coastal regions are expected and may offset the high transportation costs of domestic gas, but international competition for LNG supplies means that high prices, volatility and potential interruptions are likely to remain the norm.
- Small communities and ongoing sprawl mean dispersed populations, jobs and services that make it difficult to promote alternative transportation modes or district heating/cooling and reduce the cost effectiveness of some building efficiency options. Such diffuse populations also make it difficult for natural gas distribution to be cost effective.
- No one quick fix nor any permanent solution to energy needs exists; flexibility, adaptability and strategic prioritization of options are needed. Much can be done, however, given constant innovation and commitment.
- Emphasis on an energy independence strategy raises difficult issues. Complete energy independence is unlikely to be the best way to strengthen the NF region's economy. This is especially true for electricity supply, which is extraordinarily interconnected both physically and economically across virtually all of North America this side of the Mississippi River. However, each increment of indigenous renewable energy produced or of energy efficiency delivered reduces the *size* of the "energy *de*pendence" problem and makes further progress less difficult. Vigorous efforts in those two areas will move the NF region in the right direction.
- Greater reliance on renewable energy and energy efficiency can reduce cash outflows for fossil fuel and revitalize the NF economy, while improving energy security.
- A Least Cost Planning approach to transportation planning can create new ways of looking at transportation energy problems.
- Biomass production for direct heat and for electric generation can be a sustainable engine for NF economic growth.

1.4. Suggestions for Further Research

This report provides some energy-related insights to help the NF community initiate a conversation about building a sustainable economy for the NF region. Decision makers will need more detailed and specific information to make wise and workable choices. Agencies and others implementing those choices will need additional information. Here, we discuss the three most crucial areas for further research. Section 4 of this report presents additional recommendations.

One important problem we see is the scarcity of energy data specific to the NF region. Most energy-related information is reported at the state level, but energy issues differ greatly between the NF region and the remainder of the four states. Electricity information is usually available either at the state level or for individual utilities, but quite a few utilities serve both NF and non-NF areas. We recommend that the work of the NF Sustainable Economy Initiative include systematic collection of relevant energy and economic information, especially with regard to renewable electric generation and non-traditional fuels such as biodiesel.

Our assessment of energy policies and trends has been limited by constraints on the time available. Those analyses mainly used aggregate results from New England-wide studies and data not specific to the NF region. The energy infrastructure, needs and economics of the NF region differ greatly from the "balance of state," and we believe that those differences are material to understanding the economic pros and cons of energy policies for the NF region. We recommend detailed economic impact modeling using a model configured for the NF counties.

Clearly, whether or not action is taken by the U.S., climate change will bring about a different forest in the NF region over a time scale relevant to the goal of a sustainable regional economy. We recommend that the Initiative develop a plan for assessing the range of changes to the NF and its economy, both to provide a better background for strategic decision making and as tool for assessing the impact of the options being considered.

2. Energy and the Northern Forest Economy

Concerns about how the NF economy interacts with the energy use and energy supply turn mainly on two issues: employment in energy related industries (including energy efficiency goods and services) and the region's net "balance of payments" for energy. The energy situation in the NF region impact the ability to create a sustainable regional economy by the outflow of dollars for fossil fuel and imported electricity, net of exports of energy. Limitations on the available data prevent precise characterization of these issues within the scope of this project, but in this section we provide qualitative and some quantitative orientation to the production and use of energy in the NF region.

2.1. Energy Sources: Wood, Wind, Water and Imports

Overview

The NF region has several commercial scale, indigenous energy resources. As it happens, those resources are all renewable resources:

- flowing water in its rivers, large and small, and wood in its forests—both long used directly for heat or motive power and more recently to produce electricity,
- wind—rarely used until the last ten years, but now seen as an economical or nearly economical way to generate electricity, and
- light from the sun, which can be used directly to heat buildings and water or converted to electricity using photovoltaic cells.

Essentially all other energy sources, muscle power aside, are imported, either as fossil fuel or uranium, or over wires as electricity. It may not startle readers to realize that most of the hydroelectric output of the NF region is exported to consumers outside the region, but more surprisingly those exports economically benefit the NF region less than they might because most dams are owned by outside entities. So, the NF region's economy is run largely on imported energy. Before reviewing specific data, we will review a few additional big picture points.

- While there is a long history of hydro generation, both small and large, the potential for additions to that capacity is relatively small and some factors indicate potential reductions. The main reasons are (1) most significant sites are already developed, (2) re-licensing processes tend to restrict rather than expand output, and (3) a few dams have been or may be decommissioned. Developing some older, abandoned mill sites may be a possibility, but the best were picked up during PURPA. Some existing sites may be candidates for minor upgrades when it is time to install new turbines and generators. Some small amounts of generation may be feasible by placing small turbines inside municipal water supply pipelines if the flow is gravitational.

- There has been some small scale wind generation in or near the NF region over the years, going as far back as WW II, and we are now seeing surging development, or at least, proposals for development driven by state renewable portfolio standard ("RPS") goals. Proposals to locate wind generation have met strong backlash is a few locations and succeeded in others.[2] The total potential (if all sites were developed, which is quite unlikely) is significant compared to the electric use in the NF region.

- Woody biomass from the forest is widely used for direct heat in all sectors, but especially in homes. It is used in a few modest sized plants of up to 50 MW for electric generation, and there is a trend towards high efficiency, clean biomass combustion technologies for both direct heat and electric generation applications. Other forms of biomass production show promise as well, including short rotation woody crops and grasses.

- There are very small amounts of photovoltaic power in scattered locations. The total is tiny, and the equipment is expensive. Technological improvements are expected over time, and the NF region actually has a reasonable level solar input, especially on the coldest days of mid-winter and the hottest days of summer.

- Solar siting (the careful orientation of buildings to maximize the winter heating value of solar gain) and passive solar collectors (equipment or structures designed to trap solar heat in liquids or solids for later use) can use thermal energy from the sun to warm buildings and water without overheating in the summer. Solar-friendly construction was the subject of wide spread interest in the 1970s and 80s and could be a reasonable policy tool again. A specialized, but instructive example is the Champlain Mill shopping center in Essex Jct., VT. This 19th century mill building has a very long wall with windows positioned in a way that provides high solar heat gain. It also has numerous internal heat sources, such as restaurant kitchens. Solar gain and internal heat are captured during the day by small heat pumps throughout the building and stored by heating up a railroad car sized and heavily insulated water tank in the basement. After dark, heat is removed from the water and circulated through the building by reversing the action of the heat pumps. Modern technologies can be used creatively to make the most of solar heat.

[2] The most frequent issue for local opposition to siting wind generation is aesthetics. In the Northeast, wind resources tend to be of highest quality on exposed ridgelines and in certain offshore locations. These are often aesthetically sensitive areas, so opposition can be quite vigorous in locations that are prized, pristine or of prime importance to tourism and recreation. Examples include northeastern and southwestern Vermont and off shore of Martha's Vineyard. Aesthetic issues can also arise from the siting of transmission lines to bring wind power to the grid and service roads. In some locations, siting wind generators and support facilities can intrude on wildlife habitat. Noise and interference with radio reception are sometimes issues. Concerns about bird and bat strikes were once significant and sometimes still arise, but research and design changes have reduced that concern.

- Virtually all transportation fuel used in the NF region is imported fossil fuel. The biggest levers for addressing that need are likely to be vehicle efficiency and travel demand management. However, biodiesel (a diesel-like fuel made from agricultural products or waste cooking oil) and methanol (made from agricultural products or wood) are now tiny contributors, but show promise as indigenous fuels for the future and have other desirable characteristics.

Selected Data and Observations on NF Region Energy Production

Wind

Existing wind generation sites in the NF region are mainly small scale so far. Total generation capacity in the NF counties is about 140 MW (somewhat more than 1/10 of the peak load of the state of Vermont to put this into scale), almost entirely at the 137 MW Maple Ridge wind farm in Lewis County, NY. There are another 330 MW of proposals and projects under construction, including a 185 MW-capacity project to expand Maple Ridge and proposals for 50 MW and 90 MW of wind capacity in Aroostock and Franklin Counties, ME.[3] (American Wind Energy Association 2005) The escalating of number of wind farm proposals is driven by the Renewable Portfolio Standards in surrounding states. While these proposals are meeting a strong backlash in a few areas, they are succeeding in others.

The NF region has significant potential for new wind power development, located mainly along mountain ridges and on the shores of the Great Lakes and the Atlantic ocean. The following table shows estimates of the wind power potential for the four states; note that much of the potential lies in areas outside of but within easy transmission distance NF counties.[4]

Total Wind Energy Potential in NF States – All Counties

Location	Average Power Output (MW)	Annual Generation (TWh)
Maine	6,390	56
New Hampshire	502	4
New York	7,080	62
Vermont	537	5

(American Wind Energy Association 2005)

Biomass

Use of chunk wood for direct heat in all sectors rose rapidly after oil embargos of the 70s, but peaked and dropped off somewhat starting in the late 80s, probably due to slack oil prices and

[3] The proposed 90-MW Redington wind farm's energy and renewable energy credits are already under contract by Constellation NewEnergy under a 10-year deal. Staff reporter (2006). Proposed wind farm has deal to sell 'green' power. Blethen (Maine) Newspapers.

[4] Much of New York State's wind energy potential is located off of Long Island. Only two NF counties (Oswego and Jefferson) border Lake Ontario, the other area in NYS with significant potential. The wind potential in the mountainous areas of Maine, New Hampshire, and Vermont is mostly within the NF region. Wind power onshore to 5 miles off the entire coast of Maine is good to outstanding, with excellent potential located very close to shore in the coastal NF counties.

disenchantment with the work and mess. With newer, clean and/or automated technologies like screw-fed pellet furnaces and wood chip gasifiers, there is considerable potential for expanded use in commercial and institutional settings. There are a few utility scale electric generators using traditional boiler technology and wood chips from whole tree harvesting, forest residue or mill residue, but the trend is likely to be towards high efficiency, clean technologies such as gasifiers for any future utility scale generation. It has been demonstrated that sustainable harvesting practices can be designed and enforced, but transport costs will remain an issue for wider development of biomass generation.

The potential for increasing the role of biomass generation depends on the price paid to the fuel. At a price of $3.50/MMBtu, much less than the current price of natural gas, as much as 3 million acres of *non-forest* land in the NF region could economically produce biomass suitable for electric generation. Further information on biomass potential is provided in Section 7 of this report.

Biodiesel and Methanol Fuel

There are no existing biodiesel plants in the NF region. Small cottage industry operations exist, some starting with used cooking oil. Of the NF states, only Maine has a plant, located just south of the NF region in Belgrade, with a 250,000 gal. annual capacity. In the NF region, one plant is scheduled for completion in February, 2006, in Fulton, NY (Oswego County). It is to have a 5 million gallon annual capacity using soybean oil as the primary feedstock. (National Biodiesel Board 2006) New developments in production of methanol from cellulosic (woody) feedstock and biodiesel from non-soy crops suggests the potential in the NF region is significant. Further information on biomass potential is provided in Section 7 of this report.

Selected Data and Observations on Imported Energy

Natural Gas

Natural gas use per capita in Vermont, New Hampshire, and Maine is lower than much of the rest of the country, due largely to the limited availability of natural gas in the area. Natural gas passes through NF region in pipelines, but local interconnections rare. Interconnection costs usually prohibitive absent very large anchor load. New York is the only NF state that produces natural gas. Natural gas represents about one-fourth of the total energy consumed nationwide, but only 18% in New England. ((VT) Vermont Department of Public Service 1988, vol. 2, p. 3-75)

The only part of the NF region in Maine with gas utility service is Bangor, Brewer, Old Town, Orono and Veazie, from Bangor Gas. ((ME) Public Utility Commission) In Vermont, Franklin and Chittenden are the only NF counties with natural gas service. Gas for both states is delivered from Canadian sources.

