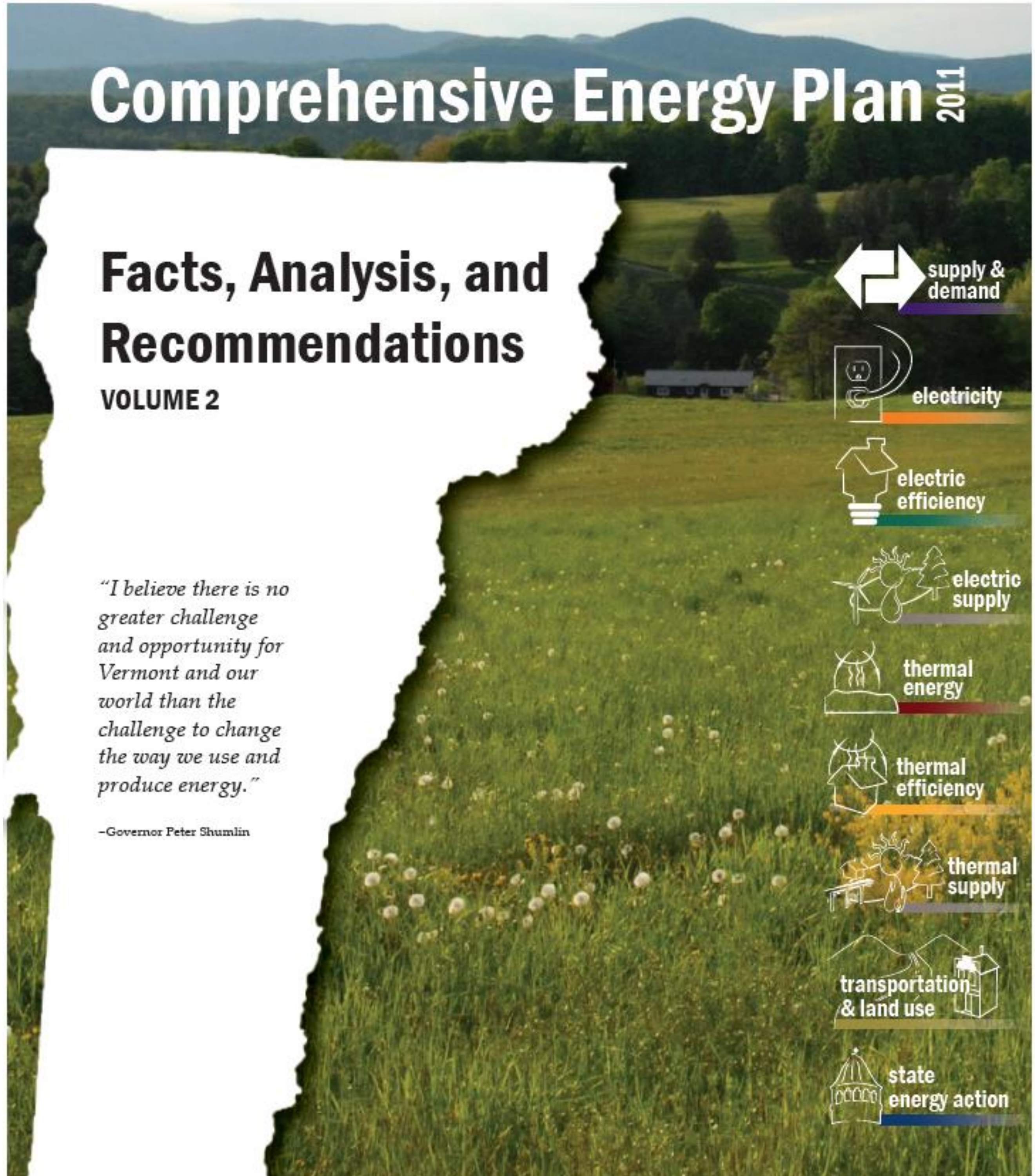
Comprehensive Energy Plan 2011

Facts, Analysis, and Recommendations

VOLUME 2

"I believe there is no greater challenge and opportunity for Vermont and our world than the challenge to change the way we use and produce energy."

–Governor Peter Shumlin



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1 Preface

1.1 Objectives for the CEP

This Comprehensive Energy Plan (CEP) has three primary objectives. First, the CEP is intended to inform readers of the many challenges and opportunities facing Vermonters in our mutual efforts to maintain a safe, reliable, affordable, environmentally sound, and sustainable energy supply across all sectors—electricity, transportation fuels, and heating and process fuels. Because it is both a policymaking and a reference tool, readers can use the CEP to learn more about the energy initiatives going on in the state and how Vermont's energy issues relate to regional, national, and even international developments. It attempts to raise policymaker and public awareness of critical concerns related to energy issues.

Second, the CEP recognizes the dynamic and interrelated nature of energy policy, while examining current efforts to address our energy challenges. As of the time of the CEP's release, our national economy is struggling. The strains of the economic downturn of 2008 and 2009, coupled with the debt ceiling crisis and continued lack of robust job creation, have put the federal budget in significant turmoil, creating funding uncertainty here in Vermont. Meanwhile, although the Vermont economy has escaped some of the effects of the downturn felt elsewhere, damage from Tropical Storm Irene during the summer of 2011 will significantly impact our state budget and our efforts and priorities in the coming months and years. At the same time, federal and state laws are evolving and are altering the policy framework under which energy planning occurs. Given the complexity of energy issues and their interrelatedness with other challenges facing government, the CEP attempts to take an integrated look at energy decisions regarding not just electricity, but also heating, transportation, and land use.

Finally, the CEP makes specific recommendations on ways in which the state can support, guide, expand, or take the critical next steps to help lead Vermont, the region, and the nation into a sustainable, affordable renewable energy future. It sets an ambitious long-term goal of obtaining 90% of the state's total energy needs from renewable sources by mid-century. The CEP recognizes, however, that there is no single, lockstep path that may help Vermont attain this goal; instead, incremental policy changes, along with progress on education, finance, and innovation, will be required.

The CEP reflects the challenges and initiatives in play at the time of its publication. The issues are complex, and the policy, economic, and scientific frameworks surrounding them are changing rapidly. New challenges, new initiatives, and new events that contribute to a greater understanding of energy policy and climate change occur monthly, weekly, and sometimes even daily. The CEP attempts to provide a comprehensive look at these challenges and opportunities in this moment, and offers recommendations for progress going forward.

Since the release of the Public Review Draft of the CEP in September 2011, the Department of Public Service has received considerable public comment and engagement. This final plan reflects changes based upon that input.

1.2 Statutory Goals and Requirements

Vermont law requires the Department of Public Service to produce a Comprehensive Energy Plan for the state covering at least a 20-year period. 30 V.S.A. § 202(b) states:

> (1) The department of public service, in conjunction with other state agencies designated by the governor, shall prepare a comprehensive state energy plan covering at least a 20-year period. The plan shall seek to implement the state energy policy set forth in section 202a of this title. The plan shall include:
>
> (1a) A comprehensive analysis and projections regarding the use, cost, supply and environmental effects of all forms of energy resources used within Vermont.
>
> (1b) Recommendations for state implementation actions, regulation, legislation, and other public and private action to carry out the Comprehensive Energy Plan.

The CEP itself is designed to serve as an actionable framework for moving forward from the goals defined in the statute. At the highest level, Vermont's statutory policies include these major goals:

- To assure, to the greatest extent practicable, that Vermont can meet its energy service needs in a manner that is adequate, reliable, secure and sustainable; that assures affordability and encourages the state's economic vitality, the efficient use of energy resources and cost effective demand side management; and that is environmentally sound. 30 V.S.A. § 202a(1)
- To identify and evaluate on an ongoing basis, resources that will meet Vermont's energy service needs in accordance with the principles of least cost integrated planning; including efficiency, conservation and load management alternatives, wise use of renewable resources and environmentally sound energy supply. 30 V.S.A. § 202a(2)
- To promote the state energy policy established in § 202a of this title by:

  (1) Balancing the benefits, lifetime costs, and rates of the state's overall energy portfolio to ensure that to the greatest extent possible the economic benefits of renewable energy in the state flow to the Vermont economy in general, and to the rate paying citizens of the state in particular.

  (2) Supporting development of renewable energy and related planned energy industries in Vermont, in particular, while retaining and supporting existing renewable energy infrastructure.

  (3) Providing an incentive for the state's retail electricity providers to enter into affordable, long-term, stably priced renewable energy contracts that mitigate market price fluctuation for Vermonters.

  (4) Developing viable markets for renewable energy and energy efficiency projects.

(5) Protecting and promoting air and water quality by means of renewable energy programs.

(6) Contributing to reductions in global climate change and anticipating the impacts on the state's economy that might be caused by federal regulation designed to attain those reductions.

(7) Supporting and providing incentives for small, distributed renewable energy generation, including incentives that support locating such generation in areas that will provide benefit to the operation and management of the state's electric grid. 30 V.S.A. § 8001

The Department is also required to produce an Electric Plan per 30 V.S.A. § 202 Electrical Energy Planning, which states in part:

(b) The department shall prepare an electrical energy plan for the state. The plan shall be for a 20-year period and shall serve as a basis for state electrical energy policy. The electric energy plan shall be based on the principles of "least cost integrated planning" set out in and developed under section 218c of this title. The plan shall include at a minimum:

(1) An overview, looking 20 years ahead, of statewide growth and development as they relate to future requirements for electrical energy, including patterns of urban expansion, statewide and service area economic growth, shifts in transportation modes, modifications in housing types and design, conservation and other trends and factors which, as determined by the director, will significantly affect state electrical energy policy and programs;

(2) An assessment of all energy resources available to the state for electrical generation or to supply electrical power, including among others, fossil fuels, nuclear, hydro-electric, biomass, wind, fuel cells, and solar energy and strategies for minimizing the economic and environmental costs of energy supply, including the production of pollutants, by means of efficiency and emission improvements, fuel shifting, and other appropriate means;

(3) Estimates of the projected level of electrical energy demand;

(4) A detailed exposition, including capital requirements and the estimated cost to consumers, of how such demand shall be met based on the assumptions made in subdivision (1) of this subsection and the policies set out in subsection (c) of this section; and

(5) Specific strategies for reducing electric rates to the greatest extent possible in Vermont over the most immediate five-year period, for the next succeeding five-year period, and long-term sustainable strategies for achieving and maintaining the lowest possible electric rates over the full 20-year planning horizon consistent with the goal of maintaining a financially stable electric utility industry in Vermont.

(c) In developing the plan, the department shall take into account the protection of public health and safety; preservation of environmental quality; the potential for reduction of rates paid by all retail electricity customers; the potential for reduction of electrical demand through conservation, including alternative utility rate structures; use of load management technologies; efficiency of electrical usage; utilization of waste heat from generation; and utility assistance to consumers in energy conservation.

Meanwhile, the plan must also take into account complementary state policies set forth in other titles of our statutes that concern greenhouse gas emissions and energy:

- To reduce emissions of greenhouse gases from within the geographical boundaries of the state and those emissions outside the boundaries of the state that are caused by the use of energy in Vermont in order to make an appropriate contribution to achieving the regional goals of reducing emissions of greenhouse gases from the 1990 baseline by:

  (1) 25 percent by January 1, 2012;

  (2) 50 percent by January 1, 2028;

  (3) if practicable using reasonable efforts, 75 percent by January 1, 2050. 10 V.S.A. § 578(a)

- To produce 25 percent of the energy consumed within the state through the use of renewable energy sources, particularly from Vermont's farms and forests. 10 V.S.A. § 580(a)

- To increase energy efficiency of buildings

  (1) To improve substantially the energy fitness of at least 20 percent of the state's housing stock by 2017 (more than 60,000 housing units), and 25 percent of the state's housing stock by 2020 (approximately 80,000 housing units).

  (2) To reduce annual fuel needs and fuel bills by an average of 25 percent in the housing units served.

  (3) To reduce total fossil fuel consumption across all buildings by an additional one-half percent each year, leading to a total reduction of six percent annually by 2017 and 10 percent annually by 2025.

  (4) To save Vermont families and businesses a total of $1.5 billion on their fuel bills over the lifetimes of the improvements and measures installed between 2008 and 2017.

(5) To increase weatherization services to low income Vermonters by expanding the number of units weatherized, or the scope of services provided, or both, as revenue becomes available in the home weatherization assistance trust fund. 10 V.S.A. § 581.

We look to the Vermont statutes as our primary source of goals, but we also look to actions by state groups and groups at the regional level as sources of further direction. The Vermont Climate Cabinet and the Governor's Council on Energy and the Environment are two examples of state government groups that can provide valuable guidance for establishing a Comprehensive Energy Plan. At the regional level, we see helpful policy directions set out in the New England Governors' Renewable Energy Blueprint. The governors determined that the blueprint "would serve as a basis for a state–federal partnership to support the development of cost-effective, low-carbon, secure energy resources in or proximate to New England." The blueprint also lays out "a variety of ways a state–federal partnership can assist our efforts to simultaneously advance state and national energy goals."

Other sources of regional direction were the climate change commitments made in the New England Governors–Eastern Canadian Premiers Climate Change Action Plan adopted in August 2001, the Northeastern International Committee on Energy (NICE), the creation of the Regional Greenhouse Gas Registry (RGGR) by the Northeast States for Coordinated Air Use Management (NESCAUM), and the Regional Greenhouse Gas Initiative (RGGI), a cooperative effort by ten Northeast and mid-Atlantic states to design and participate in a regional cap and trade program covering carbon dioxide emissions from power plants in the region.

When setting forth our energy goals, we are also taking into account the mandates and policy directives of the federal government. The U.S. Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) issue joint rules to establish fuel economy and GHG standards for motor vehicles. Federal appliance standards are another area that directly impacts Vermont. Federal transmission reliability standards and transmission planning mandates also affect state energy policy. Finally, the DPS also reviews federal research and policy directives such as the Obama administration's *Blueprint for a Secure Energy Future* (released in March 2011) and the Department of Energy's *Quadrennial Technology Review* (released in September 2011). For a more thorough review of the state's energy terrain, see Appendix 1—Conceptual Map.

Vermont is not an island. Although we can set ambitious goals to move ourselves away from fossil fuels, for the health of our economy and our environment, we can reach these goals only if state policies align with the interests and initiatives of our private sector and of our national government. For example, the CEP calls for a significant increase in focus on transportation energy usage—but we will not successfully reach our transportation energy goals unless electric vehicles and biofuels truly take hold nationwide, conventional fuel standards are significantly improved, and transportation infrastructure funding is decoupled from petroleum usage. Nevertheless, we can and should set a direction for Vermont that moves toward a more sustainable future, while simultaneously advocating for private-sector and national government policy alignment.

1.3 Economic and Environmental Context

1.3.1 Energy and the Economy—Positioning Vermont for a Clean Energy Economy

The evolving renewable energy economy has the potential to fundamentally change our economic system, as did the Industrial Revolution and the development of the Internet. Jobs in clean energy and energy efficiency will become more prevalent in the decades to come. The private sector has already embarked on making changes in business practices to adapt to the changing economy, and is concerned about fuel availability and price volatility, the environment, and the effects on short- and long-term operating costs.

The public sector is helping to foster this changing economy. In order to help develop the green economy, President Obama has pledged to spend $150 billion over 10 years to create 5 million new green jobs. These funds will be used to advance the next generation of biofuels and fuel infrastructure, accelerate the commercialization of plug-in hybrids, promote development of commercial-scale renewable energy, and transition to a new digital electricity grid. Funding will also be used to invest in the nation's manufacturing workforce and manufacturing centers to ensure that American workers have the skills and tools they need to develop the green technologies that will be in high demand throughout the world.

The potential benefits to the economy are substantial. A study completed by the University of Tennessee found that if 25% of all American energy were produced from renewable sources by 2025, the country would generate about 5 million new jobs.[1]

Commitment to clean energy could also create more permanent and sustainable jobs. A recent study by the Political Economy Research Institute found that investments in "clean tech" yield roughly three times as many jobs per dollar as does spending the equivalent amount of money in the fossil fuel sectors.[2] About half of these jobs are expected to be available to low-credentialed workers.[3]

The significance of the emerging green economy is evident in the U.S. Department of Labor's interest in quantifying green jobs. The Bureau of Labor Statistics received funding beginning in Fiscal Year 2010 to collect new data on green jobs. These activities are being conducted through the Quarterly Census of Employment and Wages (QCEW) and Occupational Employment Statistics (OES) programs (BLS Green Jobs Initiative).

Vermont, too, has embraced the emerging green economy. In January 2010, a $4.8 million economic stimulus grant was awarded to the Central Vermont Community Action Council to train about 2,400 Vermonters under a

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[1] *"25% Renewable Energy for the United States by 2025: An Analysis on Jobs Created By Meeting This Goal"; Burton C. English, Jamey Menard, Kim Jensen, Chad Hellwinckel, and Daniel G. De La Torre Ungarte; 25 x '25: America's Energy Future, September 2011, p. 1,* www.25x25.org/storage/25x25/documents/Economic%20Analysis/utenn_jobs_analysis_of_25x25_goal_sept_11.pdf

[2] *The Economic Benefits of Investing in Clean Energy; Robert Pollin, James Heintz, and Heidi Garrett-Peltier; Dept. of Economics and Political Economic Research Institute, University of Massachusetts; June 2009, p. 30.*

[3] *Ibid., p. 38.*

green jobs program. The Vermont grant—one of 25 announced by the U.S. Department of Labor—was among the largest awarded under the $100 million Energy Training Partnership program. The awards ranged from $1.4 million to $5 million.

Vermont was also successful in obtaining $530,000 in federal funding for green jobs research. In November 2009, the U.S. Department of Labor announced that the Vermont Department of Labor, along with seven other states in a joint research consortium, had been awarded a $4 million grant to study the demand for green jobs in Vermont and the Northeast regional economy.

Thus, Vermont stands at a moment of substantial opportunity for continued jobs creation in the energy sector. The state is in a position to maintain leadership in the environmental arena through the mix of energy sources used by its residents and is showing others the path forward to reduced greenhouse gas emissions. We can and must keep this leadership position while maintaining a competitive cost profile. In leveraging our leadership position, we see a bright economic future for Vermonters working in the green energy sector as they export skills, expertise, and products to the rest of the country and the world.

Equally important to a green jobs economy is the effect that investments in efficiency can have on the economy in general. High energy costs act like a hidden tax on Vermonters, sapping cash flow from companies and citizens. Unlike a tax, however, most energy purchases have no offsetting beneficial expenditure in Vermont. These dollars are simply lost. High energy costs in the state compared with costs in other locations can also impair the competitiveness of Vermont firms, leading companies to invest elsewhere. Sensible investments made now in efficiency and conservation mean future cash will be available for more important things. In the meantime, those investments put Vermonters to work today, instead of sending money out of state. Investments in Vermont-based renewable energy will also lead us to better energy security, more in-state jobs, and reduced total energy costs for Vermonters, particularly as the price of fossil-based fuels rises and the price of renewable technologies decreases over time.

States are currently facing a broad need for infrastructure investments on all fronts, and, particularly in the follow-up to Tropical Storm Irene, Vermont is no exception: Roads, bridges, stormwater and wastewater systems, state buildings, and utility investments all need attention. Making the most of all our investments will support improving the quality of life of all Vermonters. Continued focus on energy conservation and efficiency in all sectors, on the sources of our energy, and on our energy infrastructure is critical. The technical lessons we learn will be a valuable export. The challenges are great and the requirements many, but the reward for tackling these tough problems will be tremendous and will reach all Vermonters.

1.3.2 The Vermont Economy and Baseline Economic Assumptions Underlying the 2011 CEP

1.3.2.1 National Economic Conditions

As the CEP is released, both national and state economic outlooks remain challenging. U.S. economic growth so far in 2011 has been slower than expected as labor market conditions have deteriorated again and unemployment has not eased. Household spending is flat, and the housing sector is depressed. Business investment in equipment and software is expanding, but investment in commercial real estate is weak.

Some of the weakness in economic activity may be related to temporary factors; these include the hit to household income from higher food and energy prices, and supply chain disruptions following the earthquake, tsunami, and nuclear disaster in Japan. Part of the situation stems more recently from the extensive weather-related damage to communities in 2011. Although these forces may abate, in the near term the expectation for the pace of recovery remains diminished. Despite an expected recovery period from the Great Recession of 2007–09, a long-term growth rate of real gross domestic product of only 2.6% is assumed in the CEP.

Inflation, always a wild card in long-term planning, is being driven in the near term by energy and commodity prices, prices of imported goods, and supply disruptions from Japan. A recent monetary policy report released by the Board of Governors of the Federal Reserve System commented, "The [Federal Open Market Committee] also anticipates that inflation will settle, over the coming quarters, at levels at or below those consistent with the Committee's dual mandate (promote full employment and price stability) as the effects of past energy and other commodity price increases dissipate further." [4] In accordance with this outlook, the CEP assumes a stable and low long-term inflation rate of 1.5% to 1.7%.

It is important to note that the CEP and its recommendations come at a time when the federal debt held by the public has surpassed $9 trillion (as of the end of Fiscal Year 2010), equal to 62% of GDP. The Congressional Budget Office projects under current law that debt held by the public will exceed $16 trillion by 2020, equal to nearly 70% of GDP, and that interest rates will rise. The combination of rising debt and rising interest rates is projected to cause net interest payments to approach nearly $800 billion, or 3.4% of GDP, by 2020.[5] Federal financing for activities recommended in the CEP will depend upon the ability to resolve the debt challenges facing the nation.

1.3.2.2 Vermont Economic Conditions

For Vermont, the outlook and baseline assumptions used for long-term planning are based largely on the regional macroeconomic forecast prepared by Moody's Analytics (http://www.economy.com/). On the basis of historical trends and the regional forecast, the CEP assumes Vermont real gross domestic product (GDP) will grow at an annual rate of approximately 2.1%, somewhat slower than the expected national rate of growth.[6]

Consistent with GDP growth, in the CEP, employment is assumed to grow by only 0.6% annually. The majority of job gains are expected in the state's service sector, whereas manufacturing is expected to decline at a rate of

[4] *Minutes of the Federal Open Market Committee, Board of Governors of the Federal Reserve System, Washington D.C., August 9, 2011.*

[5] *Federal Debt and Interest Costs, Congressional Budget Office,* www.cbo.gov/doc.cfm?index=11999&zzz=41471.

[6] *Regional Macroeconomic Forecast for Vermont and U.S., June 2010, Dec. 2010, Economy.com, Moody's Analytics, West Chester, PA.*

0.8%. Growth in the residential sector is limited by marginal gains in population and the number of households, both assumed to grow by 0.4% annually.[7] The assumptions for economic growth remain modest compared with historical trends because of modest national economic growth and a relatively high cost of living. However, the state has other economic planning processes and initiatives in place, along with a resilient business sector. It is possible the CEP will require revision because Vermont could begin to outperform the conservative economic assumptions used herein.

1.3.3 Energy and the Environment

Many of our environmental goals and challenges are directly affected by our energy decisions. Through the CEP, we have a unique opportunity to leverage our decisions about our energy future to simultaneously address both our energy goals and our goals for a healthier environment, including protection of Vermont's natural resources and working landscape.

If we think about the environmental challenges we face—air quality issues such as ozone pollution and climate change, water quality issues such as acid rain and mercury deposition, land use concerns such as conservation of our forests and farmland—all these challenges are either exacerbated or improved by our energy choices. By relying on more local and renewable sources of energy, we not only improve our energy security and independence, and improve Vermont's economy by keeping energy dollars local, but we also have the opportunity to make choices that keep our working landscape viable, preserve our natural resources, and encourage development patterns and transportation systems that reduce our overall need for energy.

No energy source is free of environmental impacts. We recognize that the choice to use more local renewable energy resources will affect our landscape and environment. We must balance those impacts with the benefits of renewable energy, and choose diverse energy sources at an appropriate scale to ensure that negative impacts are limited, and that the benefits of individual energy projects justify their environmental impacts. An emphasis on using a variety of local renewable sources, sustainably managed and located throughout the state, will assist greatly in reducing our carbon footprint; we will thus mitigate climate change while increasing our energy flexibility, strengthening our energy security, and stabilizing costs. By addressing all sectors of energy together—electricity, heating, transportation, and land use—the CEP lays out a pathway through which our energy future can be in harmony with our environmental goals and standards. Indeed, the CEP intends to leverage the advantages of Vermont's environment to answer its energy needs.

[7] *These assumptions were based on findings reported in the Economic Outlook & Revenue Forecast, July 2010, and updated in July 2011, by Kavett, Rockler & Associates, prepared for the State of Vermont & Legislative Joint Fiscal Committee, and the Vermont Economic Outlook, by Jeff B. Carr, Economic & Policy Resources, Williston, VT, presented at the New England Economic Partnership (NEEP) Conference(s), Fall 2009, Spring 2010, Fall 2010, Boston, MA, http://neepecon.org/Conferences.htm.*

1.3.4 Energy Choices and Carbon Reduction

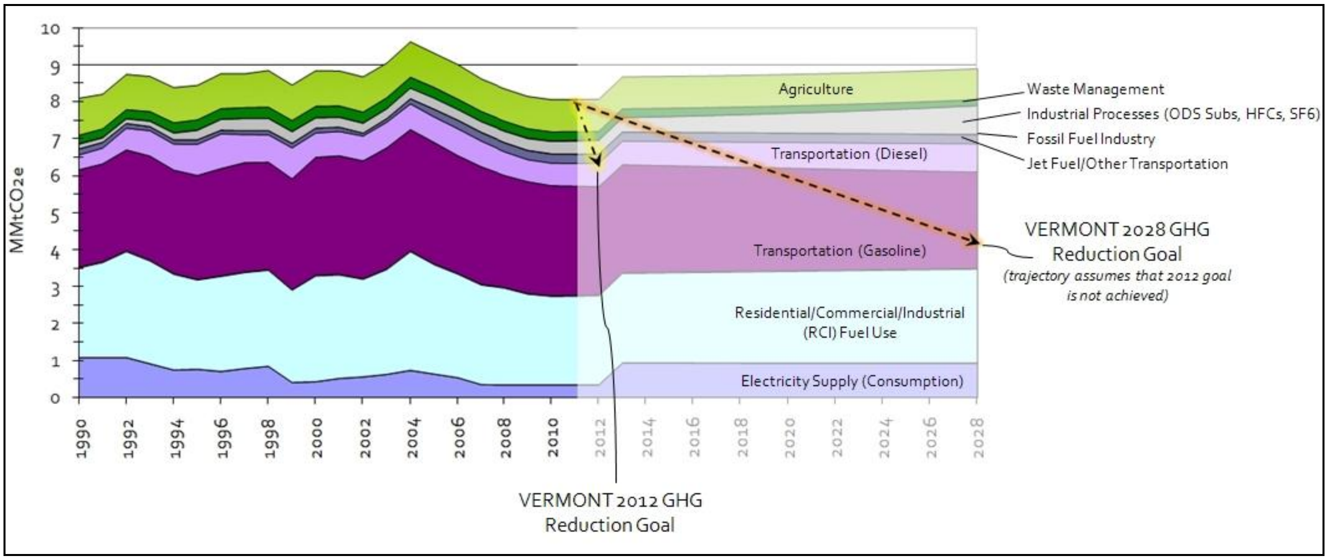
The CEP is intended to explore and delineate many of the choices that can help Vermont meet 90% of its energy needs with renewable sources by 2050. Appropriate steps taken toward this energy goal will also enhance Vermont's energy security, reduce environmental and health impacts, and enable Vermont to reach the greenhouse gas (GHG) emissions reduction goals previously established through executive order and state legislation.[8]

Our current energy demand relies heavily upon fuel combustion. The combustion of carbon-based fuels results in emissions in our atmosphere of air pollutants that degrade our environment and health, and GHGs (including carbon dioxide) that are altering our climate. Energy consumed for transportation, space heating, and electricity generation accounts for more than 80% of Vermont's statewide GHG emissions annually, and will continue to do so in the future if we do not make substantial changes to the way we generate and use energy (see Exhibit 1-1). Vermont has made progress in reducing GHG emissions; 2010 levels were approximately 13% lower than the 2004 emissions peak. However, it is apparent that Vermont will fall short of its 2012 goal of reducing GHG emissions to 25% below 1990 levels. Likewise, further steep emissions reductions will be required to meet the 2028 goal (50% below 1990 levels).[9] Fortunately, the choices we make now regarding our energy future can make a measurable difference, because not all fuels or technologies are created equal when it comes to their environmental impacts.

[8] *Vermont's GHG reduction goals were established under executive order #07-05 (see: www.anr.state.vt.us/anr/climatechange/Pubs/GCCC%20Appendix%201.pdf) and written into law by the Vermont Legislature as Act 168: AN ACT RELATING TO ESTABLISHING GREENHOUSE GAS REDUCTION GOALS AND A PLAN FOR MEETING THOSE GOALS (see: www.leg.state.vt.us/docs/legdoc.cfm?URL=/docs/2006/acts/ACT168.HTM).*

[9] *Vermont Greenhouse Gas Emission Inventory Update (1990-2008) (see: www.anr.state.vt.us/anr/climatechange/Vermont_Emissions.html).*

Exhibit 1-1. Vermont's Historical GHG Emissions, GHG Reduction Goals, and Draft Forecast of Future GHG Emissions



Source: ANR

Major reductions in our reliance on fossil fuels will not happen overnight. However, thoughtful use of energy (e.g., conservation, efficiency) coupled with greater reliance on existing clean renewable energy and efficiency technologies can bridge the gap in the short term as Vermont makes the necessary larger shifts in energy supply and infrastructure that are summarized in the CEP. The plan, in short, is to use more renewable sources of energy and fewer greenhouse gas–intensive sources, through a shift toward electric vehicles and renewable heating, among other strategies.

Vermont's comprehensive energy planning efforts also will help the state gain a more complete understanding of the true carbon footprint of its energy choices. To accomplish this, the state of Vermont intends to explore tools that will facilitate a more comprehensive accounting of life-cycle energy/carbon intensity in addition to the energy and emissions associated with the direct use of a particular fuel or technology. The ideal methodology would enable concurrent comparison of all attributes of our energy choices, including greenhouse gas emissions, other pollutant emissions, land-use changes, economic effects, etc., and would be universally accepted and applied. Current analysis methods (including those developed by the EPA, the state of California, and the European Union) focus on accounting of direct and indirect GHG emissions from particular fuel/feedstock pathways. These methodologies are not consistent with each other, particularly in the way they account for indirect emissions. There is also ongoing academic research in this field. The state of Vermont will continue to monitor developments in this area both independently and in conjunction with other states in the region, with the goal of adopting a methodology based on the latest scientific knowledge that can be used to evaluate a wide array of energy sources and rapidly evolving technologies. This effort will be consistent with the state's definition of "least cost" integrated resource planning as set forth in 30 V.S.A § 218(c).

Future energy demands will likely begin to put more pressure on Vermont's forests and farmland as a source for biomass and biofuels. As a result, careful consideration will need to be given to the underlying purposes of our forests, including ecosystem values such as wildlife habitat, air and water quality, forest health, recreation, wood products, food crops, etc. Biomass and biofuels can fill an important role as a local, renewable energy source. Done correctly, an improved biomass and biofuels market can enhance the sustainable management of our forests and farmlands, and help advance the underlying goals of those lands. With respect to carbon, it is important to keep in mind that the actual effect on the carbon cycle of increased biomass use (sequestration vs. emissions) can vary substantially depending on specific type of biomass fuel, its growth rates, growth and harvesting practices, transport distances, and the end uses of the fuel.

Given the clear link between our energy choices and GHG emissions, the CEP incorporates many of the conclusions and analyses put forth by the 2008 Governor's Commission on Climate Change (GCCC). The state of Vermont is also involved in numerous regional efforts that focus on the energy/carbon link. These efforts include participation in the Regional Greenhouse Gas Initiative (RGGI), as well as involvement in regional discussions regarding a potential low-carbon-fuels program designed to encourage the production and use of fuels with lower carbon intensity for transportation and perhaps other sectors.

1.3.5 Energy and Human Health

Energy planning as required by the Vermont Legislature must take into account the protection of public health and safety. This analysis includes consideration of both the direct and indirect impacts of energy choices on public health and safety. Energy for electricity, heating, cooling, and transportation directly impacts public health. Most forms of energy production, distribution, and use generate emissions that pass through the environment and contaminate the air, water supplies, and food chain. These environmental effects can, in turn, have adverse public health consequences, ranging from increased rates of asthma and cardiovascular disease associated with diminished air quality to increased rates of obesity and other diseases associated with reduced physical activity due to overreliance on motorized transportation.

Energy policies also can have indirect, sometimes unintended, impacts on public health and safety, both positive and negative. Certain energy policies and strategies deliver positive benefits to health. For example, encouraging Vermonters to walk or bike to work or school to reduce fossil fuel burning in transportation can have cardiovascular health and obesity prevention benefits, among others. In addition, improvements in population health, health-care delivery, and health outcomes are connected to economic development, which is also dependent on effective energy policies. Use of renewable sources over non-renewable sources can have positive air and water quality outcomes, enhancing human health. Negative consequences also can result from our energy choices. For example, herbicides used to maintain access to transmission lines can leach into groundwater and public and private water supplies, and can affect food supplies. Similarly, when natural gas is obtained by hydraulic fracturing ("fracking"), that process can have potentially harmful impacts on groundwater supplies.

The derivation of specific energy policies and the development of particular energy projects can have profound beneficial results for individuals and society as a whole. Neither should occur without recognition of potential adverse public health impacts. Public health assessments (PHAs), as described in Appendix 2—Public Health

Assessments, provide a framework for considering public health and safety in developing state energy policies and also in reviewing specific energy-related projects. A PHA need not be an excessive burden on policymakers and project managers. On the contrary, a PHA can identify positive health impacts as well as previously unrecognized costs and potential modifications and controls to minimize adverse health impacts. These costs may make another alternative more attractive or lead to further efforts that eliminate or minimize the costs to make the original alternative more cost-effective. The result can be increased protection of public health and safety in our energy planning and project approval processes. The Department of Health will work with the Department of Public Service, the Vermont Climate Cabinet, and other stakeholders to investigate how PHAs may be effectively integrated into energy planning and permitting.

1.4 The Approach to CEP Development and Public Engagement

The current Comprehensive Energy Plan is the result of intensive collaboration among state agencies coupled with substantial public involvement that began under the Shumlin administration in January 2011. Per the statutory mandate and the governor's request, the CEP represents the collective efforts of senior leaders and staff from state agencies and departments, as well as input submitted to the Department of Public Service from Vermont citizens and stakeholders. During the course of the CEP's development, the DPS received about 9,000 comments.

Many government and nonprofit organization documents were reviewed as part of the process, in addition to energy plans from a number of states, including California, Colorado, Delaware, Florida, New Jersey, New York, North Carolina, Oregon, Rhode Island, and Washington.

The Vermont Department of Public Service opened conversations with agency partners about the process, issues, policies, and programmatic cross-connections and opportunities for coordination. Vermont government partners included the Agency of Natural Resources; Agency of Transportation; Agency of Commerce; Agency of Agriculture, Food and Markets; Agency of Human Services; Agency of Administration; Department of Buildings and General Services; Department of Taxes; and Department of Health. These conversations continue as the agencies advise, plan, work with one another, and challenge one another's thinking on issues currently under consideration in state government.

In May 2011, Governor Shumlin formed the Vermont Climate Cabinet. (See Appendix 3—Executive Order, Vermont Climate Cabinet.) It is composed of the secretaries of the Agencies of Natural Resources; Administration; Agriculture, Food and Markets; Commerce and Community Development; and Transportation, as well as the commissioners of the Departments of Economic Development; Housing and Community Affairs; Buildings and General Services; and Public Service. This group will play a central role in implementation oversight as the CEP moves forward. Among the goals of the Vermont Climate Cabinet are:

- Identify strategies to reduce Vermonters' dependence on fossil fuels for transportation, and reduce greenhouse gas emissions by encouraging alternatively fueled vehicles and more efficient vehicle and mobility choices.

- Improve energy efficiency for existing and new buildings.
- Foster development of in-state renewable and sustainable energy sources.

To inform the CEP, in addition to drawing on DPS and other agency expertise, we engaged technical energy consulting services to provide various analytic supports, including modeling of energy variables (prices, supply, reliability, market impacts, etc.) under specific scenarios (see Appendix 4—Modeling Study); analysis of the Vermont decisional framework for energy policy (see Appendix 1—Conceptual Map); and analysis of the economic impact of energy efficiency investments (see Appendix 5—Economic Impacts of Energy Efficiency Investments).

1.4.1 Previous Participatory Planning (2007–08)

In response to concerns about the replacement of major power contracts and other energy issues, the DPS conducted a comprehensive, statewide public engagement process on energy planning in 2007 and 2008 with widespread opportunities for Vermonters to weigh in on energy-related decisions. The process was designed to educate the public about the energy supply challenges facing the state and to gather meaningful and informed public input about the values and preferences of Vermonters regarding energy supply. By doing so, the DPS aimed to foster a broader base of public support for the resulting choices. DPS worked with legislators and stakeholders to design the project. In the end, a series of proposals were selected that engaged the public through regional workshops, deliberative polling, and online conferences. An advisory committee for the project developed educational materials that provided a foundation for the discussions.

In the end, there was a high level of agreement on many issues across the three different processes (regional workshops, deliberative polling, and online surveys). Coal and oil were the least popular energy options. Among fossil fuel sources, natural gas enjoyed the greatest support. Nuclear energy from the Vermont Yankee facility was one of the most divisive issues, evoking both strong opposition and support among Vermonters.

Meanwhile, participants expressed broad support for sustainable resource options such as energy efficiency and renewable energy. Roughly 10% of Vermont's energy comes from in-state hydro resources, and roughly 5% from in-state biomass. Vermonters also continued to show strong support for purchases of clean electricity from sources outside Vermont, including large-scale hydro from Canada. Although affordability remained a concern, the majority of Vermonters who participated in the 2007 deliberative process indicated a willingness to pay something more for cleaner resources and for local economic opportunities.[10]

[10] *Information on the 2007-08 public engagement process can be found in the Public Review Draft 2011 Comprehensive Energy Plan, Appendix 4,* www.vtenergyplan.vermont.gov.

1.4.2 Public Process

To update its understanding from the 2007-08 process and to engage the public regarding the state's new planning efforts, the DPS designed a two-phase public engagement process. Phase I sought input on the crafting of the initial public review draft through mid-July 2011, and Phase II gathered input on the released draft itself.

Phase I began with public forums in March and April 2011. The first daylong event focused on energy supply and renewable energy; the second focused on transportation and land use–related energy issues. Each event featured topical presentations by state agency and department leaders. The gatherings attracted a wide range of stakeholders and members of the public who shared insights on goals, structure, priorities, and recommendations for the CEP.

On April 14, 2011, a joint public hearing of the Vermont House and Senate took place to engage citizens regarding the CEP. Subsequently, the DPS conducted additional stakeholder events and consultations in May and June to gain insight into the challenges and opportunities regarding energy, and to gather suggestions for how to move forward. These included meetings focused on renewable energy, energy efficiency, and biofuels. A separate meeting of the Biomass Energy Development Working Group established by the Vermont Legislature ("BioE") convened on June 14; stakeholders provided testimony at that meeting. Through June 2011, meetings organized in conjunction with the Vermont Natural Resources Council, Vermont Energy Climate Action Network (VECAN), and regional planning commissions provided more opportunities for Vermonters to learn about energy and share their perspectives on the CEP. These meetings were held in Montpelier (June 1), Springfield (June 9), Rutland (June 16), and Colchester (June 28).

Throughout Phase I, DPS also collected input from the public via e-mails, letters, and the CEP website (www.vtenergyplan.vermont.gov). The planning process resulted in comments representing a wide range of perspectives and suggestions that have informed the CEP. The approach has been to consider public input whether received verbally at public hearings or via e-mail and online comments. The role of public input not only has stimulated discussion in public forums and planning rooms, but also has influenced and shaped the outcome of the CEP.

The DPS began Phase II of the public engagement process with the release of the Public Review Draft 2011 CEP in September 2011 and created a formal public comment period. Five public hearings held around the state garnered detailed suggestions that DPS posted on the CEP website (www.vtenergyplan.vermont.gov). Meetings were held in Middlebury (September 27), Brattleboro (September 28), Rutland (September 29), Colchester (October 3), and Danville (October 6).

Throughout Phase II, the DPS collected and reviewed public comments obtained at the hearings and via e-mails, the CEP website, and U.S. mail. As in Phase I, the public input process stimulated consideration of the many significant factors that affect energy production and usage. Due to the demand from stakeholders for additional time to review the extensive plan, and the need for staff to digest the volume of comments, the DPS extended the comment period to November 4, 2011.

By the close of the Phase II comment period, the DPS had received additional comments that brought the total number of comments received for the 2011 plan to about 9,000. This final version of the CEP therefore represents the culmination of input by dozens of Vermont state agency staff along with that of thousands of Vermonters. The final document includes specific ideas and recommendations that surfaced during the comment period. A summary document reflecting the themes and areas of frequent comment received during the public comment period is available through the CEP website.

1.5 What the CEP Does Not Do

The CEP is a forward-looking document, but it is not intended to address all issues. The CEP does not prescribe outcomes or make recommendations for specific pending projects. It also does not analyze the continued operation of Vermont Yankee, regarding which a case is pending in federal court as the CEP is released, or other specific projects that are pending before the Vermont Public Service Board.

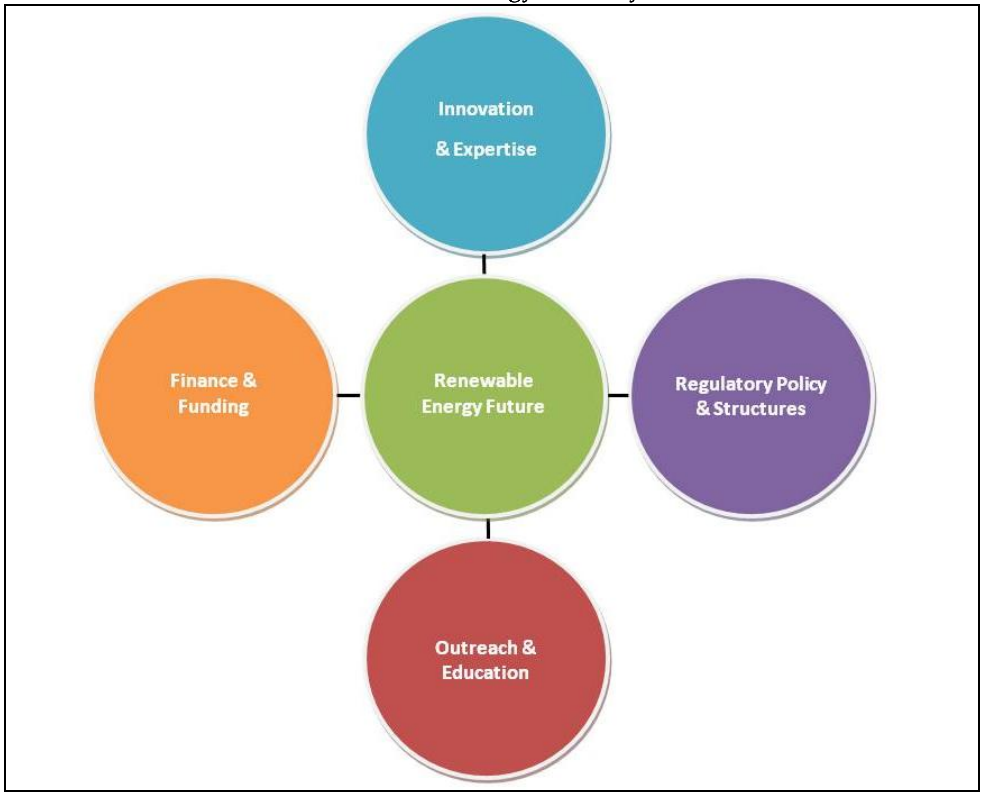
The CEP also does not presume to know all the choices Vermont will make to reach the goals set forth herein, or the exact timeline in which some will be achieved, although a recommendations matrix will be presented along with the CEP. For example, although the CEP sets forth models for a high-renewables and high-efficiency electric portfolio, it is the precise mix of resources actually built or contracted by our utilities over time that ultimately will dictate cost and GHG emission profile. The CEP also does not present a thorough load analysis of plug-in electric vehicle penetration, because the DPS judged the data not yet robust enough to allow for anything more than the identification of the need to conduct further load analysis as such vehicles take hold in Vermont.

1.6 Organization of the 2011 CEP

The result of this extensive planning work is this Comprehensive Energy Plan 2011, which includes two volumes. *Volume 1: Vermont's Energy Future* summarizes the current energy picture and lays out the CEP's goals and vision for the future; *Volume 2: Facts, Analysis, and Recommendations* (this document) contains the details behind the recommended goals, initiatives, and key programs as they relate to electricity, thermal and process fuels, and transportation and land use. Volume 2 encompasses 10 sections that are organized by topic, and provides background on history and current use, as well as supply and demand issues, for particular forms of energy, along with analysis and recommendations. The CEP concludes with a set of supporting appendixes.

Energy efficiency and conservation emerge as the central policy focus, as they apply directly to all forms of energy use, including electricity, thermal energy, process fuels, transportation, and land use. The CEP also focuses on greater use of renewable energy in all sectors to help ensure energy independence and environmental sustainability. Recommendations address state implementation actions, regulation, legislation, and other public and private actions. They suggest policies, strategies, and tools based on four key drivers of the renewable energy future: Innovation & Expertise, Regulatory Policy & Structures, Outreach & Education, and Finance & Funding (see Exhibit 1-2).

Exhibit 1-2. Four Drivers for the Green Energy Economy



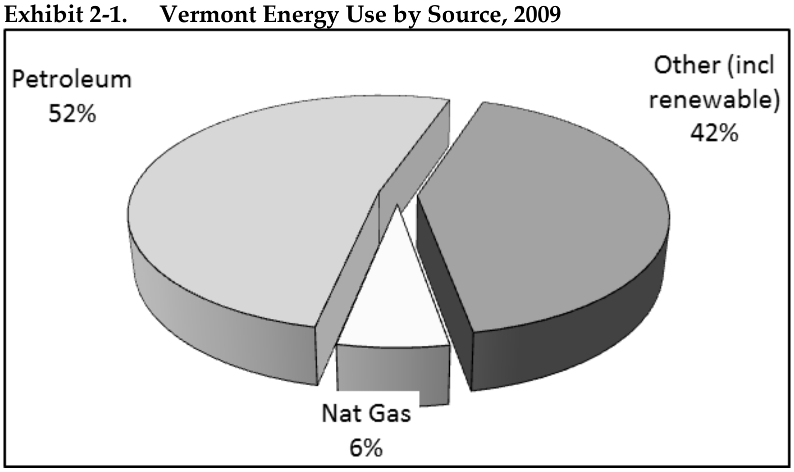
Events involving energy and the environment change monthly, and sometimes even more frequently. This being the case, the CEP must be responsive to the changes that are taking place. Sectors that were formerly quite distinct are beginning to converge (e.g., electricity and transportation). The DPS has therefore integrated the Electric Plan required under 30 V.S.A. § 202 with this CEP. Going forward, DPS recommends updating the CEP regularly and routinely, and on a cycle that matches other mandated state planning, such as the State Agency Energy Plan. In addition, the DPS intends to work closely with the newly formed Vermont Climate Cabinet, which will become the steward of the CEP, responsible for tracking execution of the CEP's elements that lie within the executive branch. The Vermont Climate Cabinet is also investigating the best strategies for assisting implementation elsewhere, through engagement of the many private, nonprofit, and community groups deeply involved in and concerned with energy policy here in Vermont.

2 Overview of Energy Supply and Demand

2.1 Synopsis of Usage and Trends

The Comprehensive Energy Plan (CEP) for 2011 is based on historic patterns, economic and demographic trends, and current energy policy. Section 2 presents an overview of total energy supply and demand in Vermont, with future projections that assume current laws and regulations remain unchanged throughout the projections. This presents a "business as usual" energy picture for Vermont, which forms a framework for recommendations set forth in other sections. Thus, Section 2 serves as a starting point for the analysis of potential changes in Vermont energy policies that would achieve the CEP's goals. The energy statistics and projections contained herein cover all forms of energy use—electricity, thermal and process fuels, and transportation.

Exhibit 2-1. Vermont Energy Use by Source, 2009



Source: EIA

In 2009, the most recent year for which data was available from the U.S. Department of Energy's Energy Information Agency (EIA), 52% of Vermont's energy use was met by petroleum-based fuels. Natural gas consumption, which is constrained by pipeline infrastructure, provided 6% of overall energy use. Other energy sources, which included nuclear energy and all renewable energy sources (hydro, biomass, wind, and solar) accounted for the remaining 42% of Vermont's energy supply.

Demand for energy in Vermont is driven largely by the size and growth of the population, the growth and structure of the state's economy, and the transportation patterns of both Vermonters and visitors to the state.

Overall energy demand grew to 158.1 trillion Btu (British thermal units) in 2009 from 135.4 trillion Btu in 1990, a 17% increase. Meanwhile, the leading drivers of energy demand—real gross domestic product, population, and vehicle miles driven—grew by 51%,[11] 10%,[12] and 31%,[13] respectively.

[11] *Source: U.S. Bureau of Economic Analysis*

During this 19-year period, changes in annual energy use ranged from a drop of 4.9% during the recession year of 1990 to an increase of 8.7% in 2004, a year of above-average economic growth.

Exhibit 2-2. Total Energy Consumption, Vermont

Period	Total Btu	% Chg		Period	Total Btu	% Chg
1990	135.4	-4.90%		2000	164.3	3.1%
1991	141.3	4.40%		2001	161.8	-1.5%
1992	149.1	5.50%		2002	157.2	-2.8%
1993	149.7	0.40%		2003	155.3	-1.2%
1994	149.1	-0.40%		2004	168.8	8.7%
1995	149.8	0.50%		2005	169.6	0.5%
1996	155.7	3.90%		2006	166.2	-2.0%
1997	161.4	3.70%		2007	165.5	-0.4%
1998	154.1	-4.50%		2008	158.3	-4.4%
1999	159.3	3.40%		2009	158.1	-0.1%

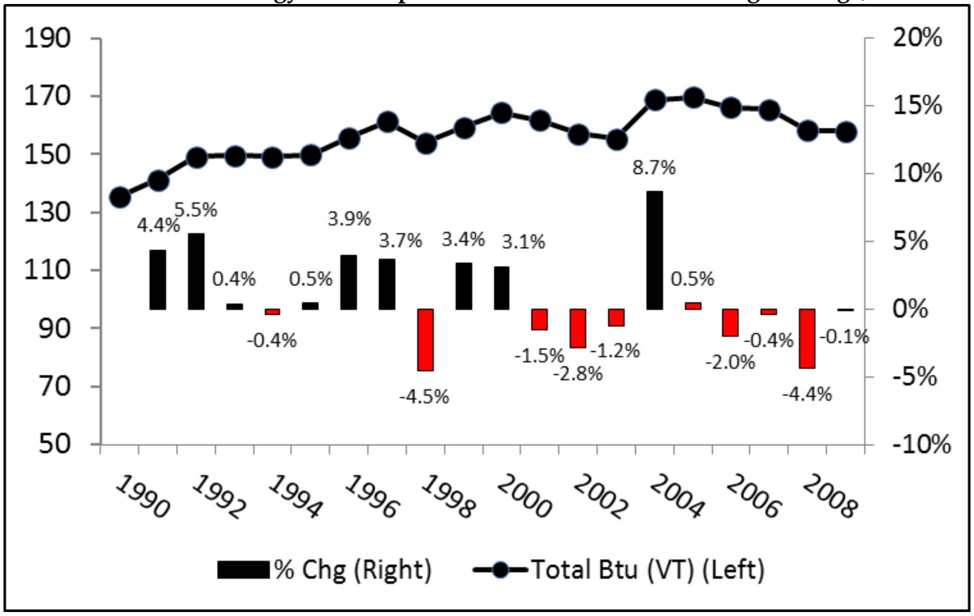
Source: EIA

Exhibit 2-3 illustrates the recent trend in Vermont energy use along with the annual percentage change. Energy demand increased at a 1.8% rate of growth from 1990 to 1999, but has been close to 0% for the past 10 years. The likely combination of state energy efficiency programs and the 2007–09 recession impacted energy demand across most end-use sectors.