Domestic U.S. gas, primarily from the Gulf Coast area, accounts for approximately 62% of the gas consumed in New York with nearly all of the remainder from Canadian sources. Gas production within New York is growing and currently meets about 2% of the State's annual gas use. (NYSERDA 2005 p. 45) In the NF region, there are operating wells in Oneida and Oswego counties. ((NY) Department of Environmental Conservation n.d.) Several local distribution companies provide natural gas in the NF counties. Niagara Mohawk (now owned by National Grid) serves parts of Oswego, Jefferson, Oneida, Herkimer, Fulton, Saratoga, Warren, and Washington counties. (National Grid) In addition, NYSEG serves parts of Clinton and Saratoga counties. (NYSEG)

Oil, Gasoline, Diesel Fuel and Propane

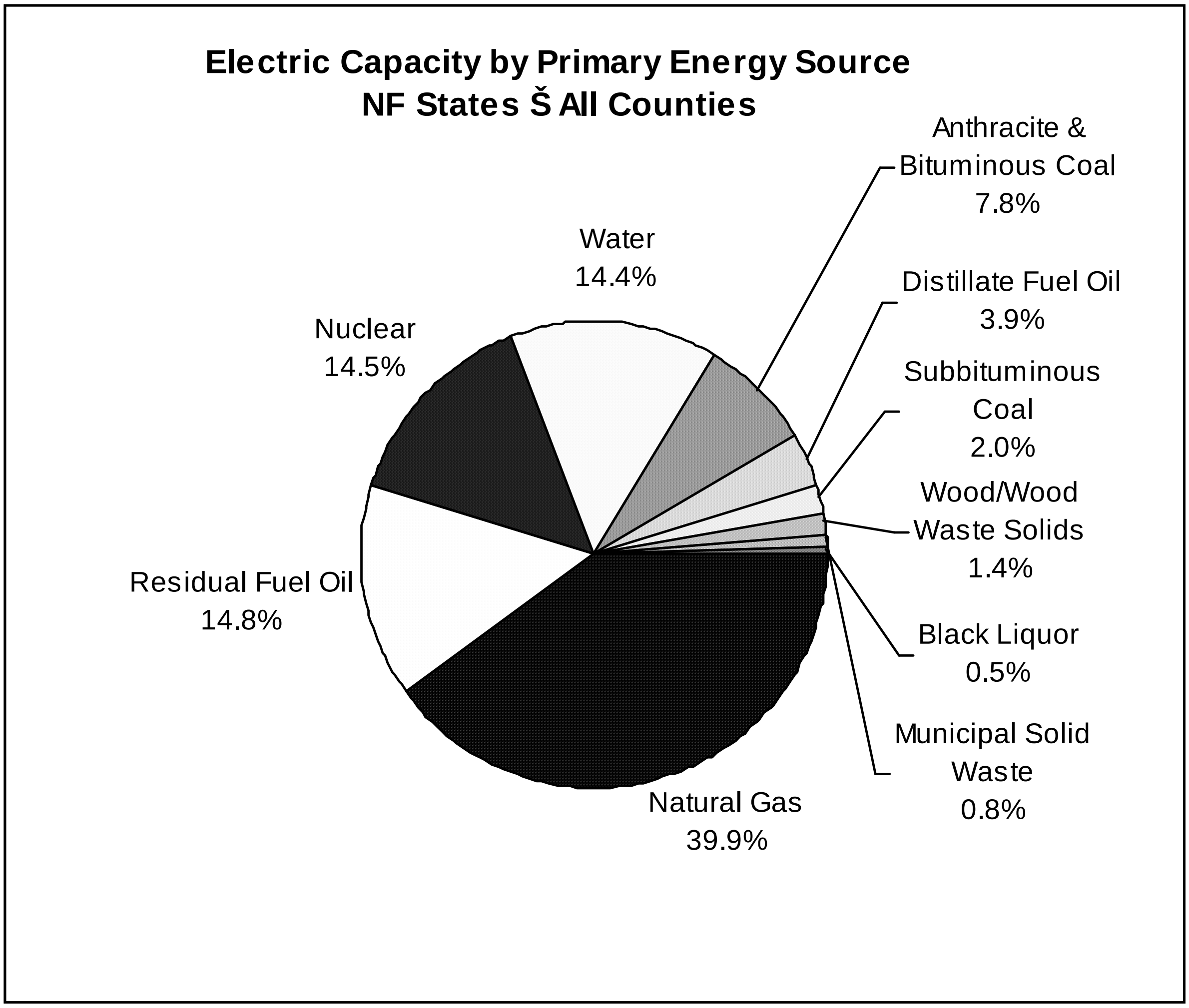
Oil, gasoline, diesel fuel and propane are almost entirely imported into the northeast. New York is the only NF state that has active oil wells, and all of the crude oil production is located in the western region of the state.[5] (NYSERDA 2005, p. 45). No currently operating wells are located in the NF region. (NYSDEC)

Electricity

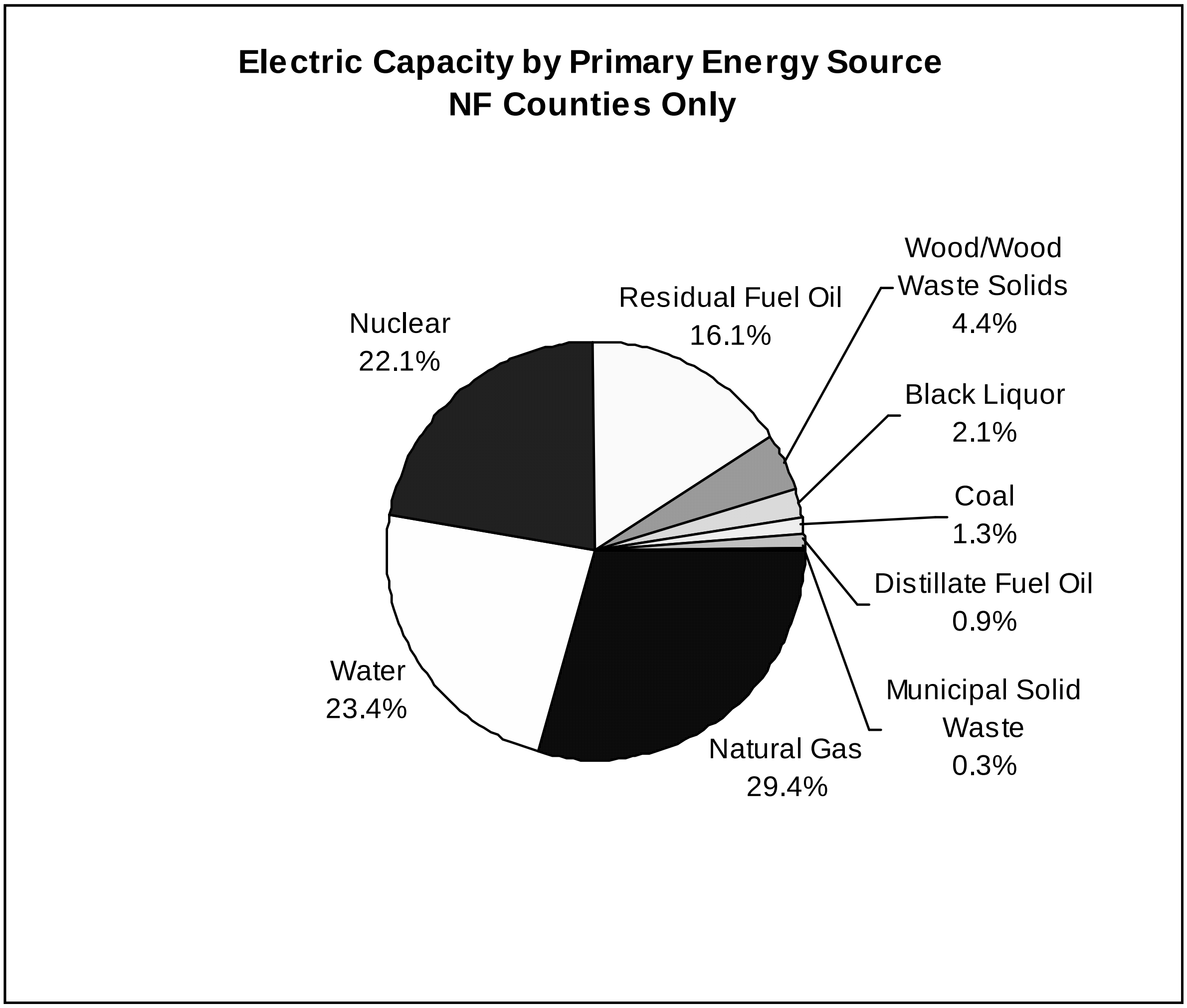
Information on electric power production physically located in the NF counties is not easily available. Even if it were, the tightly interconnected nature of the electrical grid would render that information hard to interpret in terms of energy independence. For example, generators located in the NF region often supply mainly non-NF consumers, while utilities serving the NF region often import most of their power, but do not report statistics for the NF counties separately from their other customers. Estimating such breakdowns is beyond the scope of this project.

Considering the NF states as a whole, almost half of the generating capacity in the NF states runs on fossil fuels, which are almost entirely imported. Nuclear capacity, also running on imported fuels, accounts for another 22%. Hydroelectric power and wood boilers also make up a significant portion of capacity, at 23% and 4% respectively. Other renewable and in-region resources make negligible contributions to total capacity.

[5] New York State's oil production in 2000 totaled 180,590 barrels, less than 0.1% of annual state-wide demand. Total production and new oil well completions in New York State have declined, partially due to the lack of new discoveries and plugging existing wells to deal with environmental compliance costs. Even during periods of commodity price increases, production continues to decline. NYSERDA. (2002). "State Energy Plan and Final Environmental Impact Statement." from http://www.nyserda.org/Energy_Information/energy_state_plan.asp.



Note: Jet Fuel, landfill gas, and wind also made very small (>0.1% each) contributions to total electric capacity in the four states in 2001. There was no electric capacity reported by this source that used solar, geothermal, and other biomass sources (including agriculture crop byproducts/energy crops, animal manure, ethanol, and digester gas). The existence of small amounts of wind, solar and "other biomass" generation is well known, and we believe this discrepancy is due to limitations of EIA data collection, such as who is required to file or definitional problems. Data Source: EIA 2001 Annual Electric Generator Report Form 860.



Note: Jet Fuel and landfill gas also made very small (>0.1% each) contributions to total electric capacity in the northern forest counties. In 2001, there was no electric capacity reported by this source that used wind, solar, geothermal, and other biomass sources (including agriculture crop byproducts/energy crops, animal manure, ethanol, and digester gas). The existence of small amounts of wind, solar and "other biomass" generation is well known, and we believe this discrepancy is due to limitations of EIA data collection, such as who is required to file or definitional problems. Data Source: EIA 2001 Annual Electric Generator Report Form 860.

2.2. Regional Energy Use

Overall Energy Consumption

Considering energy consumption in the four NF states as a whole, it is clear that transportation use, almost entirely petroleum products, is the largest single factor. (While starting to climb, the prevalence of alternative fueled vehicles remains small. See Section 7 for data.) In the other individual sectors, there is greater variety in the fuel make up.

The electric sector is heavily dependent on natural gas today, a new phenomenon in the past 20 years This trend was driven largely by environmental concerns about using coal and nuclear fuel, by the once impressive but no longer rapid growth in North American natural gas production, and by vastly improved gas turbine technologies. Residential consumption is lead by oil and natural gas, with electricity and wood following behind. Commercial and industrial fuel use patterns differ from each other, but taken together, those two sectors actually show a fuel use pattern quite similar to the residential sector, although some of the oil used is heavy residual oil.

Energy Consumption in the NF States – All Counties, 2001 (Billion BTU)

	All petroleum products	Coal	Electricity sales	Feed-stocks still gas	Natural gas	Wood, waste, & waxes	Grand Total
Commercial	190,189	2,779	274,855	258	372,256	24,333	864,670
Industrial	282,516	74,260	107,081	11,324	112,575	138,277	726,032
Residential	353,200	343	186,238	89	399,841	79,813	1,019,525
Transportation	1,193,869	-	9,027	-	7,640	-	1,210,536
Electric power sector fuel consumption	193,331	285,684	-	-	447,649	92,681	1,019,345

Source: ((US) Energy Information Agency 2001)

Motor Fuels

Statewide growth rates for total motor fuel use in New York and New Hampshire do not differ substantially from those for the rest of the U.S. The growth rates in Maine and Vermont are substantially lower. Vermont's fuel accounting methodology may have changed between 2000 and 2004, but its lower growth rate could also reflect, in part, adoption of hybrid vehicles, biodiesel use, appearance of more concentrated suburban growth patterns as opposed to the earlier rural patterns, or telecommuting.

However, despite average or below average growth in fuel use, miles traveled in rural areas of the NF states rose dramatically faster than in the U.S. as a whole. Also, growth in rural vehicle miles traveled (VMT) was dramatically greater than in the urban areas of NF states except for New York, where urban and rural VMT grew at similar rates. Given the rise in rural VMT in the four states, it is highly likely that miles traveled in the NF counties have also increased substantially, although commuting from southern New Hampshire to the Boston area may have had an impact.

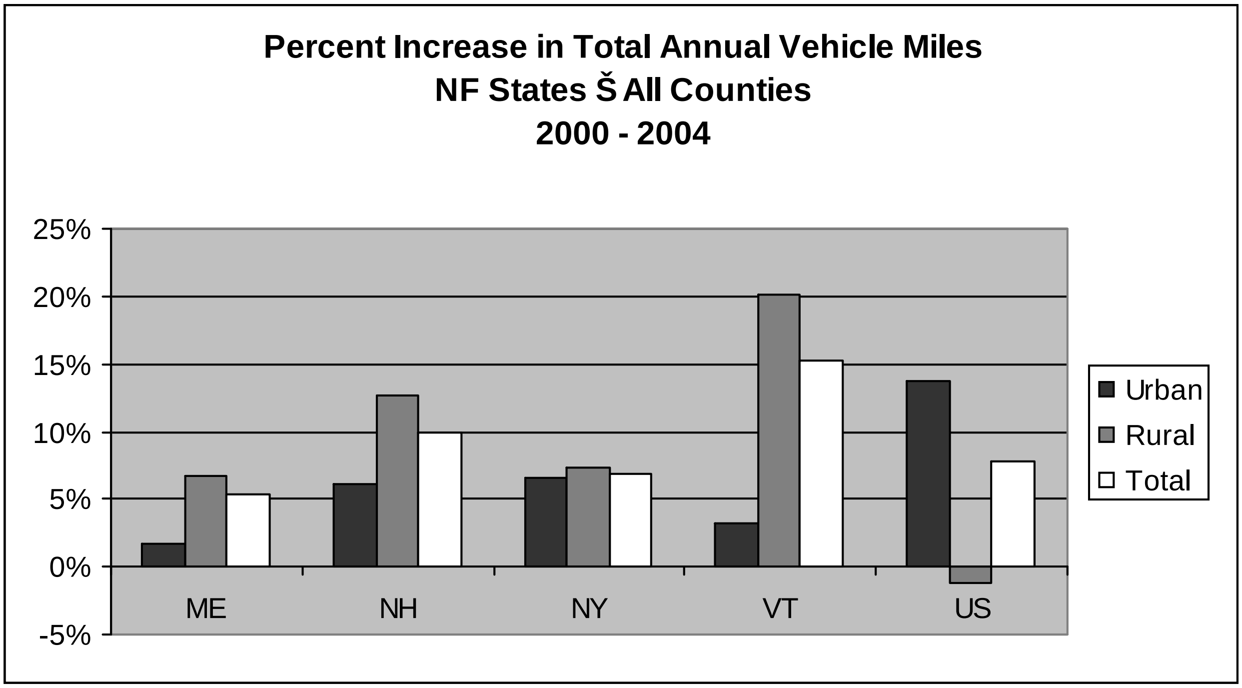
The growth in rural VMT does not reflect population trends. While the driving age (18+) population in the four states has grown from 1990 to 2000, most of that growth is in the non-NF counties.[6] Growth in population within the NF region varies widely. The counties experiencing the most growth contain or are in close proximity to urban areas.

[6] As requested by the Center, this report treats Chittenden and Grand Isle Counties in Vermont as part of the NF region.

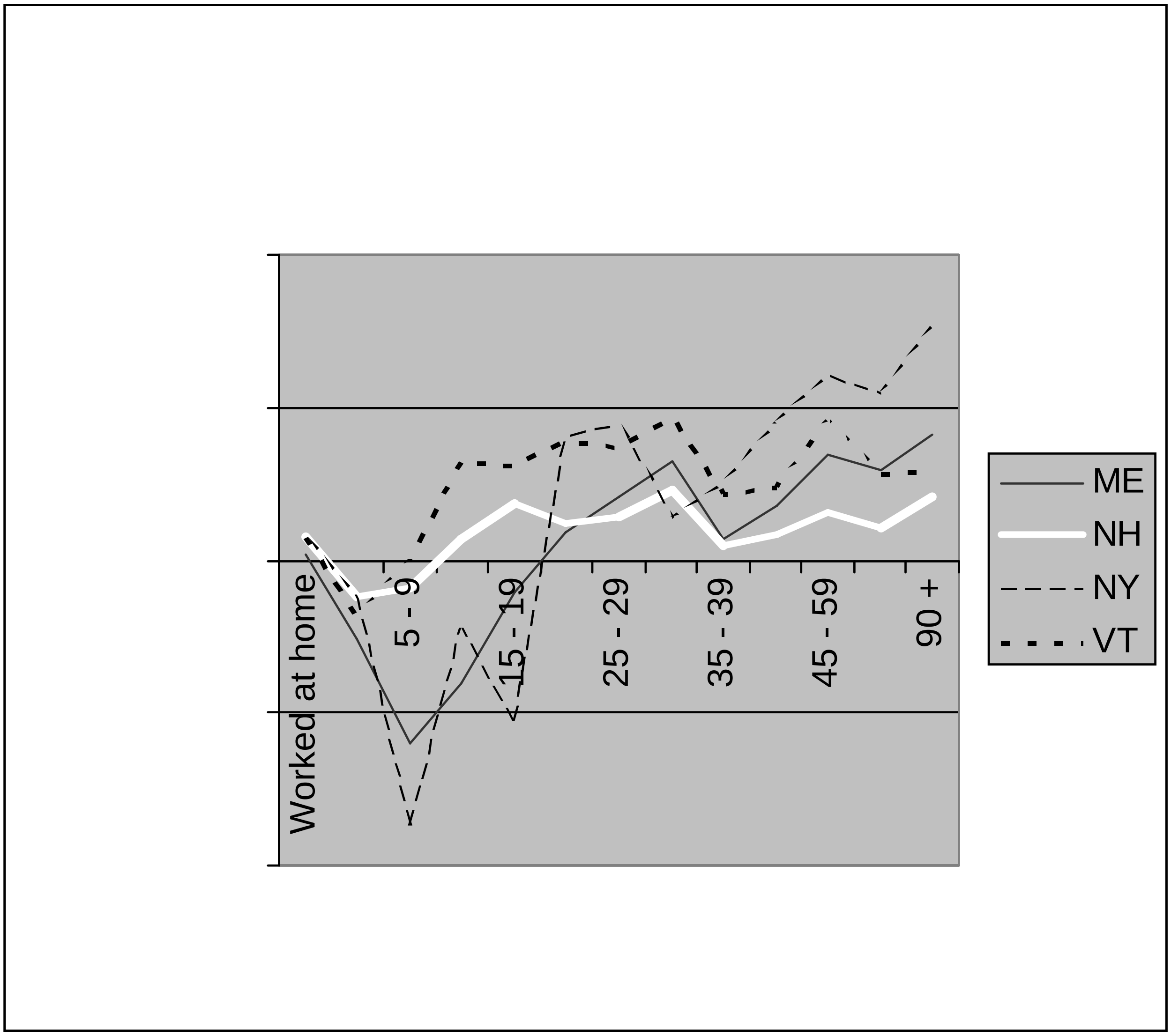
Motor Fuel Use in NF States - All Counties (thousands of gallons)

	Highway			Total, including non-Highway Gasoline Use		
Region	2000	2004	Percent change	2000	2004	Percent change
Maine	847,317	876,520	3%	860,178	895,852	4.1%
New Hampshire	759,891	810,599	7%	777,485	837,139	7.7%
New York	6,516,320	7,067,634	8%	6,634,306	7,234,490	9.0%
Vermont	403,551	405,463	0%	411,065	418,665	1.8%
U.S.	162,260,196	173,809,810	7%	165,231,832	178,536,383	8.1%

Source: ((US) Federal Highway Administration 2005); ((US) Federal Highway Administration 2001)



Source: ((US) Federal Highway Administration 2005); ((US) Federal Highway Administration 2002)



Source: U.S. Census.

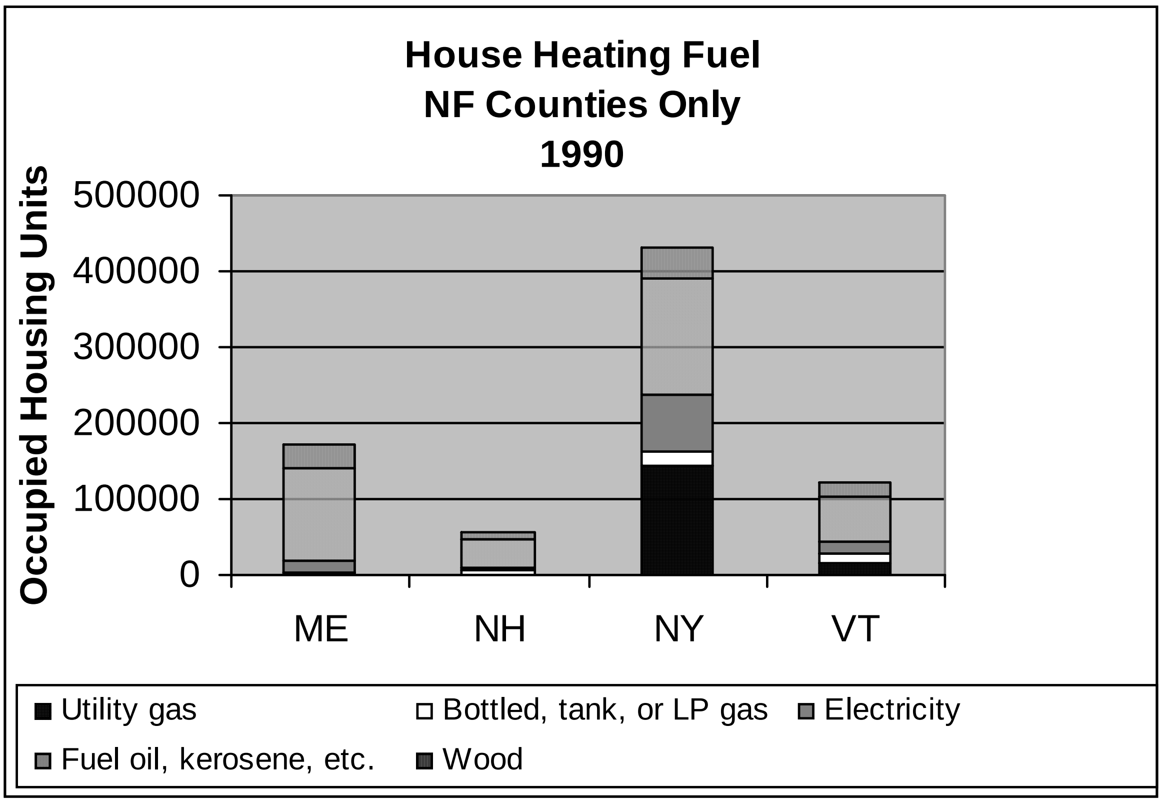
Much of the increase in VMT is due to the substantial increase in commutes for the average worker. Most startling is the number of workers living in the NF counties who commute 90 or more minutes, up 161% from 1990 to 2000. This growth rate is much higher than for the non-NF counties in the four states (54%). (Energy Advisors LLC. 2003 p. 63; NYSERDA 2006)

Heating and Cooling

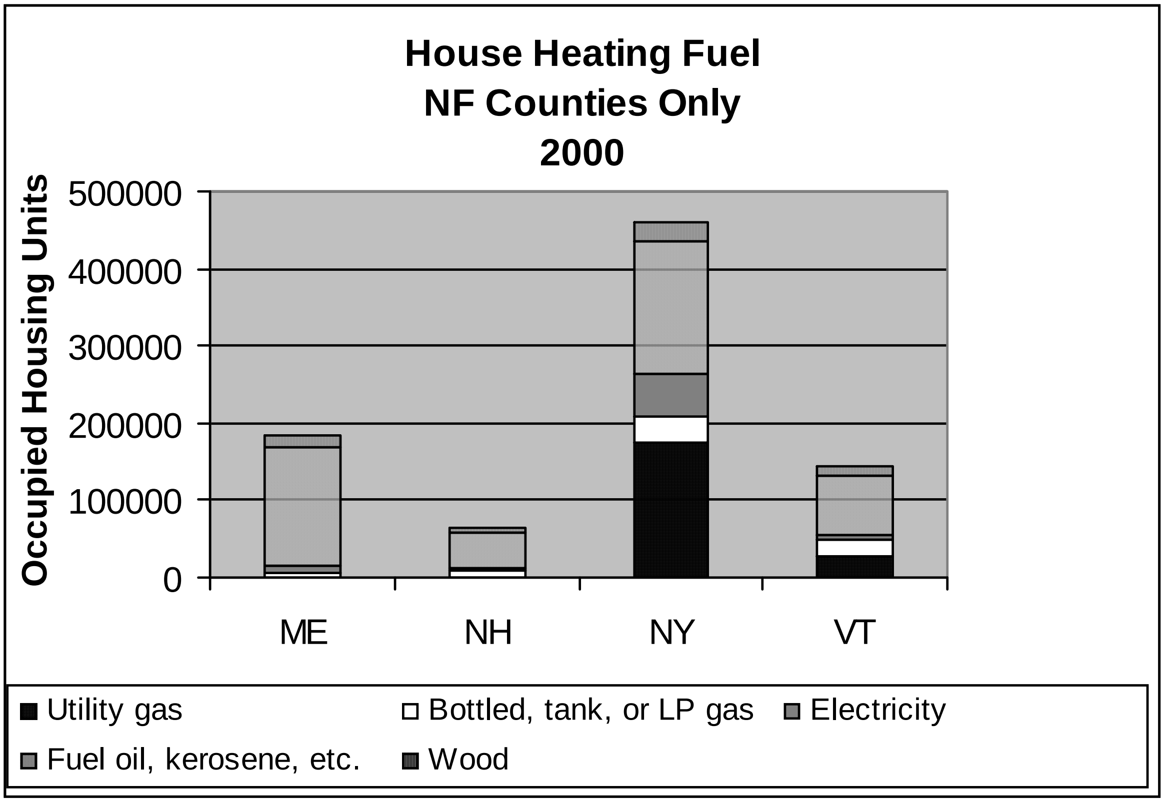
The NF region's housing stock is dominated by generally less thermally efficient detached structures and mobile homes, much of it elderly. Older mobile homes are particularly inefficient energy users. (See table in Section 7.)