[12] *Source: U.S. Census*

[13] *Source: VTrans Climate Change Action Plan, 2008, and U.S. Bureau of Transportation Statistics*

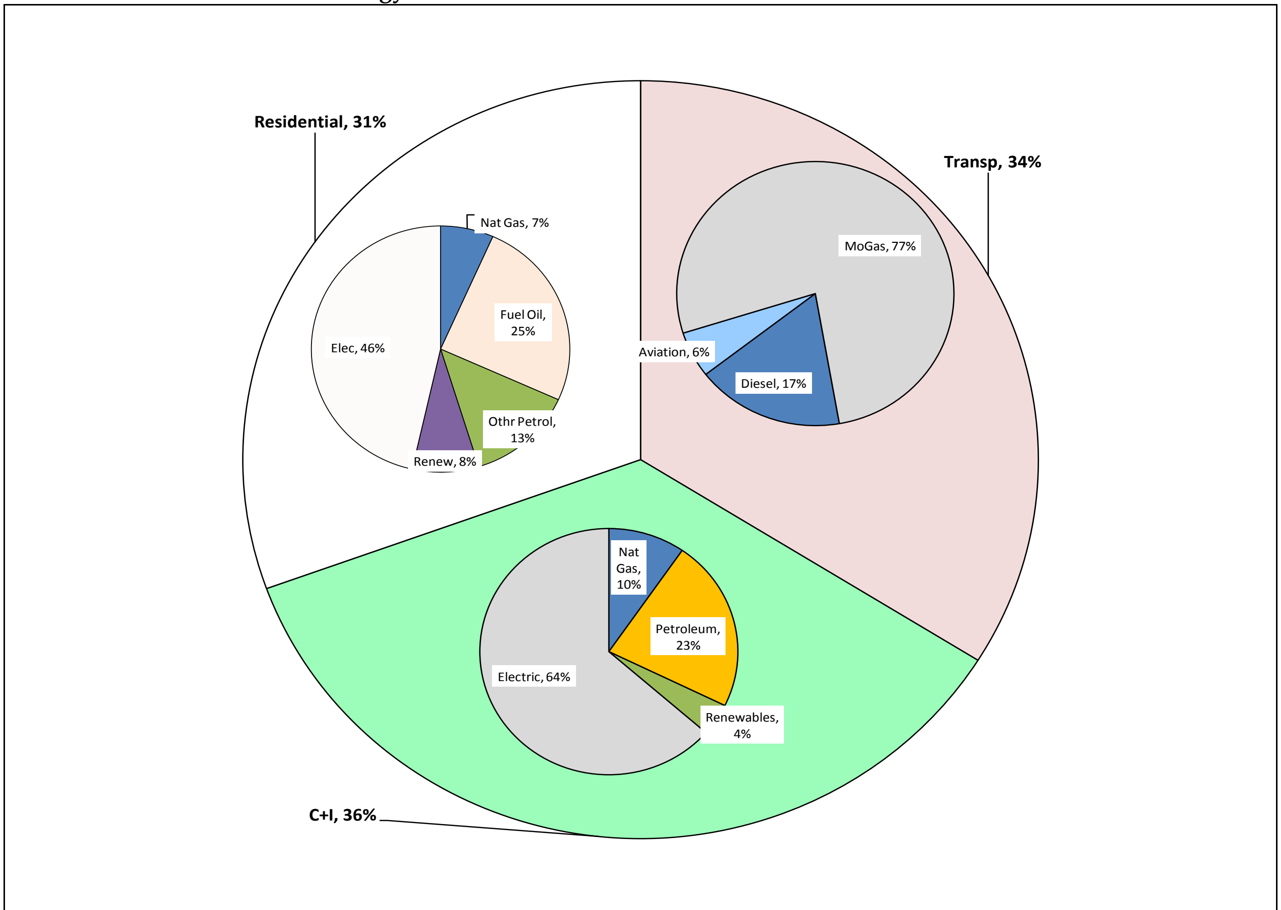
Exhibit 2-3. Total Energy Consumption (Btu in Trillions) Percentage Change, Vermont



Source: EIA

By 2009, Vermont's commercial and industrial sector consumed 36.5% of the state's total energy, transportation (all sources) consumed 34.5%, and households consumed 31%. Exhibit 2-4 below provides a general overview of the distribution of energy use within each end-use sector. Note that electricity, the largest source of energy use in the residential and commercial/industrial sectors, includes power generated by renewable sources, even though those resources are not separately delineated in the exhibit.

Exhibit 2-4. End-use Sector Energy Use

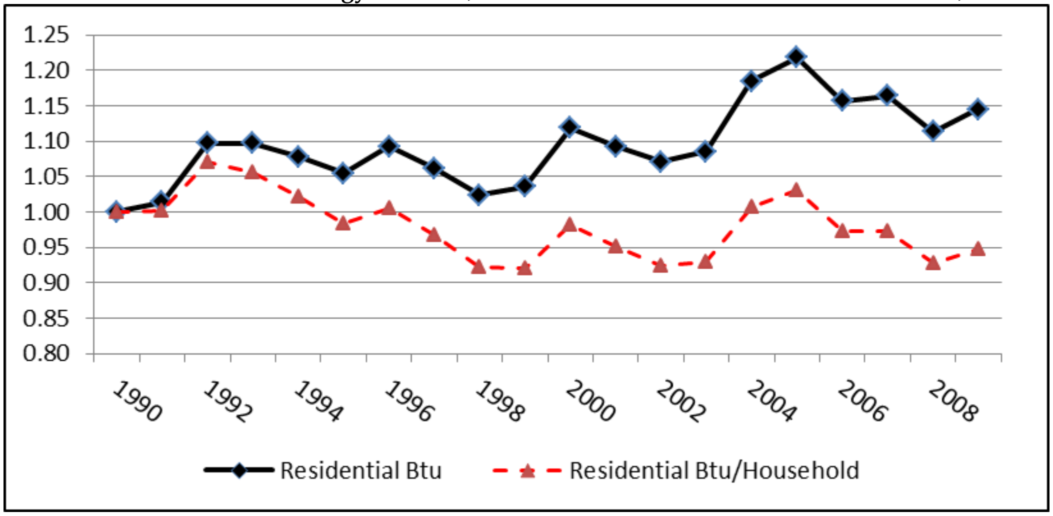


Source: EIA, State Energy Data System

Since 1990, Vermont energy demand has increased in each end-use sector of the economy (residential, commercial and industrial, and transportation), but there have been significant differences in growth among sectors. The commercial and industrial sectors, which are combined above, are described out separately in the discussion below.

> **Residential**—Residential energy demand has increased a total of 14% since 1990, a growth rate of only 0.7% per year despite the net increase in households. Notable is the declining trend in residential energy demand per household; demand has declined 0.28% annually since 1990.

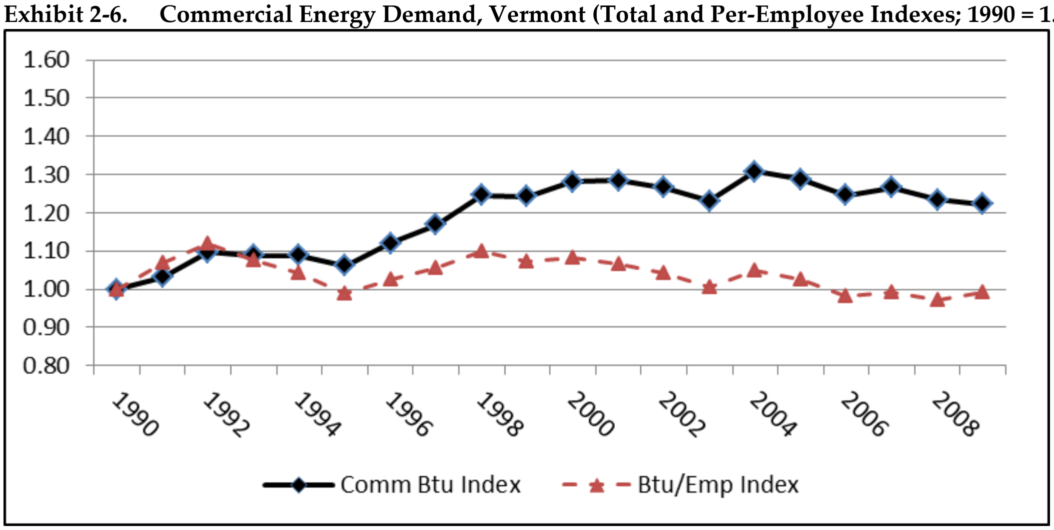
Exhibit 2-5. Residential Energy Demand, Vermont (Total and Per-Household Indexes; 1990 = 1.00)



Source: EIA State Energy Data System and U.S. Bureau of the Census

Commercial—Commercial energy demand increased by 22% between 1990 and 2009, or 1.07% per year. This increase can be attributed largely to economic expansion in Vermont's service sector, business and professional services, and travel and tourism sectors. On a per-employee basis, using employment in the non-agricultural, non-manufacturing sector, the trend in energy demand was slightly negative, –0.4%, between 1990 and 2009.

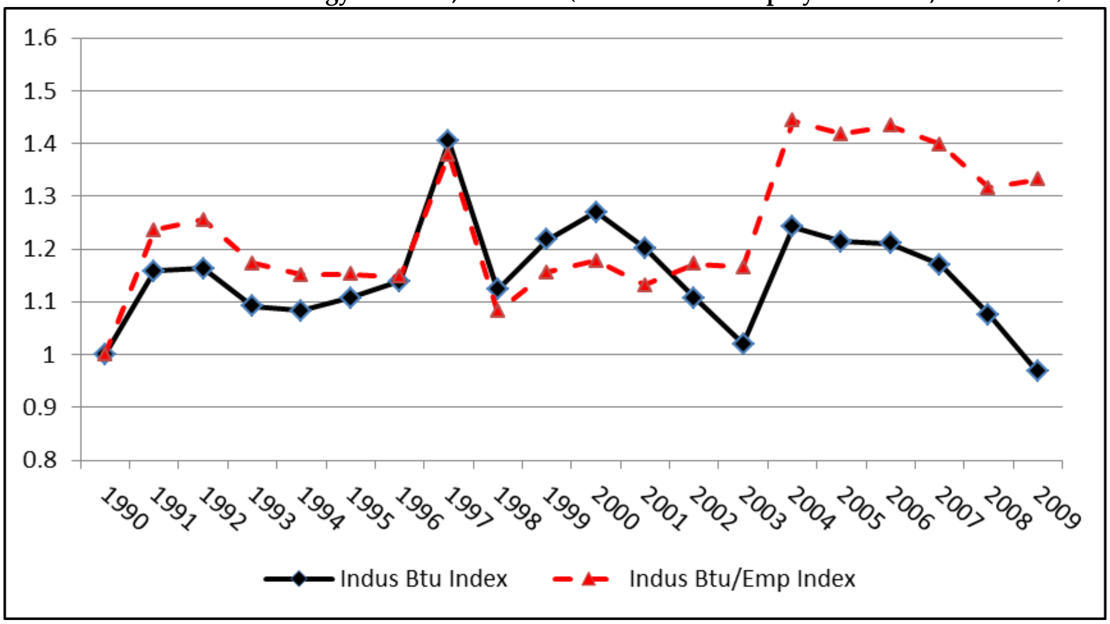
Exhibit 2-6. Commercial Energy Demand, Vermont (Total and Per-Employee Indexes; 1990 = 1.00)



Source: EIA, BLS, U.S. Dept. of Labor

Industrial—Energy demand in the industrial sector has decreased 3.2% since 1990, or –0.2% per year, with most of the decline occurring in the 2007–09 recession years. The absolute decline in energy demand coincided with declines in the number of establishments and industrial employment (manufacturing and mining). Energy demand per industrial employee has increased 1.5% annually since 1990, perhaps a reflection of increased output and productivity per existing employee.

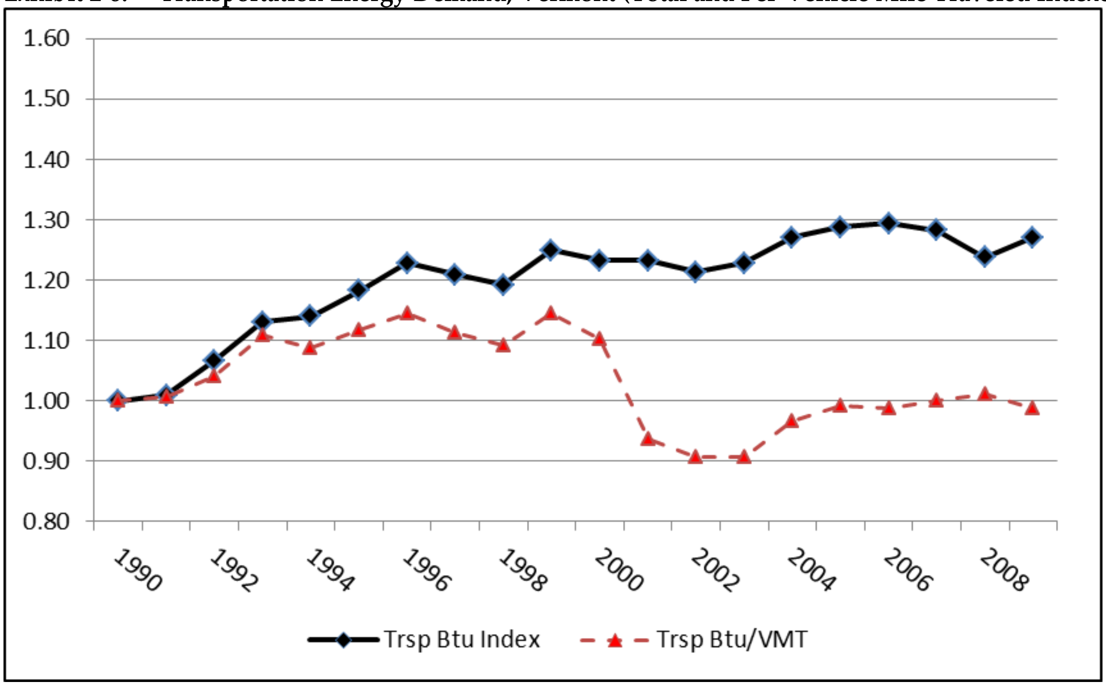
Exhibit 2-7. Industrial Energy Demand, Vermont (Total and Per-Employee Indexes; 1990 = 1.00)



Source: EIA, BLS, U.S. Dept. of Labor

Transportation—The transportation sector posted the largest increase in state energy demand, increasing 27% between 1990 and 2009. Growing at 1.3% per annum, the transportation sector is Vermont's fastest-growing end-use energy sector. Transportation-sector energy use is determined by vehicle miles traveled by residents, businesspeople, visitors to the state, and those driving through the state, as well as by aircraft travel demand. Section 9 of the CEP (Transportation and Land Use) will explore in some depth the mix and distribution of travel energy consumption.

Exhibit 2-8. Transportation Energy Demand, Vermont (Total and Per-Vehicle Mile Traveled Indexes; 1990 = 1.00)



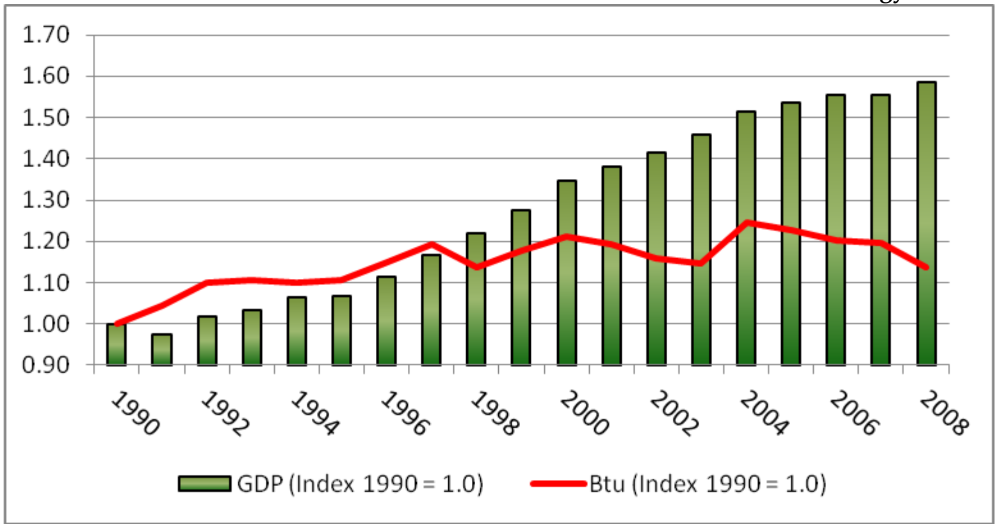
Source: EIA, VTrans

2.1.1 Energy Intensity

How efficient is the state of Vermont in producing goods and services with its limited energy resources? That is, how much energy is consumed in the process of generating the state's gross domestic product (GDP), and how has the energy content changed over time?

Vermont inflation-adjusted economic growth (Real GDP, 2005 dollars) increased 51% between 1990 and 2009. Additional employment, industrial output, and higher wages typically increase the demand for energy resources. However, the Vermont economy has been able to accommodate additional (real) economic growth with relatively less energy input. Over the same period of time, energy consumption for all end uses increased by only 17%. Exhibit 2-9 illustrates the gap between Vermont real GDP growth and the total consumption of energy (in Btu).

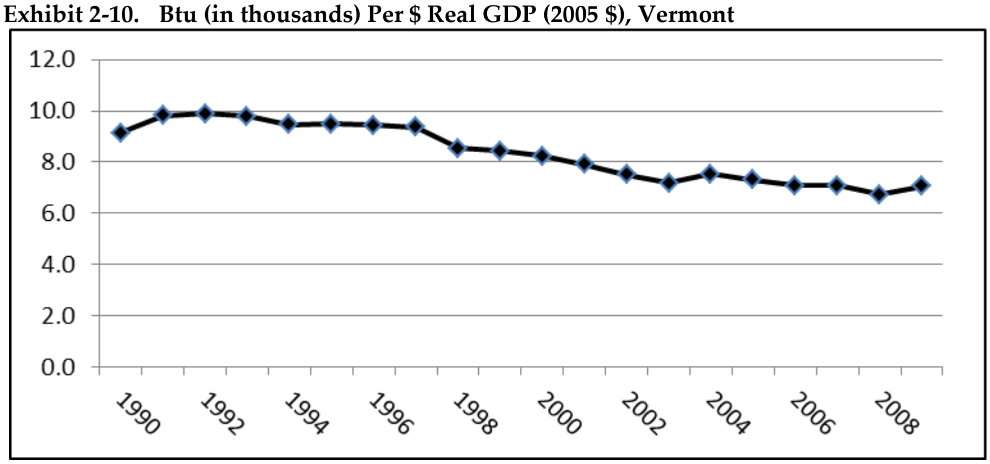
Exhibit 2-9. Index of Vermont Gross Domestic Product (2005 $) and Total Energy Consumption (Btu), 1990–2009



Source: EIA, Bureau of Economic Analysis, U.S. Dept. of Commerce

In 1990, Vermont consumed 9,100 Btu to generate $1 of GDP. By 2009, that dollar of goods and services consumed only 7,000 Btu. This amounted to an annual decline of 1.4% in energy intensity (see Exhibit 2-10).

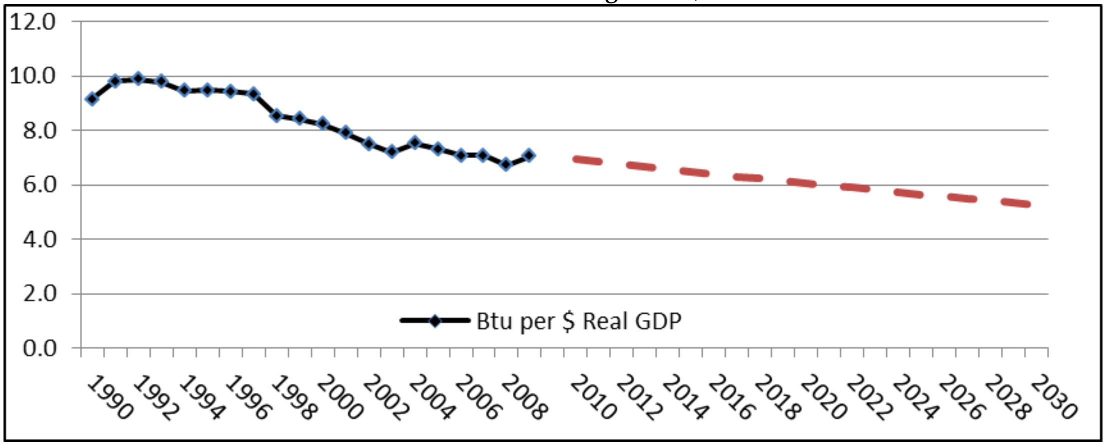
Exhibit 2-10. Btu (in thousands) Per $ Real GDP (2005 $), Vermont



Source: EIA, Bureau of Economic Analysis, U.S. Dept. of Commerce

A baseline target for the 2011 Comprehensive Energy Plan would simply extend the historic pattern of energy intensity through 2030 (as illustrated in Exhibit 2-11). Based on current economic forecasts, the straight-line projection implies that Vermont's inflation-adjusted GDP could grow by 60% by 2030 with only a 20% growth in total Btu energy consumption over that same time period.

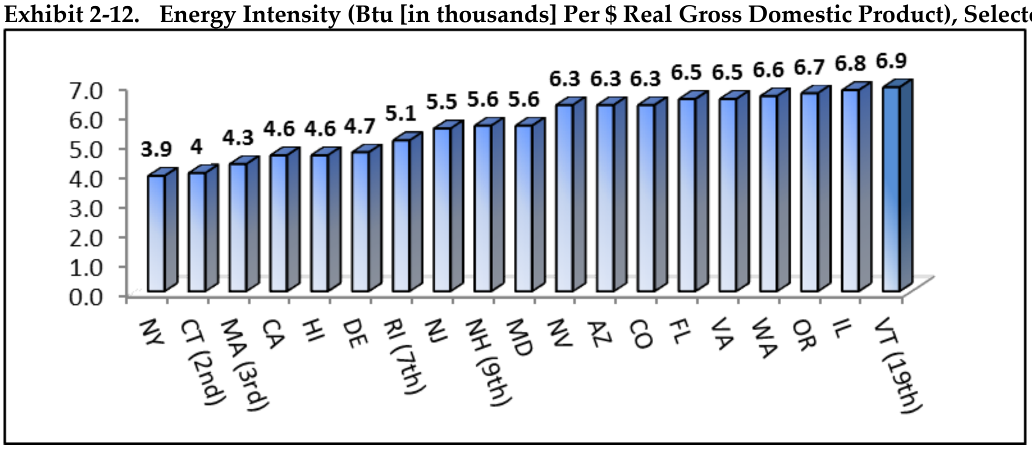
Exhibit 2-11. Btu (in thousands) Per $ Real GDP (through 2030), Vermont



Source: DPS projection

Compared to other states, Vermont ranked 19th in energy intensity in 2009; that is, it consumed fewer Btu per dollar of GDP than 31 other states. However, within the New England region, Vermont ranked behind Connecticut (which was second nationally), Massachusetts (third), Rhode Island (seventh), and New Hampshire (ninth).

Exhibit 2-12. Energy Intensity (Btu [in thousands] Per $ Real Gross Domestic Product), Selected States, 2009



Source: EIA

2.2 The Cost of Energy

The cost of energy to Vermont end users is profiled below. In 2009, the latest complete year for which data is available, Vermont households and businesses spent $2.5 billion on all forms of energy. The exhibit below breaks down the state's energy bill. Purchases of primary energy (liquid, gaseous, or solid fuels) totaled $1.95 billion, the largest share of which was for transportation fuels. Retail electricity consumers spent an additional

$700 million on electricity. Approximately $151 million worth of the primary energy was used to generate electricity, so that value is subtracted to avoid double counting.[14]

Total Energy Expenditures (in millions of $), Vermont, 2009

Primary Energy	+	Electric Power	+	Retail Electricity	=	Total Energy $
$1,952.20		($151.60)		$701.10		$2,501.70

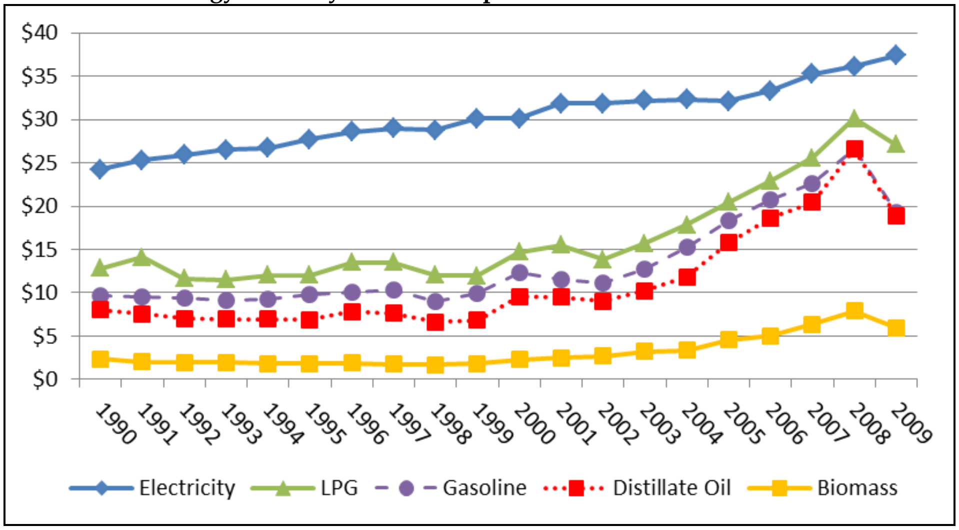
It is important to note that even within a small state like Vermont, a single average price may have limited meaning in that it represents a consumption-weighted average across the state. For example, utility-specific retail electricity prices can vary significantly from a state's weighted average.

2.2.1 The Energy Price and Expenditure Burden

Even though energy is a basic economic resource, prices still influence demand and end-use consumption. Exhibit 2-13 compares over time the price per million Btu for typical Vermont fuel sources. Electricity has been, and remains, the highest absolute priced energy source, followed by petroleum sources (LPG, distillates, gasoline) and biomass.

[14] *Energy expenditures are adjusted to remove quantities of process fuel and intermediate products used in the industrial and transportation sectors that are not purchased directly by end users. Electricity exports are also excluded from the totals. Hydroelectric, geothermal, wind, and solar energy sources are removed from primary energy expenditure calculations because there are no direct fuel costs for those energy sources. Consumption of wood in the residential sector and wood and waste consumption in the industrial and commercial sectors are adjusted to remove estimated quantities that were obtained at no cost. All expenditures are consumer expenditures; that is, they represent estimates of money spent directly by consumers to purchase energy, generally including taxes.*

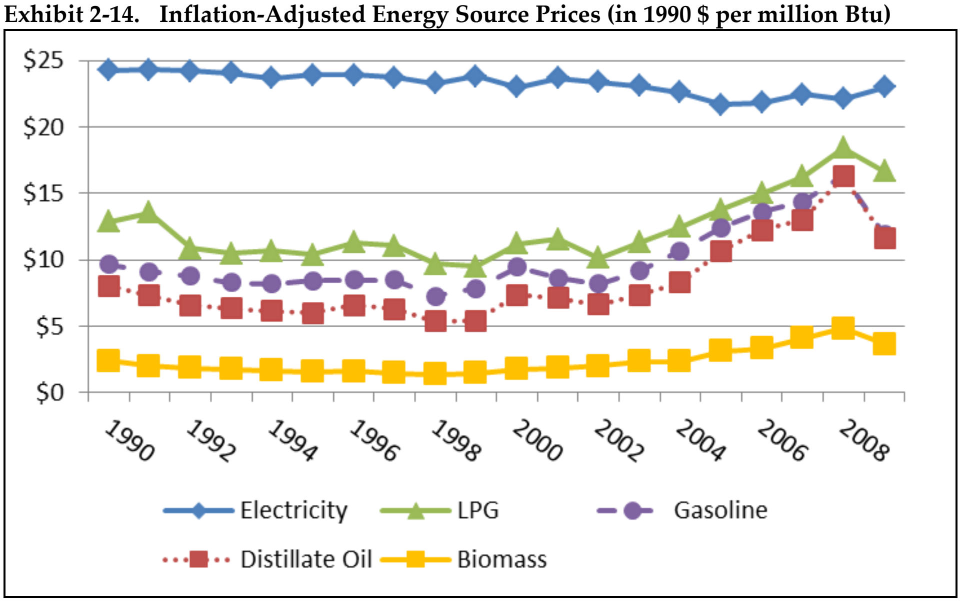
Exhibit 2-13. Energy Prices by Source (in $ per million Btu)



Source: EIA

If we adjust Vermont energy source prices for inflation (using the U.S. Consumer Price Index), the price of electricity has declined at an annual rate of 0.3% since 1990—that is, the price of electricity has increased less than the typical consumer basket of goods measured by the CPI. Meanwhile, after accounting for inflation, distillate fuel costs have increased at an average annual rate of 1.9%, gasoline has increased 1.0% annually, and biomass has increased 1.7% annually.

Exhibit 2-14. Inflation-Adjusted Energy Source Prices (in 1990 $ per million Btu)



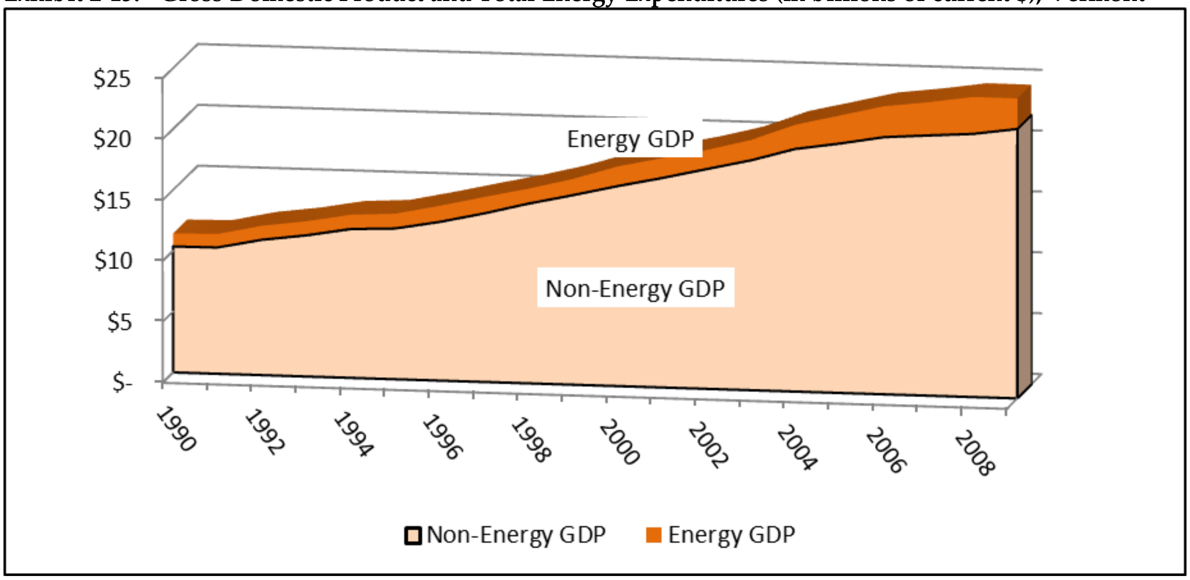
Source: EIA, DPS calculation

Annual Growth Rate of Inflation-Adjusted Energy Source Prices, 1990–2009

Energy Source	% Growth Rate
Biomass	1.7
LPG	1.3
Gasoline	1.0
Distillate Oil	1.9
Electricity	–0.3

Directly or indirectly, the cost of energy is related to the size and growth of the Vermont economy, which approached $25 billion in 2009. Overall, approximately 10% of Vermont's GDP was consumed by the energy sector. Exhibit 2-15 below illustrates the growing share of the cost of energy. The share of state GDP attributed to energy rose to 10.4% in 2009 from 9.4% in 1990. As can be seen in the previous exhibits, this increase is attributable to the cost of energy sources other than electricity.

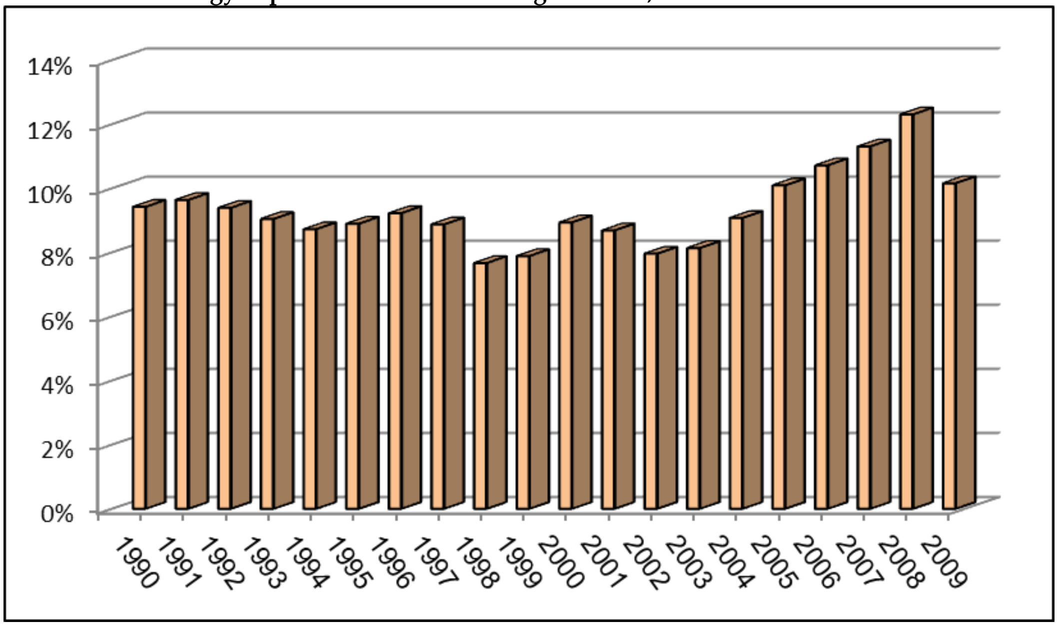
Exhibit 2-15. Gross Domestic Product and Total Energy Expenditures (in billions of current $), Vermont



Source: EIA and the U.S. Bureau of Economic Analysis

Since 1990, the cost of energy has averaged 9.3% of Vermont's GDP. However, the energy share of Vermont GDP has generally increased since 2002. In 2008, the spike in oil prices increased the state's energy bill to 12.3% of GDP, a 20-year high. In 2009, the combination of recession, conservation, and lower oil prices reduced the cost of energy to 10.2% of Vermont GDP.

Exhibit 2-16. Energy Expenditures as a Percentage of GDP, Vermont



Source: EIA, Bureau of Economic Analysis, U.S. Dept. of Commerce

Total Vermont energy expenditures by end use in 2009 are cited in Exhibit 2-17. The residential sector accounted for 33%, Vermont employers (commercial and industrial consumers) accounted for 26%, and transportation (all modes) accounted for the remaining 41% of the total energy bill.

Exhibit 2-17. Total Energy Expenditures (in billions of $) by End Use, 2009

End Use	Expenditure	
Transportation	$1,018.80	41%
Residential	$814.70	33%
Commercial	$431.40	17%
Industrial	$236.80	9%
Vermont	***$2,501.70***	***100%***

Source: EIA

3 Vermont's Current and Future Electric Sector

3.1 Overview of Sections 3, 4, and 5

Sections 3, 4, and 5 of the Comprehensive Energy Plan (CEP) address Vermont's electricity needs and the resources available to meet them. The discussion in these sections sets the stage for policy recommendations that incorporate both supply-side and demand-side resources for our electricity needs. The CEP recognizes the significant economic and environmental benefits of energy efficiency, conservation, and renewable energy sources, while seeking diverse sources of electricity production, ensuring grid reliability, and maintaining least-cost integrated resource planning principles.

Section 3 contains an overview of electric usage and demand, explains the electric dispatch modeling scenarios compiled for the CEP, and summarizes the economic modeling that was completed on the basis of that forecast power modeling. Two approaches work together to meet the state's projected electricity demand: efficiency and new supply. Section 4 addresses the state's electric energy efficiency resource and discusses current and future efficiency programs and policies, including tools to tap this resource and maximize its economic benefit. Section 5 discusses the sources of our current electric supply, the technologies available to harness supply resources, and tools and policies to cost-effectively advance the desired supply portfolio.

Pursuant to 30 V.S.A. § 202, the Department of Public Service (DPS) is assigned to serve as the state's electric utility planning agency, ensuring utility service at least cost to ratepayers when implementing other public policies of the state. Sections 3, 4, and 5 embody the requirements of 30 V.S.A. § 202 and function as the Vermont 20-Year Electric Plan. The Electric Plan serves as a basis for state electric energy policy. It is based on the principles of least-cost integrated planning, as defined in Vermont statute at 30 V.S.A. § 218c(a)(1). The Electric Plan includes a 20-year outlook, an assessment of all energy resources available to the state for electricity generation or to supply electric power, estimates of electric energy demand, and specific strategies for reducing electric rates. The Electric Plan also considers protection of public health and safety and preservation of environmental quality, among other objectives.

It is important to note that since enactment of 30 V.S.A. § 202, regional electric markets have restructured, and electricity is now sold in a regionally competitive market. Moreover, the Vermont Legislature has directed all utilities to perform individual Integrated Resource Plans (IRPs), reviewed by the DPS and approved by the Public Service Board (PSB), which are required to plan to meet customers' needs for energy services "at the lowest present value life cycle cost, including environmental and economic costs …" (30 V.S.A. § 218(c)). Although the Electric Plan continues to guide and inform utility planning, the IRP model and regional electric market have, in many respects, altered the need for a statewide electric plan as it originally existed.

3.2 Historic and Current Demand and Prices

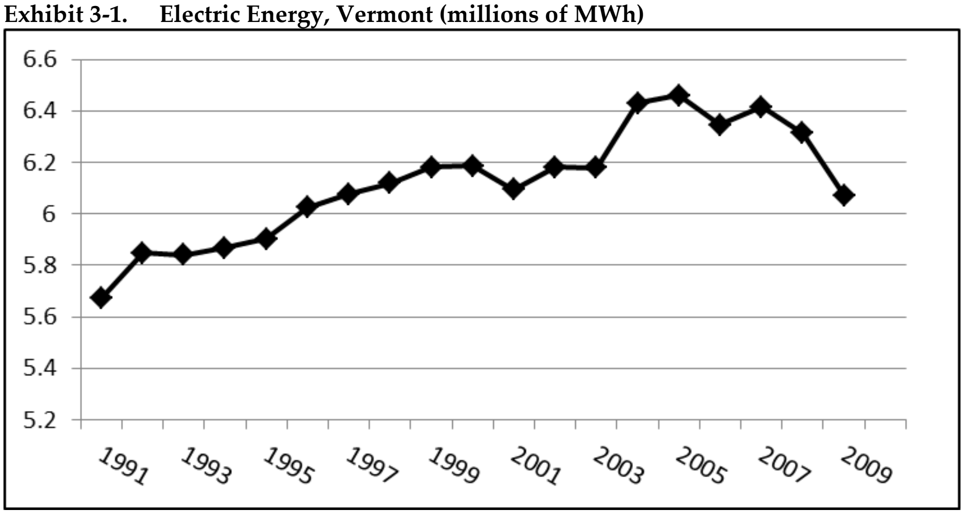
3.2.1 Global and U.S. Electricity Demand

Electricity is the world’s fastest-growing form of end-use energy consumption. The Energy Information Administration (EIA) expects global net electric energy demand to grow by an average of 1.6% per year through 2035. In developing countries, where electricity demand is expected to grow at an average of 2.3% per year, the growth is linked to rising standards of living: increased demand for home appliances and the expansion of commercial services, including hospitals, office buildings, and shopping malls. In developed nations, where infrastructures are more mature and population growth is relatively slow, growth in electric demand is expected to be much slower, averaging 0.6% per year to 2035.[15] The 2011 Annual Energy Outlook (AEO) from the EIA[16] projects U.S. electricity use to grow by 1% per year (on average) through 2035.

3.2.2 Vermont Electric Demand

Driven by modest gains in population and overall economic growth, Vermont’s annual demand for electricity has generally increased over the last 20 years. Exhibit 3-1 shows the state’s annual electric energy consumption. Between 1990 and 2009, electric demand increased by 7%, or 0.4% annually. However, since 2004, annual electricity consumption has declined. This pre-recession decline can be attributed in part to the state’s electric efficiency investment and programs, which are described later in this section of the CEP.

Exhibit 3-1. Electric Energy, Vermont (millions of MWh)



Source: 2009 Long Range Transmission Plan, VELCO, Vermont

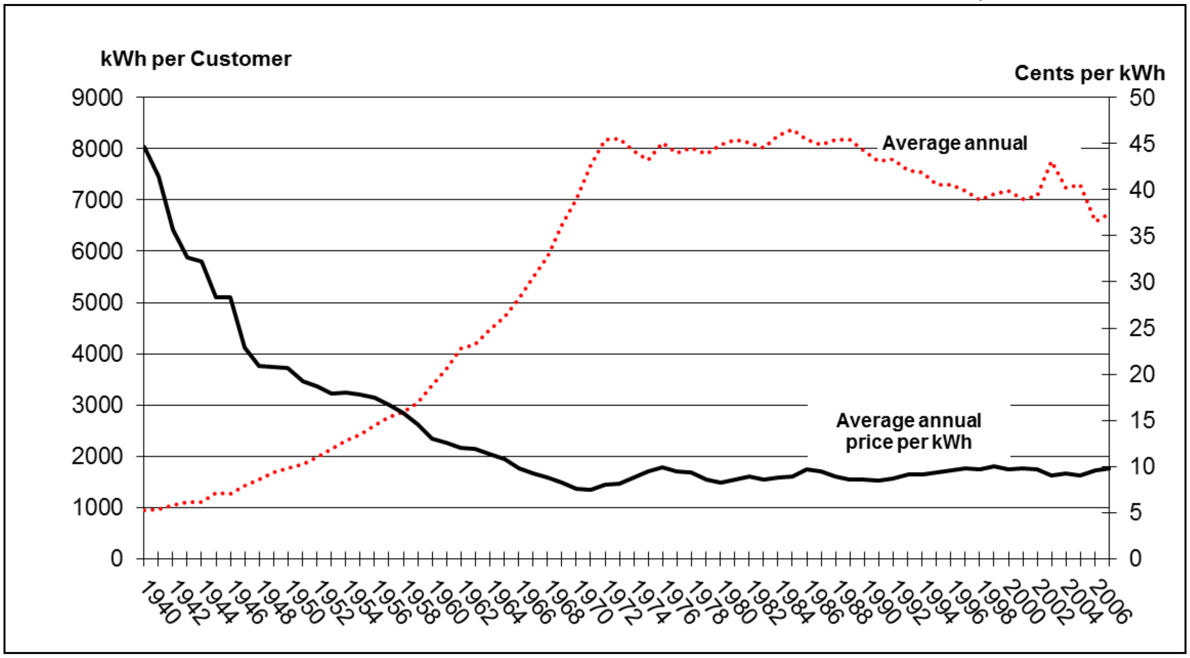
Exhibit 3-2 illustrates the long-run relationship and interplay between electric prices and demand for Vermont’s residential customers. Note the steep drop in inflation-adjusted electricity prices starting in the 1940s, as

[15] *Energy Information Administration; "International Energy Outlook 2011":* *http://205.254.135.24/forecasts/ieo/pdf/0484(2011).pdf*

[16] *http://www.eia.gov/forecasts/aeo/pdf/0383(2011).pdf*

electrification spread statewide, and the commensurate increase in customer demand. Also, as prices stabilized in the 1970s, customer use stabilized.

Exhibit 3-2. Electric Residential Demand Per Customer and Real Price Per kWh (1991 $), 1940–2007



Source: EIA, DPS, U.S. Bureau of Labor Statistics

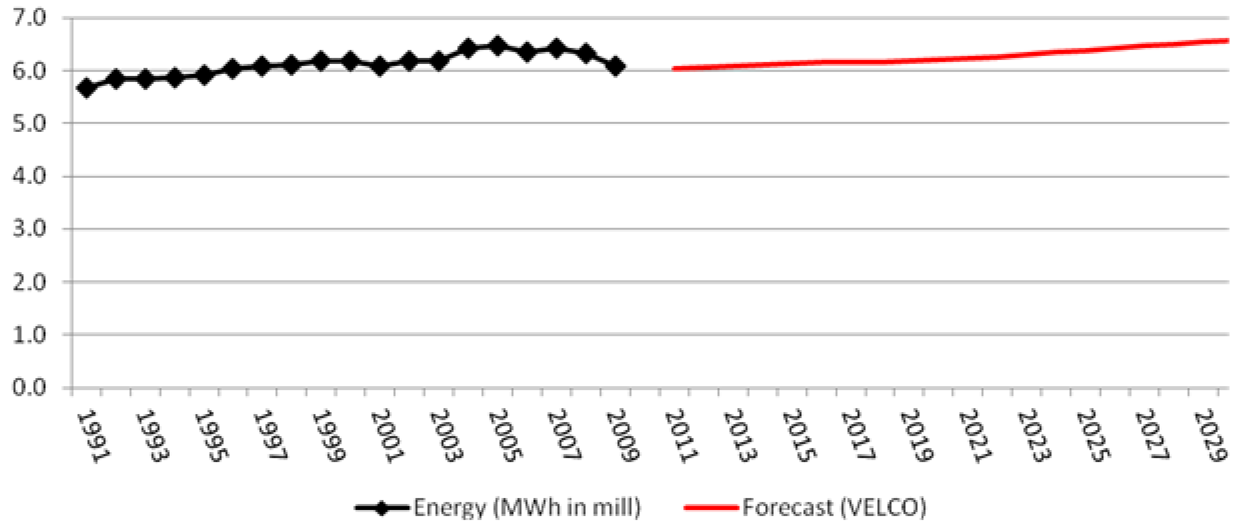
3.3 The Vermont Electric Forecast

Vermont Electric Company (VELCO) is the state's transmission company. VELCO is required to periodically complete a long-range transmission plan vetted through a stakeholder group called the Vermont System Planning Committee (VSPC). The VSPC is made up of VELCO, electric distribution utilities, the Department of Public Service, and representatives of the general public. The long-term VELCO demand forecast is based on individual utility forecasts by customer class and energy end uses. That is, the forecast captures changes in customer class and end-use sales trends that are driven by long-term structural changes such as changes in housing size, improvements in thermal efficiency, and changes in end-use saturation and end-use efficiency trends. The forecast is weather-normalized (adjusted for year-to-year weather variability) and incorporates expected effects from the most recent appliance efficiency standards. In addition, the VELCO forecast reflects a projection of program efficiency savings as completed by Efficiency Vermont in 2009.[17]

[17] *The efficiency forecast was predicated on previously approved budget levels, which are somewhat lower than that recently adopted by the Public Service Board for the 2012–14 period. Efficiency Vermont has recently updated its load savings forecast based on these approved budgets; however, the integration of the Efficiency Vermont forecast and an updated VELCO forecast will not be complete until early 2012. It should also be noted that the Department of Public Service, the VSPC, and the forecasting community in general continue to deliberate over the correct methodology for incorporating efficiency into load forecasting.*

Overall, the VELCO forecast projects an average annual electric use increase of 0.4% through 2030. The VELCO forecast does not project continued negative load growth despite the trend since 2004; it also does not account for additional load that may result from robust adoption of plug-in electric vehicles.

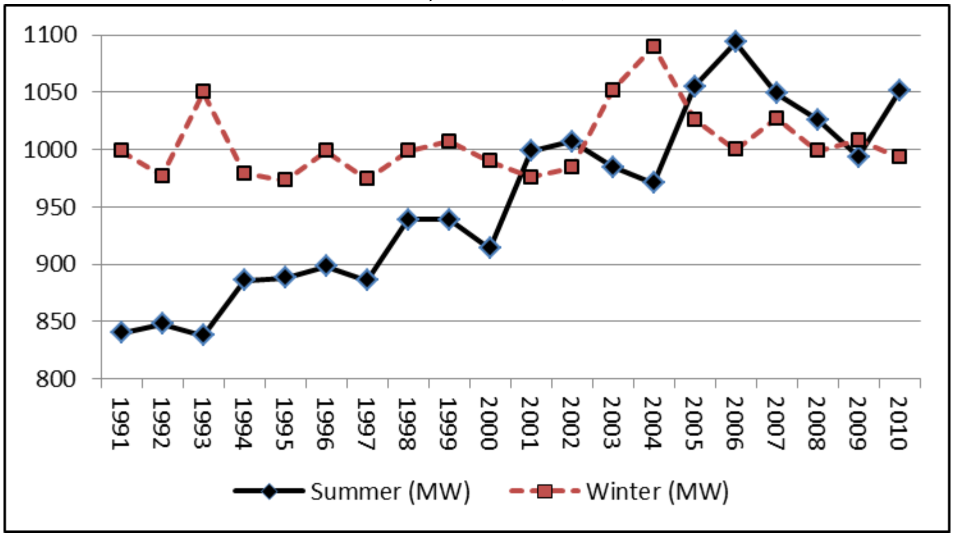
Exhibit 3-3. Electric Energy, Vermont (in millions of MWh)



Source: VELCO

In 2011, the system summer peak demand was 1050 MW and is forecasted to increase to 1,132 MW by 2030. Peak demand is expected to grow 0.7% annually over this period. Stronger summer demand growth is largely due to expected air conditioning load growth (more households installing more air conditioners). Long-term winter peak demand growth tracks energy projections, with winter peak demand averaging 0.4% annually through 2030. The VELCO forecast is a thorough business-as-usual snapshot of projected electric load growth.

Exhibit 3-4. Vermont Seasonal Peaks, 1991–2010 (in MW)



Source: ISO New England

Underlying the overall electric energy forecast are individual forecasts by customer class. The largest customer class, residential sales, is expected to increase 0.6% over the next 30 years. The residential customer class growth results from two offsetting trends: first, an expected decline in average residential use, due to planned federal mandates to improve the efficiency of household appliances and electrical equipment and due to building efficiency programs at the state level; second, increased electric demand caused by the addition of new customers.

Between 2002 and 2010, commercial sales averaged 0.4% annual growth, but this customer class was impacted significantly by the 2007–09 recession; commercial sales declined 3.9% in 2009. Through 2030, commercial sales projections closely track the total demand growth, with a 0.4% annual increase based on moderate economic growth and active intervention through state efficiency programs.

Industrial electric usage, which accounts for approximately 25% of Vermont's electric usage, has been trending down since 2002. Sales were particularly hard hit in 2009, during which they fell 10.3%. Although industrial sales are expected to recover from a depressed base level, the outlook through 2030 is for growth of just 0.3% per annum.

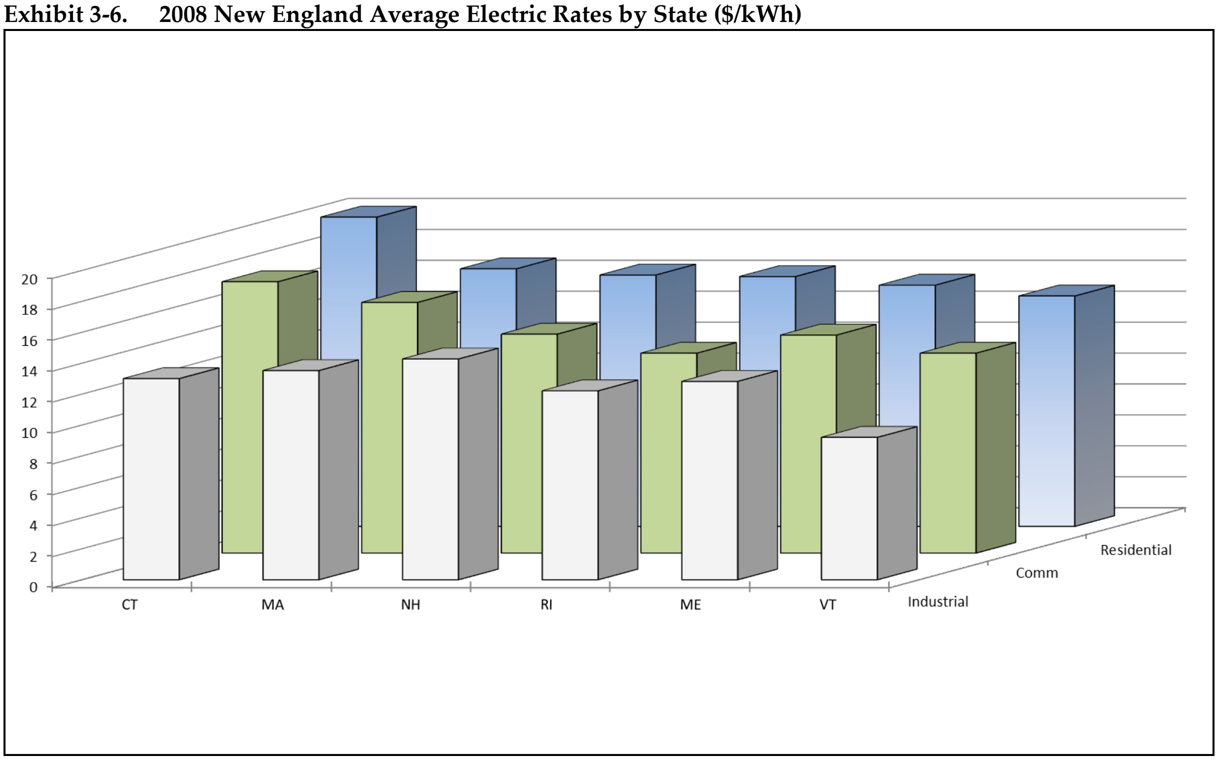
3.3.1 Forecasts of Electric Prices

As shown in Exhibit 3-2, Vermont's average price per kWh for retail electricity sales has remained relatively flat on an inflation-adjusted basis for the last several decades. Compared to the region as a whole, Vermont has had favorable electric rates over the last decade. Exhibit 3-5 and Exhibit 3-6 show a snapshot of recent New England and Vermont electric rates. Vermont currently maintains a modest price advantage, although new contracts based on current and projected market prices may narrow Vermont's favorable price differential.