From 1990 to 2000, the number of housing units using natural gas for home heating grew in the NF areas where it is available (NY and VT). Use of fuel oil or kerosene as the primary fuel for home heating generally increased, while wood and electric heat decreased in NF counties over the same period.[7]

In a significant change from historical conditions, even northern and suburban/semi-rural areas are seeing increasing consumption of energy for air conditioning. This demand is met almost entirely by electricity, although some large commercial space conditioning and refrigeration units use compressors driven by natural gas burning engines. This trend is leading to higher summer electric peak loads and is stressing transmission and distribution systems. Southern New England and New York have long been summer peaking in their electrical demand, but NF region utilities benefited from lower demand in the summer when power prices are usually at their highest. Some NF region utilities now see approximately equal winter and summer peaks for electric load. This makes efficiency programs for air conditioning prime targets for enhancement, along with programs targeted at commercial lighting and refrigeration, both of which aggravate air conditioning loads.



[7] As requested by the Center, this report treats Chittenden and Grand Isle Counties in Vermont as part of the NF region.



Source: US Census. A very small percent of housing units were not heated with fuel or were heated with solar energy, coal or coke.

2.3. Energy and the NF Economy

Outflow of cash for energy

A critical energy issue for the NF economy is the outflow of dollars for fossil fuel and imported electricity and its impact on the sustainability of the region's economy. A rough sense of this outflow can be developed from consumption and price data. This data is not reported below the state level, but we have prepared a estimate of the outflow of dollars from the NF region for petroleum products based on state data and other factors.

We began by allocating each state's 2001 consumer expenditure data for petroleum between NF counties and non-NF counties according to the 2000 census population. (We did not adjust for growth in population or consumption after 2000.) We then inflated that amount by the market price increase for petroleum between 2001 and 2006, as well as deducting an estimate of the retail markup. The result is a rough estimate of the 2006 wholesale cost of petroleum products purchases for fuel in the NF region. That estimate was $4.8 billion (2006) dollars. Using the same procedure, we estimated that the wholesale cost of natural gas used in the NF region was about $1.1 billion (2006) dollars for the same year. Combining these, we have an estimate of $5.9 billion (2006) dollars for the amount of dollars flowing out of the NF region to purchase fossil fuels for end use consumption, not including fuel purchased for electric generation. To put this perspective, that is slightly more than the amount the agriculture, forestry, fishing and hunting sectors in the four states (in their entirety, not just the NF region) contributed in 2004, namely $5.75 billion dollars.

Of course, this would mean more if we knew the *net* impact on the economy of changing that situation. That is what would be the difference in economic performance for the region between two scenarios—one business as usual and one assuming a policy change. While such modeling for the NF region was outside the scope of this report, we can get a rough indication of such impacts from the results of broader studies.

Synapse performed one such study in 2005; that project examined the impact on the New England of various energy efficiency and renewable energy projects. (Sedano, Murray et al. 2005; Steinhurst, McIntyre et al. 2005) The study estimated the net effect on the New England economy of policies to increase energy efficiency or renewable energy generation, either of which reduces the outflow of dollars for imported fuel. While the resulting multipliers do not apply to changes that might occur in the NF region, we can use them as illustrative values.[8]

The study found that one plausible scenario using energy efficiency programs to cut purchase fossil fuels had a large net benefit for the New England economy. The net result on the regional economy was estimated to be an expansion of about $180 million (2001 dollars) per year. Employment was projected to increase by an average of about 1350 jobs.

A similar scenario expanding renewable energy production to the levels required to meet the Renewable Portfolio Standards of the New England states (as they were in law at that time) also had beneficial results. This scenario assumed that 736 MW of renewable generation was added in New England; 117 MW was biomass and 365 MW was wind. (The American Wind Energy Association has estimated that the NF states have a potential wind resource of about 14,500 MW. (American Wind Energy Association 2005) The net result on the regional economy was an expansion averaging over $600 million (2001 dollars). Employment was projected to increase by an average of almost 1200 jobs.

These results were conservative in the sense that the study did not assume the development of a local industry for the manufacture of the needed equipment. In addition, they assumed only activities to reduce electricity consumption or fossil fuel electricity generation. It could be that activities to reduce, for example, outflows for transportation fuel would be even more beneficial.

Employment and Economic Growth

In the NF counties, a much higher percentage of workers are employed in agriculture, forestry, fishing, hunting, and mining than in the non-NF counties. The percent of the working population employed in manufacturing is also higher in the NF counties, whereas employment in professional, scientific, management, administrative, waste management services, information, finance, and insurance fields is higher in the other counties.[9]

Growth rates in the economies of the four NF states vary widely, although anecdotal evidence suggests that the NF counties may be more similar than the states themselves. New Hampshire ranked 9th among the 50 states in economic growth between 1997 and 2004, while Maine's rank was between 32 and 33 during that period. New York ranked 22nd in the first half of that period

[8] It is not clear whether the actual results of simulations of the NF region would be more or less beneficial than for the region as a whole. The NF region produces fewer of the goods and services that would be used to increase energy efficiency or renewable energy, which would increase economic "leakage" and reduce the net benefits. On the other hand, the NF region may be more dependent on imported electricity than the balance of New England, which could increase the effectiveness of the scenarios.

[9] As requested by the Center, this report treats Chittenden and Grand Isle Counties in Vermont as part of the NF region.

and 15th in the second half. Vermont ranked 7th in the first half of that period and 18th in the second half.

3. Energy-Economy Considerations for Planning

This section sets out our views on the issues decision makers should consider in developing a plan for a sustainable NF economy. It is relies primarily on our experience in utility regulation, energy policy development, and energy-economy modeling consulting practice.

3.1. General Observations

Energy production and use are thoroughly intertwined with virtually all aspects of the economy. Not only are the energy industries, themselves, a significant part of the economy in terms of employment and dollar output, but most other sectors of the economy require significant energy inputs, especially when transportation energy is considered.

In our view, the following are the "high leverage" energy-related opportunities for fostering a sustainable economy in the NF region:

- The Center and its constituents can take advantage of the region's shared tradition of thrift and neighborliness and of the fact that with proper support relatively small communities can be nimble and proactive in advancing aggressive policies.[10]
- Climate change (and other environmental) issues will become increasingly important for both forest health and tourism over the coming decades and will likely dominate policy making in energy issues starting sometime in the next decade. (Climate change is discussed further below.)
- The NF region has a history of significant biomass energy production and the potential for an even larger output on a sustainable basis. This potential has been enhanced by the recent development of clean, efficient biomass gasification processes for both direct heat and electric generation.
- The NF region has wide-spread and significant wind resources within reasonable distance of transmission lines. The cost per kWh of this resource is fast approaching that of petroleum and natural gas generation, even without consideration of potential GHG control costs.[11] Siting difficulties in some of the best resource locations are severe, however.
- All four states in the NF region have established state-level policies and programs to promote development of renewable electricity generation and energy efficiency for

[10] A few northeastern examples are worth mentioning. In the town of Hull, MA, there has been community support for development of small wind projects for some 20 years with power going to reduce town and school electricity bills. (See www.hullwind.org.) On a somewhat larger scale, the Vermont "Efficiency Utility," Efficiency Vermont, has a record of intensive search for program improvements and creative, aggressive program design and implementation. The Vermont Public Service Board designed and oversees a performance based contract that is largely responsible for this flexible program. (See www.efficiencyvermont.com.) Maine and Oregon are establishing similar programs.

[11] A recent run up in the price of wind turbines (due to demand greater than anticipated by manufacturers and raw material cost increases) will not likely be permanent.

electric and natural gas uses. Few, if any, programs and resources are devoted to promoting energy efficiency or renewable energy use in transportation or non-electric uses in residences or businesses.[12]

- "Green" practices, communities and vendors are likely to become more important to destination and buying decisions for consumers, tourists and businesses.
- While there is some precedent for multi-state actions in energy policy, explicit and binding interstate agreements have in the past raised real Constitutional issues, sometimes surmountable. Independent, but coordinated actions by states or other entities may be simpler to field. On the other hand the recent success of the Regional Greenhouse Gas Initiative (RGGI), discussed below, might be emulated.

Also, there are critical energy-related challenges facing the NF region in fostering a sustainable economy:

- Changes in forest types and productivity, snowfall, and other key factors affecting forestry, tourism and agriculture may be especially uncertain during climate transition periods; such transitions may be abrupt.
- High and volatile prices for fossil fuels and electricity, along with possible supply disruptions and increasing environmental constraints/costs. Construction of major liquefied natural gas ("LNG") terminals in Northeast U.S. and Canadian coastal regions are expected and may offset the high transportation costs of domestic gas, but international competition for LNG supplies means that high prices, volatility and potential interruptions are likely to remain the norm.
- Small communities and ongoing sprawl mean dispersed populations, jobs and services that make it difficult to promote alternative transportation modes or district heating/cooling and reduce the cost effectiveness of some building efficiency options.
- Many rail and most if not all lines suitable for street car/light rail service are in disrepair or obsolescent, no longer reach the locations of greatest transportation demand, or have been abandoned. Others have been maintained or even upgraded partially but are underutilized.

With these points in mind, we offer the following guidance for planning:

- No one quick fix nor any permanent solution to energy needs exists; flexibility, adaptability and strategic prioritization of options are needed.
- Much can be done, given constant innovation and commitment; programs and agencies should be given enough stability and security that they will be encouraged to take risks; they should be rewarded for constant innovation and self-criticism based on results.
- Transportation energy needs, air pollution, and costs may be the single largest energy issue in the NF region, have not been adequately addressed to date, and will require innovative solutions to make headway.
- Policies and programs need to be sustainable, too, so success will depend on meeting the needs of multiple stakeholders, as well as collaborative and upbeat planning.

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[12] Limited low income weatherization programs and certain programs to promote use of wood chips for commercial and institutional direct heat applications are notable and successful exceptions.

- Emphasis on an energy independence strategy raises difficult issues. It is not clear that complete energy independence is the best way to strengthen the NF region's economy. This is an especially difficult question for electricity supply, which is extraordinarily interconnected both physically and economically across virtually all of North America this side of the Mississippi River. On the one hand, huge amounts of money flow out of the NF region for imported energy that is volatile in price and uncertain in availability. Except for biomass production and small amounts of renewable energy, the NF region is at the "end of the pipeline" for energy.[13] On the other hand, each increment of indigenous renewable energy produced or of energy efficiency delivered reduces the *size* of the "energy *de*pendence" problem and makes further progress less difficult, at least up to a point. Therefore, vigorous efforts in those two areas will move the NF region in the right direction.

3.2. Opportunities in Production and Efficient Use of Energy

Increasing either local production or efficiency of use will help. In some ways, efficiency gains are more helpful because they reduce the total energy bill for consumers and the region, and efficiency potential is not as dependent on accidents of geography. Significant potential exists in many parts of the NF region to develop wind power and biomass production for electric generation and for direct heat applications. Significant technical potential exists for production of transportation and other liquid or gaseous fuels from locally grown biomass, and it may be that this option will be compatible with a healthy forest and economically feasible.

Greater reliance on renewable energy and energy efficiency can reduce cash outflows for fossil fuel and revitalize the NF economy, while improving energy security.

The flow of dollars out of the NF region for imported fuels and electricity is a constraint on the economy and is likely to worsen over time under a "business as usual" approach. While renewable energy production and energy efficiency efforts will address this only gradually over time, each such increment will strengthen the NF region economy, making further progress more feasible. The beneficial multiplier effects of efficiency and renewable energy discussed above justify further exploration and quantification of these potential benefits.

A Least Cost Planning approach to transportation planning can create new ways of looking at transportation energy problems.

Least cost planning ("LCP") is a concept that has, at various times and places, had currency in the electric power industry and, to a lesser extent, the natural gas utilities.[14] Least cost planning is a long term planning process that begins with projecting needs over time and then identifies a full range of options for addressing that need, whether by acquiring new resources or reducing that need through, for example, efficiency programs. The planning process then analyzes the costs of each option and seeks to assemble a portfolio of resources that is expected to address the need at the least total cost over time. (National Association of Regulatory Utility Commissioners 1998; Biewald, Woolf et al. 2003)

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[13] Some large hydroelectric generation exists, but is mainly "owned" by utilities or markets outside the NF region, and little capability exists for growth.

[14] In some jurisdictions, LCP is referred to as Least Cost Integrated Planning or Integrated Resource Planning ("IRP") to emphasize the requirement that all options, both supply and efficiency, be considered on a "level playing field."

The two essentials of LCP in the provision of any service are (1) even handed consideration of all resource options that could *either* provide the service *or* reduce the need for the service and (2) consideration of each option's costs and benefits over the long term. LCP was adopted for regulated electric and gas utilities in a number of states and is still in use or being reinstated in some. However, as retail competition was introduced in certain states, LCP received less attention and was suspended in some cases.

We believe that the thorny problem of transportation's dependence on imported fossil fuel may be successfully attacked by consistently applying LCP to transportation planning over time. People and businesses need to travel to access workplaces, goods and services, and friends and families. Simply projecting the travel needs and building roads and parking lots to meet that need ignores an array of alternatives. Those alternatives may be less costly for users and society over the long run and can make the region less reliant on imported fossil fuel, while protecting local natural resources. Mass transit, which faces significant challenges in rural areas such as the NF region, are not the only alternatives that exist.