Exhibit 3-5. Average Retail Price of Electricity (cents per kWh, 1991 $)

Source: ISO New England

Exhibit 3-6. 2008 New England Average Electric Rates by State ($/kWh)

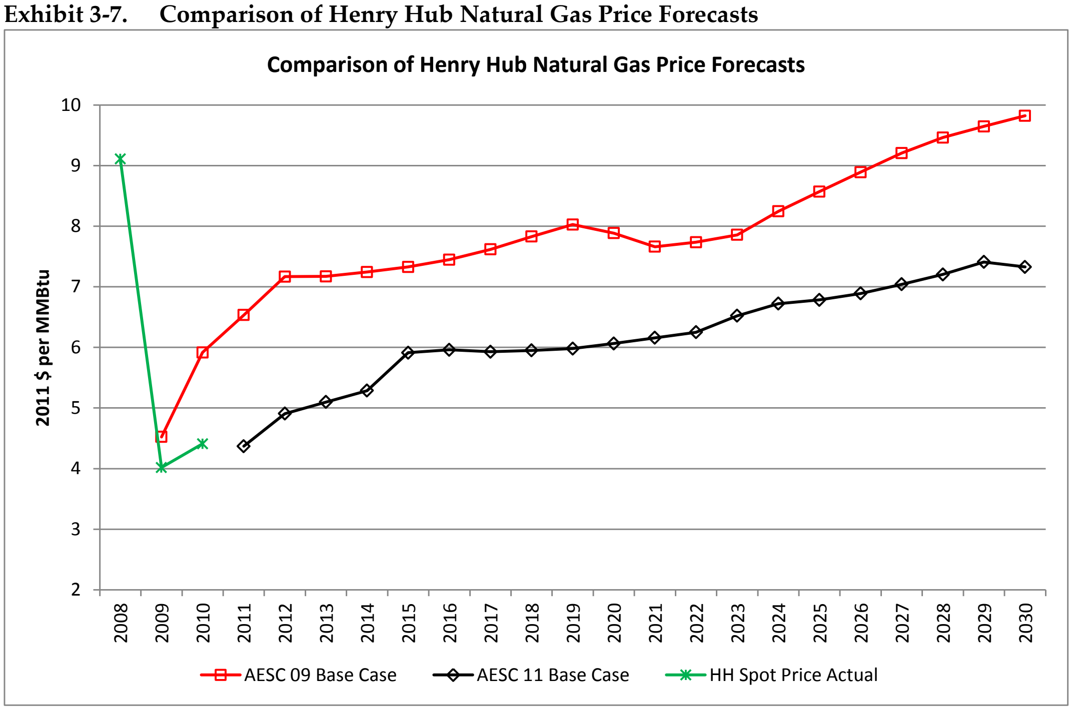


Source: ISO New England

In the fall of 2010, the Vermont DPS joined with the other New England states to prepare a forecast of avoided costs for use in screening demand-side management (DSM) programs. This 2011 Avoided Energy Supply Costs study (AESC 2011)[18] provides projections of marginal energy supply costs that will be avoided via reductions in the use of electricity, natural gas, and other fuels resulting from energy efficiency programs offered to customers throughout New England. The AESC 2011 was intended to update prior studies, the most recent from 2009, which were based on various methods, including a survey of forecasts of market prices for electricity and fuels, production cost modeling, and past experience in the energy markets.

Compared to the 2009 results, the AESC 2011 forecast shows a decrease in projected natural gas prices. Because of the region's heavy reliance on natural gas generation, this results in a commensurate decrease in forecasted electric prices. Exhibit 3-7 and Exhibit 3-8 show the comparative results.

Exhibit 3-7. Comparison of Henry Hub Natural Gas Price Forecasts



Source: Avoided Energy Supply Costs in New England: 2011 Report

[18] http://www.synapse-energy.com/Downloads/SynapseReport.2011-07.AESC.AESC-Study-2011.11-014.pdf.

Exhibit 3-8. Summer Peak Period Price Comparison

	AESC 2009	AESC 2011	% Difference
Summer Peak Period Wholesale Price ($/MWh)	$85.69	$78.16	-8.8%
Input Values			
Summer Natural Gas Price ($/MMBtu)	$7.61	$6.49	-14.7%
CO2 price ($/ton)	$22.70	$15.69	-30.9%
NG CO2 (lb/MMBtu)	118.00	118.00	
System Parameters			
Marginal Heat Rate (Btu/kWh)	9,250	10,150	
Marginal C02 Rate (tons/MWh)	0.55	0.60	
Price Effects			
Fuel Cost ($/MWh)	$70.35	$65.86	-6.4%
CO2 Cost ($/MWh)	$12.39	$9.40	-24.2%
Other Variable and Bid Costs ($/MWh)	$3.00	$3.00	0.0%
Calculated Energy Price ($/MWh)	$85.74	$78.25	-8.7%
Wholesale Risk Premium ($/MWh)	$7.72	$7.04	-8.7%
Avoided Class I REC Cost ($/MWh)	$2.65	$1.74	-34.4%
Retail Avoided Unit Cost of Electric Energy ($/MWh)	$96.11	$87.03	-9.4%

AESC 2009:
Levelized for 2010-2024 in 2011 $
AESC 2011:
Levelized for 2012-2026 in 2011 $

Source: Avoided Energy Supply Costs in New England: 2009 Report and Avoided Energy Supply Costs in New England: 2011 Report

Wholesale marginal electricity prices in New England are dependent on the regional natural gas price. Even though there is little significant gas-fired generation owned or directly contracted by Vermont utilities, Vermont's utilities often must rely on the regional market for shorter-term contracts; thus, Vermont electric ratepayers have some exposure to the variability of natural gas prices. In addition, long-term contracts entered into by Vermont utilities are often based or indexed upon regional market prices. Vermont's less-direct connection to regional natural gas prices can be positive or negative, depending on the price of natural gas. Recent narrowing between Vermont retail electric rates and New England rates is due in part to low natural gas prices driving costs down elsewhere in the region. Moreover, to achieve price and environmental objectives that might be desired by Vermont ratepayers, it is incumbent upon the serving utility to contract or build resources with certain attributes. For those reasons, the price for electricity in Vermont may not be reflective of the avoided costs described above.

3.3.2 Projections Based on Modeling/Scenarios for the Future

Although regional forecasts are helpful in predicting usage and cost trends, they are not specific to Vermont. Synapse Energy Economics was commissioned by the Department of Public Service to model the economic impacts of three electric policy scenarios, evaluating the costs and benefits associated with these alternatives for Vermont. As detailed below, this modeling exercise included *dispatch modeling*, which models the operation of the electric system in Vermont and the rest of New England under each of the scenarios, and *economic impact modeling,* which forecasts the positive and negative spending, employment, and gross domestic product impacts for the state under each scenario.

For each of the three "Vermont energy future" scenarios, Synapse estimated the impact on electric energy market prices using the Market Analytics model, licensed from Ventyx, an ABB company. The results of this analysis are provided later in this report. Market Analytics is a production-cost model that simulates the operation of the wholesale electric energy market. The dataset of the National Electric Reliability Council (NERC) for the Eastern Interconnection was used in this analysis, with various model inputs revised to more closely reflect up-to-date electricity market conditions, with particular attention paid to Vermont. These input modifications draw extensively from those made for the Avoided Energy Supply Costs in New England study and subsequent report discussed above (AESC 2011).

The dispatch modeling was based on the analysis performed by Synapse for the regional AESC report. For this modeling, the Base Case model in the AESC report was modified to include all effects from existing DSM programs in New England, which had been removed for the AESC study. The updated load forecasts used for Vermont are described elsewhere in this report.

The Synapse modeling study is described in the following sections; for more details, see Appendix 4—Modeling Study.

3.3.2.1 Electricity Scenario Analysis for the Vermont CEP

The modeling scenarios chosen by the DPS for this CEP and Electric Plan evaluate the costs and benefits associated with three possible energy strategies for Vermont during the plan period, 2012–31. Given the wide range of possible electric portfolio futures and underlying assumptions, we chose three models to allow policymakers to judge the relative benefits and costs associated with different approaches. The following is an abbreviated description of each scenario:

(1) Base case with no new DSM ("Base Case"): Assumes no further funding of demand-side management (DSM) measures in Vermont after 2011, to provide a snapshot of the costs and impacts of an electric portfolio based only on DSM progress achieved to date. Assumes increasing renewable electricity deployment, consistent with state policy, and includes an assumption that 25% of Vermont's electricity will come from renewable sources (other than hydropower and existing biomass) by 2025 and that 60 MW of additional biomass electricity will be deployed by 2028. Nine percent of Vermont's 2012 electricity is expected to be produced from renewable

sources that meet the definitions used in this scenario. Additions between 2012 and 2031 were modeled to include wind projects currently under development, 60 MW of biomass, additional wind deployment (whether in-state or out-of-state) that would roughly double the amount of wind electricity used in Vermont, and continued growth in net metered solar PV.

(2) DSM case ("High Efficiency"): Assumes incremental DSM is implemented in Vermont throughout the CEP period (2012–31) following the current DPS proposed budget, including the ongoing impacts of prior-year DSM spending. Efficiency funding is directed at both electric and thermal efficiency (electric efficiency is funded by electric ratepayers and thermal efficiency is funded by FCM and RGGI revenues). Investments in new renewables are decreased relative to the Base Case because of the smaller amount required to meet minimum assumed renewable portfolio requirements commensurate with decreased energy use in Vermont, but still constitute 25% of the portfolio by 2025. As with the Base Case, 9% of Vermont's 2012 electricity is expected to be produced from renewable sources that meet the definitions used in this scenario. Renewable technologies deployed between 2012 and 2031 are similar to those in the Base Case, but new wind deployment is reduced by approximately half due to reduced demand.

(3) High renewables and DSM case ("High Efficiency + High Renewables"): Includes all DSM in Scenario 2, and includes new renewable energy resources to reach the goal of meeting 75% of Vermont's electricity use with renewables, including hydropower and existing biomass. Forty-eight percent of Vermont's 2012 electricity is expected to be produced from renewable sources that meet the definitions used in this scenario. Additions between 2012 and 2031 were modeled to include substantially similar renewable deployment as the High Efficiency scenario, with the following changes: an additional 50 MW of solar using an expanded Standard Offer; additional Hydro-Quebec purchases including off-peak periods; and additional out-of-state large hydropower.

For all scenarios, only the projects already proposed, Standard Offer projects, distributed generation, and biomass were required to be deployed in Vermont. A complete description of each electric portfolio's parameters, assumptions, and modeling results are found in Appendix 4—Modeling Study. The energy and economic impacts of the DSM case (Scenario 2, "High Efficiency") and the combined DSM and high renewables case (Scenario 3, "High Efficiency + High Renewables") are summarized below.

3.3.2.2 Load Forecasts and Projections of Demand-Side Management (DSM) Resources

For all three modeled scenarios, the New England and Vermont load forecasts were based on the CELT (capacity, energy, loads, and transmission) forecasts published by the New England ISO.[19] For this study, the CELT forecast was adjusted to reflect Vermont DSM investments in 2011 and all prior years. In the Base Case, these investments were modeled to cease in 2011. This results in a decreasing DSM impact through the study

[19] http://www.iso-ne.com/trans/celt/report/index.html

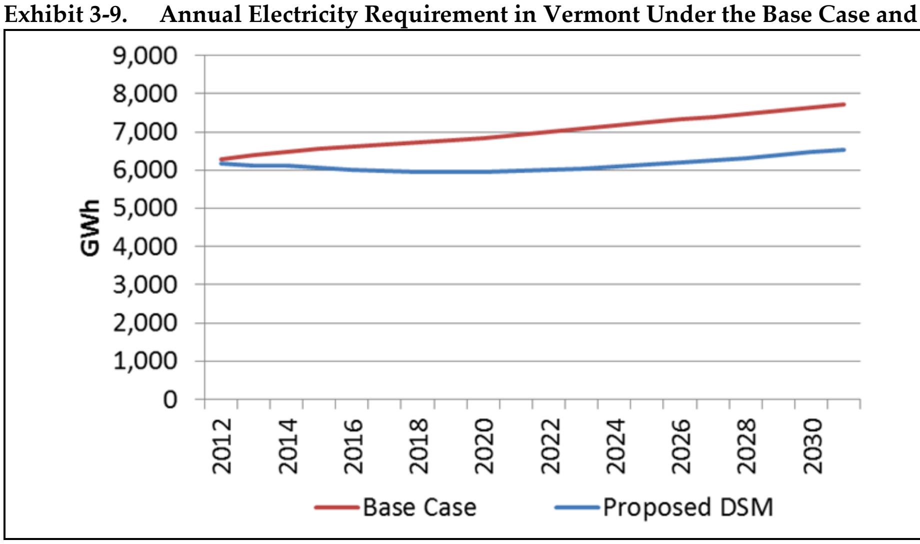
period as the impact of those investments decays over time; the average measure life is 11 years. Modeling the Base Case without efficiency investments allows quantification of the costs and benefits of efficiency programs.

For the DSM cases (Scenario 2, "High Efficiency," and Scenario 3, "High Efficiency + High Renewables"), the model assumed the level of energy efficiency program funding for Vermont recommended by the DPS and (for 2012–14) approved by the Public Service Board (PSB) beginning in 2012 and continuing through 2031. This results in increasing DSM impact through the study period, although the efficiency yield per dollar of program spending is modeled to decrease.

Other assumptions required for modeling the electricity market and costs for consumers in Vermont include fuel price forecasts, emissions prices (including the future cost of greenhouse gas emissions), transmission interface limits, and resource additions and retirements during the study period. The renewable electricity requirements and portfolios in each scenario are described above.

The resulting annual electricity requirements for Vermont under the Base Case and DSM cases—both Scenario 2 and Scenario 3—are shown below.

Exhibit 3-9. Annual Electricity Requirement in Vermont Under the Base Case and Proposed DSM Scenarios



Source: Appendix 4—Modeling Study, Exhibit 4

3.3.2.3 Economic Modeling

Synapse and the DPS collaborated in the use of the PI+ model (formerly Policy Insight) developed by REMI (Regional Economic Models Inc.) to estimate the economic impacts of the modeled electricity policies. The PI+ economic model's dynamic functionality captures structural changes in the regional economy that result from economic inputs and costs. Its built-in baseline forecasts of economic activity are calibrated to Vermont. The modeled policy changes result in changes to this forecast economic activity. In this study, such changes include alterations in consumer spending, in businesses' energy costs, and in additional commercial activity and industry demand related to energy efficiency investments. The model results presented below illustrate the impact of each scenario in terms of economic activity and employment in Vermont, relative to the Base Case (Scenario 1).

Energy efficiency generates economic activity largely through purchase and installation of energy efficiency goods and services and net energy savings to ratepayers. Households save on energy costs and can then spend additional money in the local economy. Businesses have lower energy costs that improve their bottom line and enable them to be more competitive. Energy efficiency equipment, to the extent to which the equipment is produced locally, has an economic impact on the state. System benefits, such as reduced market clearing prices and avoided transmission and distribution investments, also have positive effects on the economy.

The modeling also recognizes that as participants spend money on energy efficiency goods and services, their ability to spend elsewhere is reduced. Further, all ratepayers are impacted by initial energy efficiency program costs and the additional costs of renewable investments that are factored into energy rates. The assumptions used for the costs of renewable investments are described further in Appendix 4—Modeling Study.

The modeling results below estimate the total economic impacts to Vermonters from the energy efficiency and renewable electricity that would be procured under each of the scenarios. The costs, savings, and economic benefits resulting from the programs are modeled over the 20-year study period (2012–31). The results of the study represent the *net new economic activity* generated by the investments: the difference between the economic activity increase associated with new investments (including investments in deployment of in-state renewable generation and energy efficiency) in Vermont and the economic activity reduction associated with the costs attributable to these same investments (including the cost of implementing efficiency programs and the additional cost of procuring renewable electricity).

3.3.2.3.1 Scenario 2: Impact of Energy Efficiency Investments (High Efficiency Case)

Participants in energy efficiency programs save by forgoing the purchase of energy and related expenses. Over the course of 20 years, the modeling finds that participating residents and businesses in Vermont save $3.74 billion in estimated energy-related spending under the High Efficiency case relative to the Base Case, in current dollars.[20] Electric efficiency spending is many times thermal efficiency spending, so the vast majority of these savings are due to electric efficiency.

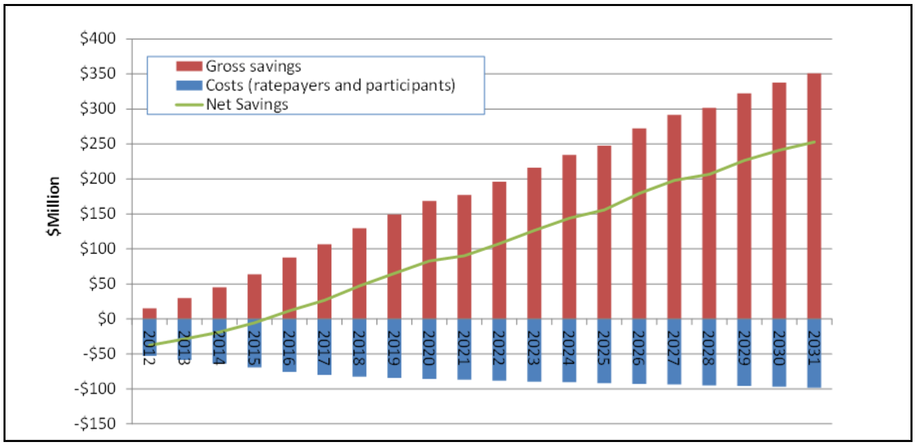
Gross savings from DSM are partly offset by ratepayer and participant expenses. Through the energy efficiency charge, ratepayers cover the costs to deliver and administer energy efficiency programs and financial incentives claimed by participants. Synapse estimates a total of $1.8 billion will be spent on program administration, equipment, and installation over the course of the CEP period.

The annual program and participant costs and savings, as well as the net savings, are shown in Exhibit 3-10. The net savings of the program total nearly $2.1 billion over the 20-year period in current dollars. As shown below,

[20] *Savings that occur after 2031 are not included in this calculation, so this is a conservative estimate of total savings.*

from 2012 to 2014, the High Efficiency scenario results in a net cost to Vermonters. The Base Case includes benefits from efficiency measures installed in 2011 and earlier, so these measures do not differ between scenarios. After 2015, the aggregate benefits of the installed efficiency measures cause program savings to outweigh the costs. These net savings continue to grow as more measures are installed through 2031.

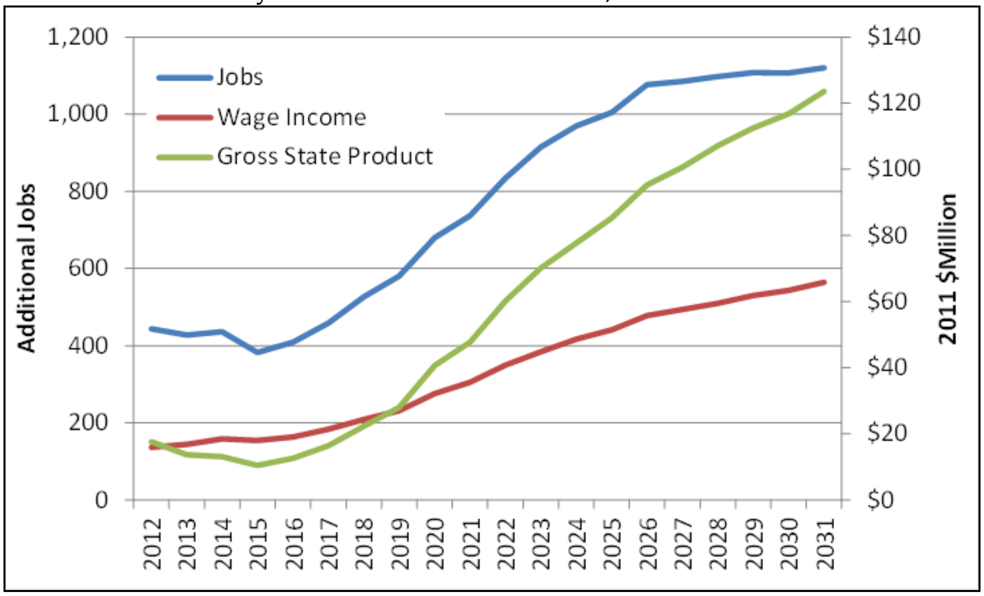
Exhibit 3-10. Gross Savings, Costs, and Net Savings, High Efficiency Scenario Relative to Base Case Scenario, 2012–31 (in current $)



Source: Appendix 4—Modeling Study, Exhibit 10

DSM investments and the resulting savings produce value and jobs in the Vermont economy. In the High Efficiency case, modeling estimates that a total of 15,394 person-years of additional employment will be produced relative to the Base Case—an average of 770 additional jobs every year in Vermont. These jobs will generate an additional $778 million (in 2011 dollars) in income for Vermonters over the study period. The average annual wage (in 2011 dollars) associated with these jobs exceeds $50,540 per year. Exhibit 3-11 shows these benefits on an annual basis.

Exhibit 3-11. Additional Jobs (left axis) and Other Economic Benefits (right axis, in 2011$) Associated with the High Efficiency Case Relative to the Base Case, 2012–31



Source: Appendix 4—Modeling Study, Exhibit 11

The investments and savings under the proposed High Efficiency scenario will also yield $1,171 million (in 2011 dollars) in increased Vermont Gross State Product over the study period.

3.3.2.3.2 Scenario 3: Renewable Energy: Base Case Compared with High Efficiency + High Renewables

For the third electric modeling scenario, the DPS chose an analysis that assumed a state renewable portfolio standard (RPS) goal of obtaining at least 75% of the electricity purchased from renewable sources during the Electric Plan period, including hydropower and existing biomass. See the scenario descriptions above for a summary of the modeled renewables portfolio.

The construction costs for new renewables were calculated for each renewable technology based on Synapse's assessment of cost and operational parameters for the Northeast United States. The construction and operation and maintenance (O&M) expenditures per MW for the region were combined with the installed MW of new renewable capacity to generate Vermont's aggregate investment in new renewable energy resources for each scenario.

Renewable investments affect consumers through higher electricity rates assessed to pay for the incremental cost in new technology. In the study, it was assumed that the amortized cost of construction and the ongoing O&M costs would be effectively added to Vermont energy costs. At the same time, utilities and their ratepayers would realize the benefits of the energy and capacity produced by each resource.

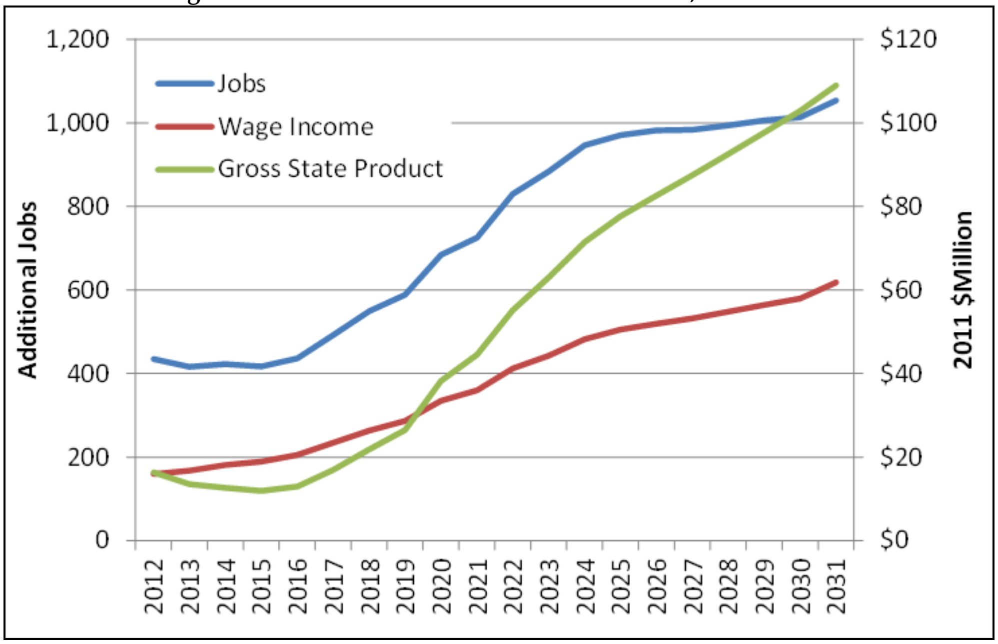
Exhibit 3-12 shows that for the High Efficiency + High Renewables case, the total bill impacts for the modeled renewable resources amount to $292 million over 20 years, when compared with the Base Case. This is a relatively small amount per energy unit, representing less than 0.2 cents per kilowatt-hour (kWh) on average, in 2011 dollars, over the study period. Additional modeled costs are largely attributable to the higher cost of solar PV relative to wind power, and to the additional cost of hydropower from both Hydro-Quebec and other sources.

Exhibit 3-12. Bill Impacts of Renewable Energy in the High Efficiency + High Renewables Case Relative to the Base Case (in millions of 2011 $, unless otherwise noted)

Technology	2012	2015	2020	2025	2031	Total (2012–31)	
Bill Impacts (in millions)	$1.9	$2.3	$11.2	$15.2	$12.9	$208	$292 (nominal $)
Load Forecast (GWh)	6,160	6,067	5,942	6,141	6,542	122,752	
Impact (cents per kWh)	$0.03	$0.04	$0.19	$0.25	$0.20	$0.17	$0.24 (nominal $)

The economic impacts of the High Efficiency + High Renewables case were generally similar to the High Efficiency case (see Exhibit 3-13). The gross state product increases about 10% less in this case, and 4% fewer jobs are created. In the High Efficiency + High Renewables case, economic impacts are dominated by the positive economic impacts of efficiency. In addition, in this case Vermont's economy benefits from the increased investment in in-state solar PV, and reduced investment in largely out-of-state wind power, relative to the other two cases.

Exhibit 3-13. Additional Jobs and Other Economic Benefits (in millions of 2011 $) Associated with the High Efficiency + High Renewables Case Relative to the Base Case, 2012–31



Source: Appendix 4—Modeling Study, Exhibit 16

The total economic benefits, and benefits per unit of spending, are shown in Exhibit 3-14 for Scenario 2 and Scenario 3. It is important to note that the costs and benefits shown are based only on those incurred and accrued in the 20-year study period. If all investment in energy efficiency and renewable electricity were to stop after this period, benefits would continue to accrue well afterward. Thus, the impacts shown below are a minimum, conservative estimate of impacts from the efficiency and renewable electricity investments in these two scenarios.

Exhibit 3-14. Leverage of Program Spending for High Efficiency Case and High Efficiency + High Renewables Case, Relative to the Base Case (in millions of 2011 $)

Scenario	2: High Efficiency	3: High Efficiency + High Renewables
Total Spending (2011 $ in millions)	$1,079	$1,287
Job-Years Relative to Base Case	15,394	14,834
Job-Years per Million $	14	12
GDP Benefit (2011 $ in millions)	$1,171	$1,055
GDP Benefit per $ Spent	$1.09	$0.82
Wage Income Benefit (2011 $ in millions)	$778	$759
Wage Income per $ Spent	$0.72	$0.59

Source: Appendix 4—Modeling Study

3.3.2.4 Dispatch and Economic Modeling of Plug-in Electric Vehicles

The projected electrification of vehicles in North America poses a challenge to the electricity grid while also offering unique opportunities. The work required to both validate PEV (plug-in electric vehicle)-based dispatch modeling and apply the associated economic impact analysis necessitates a wide range of new data and assumptions not accounted for in current dispatch models. PEV load modeling requires data and assumptions related to PEV charging behaviors and driver travel patterns, in addition to assumptions regarding needed distribution grid upgrades. This analysis will require a new partnership between electric planners and transportation planners; it exceeded the current modeling capabilities of the DPS and its consultants. In this Electric Plan, we recommend that such modeling be developed and used in future utility IRPs to allow Vermont to prepare for vehicle electrification; the Electric Plan will be updated as that modeling is developed.

Even though dispatch and economic modeling of PEV-caused load increases was not performed, the DPS did utilize a generalized economic model to investigate the effect of increasing electric load by a hypothetical 35% over the planning horizon, otherwise using the same assumptions employed in the High Efficiency + High Renewables case. The DPS believes this 35% increase in load over 20 years represents an upper limit to the pace and penetration of PEVs in Vermont, particularly because no assumptions regarding increased grid efficiency were applied. The economic analysis showed a need for an additional $2.4 billion of electric energy delivery. This analysis estimated the cost of electric generation, transmission, and distribution upgrades. The analysis did not include the offsetting cost or savings of transportation fuels or fueling infrastructure build-out or decommissioning, the impact on emissions, or the potential for utilizing PEV battery storage as a resource for managing the electric load.

The transportation world appears to be on the verge of a shift toward electrification. The management of PEV charging, at minimum, can limit the impact of new PEV loads on the grid and, at best, can provide new resources to meet load.[21] We are aware of the challenges and issues involved. We must work in the near term to build capacity in the DPS and Vermont utilities, alongside other stakeholders in the ISO-NE region, to address PEV dispatch and economic modeling, in anticipation of PEVs taking hold.

For more background on the potential of PEVs in Vermont and their impact on the grid, refer to Section 9 — Transportation and Land Use, The Shift Ahead: Transportation Fuel Sources and Vehicles in Vermont.

[21] *For further discussion on PEVs, refer to Section 9.4.3.5.5 PEV Impact on Vermont's Electric Grid, where results from the following research studies are mentioned: (1) Hadlew, S.W., and A. Tsvetkova. Potential Impacts of Plug-in Hybrid Electric Vehicles on Regional Power Generation. ORNL/TM-2–7/150, Oak Ridge National Laboratory (2008), and (2) Transportation Research Center, "Plug-in Hybrid Electric Vehicle Research Project, Phase Two Report," April 2010.*

4 Electric Energy Efficiency

The state's first and best option to meet expected electric energy demand is demand-side management (DSM). This section provides an overview of the current state of electric efficiency programs and policies in Vermont, discusses the impact of DSM on state and regional transmission and capacity needs, and examines the many ways in which electric efficiency provides benefits for Vermont. Looking forward, the section concludes with discussions of the challenges of further increases in efficiency and the potential for Smart Grid technologies to create new DSM opportunities.

DSM programs and policy consideration in Vermont have traditionally focused on utility resource decisions and investments. Energy efficiency options encompass all categories of fuel, including electricity, motor gasoline, and fuel oil for heating and process needs. This section considers electric energy efficiency as an electric resource acquisition strategy; however, it is imperative to recognize that energy efficiency investments must be considered holistically. Energy consumers base decisions on total building energy bill and consumption patterns, of which electricity usage is just one important part. Section 7—Thermal Energy Efficiency discusses thermal efficiency options, considering strategies for encouraging energy reductions on a "whole-building" basis. Strategies considered in that section, such as creation of a task force to facilitate building efficiency in the state and improved regulatory structures, also apply to electric efficiency programs. Thus, this electric efficiency section is limited to discussing resource acquisition implications of electric energy efficiency and other DSM options.

Furthermore, significant efforts to reduce electric demand should not be translated into a policy in which all electric energy and demand consumption increases are avoided. Electric energy must be used efficiently and wisely. As other sections of the CEP point out, *increases* in electric energy consumption in certain sectors and for certain end uses are probably in the best interests of the state. For instance, Section 9—Transportation and Land Use calls for policies that will facilitate increases in plug-in electric vehicles. Electric DSM is not at odds with such policies; rather, DSM is another tool to facilitate their implementation. The goal is to use the cleanest, most efficient, and most cost-effective energy for any particular end use. As described in detail below, electric efficiency programs free up resources while providing significant economic and societal benefits to Vermont.

Electric DSM encompasses a range of service alternatives that include *energy efficiency*, *demand response*, and *load management*. *Energy efficiency* investments consist of selecting or installing devices and/or equipment that will perform work using less energy input than would otherwise be necessary. *Demand response* occurs when electric customers agree to reduce load during specific periods, generally associated with peak demand periods when capacity is constrained. Demand response is related to but distinct from *load management*, wherein usage is shifted from peak to off-peak periods. Electric energy efficiency, including related utility investments in demand-side management, is the subject of the bulk of this section. Demand response and load management are discussed in Section 4.7.

4.1 Background; Historic and Current Demand Reduction; Future Trends

The Vermont General Assembly has long required that electric utilities include "comprehensive energy efficiency programs" as part of their responsibility to deliver electricity to their customers at least cost (30 V.S.A. § 218c). These comprehensive energy efficiency programs have been incorporated into rates and funded through ratepayers' electric bills. Although utilities achieved some successes with early energy efficiency programs, the full potential of energy efficiency was not realized—an in-depth approach to reducing electricity usage was needed.[22]

In 2000, Vermont began administering electric energy efficiency programs through energy efficiency utilities (EEUs). To accomplish this, Efficiency Vermont (EVT) was created, and operated under a contract with the Public Service Board (PSB) for all electric service territories other than Burlington.[23] In 2010, the PSB modified the structure of efficiency delivery by creating a longer-term "Order of Appointment" model that encourages the EEUs to better plan for long-term efficiency programs that transform markets, while allowing for a greater degree of regulatory oversight and transparent public processes to determine budget and performance targets.

Since 2000, the EEUs have acquired significant electric efficiency resources that have indeed met a significant portion of Vermont's electric needs, at a lower cost than would have otherwise been paid by ratepayers. In 2007, Vermont became the first state to fully offset its projected underlying load growth through energy efficiency program activities. Vermont continues to acquire savings at a pace that leads the nation.[24] Exhibit 4-1 shows the incremental annual MWh savings achieved by the EEUs.

Recent savings translate into an annual load growth savings of more than 2% per year.

[22] *See PSB Order in Docket 5270 and Department of Public Service, "Vermont Electric Plan 2005."*

[23] *Burlington Electric Department (BED) operates programs in its service territory; EVT serves the remainder of the state. BED's programs are required to have the same "look and feel" as EVT programs.*

[24] *For example, see "Benchmarking of Vermont's 2008 Electric Energy Efficiency Programs: A Comparative Review of Efficiency Vermont and Burlington Electric Department" (Navigant Consulting for the Department of Public Service) and "The 2011 State Energy Efficiency Scorecard" (ACEEE).*

Exhibit 4-1. Annual Incremental MWh Savings (2000–10)

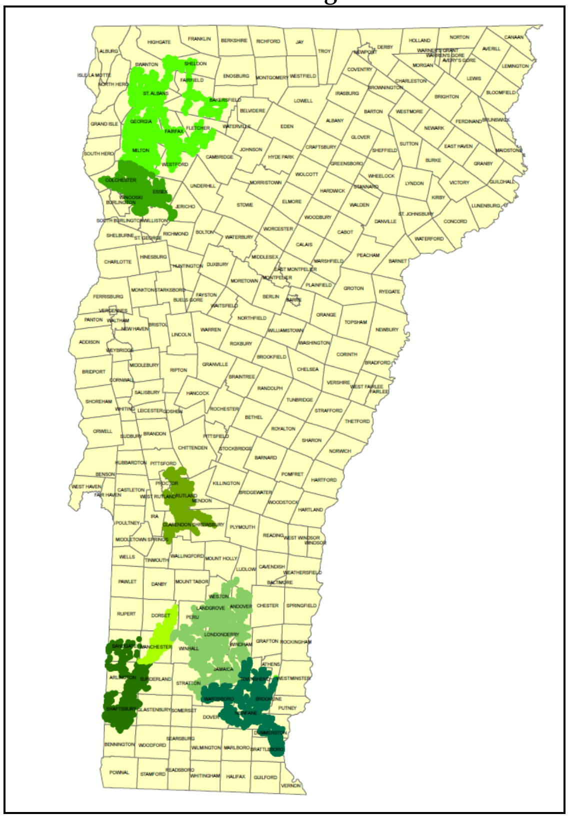
Year	Incremental MWh Savings
2000	28,760
2001	36,045
2002	38,821
2003	46,874
2004	47,750
2005	52,982
2006	62,317
2007	112,396
2008	151,702
2009	90,324
2010	120,313[25]

4.2 Geographic Targeting of Energy Efficiency Investments

Energy efficiency investments not only reduce annual electric consumption; they reduce peak consumption as well. Peak consumption can be costly to cover in the market; it also affects the Regional Network Service rate charged to all Vermonters for pooled transmission facility projects. Peak reduction has the additional benefit of reducing the need for transmission and distribution infrastructure—if it occurs in areas where the system is constrained by load growth. In recognition of this value, the Public Service Board in 2006 modified the guidance provided to Efficiency Vermont—directing a significant portion of the state's energy efficiency investments to specific geographic areas of the state. The concept behind this "geotargeting" (GT) was to place incremental energy efficiency investment into areas that were good candidates for deferring or avoiding transmission and/or distribution (T&D) upgrades. Four areas were initially geotargeted. Three of the original areas, plus one new area, were selected for the 2009–11 timeframe. These areas were the so-called "Southern Loop" area from Brattleboro to Manchester, the North Chittenden County area, St. Albans, and Rutland, and are depicted in Exhibit 4-2.

[25] *Preliminary estimate subject to verification.*

Exhibit 4-2. 2009–11 Geotargeted Areas



The DPS recently completed an evaluation of GT impacts.[26] Although targeted efficiency, a number of cool summers, and the recession have all contributed to lower peak loads across the targeted regions, making it difficult to determine whether GT investments alone actually deferred or avoided particular projects, the study found that GT works—it is possible to quickly ramp up energy efficiency programs to acquire significant peak demand savings in specific geographic areas. The study further enhances the credibility of energy efficiency as a resource acquisition strategy equal to other resource options.

Initial results have shown the GT program should continue, but there remains room for improvement. Since initiating GT, the Vermont System Planning Committee (VSPC) has been charged with, among other things, evaluating and recommending the systematic and strategic use of energy efficiency investments (through GT programs or some other vehicle) to avoid or defer transmission investments. The VSPC is now the appropriate venue to vet GT area selection, ensuring that energy efficiency is fully utilized as a least-cost alternative to transmission infrastructure development to the maximum extent otherwise allowed by regional market rules and NERC reliability standards.

[26] *"Process and Impact Evaluation of Efficiency Vermont's 2007-2009 Geotargeting Program," Navigant Consulting for the Department of Public Service, January 2011.*

Recommendation

The DPS should facilitate VSPC consideration of efficiency as a least-cost resource to defer or avoid transmission and distribution infrastructure development.

4.3 ISO-New England and Forward Capacity Market Participation

Although there is currently more than adequate generation capacity to serve the region, that was not the case a few years ago. The ISO-New England (ISO-NE) Forward Capacity Market (FCM) was developed to ensure the region would have sufficient generating capacity to meet its needs by providing advance revenues to entities that commit to providing or avoiding a particular amount at a particular date. The FCM allows not only generators, but also demand reduction, to bid into the market—so that ISO-NE may rely on either more capacity or less use in meeting demand. Vermont's portfolio of efficiency savings is submitted to the FCM, and it is used to help meet the region's need for capacity. Costs for participating in the market, including compliance with rigorous measurement and verification standards, are far exceeded by the revenues received. These revenues have been directed by the Vermont General Assembly to be used to support heating and process fuel efficiency programs (see Section 7—Thermal Energy Efficiency).

In planning for the region's capacity requirements, ISO-NE forecasts annual and peak energy consumption 10 years into the future. Regional discussions are under way between ISO-NE, the New England States Committee on Electricity (NESCOE), and public utility commissions to enable regional transmission planning to better reflect the region's collective investment in energy efficiency resources and the resulting reduction in load. Better efficiency forecasting will lead to better FCM structure and lower costs for regional ratepayers.

Recommendation

Increase the Department of Public Service's participation in ISO-NE efficiency forecasting efforts to ensure efficiency is appropriately reflected in ISO-NE's long-term planning.

4.4 Impact of Electric Efficiency Investments

In addition to significantly reducing the amount of electricity Vermont utilities need to purchase in order to serve ratepayers, the savings acquired by the EEUs provide numerous benefits to Vermont's electric grid, Vermont ratepayers, and the Vermont economy. Benefits include:

- Deferring or avoiding local or regional distribution or transmission projects (as described above). Infrastructure construction is expensive—and if targeted appropriately, energy efficiency can be an effective alternative to such construction.

- Reducing Vermont's share of the Regional Network Service (RNS) Charge. The New England states share the benefits and costs of reliability transmission projects completed in the region. These costs are significant, especially in the near term—in-progress, permitted, or planned transmission projects are projected to cost approximately $5 billion regionally (in addition to the more than $4 billion of investment Vermont ratepayers are already funding).[27] Vermont pays these costs based on its contribution to the peak New England load. Investments in energy efficiency serve to reduce Vermont's share of the peak. Even small reductions in Vermont's load at the time of the New England peak create significant benefits for Vermont ratepayers. For 2012, avoided RNS costs are expected to be approximately $.015 per kWh saved.[28] In addition, the need for ancillary services provided by ISO-NE is shared across the region—another $.0066 per kWh saved to Vermonters based upon 2012 expected efficiency measures. Taken together, each kWh saved avoids more than 2 cents in RNS and ancillary charges alone.[29]

- Reducing the overall cost of purchased electricity. Energy efficiency investment lessens the need for the next, more expensive generating unit to be dispatched to serve the energy demand in the region. Because all generating units are paid the market clearing price, reductions due to energy efficiency cause lower costs to be applied to all generating options. This so-called "demand resources–induced price effect" directly lowers the cost of all market kWh sold in Vermont, and indirectly lowers the cost of long-term electricity contracts.

- Generating local jobs. Energy efficiency programs rely on local contractors, distributors, and retailers to facilitate service delivery. These stakeholders all benefit from increased private investment leveraged by efficiency.

- Reducing the carbon emissions from electricity generation. Although Vermont has a relatively clean portfolio of electricity generation, energy efficiency reduces the need to purchase electricity from the regional market. These generating units that run to deliver kWh required at the time of peak usage, often from natural gas or oil-fired generation of electricity, have significant carbon emissions associated with them. Efficiency investments reduce the need for these marginal generating units to be dispatched. The societal cost of carbon dioxide emissions was recently estimated at approximately $80 per ton of CO_2 equivalent.[30]

- Significantly reducing electric bills for customers who participate in programs, providing greater cash flow for commercial customers to reinvest in other business opportunities or needs, and providing more disposable income for residential customers to reinvest in the economy.

- Securing revenues from the ISO-NE Forward Capacity Market (FCM) for the benefit of Vermont (discussed above), to be used for thermal efficiency investments.

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[27] *ISO-NE Regional System Plan Transmission Projects April 2011 Update, presentation, April 14, 2011.*

[28] *The RNS charges are based on kW rather than kWh. However, a kWh value is reported here for ease of use.*

[29] *Appendix 5—Economic Impacts of Energy Efficiency Investments, page 17.*

[30] http://www.synapse-energy.com/Downloads/SynapseReport.2011-07.AESC.AESC-Study-2011.11-014.pdf

- Creating other, non-quantified benefits for participants, such as increased productivity, safety, and comfort.

This list of electric efficiency benefits is compelling. However, the public investment is significant and is made up front—and there is a real initial rate impact associated with the energy efficiency charge. This rate impact must be acknowledged when considering efficiency investments made by the state's EEUs, and the savings and economic activity expected to result must be netted against this impact to ensure real and tangible benefit. To help understand and quantify these costs and benefits, the Department of Public Service commissioned Optimal Energy and Synapse Energy Economics to conduct a modeling analysis to determine the economic impact, in terms of both dollars and jobs, to Vermont of mandated electric energy efficiency investments. Many of the above factors were included in the analysis, as were the immediate negative economic effects of the rate impact caused by the state's energy efficiency charge. The study is included as Appendix 5—Economic Impacts of Energy Efficiency Investments.

The study found that energy efficiency investments generate significant net positive economic activity throughout Vermont in the form of purchase and installation of energy efficiency goods and services, administration of the program itself, and net energy savings to ratepayers and participants. Households that participate in the program save on energy costs and, therefore, can spend additional money in the local economy, spurring job growth. Businesses have lower energy costs that improve their bottom line, which enables them to be more competitive and to expand production and related employment. The investment in efficiency in itself also generates economic activity to the extent that equipment is produced, sold, installed, or maintained by Vermont businesses.

As noted above, these efficiency investments also cost participants money for their part of the efficient equipment and installation costs. Further, all ratepayers participate in funding the program. These costs are taken into account in the analysis, in that participants are negatively affected through their additional spending on the energy efficiency goods and services (constricting their ability to spend elsewhere), and all ratepayers are negatively impacted by the inclusion of energy efficiency program costs on their energy bills.

These negative impacts offset part of the positive impacts from savings and investment. However, the net results remain hugely positive for all Vermonters. Using a single year of electric efficiency investments based on the approved 2012 EEU budget, the study found that for every $1 million of public electric efficiency investment by the EEUs, $4.6 million of present value benefit is returned to the state. In terms of employment, the net change in employment in Vermont attributable to the program's total spending was approximately 46 job-years per $1 million (including direct, indirect, and induced economic activity that impacts employment). In addition, the study found that every dollar spent on EEU delivered electric efficiency that increased gross domestic product by a multiple of more than five. These results are unequivocal: Public investments in electric efficiency are beneficial to the Vermont economy.

Exhibit 4-3. Leverage of 2012 Electric Efficiency Program Spending

Total Budget (2011 $)	Job-years per million $	Net Present Value of Energy Savings per $ Budgeted
$39.1 million	46	$4.6

It should be noted that a significant portion of these benefits are not societal benefits—rather, they are benefits that occur within the Vermont economy itself. For instance, as described above, it is estimated that for every kWh of electricity saved, Vermont avoids approximately $0.021 of Regional Network Service (RNS) and Ancillary Service charges from ISO-NE. The RNS charge is the share of regional transmission costs that Vermont must pay, based on its percentage of the ISO-NE load on the region's peak day. Efficiency implementation lowers Vermont's share of that peak. While Vermont avoids those costs, society does not—other New England states must pick up the difference. However, Vermont ratepayers can avoid paying them when the state outperforms its region.

The economic impact study shows that electric efficiency investments have a large positive impact on the economy. The full results and methodology can be found in Appendix 5—Economic Impacts of Energy Efficiency Investments.

Recommendations

(1) *The Department of Public Service should collaborate with energy efficiency utilities and other stakeholders to better communicate the benefits of electric efficiency investment to the Vermont General Assembly, ratepayers, and other stakeholders*

(2) *The Department of Public Service should perform economic impact studies at least every other budget cycle to measure effects of efficiency investments.*

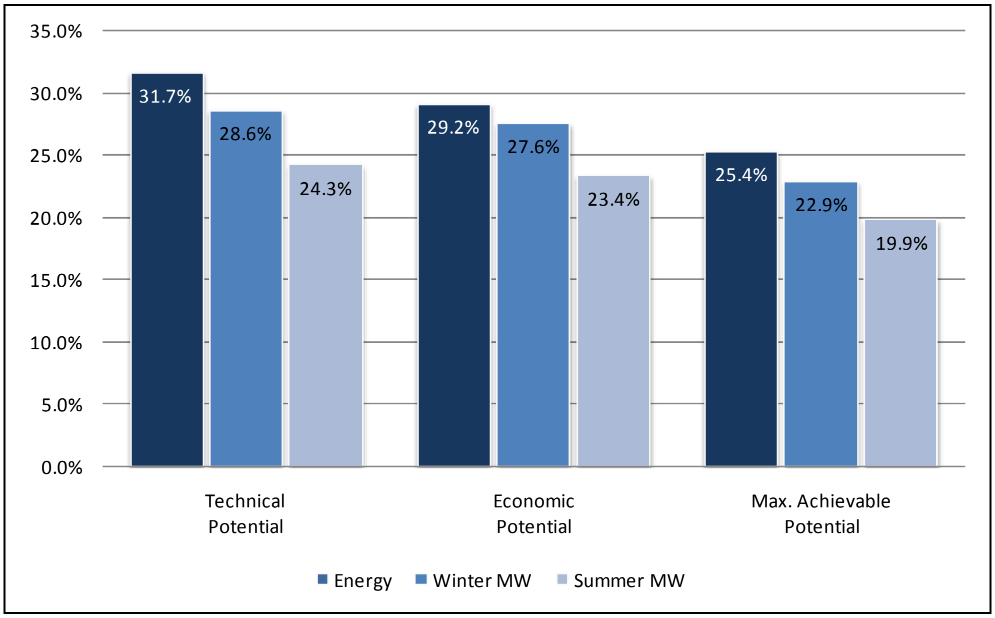
4.5 Sources of Electric Efficiency and Efficiency Utility Funding

Funding for electric efficiency program delivery is collected through ratepayers' electric bill, via a separately stated energy efficiency charge (EEC). The PSB determines the EEC, largely via a process of setting overall energy efficiency budgets for the EEUs. This process was most recently completed in 2011, to set firm budgets for the 2012–14 program cycle and prospective budgets for 2015 through 2031.

The Vermont Public Service Board balances a number of legislatively directed considerations when it determines the three-year budget and approves efficiency programs delivered by EEUs. Many of these directives can be found in 30 V.S.A. § 209(d)(4) and 30 V.S.A. § 209(e). They include the directive to acquire "all reasonably available, cost-effective energy efficiency savings" with particular emphasis on "…reducing the size of future power purchases; reducing the generation of greenhouse gases; limiting the need to upgrade the state's transmission and distribution infrastructure; [and] minimizing the costs of electricity…."

In order to inform the PSB decision regarding budgets, the DPS conducted an energy efficiency potential study. The study determined that cost-effective achievable energy efficiency potential is 25.4% of forecasted 2031 MWh sales (see Exhibit 4-4).[31]

Exhibit 4-4. Electric Energy Efficiency Potential (Percentage of Forecast 2031 MWh and MW Consumption), All Sectors Combined



These significant cost-effective efficiency resources can be “acquired” by business and residential ratepayers though private investment or efforts supported by various ratepayer-funded programs and offerings. Vermont already offers many programs via the EEU model, and the DPS works with the EEUs to continue innovating and designing the most effective programs to assist ratepayers in achieving efficiency savings.

In the 2011 Public Service Board Demand Resource Plan proceeding to develop electric efficiency budgets, the PSB ordered a modest increase in budgets that sets Vermont EEUs on a path to acquire all reasonably available cost-effective energy efficiency. The budgets are expected to yield significant electric resource savings for Vermont ratepayers. It is important to note that the PSB did not order the acquisition of *all* cost-effective potential efficiency measures, because the immediate rate impact considerations and the pace of program expansion limited *reasonable* efficiency budgets. Further, the maximum achievable cost-effective potential assumes a 100% incentive in place for efficiency measures—a level that is neither necessary nor reasonable under sound program design. Finally, the PSB’s ordered budgets allow for thorough consideration of the impacts and efficiency opportunities related to advanced metering infrastructure (discussed below). The energy

[31] *“Electric Energy Efficiency Potential for Vermont,” prepared for the Vermont Department of Public Service by GDS Associates and the Cadmus Group, April 2011.*

efficiency utility budgets approved for collection via the EEC since 2001 and projected through 2031 are shown in Exhibit 4-5.[32]

Exhibit 4-5. Energy Efficiency Utility Budgets Collected Via the Energy Efficiency Charge (2000–31)

Historic		Board Approved		Projected	
Period	Amount	Period	Amount	Period	Amount
2000	$8,674,914	2012	$40,100,000	2015	$48,741,995
2001	$10,760,991	2013	$42,800,000	2016	$52,478,059
2002	$13,141,733	2014	$45,900,000	2017	$56,092,279
2003	$14,000,000			2018	$57,548,290
2004	$16,224,477			2019	$59,638,047
2005	$17,500,000			2020	$61,634,914
2006	$19,500,000			2021	$63,196,513
2007	$24,000,000			2022	$65,430,746
2008	$30,750,000			2023	$67,513,724
2009	$30,688,000			2024	$69,350,234
2010	$33,485,000			2025	$71,761,099
2011	$38,500,000			2026	$73,963,384
				2027	$75,388,253
				2028	$77,922,930
				2029	$80,259,710
				2030	$82,353,851
				2031	$85,302,626

4.6 Challenges to Increasing Electric Efficiency

The pace at which Vermont acquires all reasonably available cost-effective energy efficiency is limited by a responsible expansion pace of programs, along with the cost-effective potential itself. Further, the state must be responsible in setting incentive levels appropriately to encourage investment without overspending public resources to get the desired outcome.

[32] *Total budgets include funds collected from ratepayers for program delivery by both Efficiency Vermont and Burlington Electric Department, evaluation, efficiency fund management, and compensation. Forward budgets are approved on a three-year basis (2012–14 budgets are firm, whereas future budgets are subject to revision based on future Demand Resource Plan proceedings).*

Vermont will continue to explore new ways to integrate energy efficiency into supply-side resource assessments, including investigating behavioral efficiency measures, and those enabled by advanced metering technology (described immediately below). The state should encourage innovation of new measures and program designs to acquire additional savings at a low cost. One example of this is Efficiency Vermont's "Energy Leadership Challenge," which calls on Vermont's largest users of electricity to reduce their energy consumption by 7.5%.[33] Another is Burlington Electric Department's proposal to develop an on-bill financing program for electric efficiency within its territory. These types of low-cost, innovative strategies should continue to be pursued.

Moreover, internal program efficiencies should continue to be monitored to ensure that Vermonters are getting top performance from their EEUs for their public investment. To that end, the DPS has collaborated with the EEUs to propose service quality reliability plans (SQRPs) and administrative efficiency quantifiable performance indicators (QPIs) to the Public Service Board. These indicators are intended to ensure continuous improvement of electric efficiency service delivery in Vermont—efficient delivery of efficiency programs.

Recommendation

Encourage and facilitate innovative program designs and strategies to increase electric efficiency resource acquisition, and continue to review and strengthen SQRPs and QPIs to ensure that efficiency services are delivered effectively.

4.7 Electric Energy Efficiency Delivery Tools: Smart Grid and Smart Meters

Smart Grid infrastructure and digital meters have significant potential to increase system reliability and energy efficiency. Digital meters will increase system reliability by allowing utilities to resolve outages more quickly or possibly avoid them; improve power quality (correcting voltage irregularities); and provide consumers data about their electricity use patterns. This data can empower consumers to manage their energy choices more closely.

Many Vermont utilities have already begun the process of replacing old analog meters with new digital meters. The U.S. Department of Energy, under the American Recovery and Reinvestment Act (ARRA), established a $3.4 billion grant pool to accelerate the adoption of Smart Grid technologies throughout the country while creating jobs to stimulate the economic recovery. In October 2009, Vermont's electric utilities were awarded approximately $69 million in ARRA funds to deploy Smart Grid technology. This was the largest per capita Smart Grid grant awarded to a state. The statewide grant application, known as eEnergy Vermont, was filed by Vermont Transco on behalf of all Vermont distribution utilities, with the support of the Department of Public Service, Efficiency Vermont, and the Office of Economic Stimulus and Recovery, as well as Vermont's Congressional delegation. Over the next two years, this grant will provide approximately half the cost of $138

[33] http://www.efficiencyvermont.com/for_my_business/energy_leadership_challenge/About.aspx

million in infrastructure improvements that utilities will make across Vermont. The project will move Vermont toward development of a statewide digital grid, using technology to convert the electric infrastructure from a one-way delivery system (conveying electricity to consumers) to a two-way communication system able to relay information about usage, voltage, existing or potential outages, and equipment performance between the customer and the utilities.

4.7.1 Automated Meter Infrastructure (AMI)

Digital metering systems being deployed in Vermont and other parts of the country typically have three components: a digital meter located at the customer premises, a communications network between the meter and the utility, and a head-end system located at the utility office.

- **Digital Meters.** Digital meters record and store interval usage data and billing data, permit demand readings, read power supply status, and determine electric service connectivity at the premises. Digital meters relay energy use data to and within a customer's home or business via web presentment options or in-home displays (IHDs). Vermont's digital meters to be deployed in this project are compatible with Zigbee communication devices, which are the industry standard for wireless home area network (HAN) communication between digital meters and IHDs.

- **Communications Network.** The communications network between the meter and the utility has the ability to transmit data, control signals, and send price alerts from the utility to the meter. Power line carrier (PLC) and radio frequency (RF) are the two primary types of communications networks being used in Vermont. Vermont Electric Cooperative (VEC) currently has a PLC system, and Washington Electric Cooperative (WEC) plans to install one as well. With PLC networks, the utilities use technology in which signals are sent over the electric line from the utility to communicate with the meters. PLC systems operate something like cable television systems; all meters on a common distribution line from the electric substation monitor a single broadcast channel, on a fixed frequency transmitted over the electric power conductor.

  In an RF network, the utility uses radio frequencies to broadcast and communicate with the digital meters installed at customer facilities. Green Mountain Power (GMP), Central Vermont Public Service (CVPS), Burlington Electric Department (BED), and Stowe Electric Department (SED) plan to install RF systems. With RF systems, two-way communication between the utility and the meter is enabled by low-power RF chips in the meters at customers' premises. RF does not require a line of sight to communicate with concentrators—each meter becomes a repeater, providing path diversity to communicate around local obstacles. Since alternative communication paths are available, the network is "self-healing," meaning that it still operates when one device becomes inoperable or a connection is impaired. During a Public Service Board proceeding to address consumer choice, privacy, and cybersecurity issues, some Vermonters raised concerns regarding the health impacts of RF-based meter communications systems. The Vermont Department of Health is performing a review of the issue; the DPS has supported customer opt-out policies to allow consumers to choose not to accept the new meter infrastructure.

- **Head-End System.** The head-end system is made up of the hardware and software used to process the collected electricity usage data. The head-end system transmits data, control signals, and price alerts on the communication network to the meters. The head-end system includes the AMI *master station*, the *meter data management system* (*MDMS*), and the *web presentment system*. The *master station* performs several important functions, including the management of the AMI communications network, scheduling and collection of meter readings, and coordination of routine customer and meter changes to ensure that all meters are read. The master station is flexible enough to support the growing needs of a utility to provide network monitoring, control of grid management, and reporting capabilities. The *MDMS* is a sophisticated database or repository for the enormous amount of data that will be recorded from the meters each day. Internet *web presentment systems* will provide the consumer with tools to view and interpret the stored data to better manage their energy consumption. Consumer benefits made possible by the head-end system may include allowing customers to perform their own rate comparisons, that is, to determine which rate is best for their service profile; customers also may benefit from usage history comparison and analysis and link to energy-saving programs, tips, and strategies.

4.7.2 Statewide AMI Energy Efficiency Objectives

When automated meter infrastructure (AMI) technology is fully deployed, utilities will realize a number of operational efficiencies that will create cost efficiencies for consumers over time. In addition, AMI is expected to yield a variety of both energy benefits and societal benefits to consumers. The DPS is currently working with utilities to establish a framework to monitor, measure, and report the costs and benefits associated with Vermont's AMI build-out. The above-mentioned utilities are in various stages of deploying digital meters and AMI technology in their service territories. The DPS anticipates that ARRA-funded AMI projects will have successfully installed digital meters and associated ARRA-funded AMI technology by spring 2013. AMI cost and benefit monitoring will begin at quarterly intervals in January 2012.

4.7.2.1 In-Front and Behind-the-Meter Tools for Energy Efficiency

AMI will be a key energy management tool for policymakers, utilities, and consumers. However, AMI technology will not, of itself, reduce customer demand for electricity—customers must either respond to price signals or change their behavior based on AMI feedback they receive if electric efficiency is to increase through this technology.

- **Front of the Meter: Dynamic Pricing and Improved Customer Choices for Rates.** The potential for cost savings through rate design has been a promise of the new advanced meter infrastructure; these tools are sometimes referred to as "in front of the meter" savings mechanisms. *Dynamic pricing* is the all-encompassing term Vermont uses for the variety of rate options made possible as a result of AMI. Dynamic pricing will benefit consumers by offering them more rate options as a function of when electricity is used. This has the potential to create a consumer-influenced shift in load from on-peak to off-peak usage, effectively adding capacity to the grid when demand is high. Dynamic pricing will not directly reduce consumer demand for electricity, nor will it increase energy efficiency; instead, it will shift the demand to lower-cost off-peak times.

Utilities are in the midst of developing dynamic pricing rate road maps with the DPS and PSB. It is important to note in the context of the CEP that AMI, dynamic pricing, and energy efficiency do have a significant relationship that has the potential to achieve savings. It is expected that dynamic pricing will create additional system capacity that:

(1) Avoids wholesale capacity charges paid by all utilities.

(2) Lowers Vermont's share of the regional peak and therefore its cost share of regional transmission projects (see RNS discussion above).

(3) Has significant monetary value in ISO New England's Forward Capacity Market (FCM). An increase in FCM revenues would, in turn, benefit other non-electric efficiency programs funded by FCM dollars. By proactively developing improved customer choices for dynamic pricing and striving to provide customer access to recent usage data, AMI technology has the potential to carve out new layers of system capacity and simultaneously deliver multiple ratepayer and societal benefits.

- **Behind the Meter: AMI Informed Retrofits and Conservation.** Tools for increasing energy efficiency "behind the meter" through AMI data—that is, at the customer's home or office—probably have greater potential to yield direct energy efficiency results. In many ways, behind-the-meter strategies are the new frontier of energy efficiency. Behind-the-meter electric efficiency has the potential to usher in new programs and strategies as utilities and consumers acquire the technology to better understand their electricity use. In other ways, AMI-related technology enables identification of traditional energy efficiency savings opportunities, such as refrigeration retrofit opportunities. Program activity for these opportunities is not constrained by new technology or new program uncertainty.

Presently, detailed retrospective bill analysis or targeted, limited-usage meters have to be relied upon to evaluate electric efficiency possibilities for consumers. AMI-informed retrofit opportunities will likely be the low-hanging fruit with regard to achieving deeper, more comprehensive energy savings via AMI. Joint consumer and EEU access to nearly real-time usage data will create a widely available mechanism for consumers and energy efficiency technicians to identify traditional energy efficiency opportunities.

Programs encouraging conservation and customer choices to reduce usage through AMI monitoring are on the rise nationally. However, uncertainty remains high regarding the methods and cost-effectiveness of obtaining measurable and persistent energy savings from these programs. The introduction of AMI technology will offer opportunities to test new energy efficiency strategies related to consumer conservation as a result of strategic energy management and consumer choice initiatives. Funding has been allocated to the EEUs to test some of these pilots here in Vermont.

Vermont is investing significant monies in AMI. An important objective going forward is establishing a successful track record of measuring and verifying energy savings associated with AMI. To that end, the DPS and the EEUs have dedicated resources to addressing concerns surrounding the service delivery methodology and resulting energy savings, including methods to evaluate the cost-effectiveness of AMI-enabled measures. Clear public messaging related to the roles of EEUs and electric utilities will be needed to seamlessly coordinate and deliver energy efficiency services and data made possible by AMI.

The Public Service Board has opened a docket to address a number of AMI-related topics, including consumers' privacy with respect to AMI data. To a large extent, this proceeding will lay the foundation for how consumer privacy will be protected and what obligations utilities will have to consumers with regard to the privacy of their AMI data. The DPS expects that policy mechanisms will be established to allow AMI data sharing between electric utilities and EEUs and that electric utilities and efficiency utilities will work together to invest in systems and test methods that move AMI-enabled energy efficiency from concept to reality. The DPS also expects robust protection from third-party access to such data (unless explicit customer consent is given).

Recommendations

(1) Establish uniform consumer privacy and cybersecurity expectations for utilities, and establish consumer choice policies.

(2) Complete RF health impact review.

(3) Complete and review consumer studies of the economic benefits of advanced meters.

(4) Establish rate road maps for dynamic pricing and base its implementation on these studies' results.

(5) Study and quantify outage savings and other non-rate-related benefits of Smart Grid implementation.

(6) Study and quantify consumer benefits from new rate designs.

(7) Establish behind-the-meter-related policies and incentives to encourage greater efficiency achievement as consumer appliances and applications are made available in the marketplace.

(8) Study the load management capabilities of new Smart Grid infrastructure, including those related to PEVs and home-based distributed generation systems, and integrate that information into utility IRPs.

5 Vermont's Electric Supply

Electric generation meets Vermonter's electricity needs by converting a variety of resources (renewable, fossil, and nuclear) into electricity and reliably delivering that power to our homes and businesses. This section describes the state's current electricity supply, the regional transmission network that delivers our power, and the potential for a number of technologies and resources to meet our supply needs in the future. The section concludes with a discussion of tools and recommended policies to improve the state's electric portfolio.

Over the last decade, Vermont ratepayers have used electricity from resources with relatively stable prices and relatively low emissions. Going forward, we will face many challenges if we are to continue to deliver electricity "in a manner that is adequate, reliable, secure and sustainable; that assures affordability and encourages the state's economic vitality…that is environmentally sound."[34] These challenges breed opportunities; indeed, the electric sector has an integral role to play in securing Vermont's energy future by implementing policies that will lead to 90% of our energy consumption coming from renewable sources by mid-century.

The challenges and opportunities ahead are a result of Vermont's present circumstances and the events that led us here. In the late 1990s, Vermont resisted the movement toward industry restructuring and retail choice while the rest of New England and the northeastern U.S. moved toward a more competitive environment that increased exposure to short-term and spot-market prices. Under current market conditions, Vermont appears to have benefited by maintaining a vertically integrated structure; the retail rate for electricity in Vermont is currently the lowest, on average, in New England. Part of this price advantage is related to long-term contracts entered into by Vermont's utilities, which will expire soon. New long-term contracts for power have been made by Vermont's electric distribution utilities, but some of these are indexed to the regional market and thus may, over time, result in prices that are more similar to those of neighboring states. And transmission and distribution infrastructure needs both within Vermont's borders and beyond can significantly affect the cost of electric supply.

To meet these challenges, Vermont utilities can continue to develop zero- and low-emissions sources of power for ratepayers, through deployment of and contracts with in-state resources, contracts with resources out of state, and strategic use of system power. Vermont must ensure that the electric sector plays its part to reduce the state's overall greenhouse gas emissions to sustainable levels, and to ensure affordable, reliable, and secure electric supply into the future. As the regional and in-state supply grows more renewable, and as the transportation fleet moves toward electrification, Vermont will be well-positioned to maintain a clean, regionally competitive power supply.

This section's discussion of electric supply begins by describing the current electric supply portfolio and future supply options, focusing on the aggregate interest of all Vermont ratepayers and the utilities' responsibility to

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[34] *30 V.S.A. § 202(a).*

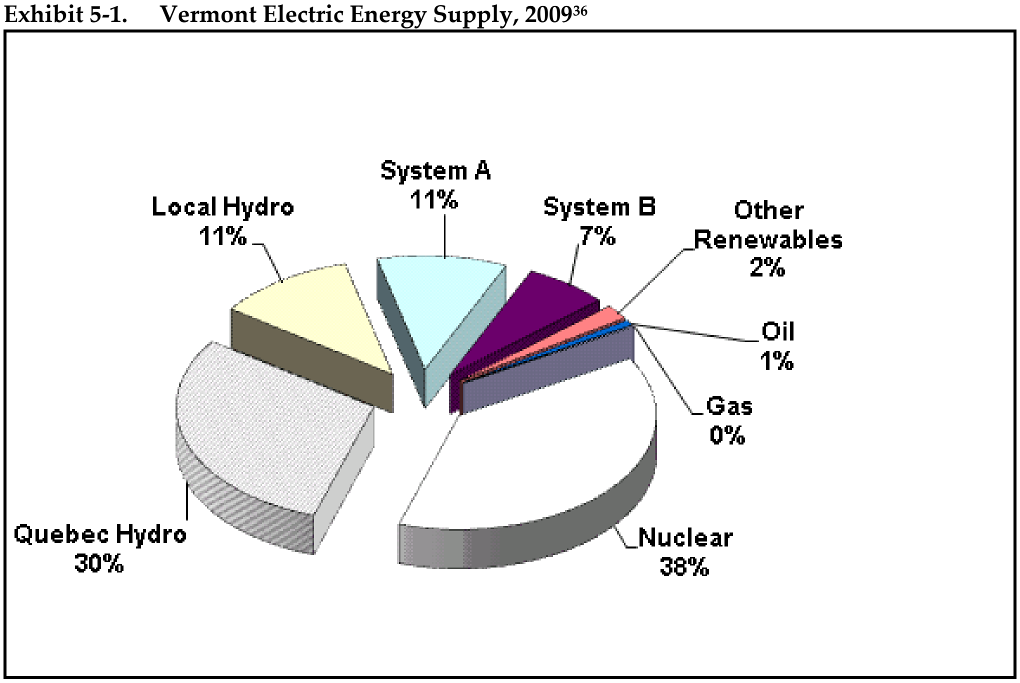
serve the entire electric load of the state of Vermont.[35] Recommendations are provided to facilitate acquisition of appropriate resources to set Vermont on a path to attain the goal of achieving 90% total renewable energy by 2050. We discuss specific policy tools that will help us achieve our goal.

5.1 Current Electric Supply

Historically, the Vermont electric grid has developed to function as an importer of electric energy, and its ties to New England, New York, and the Canadian provinces have served the state well. Nevertheless, Vermont-based resources have supplied a significant portion of the state's electric need.

Although the composition of portfolios for any one utility can vary, the aggregate supply of committed contracts or generation units (as opposed to open market purchases) has provided 85% to 90% of Vermont's energy needs over the last several years, of which 55% to 60% has been from Vermont-based resources. Exhibit 5-1 shows the mix of sources that supplied electric energy to end users in 2009.

Exhibit 5-1. Vermont Electric Energy Supply, 2009[36]



This supply mix is currently dominated by stable long-term commitments focused on two sources—Hydro-Quebec (HQ) and Vermont Yankee, which together have supplied approximately two-thirds of the electricity

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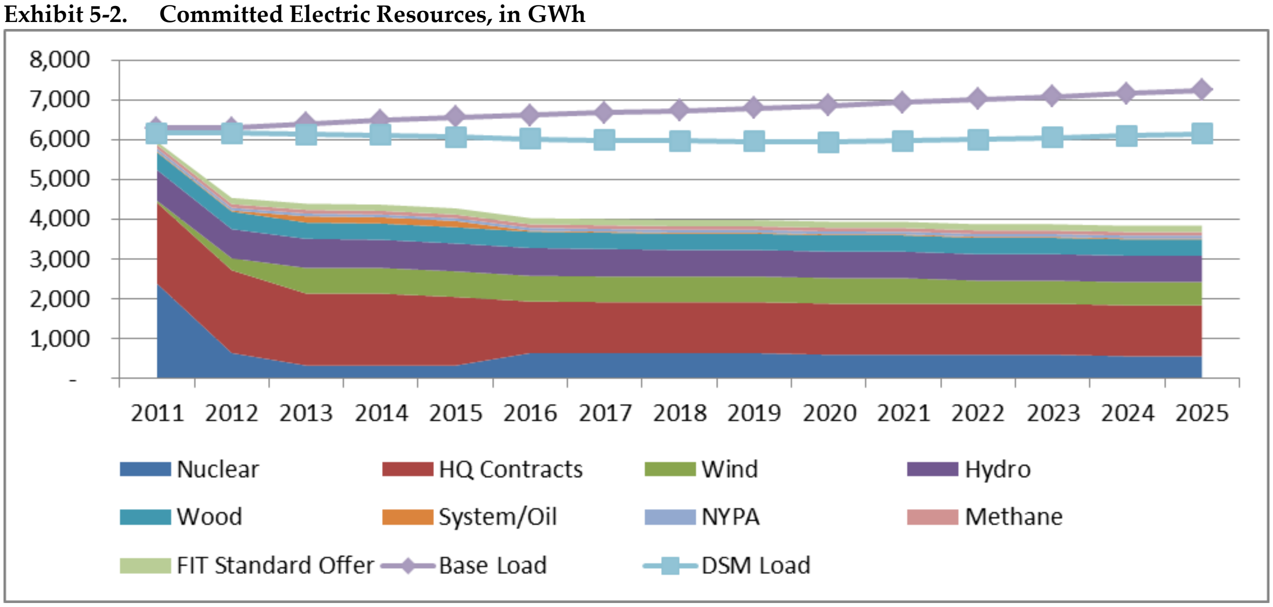
[35] *Forecasts of demand and policies to reduce demand can be found in Section 3. Moreover, although it is discussed in the context of reducing demand earlier in the CEP, efficiency can also be considered a supply resource just like wind, solar, or any other generator, and is the first choice of the state in meeting demand.*

[36] *System A is market purchases of energy by Vermont utilities. System B is energy produced by Vermont renewable facilities where the renewable energy certificates (RECs) have been sold to third parties who now own and claim those environmental attributes.*

used in the state for the last several years. Those two contracts are due to expire in 2016[37] and 2012, respectively. The replacement of these long-term contracts has begun. Recently, a new contract was signed with HQ by a coalition of Vermont utilities for 218 MW of capacity starting in 2016. In addition, as described in more detail in the section on nuclear power, some Vermont utilities have already contracted for power to, in part, replace the power previously provided by the Vermont Yankee contract.

As shown in Exhibit 5-2, even with the new Hydro-Quebec contract and other contracts to replace power previously supplied by Vermont Yankee, a gap between contracted supply and expected demand still exists. There is, however, an excess of supply in our regional market at this time. Vermont remains tied to the regional power pool, so Vermonters will have access to the vast resources inside New England and neighboring areas through the wholesale markets.

Exhibit 5-2. Committed Electric Resources, in GWh



A significant portion of electricity supplied to end users in Vermont is currently from renewable resources. In 2009, in-state hydroelectric power accounted for 11% of supply, and other in-state renewable generation accounted for approximately 2%.[38] Further, power generated from renewable resources in-state with renewable energy certificates sold out of state accounts for another 7% of Vermont's electric supply, for a total of nearly 20%.[39] When the renewable power from Hydro-Quebec, which has been approximately 30% of supply, is counted, nearly 50% of the power supplied for purposes of Vermont end-use consumption is presently from

[37] *The current HQ contract phases out in stages between 2012 and 2020; the majority of the power deliveries end by 2016.*

[38] *The percentage of energy from in-state renewable sources varies from year to year, mainly owing to fluctuations in river levels and the associated water availability for hydro generation. Wood biomass electrical generation also varies from year to year based on market prices for electricity.*

[39] *Vermont utilities own commercial-scale wind and landfill methane projects. Most of the attributes from the landfill methane project were sold into neighboring Vermont markets and therefore cannot be claimed in Vermont as renewable energy.*

renewable sources. While not downplaying the challenges and efforts necessary, we believe this fact shows that a goal of acquiring most of our electric supply from renewable sources is reasonable and attainable.

Vermont utilities should continue to diversify their portfolios with appropriate mixes of renewable energy, through contract procurement and ownership of generating supply via both in-state and out-of-state sources, with a goal of increasing the total renewable generation sources in the state's power mix to at least 75% over the next 20 years. The following sections delineate all the current resources in the electric portfolio, and describe policies and strategies to help achieve greater renewable electricity use in the next 20 years.

Generators can be divided into classes based on their size and how they connect to the grid. The CEP uses three classifications: large-scale centralized, small-scale centralized, and distributed. Large-scale and small-scale centralized generators are tied to the transmission or sub-transmission grids, whereas distributed generation is tied to utilities' distribution circuits. Large-scale is defined as a generator of 200 MW or larger. All three of these classes of generation exist in Vermont.

5.1.1 Large-Scale Production In-State

The infrastructure requirements of large facilities limit their application in Vermont. Currently, the only large-scale generator located in Vermont is the 620 MW Vermont Yankee Nuclear Power Station (Vermont Yankee) in Vernon. Some Vermont utilities contracted for a portion of its power output through March 2012, and the remainder of its power is supplied to neighboring states or the wholesale market.

5.1.2 Small-Scale Centralized Generation In-State

Small-scale centralized generation in Vermont includes hydroelectric, wood biomass, landfill methane, natural gas, and wind generators; these facilities are owned by utilities or by independent power producers (IPPs) that operate under the auspices of the Public Utility Regulatory Policies Act (PURPA).

Utility-owned generators include the McNeil Generating Station (50 MW, wood biomass), Burlington Electric's gas turbine (25 MW), Washington Electric Coop's Coventry Landfill methane plant (6 MW), Searsburg wind facility (6 MW), and a number of small hydroelectric facilities.

5.1.2.1 Independent Power Producers

In addition to utility-owned generators, Vermont has several generators owned by private merchant producers. Recently constructed examples include the Sheffield wind project (40 MW); others, such as the Deerfield wind project and the Georgia Mountain wind project, have received CPGs (certificates of public good) but have not yet been built.

Most of the presently operating, independently owned renewable resources in Vermont were developed in response to the Public Utility Regulatory Policies Act (PURPA). PURPA was passed by the U.S. Congress in 1978 in order to create a framework that allowed renewable projects and cogeneration projects access to the grid at prescribed market rates. Each state was left to implement PURPA on its own; Vermont's implementation of PURPA was through the Public Service Board's Rule 4.100.

Rule 4.100 allowed renewable generators to access stably priced long-term contracts. Twenty hydro projects and one large wood project entered into contracts under this rule. This rule also set up a central purchasing authority (Vermont Electric Power Producers Inc.) to purchase the output from Qualifying Facilities and allocate the costs and energy among the Vermont utilities. The rates for these contracts were established largely during the 1980s and early 1990s, on the basis of then forecasted future market prices. Those estimates have proven to be relatively high compared to the market prices that have transpired since the late 1990s. Although Rule 4.100 and PURPA were successful in bringing renewable energy and independent power to Vermont and much of the region, this approach to stimulating the market proved to be an expensive one when evaluated retrospectively. PURPA renewable energy projects and their annual output can be found in Exhibit 5-3. As can be seen, many of these projects have contracts ending soon.

Exhibit 5-3. Vermont Electric Power Producers (VEPP Inc.)

Project[40]	Annual Output[41] (kWh)	Capacity[42] (kW)	Contract Ending Date
Barnet	1,814,000	490	Oct. 31, 2016
Comtu	2,367,970	460	Dec. 31, 2018
Dewey's	6,903,800	2,790	Jan. 31, 2016
Dodge	27,000,000	5,000	Dec. 14, 2020
Emerson	700,000	230	Oct. 31, 2015
Killington	295,400	100	May 31, 2016
Martinsville	712,000	250	Jan. 31, 2009
Moretown 8	2,519,000	920	Jan. 31, 2019
Nantana Mill	760,000	220	Mar. 31, 2020
Newbury	1,096,268	270	Oct. 31, 2017
Ottauquechee	5,834,000	2,180	Aug. 31, 2017
Ryegate	173,412,000	20,500	Oct. 31, 2012
Sheldon Springs	70,808,000	26,380	Mar. 31, 2018
Slack Dam	1,950,000	410	Oct. 31, 2017
Winooski 1	29,000,000	7,300	Mar. 31, 2013
Winooski 8	3,500,000	910	Dec. 31, 2015
Woodside	729,000	120	Apr. 30, 2017
Worcester Hydro	400,000	170	Oct. 31, 2016

In addition to the policy tools for renewable generation discussed elsewhere in this section, the following are specific recommendations related to these Qualifying Facilities:

Recommendations

(1) *The state should work to maintain existing Qualifying Facilities provided that the plants can be operated cost-effectively compared to new renewable energy generation.*

[40] *All the VEPP Inc. projects are hydroelectric plants, except Ryegate, which is a wood-chip combustion plant.*

[41] *"Annual Output" is an estimate (provided by the producers) of average yearly production.*

[42] *"Capacity" listed is maximum capacity. In some months the capacities for some of the hydros decrease because of statistical water flows.*

(2) *Vermont utilities should explore opportunities to purchase former Qualifying Facilities as well as similar new generation projects currently under non-utility development, if such purchases would lower ratepayer costs in comparison to continued merchant ownership.*

5.1.3 Distributed Generation

Generators that connect directly with Vermont's utility distribution grids include net metered systems and those deployed through the SPEED Standard Offer Program. More than 13 MW of net metering systems have received certificates of public good CPGs), and 50 MW of projects have been approved to receive the Standard Offer. Net metered projects are limited to 500 kW or less, and the Standard Offer projects are 2.2 MW or less. Distributed generation reduces the load on transmission systems by meeting load on a distribution circuit with generation on that or a nearby circuit.

5.2 Considerations for New Generation in Vermont

Electric generation in Vermont can be a boon to the state's economy. However, not every generation technology and scale may be appropriate to meet Vermont's needs. Larger projects yield greater generation and may be able to take advantage of economies of scale, but can have greater negative impacts; smaller projects have less individual impact, both positive and negative. Although the scale of smaller projects may be more readily accepted by Vermonters, it is important to ensure that the projects (which are likely to produce relatively modest contributions to Vermont's energy supply) truly reduce rather than just distribute, environmental impacts.

Building and operating electricity generation facilities requires significant investment that generates substantial direct, indirect, and induced economic benefit. A ripple effect of direct benefits results from development, including jobs, potential land-lease payments and increased tax revenues, indirect benefits from businesses that support the facility, and induced benefits from additional spending on goods and services (e.g., restaurants, retail establishments, and child-care providers) in the surrounding area.

Such projects create engineering, legal services, manufacturing, construction, and operation and maintenance jobs. Jobs related to wind projects are concentrated during the construction phase (however, these jobs are short-term and may employ some out-of-state workers). Apart from specific project job creation, Vermont is home to a number of energy companies that employ Vermonters and export expertise and products.

Construction of new large-capacity generators such as combined-cycle natural gas plants, nuclear generators, and coal generators creates significant regulatory and other risks, due in part to large capital expenses necessary to begin construction, environmental impacts of large-scale construction, and the likely need for significant upgrades to transmission facilities to efficiently move the power. Large-capacity combined-cycle gas plants have been the favored technology for most of the new generation built recently in New England—in fact, approximately 40% of New England's power is generated via natural gas combustion. A large natural gas plant built in Vermont would compete with similar plants in New England, but would have no apparent competitive advantage by being built in Vermont; in addition, siting choices would be limited by the gas transmission infrastructure. Thus, such a plant is unlikely to be proposed here and is not recommended by the CEP.

In contrast to the addition of a large natural gas plant, strategic siting of one or more smaller combined-cycle combustion turbines that are also used for district heating could have multiple benefits—offsetting otherwise needed transmission infrastructure upgrades, reducing reliance on oil for heating, and providing moderately priced energy to parts of Vermont. The potential for combined heat and power using natural gas increases as natural gas service expands in Vermont. This is one of many factors to be incorporated in the evaluation of gas service expansion.

Development of local renewable technologies such as biomass, wind, solar, and hydro will contribute to meeting the goals set by the Vermont Legislature and in the CEP, and be responsive to the wishes of Vermonters as expressed during the broad public engagement processes held for the purposes of revising the CEP. These technologies can be deployed in either a centralized or a distributed manner, depending on the appropriate scale of the resource and the economics of deployment.

Renewable generation technologies deployed on a small scale are presently more expensive than other sources of electricity. However, given the need for zero- and low-emissions energy supply; long-term affordability and price stability helped by the lack of fuel required for most forms of renewable energy; energy security and stability; a diverse resource mix; and the expressed preferences of Vermonters for greater use of renewable resources, these smaller-scale renewable projects offer great potential. See the modeling results discussed above and in Appendix 4—Modeling Study for a discussion of the economic impacts of implementing scenarios associated with significant renewable energy investment, including small-scale distributed generation. Fostering small-scale and distributed renewable energy by increasing regulatory support is an objective of the CEP.

Small renewable electric projects have a number of incentive mechanisms already built into the policy framework in Vermont. Most notable is the SPEED program, which encourages deployment of in-state renewables in both centralized and distributed applications; the SPEED Standard Offer encourages distributed generation in particular. Net metering, the Vermont Small Scale Renewable Energy Program, the Clean Energy Development Fund, Nuclear Electric Insurance Limited (NEIL) program funds, green pricing programs, and tax incentives have all been important in encouraging small-scale renewable energy projects. These programs contribute to the maturation of these technologies, help to foster the renewable energy industry in Vermont, and generate public awareness and acceptance of these technologies. However, the distributed projects that these programs have facilitated still account for less than 3% of Vermont's total electric supply. Specific tools to further facilitate renewable energy supply in both centralized and distributed applications are further discussed below.

The Department of Public Service has created a new staff position for renewable energy project management. This position at the DPS will be responsible for leadership and facilitation of the development of renewable energy projects in the state, promoting collaboration and communication between the DPS, other state agencies including the Agency of Natural Resources (ANR) and the Agency of Commerce and Community Development (ACCD), and the developers and interested parties, in order to offer permit assistance and to facilitate the resolution of barriers to the development of responsibly implemented renewable energy projects.

5.3 Land Use and In-State Energy Resources

The siting of energy resources requires careful consideration when projects are being proposed and built within Vermont's borders. The state has bold goals in this Comprehensive Energy Plan; however, it will be important to review, research, and understand these energy goals in light of other important state goals and the trade-offs that might be made depending on the priority. The siting of in-state energy resources must happen in a thoughtful manner. The planning processes for siting should be strategic; that is, it should consider the best use of lands and townscapes by comparing the costs and benefits of all potential uses. For example: How does a solar farm near a park on the outskirts of a historic town center impact both the residents' and tourists' views of the landscape, the frequency of visits to the park and the related commercial benefits to the town? How do electric vehicle charging stations impact historic district designation and related funding sources for community development? How does biofuel crop production impact a community's ability to provide ample affordable local food at its weekly farmers' market or grow wood for home heating? How do wind towers—smaller scale or utility scale—affect the environment and viewshed? State statutes supplant local regulatory authority for electric generation siting, vesting authority in the Section 248 process. While this helps clarify and unify the permitting process for statewide energy resources, it causes some to question whether proper consideration of competing interests has been provided. Implementing the goals in this Comprehensive Energy Plan is important to the state, but there must continue to be an effort to balance the choice of renewable electricity built in-state with other public goods. (For a fuller discussion of land use issues, see Section 9—Transportation and Land Use.)

5.4 Electric Resource Planning

All the recommendations discussed in this plan—from reducing energy demand, to facilitating grid interconnection and load management of renewable electricity generation, to encouraging electric vehicle use—affect utility planning. Fortunately, in addition to the many planning mechanisms described throughout the CEP, Vermont has specific tools in place to allow for a transparent and open electric resource planning process as completed by our utilities, through integrated resource plans (IRPs) and distributed utility planning efforts. The state must continue to use these activities to ensure implementation of the CEP and its recommendations, and future updates of the CEP.

5.4.1 Integrated Resource Planning

Each of Vermont's regulated electric utilities and the state's natural gas utility must submit for DPS review and PSB approval an integrated resource plan (IRP), every three years, that documents the utility's long-term planning efforts (30 V.S.A. § 218c). A key component of each IRP is the utility's planned portfolio of supply resources, demand-side management programs, and transmission and distribution improvements that will enable the company to serve its customers at the lowest life-cycle cost, including environmental and economic costs, over the next 20 years (30 V.S.A. § 218c(a)(1)). IRPs must be responsive to the Vermont Electric Plan incorporated into the CEP. The IRP process is also intended to facilitate information exchange among utilities, regulatory agencies, and the public and culminate in the filing of utility plans that satisfy the standards for the DPS review and PSB approval with a goal of promoting shared understanding, transparent and sound decision making, and effective planning.

The IRP process that exists today is loosely structured, leaving utilities free to interpret the Vermont statute and prior orders related to the IRP process. This has resulted in significant engagement between utilities and the Department of Public Service. The IRP process has positioned utilities to explore the full range of energy options and solutions to the benefit of Vermont ratepayers. That said, the IRP process can be better utilized as a way to shape the state's electrical portfolio and represents a clear opportunity for the state to engage the utilities in a continual process of reaching the supply portfolio goals laid out in the CEP.

Recommendations

(1) *The state should use the IRP process to work together with the electric utilities to increase the amount of local and renewable energy in their supply portfolios while maintaining the principles of long-term least-cost integrated planning under the definition set forth in Section 218c(a)(1).*

(2) *All future IRPs should consider and plan for electric vehicle penetration in Vermont, and the effect that the resulting increased electricity consumption will have on their systems.*

5.4.2 Distributed Utility Planning

Related to but distinct from integrated resource planning is distributed utility planning (DUP), aimed at creating granular strategies to ensure strategic operation of a utility's distribution system. In shorthand, DUP encourages utilities to consider all available technologies to meet customer demand in the most efficient and cost-effective way. DUP accounts for strategic siting and operation of modular electric generation and storage technologies, and targeted demand-side management programs, to supplement central station generation plants and the transmission and distribution (T&D) grid for cost-effective customer benefits. Applicable generation technologies include small-scale internal combustion engine-generator sets, small gas turbine generators and microturbines, energy storage systems, and a number of "clean" generation technologies, including photovoltaics, wind turbines, and fuel cells. The benefits obtained from DUP can include reducing the load on T&D systems, improving local power quality, and reducing T&D system losses. Distributed utility planning also provides potential for significant benefits for utilities and their customers while lowering financial, environmental, and institutional risks. To date, few electric utilities have fully utilized DUP, owing to a number of regulatory and institutional barriers to distributed resource development. These are addressed specifically in many of the resource supply sections above, and include:

- **Dispersed Benefits**. It is unlikely that the full array of benefits of a distributed resource installation will accrue to the owner of that installation. This could lead to a market failure in which societal resources are allocated inefficiently.

- **Cost Recovery Structures.** Traditional cost-of-service ratemaking, which rewards utilities for prudent capital investments, provides little financial incentive for utilities to lower their investments in T&D. Replacing cost-of-service ratemaking with performance-based ratemaking (PBR) has the potential to reward utilities that effectively implement DUP. In principle, PBR rewards utilities for efficient operation and high-quality service, as measured by performance relative to pre-established targets, rather than for capital investments and sales of electricity.

- **Planning Methodologies.** Traditional distribution planning methods and models do not account for the various costs and benefits of distributed resources. The data required for a comprehensive assessment of distributed resources in a given area may be undeveloped.

- **Generation Ownership and Integration**. In order to effectively integrate distributed generation into distribution systems, distribution system planning needs to be closely integrated with generation planning. Such integration is a departure from traditional distribution system planning functions.

Vermont has supported and encouraged the development of DUP. The Department of Public Service views DUP as consistent with Vermont statutes and Public Service Board precedents regarding least-cost integrated resource planning for the state's electric utilities. Further, the DPS regards DUP as consistent with policies promoting the development of sustainable and renewable energy resources in Vermont. The DPS will continue to work with utilities on DUP, including performance-based ratemaking. The DPS has also been active in establishing reliability benchmarking, a prerequisite to the introduction of PBR. Going forward, the DPS plans to enter into a formal collaborative process with Vermont's electric utilities in an effort to build upon, revise, and further specify the best implementation procedures for DUP. This process will seek to develop procedures for reflecting the principles of DUP in integrated resource planning filings by electric utilities.

5.5 Electric Power Planning: Safety and Security

As many recent significant storm events, including Tropical Storm Irene, have reminded us, the state must be prepared for and plan for electric power supply emergencies. Under the State Emergency Operations Plan, the Department of Public Service has the lead role for State Support Function 12 (Energy), which includes electric energy and thermal energy. The causes of widespread power outages in Vermont have historically been severe weather events, such as those involving snow, ice, or wind. If a severe weather event is anticipated, the electric utilities, the telecommunications utilities, and state agencies such as the Department of Public Service and Vermont Emergency Management participate in daily conference calls before the event to discuss the weather forecast, the status of the electric system (i.e., whether any transmission lines or generation units are out of service for maintenance), and available resources, including plans for additional line crews and associated equipment. The communications continue during and after the weather event to discuss the extent of damage and to coordinate the restoration effort. This helps facilitate a statewide coordinated effort to restore electric service as quickly as possible. The DPS staffs the State Emergency Operations Center in order to ensure that utilities have a means of coordinating directly with key state agencies to assist with outage restoration. In addition, subsection 248(k) and (l) of Title 30 provide an expedited process for utilities to perform work necessary to resolve an emergency.

The DPS also assists in state planning regarding other energy supply disruptions, such as liquid heating and transportation fuels. The DPS is currently completing an Energy Assurance Plan under a DOE grant, which will review and likely augment the state's planning for energy supply disruptions.

Apart from emergency preparedness, 30 V.S.A. § 248, the siting statute for electric transmission and generation projects, requires the Public Service Board to review the impact of a proposed electric transmission or generation project on the public health and safety under criterion (b)(5), and to make a positive finding that there will not be an undue adverse impact on the public health and safety from any proposed facility. The Department of Health has assisted on occasion in such review, and has stated an intention to increase its role in public health review of siting projects.

5.6 Regional Markets, Electric System Reliability, and Transmission Planning

Electric system design and reliability has evolved steadily from the early days when an individual utility was focused on serving an islanded service territory with a discrete set of customers. Then, a generator was often located in the heart of the community, similar to the McNeil Generating Station today in Burlington. With growth came advancements in generation technology that produced large-scale, efficient generators. This evolution caused utilities to build the first high-voltage lines connecting large, remotely located generation with load centers. Often these connections were radial lines. It soon became clear that interconnecting isolated load centers could provide system advantages such as improved reliability as a result of redundant connections, and helped provide load profile smoothing by combining the diverse load characteristics that utilities previously needed to supply individually into a single blended dispatch. The basic model, though larger, was still a self-contained system—"generate for your own load." As we all understand today, this resulted in significant inefficiencies associated with overbuilding generation and underutilizing assets.

In the 1950s, in order to bring St. Lawrence hydropower to Vermont, a single, statewide transmission company—Vermont Electric Company (VELCO)—was formed. Although its ownership structure and purpose have evolved over the years, VELCO remains utility-owned and utility-operated, and continues to manage the statewide transmission system on behalf of all Vermonters subject to the rules of New England's Regional Transmission Operator, ISO-NE, and the Federal Energy Regulatory Commission (FERC).

In the past 15 years, we have seen a dramatic shift in transmission policy and planning, toward a much more regional and federal system. The first major federal order influencing organized markets was FERC Order 888 (1996). It required utilities to offer open access to transmission facilities without undue discrimination to bring more efficient, lower-cost power to electricity consumers. As organized markets emerged, utility mergers occurred, and open access rules were developed, the promise of competition and introduction of efficiencies became attractive. It soon became clear that all the various market participants would advance their own interests. In New England, the existing power pool was transfigured into a competitive market and the transmission owners adopted a pool-wide funding protocol that supported transmission system expansion with the goal that any generator could serve load anywhere in the New England grid. This was a successful strategy and offered some assurance that the right amount of generation would be built and shared across the grid. Rather than building generation for individual areas, generation was acquired and dispatched centrally over the entire system. Not unexpectedly, it also incentivized the building of generation in remote, low-cost areas that coincidentally required large amounts of new transmission investment to interconnect the supply with the load. In the early days, there was little regard for controlling demand by properly valuing incremental load. Early organized markets only promoted supply competition—one generator versus another.

Order 2000 (issued in 2001) was FERC's Regional Transmission Operator Order. It was the impetus for the creation of an independent system operator (ISO) with delegated authority to reliably operate the electric system by dispatching generation and controlling transmission paths on behalf of all market participants. It spawned ISO-NE and other similar organizations elsewhere in the U.S. This model extracted various efficiencies. FERC recognized the need for independence and the ability to balance the needs of all stakeholder groups. These ISO characteristics became very important. To ensure repeatability, transparency, certainty, and objectivity it also became very important to develop precise market rules and a system of checks and balances. Market rules today are as complex as the IRS code.

In 2001, to support ISO-NE's mission, management chartered a planning advisory committee and a regional system planning process. These have become important system planning tools, implemented by work groups of stakeholders. In Order 890 (2007), FERC highlighted the value of ISO-NE's process, and defined the purpose of these working groups more precisely by requiring coordinated, open, and transparent regional transmission planning processes to address undue discrimination. This was viewed as both the equal rights amendment for non-transmission alternatives (NTAs, see below) and an acknowledgment that interregional planning was needed.

The intense focus on the business aspects of electricity delivery was replaced with reliability concerns in 2005. The impetus for some of the key elements of the Energy Policy Act of 2005 (EPAct 2005) was the Northeast blackout of 2003. EPAct 2005 authorized FERC to enforce reliability standards, which has the effect of requiring transmission infrastructure upgrades to avoid penalties. FERC delegated authority to the North American Electric Reliability Corporation (NERC) to develop mandatory planning, construction, and operating standards. Broad standards affecting the bulk electric system were published and compliance mandated, with fines of up to $1 million per day for continued violations. The long-range impact of these standards is not yet clear. What is known now is that new stringent planning and design criteria are being adopted and must be incorporated retroactively into transmission systems. This trend is likely to have a significant cost impact due to the need for reliability compliance upgrades in the region and Vermont where an aging infrastructure with legacy weaknesses exists.

Recently, FERC issued Order 1000 (2011). This rule advances past requirements by more prescriptively ordering transmission planning at the regional level to consider and evaluate possible transmission alternatives and to produce a regional transmission plan. It also requires the cost of transmission solutions to be allocated fairly to beneficiaries. The "cost causer" and "beneficiary pays" model used to meet this requirement was upheld. The order is expected to shape transmission expansion activities for the foreseeable future in a number of ways:

- Public utility transmission providers are required to participate in a regional transmission planning process that produces a regional transmission plan.
- Local and regional transmission planning processes must consider transmission needs driven by public policy requirements established by state or federal laws or regulations.
- Public utility transmission providers in each pair of neighboring transmission planning regions (for Vermont, ISO-NE and New York's ISO) must coordinate to determine whether more efficient or cost-effective solutions are available.

The second issue is particularly relevant. Order 1000 requires each public utility transmission provider to establish procedures that identify transmission needs driven by public policy requirements, and evaluate potential solutions to those needs. Public policy requirements are defined as enacted statutes and regulations promulgated by a relevant jurisdiction, whether within a state or at the federal level. In addition, Order 1000's provisions are likely to allow and even encourage competition by independent or merchant transmission providers where the incumbent transmission owner is unable to effectively respond to a particular need.

Finally, per the third point above, the topic of interregional planning is addressed by this order. Interregional transmission facilities are those that are located in two or more neighboring transmission planning regions. The order states that each pair of neighboring transmission planning regions must share information regarding the respective needs of each region and potential solutions to those needs, and identify and jointly evaluate interregional transmission facilities that may be more efficient or cost-effective solutions to those regional needs. This is a promising development because it encourages regional transmission organizations to look for solutions that lie outside their footprint and capture efficiencies that may be described as low-hanging fruit. Often, complicated cost allocation schemes and lack of communication between areas limit opportunities to craft mutually beneficial solutions.

Electrically speaking, Vermont occupies an integral position in the New England electric system and enjoys a strategic advantage because it is interconnected with the separate systems in New York and Canada, both of which have power resources and robust transmission. The current regulatory environment has a disposition for competitive market solutions and offers an encouraging outlook for advancing creative transmission solutions related to public policy needs. In this climate, it is plausible to envision successful projects that interconnect renewable resources with load centers in all three regions.

To accomplish such new transmission solutions in a manner that benefits Vermonters requires a good plan and the support of interested stakeholders. We are fortunate to have an established planning organization in

Vermont—the Vermont State Planning Committee (VSPC). Although the prime responsibility for reliability planning of the bulk power grid has shifted to ISO-NE as a result of EPAct 2005 initiatives, Vermont will still control key decisions that affect our transmission system, such as permitting. Nevertheless, board rules and the VSPC will need to adapt based on the mandates from EPAct 2005. For example, planning criteria established by NERC are now mandatory and enforceable, and they largely preempt state review. So, while permitting remains a Vermont PSB role, planning has shifted to the regional level, and penalties are incurred if needed upgrades are not accomplished. Order 1000 requirements and the lessons from the Eastern Interconnection States Planning Council (EISPC) are likely to continue to push transmission planning responsibility away from Vermont. It will be vital for Vermont to effectively participate in these regional and national decision-making processes. A review of VSPC's role and charter is appropriate to ensure it fully reflects the changes that have occurred in transmission planning standards and authority.

As evidence of this change, several independent transmission companies are already advocating for a greater role in the system regionally, describing their belief that allowing independent transmission developers to compete for cost-of-service projects will result in benefits such as new capital investment in a region, more cost-effective transmission projects, and better ways to integrate small renewable generation projects into the grid, by, for example, one radial line lead connecting multiple projects to the larger transmission grid. One merchant generator partnership project with VELCO, the Champlain Wind Link that would connect northern New York to northwestern Vermont in the Burlington area, continues to be considered and may provide both additional transmission capacity and reliability benefits. Evaluating the evolving role of independent, merchant transmission companies must be a part of Vermont's energy planning going forward.

Building transmission should not be the only answer to a reliability issue. Recently issued FERC Order 1000 prescribes a role for public policy considerations that may allow Vermont to advance a position we have long advocated: regionally shared funding of alternative market solutions, or non-transmission alternatives (NTAs), as they have sometimes been called. The current system for regional cost sharing is exclusive to transmission projects even when equivalent lower-cost alternatives are found. NTAs presently are not eligible for regional cost sharing.

The recent Vermont/New Hampshire 10-Year Transmission Needs Assessment provides a practical illustration of how, in some instances, NTAs such as generation and demand-side resources can provide less costly alternatives to solving a reliability problem than building or upgrading transmission. A recent pilot study suggested that either a $220 million transmission upgrade project or a targeted generator project at less than one-third the cost may address an identified reliability issue in northwestern Vermont. Although the study was not meant to be a complete and conclusive reliability analysis, the finding that a particular NTA might avoid a significantly more expensive transmission solution generated significant interest in better understanding the mechanics of how sharing the costs of one solution but not another can create perverse incentives.

Vermont's funding obligation for reliability transmission projects is based on the regional load ratio share, currently at about 4%. This means that Vermont's share of a $220 million project would be less than $10 million, whereas there would be no regional sharing of the costs associated with choosing the NTA, even though the overall cost could be much lower. This conundrum is likely to be repeated throughout New England. This issue needs to be addressed to ensure that financial signals consider, influence, and optimize both system performance and cost structure in order to avoid unnecessary electric transmission build-out and greater long-term cost for all ratepayers.

Vermont's interest in treating the cost of equivalent solutions equitably is not intended to discount another important concern raised by ISO-NE: that any individual NTA must truly resolve an identified transmission reliability problem. Expansion of solution sets in the planning process would help ensure selection of appropriate alternatives. Vermont supports a robust process and recognizes that any identified reliability issue may require a combination of projects. We object only to an uneven playing field that does not encourage cost-effective choices.

Transmission planning and market advocacy should be done holistically, because in some cases, one project has the potential to spur another project of value. For example, if our interconnection to New York (known as PV20) is upgraded, and imports there become more reliable, there is likely to be value in establishing PV20 as a pricing node for scheduling transactions. The present import configuration combines multiple interconnects and then prices them all at one proxy node. Unfortunately for Vermont, that node is in western Massachusetts and often reflects higher location marginal price than PV20 might because of congestion. After we resolve the operational restrictions at PV20, we could investigate resolving the market barriers that have the potential to allow delivery of lower-cost power to Vermont.

Looking forward, we must improve our place in the regional market and work to strengthen our transmission system here in Vermont.

Recommendations

It is critical that Vermont:

(1) Focus on ensuring that existing regional transmission facilities and interconnections at Highgate, Derby Line, and elsewhere are as robust and reliable as possible.

(2) Focus on electric efficiency and peak load reduction, because it is Vermont's coincident peak load that is used to calculate Vermonters' share of regional transmission reliability projects.

(3) Place greater focus on Vermont's regional participation and advocacy at ISO-NE, FERC, and regional organizations such as the New England State Committee on Electricity. Vermont participation in market rule making and the regional transmission planning structure is key to keeping the state's interests protected as transmission policy continues to evolve toward regional and national control.

(4) Focus on greater connection between in-state energy policy and regional transmission planning advocacy. VSPC should complete its process of revisiting its mandate and effectiveness as even greater

federalization of transmission planning continues to emerge. Vermont must have a say in the development (or reform) of market rules and must position Vermont to respond to developments in the market itself.

(5) *Advocate for and cooperate regionally in transmission projects that will improve inefficiencies in neighboring transmission zones—for example, the existing PV20 transmission line from the Plattsburgh, N.Y., to Sand Bar, Vt., substations. This asset is currently underutilized because reliability criteria limit its operation. Coordination efforts with NY-ISO and NYPA are under way to approve construction in New York to relieve system constraints that presently restrict imports on PV20 into Vermont.*

(6) *Support appropriately sited and planned transmission projects capable of bringing renewable energy from its source to market throughout the region, in order to bolster the economics of renewable electricity for Vermonters and their neighbors.*

(7) *Continue to push for market reforms that will allow Vermont to effectively pursue NTAs wherever feasible.*

(8) *Promote regular communication about energy matters among all Vermont stakeholders, including utilities, regulators, legislators, communities, and the media, to ensure there is an understanding and awareness of the issues and challenges surrounding this vital matter.*

Overall, we must focus our attention on the reliable and strategic use of our transmission system, and we must continue to press for regional market rules that align with our goals. An appropriately sized and utilized transmission system, in conjunction with efficiency programs that reduce demand and effective development of distributed renewable generation, will ensure a reliable and robust electric transmission system.