Unfortunately, transportation planning rarely researches all the options and compares them on an even footing. For example, studies about building a new highway to address unacceptable congestion delays will *always* consider several different highway configurations and sizes, *might* consider buying and operating commuter buses, but will *rarely* consider providing incentives for carpooling or upgrading phone systems to support telecommuting. Similarly, highway planning will evaluate in detail the costs building and maintaining the highway options, but will rarely estimate the costs to employers of building and maintaining parking, the cost to commuters of extra driving, environmental costs[15], costs for policing more miles of road, and the like.

Biomass production for direct heat and for electric generation can be a sustainable engine for NF economic growth.

The region has sustainable biomass productivity that can supply a greater amount of its energy needs than it now does and do so cleanly and efficiently *if* the latest technologies are utilized. This biomass production potential includes sustainable use of forest harvests or residue, short rotation woody crops (e.g., hybrid poplar), and agricultural crops (e.g., switchgrass). However, transportation of fuel is problematic. Weak rail networks and scarcity of east-west highways in northern New England may be barriers. Wind development potential is also significant. Both of these resources have the potential to reduce cash outflows for fuel and imported electricity, as well as generating local employment and income. National studies vary widely, but indicate a potential job creation of perhaps 6 jobs per MW of biomass generation put in service. ((OR) Department of Energy 2003; California Biomass Energy Alliance 2003)

Biodiesel, methanol and the like are a tiny, but promising part of the NF energy scene. They have the potential to be clean, sustainable alternatives to fossil fuel, while benefiting the NF economy. However, much remains to be learned about how best to develop these fuel sources and their ultimate value. (Further information on biodiesel and methanol production is provided in Section 7 of this report.)

[15] Examples of environmental costs of highway travel include habitat impairment and air pollution. Air pollution can impose fairly direct costs on businesses and consumers, even aside from health impairment and medical costs. One way this can happen is related to ozone and particulate pollution limits set by the federal Clean Air Act. If the air quality in a county is below the standards set in law, the state may be required to develop and implement a plan for bringing that region back into compliance. Such plans can impose (and have imposed) burdensome mandates on local businesses that wish to build or expand.

3.3. Potential Export Industries

Several of the options discussed above may possibly support export industries. Forest product biomass or biodiesel and methanol from non-forest lands could be produced and exported in addition to being used locally to replace imported fossil fuel. Wood products for energy production are unlikely to have the economic and energy value per ton to travel very far, especially given the shortcomings of the region's rail system. Liquid fuels appear more likely to justify long range transport, and their production would retain more economic value added within the NF region. Biodiesel, in particular, may become a high value product if air pollution controls in the southern parts of the NF states become more stringent. An assessment of the potential for this industry could be valuable for NF economic planning.

Many states have set targets for the amount of renewable energy in the electric generation mix of their utilities and competitive retail marketers. The requirement is usually expressed as a renewable energy portfolio ("RPS") standard, sometimes as a voluntary goal, but usually as a mandatory standard. RPS requirements are compatible with retail competition and usually apply equally to retail competitors and default service providers. Each state defines what types of technologies will qualify as renewable under its standard. Some allow only plants built after a certain date; some allow municipal solid waste incinerators, many do not. Renewable Energy Credits ("RECs") can be established as a way to comply with an RPS. Under this approach, each qualifying renewable generator receives an REC for each unit of renewable generation produced. Generators can then sell the RECs, either with the power or separately. Retail electricity sellers buy the RECs, either with the power they need or separately, and turn them over to their state regulators to comply with the RPS. For more information on RPS policies in New York and New England, see Section 6.8 of this report.

This tradable credit system is in place in New England and provides an additional revenue stream for developers of renewable energy. RECs can be viewed as an export industry in and of themselves. RECs provide extra revenue to wind and biomass generators, allowing them to be a more competitive and stable consumer of forest residue. RECs also provide wind developers with a larger income stream, reducing financing requirements and allowing larger royalties or lease payments to land owners doing business with them. Such revenues should be taken into account when analyzing the potential economic value of renewable energy development in the NF region. (Chen, White et al. 2003)

The manufacture of renewable energy and energy efficiency goods, such as windmills, already provide some stimulus to the NF economy. While some such products, e.g., compact fluorescent light bulbs, are essentially commodities manufactured in huge volumes worldwide, others could provide niches in which moderate scale industries could thrive, as some do now in the NF states. In addition, jobs can be created in businesses that install and service renewable energy equipment. Similarly, energy efficiency goods and services is an industry with potential to provide exports.

Finally, as explained in the next subsection, climate change is expected to lead to policies controlling GHG emissions. Many of the policies under consideration would set emission targets and allow emitters to meet their targets either by cutting down on emissions (say, by switching from coal to natural gas) or purchasing "offsets." Purchasing an offset in this context means to pay another entity to either reduce its emissions or to pay an entity who has removed a quantity of GHG from the atmosphere for the right to claim the benefit of that removal. This removal of carbon dioxide from the atmosphere, together with its subsequent permanent storage, is called "carbon sequestration." One tried and true way to remove carbon dioxide from the atmosphere is to plant trees and leave them standing. California, for example, has established goals in this area and has developed a system for measuring and certifying such carbon sequestration. Similar systems might be created under regional or national GHG regulations and already exist in a voluntary form. Thus, owners of non-forested land in the NF region could create tradeable offsets by sequestering carbon in newly grown (or regrown) forests, creating a new export industry. Owners of forested land could create offsets by improving the quality of the forest inventory on their land. We recommend the Initiative include monitoring the development of such offset systems and include developing a carbon sequestration industry as an option in economic planning.

3.4. Climate Change and the Northern Forest

The reality and seriousness of climate change caused by human impacts on the atmosphere and the environment is no longer seriously disputed, despite the claims of a few nay sayers. The precise magnitude and timing of climate change impacts, both globally and locally, are still uncertain, but two points are quite clear.

First, changes in our use and production of energy *will* be necessary. These changes are likely to make fossil fuels more expensive and to place a premium on low-carbon or zero-carbon resources, such as renewable energy production and energy efficiency.

Second, a significant amount of climate change is already inevitable. Early (and admittedly preliminary) estimates suggest that within 50 to 100 years the entire Northern Forest region will see the kind of climate we now associate with the forests much farther to the south, specifically a oak-pine or oak-hickory type forest in place of the spruce-fir and maple-beech-birch forests now occupying the NF region. ((US) Global Change Research Program National Assessment Synthesis Team 2000) Implications for timber, tourism, recreation, wildlife habitat, and human health could be significant. Thus, the NF community not only needs to develop ways to support a sustainable economy for the NF region, but must do so in the context of potentially fundamental changes in the *kind* of forest that will be there.

The prospect of climate change presents both challenges and opportunities for the NF economy and ecosystems. Debates about "peak oil" aside, fossil fuel prices are likely to rise as GHG regulation imposes carbon dioxide emission limits or offset requirements. Major changes are likely to occur in the type of forest ecosystem that is viable, with possible disruption of forest productivity and amenities during that shift. Skiing and other winter tourism revenues will be at risk. On the other hand, forestry may ultimately become more productive in terms of timber value, and planting trees for carbon sequestration may become a valuable revenue stream.

Although the U.S. has not acted on GHG controls as yet, some states and groups of states have. For example, New York, New England and some adjoining states have for the Regional Greenhouse Gas Initiative ("RGGI") to reduce emissions of carbon dioxide—a greenhouse gas that causes global warming. The RGGI participating states have developed a regional strategy for controlling GHG emissions. This strategy is based on a model rule enacting a cap and trade system limiting GHG emissions over time.[16] The model rule requires electric power generators in participating states to reduce carbon dioxide emissions and provides for "offset projects" to receive tradeable credits that may be sold to generators.[17] It is also worth noting that the rule also provides an incentive for biomass generation by exempting generating plants that utilize more than 50% eligible biomass fuel.

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[16] http://www.rggi.org/

[17] Model Rule section 10.1 available at http://www.rggi.org/

4. Suggestions for Further Research

We believe decision makers will need more detailed and specific information to make wise and workable choices. Agencies and others implementing those choices will need additional information. To begin with, we discuss what are, in our view, the three most crucial areas for further research and development.

One important problem we see has to do with energy data specific to the NF region. Most energy-related information is reported at the state level, but energy issues differ greatly between the NF region and the remainder of the four states. Electricity information is usually available either at the state level or for individual utilities, but quite a few utilities serve both NF and non-NF areas. The existence of competitive retail marketers in Maine, New Hampshire and New York make this issue even more difficult. We recommend that the Initiative include the development and implementation of a systematic data collection and maintenance plan for energy and economic information.

Our assessment of the economic impact of potential energy policies and trends for this report has been limited in two ways due to constraints on the time available. First, only a few of the concepts were analyzed quantitatively and, then, only in an illustrative manner. Second, those analyses were done using aggregate results from a New England-wide study that was not specific to the NF region. The energy infrastructure, needs and economics of the NF region differ greatly from the "balance of state," and we believe that those differences are material to understanding the economic pros and cons of energy policies for the NF region. In order that decision makers may make informed choices, we recommend detailed economic impact modeling, similar to that Synapse performed for the Regulatory Assistance Project in 2005, but using a model configured for the NF counties. (Sedano, Murray et al. 2005) Such a model should, preferably, be structured as at least eight interacting regions: one for each state's NF counties and one for each state's non-NF counties. It may even be desirable to further subdivide the NF region if county energy situations and economies are deemed to differ materially.

It has been predicted that the NF region will undergo immense changes to its forest biome over the next 50 years under conservative projection of future warming trends. (Joyce, Aber et al. 2000) To give just two examples, those changes could eliminate the maple syrup industry, a $20 million a year input just for the New England states, and drastically affect the skiing industry, $1.8 billion a year business in New Hampshire and Vermont alone. (New England Climate Coalition 2003) (New England Climate Coalition 2003) Energy demands will change, at least in their seasonal patterns, and productivity of biomass would be altered, as well. Clearly, climate change, whether or not action is taken by the U.S., will bring about a different forest in the NF region over a time scale relevant to the goal of a sustainable regional economy. We recommend that the Initiative develop a plan for assessing the range of changes to the NF and to the NF region's economy and energy situation that may result, both to provide a better background for decision making and as tool for assessing the impact of the options being considered.

Additional recommendations for action by the Center include:

1) Sponsor or co-sponsor a region-wide conference or conferences on sustainable development economics in forest regions or in the NF region, specifically. The conference(s) might be an academic meeting of experts in economics, manpower, environmental and economic development; this would make sense if the work of the Initiative concludes that there is a need for new information, analytical tools and basic understanding. Or it might be an action or consensus oriented meeting of key stakeholders or a session to build bridges between

counterparts in the four states, such as state and regional foresters or economic development agencies. Perhaps both would be needed.

2) Sound comparison of the impacts of policy options on the NF economy and energy situation, as well as any projections of energy need and supply, will require ongoing access to regularly updated data on energy production, expenditures and consumption by sector, industry, state and county. Currently, much of this data is not readily available below the state level. We suggest the Initiative examine options for better methods for tracking energy data in the NF region economy, especially dollar inflows and outflows for various fuels and energy related goods and services, including biomass energy production and total forest production (dollars and tons by type and source), as well as biomass energy use (dollars and tons by type, source, user, and use).

3) Similarly, we suggest the Initiative examine the costs and benefits of developing and tracking measurable indicators of energy use, imports, production (especially with regard to renewable electric generation and non-traditional fuels such as biodiesel) and efficiency, as well as indicators of sustainability of energy consumption and production. (Even where relevant energy data exist, there is little data to support assessment of how sustainable that energy use or production may be.)

4) We recommend that the Initiative analyze the potential for cost effective biodiesel and ethanol production in the NF region, now and in the future, and how it could act as an economic stimulus and as a possible contributor towards reducing cash outflows for transportation and heating fuel. The Initiative may also want to assess the economic feasibility, environmental impacts and sustainability of such production and, eventually, develop plans for encouraging appropriate implementation.

5. Glossary

biodiesel	a safe, biodegradable, and nontoxic fuel mainly produced as a by-product of soy bean production, but it can be manufactured from virtually any kind of vegetable oils or recycled cooking oil, animal fat waste, and algae
biomass	fuel produced from growing plant, including woody plants and grasses
Btu	the quantity of heat energy necessary to raise the temperature of one pound of water at its maximum density (39.1 degrees Fahrenheit) by one degree Fahrenheit; approximately 251.9 calories
greenhouse gas (GHG)	any of several gases that allow the sun's energy to enter the earth's atmosphere, but prevent or retard the escape of energy in the form of infrared radiation from the atmosphere; the primary GHG is carbon dioxide (CO2); others include methane (CH4), and SF6 (a gas used as an electrical insulator in high voltage switches)
direct heat	use of heat energy, itself, for consumption, as opposed to using heat to produce electricity; examples include space and water heating, cooking, and industrial processes that use heat
distillate fuel oil	a relatively light density petroleum product often used for home and commercial heating and for electric generation at times of peak load; similar to diesel fuel; often called No. 2 oil
gasifier	a device that converts solid fuel, such as biomass or coal, to a flammable gas by heating it under low oxygen conditions; the gas is then burned for direct heat or to run an electric generator; residues are typically small amounts of relatively clean ash
kiloWatt	one thousand Watts
kiloWatt-hour	one thousand Watt-hours
kW	kilowatt
kWh	kiloWatt-hour
landfill gas	flammable gases given off by decaying garbage and trash buried in landfills; largely methane
liquefied natural gas (“LNG”)	natural gas that has been compressed to form a liquid that can be transported by ship, rail or truck; a re-gasification plant is required at the receiving end to make LNG available to users
MegaWatt	one million Watts
MegaWatt-hour	one million Watt-hours
methanol	a liquid fuel made from agricultural products or wood; wood alcohol
MMBtu	one million Btu's
MW	MegaWatt

natural gas	a gaseous fossil fuel, mainly methane, derived from subterranean drilling, both on land and off-shore; usually transported to users via underground pipelines
NF	Northern Forest, a 34 county regions extending from western NY to eastern ME
NOx	a general term for various nitrogen-oxygen compounds produced when most fuels are burned in air; precursors of both acid rain and low level ozone
petrodiesel	a term used to refer to Diesel fuel derived from petroleum as opposed to biodiesel
propane	a gaseous fuel derived from petroleum or as a by product of natural gas production; usually compressed to a liquid (liquefied propane gas or LPG) and delivered in tanks, but occasionally mixed with air and distributed by underground pipe; often used to supplement natural gas at times of peak load by injecting it with air into local natural gas distribution lines
PURPA	the Public Utilities Regulatory Policy Act of 1978; among other things PURPA created the category of Qualifying Facility, a status that certain renewable energy and cogeneration plants could obtain and which guaranteed their output would be purchased at favorable rates by local utilities
renewable	A resource is renewable if it is naturally replaced. Examples include solar, wind, hydroelectric, geothermal and wave power, as well as most forms of biomass. Fossil fuels, nuclear fuel, and municipal solid waste are not renewable, although a few renewable standards allow municipal sold waste to qualify.
residual oil	a heavy grade of petroleum product that remains after distillate oil and gasoline are removed; usually requires specialized equipment for handling and burning; often called No. 6 oil; typically used in boilers in factories large generating plants that are in use many hours per year
sustainable	A resource or its use is sustainable if it is consumed at a rate no more than its natural replacement rate and without causing negative impacts on environment that impair the ability of future generations to benefit from the resource.
EE	energy efficiency; decreasing the amount of energy required to produce a given level of amenity
RE	renewable energy
telecommuting	employment to perform work at home some or all of the time using voice and data connections to the employer and customers; typical fields for telecommuting include customer service and technical support hot lines, sales and reservations, data entry, computer programming, financial services, and various forms of consulting work
VMT	vehicle miles traveled, a measure of motor vehicle use
Watt	a measure of electric power or the ability to produce or consume electric energy at a certain rate; a typical incandescent light bulb might consume 100 Watts of power.
Watt-hour	the amount of electrical energy equivalent to consumer power at one Watt for one hour

6. Supporting Materials

6.1. Employment and Economic Data

Total Personal Income in NF Counties Only as a Percent of Total State Income, 2000 - 2004

State	2000	2001	2002	2003	2004
ME	31.2%	31.0%	31.0%	30.8%	30.6%
NH	11.4%	11.6%	11.6%	11.9%	11.9%
NY	4.4%	4.4%	4.5%	4.5%	4.5%
VT	61.2%	61.5%	61.6%	61.7%	61.7%

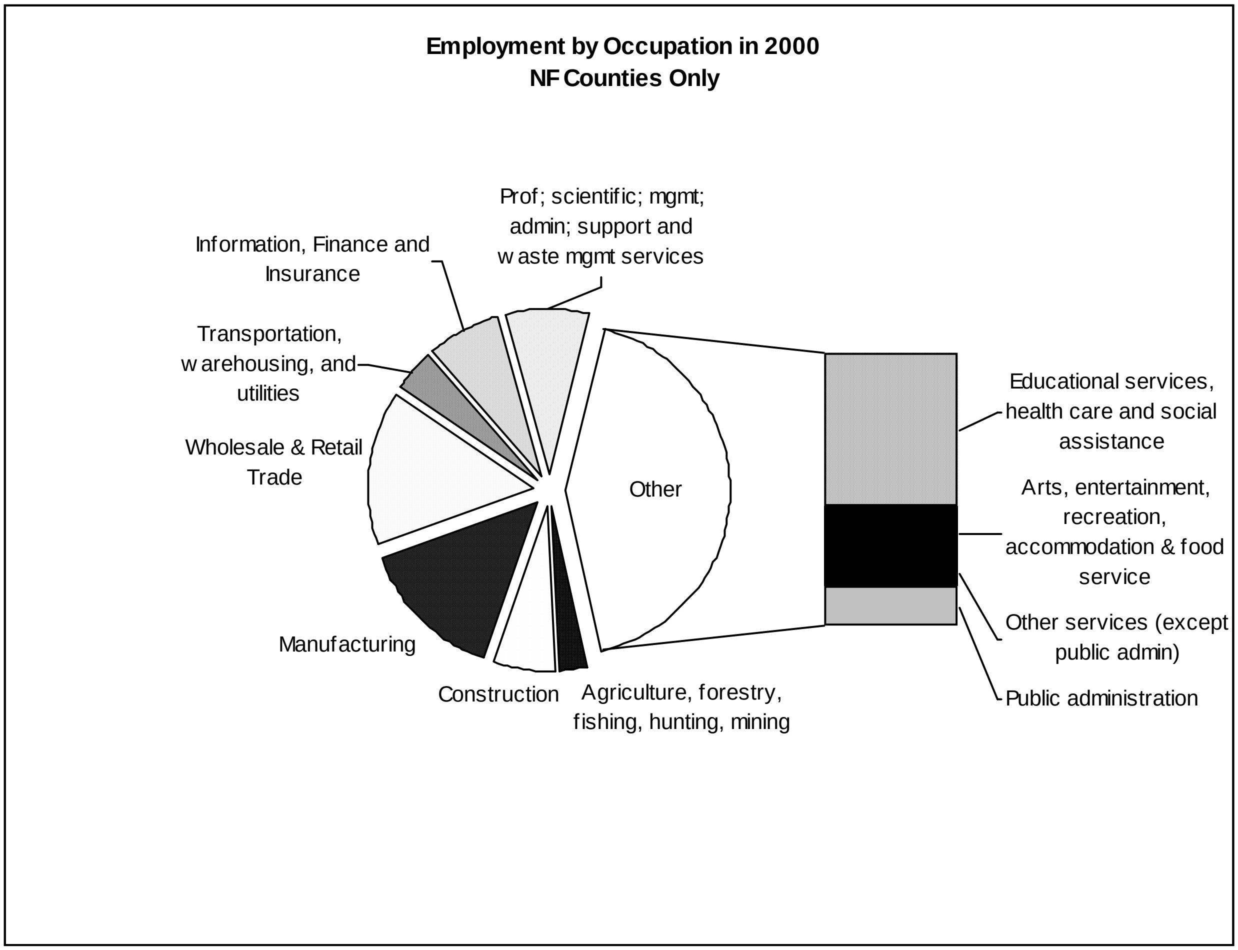
Source: Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce

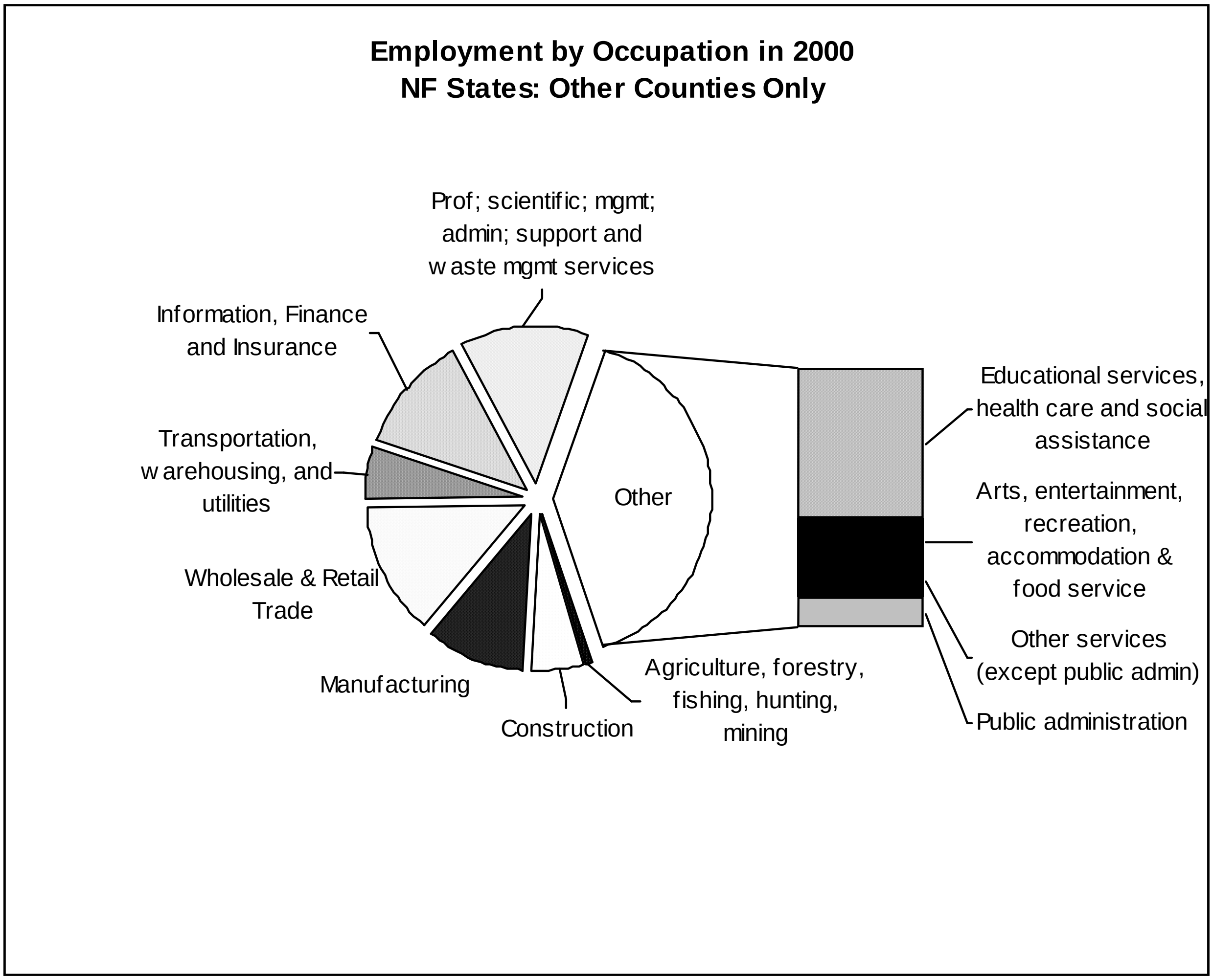
2004 Gross State Product in NF States – All Counties Current Dollars [Millions of dollars]

	Total	Agr., forestry, fishing, & hunting	Mining	Utilities	Construction	Durable goods manuf.	Non-durable goods manuf.	Whole-sale & retail trade	Trans. & ware-housing	Inf., Finance & Insurance	Real estate, rental, & leasing
U.S.	11,665,595	116,589	147,502	241,236	541,414	862,611	631,415	1,485,734	338,643	1,519,584	1,451,288
ME	43,336	575	5	941	2,021	2,612	2,565	6,376	1,031	4,263	5,821
NY	896,739	1,670	454	18,457	28,773	30,345	31,736	96,783	16,557	212,140	114,056
NH	51,871	214	40	1,816	2,850	4,847	1,623	7,921	902	6,045	7,232
VT	21,921	289	28	637	1,054	2,263	691	2,963	468	2,120	2,760

	Real estate, rental, & leasing	Profes-sional & technical services	Manage-ment of com-panies	Adminis-trative & waste services	Ed., social assist. & health care	Arts, enter-tainment & rec-reation	Accomo-dation & food services	Govt. & other services
U.S.	1,451,288	792,133	213,639	335,580	903,900	111,758	308,058	1,389,018
ME	5,821	1,943	513	912	4,950	349	1,329	6,159
NY	114,056	75,337	23,899	22,372	82,957	10,292	20,163	91,801
NH	7,232	3,195	796	1,312	5,044	505	1,560	4,718
VT	2,760	1,167	48	426	2,431	190	962	2,891

Source: U.S. Bureau of Economic Analysis, Table 3. www.bea.gov/bea/newsrelarchive/2005/gsp1005.xls


Employment by Occupation in 2000
NF Counties Only
Prof; scientific; mgmt; admin; support and w aste mgmt services
Information, Finance and Insurance
Transportation, w arehousing, and utilities
Wholesale & Retail Trade
Other
Manufacturing
Construction
Agriculture, forestry, fishing, hunting, mining
Educational services, health care and social assistance
Arts, entertainment, recreation, accommodation & food service
Other services (except public admin)
Public administration



Growth Rates in Real Gross State Product, NF States – All Counties, 1997-2004

	Average annual growth rate 1997-2003		Percent change 2003-2004	
	Percent	Rank (U.S.)	Percent	Rank (U.S.)
United States	**3.0**	**….**	**4.3**	**….**
New England	**3.2**	**….**	**4.6**	**….**
Maine	2.2	33	3.9	32
New Hampshire	3.8	9	5.4	9
Vermont	4.0	7	4.6	18
Mideast	**2.8**	**….**	**4.2**	**….**
New York	3.0	22	4.7	15

Source: ((US) Bureau of Economic Analysis 2005)

6.2. Biodiesel

Biodiesel is a safe, biodegradable, and nontoxic fuel that can be mixed with or substitute for petrodiesel for transportation, heating, and power generation. It can be added to No. 2 heating oil, as well. Although biodiesel has been mainly produced a by-product of soy bean production, it can be manufactured from virtually any kind of vegetable oil including corn, rapeseed (canola), mustard seed, cotton seed, peanut, and sunflower. It can also be produced from recycled cooking oil (from restaurants and fast food shops), animal fat waste, and algae.[18] The UNH Biodiesel Group is investigating mustard and algae for producing biodiesel in New Hampshire.[19]

According to EIA, national consumption of biodiesel was 36 million gallons in 2004, representing 0.08% of the 43,852 million gallons of diesel fuel used for transportation or 0.05% of 62,384 million gallons used for all purposes including heating and power generation.[20] Biodiesel is mostly produced in the Midwest. In Northeast, several biodiesel retailers are selling B20 (20 percent biodiesel mix in petrodiesel or No. 2 heating oil) for transportation and home heating. There are no existing biodiesel plants in the NF region. Small cottage industry operations exist, some using used cooking oil. Of the 4 NF states, only Maine has a plant, located just south of the NF region in Belgrade, with a 250,000 gallon annual capacity.[21] A biodiesel production plant is scheduled for completion in February, 2006, in Fulton, NY (Oswego County), with a 5 million gallon capacity using soybean oil as the primary feedstock.[22] While the current biodiesel production in the NF region is very small, there is substantial potent in this region given the wide variety of resources availability for producing biodiesel.