5.7 The Regional Greenhouse Gas Initiative

Since 2005, Vermont has participated in the Regional Greenhouse Gas Initiative (RGGI), a regional cap and trade effort designed to reduce CO_2 emissions. Each of the 10 states[43] that participate in RGGI is represented by energy and environmental regulators; in the case of Vermont, these representatives are the chair of the Public Service Board and the secretary of the Agency of Natural Resources (or their designees).

[43] *There have been 10 states participating in RGGI: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Jersey, New Hampshire, New York, Rhode Island, and Vermont. However, New Jersey is withdrawing from RGGI at the end of 2011.*

All the RGGI states have implemented statutes or rules that require fossil fuel–fired electric generating units with a capacity of 25 MW or greater to hold enough allowances to cover the CO_2 emitted from the generating unit. Under RGGI, each of the participating states is allocated a certain number of allowances during a three-year compliance period, based on the CO_2 emissions from that state. The states collectively auction the allowances on a quarterly basis, and any entity can purchase allowances. In addition, there is a secondary market in which allowances can be traded. In Vermont, the proceeds from the RGGI auctions are used to fund thermal efficiency programs and also to fund the Property Assessed Clean Energy (PACE) loan loss reserve program.

There are currently two generating units in Vermont that must comply with RGGI requirements, one owned by Green Mountain Power Corporation and the second owned by the city of Burlington (Burlington Electric Department). Each of these units runs only a relatively small number of hours per year, and accordingly, GMP and BED need to purchase only a small number of allowances for the compliance period.

RGGI is the first CO_2 cap and trade program in the U.S., but it is not an unqualified success. Most seriously, the cap is significantly over-allocated, resulting in regional emissions that fall well under the cap. Although the cap is, by design, expected to be slowly lowered over the next five years, allocations could still exceed emissions. Several factors account for this, including the economic recession, which began shortly after RGGI began conducting auctions, and reduced energy use (and therefore reduced emissions from generating units) in the United States. In addition, the decline in natural gas prices resulted in generation units in the Northeast switching from dirtier fuels, such as coal or oil, to natural gas, with a corresponding reduction in CO_2 emissions. Finally, there have been additional significant investments in energy efficiency, in part due to the investment made in utilizing RGGI proceeds.

Additionally, the methodology used to allocate emissions among states could be improved. The methodology starts with the historical CO_2 emissions for each state; the number of allowances for each state, however, was based in part on historical emissions and in part on negotiations involved in developing the program. A methodology that is based solely on historical emissions penalizes states such as Vermont, which has a long history of implementing energy efficiency programs and encouraging utilities to pursue contracts with renewable generation units. The goals outlined in the CEP will exacerbate this problem if RGGI reforms are not accomplished, by further reducing the emissions generated from Vermont's electric usage.

Recommendation

The participating states have announced that they are preparing for a comprehensive review of the RGGI program in 2012. To the extent that the number of allowances allocated to individual states is altered in the future, the methodology should reflect the fact that some states have invested considerable effort in reducing CO_2 emissions independent of the RGGI program. Further, the remaining participating states should actively investigate lowering the cap to effectuate actual decreases in CO_2 emissions.

5.8 Electric Supply Resources

Several resources currently contribute substantial portions of Vermont's electricity supply, and are expected to continue to supply Vermont's electric power needs. These resources include biomass, hydroelectric, solar photovoltaic, wind, natural gas, and nuclear.

5.8.1 Biomass

> Bioenergy includes:
>
> —Solid biomass from woody plants and agricultural crops, such as corn or grass.
>
> —Liquid biofuels, including biodiesel and ethanol.
>
> —Biogas, such as methane from agricultural digesters, landfills, or wastewater treatment plants.

Biomass from agriculture and forests can play an important role in providing energy for Vermont. Resources such as woody biomass, agricultural crops including grass and residues in the form of solid fuel, liquid biofuels, and biogas—collectively known as bioenergy—are steadily becoming more attractive in the Vermont energy market. Bioenergy is a broad category with individual fuels, feedstocks, and technologies at different stages of R&D, commercialization, and market readiness in the state.

Certain types of biomass, such as wood, can be used for energy without significant processing; many other organic products are converted to biofuels such as ethanol or biodiesel—liquid forms of biomass energy—before being consumed, or are processed into dried solid biomass pellets (woods and grasses). Other forms of biomass, such as municipal solid waste and manure from livestock, are used to produce biogas at landfills or in methane digesters on farms. These forms of energy have helped to displace a significant amount of fossil fuel consumption in the U.S., and have concurrently addressed disposal problems associated with these wastes.

Vermont's bioenergy options are at different stages of market development, and each will require a different development timeline and investment strategy. All forms of bioenergy, like the other forms of energy production, have pros and cons that must be weighed carefully prior to implementation. The CEP discusses some of the ways that Vermont can expand the use of bioenergy resources while making decisions that are economically, environmentally, and socially responsible.

This section poses strategies and recommendations for appropriately and sustainably mobilizing supply and demand, primarily for wood-fired biomass and biogas resources for electricity generation. There is potential for the greater use of biomass material other than forested wood for electric generation; for example, grass, crops such as corn, and fast-growing trees such as willows can be cultivated as energy crops. Although the CEP recognizes the potential of these non-wood sources, they are not anticipated to contribute significantly to electric production in Vermont in the near term. Therefore, this section focuses primarily on generating electricity from farm methane and woody biomass. This is not meant to discourage development of these other sources; indeed, the DPS believes these sources may mature into significant contributors to our energy mix in future years. The DPS will continue to follow these sources and associated technologies, and will evaluate their potential for Vermont as they develop.

Section 8—Thermal Energy Sources and Section 9—Transportation and Land Use address agricultural biomass (e.g., grass pellets) and other biofuel sources, issues, and recommendations for heating and mobility, respectively.

It is important to recognize that at the time of the CEP's release, there are other, concurrent efforts to evaluate the current and future uses of biomass for energy in Vermont. For example, the state's Biomass Energy Development Working Group, discussed below, is scheduled to release its findings at the end of 2011. Further, our understanding of the science of forest carbon exchange is shifting rapidly, as are forest products markets, thus increasing the importance of public and private stakeholders' working together to monitor and evaluate the effect of policies during their implementation.

5.8.1.1 Current Wood-Fired Electricity Generation

Currently, biomass meets about 6% of the electric load in Vermont, including biomass electric facilities, farm methane, and landfill methane.[44] About 14% of the state heating needs are met with biomass fuels, including cordwood.[45]

Vermont currently hosts two wood-fired biomass electric facilities: Burlington's 50 MW McNeil Generating Station, and the Ryegate 20 MW plant. Woody biomass is also used for combined heat and power (CHP) in some businesses, universities, and institutions around the state.

Opening in 1984, the McNeil plant was the first in-state wood-fired generator, providing a market for low-grade wood and creating jobs and economic benefits throughout the state. McNeil does not operate as a baseload facility as envisioned, but rather functions as an intermediate plant at a 50% to 60% capacity factor, owing to a combination of wood supply and bid pricing issues. Although the plant can use oil or natural gas, it runs primarily on wood chips, using 1.45 tons of wood to produce each MWh.[46] The plant burns about 400,000 tons of wood per year.[47] McNeil was also constructed with the idea that it could provide district heating to either the University of Vermont or to Burlington, making use of the energy otherwise lost, but this aspect of the project has not yet been implemented. However, the Burlington Electric Department (BED) and the city of Burlington's Community and Economic Development Office (CEDO) are exploring options to heat downtown homes and businesses with the existing surplus heat from the McNeil Generating Station. A group of local citizens and staff from BED and CEDO formed the Burlington Electric District Energy System (BURDES) and are in the early stages of planning the service.[48]

[44] *EIA Renewable Electricity Profile,* www.eia.gov/cneaf/solar.renewables/page/state_profiles/vermont.html

[45] *EIA 2009 State Energy Data System.*

[46] *BED 2008 Integrated Resource Plan.*

[47] *Actual consumption reported was approximately 327,000 tons in 2009. Estimated Wood Fuel Usage in the State of Vermont, Vermont Department of Environmental Conservation.*

[48] *For more information, see:* www.burlingtonelectric.com and www.burlingtondistrictenergy.org

The Ryegate wood-fired generation plant came online in 1992 with a capacity of 20 MW. It is the only non-hydroelectric independent power producer that sells through the Vermont purchasing agent.[49] The plant burns about 250,000 tons of wood per year.[50] The facility produced 175.1 million kWh of electricity in 2010, which was sold to Vermont utilities at an average price of about $0.14 per kWh.[51] Because its PURPA contract is set to expire, the plant received attention during the 2011 Vermont legislative session, culminating with Act 47, which required the SPEED facilitator to purchase baseload power from the facility at a price to be set by the Public Service Board.[52]

Out of the 1.5 million tons of wood consumed in Vermont annually for energy, approximately 650,000 green tons of wood are used to generate the 70 MW of electricity at McNeil and Ryegate.[53]

The two power plants fueled with wood in the state have been a valuable part of the forest products economy. Retaining them should be a goal of state policy.

The wood used in Vermont's two power plants has been obtained from Vermont and from surrounding states and provinces. Since 1984, some wood fuel has also been shipped from Vermont to power plants in New Hampshire, Maine, and New York. The amount of wood shipped to out-of-state power plants has fluctuated, and no simple trend has been exhibited. The maximum shipped out of state to date was 76,451 green tons (1998), and the minimum was 68,453 green tons (2003).[54] This illustrates the regional market for wood; as a commodity it is being bought and sold across borders throughout the region.

In addition to the two large biomass power plants, there are several smaller institutional and commercial CHP wood-fired biomass operations. Collectively, these micro CHP facilities add only a few MW of electric capacity to Vermont and consume about 30,000 tons of wood per year.[55]

5.8.1.2 Projected Biomass Wood-Fired Electric Production Potential

The Vermont statutes set forth a statewide goal of 20% of electricity sales from new renewable sources by 2017, and also seek, by the year 2025, to produce 25% of the energy consumed within the state through the use of

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[49] *See VEPP Inc., http://veppi.org/*

[50] *Actual consumption reported was approximately 272,000 tons in 2009.Estimated Wood Fuel Usage in State of Vermont, Agency of Natural Resources, 2009.*

[51] *Vermont Electric Power Producers Schedule C Monthly Billing Information, 2010 (http://veppi.org/monthly-production).*

[52] *30 V.S.A. § 8009.*

[53] *The actual reported combined use was about 599,000 tons in 2009. Estimated Wood Fuel Usage in the State of Vermont, Vermont Department of Environmental Conservation.*

[54] *Vermont Agency of Natural Resources Department of Forests, Parks and Recreation data.*

[55] *Estimated Wood Fuel Usage in State of Vermont, Agency of Natural Resources, 2009*

renewable energy resources, particularly from Vermont's farms and forests (30 V.S.A. § 805(d)(2) and 10 V.S.A. § 580, respectively). Vermont law also stipulates that a goal of this Electric Plan be to assure that by 2028 at least 60 MW of power are generated within the state by CHP facilities powered by renewable fuels or by non-qualifying SPEED resources.[56] This Electric Plan includes evaluation of 60 MW of CHP in the economic model (see Appendix 4—Modeling Study).

The Vermont 25 x '25 Initiative, launched in 2008, determined that bioenergy fuels from our fields and forests have the technical potential to produce about 25% of the total energy consumed in Vermont by 2025, and that we should strive to attain that level.[57] The 25 x '25 Initiative provided specific technically achievable goals for wood energy production, which can be seen just below.

Exhibit 5-4. Wood Energy 25 x '25 Energy Production Goals

Technology	Energy Type	Energy Prod (2008) (in Billions of Btu)	% of Load (2008)	2025 Energy Production (in Billions of Btu)	% of Load (2025)
Chunk Wood	Heat	5,160	3.05%	764,000 green tons (5,800)	3.40%
Wood Pellets	Heat, Electric	327	0.19%	228,000 green tons (1,550)	0.92%
Wood Cips	Electric only	1,200	0.71%	1,000,000 green tons (1,720)	1.02
Wood Chips	Heat only	520	0.31%	126,500 green tons (707)	0.42%
Wood in CHP	Heat, Electric	760	0.45%	547,000 green tons (3,060)	1.81%

Source: Vermont 25 x '25 Initiative Preliminary Findings and Goals, Spring Hill Solutions, January 23, 2008

In 2008, the 25 x '25 Initiative conservatively calculated that wood-fired electric-only plants produced approximately 1,200 billion Btu of energy, equivalent to about 40 MW, which is below the rated capacity for the two existing plants. The goal for 2025 of 1,720 billion Btu would require an additional 520 billion Btu of power from wood-fired electric-only plants, equivalent to another 25–30 MW facility. This new production was estimated to require 300,000 green tons of wood, which, when combined with the estimates for wood used at the McNeil and Ryegate plants, would total about 1 million tons of wood annually for the production of electric energy in 2025.[58]

The CHP base level in 2008 showed 760 billion Btu of CHP (~25 MW) increasing markedly by 2025 to 3,060 billion Btu (~100 MW at 65% system efficiency). Using estimates from the 25 by '25 Initiative, this additional production of 75 MW CHP would require approximately 400,000 green tons of new wood supplies. Combined with existing CHP, total CHP would require about 547,000 green tons in 2025. Adding this to the electric-only

[56] *30 V.S.A. § 202(i).*

[57] *Vermont 25 x '25 Initiative: Preliminary Findings and Goals, Spring Hill Solutions, 2008, Table 1, pp. 4–5, www.vermontagriculture.com/energy/index.html.*

[58] *See Vermont 25 x '25 Preliminary Findings and Goals, p. 12 and Appendix A—Energy Calculation Notes, for information on assumptions in the calculations, January 23, 2008.*

projections would require 1.5 million tons per year for projected power. Other projected wood uses estimated at about 1,118,500 tons of wood would be used for heating purposes, plus 500,000 tons for possible cellulosic ethanol production, bringing total wood use to an estimated 3.1 million tons per year.

The 25 by '25 technical analysis assumed 1.5 million green tons would be available for new harvest in addition to the 1.5 million tons currently used. One million of those new tons were to be dedicated to both electric and thermal energy and the balance used for cellulosic ethanol. Since cellulosic ethanol R&D has not made much progress in the region, the CEP does not assume that wood will be used to produce ethanol. More recent studies indicate that a level of 1.5 million green tons per year for energy production may be high. A study conducted by the Biomass Energy Resource Center set forth a level of harvest of approximately 900,000 green tons per year from Net Available Low-grade Growth (NALG). (See Appendix 6—Forest Management for Bioenergy for details.) This amount of wood would need to service any expanded electrical and thermal demands emerging in the region.

Assuming that the estimated new electric and CHP wood-fired production capacities were to come on line by 2025, such deployment would require an additional 700,000 tons of wood (300,000 tons for new electric plus 400,000 for new CHP). Section 8.3.2 of the CEP (Biomass Availability for Thermal Energy Use) identifies that the state could potentially use all 900,000 green tons NALG for thermal heating. If some or all of the projected electric and CHP facilities are sited, the state would have less wood available to meet potential thermal uses.

These projections show there may be more potential demand for wood for energy than is available in the state. Fulfilling both potential thermal and potential electric demand may require obtaining wood from surrounding states, and they face similar challenges. Moving in the direction of both new electric and CHP with thermal uses continuing at the same time would likely lead to rising prices, could lead to overharvesting, and likely would constitute a missed opportunity for the state to effectively prioritize the most efficient thermal applications that displace the most fossil fuels.

The increased efficiency of thermal-led CHP yields greater energy output with proportionately less harvesting than electric-only production. Assuming regional harvest rates remain below the annual growth rates, and forest management practices continue to support long-term forest health, there may be an opportunity to site small- to medium-sized electric-only woody biomass power facilities while maintaining the state's priority to reduce fossil fuel use by using wood resources for thermal and thermal-led CHP applications that displace fossil fuels. However, any decisions about wood-fired electric or CHP projects must take into account the potential competing demand for woody biomass emerging in the region, as well as prioritized demand for thermal energy production as recommended by the CEP. Since the addition of a new wood-fired electric facility would have a measurable impact on biomass supplies, it is important to understand overall emissions, carbon impacts, and impact on competing uses as a part of overall planning and permitting for any new electric plant.

5.8.1.3 Challenges to Wood-Fired Electrical Generation

The limited efficiency of wood-fired electric generation plants presents a challenge to wood-fueled generation's development. The upper end of efficiency is typically around 25% for electric-only woody biomass plants. In the context of a large increase in demand for wood and the partially understood limits to sustainable forest production, this level of efficiency, when compared to other uses, is low. In addition, this low efficiency affects the carbon balance of wood combustion as well as the balance of carbon in forest stocks and soils. Even though forest biomass does not represent sequestered carbon in the way oil or coal does, wood combustion does create CO_2 emissions. A more efficient burn would improve that balance.

The past five years have been a time of speculation for wood-fueled power generation. Both new utility-scale and smaller-scale developments have been proposed throughout our wood supply market. Though none have yet been built in Vermont, new facilities such as the 75 MW Burgess Biopower facility in Berlin, N.H., are under construction in the region, meaning that the practical outcome will be increased competition for fuel grade wood in our region.[59]

The CEP recommends a focus on higher-efficiency uses of woody biomass energy given the inherent limits and increasing demands on forests in the region. At the time of the CEP's release, there were two proposed woody biomass electric production facilities in Vermont under consideration that would each yield approximately 30 MW of electricity and use a portion of the thermal energy generated for other purposes. These facilities, or others that may be proposed, could help meet the 60 MW CHP goal set by the Vermont Legislature if they could find a use for the large amounts of thermal energy the plants create. In addition, there may be opportunities for small-scale CHP projects at the community, commercial, and institutional level for wood, grass, or other biofuel sources. For example, one 400 kW wood-fired CHP project is under development at Rutland Plywood Corporation's plant in Rutland.

Wood fuel has evolved from being essentially a waste product to being a commodity whose price is reflective of its economic value. From 1984 to about 2001, the price paid by power plants for wood fuel was $18 per green ton. From 2001 to present, the price has risen to about $32 per ton. Throughout those two periods, there have been instances of spot pricing, when the price for wood fuel paid by power plants increased to $28 per green ton as a peak during 1984–2001 and $39 during 2001–present. For most of the period 1984–present, the wood-fueled power plants relied on a blend of wood processing residues, wood from forest harvesting, and wood residues from municipal and other sources. In or around 2001, the demand for wood processing residues surpassed supply. Since then, the additional demand for wood fuel has been satisfied by forest harvesting.

The CEP recognizes the challenges inherent with development of new biomass energy options in the state. Facilities proposed for development as electric or CHP projects have the potential to increase the number of jobs in the state and generate a modest addition to the state's baseload power production. Additional baseload production from renewables is required to meet the challenge of the CEP's 90% goal, and biomass electric production at one or more facilities has the potential to contribute to that goal. Such additions would contribute to state and municipal tax revenues while circulating dollars in local economies.

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[59] *Groundbreaking held for N.H. biopower plant, Biomass Power and Thermal.* http://biomassmagazine.com/articles/5846/groundbreaking-held-for-nh-biopower-plant.

At the same time, devotion of forest biomass to electric-only generation increases the short-term carbon debt and has the potential to threaten the long-term health of forest ecosystems should market pressures lead to overcutting and poor forest management practices. Increasing the demand for forest products risks raising the prices for lower-grade firewood—a burden that would fall disproportionately on lower-income Vermonters who rely on firewood to heat their homes. As reflected in the volume of public comments received by the DPS in opposition to electric-only woody biomass power, many people are interested in seeing that forest resources be used as efficiently as possible.

One of the major challenges facing all biomass power is facility siting. Siting challenges include the limited number of properties suitable for industrial development, transportation infrastructure limitations, public infrastructure limitations (water, sewer), and both power and thermal infrastructure limitations for CHP. Particulate matter from biomass combustion typically requires advanced technologies to control emissions. Such pollution control technologies can reduce emissions but add to the cost, which can make biomass less competitive with natural gas plants that do not need such equipment.

The key challenge in developing CHP at the power plant size is locating a host facility that has the ability to use the magnitude of waste heat produced on a continuous basis. People generally do not want power plant–sized facilities located in or near population centers, but this is exactly where such facilities would need to be to make use of the thermal heat if industrial process uses can't be developed. As noted above, the McNeil plant has the potential to add a heating loop because it is near the UVM campus, but to date has not done so. Ryegate, on the other hand—which has the capability of heating approximately 1,300 homes—has no such potential host within a feasible distance.

The Standard Offer Program currently requires biomass plants to meet an efficiency level of 50% to be eligible.[60] With an electric-only plant's efficiency below 30%, the only way to meet the requirement is with a CHP plant, which was the intent of the eligibility requirement. However, with the lack of industrial heat loads in Vermont, this requirement has been very difficult to meet. This suggests the need to revisit the efficiency standards for the Standard Offer Program, with an eye toward whether the present requirements allow for sufficient development of CHP applications.

Adjusting the requirement to allow for thermal-led CHP projects to participate in the Standard Offer Program would benefit the state by providing additional baseload electric capacity, increasing our operational knowledge of CHP plants, decreasing reliance on fossil fuels, and supporting the local economy. Therefore, the DPS recommends that the PSB be charged with setting the efficiency standard for biomass CHP projects in the Standard Offer Program with the goal of meeting the statutory objective of robust deployment of CHP plants.[61]

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[60] *30 V.S.A. § 8005(j).*

[61] *Title 30 § 202(i): "it shall be a goal of the electrical energy plan to assure, by 2028, that at least 60 MW of power are generated within the state by combined heat and power (CHP) facilities powered by renewable fuels or by nonqualifying SPEED resources."*

The efficiency requirement should include a mechanism to incentivize CHP plants with efficiencies of less than 50% that are allowed into the program to increase their efficiencies over time.

Overall, the DPS recommends that Vermont's limited state incentives and financial resources flow first to the most efficient projects that displace the most fossil fuel for the investment. Combined heat and power projects thus remain the priority. However, biomass electric-only power plants that qualify as a renewable resource may be constructed in Vermont if projects are viable financially with only the federal incentives in place. It should be noted that these existing incentives, such as the production tax credit and RPS incentives in other states, favor electric development. The recommendation to prioritize thermal uses of woody biomass means that Vermont will have to be vigilant in its own policy so that federal incentives do not function as the main determinant for energy development in the state.

5.8.1.4 Carbon Implications for Biomass

All fuels release carbon dioxide when burned, yet the emissions balance for biomass energy is a complex issue. Increased harvest of biomass for electricity or thermal energy changes natural carbon dynamics. Carbon is taken in and stored in soils, trees, and other biomass during plant growth, when sunlight is used to convert carbon dioxide into carbohydrates (cellulose and lignin, primarily) and oxygen, which is released into the atmosphere. This process removes carbon from the air and stores it on land, and is referred to as carbon sequestration. Biomass harvesting, transport, processing, and combustion all release carbon, in the form of carbon dioxide, along with other GHG and air pollutants. Thus, biomass energy and forest carbon sequestration form competing demands on the state's forests that land managers must balance.

The complexity of the process of sequestration and emission makes it difficult to quantify true carbon impacts of a given application. Sequestration depends on the area of forest or cropland, tree species and age, type of forest or crop management, past land uses, forest damages, harvesting intensity and frequency, and other factors. Emissions depend on equipment used, efficiency, distance of transport, processing, type of product, and combustion type. On average, Vermont forests store between 77.1 and 84.6 metric tons of carbon per acre in above-ground carbon.[62] Although harvesting biomass for electricity or thermal energy (or any other uses, such as lumber and pulp) may reduce what is naturally sequestered by forests, forests that are cleared for development would emit 30% of stored soil carbon, and much of the above-ground carbon.[63] By keeping forestland productive and preventing land conversion, we can see a positive gain in avoided emissions.

It is generally accepted in international emissions protocols that biomass and biofuels are carbon neutral, meaning that the carbon emitted during combustion is reabsorbed rapidly enough by new growth that the two effectively cancel each other out. This is also described as having net-zero emissions. Yet in practical terms, when taking a life-cycle view, the carbon balance depends upon a variety of factors, as listed above. Preliminary

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[62] *Carbon Storage in U.S. Forests, by State, Sub-Region, and Ownership Group (current data as of October 5, 2010). www.fs.fed.us/rmrs/forest-carbon.*

[63] *Lal, R. 2005. Forest Soils and Carbon Sequestration, Forest Ecology and Management, Volume 220, pp. 242–258.*

efforts are under way at the Agency of Natural Resources, which maintains primary responsibilities in the state for emissions accounting, to evaluate life-cycle carbon accounting as it applies to biomass. The EPA is undertaking a similar exercise. It may be possible in the future to determine that "Biofuel A" from "Source X" meets the criteria for carbon neutrality, whereas other biofuels may only partially meet the criteria and still others are deemed to increase the overall amounts of carbon in the atmosphere.

It is recommended that the Agency of Natural Resources continue its efforts to evaluate and use tools that elucidate the relative carbon impacts of all biomass resources used for electricity, thermal uses, and transportation purposes in Vermont. These life-cycle analysis tools can then be used to evaluate levels of carbon neutrality for different forms of bioenergy usage in Vermont under different scenarios.

It is possible through careful and appropriate management that Vermont's forests and fields can provide fuel for energy while continuing to sequester carbon dioxide. The Plenary Group of the Governor's Commission on Climate Change recommended increasing net sequestration in Vermont's forests by 3% by implementing forest management on an additional 1 million to 3 million acres through various forestland incentives programs by 2028 (47,619 to 142,857 acres per year from 2008 to 2028).[64] The Plenary Group also recommended that Vermont could further reduce greenhouse gases by increasing the use of low-value wood by appropriate processing centers and end users to offset fossil fuel use. The goal was to increase production and use of forest biomass energy feedstocks by 30% by 2028. Private ownership of so much of the state's forestland makes these goals contingent on landowner decisions; landowners may be influenced by incentives, market prices, or other factors to sell biomass for one purpose over another. One factor that surely affects long-term sustainability and has direct implications for carbon storage is our ability to keep forests as forests. We must seek ways to ensure a reasonable return to landowners lest conversion to development results in whittling away at our forest and farmland base.

5.8.1.5 Tools to Utilize Woody Biomass for Generating Electricity[65]

- **Financing.** It remains a challenge for forest products and logging operations seeking to augment traditional timber products with chipping operations to gain access to capital. Efforts to expand access to finance would help facilitate a transition to biomass energy.

  The cost of capital for installing new biomass technologies at the institutional and community levels is one of the primary hurdles to shifting schools, campuses, and municipalities from imported heating oil to locally sourced biomass. CEDF grants and loans support the ability of school buildings, community buildings, and other public buildings to convert to biomass heating systems, district heating, and combined heat and power systems.

[64] *Plenary Group Recommendations to the Governor's Commission on Climate Change, Final Report. October 2007. Pp. 5-8 to 5-9.*

[65] *Woody biomass electricity is a more mature sector than biomass electricity using other feedstocks. As other technologies and supply chains develop, the Department of Public Service will evaluate how the tools described here may be expanded or adapted.*

The use value appraisal program helps landowners maintain land in its productive state. This program remains vital to the working landscape.

- **Policy and Regulatory Actions**. The Vermont Legislative Study Committee on bioenergy established in 2008—the Biomass Energy Development Working Group (also known as BioE)—is in its third year of work and will be making recommendations in late 2011 regarding forest health and increased woody biomass use. Implementation of the CEP should take into account any recommendations of the BioE group, particularly with regard to forest health and sustainability approaches.

  Use of woody biomass includes electric, thermal, and potential transportation uses. Statute provides certain standards for efficiency for wood biomass electric production. Development of economically viable CHP projects remains difficult under the current standards, and efficiency levels should be revisited to explore options for partial thermal usage.

  The Standard Offer Program provides a tool to help advance the use of biomass in the state. This program is limited to qualifying resources with a plant capacity of 2.2 MW or less, and can be used for efficient CHP only.

  Adequate access to forest products to meet the expanding demand for low-grade wood products is essential to supply the necessary raw materials.

- **Outreach and Communications**. Given the debate over whether to harvest forest resources for electricity or thermal uses, outreach programs can help inform citizens about the status of forest health and the amount of harvest that forests can sustain to produce heat and electricity for Vermonters.

  An information clearinghouse and public information capacity through the DPS, ANR, Vermont Agency of Agriculture, Food, and Markets (VAAFM), and partner organizations for current and emerging biomass thermal and CHP technologies would help market participants and consumers remain abreast of rapid changes in this sector.

- **Innovation and Economic Development.** As traditional lumber and logging operations transition toward forest energy, there is a need for additional assistance in helping companies and individuals develop plans and technologies for chipping, storing, and marketing.

  Advances in electric generation technologies and particulate emissions controls also may help woody biomass electric generation viability.

5.8.1.6 Recommendations for Woody Biomass

There is a debate in Vermont over whether it is advisable to convert forest biomass into electricity rather than thermal uses or CHP applications. Vermont will need additional renewable sources of electricity to meet the renewable energy goals in the CEP, and locally derived biomass including woody biomass for electricity can contribute to that mix. It may also be possible for other agricultural biomass crops such as grass to contribute to the electric mix at some point in the future.

Any biomass fuel and usage scenario requires close attention to the status of Vermont's forest and agricultural resources. Biomass resources are finite in quantity and regenerate at different rates. Great care must be taken to guard against boom-and-bust cycles that could threaten the long-term viability of biomass resources. For more information on this essential aspect of biomass energy as it applies to woody biomass, see Appendix 6—Forest Management for Bioenergy.

At about the time the CEP enters its implementation phase, Vermont's legislative BioE committee should be finalizing its recommendations. Based on the interim report of that committee, we expect the recommendations herein regarding woody biomass to be consistent with the work of that committee; however, any recommendations made in that report should be reviewed and considered in the implementation of the CEP.

Recommendations

The DPS provides the following recommendations for the advancement of biomass electrical generation in Vermont:

(1) *Evaluate and help implement appropriate recommendations of the Vermont BioE Legislative Study Committee, including implementation of harvesting and procurement guidelines to support sustainable woody biomass supply and the long-term health of Vermont's forests and assure the public of harvest sustainability.*

(2) *Ensure that sustainable, monitored forest management practices and efficiency serve as the guiding principles for use of biomass resources, rather than placing specific restrictions on end usage.*

(3) *Support monitoring and study, by ANR, of the amount of woody biomass available and of the associated impacts of biomass harvesting on the forest ecosystem, including the full range of forest species that are adapting to a changing climate, as well as water quality, capacity to moderate floods, soil productivity, and other important forest services.*

(4) *Remove the 50% efficiency requirement from the Standard Offer statute and replace it with a charge to the PSB to set the efficiency standard for biomass CHP projects with the goal of robust deployment of CHP plants that substantially utilize thermal load at least seasonally. The charge to the PSB should also include a mechanism to incentivize those CHP plants with efficiencies of less than 50% that are allowed into the program to increase their efficiencies over time.*

(5) *Consider providing incentives to private landowners, who hold more than 85% of the forested landscape, to encourage harvesting that does not exceed average growth rates. This will help ensure the sustainability of biomass resources.*

(6) *Carry out all wood biomass harvesting for energy under best management practices (BMPs), revised to incorporate considerations of forest health beyond water quality goals.*

(7) *Consider developing a carbon value for land retained as productive land for forest products (and agriculture) and credit for sustainably managed forest resources.*

(8) *Support efforts at the Agency of Natural Resources to build and use effective life-cycle analysis tools to evaluate levels of net carbon emissions or sequestration for different forms of bioenergy usage in Vermont under different harvesting scenarios, and incorporate them into PSB Section 248 criteria once established.*

(9) *Build on the existing forest monitoring capacity at the Agency of Natural Resources to develop a robust forest monitoring program and an adaptive forest management system.*

(10) *Provide additional funding for CEDF (grants and loans) to support the ability of school buildings, community buildings, and other public buildings to convert to biomass heating or combined heat and power systems.*

(11) *Bolster outreach about the environmental and health protection benefits that accompany improved efficiencies with advanced emission control technologies installed on biomass heating and combined heat and power units.*

(12) *Create an information clearinghouse and public information capacity through the DPS, ANR, VAAFM, and other partner organizations for current and emerging biomass thermal and CHP technologies.*

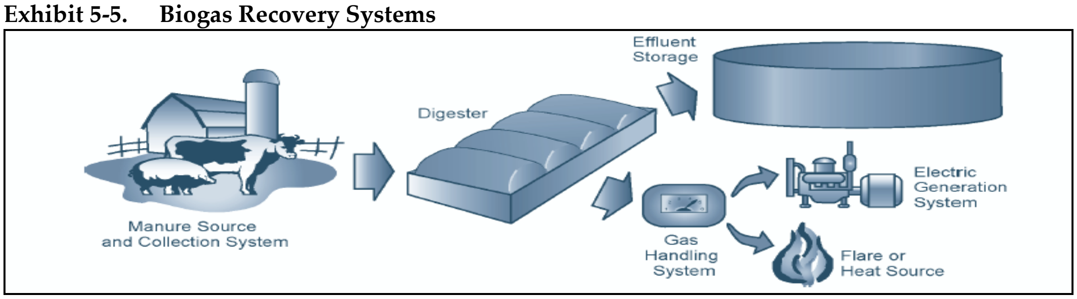
(13) *Investigate renewable heating standards for new and refurbished public buildings that include all renewable heating technologies (biomass, solar, geothermal).*

5.8.1.7 Biogas: Farm and Landfill Methane

Farm-Based Methane Digesters. Vermont draws social and economic benefits from its working agricultural sector. Yet dairy farming in Vermont continues to operate under increasing economic stress. The amount of land dedicated to farming in the state has decreased significantly in the past 35 years.[66] Capitalizing on farm energy resources can help improve and diversify the bottom line of Vermont's agricultural enterprises. Benefits extend beyond the farm to the public by providing renewable baseload power to the grid, additional energy security, and a range of environmental benefits, from odor amelioration to greenhouse gas reduction. These private and public benefits are why the DPS, the Vermont Agency of Agriculture, and the USDA have partnered to utilize manure as an energy resource. Through the efforts of these agencies and their partners, farmers are beginning to appreciate manure as an energy resource.

Anaerobic digestion is the degradation of organic matter including manure, brought about through the action of microorganisms in the absence of oxygen. Technologies that use this process yield methane used for energy, while decreasing pollutants and odors resulting from traditional manure management techniques. In addition, the nutrients in the manure become more readily available for plants to uptake, potentially reducing runoff. The resulting product of anaerobic digestion is biogas, composed primarily of carbon dioxide and methane. Biogas can be combusted directly for heat or used to fuel an engine to generate electric power. Exhibit 5-5 shows a simplified diagram of the process. An additional by-product of the process is the remaining undigested solids. This bacteria-reduced material can be used as bedding material for the cows, replacing the need for sawdust, or it can be used as a soil amendment.

Exhibit 5-5. Biogas Recovery Systems



Source: EPA

Anaerobic digestion of manure provides a number of societal benefits. Manure has traditionally been stored in storage lagoons, where it produces methane that escapes into the air; biogas systems capture and harness the methane. The greenhouse gas value of methane in the atmosphere is, over a 100-year time horizon, 21 times that of carbon dioxide, so biogas recovery systems significantly reduce overall greenhouse gas emissions. The systems reduce the odor in the remaining effluent significantly, allowing farms to spread without having to be concerned about odors such as those released when manure stored in a storage pond or lagoon is spread. There are added carbon benefits in that the power produced can offset power produced from higher-carbon sources.

The DPS and Vermont Agency of Agriculture, Food, and Markets (VAAFM) recognized the role of anaerobic digestion. Over the past decade Vermont has taken the lead in helping farmers achieve manure management goals, decreasing their energy requirements and providing a source of additional

[66] *The 2007 Census of Vermont agriculture reports that between 1974 and 2007, the number of acres dedicated to farming dropped from 1.7 million to 1.2 million.*

income. Incentives for farm biogas production facilities are available in Vermont through programs like CVPS's Cow Power, GMP's Greener GMP, the state's Clean Energy Development Fund, the Vermont Economic Development Authority, and the USDA. As of July 2011, there were 12 systems operating in Vermont, with an installed capacity of about 3 MW.

Thanks to the combined efforts of farmers and their partners, Vermont farms have emerged as leaders in the field of small-scale farm methane digester development. Central Vermont Public Service introduced methane digestion for electrical generation to Vermonters through its Cow Power program in 2005, when the Blue Spruce Farm began delivering power to the grid. This innovative green pricing program received grant support from the CVPS Renewable Development Fund, USDA Rural Development, and the Vermont Clean Energy Development Fund. Additional support came from the VAAFM and USDA's Natural Resources Conservation Service.

Exhibit 5-6. Standard Offer Program Methane Generation, July 2010 to June 2011

Production Site	Size (kW)	Production (kWh)
Blue Spruce Farm*	490	1,282,842
Berkshire Cow Power LLC*	600	2,610,767
Chaput Family Farms*	300	1,343,649
Dubois Energy LLC*	335	1,695,443
Gervais Family Farm, Inc.*	200	1,200,449
Green Mountain Dairy*	225	1,622,408
Montagne Farm*	240	461,644
Maxwell's Neighborhood Energy LLC*	200	1,264,386
Westminster Energy Group	200	1,077,913
Total	***2,790***	***12,559,501***

**Participant in CVPS Cow Power program.*
Source: Vermont SPEED Program Monthly Billing Information

In 2009, the advent of the Standard Offer Program within the Sustainably Priced Energy Enterprise Development (SPEED) program created more opportunities for farm methane producers to generate sufficient revenues to become viable.

In June 2009, the Vermont Public Service Board opened Docket 7523 to investigate the development of Standard Offer prices for qualifying renewable generation under the SPEED program. In September, the PSB issued an order that set the rates for farm methane at $0.16/kWh. Subsequently, in January 2010, the PSB opened Docket 7533, in which it reduced that price to a levelized rate of $0.141/kWh. Farmers in the CVPS Cow Power program receive this payment plus an additional $0.04/kWh for farm energy attributes from CVPS as long as enough CVPS customers pay the voluntary Cow Power premium.

As the nation slipped into recession, wholesale energy prices fell, leading to a decrease in revenue for some of the farms that were not initially eligible for the Standard Offer because they had contracted to sell their power at market rates to CVPS. Legislation introduced in 2010 (H. 566) eventually permitted all farms selling farm methane–generated power to a utility to be eligible for the Standard Offer rates, which helped improve the prospects for continued generation. However, some participants in the program continue to endure a degree of economic uncertainty when they do not receive sufficient revenue from the sales of their farm-generated energy attributes. This condition increases the risk for future farms and their backers considering investment in farm methane generation.

Landfill Methane. As refuse decomposes in landfills, methane gas is released, eventually rising to the atmosphere. Large landfills control this flammable gas by collecting it via pipelines buried in the landfill and either flaring it or allowing it to be used for energy. Combustion of methane, a potent greenhouse gas (GHG), is one strategy for reducing the buildup of GHGs in the atmosphere.

Vermont currently has a small number of landfill biogas generation facilities, with operations in Coventry (8 MW), Moretown (3.2 MW), Burlington's Intervale (350 kW), Williston Gas Watt Energy (90 kW), and Brattleboro (300 kW). There is a limited capacity for new landfill biogas generation in the state, mostly from expansion of existing systems or installation of generators on smaller landfills such as Randolph's. Efforts are under way to increase production at the Moretown landfill by installing an additional 1.6 MW generator. Carbon Harvest in Brattleboro is exploring the option of adding a second 250 kW generator at the Brattleboro landfill. Efforts to expand this sector will provide additional GHG reductions. Landfill gas will contribute only a minor portion of power to the state's electricity portfolio in the future. Collectively, landfill methane represents about 12 MW of power operating at about 80% to 90% capacity factor, with the potential to expand this amount to about 13.5 MW.

5.8.1.7.1 Projected Biogas Electric Production

As shown in Exhibit 5-7, the Vermont 25 x '25 Initiative presented specific goals for biogas energy production.

Exhibit 5-7. Agricultural Energy 25 x '25 Energy Production Goals

Technology	Energy Type	2008 Energy Production (in Billions of Btu)	% of Load (2008)	2025 Energy Production (in Billions of Btu)	% of Load (2025)
Manure Digestion	Electric	29	0.02%	444 (15 MW installed capacity)	0.26%

Source: Vermont 25 x '25 Initiative Preliminary Findings and Goals, Spring Hill Solutions, January 23, 2008

As of 2011, Vermont has about 1,000 dairy farms milking a total of about 140,000 cows. These cows are housed in a variety of barn types and are managed in a wide variety of ways. Many farms are facilities at which most of the manure is collected and stored or spread. Some of these farms are pasture-based in the months when grazing is practical and the manure is self-spread. For the 2009 Vermont 25 x '25 Initiative report, the VAAFM estimated that about one-half of the manure in the state would be available for digestion. VAAFM estimates that this would give a total installed electric generation capacity from manure of 15 MW, producing about 118.3 million kWh of electricity annually by 2025.

The 3 MW of farm methane power currently in production at 12 Vermont farms will be joined by an additional 2.6 MW under development. To meet the goal for 25 x '25, an additional 9 MW of new methane-generated power will be required. The VAAFM estimates for available manure indicate that this goal is attainable. However, given the high costs and long lead times, farmers are going to need predictable power prices and enhancements to net metering, such as renewable energy certificate (REC) ownership to proceed.

In addition to farm and landfill methane sources of biogas, other biogas opportunities may emerge in the future. For example, nascent projects in other states, one with the backing of a Vermont entrepreneur, seek to commercialize extremely high temperature plasma gasification of landfill waste. Should such a technology prove effective, environmentally sound, and otherwise viable, Vermont should revisit the use of landfill waste for direct fuel.

Potential New Sources of Biogas Electricity

Farm Methane Digesters. Currently, about nine new methane digesters in various stages of development in the state are going through the Standard Offer Program, and four farms are expanding their existing digester systems. Collectively, these projects will add about 2.6 MW to the biogas pool should they all come to fruition. Additional potential remains on Vermont farms for manure digesters.

To expand the number of digesters, the state will need additional support for research and development of small-scale digesters such as the 17 kW unit at the Foote Farm. Many pieces of smaller systems are under development, including alternative systems with closed-loop units that have the potential to improve the outcomes from digester projects. Researchers are also exploring connections to hydroponic greenhouses growing vegetables and algae that will use farm resources more efficiently.

Most of the farm systems in Vermont are designed such that they can use more than just manure in their digester. These take in some food wastes, such as whey from cheese making, to enhance the energy output of their system. Farm-based systems that are planning to use separated solids for bedding need to use caution with the materials they use so that they do not have undesirable side effects on the cattle. There are also limits to the types and volume of materials that can be brought in. ANR and VAAFM cooperate with the farms to determine whether the materials proposed are appropriate for land application after digesting, and if the farm has enough storage capacity to get them through the winter, including the new materials. Farms need to derive the majority of the feedstock for a digester from their farm to have the system qualify as an accepted agricultural practice.

Digesters can also be designed to run primarily on materials other than manure. These "mixed-substrate" anaerobic digesters can utilize as inputs various livestock manures, crops harvested or stored as silage, food scraps, and many other food-processing wastes or agricultural waste products. The biogas yields per ton of crops or food wastes are much higher than those of cow manure (for example, grass silage, corn silage, and food scraps yield approximately eight times as much as cow manure, and waste grease and baking wastes can yield 25 times as much as cow manure). The silage from one acre of crop can run about 1 kW of generation continuously. The 2009 Vermont 25 x '25 Initiative report estimated that Vermont has the potential for about 36 MW of generating capacity from these systems.

The mixed-substrate digesters require cow manure as a source of methane-producing bacteria at startup, but can then theoretically run without additional cow manure. This technology is relatively new to the United States, but is mature in Europe, which has several thousand operating systems with generating capacities ranging from approximately 20 kW to several megawatts.

Vermont has some projects growing algae or other plant materials in a waste stream. The algae can then be harvested for oil or fed into a digester where the plant material can be converted to energy. A goal of the VAAFM is to help develop a system that will take the liquid stream coming from a traditional manure-based digester and grow plants in the waste stream while purifying the wastes so that a farmer would save the energy and time needed to haul liquid manure to the fields. A system that does this could also enhance the energy output by feeding some of the materials grown back into the digester to produce more energy while reducing the energy needed to apply the output products to land and growing other products for new revenue streams.

Mixed-substrate digesters offer a new flexibility because their generating capacity and economic feasibility are not solely dependent upon the number of cows on the farm, but rather on the number of tons of crops or food waste that are available. Thus, a farm that has only a small number of cows (or no cows at all), but owns or has access to cropland, could install a mixed-substrate anaerobic digester.

Other Anaerobic Digesters. Food-processing facilities and municipal waste facilities can also use anaerobic digestion to produce energy. A recent example is provided by a brewery in Vermont that has installed an anaerobic digester to produce combined heat and power and reduce the biological oxygen demand (BOD) load in its waste stream. Essex Junction, Vt., has an anaerobic digester on its municipal waste system that provides heat and 30% to 40% of the power needed for its waste treatment facility. These systems provide environmental benefit from methane destruction and BOD reduction as well as energy from a source that traditionally has been disposed of in a manner that uses energy. The DPS, VAAFM, and ANR need to cooperate on assisting commercial ventures that can use organic wastes or crops that are appropriate for this application. The state also needs to work with municipalities that are remodeling their waste treatment facilities to encourage anaerobic digestion with methane capture as part of their treatment system.

Challenges to Development of Biogas Electric Power

Development Risks for Farm Methane Biogas Projects. Development of new farm methane digesters is a long and costly process. Challenges such as gaining access to the three-phase power needed to support and transmit power from the systems, earning sufficient revenues from the sale of renewable/farm-based energy attributes, and accessing capital are all difficult barriers that must be overcome. The current cap on the number of MW for renewable projects in the Standard Offer Program, and limitations and uncertainty in the net metering program, also serve as impediments.

New methane digesters can cost millions of dollars and take upward of four years to commission. Farms must provide substantial amounts of their own cash and in many cases increase their debt to capitalize such facilities. Access to grant funding has proven essential to covering costs for such expenses as planning, engineering, and connecting to three-phase power, as has access to low-cost credit from organizations such as CEDF and VEDA. Farms generally have to mortgage their farm to develop a digester because lenders often will not take the digester as collateral.

Another challenge entails rates paid to some farmers and demand for renewable energy by Vermont customers. The CVPS Cow Power program faced a situation in 2009 and again in 2011 wherein the number of farm-produced "renewable" attributes exceeded the demand for these attributes from customers. It is possible that such imbalances may continue in the future, creating the potential to strain the economics for some of the farm methane producers.[67] Farmers in green pricing programs must earn sufficient revenues from the sale of renewable attributes or the Standard Offer Program price to remain viable. If the local demand for renewable attributes drops below the number of attributes produced by farmers, farmers would need to sell those attributes in other markets where they might not receive an equivalent price (e.g., 1 cent per kWh for renewable energy certificates versus 4 cents per kWh). One possible remedy for this situation would be to expand green pricing programs to all Vermont electric customers, thus increasing the overall demand for farm-produced attributes.

Recommendations for Farm Methane and Other Biogas

(1) *Vermont state agencies and electric utilities should continue to support development of biogas recovery systems through incentive programs.*

(2) *The DPS, ANR, and VAAFM should collaborate to identify how to overcome barriers to the development of cost-effective farm methane systems, particularly for smaller-sized digesters for farms with fewer than 200 cows.*

(3) *Investigate mechanisms that encourage development by ensuring a stable, predictable price (such as enhanced net metering and the Standard Offer Program) that farm-based systems could access.*

(4) *Continue support through the Clean Energy Development Fund for effective farm-based renewable energy systems, including methane digesters, and develop other revolving loan funds, both public and private.*

[67] *See CVPS Renewable Development Fund Progress Report, June 30, 2011.*

(5) *Develop a model farms could use to create group net metered projects.*

(6) *Work with technical experts and system designers and developers to bring down the system size and cost for smaller farms.*

(7) *Create greater statewide consistency with the interconnection process and procedures across all utilities.*

(8) *Enhance DPS review of interconnection plans and costs proposed by utilities to ensure that they are reasonable and do not create an undue burden for developers.*

(9) *Work with Vermont's Congressional delegation for continuation of NRCS and USDA REAP grants for on-farm bio-digesters.*

(10) *Support the research into enhancing anaerobic digester conversion efficiencies, such as the project at UVM that is looking at optimizing a digester to utilize the most efficient methanogenic microorganisms, which have the potential of increasing gas output by 20% with the same amount of manure.*

(11) *The DPS and ANR should work with municipalities that are remodeling their waste treatment facilities to encourage anaerobic digestion with methane capture as part of their treatment system.*

5.8.2 Hydropower

5.8.2.1 Hydroelectricity in Vermont

Prior to the 1920s, Vermont relied on hydro resources almost exclusively for its electricity needs. Many of the projects were small and served the modest local demand for energy. While the state is now less reliant on small hydro sources, in-state hydroelectric power still makes a significant contribution to Vermont's electric load. Hydropower has many benefits. It is renewable, has low emissions of greenhouse gases, and contributes to the stability of the electric grid. Vermont-based hydropower also can support the local economy through jobs and taxation. Thus, Vermont should preserve its use of the local hydropower resources and be open to environmentally sound hydropower development in the state.

Vermont today has 68 FERC-licensed hydropower generation facilities, with an estimated installed capacity of more than 150 MW. In-state hydropower generated in 2009 equaled about 8% of the electricity consumed in Vermont. In addition, there are eight facilities on the Connecticut and Deerfield river systems with a total capacity about 500 MW—however, none of that power is presently contracted for delivery to Vermont utilities.

Hydro project descriptions and documents relating to the development of small hydro in Vermont may be found at the Vermont Renewable Energy Atlas website.[68]

Exhibit 5-8. Vermont Hydroelectric Projects

Plant Owner	Capacity (MW)
CVPS	57
VEPP[69]	48
GMP	24
All Other	28
Total	*157*

A portion of current capacity was added in the 1980s under the Public Utility Regulatory Policies Act (PURPA) in 1978. Spurred by the energy crises of the 1970s, PURPA provided economic incentives for the development of small hydro projects. Under PURPA, 41 new hydro facilities were constructed in the state.

In the late 1980s and early 1990s, the elimination of economic incentives and other factors resulted in a sharp drop in development, and no new projects were proposed for almost 20 years. Further, six facilities developed in the 1980s were decommissioned because of equipment failures and for other reasons. The PURPA initiatives were successful in adding considerable new renewable power to the Vermont mix (about 6%), but at a higher price relative to the wholesale market.

Spurred by new energy concerns, in 2007, the Vermont General Assembly requested a study of the available hydroelectric potential and associated permitting requirements.[70] ANR's conclusions and recommendations have been updated and incorporated into the sections below. Current state policy supports the development of environmentally sound in-state hydroelectric projects. This policy achieves the objectives of helping Vermonters meet their long-term energy needs, shifting Vermont's energy supply to increased renewable resources while also protecting the health of Vermont's waters. In-state hydro is the least expensive power currently being generated by the utilities. CVPS's costs are less than 3 cents per kWh and GMP's are less than 4 cents. Nevertheless, very few new hydro projects have moved forward in the state.

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[68] *www.vtenergyatlas.com or www.vsjf.org.*

[69] *Vermont Electric Power Producers, Inc.*

[70] *2007's H.520 (Act relating to Vermont energy efficiency and affordability) required ANR to study issues relative to development and permitting of small hydro projects. Although it was ultimately vetoed, the governor directed ANR to develop the report "The Development of Small Hydroelectric Projects in Vermont: A Report to the Vermont General Assembly, January 9, 2008." The report can be viewed at www.vtenergyatlas-info.com/hydro. Click on "Reports and Links."*

5.8.2.1.1 Undeveloped In-State Capacity

Obtaining an accurate estimate of how much undeveloped hydro capacity exists in Vermont and how much of that capacity can be developed in an environmentally benign way is challenging. Opinions differ on the amount of available hydropower in Vermont. Depending on assumptions used, reports vary from 25 MW at 44 sites (estimated by the ANR in 2008) to 434 MW at 1,291 sites (estimated in a DOE study in 2006).[71] A 2007 study for the DPS identified more than 90 MW developable at 300 of the existing 1,200 dams.[72] The ANR is currently working on an updated assessment of the undeveloped in-state hydro capacity.

Under any assessment, it is clear that the best hydropower sites have already been developed. There are very few undeveloped sites that could support capacity greater than 1 MW, and a relatively low number in the 500 kW to 1 MW range. There are many potential smaller community and residential sites sized at less than 200 kW.

Incentives such as net metering, group net metering, and the Standard Offer Program are necessary to facilitate the development of the smaller sites. The ANR has recently approved sites with generation capability as low as 15 kW and 50 kW.

Because there are few undeveloped sites that are candidates for new hydroelectric plants, an effective way to increase capacity is to improve efficiency and output at existing hydroelectric facilities through three types of activities: installing more efficient turbines, installing small turbines at the dams that utilize bypass flows, and installing new turbines that can operate efficiently over a wider range of flows. These upgrades are often possible without changing the current operating requirements, i.e., power production can be increased without additional environmental impacts.