Biodiesel has significantly lower emissions of green house gases, carbon monoxide, and particulate matter than petrodiesel. The effect on NOx emissions is mixed. They can be slightly greater when biodiesel is used in internal combustion engines, but those emissions can be reduced with appropriate NOx treatment methods. According to Massachusetts Consumers Appliance, biodiesel for home heating applications leads to NOx emission reduction.[23] In addition to these emission reductions, biodiesel reduces waste water by 79 percent, biodegrades four times faster than regular diesel, and creates 95% less hazardous waste.[24]

Biodiesel Emissions: Percent change from petrodiesel

Emission Type	**B100**	**B20**
Regulated		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
NOx	+10%	+2%

[18] Algae for biodiesel is still in a experimental stage, but studies have shown that it can produce the largest amount of biodiesel per acre among all resources listed above.
[19] http://www.unh.edu/p2/biodiesel/goals_index.html#intra
[20] http://www.eere.energy.gov/cleancities/blends/pdfs/37136.pdf; Congressional Research Service 2006. *CRS Report for Congress: Agriculture-Based Renewable Energy Production*, February 28, 2006, available at www.nationalaglawcenter.org/assets/crs/RL32712.pdf
[21] http://www.nbb.org/buyingbiodiesel/producers_marketers/ProducersMap-Existing.pdf
[22] http://www.nbb.org/buyingbiodiesel/producers_marketers/ProducersMap-Construction.pdf
[23] Massachusetts Energy Consumers Alliance and People's Power & Light 2004. *Use of Biodiesel as a Heating Oil in New England*, October 15, 2004.
[24] U.S. DOE and the USDA 1998. *Life Cycle Inventory of Biodiesel and Petroleum Diesel for Use in an Urban Bus.*

Non-Regulated		
Sulfates	-100%	-20%*
PAH (Polycyclic Aromatic Hydrocarbons)**	-80%	-13%
NPAH (nitrated PAH's)**	-90%	-50%***
Ozone potential of speciated HC	-50%	-10%
* Estimated from B100 result ** Average reduction across all compounds measured		
*** 2-nitroflourine results were within test method variability		
http://www.worldenergy.net/product/emissions.asp		

Biodiesel produced from soybeans has a net energy ratio of 3.2, meaning that for every Btu consumed to produce the fuel, there is 220 percent energy gain, while regular diesel has an energy ratio of just 0.843, which indicates 15.7 percent net energy loss, according to the US Department of Agriculture.[25]

Energy Balance/Energy Life Cycle Inventory of Several Liquid Fuels

Fuel	Net Energy Ratio	Net Energy (loss) or gain
Gasoline	0.805	(19.5 percent)
Diesel	0.843	(15.7 percent)
Ethanol	1.34	34 percent
Biodiesel	3.20	220 percent

One study of the economic impacts of a national program to produce biodiesel from soy beans estimated a job creation potential of about 52,400 jobs nationally from a sustained ten year investment in production facilities. (Urbanchuk 2002) Quantifying the job potential of ethanol production from crops suitable for use in the NF region would require further analysis. Ethanol production is discussed in the next section.

6.3. Ethanol

Ethanol can be used as an alternative fuel or as an octane-boosting, pollution-reducing additive to gasoline. Currently there are nearly 5 million flex-fuel vehicles (FFV) that can use E85 fuel (85 percent ethanol mixed with gasoline) on the road.[26] In 2004, 3.4 billion gallons of ethanol was produced, which accounts for about 1.6% of U.S. gasoline consumption. According to the Department of Energy (DOE), there are over 80 ethanol producing plants in 21 states, which have

[25] United States Department of Agriculture (USDA) 2002. *Estimating The Net Energy Balance Of Corn Ethanol: An Update*; http://www.mda.state.mn.us/ethanol/balance.html

[26] http://www.renewableenergyaccess.com/rea/news/story?id=42661

the capacity to produce 4.4 billion gallons annually.[27] The federal Energy Policy Act of 2005 set a goal of 7.5 billion gallons of biofuel production by 2012 which is likely to be mainly ethanol, given that current biodiesel production is estimated to be around 75 million gallons.

Most ethanol is currently produced from corn. However, ethanol can be produced from various kinds of cellulosic biomass (e.g., agricultural forestry residues, industrial waste, some materials in municipal solid waste, trees, and grasses). While the conversion technologies from cellulose to ethanol have been under development and still costly, there are significant advantages for cellulose ethanol: (1) cellulosic feedstocks are significantly less expensive than corn; (2) the theoretical potential land area suitable for cellulosic feedstocks is nearly 10 times larger than for corn on national level[28]; (3) while the net energy ratio for producing corn-ethanol is somewhat controversial (estimates range from 0.86 to 1.67 depending on the study), cellulose-ethanol is expected to yield significant net energy gains ranging from 2.0 to 8.[29] For these reasons, state and federal governments have been focusing on cellulose-ethanol production development.

According to the National Renewable Energy Laboratory's recent study on the potential of biomass resource availability, the NF region has or could produce over 4 million dry tons of biomass resource potential including residues from crops, forest, primary and secondary mills, and urban wood and energy crops (NREL 2005). Assuming the technology can produce 80 gallons of ethanol per dry ton of cellulosic biomass, this biomass resource potential could produce 330 million gallons of ethanol per year. The actual job creation rate is uncertain.[30] However, it is certain that ethanol production on such a scale would bring about a substantial number of jobs in the NF region.

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[27] http://www1.eere.energy.gov/biomass/ethanol.html; http://www.frazierbarnes.com/html/body_ethanol_plant_map.html; http://www.ethanolrfa.org/industry/locations/

[28] In the U.S. in 2001 nearly 76 million acres were planted to corn, out of 244 million acres planted to the eight major field crops (corn, soybeans, wheat, cotton, barley, sorghum, oats, and rice). In contrast, that same year the United States had 433 million acres of total cropland (including forage crops and temporarily idled cropland) and 578 million acres of permanent pastureland, most of which is potentially viable for switchgrass production.

[29] LBNL 2006. ERG Biofuel Analysis Meta-Model, available at http://rael.berkeley.edu/EBAMM/ ; Congressional Research Service 2006. *CRS Report for Congress: Agriculture-Based Renewable Energy Production*, February 28, 2006, available at www.nationalaglawcenter.org/assets/crs/RL32712.pdf; McClaughlin and Walsh 1998. "Evaluating Environmental Consequences of Producing Herbaceous Crops for Bioenergy" in Biomass and Bioenergy Vol. 14, No. 4, pp. 317-324, 1998, available at http://www.public.iastate.edu/%7Ebrummer/papers/McLaughlin-Walsh.pdf

[30] A study of the economic impacts of a national program to produce ethanol from corn estimated a job creation potential of about 13.7 job for each million gallons of production. Urbanchuk, J. M. (2000). Ability of the U.S. Ethanol Industry to Replace MTBE. It is not clear why ethanol production is projected to generate this much more employment than biodiesel or biomass generation. There are two other studies that estimate job creation from cellulose-based ethanol production. See California Biomass Energy Alliance (2003) Benefits of California's Biomass Renewable Energy at www.calbiomass.org/technical4.htm and McNeil Technologies, Inc. (2003) Biomass Resource Assessment and Utilization Options for Three Counties in Eastern Oregon at http://www.oregon.gov/ENERGY/RENEW/Biomass/assessment.shtml. These studies found that ethanol production will create 7 to 8 direct jobs per million gallons. Urbanchuk (2000) estimated 8.6 direct jobs per million gallons of ethanol.

6.4. Biomass for Electric Generation

The potential for increasing the role of biomass generation depends on the price paid for the fuel. At a price of $3.50/MMBtu, much less than the current price of natural gas, as much as 3 million acres of *non-forest* land in the NF region could economically produce biomass suitable for electric generation. One study found that the New England states could economically increase their biomass electricity generation by a factor of up to seven times at a fuel price of $3.50/MMBtu, much less than the current and projected market prices of natural gas for electric generation. (In that study, biomass included landfill gas, mill residue, agricultural waste and other feedstocks.) (XENERGY and Associates 2003) One avenue for expanded biomass generation is in dedicated energy crops. The following table shows that considerable *non-forested* acreage existing in the NF region suitable for such crops, a total area equivalent to perhaps as much as one-tenth the NF itself.

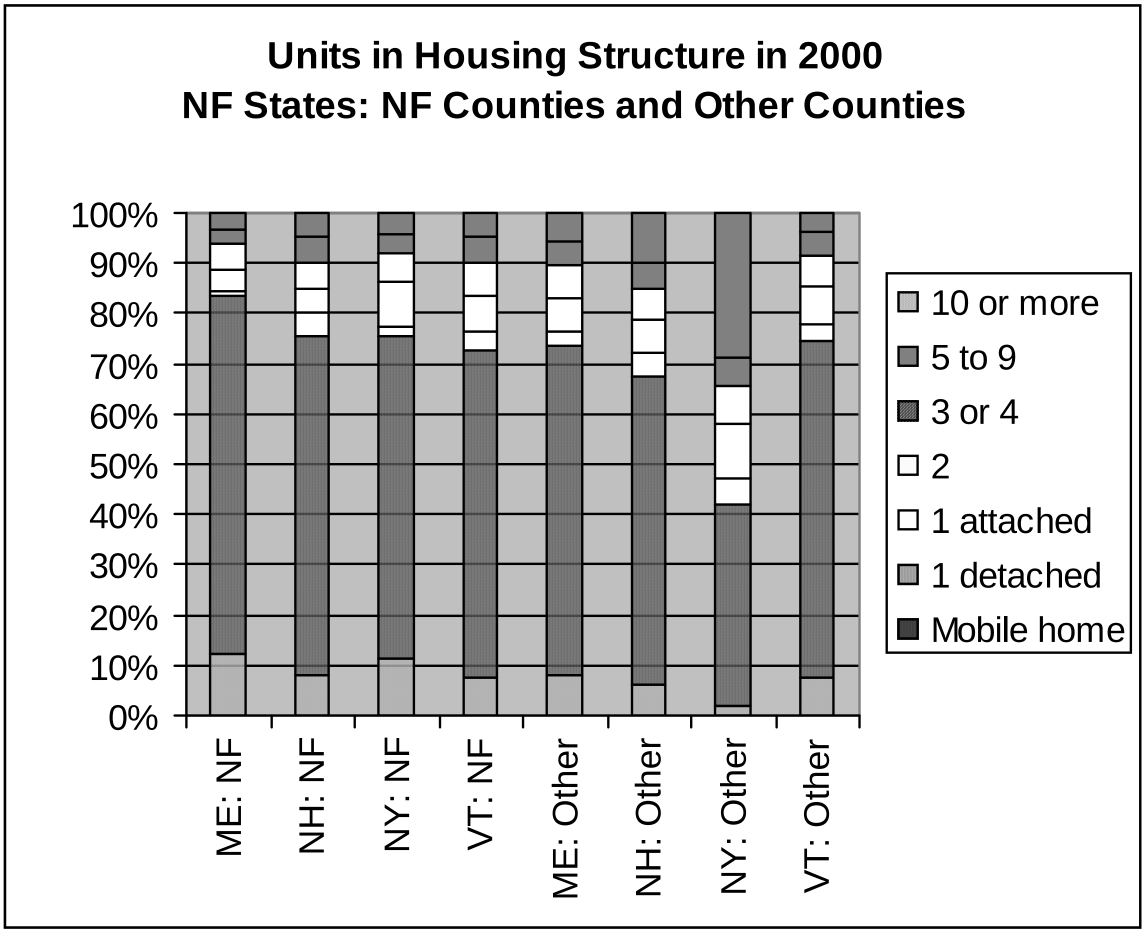
Share and number of acres in NF and non-NF counties suitable for short rotation woody crops (SRWC) and switchgrass, 1996

Location	Units	USDA classified cropland	USDA classified pasture	Cropland suitable for SRWC	Pasture suitable for SRWC	Cropland suitable for switchgrass	Pasture suitable for switchgrass
Total: NF States – All Counties	acres	6,225,147	675,333	4,980,685	1,645,050	3,864,854	1,237,712
NF Counties Only	acres	2,062,105	257,567	1,648,507	642,583	753,609	321,429
NF Counties: Share of NF States – All Counties	%	33%	38%	33%	39%	19%	26%
NF States - Other counties	acres	4,163,042	417,766	3,332,178	1,002,467	3,111,245	916,283
Other Counties: Share of NF States – All Counties	%	67%	62%	67%	61%	81%	74%

Source: (Graham, Allison et al. 1996)

6.5. Residential Housing Stock Data

The NF region's housing stock is dominated by generally less thermally efficient detached structures and mobile homes.