In addition, existing municipal water supply and wastewater treatment pipelines could capture the energy in these systems by installing hydro turbines to the pipelines without otherwise altering the regular operation of the system. Such in-pipe hydroelectric systems have minimal environmental impact. The town of Bennington has developed such a project, and another project is under development by the city of Barre. These projects generate electricity from the excess pressure in the municipalities' water supply systems.

5.8.2.1.2 Regulatory Process

Unlike other types of local renewable energy development, hydroelectric projects are regulated by the Federal Energy Regulatory Commission (FERC).[73] New projects may also require a permit from the U.S. Army Corps of Engineers. These federal permits trigger state review delegated under the federal Clean Water Act.

[71] *Hall et al., 2006, U.S. Department of Energy.*

[72] *See www.vtenergyatlas-info.com/hydro.*

[73] *Hydropower in municipal water or wastewater systems may request an exemption from FERC licensing.*

FERC has a well-defined permitting process, but it can take two to seven years to complete. The long timeline is largely due to the need to gather the information necessary for the regulatory agencies to make informed permitting decisions and provide for public participation in the process. Hydropower projects involve the use of public waters, a public trust resource, so there is considerable public interest in these developments. Further, care is taken because the terms of the permits are at least 30 years. One class of permits has no expiration date; those projects may operate indefinitely without further review.

Some European countries have regulatory regimes that seem to facilitate hydro development, and some states have worked to streamline their permitting process. Vermont continues to receive public comment that the federal and state hydro permitting process is difficult and lacks clarity. The more that ANR and FERC can coordinate, integrate, and make explicit their procedures, the better it will be for those attempting to develop hydropower resources in the state. FERC recently initiated a process to help simplify the permitting of small hydro.[74] ANR has committed to review its process as well.

Low-impact projects can negotiate the permitting process in a matter of months (from application to issuance of the permit), provided the necessary pre-application work is completed. The key steps developers should take to receive timely permitting decisions are (1) involve regulatory agencies and other stakeholders early in the feasibility phase of the project, (2) engage a licensed professional engineer with hydropower experience to assist with project design and permitting, and (3) complete the necessary studies and include complete information in permit applications. The ANR states that as experience with small hydro projects grows, permitting will continue to gain efficiency.

5.8.2.1.3 Environmental Impact

According to the ANR, the hydro resource is already heavily developed in Vermont, and the resulting impacts on the state's waterways have not been inconsequential. These environmental impacts include intermittent manipulation of flows and water levels, a possible increase in flood hazards resulting from the disruption of natural river processes, some loss of riverine aquatic habitat, and barriers to movement of fish and other aquatic life. For these reasons, construction of new dams is unlikely to be permissible under the anti-degradation policy in the Vermont Water Quality Standards and is not supported by ANR. Of the operating facilities, about 60 have been certified by ANR as complying with the Clean Water Act. ANR has plans to use existing regulatory tools to bring the remaining 20 sites into compliance over time.

However, the environmental impact of a project is not necessarily related to its size, so smaller hydroelectric projects (often called "micro-hydro," "mini-hydro," or "community hydro") are not necessarily low-impact. ANR's 2008 Report "The Development of Small Hydroelectric Projects in Vermont"[75] identified the following criteria as likely to meet a low impact standard:

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[74] www.ferc.gov/industries/hydropower/gen-info/licensing/small-low-impact.asp.

[75] www.anr.state.vt.us/dec//waterq/rivers/docs/rv_smallhydroreport.pdf.

- No new dam or other barrier to aquatic organism movement and sediment transport.
- Run-of-river operation.
- Bypass flows necessary to protect aquatic habitat, provide for aquatic organism passage, and support aesthetics.
- Fish passage where appropriate.
- No change in the elevation of an existing impoundment or in water level management.
- No degradation of water quality, particularly with respect to dissolved oxygen, temperature, and turbidity.
- No change in the upstream or downstream flood profile or fluvial erosion hazard.

The ANR has stated that more work is needed to define projects that are truly low-impact, regardless of size, and has committed to this project.

5.8.2.1.4 Hydro-Quebec and Other Out-of-State Hydro Resources

In addition to the approximately 10% of its power coming from in-state hydro, Vermont currently receives a significant portion of its electricity from out-of-state hydro, principally from Hydro-Quebec (HQ). HQ power is stably priced, immune to escalating fossil fuel prices and retrofit costs, and does not contribute to the air quality problems of our region.[76] Further, since the power is supplied from many generators, its reliability is based on HQ's total system reliability, rather than the performance of a single dam or plant. The Vermont Legislature has recognized this resource as renewable.

Vermont has a long-standing contractual relationship with Hydro-Quebec. In 1990, a group of eight Vermont utilities (the Vermont Joint Owners, or VJO) entered into a 30-year agreement to purchase baseload power from HQ and to make it available at wholesale prices to other Vermont utilities. Under this HQ/VJO contract, power purchases increased from 51 MW in 1994 to approximately 310 MW today. This is a take-or-pay contract (i.e., regardless of whether the Vermont utilities need the contracted power, they still pay for it, although they may resell excess HQ power in wholesale markets. Currently, the average cost of HQ/VJO power is 7.0 cents per kWh, which was 16% above the cost of market alternatives in 2010). The HQ/VJO contract phases out beginning in 2012, with a large portion of its deliveries terminating between 2012 and 2015 and the last schedule expiring by 2020. The HQ/VJO contract currently supplies roughly one-third of Vermont's power requirements.

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[76] *All power purchased from HQ is system power and not tied to any single unit. Of the HQ power in 2010, 97.8% is from hydro. Hydro-Quebec, Sustainability Report 2010,* *www.hydroquebec.com/publications/en/enviro_performance/pdf/rdd_2010_en.pdf*

In 2010, 20 Vermont utilities signed a 26-year power contract with HQUS (the power marketing arm of HQ) to purchase 218 MW to 225 MW of electricity from January 2012 through 2038. Under this new contract, the contracting utilities also purchased an equivalent quantity of environmental attributes corresponding to the energy from the HQ power system mix composed of at least 90% hydroelectricity. However, the environmental attributes reflecting the HQ power system mix are not currently traded within New England and do not currently qualify for any New England REC program, because only Vermont currently recognizes this resource as renewable.

The new HQUS power purchase agreement's (PPA's) starting price is $58.07 per MWh for the first year of the contract.[77] After that, the price is derived by a formula that remains the same over the contract term. The formula is based on regional electricity prices, and the movement in general of price levels observed across the U.S. economy subject to a damping feature that limits the change from the prior year's price. Contract price adjustments are made annually. The contract is thus stably priced in a way that mitigates market price fluctuations. The annual adjustments are expected to keep the contract price closely associated with market prices during periods of moderate volatility while significantly limiting Vermont's exposure to price spikes or sustained high price periods. In general, this type of protection can be obtained only from resources (like renewable energy) that are not directly exposed to high fossil-fuel input costs. The price of power under the HQ PPA is expected to be either competitive with, or favorable to, forecast market prices over its term and lower than the price of currently available power sources with similar characteristics, and the arrangement offers other favorable characteristics (low air emissions, relative price stability, renewable fuel, freedom from relying on a single generator, and potential for power system benefits).

Vermont will buy this new HQ energy via an internal bilateral transaction (IBT). An IBT significantly reduces performance risk to the utilities and their ratepayers compared to the HQ-VJO contract or to other non-firm power. The IBT mechanism also assures Vermont that the HQUS power deliveries will provide protection from lack of diversity associated with the HQ-VJO contract.

Under the HQUS contract, the initial amount of energy provided is equal to the current transfer capability at the Highgate interconnection, which is 218 MW. If Highgate's transfer capability is increased to 225 MW during the term of the HQUS contract, then delivered energy will likewise increase. Although the contract amount is tied to the size of the Highgate interconnection, Vermont can and does receive power through other interconnections, and the HQUS contract does not require delivery of power at Highgate.

HQ currently has approximately 41,000 MW to 42,000 MW of generating capacity. Approximately 97% to 98% of HQ's power system portfolio is produced by hydroelectric facilities. According to HQ's most recent strategic plan, HQ has a surplus of approximately 10 terawatt hours (approximately 5%) and is expected to add another 10 terawatt hours (an additional 5%) of hydroelectric supply by 2014. In other words, HQ has additional supply available for export.

[77] *The following language has been obtained from the docket for the current HQ contract. The docket order can be viewed at* psb.vermont.gov/docketsandprojects/order/2010. *Look for order #7670 dated 9-15-10.*

In addition to HQ, other Canadian hydro resources may be available to Vermont and the region in the future. Newfoundland and Labrador have started a new major hydro project, the Lower Churchill Development (includes Gull Island and Muskrat Falls project sites). This project is to be on line by 2015. When completed, this facility should add another 2,264 MW to the electric grid. Newfoundland and Labrador are investigating means to transmit excess power to New England and neighboring markets, and have indicated that further hydro development for export is in their long-term plans. Other hydro resources exist in neighboring provinces. Canadian exports of hydro power are expected to continue to be available to Vermont and the region; indeed, the available amounts will increase markedly in the coming decades.

- **New York Hydro.** Since the late 1950s, Vermont has obtained hydro power from the New York Power Authority (NYPA) and its predecessor, the Power Authority of the State of New York (PASNY). This power is very inexpensive thanks to historical federal subsidies for hydro dam construction. Until July 1985, Vermont received 150 MW of 0.2 cents per kWh energy from the St. Lawrence and Niagara hydro projects. As fuel prices soared in the 1970s, other states purchased low-cost NYPA power, reducing Vermont's share. NYPA directed Vermont's St. Lawrence project entitlement to drop from 68 MW in 1985 to 1 MW by 1994. Vermont's Niagara power entitlement has also been reduced (11.2 MW in 2004). Even at the reduced level, the price continues to make this energy attractive to Vermont. The power is purchased for Vermont municipal utilities.

- **Connecticut and Deerfield River Dams.** Some Vermonters feel that in 2003, Vermont lost an opportunity to gain ownership of and access to the eight hydroelectric dams on the Connecticut and Deerfield Rivers with their nearly 500 MW of renewable power, when the prior owner suffered financial distress and sold the dams. The final cost of the purchase to the new owner, TransCanada—$500 million—would have added significant increased risk to Vermont's finances and, given market electric prices between 2003 and 2011, would not have been offset by savings in retail sales. Since many Vermonters value this local renewable resource, which provides some tax revenue and jobs to the state, it would be a positive step for Vermont utilities to enter into contracts for power from the eight dams, if acceptable price and quantity terms could be negotiated. The state will also watch for any new opportunity to purchase these hydro facilities if they become available.

Recommendations for Hydro

(1) Maintain the existing Vermont-based hydro projects in the Vermont energy portfolio, and ensure all hydro projects conform with Vermont Water Quality Standards.

(2) Continue to work with FERC and the Army Corps of Engineers to integrate the federal and state permitting processes to avoid delays and duplication while maintaining a high standard of environmental protection for hydro siting.

(3) *Simplify permitting for installation for run of river projects at existing dams. Continue to provide initial project reviews for proposals in the feasibility study phase to identify environmental issues that will need to be addressed during the permitting process.*

(4) *Encourage increased hydropower production at existing sites and projects that add hydropower to existing water supply and wastewater treatment systems.*

(5) *Investigate the possible use and potential environmental impacts of pumped storage hydro to see if it should be a part of Vermont's energy mix.*

(6) *Investigate the removal of existing dams that are not appropriate candidates for hydropower after first determining their hydroelectric potential and environmental circumstances.*[78]

(7) *ANR should investigate developing an explicit "low-impact" standard for hydro power.*

(8) *The DPS and ANR should produce a guide for those interested in developing small hydroelectric projects to help with understanding the economic and environmental issues, the regulatory system, and the importance of initial project reviews.*

(9) *Vermont utilities should investigate securing additional stable long-term hydropower supply potentially available from Canadian provinces and from hydro projects adjacent to Vermont.*

(10) *Because many hydro stations in Vermont are historic, the DPS and hydro developers should partner with the Vermont Division for Historic Preservation to streamline required historic project reviews and potentially help developers qualify for federal historic tax credits for rehabilitation work on hydro station buildings.*

5.8.3 Solar: Photovoltaic Electric

Photovoltaic (PV) electricity is created by sunlight hitting specially constructed substrates.[79] Contrary to public perception formed by Vermont's long winters, sunlight is Vermont's most abundant renewable energy resource. For illustrative purposes only, consider that Vermont's solar resource could generate 100% of the state's annual

[78] *Because dams serve multiple purposes, the Legislature has required that dams meeting certain criteria cannot be removed unless their hydroelectric potential is determined.*

[79] *Silicon is the most common material used, but other materials are being developed and deployed.*

electricity consumption (5.5 billion kWh) with a solar array of 23 square miles (~0.25% of the state's total land area) using today's PV technology.[80]

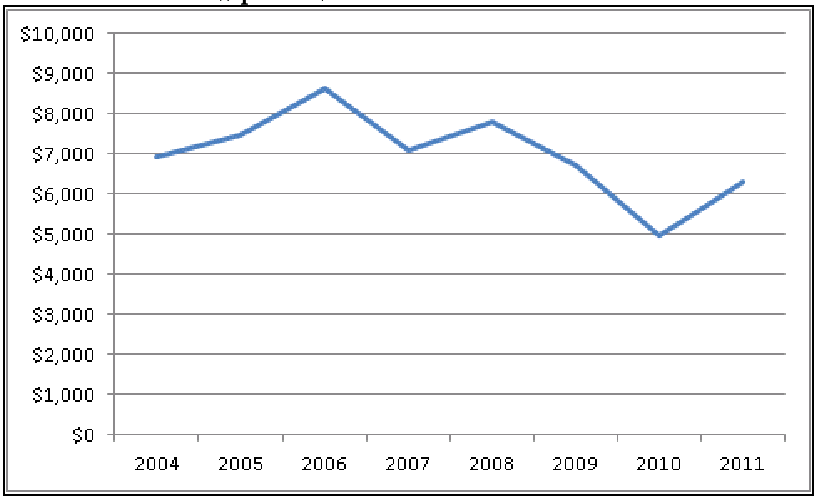
Vermont has recently seen a tremendous growth in the amount of PV deployed across the state, as shown in Exhibit 5-9. Long considered an inconsequential niche player in the electrical sector, PV is now becoming a serious and meaningful contributor to the state's electrical needs and is an important part of Vermont's renewable energy industry.

One reason for the dramatic increase in the use of PV is that the technology has been advancing, bringing the cost steadily downward. The cost to install 1 kW of PV in Vermont has dropped approximately 40% in the last six years.[81]

[80] *Solar thermal electric technology uses the thermal energy of sunlight to create steam to generate electricity. At this time Vermont does not have any solar thermal electricity plants in operation or planned, nor are any of the utilities purchasing this type of power from outside Vermont. Solar thermal is not a technology the CEP expects to produce any meaningful amount of electricity in Vermont. However, it is important to differentiate solar thermal energy from solar thermal electric production. Solar thermal energy used for heating is recommended as an important energy source for Vermont and warrants the increased focus of energy policy initiatives. Solar thermal energy is discussed further in Section 8, Thermal Energy Sources.*

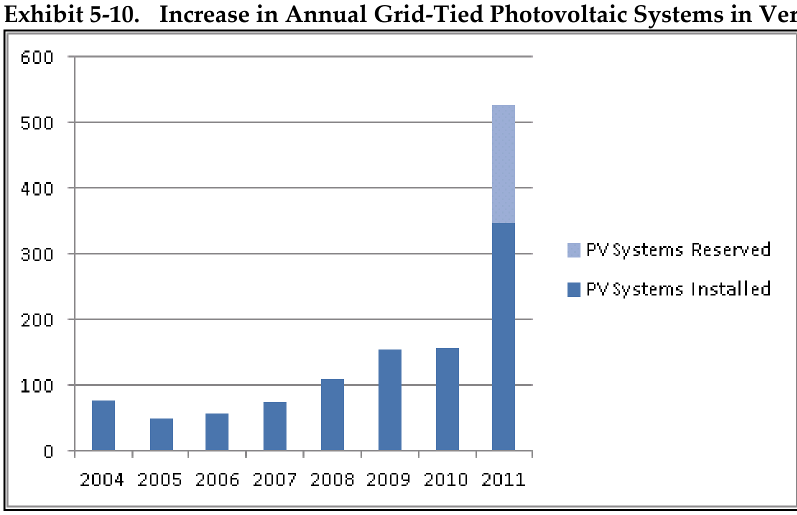
[81] *Vermont Small-Scale Renewable Energy Incentive Program data, 2004–11.*

Exhibit 5-9. Cost ($ per kW) of Grid-Tied Photovoltaic Power in Vermont, 2004–11



Source: Vermont Small Scale Renewable Energy Program, through June 2011

Exhibit 5-10. Increase in Annual Grid-Tied Photovoltaic Systems in Vermont



Source: Vermont Small Scale Renewable Energy Program

Although Vermont's total installed PV capacity is small compared to that of larger states, Vermont is already one of the top 10 states for PV on a per capita basis. This is impressive given Vermont's small size, lower incentive levels, and lower solar resource compared to other states.

Exhibit 5-11. Top 10 PV Capacity per Capita[82]

State	Cumulative 2010 PV Installations (WDC /person)
1. Nevada	38.8
2. Hawaii	32.9
3. New Jersey	29.6
4. California	27.4
5. Colorado	24.1
6. New Mexico	21
7. Arizona	17.2
8. District of Columbia	7.4
9. Connecticut	6.9
10. Vermont	***6.4***

A potential drawback of PV power is that when compared to the current market price forecast for electricity, the price of PV remains high. However, PV power has several advantages that make it a power source that the state should continue to support. PV is largely a peak electric load–following resource, meaning that during peak summer loads, the PV systems are at their highest production, resulting in peak shaving and grid reliability benefits. In addition, PV power is generated without noise, requires low levels of maintenance, emits no pollution, and is extremely distributable.

The Vermont Small Scale Renewable Energy Program (also called the renewable energy rebate program) has helped bring down the capital costs necessary to install PV and has been very popular and successful.

Exhibit 5-12.[83] **Vermont Small Scale Renewable Energy Program Solar PV Metrics**

Metric	Value
Total Number of Systems Installed	892
Total Cost of Installed Systems	$27,593,675
Incentives/Rebates Paid for Installed Systems	$5,204,802
Total Installed Capacity (kW)	3,674
Estimated Annual kWh/yr production	4,213,659

[82] *DPS data combined with data from the Interstate Renewable Energy Council's 2011 Report on 2010 PV installed capacity.*

[83] *Vermont Small Scale Renewable Energy Program Data from January 2004 through August 2011.*

In addition to offering the rebate program, Vermont has supplied incentives to larger PV projects through the Clean Energy Development Fund[84] grant and loan program as well as through business solar tax credits. This state's investment in the development of PV has paid off in several ways over the last 10 years by producing:

- Exceptional growth of PV installations.
- The leveraging of tens of millions of private dollars invested in local real property.
- The growth and increased maturity of Vermont's PV industry.
- An increased number of jobs in the PV sector.
- An increased amount of locally produced renewable electricity.

Further discussion of PV is broken down into three categories: (1) residential, (2) community and commercial, and (3) utility systems.

5.8.3.1 Residential PV

Residential PV is defined here as systems under 10 kW of rated capacity and installed at a home. Such home-based systems are commonly installed on south-facing roofs, but are increasingly being deployed on the ground with pole-mounted systems, including those that actively track the sun. PV's ability to be easily installed on many homes makes it a popular choice for Vermonters who want to produce their own renewable electricity and participate in creating the clean energy future for which Vermont is striving. Given this, the state should work to ensure that Vermonters have access to the grid for interconnecting PV and that buildings are constructed to allow Vermonters to make the investment in a solar system.

The CEP also encourages community and commercial net metered projects, but the presence of more community and commercial projects should not prohibit homeowners from installing PV systems. Currently, the net meter law caps installations at 4% of a utility's total load. Although system reliability is paramount, the CEP recommends exempting residential installed PV systems of up to 10 kW from the 4% cap, subject to utility infrastructure needs, so that homeowners continue to have the ability to install small systems.

Recommendations for Increasing the Deployment of Residential PV

(1) Update the permitting process for net metering to a web-based electronic procedure.

[84] *The future of the Clean Energy Development Fund and funding decision methodology is further discussed below.*

(2) *Facilitate the statewide collection of aerial photographs or LiDAR images through interagency cooperation and add them to the Vermont Renewable Energy Atlas to allow for better remote site assessments.*

(3) *Extend the 10-day registration-type permitting for net metered systems from 5 kW to 10 kW.*

(4) *Investigate the possibility of utilities' offering customers the option of making PV loan payments on their electric bills.*

(5) *Work with the state and towns to address property tax uncertainty regarding residential systems.*

(6) *Continue providing rebates for PV systems with the goal of reducing the incentive amounts as prices of PV power come down and the market matures.*

(7) *Exclude all residential PV systems up to 10 kW from the calculation of each utility's 4% net metering cap, subject to utility infrastructure needs, effectively allowing an unlimited amount of these very small home-based systems.*

(8) *Establish new solar-ready building standards for new residences.*

5.8.3.2 Community and Commercial PV

Community and commercial PV systems can range from a small net metered system installed on a business to systems of up to 500 kW.[85] Recent changes to Vermont's first-in-the-nation group net metering law make it much easier for entire communities or just a few neighbors to group together to take advantage of PV electricity's benefits. Group net metering is also being used by companies that have multiple locations to meet their power needs with renewable energy by installing one large system at the best location, instead of putting in several smaller installations at different locations.

Like homeowners, businesses are increasingly installing PV systems. Almost all the current commercial PV installations are net metered, under the prior net metered cap of 250 kW. The largest net metered PV system presently is the 200 kW system located at IVEK Corporation's offices in Springfield, Vt.

Due to net metering certificate of public good (CPG) rules, most commercial systems are designed for a capacity of less than 150 kW. This is because projects above 150 kW have a more complex and lengthy permitting and interconnection approval process with the PSB and the interconnecting utility. The 150 kW threshold for more extensive review may no longer be the best capacity point for PV systems. We recommend that the DPS,

[85] *Act 47 of 2011 increased the net metering cap to 500 kW (30 V.S.A. § 219a).*

utilities, and stakeholders collaboratively investigate the best capacity level at which a PV system needs a more thorough review for both the interconnection and CPG approval processes.

We anticipate that as communities develop the best organization for net metered groups, the state will see a rapid increase in the deployment of larger group net metered PV systems in the 150 kW to 500 kW range.

Recommendations for Community and Commercial PV

(1) *The DPS, utilities, and stakeholders should collaboratively investigate the best capacity level at which a PV system needs a more thorough review for both the interconnection and CPG approval processes, determining whether the current 150 kW capacity trigger is the appropriate level, and if it is not, suggesting what a more appropriate level would be.*

(2) *Based upon the Department of Taxes/DPS study currently under way, the Vermont Legislature should establish a state property tax formula for commercial-sized PV systems over a certain kW size.*

(3) *The state should work to install PV systems on state buildings, either directly or with PV developers under leasing or other such financial arrangements, and should continue to find creative cost-saving uses of PV systems for remote power needs, such as in state parks, telecommunication sites, and roadway signage.*

(4) *Establish "solar ready" construction standards for commercial and public buildings. All new state buildings should be designed and built as solar ready if a PV system is not installed during construction.*

5.8.3.3 Utility-Scale PV Systems

Utility-scale systems are those above 500 kW in size. In 2010, Vermont commissioned its first PV system above the net metering size. Vermont now has two utility-scale projects operating and others under active development. The Ferrisburgh Solar Farm is a 1 MW plant, and the Chittenden County Solar Partners project in South Burlington is a 2.2 MW plant that uses Vermont-built trackers. A third utility-scale project is being developed in Pownal, Vt. Construction on this 2.2 MW project is planned to begin in 2012.

Without the financial assistance provided by the state and federal government, it is unlikely that these utility-scale systems would have been built. The Standard Offer Program provided fixed long-term contracts for the power. In addition, the Vermont Business Solar Tax Credit made the economics for these projects favorable enough for the developers to take on the capital risks in bringing these projects on line.

With the economies of scale, utility-scale systems are the most cost-effective way to install PV. However, these large systems require large open spaces with good southern exposure. Thus, concerns about land use and aesthetic impacts of such large systems should be addressed.

Recommendations for Utility-Scale PV

(1) *Investigate the need for changes to Vermont's PV interconnection standards for utility-scale systems.*

(2) *Based upon the Department of Tax/DPS study currently under way, the Vermont Legislature should establish a state property tax formula for utility-scale sized PV systems.*

(3) *The State should ensure, through the Section 248 process, that there is not an undue loss of access to prime agriculture land due to utility-scale PV systems.*

5.8.4 Wind Energy

Wind power generation grew by 15% in 2010, providing 26% of all new electric generating capacity in the U.S.[86] Wind projects across the country now supply enough electricity to provide power for approximately 10 million homes.[87]

In Vermont, 1.2% of electric power is currently sourced from wind energy, all of it generated in-state at the Searsburg and Sheffield wind facilities, and at other small systems across the state. Total installed wind power capacity available for Vermont use is 28.85 MW; this would produce approximately 74.8 GWh annually. Significant growth is expected. As shown in Exhibit 5-13 below, a number of utility-scale projects are currently proposed or under construction in Vermont. If all of these projects become operational, the combined capacity will be 161.6MW. The power contracted for delivery in Vermont, including a New Hampshire project under construction, will total 192.8 MW. This potential equates to approximately 9.2% of Vermont's 2009 total electric portfolio.

Wind power is considered a complement to solar in a renewable portfolio. When solar power is low or unavailable, during cloudy days or at night, the wind is often more potent. For example, during Vermont's winter, when sunlight is diminished, average wind speeds measure at their annual high. Wind power is intermittent in nature, like other renewable sources of power; thus, resource planning for effective grid integration is required.

Vermont could continue to add wind power to its portfolio in several ways—wind purchased from out-of-state wind projects, in-state wind projects, and small-scale net metered installations that serve homes, businesses, and

[86] *2010 AWEA U.S. Wind Industry Annual Market Report.*

[87] *Ibid.*

communities.88 Regardless of Vermont's own wind power development, it is clear from the projects in development regionally that wind energy will be a growing source of electric supply in the regional markets.

Exhibit 5-13. Wind Projects in Vermont's Electric Portfolio

Scale	Project	Developer	Location	Turbines	Turbine Capacity	Project Capacity	Status
Utility Scale, In VT	Searsburg	Green Mountain Power	Searsburg	11	.55 MW	6 MW	Operating
	Deerfield	Iberdrola	Searsburg & Readsboro	15	2 MW	30 MW	Permitting
	Georgia Mountain Community Wind Project	Georgia Mountain Community Wind, LLC	Milton and Georgia	5	1.5–2.5 MW	7.5-11 MW	Permitting
	Kingdom Community Wind	Green Mountain Power	Lowell	21	3.0 MW	63 MW	Under Construction
	First Wind Sheffield	First Wind LLC	Sheffield	16	2.5 MW	40 MW	Operating
Utility Scale, Out of State						**Capacity Sold to VT**	
	Granite Reliable Power Windpark	Nobel Environmental Power	Coos County, NH			65MW	Under Construction
Small Community				**# Sites**	**Avg kW**		
	Net-Metered[89]	Various	Various	158	10 kW	1.6 MW	Installed
	Standard Offer	Various	Various	6	1,675 kW	10.1 MW	Proposed

5.8.4.1 In-State Wind Power

Vermont's mountain ridges provide considerable technical potential for the development of wind resources. The achievable potential is much less; sites are eliminated as various factors are considered, including environmental matters, visual issues, ownership patterns, access to transmission, and other factors. Improved technology, changes in facility costs, and changes in energy prices also influence the viability and achievable potential of sites.

In 2002–03, the Department of Public Service participated in a U.S. Department of Energy study[90] that estimated Vermont's theoretical wind power potential to be approximately 6,000 MW. The study considered the strength

[88] In Vermont, wind facilities rated at no more than 100 kW are considered small scale. Those rated up to 500 kW can be net metered. Larger facilities are classified as commercial or large scale.

[89] This includes grid-connected installations only. The DPS does not presently have a means of tracking off-grid small wind turbines.

of the wind resource and proximity to the existing electric transmission and distribution (T&D) system, as well as using several criteria to exclude environmentally sensitive and other non-compatible land use areas. A 2010 study by the National Renewable Energy Laboratory (NREL) arrived at similar conclusions when plants with 30% gross capacity factor were considered.[91] In 2006, the Green Mountain National Forest updated its Forest Plan.[92] The plan identified over 160,000 acres on which wind development is allowed and approximately 20,000 acres on which wind development actually may be suitable, including the Deerfield Wind Project location.

Many sites identified in the studies above with high wind potential are owned by the state or federal government. In 2004, Vermont's Agency of Natural Resources explored wind power potential on state-owned lands and concluded that large-scale wind project development on state lands is incompatible with the Agency of Natural Resource's mission of land stewardship.[93] The policy did acknowledge that small-scale projects that are compatible with existing management plans could be allowed. The Agency recently did allow a 100 kW turbine to be installed on state forest land leased to the Burke ski area.

Completed in 1997, Green Mountain Power's Searsburg wind farm was the first utility-scale wind power facility in the Eastern United States. The Searsburg project was selected by the U.S. Department of Energy (DOE) and the Electric Power Research Institute (EPRI) for participation in the Utility Wind Turbine Verification Program, with a goal, in part, of verifying the performance of wind turbines in cold climates. Ten-plus years of wind measurements indicate the average wind speeds along the ridge are 15 to 17 mph. Annually, 11 Searsburg 550 kW turbines produce about 12,000 MWh; this is enough to power about 1,700 homes.

Since Searsburg's development, turbine capacity for inland sites has grown from approximately 500 kW to 3 MW; turbines are also now taller, with larger capacities. Continuing technical improvements have increased turbine capacity and reliability, and reduced the costs of production.

As shown in Exhibit 5-13 above, several new Vermont wind projects are in various stages of development. The First Wind project in Sheffield came on line in October 2011, with a rated capacity of 40 MW. The Lowell project is under construction now, and will add 63 MW of capacity once completed. The Deerfield project rated at 30 MW is not yet under construction, but has contracted with CVPS to sell 66% of its output for the first nine years. A portion of the electricity from Sheffield and Deerfield will be sold out-of-state during the expected life of the projects.

A map and listing of all the wind turbines installed in Vermont, including small-scale wind, can be found in the Vermont Renewable Energy Atlas, www.vtenergyatlas.com.

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[90] *Wind and Biomass Integration Scenarios in Vermont Summary of the First Phase Research: Wind Energy Resource Analysis*, March 2002, www.perihq.com/documents/wind-biomass_integration_scenarios_in_VT.pdf.

[91] www.windpoweringamerica.gov/wind_resource_maps.asp?stateab=vt&print.

[92] www.fs.fed.us/r9/forests/greenmountain/htm/greenmountain/links/projects/forestplan.htm.

[93] *See* www.vtfpr.org/wind/index.html.

As of October 2011, 158 small wind installations have been permitted for net metering. These systems total a combined capacity of 1.6 MW. Under the Standard Offer Program, there are six proposed projects with a total capacity of 10 MW. The DPS does not presently have a means to track off-grid small wind turbines.

Small-scale wind facilities are most often represented by a single turbine, which can range from less than 1 kW to 100 kW for a small commercial turbine. A number of factors affect the success of a small wind project. In order to harness the best wind spectrum, turbine siting is absolutely critical within the microclimate of the landscape. Turbines must be positioned so they extend as high as possible above obstacles. Technical expertise to maintain the system is also essential to securing years of optimum performance.

5.8.4.2 Out-of-State Wind Power

Wind generation projects are being built across the Northeast and in bordering provinces in Canada. Vermont utilities will be purchasing wind power from some of these resources into the future. In November 2010, ISO-NE completed the New England Wind Integration Study[94] acknowledging that public policy initiatives to increase renewable sources of energy and reduce carbon and other emissions are driving the development of large-scale wind generation. These include state renewable portfolio standards, emissions reductions of sulfur dioxide (SO_2) and nitrogen oxide (NOx), and regional carbon dioxide (CO_2) efforts such as the Regional Greenhouse Gas Initiative.

Below is a brief description of wind development goals and some wind projects in progress in our region:

- In Coos County, N.H., the Granite Reliable Wind project is under development. The facility's owner, Nobel Environmental Power, has contracted with CVPS and GMP to purchase 65 MW of the 99 MW project, for a period of 20 years starting April 1, 2012.

- According to Maine's 2009 Comprehensive Energy Plan, Maine is poised to develop 2,000 MW of land-based wind by 2015 and nearly 3,000 MW of on-shore and offshore wind by 2020. Maine views its offshore wind resource as an important export.

- The Massachusetts Clean Energy and Climate Plan for 2020 includes a goal of 2,000 MW installed wind power in state by 2020, much of which is to be supplied from offshore facilities. The Cape Wind project may be the first significant offshore wind project in the U.S. if built; its capacity will be 468 MW.

- In 2001, the New York State Energy Resource and Development Authority (NYSERDA) reported that 41.5 MW of wind energy was in operation in New York and that 425 MW of new wind energy was proposed. By 2011, installed wind power capacity in New York was more than 1,300 MW.[95]

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[94] www.iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/mtrls/2010/nov162010/newis_iso_summary.pdf.

[95] www.windpoweringamerica.gov/wind_installed_capacity.asp.

- Hydro-Quebec's (HQ) on-line wind generation capacity currently is 547.5 MW, with 211.5 MW under construction and 1,873 MW planned to be installed by 2015.[96]

It is clear that, regardless of Vermont's own utility-scale wind production, wind energy will be a growing resource in the regional market.

5.8.4.3 Balancing the Benefits and Challenges of Wind Power Development

Like other large electric generation technologies, wind generation has impacts and trade-offs that require careful evaluation and decision making. These trade-offs are discussed in detail below.

5.8.4.3.1 Relative Cost and Price Stability

New wind generation is the least expensive form of new renewable energy electric generation to build in Vermont today. That said, the high permitting and construction costs have a major impact on the total electricity costs of wind power in Vermont. Once a system is installed, however, operating costs are relatively low. This leads to stable pricing over the projected 20-year life of a typical installation. For new facilities, the Energy Information Administration's Annual Energy Outlook 2011 projected that by 2016 the total cost of electric generation will be 10 cents per kWh for inland wind, compared to 7 cents per kWh for combined cycle natural gas, and 24 cents per kWh for offshore wind.[97]

5.8.4.3.2 Reduced Emissions

The generation of wind power itself produces no emissions; wind generation in New England is estimated to save 828 lb of CO_2 per MWh generated. Thus, all wind projects now installed in Vermont reduce approximately 106.7 million lb in CO_2 emissions annually. If all proposed wind projects sited in Vermont are included, CO_2 annual emissions saved will be approximately 376.8 million lb per year.[98] Under present laws, Vermont wind projects may sell electricity and renewable energy certificates out-of-state, allowing the out-of-state buyer to gain the emissions credits and other environmental credits. If all proposed wind projects contracted to sell in Vermont are included, annual CO_2 emissions saved will be approximately 459.8 million lb.

5.8.4.3.3 Aesthetics

The beauty of Vermont's natural scenic landscape cannot be overstated. Thus, the permitting process for all energy facilities includes a review of the aesthetic impact of the proposed project. For wind power projects, the

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[96] www.hydroquebec.com/distribution/en/marchequebecois/parc_eoliens.html.

[97] *Energy Information Association's Annual Energy Outlook 2011,* www.eia.gov/forecasts/aeo/pdf/0383(2011).pdf.

[98] *These calculations present the full production capacity of all projects sited in Vermont, and include CO2 emissions for power and RECs sold out of state. These calculations used 15% capacity factor for net metered and 20% capacity factor for Standard Offer.*

aesthetic question is often more pronounced and controversial than it is for other generation projects. Wind power aesthetic concerns arise from the visual impacts of both the turbines and hazard lighting, from near and far perspectives, during the day and the night.

In order to start construction, wind turbines must be granted a certificate of public good (CPG) from the PSB. To assess the aesthetic impact, the PSB judges whether the structures will create "undue adverse impacts on the scenic and natural beauty of the area." The PSB reviews state and local standards, as well as testimony from experts, elected and governmental officials, and citizens. The DPS has engaged aesthetic experts for the permitting process to provide testimony on the aesthetic impact of proposed wind power projects. Simulated pictures and drawings of the proposed project are presented from different viewpoints, near and far. Many factors are considered. Ultimately, the PSB must find that the societal benefits of a project outweigh the adverse aesthetic impacts in order to grant a CPG.

To guide a more systematic review of aesthetic impacts for small-scale systems, the PSB has developed a scoring system. Its brochure, "Siting a Wind Turbine on Your Property," offers advice to those planning a wind site.[99] Larger projects present different concerns and challenges. For example, given Vermont's narrow ridgelines, should projects within view of the Long Trail, or of a historic downtown, or of a popular mountaintop, from a given distance categorically fail the aesthetics review? Should the answer depend on the cost of the power and other economic benefits? Though these questions will never receive uniform answers from all Vermonters, to help bring more uniformity to the aesthetic review process for utility-scale projects, the DPS is investigating either expanding its in-house staff expertise or creating longer-term contractual relationships with aesthetics review experts.

5.8.4.3.4 Environment

The windiest areas in Vermont are most often on the higher-elevation ridgelines that can host sensitive habitats for plants and wildlife, and are the source of the state's most pristine headwaters. In previously roadless areas, permanent road access is built to service the wind facility. The Wilderness Society cites a number of potential environmental harms caused by wind facilities: bird and bat injuries, habitat disruption and fragmentation, erosion, pollution from facility maintenance, turbine noise, and visual flicker.[100] These environmental disturbances can impact wildlife and people in the vicinity of a wind facility. All of the impacts are carefully assessed during the CPG process.

To aid siting of all types of energy projects, including wind power, ANR is engaging in a natural resource identification and mapping project for renewable energy development. That process is expected to be completed by the end of 2012.

[99] *http://psb.vermont.gov/sites/psb/files/forms/PSB_Wind.PDF*.

[100] *Ann Ingerson, July 2011, Renewable Energy in the Northern Forest, the Wilderness Society.*

5.8.4.3.5 Measured Production Capacity

The electrical output of a wind turbine is based on its technical capacity and the wind resource at the installed site—the average wind speed. Each wind project presents an estimated production capacity during the permitting process. Actual production is monitored continually once a project is operational. It takes a number of years to collect accurate output data once a site is operational.

There is often concern and confusion regarding wind power's capacity factor, which is a measurement of the projected or actual kWh production output versus the maximum output of a facility if it ran at its full rated capacity 100% of the time. Green Mountain Power (GMP) has rated the lifetime average capacity factor for Searsburg at 23.4%. In 2010, GMP measured Searsburg's most productive year due to above-average wind speeds, which resulted in a capacity factor of 30.6%. The Renewable Energy Research Laboratory at the University of Massachusetts rates the capacity factor for wind power at 20% to 40%.[101]

If the production capacity of a project is found to be below the estimated projected capacity presented during the permit process, the societal benefits anticipated for the project may not be realized. This issue is addressed during the CPG permitting process. The PSB has required reporting of power produced and has set minimum production requirements for a project that if not met would trigger PSB review of a project's CPG. As more projects with CPGs come on line, there will better data on the actual power production of wind turbines in Vermont's distinct environment, which can be used to evaluate the estimated production presented by any new proposed projects.

5.8.4.3.6 Wind Variability

The variability of wind generation and the complexities of accurate forecasting present challenges to the reliable operation and planning of the regional power system. ISO New England commissioned a comprehensive study of this issue, in response to the growth of commercial wind power in New England and neighboring electric systems. The results of this study, known as the "New England Wind Integration Study" and published in December 2010, analyzed wind penetrations of 2.5%, 9%, 14%, 20%, and 24%.[102] The study found that New England's regional electric generation system, which is dominated by natural gas–fired generators, is very flexible and compatible with wind generation. Natural gas generators are able to quickly ramp production up or down, in sync with variable production sources, such as wind and other renewables.

Other key findings of the ISO-NE study:

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[101] *Renewable Energy Research Laboratory, University of Massachusetts at Amherst, Wind Power: Capacity Factor, Intermittency,and What Happens When the Wind Doesn't Blow?* www.umass.edu/windenergy/publications/published/communityWindFactSheets/RERL_Fact_Sheet_2a_Capacity_Factor.pdf.

[102] http://iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/reports/2010/newis_es.pdf.

- Wind could meet up to 24% of the region's electricity needs in 2020 under certain assumptions for load growth, conservation, and infrastructure forecasting improvements. This corresponds to 12,000 MW of installed nameplate capacity. Locational marginal prices were reduced by $5 to $11 per MWh in models for 20% wind penetration.

- Wind generation will displace fossil fuel generation, primarily natural gas–fired plants, which currently provide about 50% of New England's power.

- The region needs a flexible wind system, such as that afforded by its fleet of natural gas generators. Current generation resources are adequate even at 20% wind penetration.

- Regulation and operating reserve requirements will increase with wind penetration levels because of the inaccuracies inherent in predicting short-term wind power differentials. Day-ahead and hourly wind forecasting should be performed to optimize analysis of day-ahead and intra-day system reserves.

- ISO-NE should continue to research improvements to the calculation of wind production capacity values as it gains experience with wind energy.

Some studies report that as wind power supplies an increasing percentage of the ISO-NE grid, the wind's intermittency will have a greater impact on reliability. A 2005 study by Gregor Giebel cites various research papers, and concludes that as the penetration of wind power rises to 30% of an electric grid's load, the capacity credit of wind resources may be only 10% to 15%.[103] Currently wind power is less than 0.5% of the ISO-NE grid,[104] but there is a focus among system planners to optimize resources in light of growing energy production from intermittent renewables.

The issues of optimization need to be considered in the context of the entire ISO-NE power pool. Wind integration has been extensively modeled by ISO-NE. ISO-NE is implementing new technology (intelligent software complemented with distributed measurements of supply and demand, including advanced meters) and practices to efficiently manage the power system's variable renewable resources. For example, ISO-NE's 2012 system plan and budget calls for greater wind forecasting resources, to help balance loads through more precise just-ahead forecasting of wind speeds.

The National Renewable Energy Laboratory states, "with increased experience in integrating wind generation and balancing various sources of electric power over a large power control area, utility grid operators have learned how to reduce variability and limit reserve additions to modest requirements when wind generation is

[103] *Gregor Giebel, Risø National Laboratory, Wind Power Has a Capacity Credit: A Catalogue of 50+ Supporting Studies, GGiebel-CapCredLit_WindEngEJournal_2005_right_links[1].pdf.*

[104] *ISO New England, 2010 Annual Markets Report,* www.iso-ne.com/markets/mkt_anlys_rpts/annl_mkt_rpts/2010/amr10_final_060311.pdf.

brought online."105 ISO-NE's December 2010 "New England Wind Integration Study" agrees.[106] ISO-NE does not portray the capacity backup requirement of wind or other variable resources as a major cost or impediment to an efficiently integrated system in New England. Instead, it is discussed as a technical adjustment that is diminishing in consequence as the power pool adapts.

5.8.4.3.7 Permitting Issues

In Vermont, the primary permit for all electric generation projects is a certificate of public good (CPG) issued by the Vermont Public Service Board (PSB) under 30 V.S.A.§ 248 of Vermont's statutes. After considering statutory criteria and weighing the overall costs and benefits of the proposed project, the PSB must find the project promotes the general good of the state.

Among the criteria, the PSB considers local ordinances and town and regional plans, and whether such plans specifically address renewable energy siting.[107] Statutory parties[108] include the Department of Public Service, "representing the public interest," and the Agency of Natural Resources (ANR), whose "mission is to protect and improve the health of Vermont's people and ecosystems and promote the sustainable use of Vermont's natural resources." The Vermont Division for Historic Preservation has developed a protocol for evaluating impacts of wind, transmission, and cell tower installations on historic resources, in order to foster predictability in project permitting. (See www.historicvermont.org/programs/evaluatingcelltowers.pdf.)

The permitting process includes approval of binding plans for transportation, blasting, post-construction monitoring of sound and wildlife impacts, and decommissioning. The PSB considers on-site mitigation; purchase and development of alternative sites; and impact fees for recreational, scenic, natural, and cultural resources deemed unduly affected. Mitigation, alternative sites, and fees need be in place only until the facility is fully decommissioned and the environment repaired, unless there are clearly specified permanent disturbances.

Many interveners in wind project matters have voiced concern that the PSB process makes it too expensive for them to effectively participate. Others have faulted a lack of process for resolution of objections apart from full-scale litigation. Meanwhile, wind developers ask for relief from higher costs and permitting times in Vermont, which exceed those of neighboring states.

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[105] *D. Jacobson and C. High, National Renewable Energy Laboratory, February 2008, Wind Energy and Air Emission Reduction Benefits: A Primer, Subcontract Report NREL/SR-500-42616.*

[106] http://iso-ne.com/committees/comm_wkgrps/prtcpnts_comm/pac/reports/2010/newis_es.pdf

[107] *A number of municipalities and regional commissions have voiced disagreement with the designation under Act 250 and Title 30 of "public power generating plant" for small-scale turbines.*

[108] http://psb.vermont.gov/statutesrulesandguidelines/guidelines/GuidetoFiling248Petition

In 2004, the Vermont Commission on Wind Energy and Regulatory Policy provided recommendations[109] on whether 30 V.S.A. § 248 provided appropriate review of "commercial"[110] wind generation projects. The Commission identified Section 248 as "the appropriate vehicle for siting commercial wind generation projects." It made recommendations that included increasing public involvement and encouraging developers to collaborate early with stakeholders; these recommendations have been subsequently implemented by the PSB. Recommendations included as part of this section address the Commission's recommendation of appointing an ombudsperson.

Recommendations

As we weigh the benefits and drawbacks of wind generation, we conclude that wind power should continue to be an important renewable resource for Vermont's diverse electricity portfolio going forward. To improve wind project permitting and siting and to address some of the concerns that have been raised regarding these projects, we recommend the following:

(1) Vermont utilities should continue to monitor opportunities to purchase cost-effective in-state and out-of-state wind generation to add to their sources of energy supply.

(2) Vermont should continue to facilitate development of in-state wind projects in order to achieve the state's renewable energy goals, with particular focus on community and small-scale projects. For utility-scale projects, development should be permitted if there are significant economic and societal benefits to Vermonters, and all other CPG criteria are fulfilled.

(3) ANR should complete its natural resource inventory and mapping project to identify resources that may affect siting for the build-out of renewable energy projects, including utility-scale wind generation.

(4) The DPS, the ANR, and the PSB should consider developing generic siting guidelines for developers of wind projects, to aid permit process uniformity and provide guidance on aesthetics and other common issues. Regarding consistency among siting renewable resources, refer to Section 5.10.6 Regulatory System—Recommended Improvements.

(5) Site decommissioning plans for utility-scale wind projects should continue to cover criteria for deconstruction and remediation upon permanent retirement of each turbine, where appropriate, as well as the entire site.

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[109] http://publicservice.vermont.gov/energy/ee_files/wind/WindCommissionFinalReport-12-15-04.pdf

[110] *Commercial was defined as "larger than net metered projects, which are generally 150 kW or less."*

(6) *Hazard lighting for turbines should use radar-activated lighting wherever possible.*

(7) *For wind siting, and all other Section 248 siting proceedings, the DPS and the PSB should develop a mediation program to be used to resolve disputes among parties. Mandatory mediation at points in the process should be considered. For additional comments on this recommendation, refer to Section 5.10.6 Regulatory System—Recommended Improvements.*

5.8.5 Natural Gas

In 1995, less than 10% of the regional energy mix was natural gas. Currently, roughly 40% of the energy sold on the wholesale market is from natural gas. Ninety-eight percent of the region's capacity additions since 1999 have come in the form of high-efficiency natural gas combined-cycle generation facilities. Natural gas now sets the market price of wholesale electricity in most hours.

Reduced demand combined with shale gas discovery and extraction has driven recent natural gas prices lower, and decoupled the natural gas price from the rising price of oil. Shale gas refers to natural gas that is trapped within shale formations. Shales are fine-grained sedimentary rocks that can be rich sources of petroleum and natural gas. Over the past decade, the combination of horizontal drilling and hydraulic fracturing has allowed access to large volumes of shale gas that were previously uneconomical to produce. The production of natural gas from shale formations has rejuvenated the natural gas industry in the United States. Dramatic increases in the quantity of technically recoverable shale gas resources, coupled with decreases in the expected costs of finding, developing, and producing gas from those resources, is leading to lower projections of avoided costs for natural gas and gas-fired electric energy.[111]

The environmental effects of shale gas may lead to reduced exploration and extraction, adding costs and calling into question projected low prices. An area of uncertainty for shale gas "is the potential impact of changes in the future regulation of shale gas development; in particular changes in the future regulation of hydraulic fracturing. Concerns have been raised regarding the need for additional regulation of hydraulic fracturing in order to minimize its environmental impacts on groundwater, surface water, and air emissions and the potential impact of such changes in regulation on shale gas production quantities and cost."[112] Nevertheless, shale gas is having a present and significant effect on prices in the regional energy markets, and is projected to continue to do so.

Extraction technique aside, natural gas is not as environmentally friendly or as stably priced as renewable energy, but it is currently less expensive. It is also a far cleaner resource than coal or other fossil fuels, when properly extracted and distributed. However, exposure to supply disruptions, price volatility, the region's heavy dependence on a single fuel source, and greenhouse gas emissions associated with the fuel are all reasons for caution.

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[111] *U.S. Energy Information Administration.*

[112] *Avoided Energy Supply Costs in New England: 2011 Report, July 21, 2011.*

5.8.5.1 Natural Gas Electric Generation

Natural gas is a secondary fuel source for the wood-fired McNeil generator in Burlington, and Vermont depends on a certain amount of natural gas generation from out of state. However, there are currently no electric facilities that burn natural gas as a primary fuel in Vermont. Vermont should consider allowing the construction of small or midsized natural gas electric generation plants, strategically located to enhance system reliability and help defer transmission system upgrades, or used as an anchor load to leverage expansion of the Vermont Gas Systems network to communities that are currently without natural gas. (See Section 8—Thermal Energy Sources regarding expansion of the natural gas system in Vermont.)

Increasing our use of renewable energy and decreasing our dependence on fossil fuels are important goals for Vermonters. Nevertheless, fossil fuel power plants are still a strategic component of the region's electric supply mix because of their ability to produce a certain quantity of electricity at a specifically designated time, and natural gas presents the best environmental and economic choice among fossil fuels used for that purpose. As we increase the amount of intermittent renewable energy in our portfolio, it will be important to ensure that we can meet Vermont's energy demand with resources that can guarantee delivery of electricity during periods of peak demand and low output from intermittent renewable energy. Since the Vermont Gas System peak is currently in the winter and the Vermont electric system peak is increasingly during the summer, there are excellent opportunities for additional peaking electric generation using natural gas. Natural gas has the potential to reliably provide electricity, producing fewer point-of-combustion emissions and minimal local air pollution or long-term pollution problems. Natural gas electric generation emits nitrogen oxides and carbon monoxide in amounts per unit of energy used that are similar to those of oil-fired plants. However, natural gas CO_2 and particulate emissions are considerably lower than those from other fossil fuel-powered plants, and natural gas plants present no long-term by-product waste concerns. Because of their lower capital costs and emissions profile, natural gas plants are ideal for adding more peaking generation capacity or small baseload capacity.

The decision regarding whether to permit natural gas-fired electric generation in Vermont must take into consideration that there is already a heavy dependence on natural gas generation in New England. Approximately 40% of both energy and capacity in the region currently comes from natural gas generators. Although Vermont's electric portfolio currently has only a moderate exposure to natural gas price volatility, increasing Vermont's dependence on variably priced electricity such as natural gas would expose Vermonters to additional energy price volatility. Therefore, it is important to size and locate any such plant to provide system reliability enhancements or other benefits, such as leveraging natural gas expansion as an available heating fuel.

Recommendations

(1) Considering permitting strategically located natural gas electric generation closer to electric loads, constrained areas, or in locations that leverage natural gas thermal expansion or combine thermal energy and electric generation.

(2) *The DPS, PSB, and VGS should continue to evaluate and take advantage of cost-effective opportunities to extend the natural gas service territory and/or site additional natural gas pipelines within Vermont's borders.*

5.8.6 Nuclear

Currently, five nuclear power plants operate within the New England grid, with a total capacity of 4,629 MW, supplying roughly 20% of the energy for the New England grid. Opinions gathered during the CEP public comment process and prior deliberative process indicated that Vermonters have polarized views regarding nuclear power and the role, if any, it should play in Vermont's energy future. Those opposed to nuclear power cite its safety risks and the lack of an adequate system for long-term disposal of nuclear waste. Those supporting nuclear power cite its low carbon profile at generation and ability to supply inexpensive baseload power to the grid. Whatever the future of Vermont Yankee—Vermont's sole large-scale electric generator, which first operated in 1972—a significant amount of nuclear power will continue to supply baseload energy to the New England grid and will be used by Vermont utilities as well as those of other New England states for years to come.