Source: U.S. Census.

6.6. Transportation-Related Demographic Data

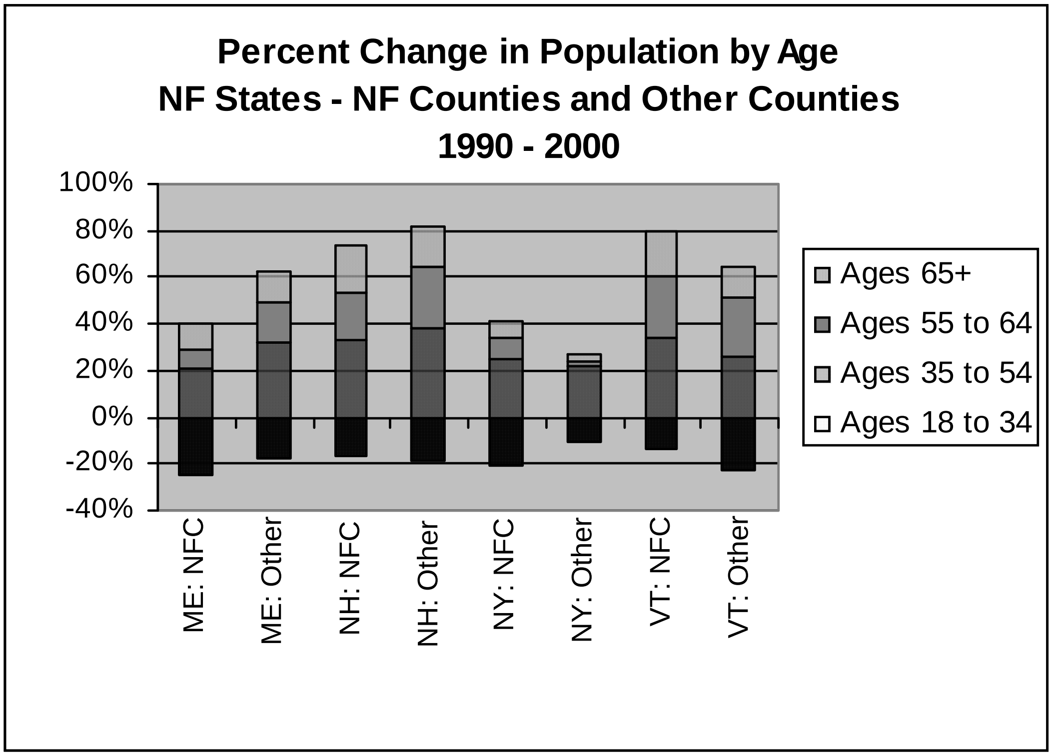
Metropolitan Influence in NF States - NF Counties and Other Counties

	Northern Forest		Other counties	
	NF	NF %	Other	Other %
Large metro area, 1+ million	0	0%	19	28%
Small metro area, <1 million	11	31%	18	26%
Micropolitan adjacent to large metro	3	9%	15	22%
Noncore adjacent to small metro w/town	7	20%	7	10%
Micropolitan not adjacent to metro	7	20%	3	4%
Noncore adjacent to large metro	1	3%	2	3%
Noncore adjacent to small metro w/o town	2	6%	2	3%
Noncore adjacent to micro w/town	1	3%	2	3%
Noncore not adjacent to metro or micro w/town	3	9%	0	0%

Source: U.S. Census.

The above table illustrates the degree to which the NF counties are less dominated by urban areas compared to the rest of the NF states, an important influence on travel patterns and transportation use. However, even in the NF counties, there is substantial influence *from* non-urban areas (not "large metro") *to* micropolitan or noncore areas. This reflects the extended commuting patterns discussed in the body of this report.

The growth in rural VMT does not reflect population trends. While the driving age (18+) population in the four states has grown from 1990 to 2000, most of that growth is in the non-NF counties.[31]



On a county basis, growth in population within the NF region varies widely. The counties experiencing the most growth contain or are in close proximity to urban areas.

NF Counties Only: Highest and Lowest Population Growth, 1990 to 2000

Top 10			Bottom 10		
County	*State*	*% change*	*County*	*State*	*% change*
Grand Isle	VT	30%	Aroostook	ME	-15%
Carroll	NH	23%	Piscataquis	ME	-8%
Lamoille	VT	18%	Clinton	NY	-7%
Franklin	VT	14%	Oneida	NY	-6%
Chittenden	VT	11%	Coos	NH	-5%
Saratoga	NY	11%	Washington	ME	-4%
Hancock	ME	10%	Herkimer	NY	-2%

[31] As requested by the Center, this report treats Chittenden and Grand Isle Counties in Vermont as part of the NF region.

Franklin	NY	10%	Penobscot	ME	-1%
Orleans	VT	9%	St. Lawrence	NY	0%
Grafton	NH	9%	Oswego	NY	0%
All NF Counties					*4.29%*

Source: U.S. Census.

6.7. Alternative Fuel Vehicle Data

Estimated Number of Alternative-Fueled Vehicles in Use, NF States – All Counties by Fuel Type, 2002

State	Liquefied Petroleum Gases	Natural Gas	Methanol	Ethanol	Electricity	Total
Maine	158	77	0	134	21	390
New Hampshire	718	42	0	169	167	1,096
New York	6,213	13,100	88	3,723	9,299	32,423
Vermont	366	5	0	199	178	748
U.S. Total	187,680	123,547	5,873	120,951	33,047	471,098

Notes: Natural gas includes compressed natural gas (CNG) and liquefied natural gas (LNG). Methanol includes M85 and M100. Ethanol includes E85 and E95. Excludes gasoline-electric hybrids. Totals may not equal sum of components due to independent rounding.
Source: Energy Information Administration, Office of Coal, Nuclear, Electric, and Alternate Fuels and the DOE/GSA Federal Automotive Statistical Tool (FAST). http://www.eia.doe.gov/emeu/states/_states.html

6.8. Renewable Portfolio Standards

Renewable energy has been the focus of two new types of policy in response to the virtual elimination of integrated utility resource planning and R&D following the introduction of retail choice: the renewable portfolio standard (RPS), and the research, development and deployment (RD&D) fund. An RPS requires retail sellers meet a minimum percentage of their load with qualifying renewable energy. An RD&D fund (sometimes called a "clean energy" fund) collects a non-bypassable surcharge on retail electricity rates for the purpose of developing renewable technologies.

Massachusetts and Connecticut have RPSs that require investment in new renewable resources. Maine's RPS does not require an increase in the share of renewables. In 2004, Rhode Island also adopted an RPS to be effective in 2007 designed to attract new renewable resources. New York's program will require adding new renewable resources and is operated mainly through the New York State Energy Research and Development Authority and an RD&D surcharge, rather than through mandates on electricity providers. Vermont's RPS sets a goal for utilities to meet between 2005 and 2012; if that goal is not met, the program will convert to a mandatory RPS in 2013.

For a thorough account of RPS policies in the U.S. see http://www.dsireusa.org//

7. References

(ME) Public Utility Commission. "Frequently Asked Questions about Natural Gas in Maine." from http://www.maine.gov/mpuc/industries/natural_gas/faq.html.

(NY) Department of Environmental Conservation. (n.d.). "Location of Wells Regulated by the Division of Mineral Resources." Retrieved April 27, 2006, from http://www.dec.state.ny.us/website/dmn/wells1.htm.

(OR) Department of Energy. (2003). "Eastern Oregon Biomass Assessment." from Eastern Oregon Biomass Assessment.

(US) Bureau of Economic Analysis. (2005). "News Release." from http://www.bea.gov/bea/newsrelarchive/2005/gsp1005.xls.

(US) Energy Information Agency. (2001). "State Energy Consumption, Price, and Expenditure Estimates (SEDS)." from http://www.eia.doe.gov/emeu/states/_seds.html.

(US) Federal Highway Administration (2001). Highway Statistics 2000**:** Section I, Table MF21.

(US) Federal Highway Administration (2002). Highway Statistics 2000**:** Section V, Table VM2 (updated).

(US) Federal Highway Administration (2005). Highway Statistics Section I, Table MF21.

(US) Federal Highway Administration (2005). Highway Statistics 2004**:** Section V, Table VM2.

(US) Global Change Research Program National Assessment Synthesis Team (2000). Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change Overview: Forests.

(VT) Vermont Department of Public Service. (1988). "Fueling Vermont's Future: Vermont Comprehensive Energy Plan and Vermont Greenhouse Gas Action Plan." from http://publicservice.vermont.gov/pub/state-plans-compenergy.html.

American Wind Energy Association. (2005). "Wind Project Data Base." from http://www.awea.org/projects/index.html.

Biewald, B., T. Woolf, et al. (2003). Portfolio Management: How to Procure Electricity Resources to Provide Reliable, Low-Cost, and Efficient Electricity Services to All Retail Customers. Cambridge, MA, Synapse Energy Economics, Inc.**:** 124.

California Biomass Energy Alliance. (2003). "Benefits of California's Biomass Renewable Energy." from www.calbiomass.org/technical4.htm.

Chen, C., D. White, et al. (2003). The Maryland Renewable Portfolio Standard: An Assessment of Potential Cost Impacts, Synapse Energy Economics, Inc.**:** 17.

Energy Advisors LLC. (2003). Maine Energy Policy: Overview and Opportunities for Improvement.

Graham, R. L., L. J. Allison, et al. (1996). ORECCL-Oak Ridge Energy Crop County Level Database. BIOENERGY '96 - The Seventh National Bioenergy Conference: Partnerships to Develop and Apply Biomass Technologies, Nashville, TN.

Joyce, L., J. Aber, et al. (2000). Potential Consequences of Climate Variability and Change for the Forests of the United States. US National Assessment of the Potential Consequences of Climate Variability and Change: A detailed overview of the consequences of climate change and mechanisms for adaptation. (US) Global Change Research Program National Assessment Synthesis Team, US Climate Change Science Program / US Global Change Research Program,**:** 489-522.

National Association of Regulatory Utility Commissioners (1998). Least-Cost Utility Planning Handbook for Public Utilities Commissioners. **1**.

National Biodiesel Board (2006). Biodiesel Production Plants Under Construction.

National Grid. "Service Territory Map." from http://www.nationalgridus.com/niagaramohawk/construction/serviceterr_map.asp.

New England Climate Coalition (2003). Global Warming and New England: Progress, Opportunities and Challenges After Two Years of the Regional Climate Change Action Plan.
Northern Forest Center (2005). Communities, Economy & Land: A Regional Strategy for the Northern Forest Funding the Vision.
NYSEG. "ESCO." from http://www.nyseg.com/nysegweb/webcontent.nsf/esco/ESCO.
NYSERDA. (2002). "State Energy Plan and Final Environmental Impact Statement." from http://www.nyserda.org/Energy_Information/energy_state_plan.asp.
NYSERDA. (2005). "Patterns and Trends: NYS Energy Profiles: 1990-2004." from http://www.nyserda.org/Energy_Information/energy_facts.asp.
NYSERDA. (2006). "Trends Report." from http://www.nyserda.org/Energy_Information/energy_facts.asp.
Sedano, R., C. Murray, et al. (2005). Electric Energy Efficiency and Renewable Energy in New England: An Assessment of
Existing Policies and Prospects for the Future, Regulatory Assistance Project**:** 131.
Staff reporter (2006). Proposed wind farm has deal to sell 'green' power. Blethen (Maine) Newspapers.
Steinhurst, W., R. McIntyre, et al. (2005). Preliminary Estimates of Economic Impacts and Potential Air Emission Reductions from
Renewable Generation & Efficiency Programs in New England: Phase I Summary.
Urbanchuk, J. M. (2000). Ability of the U.S. Ethanol Industry to Replace MTBE.
Urbanchuk, J. M. (2002). Macroeconomic Impacts of S.1058
XENERGY and E. M. Associates (2003). Securing a Place for Biomass in the Northeast United States: A Review of Renewable Energy and Related Policies.