The Vermont Yankee Nuclear Power Station (VY or Vermont Yankee) presently supplies approximately one-third of the state's electricity needs, through sales to four of Vermont's utilities.[113] CVPS also owns 1.7% of the Millstone 3 unit located in Connecticut. This is a 1,155 MW plant first operational in 1986 that has received an extended operating license through 2045. Historically, Millstone has supplied about 5% of CVPS's power requirements.

Vermont Yankee is located in Vernon and is currently owned by Entergy Nuclear Vermont Yankee LLC, a subsidiary of Entergy Nuclear Operations, Inc., an independent owner/operator of nuclear facilities. Power is currently supplied to Vermont utilities through a purchase power agreement (PPA) executed when the plant was sold to Entergy in 2002. Entergy is the second-largest nuclear plant operator in the U.S., owning 10 nuclear plants, five in the South and five in the Northeast.[114] Prior to 2002, VY was owned by Vermont Yankee Nuclear Power Corporation (VYNPC), which was owned, in turn, by eight New England utilities. Vermont utilities owned 55% of VYNPC and received 55% of the output of the VY station.

In 2003, Entergy petitioned the PSB for an increase to the output, known as a power up-rate, at the VY plant of about 20%, from 510 MW to approximately 620 MW. In March 2004, the PSB conditionally granted that request, subject to an independent engineering assessment of the facility. The Nuclear Regulatory Commission (NRC) approved the power up-rate in 2005. As a result, the plant was able to increase power by approximately 120 MW. This additional power is owned by Entergy and sold into the New England market. As part of the proceeding before the PSB, Entergy agreed to a revenue-sharing provision related to its sales of up-rate power,

[113] *This accounts for approximately 46% of the plant's total output. The other 54% is sold under contract to other states' utilities, or sold into the New England market.*

[114] *The other plants in Entergy's Northeast fleet are Pilgrim (Massachusetts), Indian Point Units 2 & 3 (New York), and James A. Fitzpatrick Nuclear Plant (New York).*

and this being the case the DPS agreed that the power up-rate proposal represented an economic benefit to the state of Vermont. Funds received from Entergy for operations through March 21, 2012,[115] are used to support renewable energy development in the state through the Clean Energy Development Fund.

5.8.6.1 Future of Vermont Yankee

Starting in 1998, the NRC began granting 20-year operating license renewals to nuclear plants. A plant must obtain an NRC license renewal before running beyond its current license. In 2007, Entergy submitted its application to the NRC for a license renewal beyond the original March 2012 date. Entergy received that license renewal in March 2011. Entergy submitted a separate application to the Vermont PSB on March 3, 2008, to obtain a new certificate of public good (CPG) because the original CPG is set to expire in March 2012. The PSB opened a docket for this purpose. As a condition of its purchase, Entergy is prohibited from operating the plant beyond March 21, 2012, without obtaining a renewed CPG. Additionally, the Vermont General Assembly must approve the continued operation of the plant beyond its current CPG. The Public Service Board "may not issue a final order or a Certificate of Public Good until the general assembly determines that operation will promote the general welfare and grants approval for that operation," according to 30 V.S.A. § 248(e)(2). In February 2010, the Vermont Senate did not approve a bill that would have allowed the PSB to issue a final order in the CPG case. The Vermont House of Representatives did not take up the bill in that session.

Entergy has made several additional commitments regarding purchased power transactions should the plant receive permission to run past March 2012. These were the result of terms and conditions negotiated in the agreements made at the time of the sale of the plant in 2002. Entergy's commitments do not obligate the company to sell any power from the Vermont Yankee plant to Vermont utilities should it continue to run past March 2012, though a revenue-sharing agreement for sales beyond that date remains in place. Entergy has not reached agreement regarding power purchases with any Vermont utility beyond its CPG expiration date of March 2012 and, at this point, the Vermont utilities that receive VY power have planned to move beyond reliance on VY by purchasing market power hedges and investing in renewable projects and other long-term contracts to cover their exposure. For example, GMP entered into a long-term contract to obtain power from the Seabrook Station in New Hampshire, with a portion available to other Vermont utilities on similar terms and conditions, and CVPS entered into contracts to cover its near-term power needs presently supplied by Vermont Yankee. GMP and CVPS have also contracted for 99 MW of wind power from Granite Reliable.

In April 2011, after Entergy was unable to secure either a buyer for its facility or a long-term power contract and was unable to secure a Vermont legislative vote in favor of the CPG process, Entergy sued the state in federal court, claiming that Vermont's post-2002 legislative enactments and the CPG process itself are preempted by federal law. That suit is pending at the time of the CEP's publication. Should the plant prevail in its suit or otherwise continue the CPG process, many other matters, including decommissioning, water discharge, and other oversight issues, would have to be addressed in the state process.

[115] *There is one payment in March 2013 that will cover the January 2012–March 21, 2012, time period.*

The CEP will not take a position on whether VY should continue to operate; that is the role of state laws and processes and is the subject of the pending lawsuit. Instead, this document focuses on Vermont's energy future to prepare the state regardless of whether the plant ceases operation on schedule in March 2012. This being the case, the CEP recommends that Vermont utilities diversify their resource mix toward renewable energy and alternative low-carbon baseload resources.

Recommendations

(1) *Vermont electric utilities should continue to manage portfolio risk and explore strategies for source diversification to reduce the exposure to ratepayers from unit-contingent contracts.*

(2) *Vermont utilities should continue planning for alternatives to power from the VY facility, including through owned-generation projects, through system power contracts, and through merchant power obtained through negotiations or solicitations.*

(3) *Vermont utilities and agents that are party to the negotiations of major contracts, including out-of-state nuclear, should help ensure that the smaller municipal and cooperative utilities gain access to those resource contracts on similar terms and conditions.*

(4) *The state should continue to advocate for effective oversight of all safety aspects of the plant by the U.S. Nuclear Regulatory Commission.*

(5) *The state should continue to advocate for an appropriate and effective federal solution to the problem of spent nuclear fuel stored on site.*

(6) *The state should provide oversight of decommissioning funding and activities as permitted by law.*

(7) *The state should ensure that Entergy funding of environmental monitoring and emergency preparedness is sustained after March 21, 2012, regardless of whether Vermont Yankee operates or enters into decommissioning activities.*

5.9 Energy Storage

As Vermont expands its reliance on intermittent renewable energy, concerns about the effects on the grid increase. The New England grid has sufficient capability to handle the types and levels of renewable energy envisioned in the CEP in the short term. More specifically, it is expected that Vermont has the transmission resources to handle the level of renewable energy called for during the next five years. Increased efficiency investments will facilitate the ability of the current infrastructure to handle even higher levels for longer.

However, as Vermont's integration of renewable and other in-state electricity projects increases, certain interconnection and grid operation issues will need to be addressed. This must be considered for both smaller systems installed in stressed distribution areas and large utility-scale renewable energy projects interconnected with the transmission system. These issues can be dealt with in numerous ways, including upgrades to the distribution and transmission infrastructure. Another solution that has promise in Vermont is the use of power storage technology. Power storage can smooth out the intermittent generation of renewable energy, can help meet peak demand, and can assist with optimization of the grid and power harmonics.

In South Burlington, the Dynapower Corporation is developing a power storage demonstration project that has promise to help integrate renewable energy into the grid. The project consists of a 1 MWh battery-based energy storage component, a highly efficient 1.5 MW bidirectional inverter, wind and solar renewable generation, and the associated controls to manage the system and communicate with the utility. This project will demonstrate the increased dispatch and utilizations of intermittent renewable energy sources that can be achieved with the addition of energy storage and advanced power electronics.

In addition, Dynapower's project demonstrates that systems of this size and complexity can be designed, manufactured, and commissioned almost entirely in the state of Vermont—providing the type of clean energy economic development envisioned by this CEP.

Power storage systems can benefit the utilization of the local grid by:

- Substantially reducing the demands placed on the grid by a large manufacturing facility through optimizing the use of renewable energy produced on site.
- Providing load leveling capability, reducing demand fluctuations.
- Demonstrating alternatives to infrastructure-based grid enhancement.
- Providing reserve energy to the local community during unexpected peak demands.

5.10 Tools to Create Desired Electric Portfolio

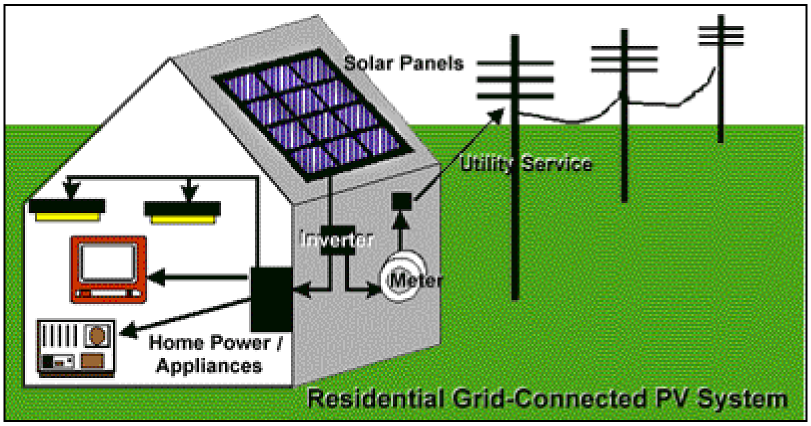
Vermont is blessed with renewable energy resources, access to electricity from a wide array of in-state and regional sources, and connection to three different power grids all larger than Vermont's in-state system. However, policy support is required if the state wishes to ensure that the electric sector portfolio facilitates the overall CEP goal of having 90% of total energy met by renewable sources by 2050.[116]

Broadly, the CEP recommends that utilities secure renewable power generation of all sizes, from small residential systems to large utility systems. The policy tools discussed here can be seen as directed to facilitate three different sizes of generation projects: residential, community, and utility-scale. Some of the policy tools needed to encourage each are discussed below.

[116] *Electric efficiency, the most cost-effective supply resource, is discussed in Section 4.*

5.10.1 Net Metering

The 1998 Vermont legislative session enacted a net metering law (30 V.S.A. § 219a), requiring electric utilities to permit customers to generate their own power using small-scale renewable energy systems. The excess power generated by these systems can be fed back to the utility, basically running the electric meters backward and providing the customer with a credit on his or her monthly electric bill.



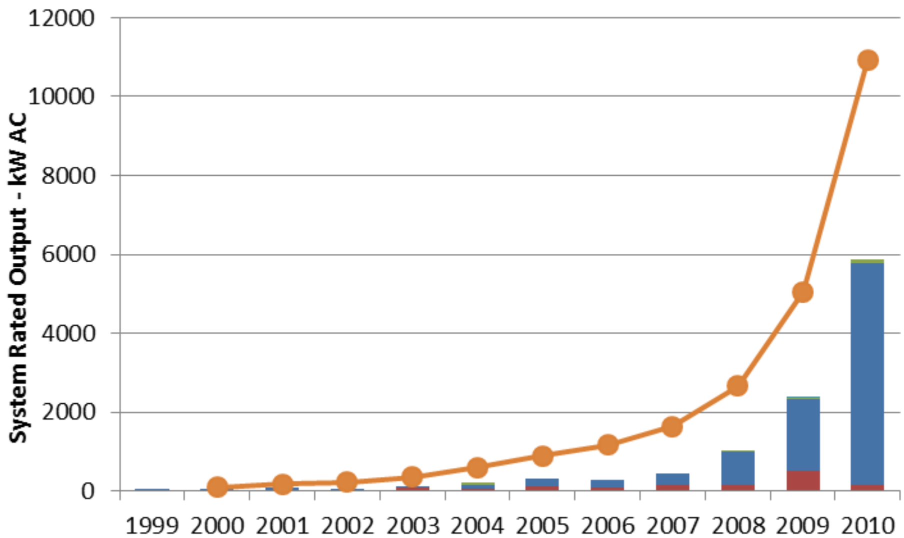
Thus, net metering provides customers with the ability to offset their use of utility-supplied power with power generated on the customer side of the meter produced from a customer-owned renewable source. Combined heat and power systems of less than 20 kW that use fossil fuels are also allowed, but none have been installed. The sources of distributed power that can be net metered have some potential to affect the need for transmission and distribution investment to the benefit of all ratepayers.

Amendments to the net metering law in 1999, 2002, 2008, 2010, and 2011 allowed the installation of a greater amount of overall net metered system capacity, qualified larger individual systems for net metered treatment, and lifted the original restriction of group net metering to on-farm only, opening group net metering to all customers.

Most recently, in 2011, the Vermont General Assembly expanded the permissible size limit per installation to 500 kW, simplified the administration for net metering groups, allowed a registration process for small residential systems, increased the overall net metering capacity cap per utility to 4% of 1996 utility system peak or previous year's peak (whichever is higher), and created a solar adder for all PV net metered systems that had the effect of increasing the value of net metering to 20 cents per kWh for customers who install net metered PV systems statewide.

Exhibit 5-14 shows that Vermont's legislative action, along with increased awareness and the availability of incentives, has led to a dramatic increase in permitted net metered capacity since 1999, particularly for solar systems. In 2006, there were only 329 permitted net-metered systems in Vermont, with an installed capacity of 1,177 kW. By the beginning of 2011, the numbers had climbed to 1,319 installed systems with an installed capacity of 10,923 kW.

Exhibit 5-14. Approved Net Metering kW Capacity by Year and Technology (with Cumulative Total)



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Hydro	0	0	0	0	0	0	0	0	0	0	15	0
Fuel Cell	0	0	0	0	0	0	0	0	0	0	0	0
Methane	0	0	0	0	0	65	0	0	0	19	39	103
Solar PV	23	39	54	16	40	93	187	171	319	859	1842	5611
Wind	32	10	28	31	96	71	119	102	143	144	501	151
Cumulative Total		104	186	233	369	598	904	1177	1639	2661	5058	10923

Source: DPS and PSB

Over the next 20 years, given the present increase of net metered systems and the growth that may be achieved through additional regulatory improvements, the CEP estimates that Vermont will achieve at least 30 MW of additional net metered capacity.

Electric companies are required to make net metering available to any customer system on a first-come, first-served basis until the cumulative output capacity of net metering systems equals a specified limit. This limit on cumulative output capacity was set initially in 2001 at 1% of 1996 or current calendar year "peak demand," whichever is greater.[117] As noted above, the Vermont General Assembly raised the cap to 4% in 2011. This cap is intended to ensure that electric rates are not unreasonably affected by the net metering option.

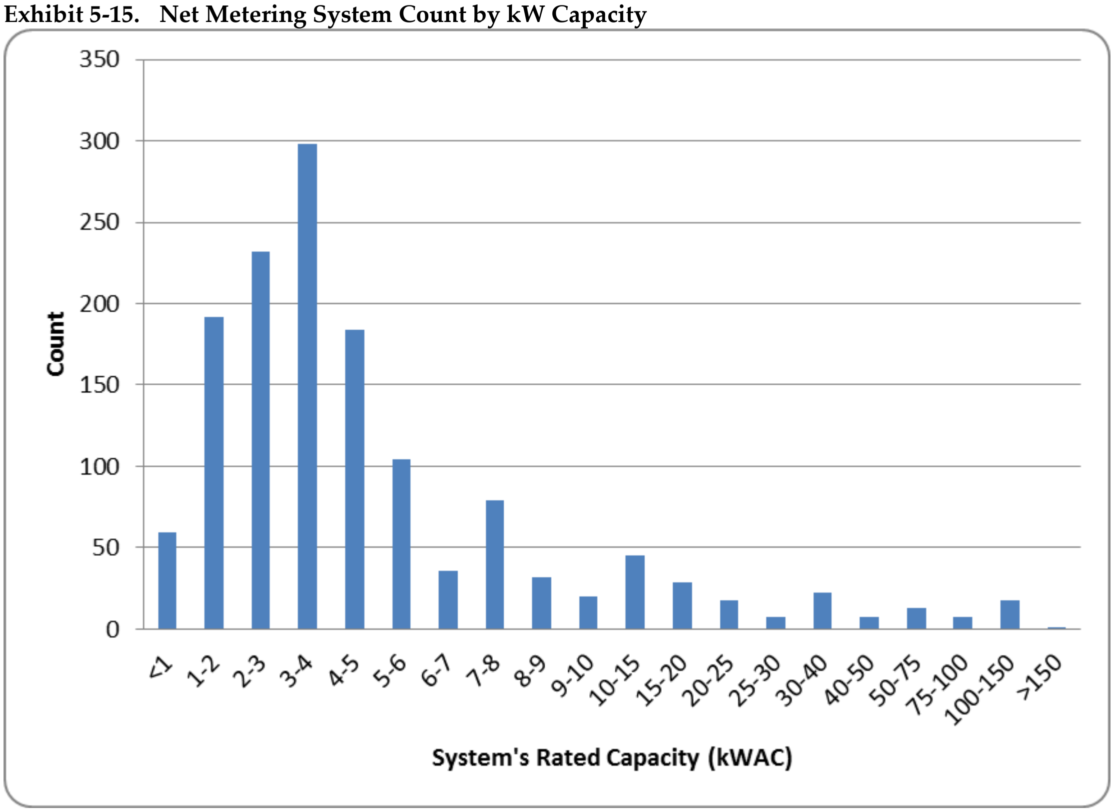
Net metering, as indicated by the data above, has been an increasingly effective tool to promote residential and small commercial renewable energy systems. Net metering started as a way for homeowners to invest in renewable energy generation equipment on their own roof. As interest has grown among both customers and

[117] *"Peak demand" means the highest monthly peak reported in either the electric company's FERC Form 1 or the electric company's Electric Annual Report to the Vermont Department of Public Service for the year.*

the utilities, and experience has shown no adverse impacts to system reliability, the state has raised the cap continually to maintain access to net metering for all customers.

The opportunity to create one's own power and have a simple interconnection with the grid should be widely available to all residential customers. Thus, instead of increasing the cap each time a utility approaches the required percentage, there should be no percentage cap per utility for systems less than 5 kW. This policy would ensure that a residential customer's access to the grid for small systems would not be precluded by larger group net metered or commercial systems using all the available net metering capacity. While the average net metered system has expanded annually, Exhibit 5-15 shows that the bulk of net metering systems permitted to date have been at the 5 kW size and below; about 90% of these net metered systems are solar PV. Approximately 20% of approved net metering capacity is represented by systems of less than 5 kW. Utility infrastructure capacity for interconnection should be the only near-term limitation on the number of small residential systems that can be installed. As net metering expands, the DPS will examine its impact on utility costs and rates in order to develop future recommendations regarding appropriate cost sharing.

Exhibit 5-15. Net Metering System Count by kW Capacity



A simple and transparent permitting process is as important as a simple and guaranteed interconnection process for net metered systems. Recently, as the number of permitted net metered systems has increased, the DPS has received an increased number of comments about the time it takes to get a CPG approved. Currently no data is available on the time it actually takes to grant a CPG, or what causes delays—whether it is the applicant or the regulatory process. To this end, the PSB and DPS should create and maintain a database of net metered CPG applications that includes a record of the time needed for a CPG to be issued once a completed application is received, and should investigate further use of registration for net metered systems, as well as online applications.

Additionally, net metering permitting and interconnection requirements that may no longer be needed, such as proof of insurance and lockable disconnects for some smaller systems, should be investigated and eliminated if no longer necessary.

Recommendations for Net Metering

(1) Exclude residential systems under 5 kW from the utilities' percentage system cap calculations, subject only to utility infrastructure needs.

(2) Investigate elimination of the net metering permit requirement of proof of insurance for non-inverter-based systems under 50 kW and inverter-based systems under the cap (500 kW).

(3) Update the net metering permit application process to include an electronic online form/paperless process option, and investigate extending the 10-day registration process to other systems.

(4) Encourage small-scale efficient combined heat and power natural gas units in areas served by natural gas. Study deployment issues for these units.

(5) Revise interconnection procedures and standards, in particular the present optional requirement that a separate lockable disconnect be installed for inverter-based systems below a certain kW size.

(6) Maintain a publicly available database of all net metering permit applications and issuances.

5.10.2 Interconnection Standards

Among the regulatory barriers identified by proponents of distributed resources are those associated with uncertain costs and requirements regarding interconnections to the grid. The Vermont General Assembly has responded to the concern by requiring the Vermont Public Service Board to establish simplified interconnection rules for small systems (<150 kW), and clear standards and a timeframe for responding to interconnection requests of larger systems.

These rules created by the PSB for systems below 150 kW have worked well to ensure safe and timely interconnections of more than 1,300 net metered systems. The interconnection rule developed for larger systems (>150 kW, Rule 5.500) are similar to rules for interconnection governed by FERC and ISO-NE. These rules are fundamentally designed to ensure timely response to a generator requesting interconnection and to filter or distill material projects requiring significant analysis and review of distribution and transmission system impacts. Where additional facilities are required to ensure the integrity of the system, the requester is required to pay for the costs. The requester is also required to pay the costs associated with any system impact or facility studies required.

Despite the significant progress already made in establishing fair and efficient interconnection standards and response times, developers of projects of more than 150 kW remain concerned about potentially stranded investments, time delays, and the appropriate pricing of backup and interconnection service. Vermont has made solid progress and had success in developing simple interconnection standards for net metered systems of up to 150 kW. The DPS and PSB should investigate extending that successful model to larger systems.

In addition to the interconnection requirements set by the PSB and the utilities, commercial projects need to obtain a permit from a state electrical inspector. As PV systems become more common and more systems are installed, there could be delays in getting a state electrical inspection. At times, the concerns raised by developers about the time delays for inspections have been caused by mistakes and miscommunications made by the developers. Regardless, there is currently a lack of verifiable information about how long it actually takes for projects to be inspected. For this reason, the Department of Public Safety should consider tracking the time it takes for an inspection to occur, and should work toward offering an electronic/paperless online application to help simplify the process.

Recommendations

(1) *The utilities and regulators should continue to ensure that interconnection arrangements, business response timetables, and relevant tariffs are fair and nondiscriminatory.*

(2) *The Department of Public Service should monitor utility activity and performance as they relate to interconnection and should request that utilities file annual interconnection reports on the time and costs associated with interconnection applications received.*

(3) *The Department of Public Safety should investigate maintaining a database of commercial PV system inspections that includes a record of the time it takes for an inspection to take place once a proper request has been made by the customer.*

(4) *The Department of Public Safety should investigate offering an electronic/paperless online application process to help in streamlining the state electrical inspection process for commercial systems.*

(5) *Vermont utilities, the DPS, and stakeholders should work collaboratively to establish improvements to the PSB's interconnection 5.500 rule, including investigation of the size of projects subject to simplified interconnection.*

5.10.3 SPEED and Renewable Electricity Portfolio Standard

The Sustainably Priced Energy Enterprise Development (SPEED) program was established by the Vermont General Assembly through Act 61 in 2005 to promote the development of renewable energy by encouraging Vermont utilities to engage in long-term contracts for power from renewable sources. The SPEED program is often confused with the establishment of specific requirements for renewable energy acquisition, which have been established through a renewable portfolio standard (RPS) in 29 states, including all New England states except Vermont.

Vermont has not enforced a mandatory RPS on retail electric sales made in the state. Although a renewable portfolio standard was established by the Vermont Legislature in the 2005 SPEED program, the implementation was delayed until at least 2013, with the stipulation that the RPS would come into effect only if new renewable energy additions to the state's portfolio were below the amount of new load growth over that time. By delaying the implementation of an RPS, the state allowed utilities to increase the amount of renewable energy in their portfolios without the regulatory requirements and potential costs of an RPS.

The 2005 law does not require utilities to acquire any renewable energy certificates (RECs) connected to the new renewable energy generation that they count toward meeting Vermont's legislative requirement. Thus, the utilities are allowed to separate the electricity from the attributes of the renewable energy, so that the RECs may be sold in out-of-state markets. Although this can reduce the cost to ratepayers for new renewable energy, it means that Vermont utilities that do not retain the RECs from renewable energy projects they use in their portfolio are no longer eligible to claim the power as "renewable energy" in advertising to consumers. The selling of the RECs to utilities in other states has allowed Vermont utilities to lower the rate impact of adding new renewable energy generation; however, it has also led to concerns that the renewable energy attributes are being counted twice, once by Vermont utilities to meet the requirement to avoid the implementation of an RPS and once by the utilities that purchase the RECs to meet RPS requirements in their home states.

In 2005, when the SPEED law was created, it was thought that load growth in Vermont would continue at the rate of approximately 1% per year. Thus, it was assumed that approximately 6% of new renewable energy would be needed by January 2012 to avoid RPS implementation. In later years, it became clear that the state's load was not growing as fast as projected—and would in fact likely decrease, in part owing to the state's aggressive energy efficiency programs. In 2008, the Vermont Legislature therefore revised the minimum renewable goal so that at least 5% of new renewable energy had to be added to the statewide total electric portfolio (or at least have a CPG issued) by July 2012 to avoid having the RPS come into effect. At the same time, the Vermont Legislature set a state goal of increasing new renewable and combined heat and power (CHP) resources to meet a total of 20% of the state's electricity retail sales by 2017.[118]

[118] *The CHP resources for this voluntary goal could be fossil fuel based but had to meet minimum standards for efficiency and use of the thermal energy produced.*

The 5% minimum requirement was met in 2011, and the utilities are on pace to meet more than 13% of retail sales with SPEED resources by 2013.[119] To a large degree, the utilities have treated the "20% by 2017" goal as if it were a requirement. In this regard, policies promoting a significant increase in the percentage of energy generated by renewable technologies in the state's portfolio without an RPS have been successful.

Nonetheless, there continues to be an interest in adopting an RPS in Vermont in order to promote higher increases of renewable energy and to eliminate the "double counting" of the renewable energy attributes. The Vermont PSB has issued a legislatively required study on whether Vermont should adopt a mandatory RPS.[120] The PSB's study and recommendations set forth the successes to date, along with the problems, of current renewable energy policies and concludes with the recommendation that an RPS could be efficiently and affordably designed and should be adopted in Vermont. The DPS concurs with the Public Service Board's conclusion.

An RPS can help advance state and regional objectives for fuel source diversity, meet environmental objectives, and satisfy demands for sustainable energy sources. Because market mechanisms are put in play through such an instrument, an RPS is viewed as an effective and efficient mechanism for promoting development of renewable energy regionally at a commercial scale. Many states have used an RPS to achieve specific state goals, such as promoting particular technologies and specifically promoting new renewable development. In the DPS's view, given the progress Vermont's utilities collectively have already made regarding renewable energy acquisition, changes to the state's current renewable energy requirements should include the following goals:

(1) Encourage maintenance of the renewable portfolio progress our utilities have made to date.

(2) Allow greater progress at cost-effective prices by permitting additional large-scale renewable power contracts, including those for existing renewable resources not currently in the Vermont portfolio, to count toward meeting renewable energy requirements.

(3) Encourage development of distributed generation, reducing demands on the transmission system.

(4) Allow new projects (and associated technologies) to compete on a level playing field.

(5) Enable long-term planning and commitments to renewable resources through policy stability.

(6) Enhance regional cost-effectiveness through compatibility between Vermont's policies and those of other New England states.

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[119] http://vermontspeed.com/project-status/ *reports existing or planned deployment of about 760 GWh of SPEED resources. 2013 Vermont electric demand is unknown, but 760 GWh is 13.8% of the state's 2009 retail electric sales of 5,494 GWh.*

[120] *Study on Renewable Electricity Requirements Prepared by the Vermont Public Service Board Pursuant to Section 13a of Public Act 159, October 3, 2011.*

(7) Allow adequate time prior to enforcement of compliance, and through the rate of increase of renewable requirements, for utilities and their customers to adjust cost-effectively.

The DPS recommends that the Vermont Legislature consider adopting a streamlined RPS for Vermont, with an aggressive total renewable electricity goal of 75% within 20 years. Such an RPS appears both achievable and responsible, so long as the RPS is designed to account for total renewable generation—existing and new (as defined by 2005 SPEED terms), small (including net metering), and large. This RPS would maximize cost-effectiveness and utility flexibility while ensuring greater certainty and higher penetration of total renewable electricity in our energy portfolio. In its report, the PSB recommends one such RPS, and the modeling done for the CEP examined another possible implementation.

In designing an RPS, a great number of details require careful consideration, including: the creation (or not) of classes of resources, with requirements for each class, to shape the final portfolio; the rate at which renewable requirements increase; the need to treat utilities equitably, respecting differences in size and current renewable portfolios; consistency with other milestones and policy goals (such as the legislated goal of 20% renewable electricity by 2017); the need to encourage retention of existing resources while not driving up costs; and the method of enforcement for utilities that do not meet the goal. The DPS looks forward to working with stakeholders and the Vermont Legislature to consider and analyze these and other details.

Looking beyond electricity, an RPS should also be designed to integrate well into any future Total Energy Standard to encourage cost-effective adoption of renewables across the entire energy portfolio.

In addition, in order to encourage targeted distributed renewable generation and other new renewable projects, the DPS recommends that any adopted RPS be coupled with programs such as net metering expansion and deployment of a clean energy contract program built upon the Standard Offer Program's success. This will ensure that local renewable electricity projects are robustly deployed. Recommendations on the Standard Offer Program are set forth below.

Finally, on the basis of comments received during the CEP preparation process, we believe there is strong interest in community-scale projects and a desire to create a program to help communities host or own clean energy projects. The DPS and the Agency of Commerce and Community Development should work with local communities to investigate whether voluntary participation in an RPS-like program that would set targets for local community project development—creating local "green energy zones" wherein communities share the benefits and the costs of project development—would help facilitate the construction of community-scale renewable energy projects that include local ownership. Group net metering offers one model, but further investigation regarding the right size and ownership model for community investment is needed.

5.10.4 The Standard Offer Program and Clean Energy Contracts

The structure of the original SPEED program limited the price paid for renewable energy in the program to an amount equal to the projected market price. This did not provide any incentive for renewable energy project developers to offer their projects in Vermont, because they already could obtain the market price without participating in the SPEED program.

Therefore, in 2009, the Vermont Legislature modified the SPEED program to include a pilot Standard Offer Program for small-scale renewable projects. The Standard Offer, sometimes referred to as a feed-in-tariff, provided to developers of small qualifying renewable generation projects a fixed price for power under long-term standard contracts. In order to ensure rapid development of the qualifying renewable technologies, the Vermont Legislature mandated that the rates paid reflect the actual costs of the various renewable technologies. The program was directed at certain renewable technologies and at projects of 2.2 MW in size or smaller. A 50 MW total cap was also set on the program.

Included in the legislation was an initial set of rates that were applicable to the first round of projects, with a direction that the PSB develop amended rates to go into effect in January 2010. After a brief but intense stakeholder process, the PSB issued a set of rates on January 15, 2010. A comparison of the 2009 statutory rates (which will be paid to those projects selected in the initial Standard Offer round) and the January 2010 rates is shown in Exhibit 5-16:

Exhibit 5-16. SPEED Standard Offer Rates, 2009 Original vs. 2010 Amended[121]

	($/kWh)	
Renewable Energy Technology	**Set in Statute**	**As Amended by PSB**
Landfill Methane Projects	$0.12	$0.09
Farm Methane Projects	$0.16	$0.141
Wind Projects (small)	$0.20	$0.214
Wind Projects (large)	$0.125	$0.118
Solar PV Projects	$0.30	$0.24
Hydroelectric Projects	$0.13	$0.12
Biomass Projects	$0.125	$0.13

To ensure all renewable energy technologies had access to the 50 MW allocated to the program, a sub-cap was set by the PSB at 12.5 MW for any single technology. Interest in the program was strong, and the 50 MW cap was reached almost immediately after the program launched. The PSB set up a queue for those projects that were not awarded a contract.

There are currently 15 Standard Offer projects operating with a combined capacity of 7.58 MW, and 43 projects with Standard Offer contracts in various stages of development representing 42.37 MW of capacity. [122] Projects

[121] *Public Service Board Order in Docket 7533. These are levelized rates that are equivalent to the rate schedule published in the PSB's order, which provides an increasing schedule of rates for some technologies.*

do not cause rate impacts until built; thus, the costs associated with purchasing Standard Offer power occur slowly over time as projects come on line.

Although there may be a few opportunities for projects that are already in the queue to obtain a Standard Offer contract as other projects do not more forward, the initial pilot program is fully subscribed and not available for new projects. A next-generation clean energy contract program is required if Vermont is to provide further support for small distributed-generation projects that provide renewable energy and local jobs to Vermonters. We have an opportunity to learn from the Standard Offer Program and to design a new program thoughtfully, to encourage development while limiting impacts on ratepayer cost.

In order to provide a stable market for small and community-sized projects and to promote the benefits of in-state distributed generation, a clean energy contract program should be created to build upon the lessons from the Standard Offer Program, to provide at least another 50 MW of deployed small-scale distributed generation for Vermont within 10 years. The design of the new program is critical; the goals should be (1) regulatory and contractual certainty for developers; (2) a fair and transparent process for contract awards; (3) legally appropriate pricing mechanisms, taking into account FERC rules and legal precedents; and (4) pricing that achieves the lowest cost for ratepayers needed to support successful deployment of these projects. Other issues, such as the precise size of eligible projects, whether there should be a total offer cap or an annual allotment the location of such projects, and the existence of sub-caps for technology participation, also must be considered. The PSB's RPS report includes a similar recommendation as a method to meet their RPS requirement that 10% of each utility's power be sourced from in-state renewable distributed generation resources[120].

These are complex issues that ought to include stakeholder input. The DPS believes any process should include market mechanisms for pricing and should allow for project deployment over time. The DPS recommends establishing a modified auction mechanism for the new clean energy contract program, similar to the PSB auction recommendation included in the RPS report. The DPS also recommends that the state consider implementing an annual clean energy contract allocation for distributed generation projects, starting in January 2013. The benefit of a regularly scheduled auction, if properly designed, would be prices more reflective of the market. An auction could be sectioned by technology so projects of the same technology would bid against each other, not other technologies. Price bonuses or penalties could be included to encourage projects at particular constrained locations, projects of particular load shape characteristics, projects of particular efficiency levels, projects with particularly robust economic development or job creation potential, etc. Any such value adjustments could be set in advance to promote transparency. Mechanisms to prevent "race to the bottom" bidding should be employed to ensure successful project development. Such an auction mechanism has advantages over the price-setting procedure now in place for the Standard Offer Program. Significantly, the price would be determined in part by the market. This ameliorates the risk of setting the price too high or too low. If the price is set too low, projects will not be developed. If the price is too high, developers could receive an unnecessary profit at ratepayer expense.

[122] *SPEED Facilitator, www.vermontspeed.com.*

Furthermore, the state should investigate whether the current efficiency requirement for biomass CHP projects to participate in the Standard Offer Program is set at the appropriate level. The current requirement of 50% efficiency may be too high to meet state objectives of robust CHP deployment,[123] because some projects could use up to 100% of the thermal load during the heating season but be unable to meet the annual efficiency standard. Because of their ability to offset fossil heating fuels while producing renewable electricity, projects that can utilize heat while operating at the plant's designed capacity during the heating season should be eligible for the Standard Offer, even if their annual efficiency drops below 50%. This recommendation should be considered after release of the BioE report later this year.

Recommendations for SPEED, RPS, and Standard Offer Program

(1) The Vermont Legislature should consider adopting an RPS with a target of 75% renewable electricity within 20 years. The DPS recommends that any RPS be designed to encourage maintenance of the existing renewable portfolio, while requiring that significant additional renewable energy be added to the Vermont portfolio over the next 20 years.

(2) Vermont regulators and legislators should also foster distributed generation, which brings local renewable energy, jobs, and other benefits to the state. To that end, the state should foster a stable and predictable regulatory environment for encouraging contracts and investments in small-scale distributed renewable energy.

(3) The existing Standard Offer Program should transition, after the stakeholder process, to a new clean energy contract program designed to include an auction mechanism for price setting and other improvements upon the original program design.

(4) In establishing a clean contract program, the current cap of 2.2 MW should be evaluated to determine whether it should be increased or should be set at a different level for different technologies.

(5) The current Standard Offer efficiency requirement for biomass CHP plants should be reevaluated after release of the BioE study.

5.10.5 Finance and Funding

Financial incentives for clean energy development in the state have been thin compared to those of other states in the Northeast, and the present state budget and economy are not expected to change this situation dramatically in the near term. Programs such as the Standard Offer help, by creating stable, long-term business

[123] *Title 30 § 202(i) states: "it shall be a goal of the electrical energy plan to assure, by 2028, that at least 60 MW of power are generated within the state by combined heat and power (CHP) facilities powered by renewable fuels or by nonqualifying SPEED resources."*

opportunities for developers, but they involve ratepayer cost. Despite its limited funds, the state can and should continue to investigate and facilitate means of financing and funding renewable energy projects. A number of innovative private ownership arrangements and financing options are emerging; one role that the state can play, regardless of its own funding capabilities, is to bring together those that participate in the renewable energy market, including developers, financiers, and investors, to encourage greater innovation.

In addition, the state can direct its limited resources in ways that leverage the dollars available. For example, Qualified Energy Conservation Bonds (QECBs) can be used to support both efficiency and renewable energy. QECBs are a taxable tax credit bond; the state has received an allocation of $6,445,000. The government issuer, or private activity borrower, of the QECB financing is eligible for a subsidy or rebate on the interest paid to the bondholders. QECBs may be issued by a state, or through conduit agencies, to finance qualified energy conservation projects. A minimum of 70% of a state's allocation must be used for government purposes, and the remainder may be used to finance private activity projects. However, in addition to public facilities, the funding of "green community programs" may also qualify for use of public QECB financing, as determined by the IRS. Examples of qualified projects include energy efficiency capital expenditures in public buildings, green communities, renewable energy production, efficiency/energy reduction measures for mass transit, and other uses.

The state of Vermont uses a prudent and conservative approach to financing that takes into consideration an annual review of the size and affordability of the state net tax-supported debt. A recommendation of the amount of debt that prudently may be authorized for the next fiscal year is submitted to the Vermont Legislature by the Capital Debt Affordability Advisory Committee (CDAAC). QECBs can be used in conjunction with a state borrowing to reduce the cost of borrowing for a qualified project within, for instance, the state's annual capital appropriation, or can be issued through a conduit, outside the state's net-tax supported debt calculation. To the extent that the former model is applicable, it is recommended that the debt be incorporated into the CDAAC annual calculation. If it is issued through a conduit or authority and the bonds are repaid from non-tax sources, there is no requirement for the state's full faith and credit. If utilized for loan loss reserve or direct loan funds, the QECBs will support broader progress than otherwise would occur. Financial products offered by the Vermont Economic Development Authority (VEDA) similarly leverage state dollars. The DPS is working to partner with VEDA to deploy Vermont's QECBs and expects to offer the QECBs in 2012.

Recommendations

(1) *The DPS should host, along with the Agency of Commerce and Community Development and the Vermont Climate Cabinet, a renewable energy financing summit to bring together those that participate in the renewable energy market, including developers, financiers, and investors, to encourage greater innovation in financing.*

(2) *Vermont should deploy its allotment of QECBs, so long as it does not burden the state's general indebtedness, to promote efficiency savings and renewable energy projects.*

(3) *DPS should explore application of financing tools such as PACE and on-bill financing to small-scale renewable generation. These tools are discussed in greater detail in Section 7.2.1.*

5.10.5.1 Clean Energy Development Fund

Currently, the primary financial tool the state has to promote clean electric generation is the Clean Energy Development Fund (CEDF). In 2005, the Vermont General Assembly established the CEDF through Act 74. The purpose of the fund is to promote the development and deployment of cost-effective and environmentally sustainable electric and thermal energy resources for the long-term benefit of Vermont consumers.[124] Since its creation, the CEDF has played a critical role in the development of distributed renewable energy projects across the state. The state should strive to continue the financial programs of the CEDF as part of a comprehensive strategy to support new residential and community-scale renewable energy projects.

Act 74 specified that the CEDF be funded with payments by Entergy Vermont Yankee, arising out of two memorandums of understanding (MOUs), and by any other monies that may be appropriated to or deposited into the fund. The two MOUs the state signed with Entergy Vermont Yankee were the results of negotiations involving the storage of spent nuclear waste in dry casks on-site and the increase of Vermont Yankee's electric generating capacity. Exhibit 5-17 below shows the total amount of funds the CEDF has received from Entergy and from other sources through fiscal year 2011.

Exhibit 5-17. Vermont Clean Energy Development Fund: Statement of Revenues from Inception

Revenues	Total Received 2006–FY 2011
Entergy Initial Payment	$200,000
Entergy Dry Cask Storage Payments	$14,375,000
Entergy Up-Rate Payments	$13,443,690
Interest Income	$510,574
Loan Interest Income	$77,206
Loan Application Fees	$10,830
Total Revenues	***$ 28,617,300***

Source: CEDF

Initially, the CEDF was a program of the DPS, with a Vermont legislative advisory committee and an appointed investment committee. In 2009, the Vermont Legislature moved responsibility for the CEDF to an independent Clean Energy Development Board. Although the funding and programmatic design decisions of the CEDF were the responsibility of the appointed board, the CEDF was still supported administratively by the DPS.

[124] *10 V.S.A. § 6523 (c).*

The CEDF law was altered again in Act 47 of 2011. In July 2011, a new advisory board was appointed and the DPS resumed oversight of the CEDF.[125] It will be the responsibility of the DPS and the CEDF fund manager employed by the DPS to make funding and programmatic decisions. The board will approve the annual budget, the program designs, and the strategic plan. The new board is appointed by the DPS commissioner and the chairs of the House and Senate energy committees. The board's first mission is to help create a strategic plan for the CEDF, including funding, by summer 2012.

5.10.5.1.1 CEDF Current Status—Funds and Projects

As of the end of the 2011 fiscal year (June 30, 2011), the CEDF had a balance of approximately $10 million (not including federal ARRA funds, which are not commingled with the state's CEDF monies), with less than $3 million of anticipated revenue from Entergy. The fund's current and anticipated balance is fully obligated. The bulk of the fund's financial obligations are the business solar tax credit from 2010 ($6.2 million), existing grants ($3.4 million), and the Vermont Small Scale Renewable Energy Program ($2.7 million). For more information about the CEDF, including programs and analysis of economic impact, see http://publicservice.vermont.gov/energy/ee_cleanenergyfund.html.

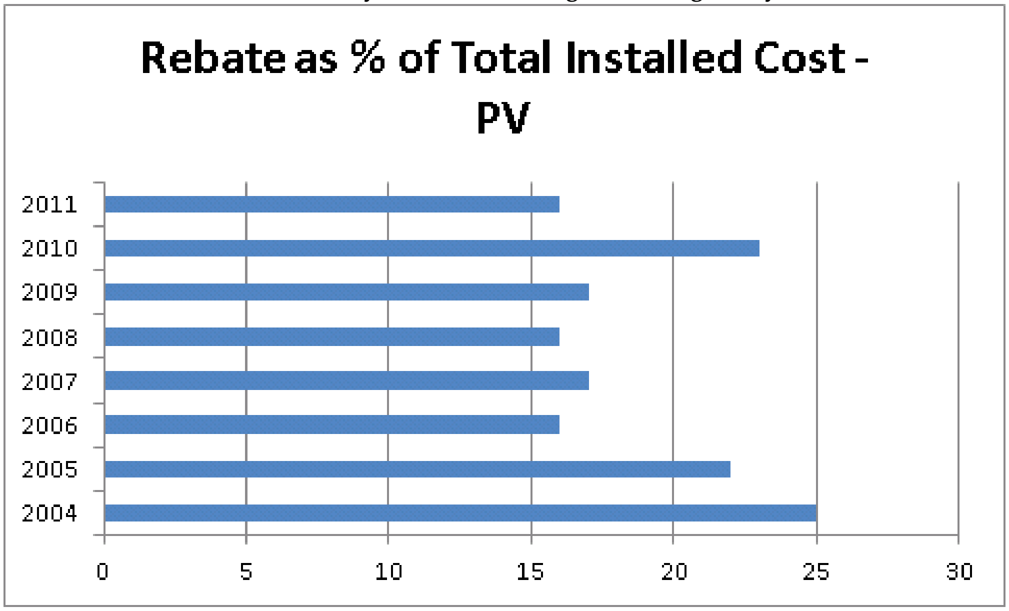
With the present lack of additional funding, the CEDF has suspended its grant programs and has put the loan program on hold until a new program design can be approved by the Clean Energy Development Board. The CEDF has two separate revolving loan fund pools. One pool was funded with $3.8 million of federal Department of Energy ARRA funds. All of the funds have been obligated and will be loaned out by the end of 2011. As these funds are paid back to the CEDF over the next 10 years, they will be available for new loans to ARRA-eligible projects. The other pool of loan funds of $3.2 million came from CEDF funds. All of these funds are already on loan. As these CEDF funds are paid back, they could either be returned to a loan pool for new loans or used for another CEDF-eligible purpose.

As of June 30, 2011, the CEDF had 172 active awardees in the process of completing their projects. Of this number, 28 are funded with state funds and the rest are ARRA funded.

The only program of the CEDF that is continuing to enroll new participants is the Vermont Small Scale Renewable Energy Program. This program has been operating as funding has allowed since 2004. Since taking over management of the program, the CEDF has tried to manage the program so as to reduce the incentives provided while still encouraging rapid deployment. The two exhibits below show how the CEDF has reduced the incentive as a percentage of the total costs for solar hot water and photovoltaic systems.

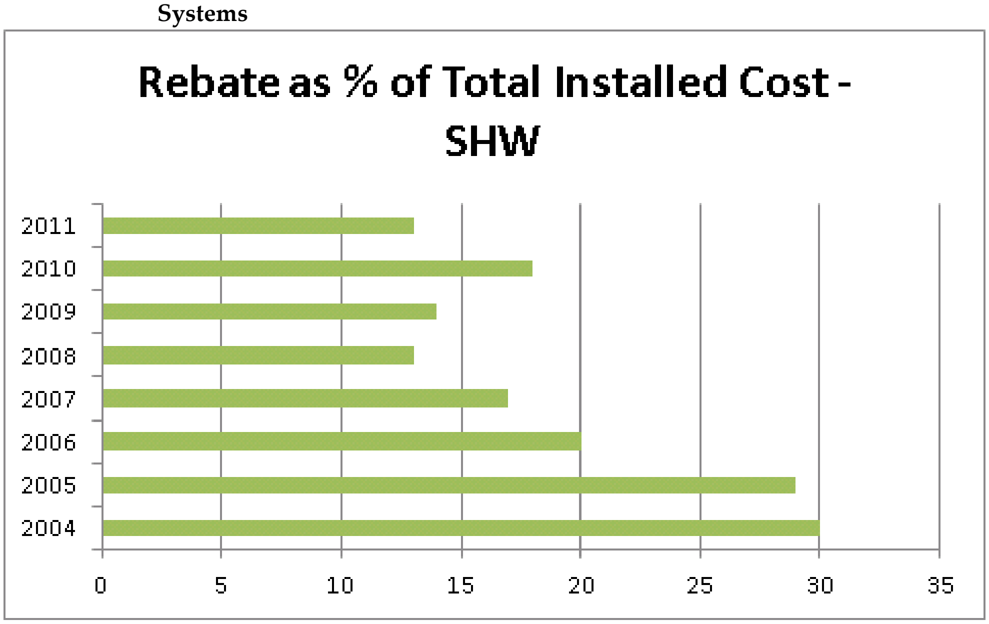
[125] *10 V.S.A. § 6523.*

Exhibit 5-18. CEDF Incentive Payment as an Average Percentage of Systems' Total Installed Cost, Photovoltaic Systems



Source: Vermont Small Scale Renewable Energy Program, 2011

Exhibit 5-19. CEDF Incentive Payment as an Average Percentage of Systems' Total Installed Cost, Solar Hot Water Systems



Source: Vermont Small Scale Renewable Energy Program, 2011

Overall, the incentive program has provided rebates that have resulted in more than 2,000 new renewable energy systems' being installed, leveraging more than $38 million of private funds and deploying more than 5 MW of new renewable energy capacity.

Exhibit 5-20. Vermont Small Scale Renewable Energy Program Project Installations from 2003 through late October 2011

Wind	Number Installed	117
	Total Cost of Installed Systems	$6,554,354
	Incentives Paid for Installed Systems	$1,245,695
	Total Installed Capacity (W)	460,890
	Estimated Annual kWh per Year	641,430
Solar PV	Number Installed	1,019
	Total Cost of Installed Systems	$32,527,863
	Incentives Paid for Installed Systems	$5,885,917
	Total Installed Capacity (W)	4,490,656
	Estimated Annual kWh per Year	5,203,764
Solar Hot Water	Number Installed	930
	Total Cost of Installed Systems	$10,991,461
	Incentives Paid for Installed Systems	$1,758,276
	Total Installed Capacity (kBtu/day)	87,671
Total	Number Installed	2,066
	Total Cost of Installed Systems	$47,073,678
	Incentives Paid for Installed Systems	$8,889,888
	Total Dollars Leveraged	$38,183,790

Source: Vermont Small Scale Renewable Energy Program, 2011

A recent economic review of the CEDF by Kavet, Rockler & Associates determined that the CEDF had leveraged the $28 million in state expenditures nearly four-to-one, creating $110 million in total project expenditures since its inception.[126]

5.10.5.1.2 Future of the CEDF

The 2010 CEDF board outlined four principal objectives to guide the activities of the fund:

- Maximize clean energy generation and energy savings.
- Accelerate economic development.
- Build the knowledge base and clean energy infrastructure.
- Leverage public and private funding.

[126] http:// publicservice.vermont.gov/energy/ee_files/cedf/Memo%20-20Clean%20Energy%20Development%20Fund%20Summary.pdf

The new CEDF board will revisit these objectives as part of the strategic planning process and will make recommendations regarding deployment of returning loan funds and regarding future funding sources. The DPS and CEDF board will complete a strategic plan that will include suggestions for new funding of the CEDF programs as well as program design for existing programs. In the event that no further funding sources are available, the CEDF will likely continue to operate its revolving loan fund and the Vermont Small Scale Renewable Energy Program. The revolving loan program totals approximately $7 million. The CEDF has $2.7 million earmarked for the Vermont Small Scale Renewable Energy Program and will begin to use those funds to keep the program operational as the current federal funding for it is depleted.

Given the current funding constraints, the CEDF is looking to wean the technologies that are maturing within local markets from the need for CEDF incentives. The CEDF should focus on those technologies that need the most market assistance while providing the greatest progress toward the CEDF's four principal objectives. For example, photovoltaic power has received considerable financial incentives (approximately 50% of all CEDF funds through 2010 have gone to support PV). Although PV warrants continued CEDF attention, there are other worthy technologies that have not received any CEDF support to date. The CEDF board will include consideration of this issue in the next CEDF strategic plan.

Two important guiding concepts for the CEDF's work will likely be performance and efficiency. As a result, certain program designs might be established, such as the following:

- The Vermont Small Scale Renewable Energy Program could be coupled with efficiency retrofits completed so that a project that has made efficiency gains would be rewarded with an increased rebate amount. This would help prevent the CEDF from encouraging new generation that could be achieved through efficiency at the same location at a much lower cost.
- Any technology receiving a CEDF incentive should be able to offer third-party verification of the system's rated capacity and performance.
- Incentives should be market-based and leveraged where possible.

In addition to grant and loan programs to renewable energy projects, the DPS and CEDF have supported education efforts through the School Energy Management Program (SEMP), the Municipal Technical Assistance Program (MTAP), and the Vermont Energy Education Program (VEEP). These programs provide much-needed public and technical education and outreach. The DPS strongly recommends that the DPS/CEDF continue to support these efforts.

Recommendations

(1) The CEDF strategic plan should address a sustainable funding model for CEDF. The CEDF's funding priorities should focus on technologies that do not already have a mature market presence, and should be weighted to maximize performance and efficiency of dollars spent.

(2) *The CEDF is a fund that serves many populations. The website for the CEDF should be made more useful and informative, clearly setting forth available funding and programs. It also should make available all the final reports of CEDF-funded projects.*

(3) *The CEDF should continue to support educational efforts to promote renewable energy technology.*

5.10.6 Regulatory System Improvements

Many of the recommendations discussed throughout this section will aid in simplifying or improving regulatory processes. There are other overarching regulatory improvements that could be made to increase the efficiency of the energy generation permit process, reducing overall costs and supporting the state's goals.

Recommendations

(1) *The state should make improvements to the permitting and regulatory process governing electric generation siting. Specifically, right now nearly all projects, regardless of size, undergo the same regulatory scrutiny—whether the project is a five-turbine wind installation, a 20-turbine wind installation, a modest solar tracker, or the expansion of a substation footprint and internal configuration. (The only exceptions are projects that qualify under Section 248(j) of Title 30 as being of "limited size and scope" and not raising a "significant issue.") The DPS, the stakeholders, and the PSB should develop legislation to create a revised regulatory process for projects that do not qualify for the Section 248(j) process but are nevertheless small enough to justify a less-intensive process than complete Section 248 review. This new process should be written to apply particularly to community-scaled and owned projects designed to support local load.*

(2) *Given the potential benefits of renewable energy and the allowance of other types of development (such as telecommunication towers) permitted on public lands, ANR should consider revising and clarifying its December 2004 written policy on renewable energy projects sited on state lands, specifically with regard to net metered and small-scale projects.*[127]

(3) *The state should consider creation of an even more streamlined net metering process for all net metering applications. Consideration should be given to an automated process in which applicants file electronically and are advised in a short timeframe regarding the completeness of the application. In the absence of comments expressing concerns by interested parties, net metering applications should*

[127] *Vermont ANR, "Wind Energy and Other Renewable Energy Development on ANR Lands," December 2004,* www.vtfpr.org/lands/documents/windpower.pdf.

receive shorter review time by PSB and DPS if an interconnection has been previously approved by the utility or meets the criteria of a standard interconnection protocol.

(4) *The DPS has been asked by the Vermont Legislature to consider "intervenor funding," requiring project applicants to pay for the legal and other costs of those who may intervene to oppose a project at the PSB. The DPS is concerned that intervenor funding will increase the intensity and duration of litigation without assisting in resolution of disputes between developers and those who may oppose the project. Rather, DPS recommends developing other mechanisms to address the concern that intervenors lack an effective voice in the Section 248 permitting process. Regional planning commissions and town energy committees should be encouraged to develop and approve specific energy siting policies that the PSB can consider in the Section 248 process. Moreover, the DPS and the PSB should develop a mediation program to be used to resolve or narrow disputes among parties. Mediation has successfully been integrated into Vermont civil proceedings and should provide an avenue for dispute resolution in Section 248 proceedings if used at points in the process where parties are committed to finding solutions, rather than elevating litigation, and if it is integrated within the process in a manner that does not add significant time and complexity to the process. Applicant funding of mediation should be considered.*

(5) *As briefly discussed above in the Transmission Planning section, modifications need to be made to the memorandum of understanding in the transmission planning docket (Docket 7081) that will increase consistency between the Vermont transmission planning process and the regional planning process. Modifications are necessary to reflect the reality that ISO-NE has taken on the principal regional transmission planning role as delegated to it by FERC.*

5.10.7 Toward a Total Energy Standard

The Vermont Comprehensive Energy Plan is designed to encompass all forms of energy generation and consumption, in recognition of the fact that all energy is interconnected. If we plan and set goals separately by energy sector, we run the risk of taking a step toward one goal while taking two steps away from another. The state's approach to energy planning must be comprehensive in its approach and goals.

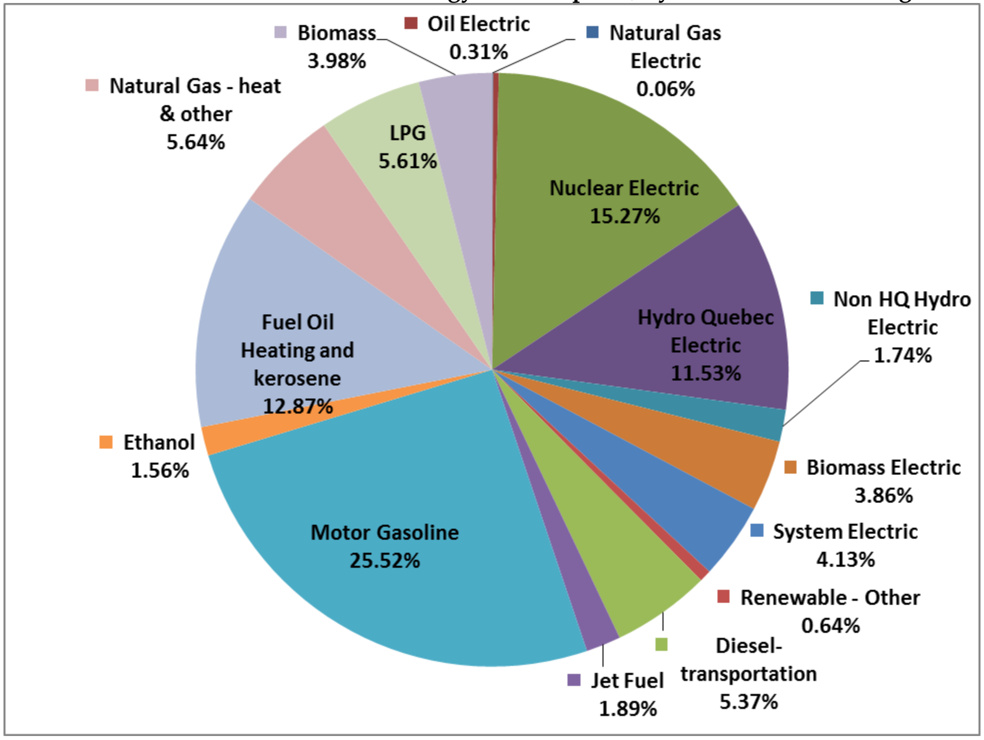
Thus, the state should develop holistic goals for total energy use. The RPS and SPEED goals discussed above help promote renewable electricity generation, but they do nothing to address increased renewable energy for transportation and heating. In fact, to the extent that such policies target *only* electricity, they risk charging electric ratepayers for progress on renewable electric goals rather than targeting progress—and cost—where it might most be needed. In the 21st century, with an awareness of the effects of climate change and a growing desire for energy security and economic independence, we need regulatory policies and funding mechanisms that encourage a more efficient, cleaner energy portfolio in all sectors, not simply regulated electricity.

To this end, the DPS recommends that the state investigate creation of an interagency and stakeholder working group to develop a proposal for a Total Energy Standard (TES) by the end of 2013. A TES would work with and complement any RPS or new SPEED program the Vermont Legislature may implement, but would apply to Vermont's total energy usage. Essential to the creation of a TES would be adoption of a common measurement unit for all energy. Most of the world measures energy in watts per hour, which is easily scalable—kWh/MWh/GWh/TWh—and that would seem to be the most logical unit to adopt. However, the U.S. Energy Information Agency (EIA) uses British thermal units, Btu, as the common measure, and the EIA is the source of much of our energy consumption data. Thus, until Vermont can collect its own energy consumption data for all sectors or until the EIA changes units, there is a compelling reason to use Btu for a Vermont TES if one is adopted.

The DPS has conducted a preliminary analysis of total energy usage to help facilitate the discussion of a TES. Using a compilation of EIA and DPS data, the DPS has calculated that Vermont's total energy use was approximately 154 trillion Btu in 2009.[128] Of that total (and as described elsewhere in the CEP), 23% (35.7 trillion Btu) came from renewable energy sources. The state could build upon this total renewable energy progress by establishing five- and 20-year goals for increasing this percentage as part of a TES. The TES goals could be met by a combination of reduced demand, through efficiency and conservation, and through new renewable energy usage by sector. Exhibit 5-21 shows Vermont's 2009 total energy usage with all energy converted to Btu.

[128] *Designing the accounting rules for conversion of diverse energy types to a single metric would be one of the tasks of the TES study recommended below. For example, EIA standards convert non-thermal electric generation to a common Btu metric using the average heat rate of fossil fuel generators. Given the small fraction of Vermont electricity generated using fossil fuel combustion, this may not be the rule best suited for Vermont. This plan uses the EIA rule for consistency with other reports, pending recommendations from a TES study.*

Exhibit 5-21. Vermont's 2009 Total Energy Consumption, by Source and Percentage



In order to encourage progress, a compliance payment similar to that employed in RPS structures could be used. If such a payment were both small and targeted, it would help achieve the TES goals and ramp down as progress is achieved. For example, the payment could fund training and financing programs for fuel dealers who might wish to offer energy efficiency contractor services, in order to redirect their business as fossil fuel usage declines over time. Or it could provide incentives for expanding transit routes or for farm production of renewable heating fuels.

As an example only, if a compliance fee were set at $0.0002/kWh (two one-hundredths of a cent per kWh),[129] such a fee applied to heating oil would be approximately eight-tenths of a penny per gallon of fuel ($0.008 per gallon). Using the total renewable energy calculations set forth above, a compliance payment of $0.0002 per kWh for non-renewable energy could generate approximately $6 million per year for renewable energy programs in all sectors. Such funding could be allocated by sector to ensure that progress is made in proportion to the funds raised, thereby helping most those sectors with the least renewable energy. There are, without doubt, many policy issues both large and small that must be considered if Vermont chooses to investigate adoption of a total renewable energy standard applicable to all fuels and energy uses. The DPS offers this recommendation to help move Vermont from comprehensive energy planning to comprehensive implementation.

[129] *Although the TES would be based on Btu, any compliance payment would likely be set as a kWh charge. All energy sources could be converted to a comparable Btu value for the TES and then converted to kWh for the compliance payment. Non-renewable electricity would be converted to Btu using its heat rate, and then converted back to kWh.*

Recommendation

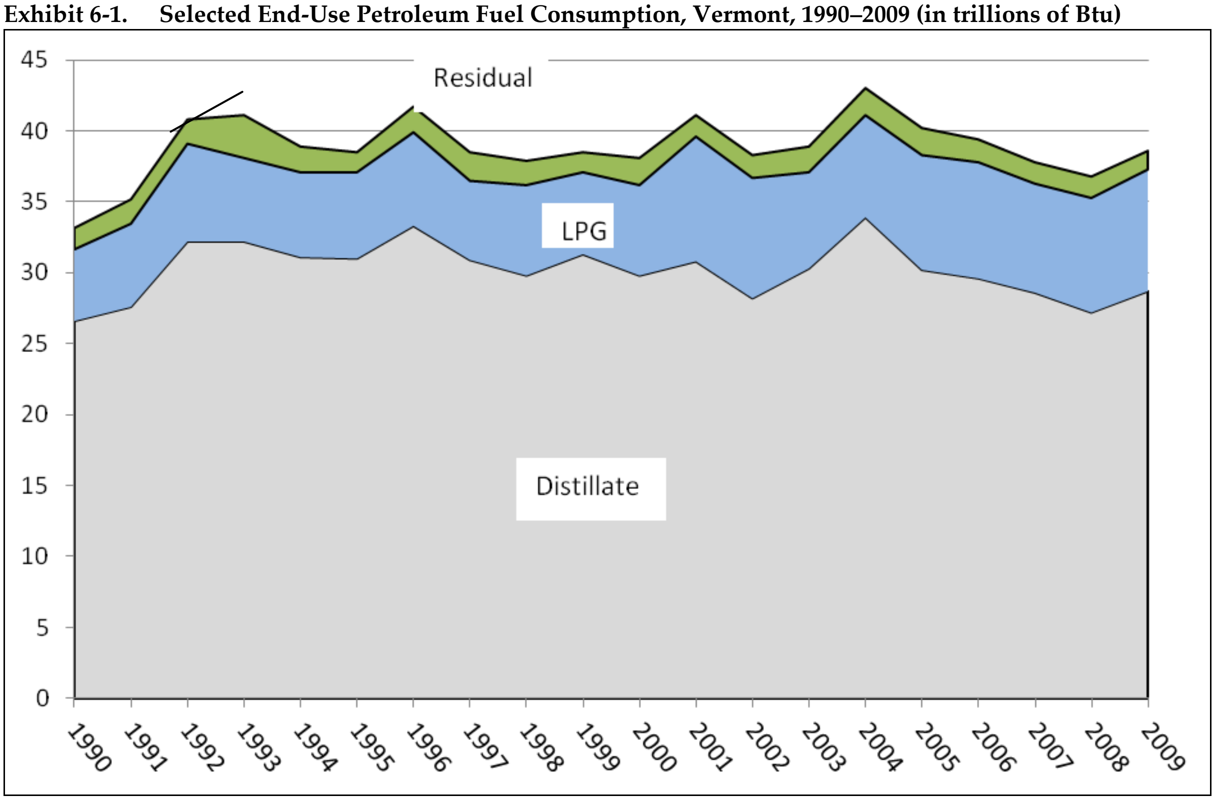
The Vermont Climate Cabinet and/or the Vermont Legislature should create a study committee for a Total Energy Standard program, targeting legislative consideration of any plan developed in 2013.

6 Vermont's Current and Future Thermal Energy Usage

6.1 Thermal Energy Usage: Supply and Demand

Vermont's consumption of liquid fuels, excluding fuels used for transportation, has changed little during the past 20 years. (See Section 9—Transportation and Land Use for a discussion of transportation fuel demand.) Petroleum fuel consumption by end users (residential, commercial, and industrial) for the three principal fuels used for heating processes grew by only 0.8% per annum between 1990 and 2009. Distillates, the largest category of heating fuels, grew at an annual rate of 0.4%; liquefied propane gas (LPG) grew at 2.8%; and heavy residual fuels declined by 0.8%. (See Exhibit 6-1.)

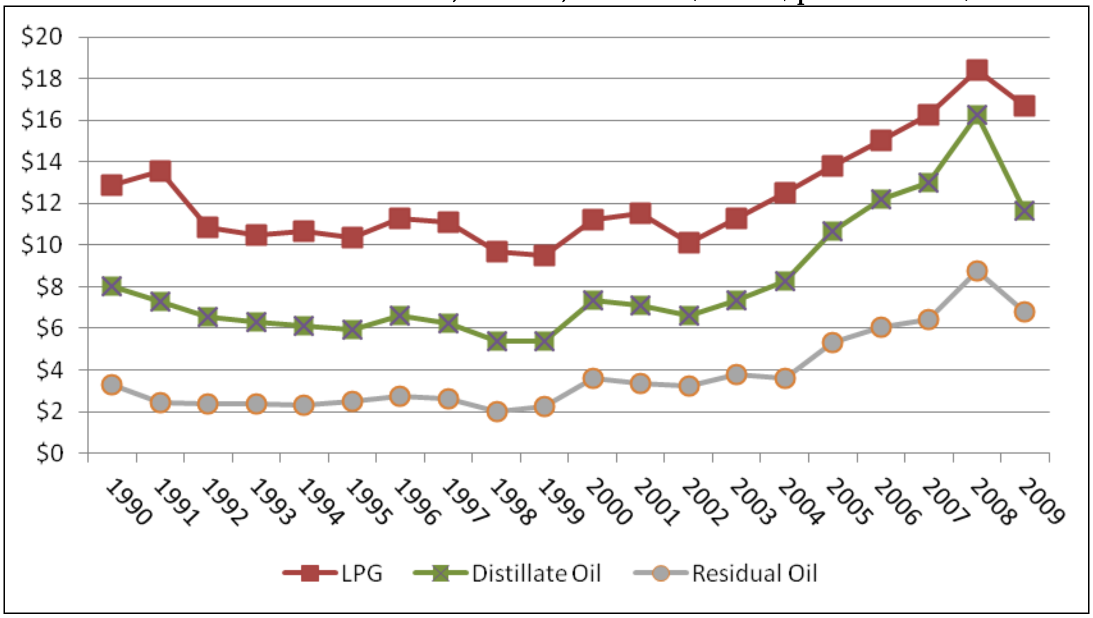
Exhibit 6-1. Selected End-Use Petroleum Fuel Consumption, Vermont, 1990–2009 (in trillions of Btu)



Source: EIA

Primary energy consumption, although directly related to economic output, also responds to price signals that may encourage fuel substitution. Current dollar prices of distillates, LPG, and residual oil have risen at an annual rate of 4% to 6% since 1990. With fuel price changes adjusted for inflation, distillate oil rose at a rate of 2.0%, LPG at 1.4%, and residual oil at 3.8% (see Exhibit 6-2).

Exhibit 6-2. Real Petroleum Fuel Prices, Vermont, 1990–2009 (in 1990 $ per million Btu)



Source: EIA, U.S. Bureau of Labor Statistics

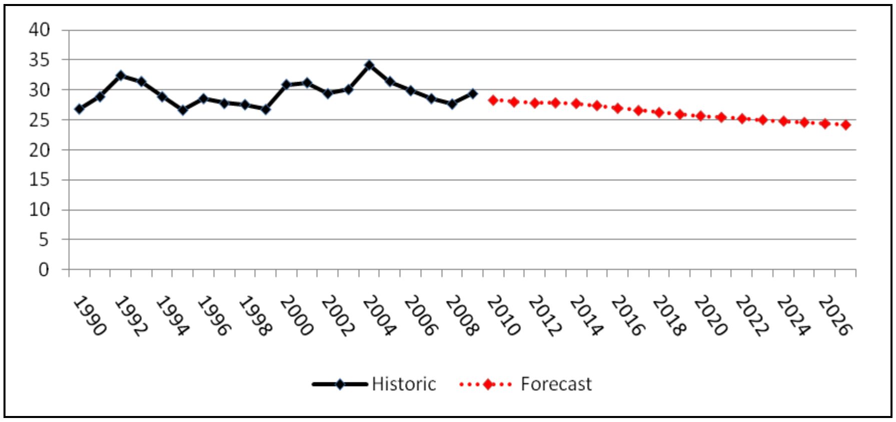
The Vermont Department of Public Service (DPS) has estimated a forecast for Vermont petroleum fuel demand, which is based on the expected future size and growth of the state's economy. Because the underlying drivers of fuel demand differ by end user, the DPS disaggregated the consumption of fuel by end user, developed demand forecasts for each user class, and then reaggregated forecast results to derive the total Vermont demand for fuels. Note that this forecast does not include the historic demand or future outlook for thermal applications of wood pellets and other wood biomass products.

The DPS also recognizes that since the forecast is based on fundamental economic and demographic trends, the actual consumption of fuels will likely be affected by the development and market adoption of biofuels. At this time, biofuels make up such a small share of fuel demand that a separate forecast was not attempted. However, we expect biofuels to assume a growing share of future fuel demand, limited only by the availability of supply and prices relative to petroleum-based products.

Also complicating the forecast and the future mix of fuels are possible policy interventions, such as the imposition of a renewable fuel standard (RFS) or Total Energy Standard that would discourage the consumption of high carbon–based fuels in favor of biofuels. Although an RFS is commonly associated with transportation fuels, the standard could be extended to fuels for thermal and process uses.

Given these caveats, the forecast for end-use fuel demand largely reflects the base case expected long-term outlook for state gross domestic product (GDP), the expected changes in the state's industrial mix, and the expected growth in residential households. The outlook is also based on normal heating conditions; we used the 20-year average heating degree days as a frame of reference. Overall, demand for heating and process fuels, which had been growing at 0.5% per year since 1990, is forecast to decline at an annual rate of 0.9% through 2027. (See Exhibit 6-3.)

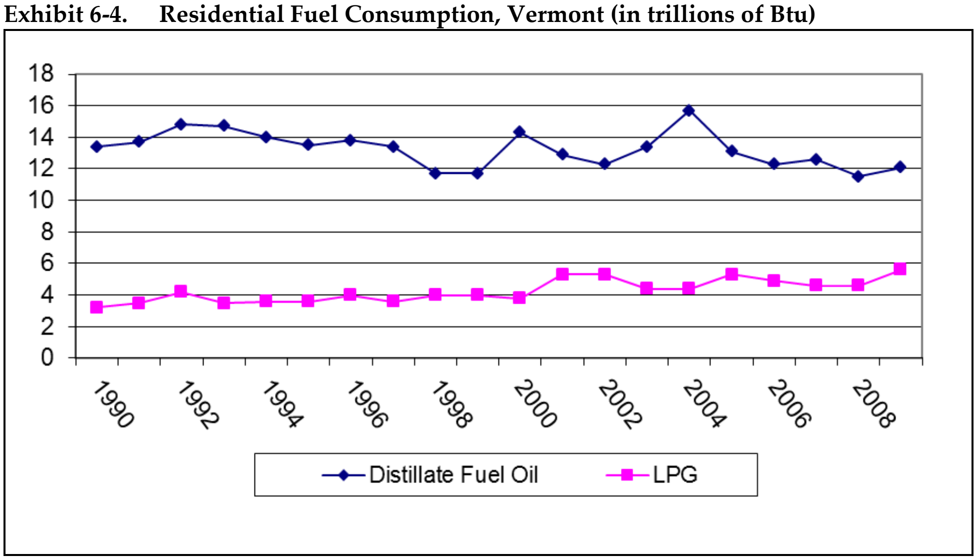
Exhibit 6-3. End-Use (Non-Transportation) Petroleum Fuel Consumption and Forecast, Vermont, 1990–2027 (in trillions of Btu)



Source: EIA, DPS Forecast

The contribution of each end use to total fuel demand is presented below. Residential fuel demand had been growing by 0.57% annually since 1990, with the most significant driver being the growth in households (see Exhibit 6-4). Distillates (including products known as No. 1, No. 2, and No. 4 diesel fuel that are used for a variety of applications such as agricultural machinery and space heating) make up the bulk of residential demand, followed by LPG.

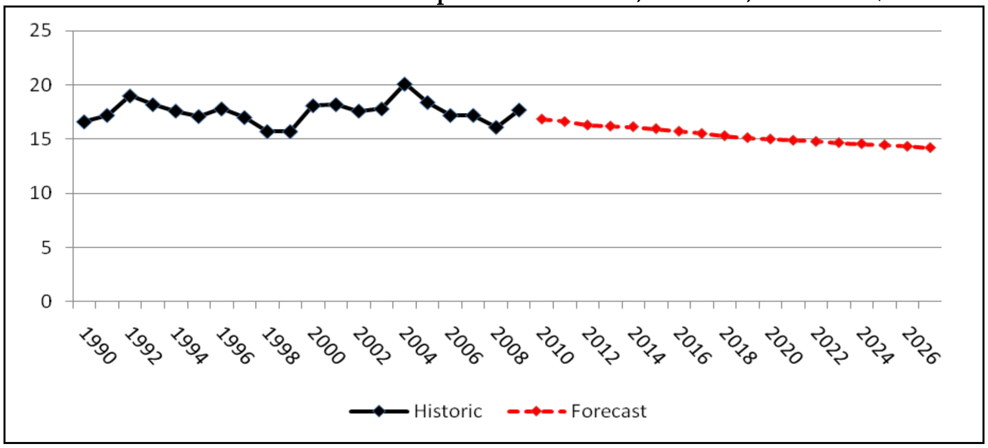
Exhibit 6-4. Residential Fuel Consumption, Vermont (in trillions of Btu)



Source: EIA

Residential fuel consumption is forecast to decline at an annual rate of 1% through 2027 (see Exhibit 6-5). The expected decline in consumption will coincide with gains in thermal efficiency, which decrease per-household demand. Efficiency improvements will also offset modest gains in the number of residential households and gains in real disposable income.

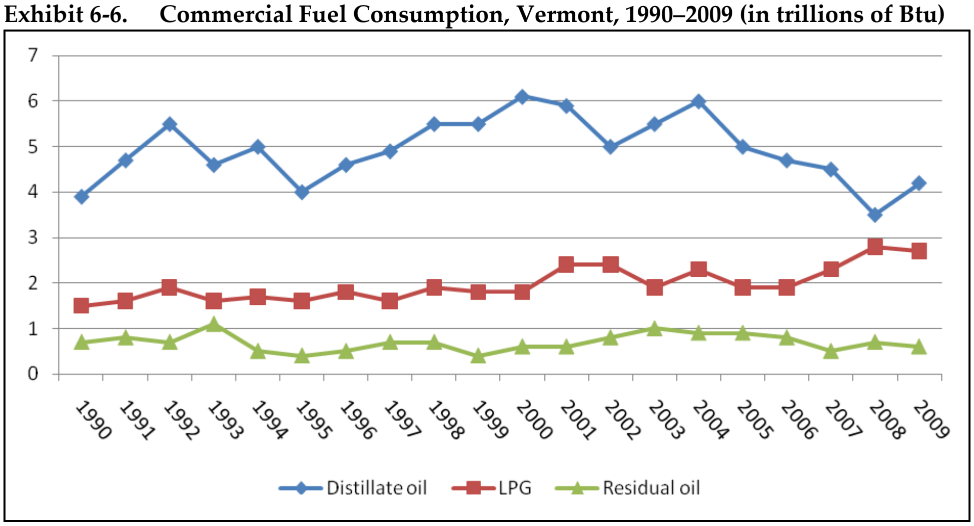
Exhibit 6-5. Residential Fuel Consumption and Forecast, Vermont, 1990–2027 (in trillions of Btu)



Source: EIA, DPS forecast

Historically, commercial fuel demand has closely tracked changes in Vermont's economy (see Exhibit 6-6).

Exhibit 6-6. Commercial Fuel Consumption, Vermont, 1990–2009 (in trillions of Btu)



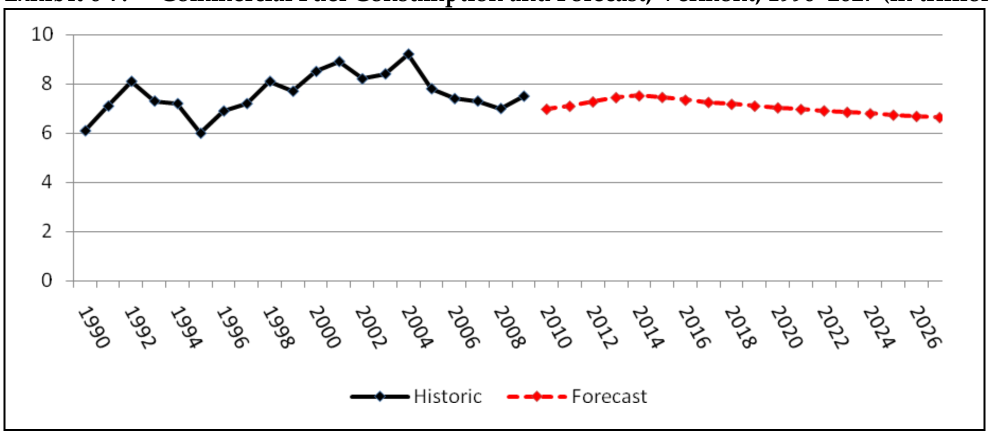
Source: EIA

During the past 20 years, economic recoveries and periods of expansion have coincided with increased petroleum fuel demand. Conversely, contracting economies have stabilized or reduced fuel demand. On average, fuel demand has increased 1% per annum, with wide year-to-year variations.

The largest components of commercial fuel demand have been distillates, LPG, and heavy residual oils (*heavy residual oils* is a general classification for the heavier oils, known as No. 5 and No. 6 fuel oils, largely used for space heating and various industrial purposes).

The forecast for commercial fuels was based on expected growth in Vermont GDP, normal heating degree demands, and a trend toward greater efficiency. The forecast through 2027 declines 0.29% annually (see Exhibit 6-7). The modest decline in demand for commercial fuels results from anticipated gains in efficiency, offsetting both economic growth and a shift in the state's industry mix away from industrial output to commercial and service-based demands.

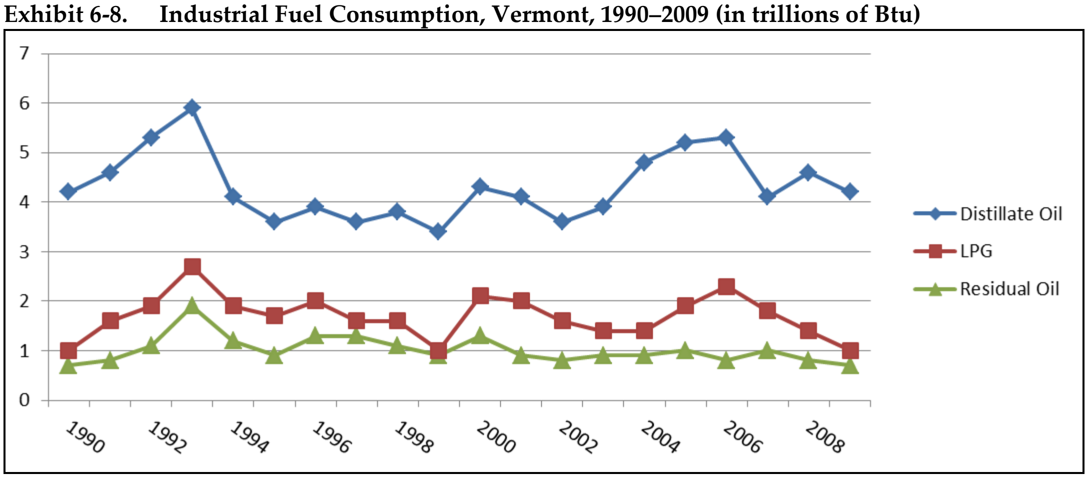
Exhibit 6-7. Commercial Fuel Consumption and Forecast, Vermont, 1990–2027 (in trillions of Btu)



Source: EIA, DPS forecast

Industry is the smallest end user of petroleum fuels, accounting for approximately 15% of total state demand. The 20-year trend has been flat, with no growth since 1990 (see Exhibit 6-8). The zero-growth pattern is the end result of a shrinking industrial sector, and increasing output (and fuel demand) from remaining manufacturers.

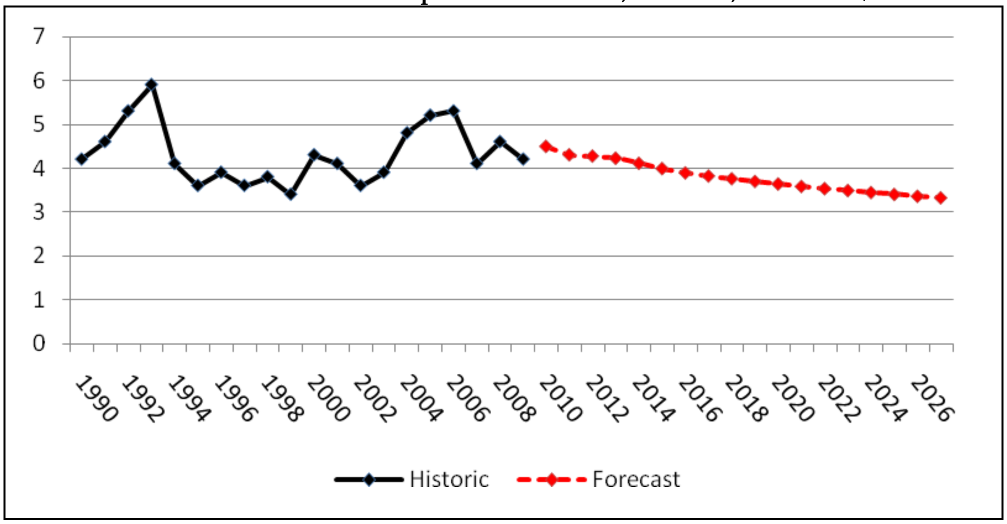
Exhibit 6-8. Industrial Fuel Consumption, Vermont, 1990–2009 (in trillions of Btu)



Source: EIA

The outlook for the industrial sector projects an annual decline in fuel demand of 1.7% through 2027 (see Exhibit 6-9), the largest decline among end-user categories. Industrial demand is expected to respond strongly to projected economic growth, but a continuing decline in the manufacturing sector combined with fuel efficiency improvements will result in a net reduction in fuel consumption.

Exhibit 6-9. Industrial Fuel Consumption and Forecast, Vermont, 1990–2027 (in trillions of Btu)



Source: EIA, DPS forecast

6.1.1 Looking Ahead

Assuming continuation of current policies, Vermont's demand for non-transportation petroleum fuels is expected to decline at an average annual rate of 0.93%. This forecast takes into account expectations of modest growth in the Vermont economy, improvements in thermal efficiency, and a continuing shift from a manufacturing economy to a service economy. Combined, these factors result in net reductions in fuel demand.

Changes in demand are also likely to be influenced by changes in absolute and relative prices of fuels that encourage fuel substitution. This may also encourage the substitution of biofuels for petroleum-based fuels.

The absolute and relative increase in distillate prices creates an opportunity for the adoption of substitute biofuels, such as biodiesel (also called *bioheat* when used for heating systems). Currently, biofuels are more expensive than fossil fuels, on a Btu equivalent basis. However, biofuels are cleaner-burning fuels, producing fewer air pollutants.

According to the U.S. Energy Information Administration (EIA), world oil prices are expected to rise through 2035, which encourages domestic energy production. As a result, the EIA expects biofuel production and consumption to increase.

Exhibit 6-10. Consumption of Alternative Fuels, U.S., 2001–10 (in trillions of Btu)

Year	Biodiesel	Fuel Ethanol	Total Alternative Fuels
2001	1.3	143.7	145.0
2002	2.1	171.2	173.3
2003	1.7	233.4	235.1
2004	3.4	293.3	296.8
2005	11.6	335.1	346.7
2006	33.2	452.6	485.9
2007	45.7	568.6	614.3
2008	40.3	799.6	839.9
2009	40.4	909.7	950.1
2010	28.1	1,088.6	1,116.7
		Annual Growth rate =	25%

Source: EIA, Annual Energy Report (2010)

Heating fuels that are not regulated, such as fuel oil, kerosene, propane, and wood (biomass), currently account for 27% of Vermont's total energy demand, 27% of the state's greenhouse gas emissions, and 82% of Vermont's space-heating and industrial process heat requirements. To place it in context, heating fuel demand (35 billion Btu) is greater than the Btu demand met by Vermont Yankee and Hydro-Quebec power combined. The residential sector accounts for 65% of unregulated fuel consumption, nearly double the combined usage of the commercial (21%) and industrial (14%) sectors.

7 Thermal Energy Efficiency

Regulated industries have traditionally been the focus of state energy efficiency policy; cost-based regulated utilities traditionally offer more opportunity for meaningful policy interventions than unregulated industries. Recently, however, as prices have become more volatile and generally increased, fuels that are not regulated, such as fuel oil, kerosene, propane, and wood (biomass), have received increased attention. Each of these fuels is distinct from regulated utility fuels in that the costs are not shared among a defined and closed group of ratepayers.

High levels of consumption of these fuels create challenges and opportunities for efficiency initiatives in the unregulated fuels sector. To get an indication of the scope of fuel usage and the total efficiency savings available, the DPS completed a study in 2007 on the energy efficiency potential of oil, propane, kerosene, and wood. The study selected appropriate energy savings measures to determine the total technical and achievable cost-effective potential energy savings in unregulated fuels.

Technical potential, defined as all the energy savings measures that are technically feasible to install across the residential, commercial, and industrial sectors, provides a good basis for understanding the magnitude of the energy savings available in the unregulated fuels market. The total technical energy savings potential as a percentage of the forecast of fuel consumption by the year 2016 was found to be 29.7% for distillate fuel oil, 17.7% for propane, 12% for kerosene, and 29.7% for wood. Although the results of the DPS study show that large energy savings in unregulated fuels are technically possible, achieving maximum savings would come at a significant cost to the consumer. Therefore, the study also considered the achievable cost-effective unregulated fuels efficiency potential.

Achievable cost-effective potential is defined as the potential for the realistic penetration of energy-efficient measures that are cost-effective[130] and that could be acquired given aggressive funding levels. As shown in Exhibit 7-1, the total achievable cost-effective potential as a percentage of the forecast of fuel consumption by 2016 is 14% for fuel oil, 8% for propane, 5.9% for kerosene, and 14.2% for wood. It is important to note here that fuel oil accounts for most of the savings because it is more extensively used throughout the state than the other fuels: The savings from fuel oil account for 72% of all achievable cost-effective efficiency in the unregulated fuels sector. Further, because this study was conducted in 2007 prior to significant cost increases in some of these fuels, measures are likely to be more cost-effective now than they were at the time of the study. Thus, the exhibit below likely represents a conservative estimate of the achievable cost-effective efficiency potential.

[130] *Defined by the Societal Test applied as directed in Public Service Board Dockets 5270 (Order of 4/16/90) and 5980 (Order of 9/30/99). Available at* http://psb.vermont.gov/

Exhibit 7-1. Energy Efficiency Achievable Cost-Effective Potential by Sector and Fuel Type (2016)

Sector	Oil	Propane	Kerosene	Wood
Residential	10.2%	5.6%	3.3%	18.3%
Commercial	24.2%	21.7%	21.9%	16.0%
Industrial	10.2%	6.7%	10.2%	9.7%
Total	***14.0%***	***8.0%***	***5.9%***	***14.2%***

The reported public funding necessary to acquire the savings shown above is significant: $149 million over 10 years, or $14.9 million per year (nominal dollars). This figure does not include program participant costs, which add another $92 million to the overall investment over the next 10 years. The investments were found to provide net present value savings to Vermont of approximately $486 million. These net present value savings are also a conservative estimate, because they consider the avoided cost of various fuels as estimated in 2007, prior to the rise in energy prices.

To update its understanding of energy efficiency potential and economic benefits, the DPS recently commissioned Optimal Energy and Synapse Energy Economics to determine the economic impact of electric and thermal efficiency investments from Vermont's energy efficiency utilities (EEUs). The study, attached as Appendix 5—Economic Impacts of Energy Efficiency Investments, showed that for every $1 million of public funds spent on thermal efficiency programs, a net of 16 job-years were created through increased demand for efficiency retrofits (and the associated demand for labor created) and through indirect economic effects created by increased disposable income for program participants that is spent largely within the Vermont economy. Overall, net present value benefits of $1.6 million were put back into the state's economy over the lifetime of the thermal efficiency measure.

Although these returns are more modest than electric EEU program impacts (see Section 4—Electric Energy Efficiency), it should be noted that the thermal efficiency programs are still in their infancy; many fewer dollars have been invested in these programs compared with electric efficiency programs. There is reason to believe that greater investment would yield greater results, because fixed program costs would be spread over a greater number of projects and the net present value of benefits would increase. Further, the results are based on energy savings impacts only—impacts of efficiency measures on health, safety, and comfort for the customer (and the indirect positive impacts they create) are not included in this analysis. The DPS's results are consistent with the Regulatory Assistance Project's report "Affordable Heat: Whole-Building Efficiency Services for Vermont Families and Businesses," which found that the net present value of benefits for every public dollar of thermal efficiency investment brought back $1.55.[131] These findings are unequivocal: Public investment in thermal energy efficiency is good for the Vermont economy.

The DPS suggests that these findings provide ample justification to aggressively pursue the building efficiency goals established in the 2007/2008 Vermont legislative session through Act 92 (10 V.S.A. § 581). Act 92 established the following building efficiency goals:

(1) Improve 20% of housing by 2017 (more than 60,000 units), and improve 25% of housing by 2020 (about 80,000 units).

(2) Reduce fuel needs by 25% in building units served.

(3) Reduce fossil fuel consumption across all buildings by 0.5% per year, leading to reductions of 6% annually by 2017, and 10% annually by 2025.

(4) Save $1.5 billion on fuel bills through improvements installed between 2008 and 2017.

7.1 Challenges to Comprehensive Thermal Efficiency

There are a variety of challenges to obtaining comprehensive thermal efficiency improvements in Vermont. In developing a comprehensive statewide thermal efficiency program, we need to address barriers to customers; the needs of different types of consumers (including low- and moderate-income homeowners, commercial property owners, residential and commercial renters, and landlords); the different needs for retrofitting different types of buildings (including historic buildings); and lack of robust financing opportunities and funding for incentives and programs. (The challenges listed here are described in the context of thermal efficiency; however, most apply equally to electric efficiency.) Specific tools (both existing and to be developed or expanded) are discussed starting in Section 7.2—Tools to Achieve Comprehensive Thermal Efficiency.

7.1.1 Challenge: Customer Barriers

Despite the evidence of a significant number of cost-effective energy efficiency opportunities, consumers regularly underinvest in energy efficiency. A recent report completed by the Regulatory Assistance Project (RAP) titled "Affordable Heat: Whole-Building Efficiency Services for Vermont Families and Businesses" (herein, "the RAP report")[132] identifies numerous customer barriers, many of which are summarized below.

[131] *"Affordable Heat: Whole-Building Efficiency Services for Vermont Families and Business," Regulatory Assistance Project, available for download at www.raponline.org/document/download/id/4439. The RAP report was funded by the High Meadows Fund.*

[132] *"Affordable Heat: Whole-Building Efficiency Services for Vermont Families and Businesses," Regulatory Assistance Project.*

- **Multiple Organizations/Entities Delivering Efficiency Services in Vermont.** The fact that Vermont has many entities with significant experience in offering efficiency services puts the state in a good position to reduce building energy consumption in a holistic fashion. However, the range of options available and the multiple entity interactions a customer must have to fully complete an efficiency project require stamina on the customer's part, may cause confusion, and can lead customers to abandon projects.

- **Split Incentives**. The term split incentives refers to situations in which the benefits and costs of efficiency measures are divided, or believed to be divided, between two different market actors. For example, one situation that has long been a barrier to efficiency programs occurs when a tenant pays the energy bills, but the landlord is responsible for building upgrades. The landlord may not be motivated to invest in the improvements because he or she will not directly benefit from them. A second example is when building owners are not sure that they will remain in the building long enough to earn payback on their investment, and so choose not to invest. Finally, builders often do not occupy the buildings they construct, so they do not perceive that they will directly benefit from any energy efficiency improvements they install. The short-term outlook of these market actors often works to the detriment of long-term efficiency investments.

- **High Up-Front Costs and Financing Aversion.** Efficiency investments have up-front initial costs, with payback occurring over a number of years. Efficiency retrofits can be cost-effective over a period of time and provide the consumer with additional health, safety, and comfort benefits—but many Vermonters simply cannot afford to make the up-front investment. Some financing options currently exist (see Section 7.2.1.2—Financing Energy Efficiency); however, consumers may not be able or willing to access the option that would be most advantageous for them (such as a long-term loan). In addition, the path to securing a loan can be a barrier.

- **Lack of Information.** Building owners often have a limited understanding of the connections between their energy use and potential building problems such as drafts, discomfort, air quality, and ice dams. They also frequently do not realize or factor into energy decision making the non-energy benefits that result from energy efficiency improvements, such as increased comfort and safety. Additionally, building owners are often unsure of how to start the process to improve the efficiency of their building and where to go to get objective information. If this information is too difficult to find or understand, building owners can get frustrated and give up on the process.

7.1.2 Challenge: Older and Historic Buildings

Many of Vermont's buildings are old, and many of these older buildings are considered historic and are either listed on or eligible for listing on the State and National Registers of Historic Places. In fact, more than 40% of

Vermonters live in historic buildings, of which there are more than 30,000 in our state. Approximately 76,800 homes (30% of the total number of homes in Vermont) were constructed before 1940.[133]

There are ample opportunities for improving the energy efficiency of older and historic buildings, but it may seem like a particularly daunting task to owners. These buildings often have special historic characteristics that must be addressed when performing energy efficiency upgrades, which can sometimes add to the cost. However, improving the energy efficiency of our existing buildings is an essential piece of a comprehensive efficiency program and is also a critical component in addressing climate change. According to the National Trust for Historic Preservation, "The construction, operation and demolition of buildings account for 48% of the United States' greenhouse gas emissions." If we retrofit, reuse, and recycle our older and historic buildings, we can significantly reduce these greenhouse gas emissions in Vermont.

In developing strategies for upgrading the efficiency of the existing building stock in Vermont, revisions to energy codes and other energy efficiency goals or mandates, and the development of efficiency strategies, must consider potential difficulties and limits for older and historic buildings as well as other unique types of homes.

Recommendations

(1) Form a working group that includes the DPS, the Office of Economic Opportunity (OEO), the Agency of Commerce and Community Development (ACCD), and other stakeholders to develop a package of energy efficiency measures that are cost-effective and appropriate for historic buildings.

(2) The Vermont Department of Buildings and General Services (BGS) should develop case studies for energy conservation in historic state-owned buildings that can serve as models to others for making energy improvements to historic residential, office, and institutional buildings.

(3) The state should investigate collaborating with the Preservation Green Lab, the National Trust for Historic Preservation's Sustainability Program (www.preservationnation.org/issues/sustainability/green-lab/about.html).

7.1.3 Challenge: Funding

Currently, no comprehensive funding source exists that is large enough to facilitate meeting the state's goals for building thermal efficiency. A variety of programs deliver thermal efficiency services; they include the state Weatherization Program, the Vermont Fuel Efficiency Partnership (using RGGI [Regional Greenhouse Gas Initiative] and ARRA funding), the Vermont Housing and Conservation Board (using ARRA and other funding), Efficiency Vermont (using RGGI and FCM [Forward Capacity Market] funding), Neighborworks of

[133] *Eric Phaneuf, Vermont Association of Realtors, Presentation: "Working Group on Building Energy Disclosure," August 2011.*

Western Vermont (using ARRA funding), and Vermont Gas Systems. However, many of these programs are funded largely with dollars from the American Recovery and Reinvestment Act (ARRA), and that funding will end by December 2012. A total of approximately $34.5 million of ARRA funding has been available for energy efficiency retrofits for the period of 2009–12.[134] This has enabled a substantial increase in completed efficiency projects and workforce development. However, when these funds are spent, a large number of trained workers may be unemployed or underutilized if no additional funds are raised to help sustain the demand for building efficiency projects.

The RAP report estimated the costs and benefits of meeting the Act 92 goals by 2020. That report proposed that the following total amounts will be needed through 2020 to meet the goals: $63.3 million in new public funds, $461 million in leveraged private investment, and $182.3 million[135] for existing programs (including the state Weatherization Trust Fund). The report recommends a ramp-up of the public funds starting at $17.1 million in 2012 and increasing to $33.6 million in 2020. The recommendation for these funding levels is dependent on implementation of numerous policy and regulatory changes, without which the necessary funding levels could be much higher.

The DPS estimated the cost to provide thermal efficiency retrofit incentives to meet the building efficiency goals of Act 92 in the absence of other policy and regulatory changes. Assuming an incentive of 25% of the total average costs for a retrofit to achieve 25% savings in a home (estimated as averaging $7,500 per home),[136] it would require just over $15 million a year to retrofit an additional 8,165 homes per year through 2020.[137] If a quarter of the homes are retrofitted through the low-income Weatherization Program (in which 100% of the retrofit costs are paid by the program), required funding would increase to more than $22 million per year. This amount does not include program/operational costs and does not take into consideration the use of existing funds in meeting this goal.[138] (It should be noted that no analysis was conducted to determine whether this level

[134] *This includes direct ARRA funding provided to the Weatherization Program and Neighborworks as well as DPS-directed SEP and EECBG ARRA funding to VHCB, public-serving institutions, the Vermont Fuel Efficiency Partnership, Vermont BGS, and schools and municipalities.*

[135] *This is the amount of funding estimated for existing programs going forward, based on amounts received in previous years.*

[136] *According to Ajith Rao of the Regulatory Assistance Project and Emily Levin of Efficiency Vermont, the current average cost for a Home Performance with Energy Star project is approximately $7,500. According to the RAP report "Residential Efficiency Retrofits: A Roadmap for the Future," an incentive of 25% of the efficiency retrofit cost is needed to encourage consumers to complete projects.*

[137] *The number of retrofits completed through the Home Performance with Energy Star program and the state Weatherization Program from 2008 to 2010 is estimated to be approximately 6,517 homes/units. This leaves 73,483 to complete by 2020 (or 8,165 per year for the next nine years). There is no current estimate of the number of units that may have been retrofitted outside those programs.*

[138] *The estimated funds going forward for the state Weatherization Program (based on pre-ARRA Weatherization Trust Fund amounts), RGGI, and FCM is approximately $16.1 million per year, according to the RAP Report. However, because*

of effort and funding would also meet the Act 92 goal of reducing fossil fuel consumption across *all* buildings, including those in the commercial sector, by 6% annually by 2017 and 10% annually by 2025.)

It is clear that if Vermont is to adequately progress on its thermal efficiency goals, an additional source of stable public funding is necessary to facilitate private investment.

7.1.4 Challenge: Insufficient Energy Services for Low-Income Households

As we begin to develop a more comprehensive statewide thermal efficiency program, it is crucial not to forget Vermont's most vulnerable citizens. Yet to meet our building efficiency goals, it will certainly take a level of building owner investment that this population cannot provide without assistance. The state needs to determine the appropriate balance for funding low-income and non-low-income energy efficiency improvements.

As heating fuel prices continue to increase, the strain on low-income households grows. Energy costs typically make up a high percentage of low-income households' budget, because these residents tend to live in older and less efficient homes. Also, energy costs have increased at a much faster pace than the average wages for lower-income workers and retirement benefits for seniors.[139] Rising fuel prices are also a substantial risk to the affordability of the low-income multifamily housing portfolio in the state. The energy efficiency of these buildings will need to be substantially upgraded if they are to remain cost-effective and available for low-income housing.

Vermont has seen tremendous success with the state Weatherization Program; however, owing to funding constraints, it is still serving only a very small percentage of the low-income population. In the 2010–11 program year, 1,722 housing units received energy efficiency services. It is estimated that there are almost 50,000 households eligible for weatherization services in the state.[140] An additional benefit from completing weatherization in low-income households is the reduction in need for fuel assistance and often other public assistance. (See more information in Section 7.2.2.6—Vermont's Weatherization Program.)

A comprehensive thermal efficiency program should also address the considerable gap in energy efficiency services and funding available for low-income Vermonters who do not qualify for the existing Weatherization Program. We acknowledge that there is a greater demand for the existing program than it can currently serve. Nonetheless, there should be an investigation into potential opportunities such as "do-it-yourself" programs, no-interest loans, and needs-based tiered incentives for those who do not meet the eligibility requirements but are unable to afford efficiency measures.

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the Weatherization Program exclusively serves the low-income population, it must pay 100% of the costs for a retrofit, so a much smaller number of units can be completed with those funds.

[139] *"Affordable Heat: Whole-Building Efficiency Services for Vermont Families and Businesses," Regulatory Assistance Project, June 2011.*

[140] *Estimate is based on 2010 Census.*

Recommendation

In the development of coordinated statewide comprehensive thermal efficiency services, ensure an adequate balance of funding between low-income and non-low-income households and consider how to best provide services to lower-income households that do not meet eligibility requirements for Weatherization Program services.

7.2 Tools to Achieve Comprehensive Thermal Efficiency

The DPS 2007 study "Vermont Energy Efficiency Potential Study for Oil, Propane, Kerosene, and Wood" demonstrated that significant opportunity exists to increase the efficiency of unregulated fuel use in Vermont. There are a number of ways to achieve these efficiencies, including current retrofit and market opportunity initiatives such as Home Performance with Energy Star, Vermont Gas retrofit programs, building energy codes, and others. This section of the Comprehensive Energy Plan (CEP) discusses a suite of policies that have a goal of reducing demand for unregulated fuels in Vermont, including building energy standards and an enhanced Weatherization Program that complements a statewide thermal efficiency program. The policies should lead to a reduction in both energy expenditures and emissions. Efforts should be made to implement the policies that provide energy savings at the lowest life-cycle cost.

As previously mentioned, demand-side management programs and policy considerations in Vermont have traditionally focused on utility (electricity and gas) resource decisions and investments. Until recently, residential energy efficiency programs targeted at unregulated fuels have been delivered via the Weatherization Program for income-eligible participants, and there has been little in the way of commercial unregulated fuels efficiency programs, despite the significant opportunity presented by the sector. Building energy codes have increased and will continue to increase the baseline efficiency levels of newly constructed and substantially renovated homes and commercial buildings. Federal tax incentives, and more recently grants associated with the American Recovery and Reinvestment Act (ARRA), have also spurred investment in energy efficiency among unregulated fuels. Energy efficiency options encompass all categories of fuel, including electricity, motor gasoline, and fuel oil for heating and process needs. This section of the CEP discusses thermal energy efficiency; however, the DPS believes energy efficiency investments should be considered holistically.

We must continue to explore new ways to integrate energy efficiency into all Vermonters' lives. Energy efficiency is the cleanest, most cost-effective, and most abundant resource we have for paving our way to a bright energy future.

7.2.1 Programs and Tools to Be Developed or Expanded

Achieving the state's ambitious goals for energy efficiency requires an integrated approach that combines the elements of policy, finance, outreach, and innovation. To achieve success, the state will need to craft new policies for whole-building approaches using simplified mechanisms that include easy access to financing. Service providers will need to amplify and increase their outreach using a range of approaches that engage building owners and support the completion of efficiency improvements in a simple, hassle-free manner. At the same time, coordination among the many stakeholders involved with efficiency delivery will need to be increased to meet the state's goals.

7.2.1.1 A Whole-Building Approach

A whole-building approach to efficiency looks at a building as a system and recognizes the interaction of all the components within the building. Currently, comprehensive state-funded electric efficiency programs are delivered through the state energy efficiency utilities (EEUs), which are Efficiency Vermont (EVT) and Burlington Electric Department. These EEUs focus primarily on electric savings, given that their mandate is to acquire electric resources and their main funding source is electric ratepayers. Only a small amount of funding is currently available for thermal measures. However, thermal efficiency measures represent a majority of the energy savings opportunity in many buildings (particularly homes). The result is that much of the potential energy efficiency savings remains unaddressed.

The state Weatherization Program for low-income residents is one state energy efficiency program that has succeeded in a whole-building approach. (Detailed information on this program is included later in the Weatherization Program section.) The Weatherization Program completes a whole-home assessment, determines what electric and thermal measures should be completed, and then utilizes EEU funding for the electric efficiency measures and other funding for the thermal measures. For consumers, the process is seamless; they do not need to get involved in separate programs to determine how they will cover the costs of the improvements. Additionally, the Weatherization Program implementers (the Community Action Partnership [CAP] agencies) facilitate the completion of all work—including hiring subcontractors and selecting the products and equipment to be installed—minimizing the burden and time investment for building owners. Although this model is unique because the program pays 100% of the costs for the efficiency measures, it does demonstrate how a whole-building approach can be taken even when a variety of funding incentives and opportunities are utilized.

EVT also currently has a comprehensive home retrofit program called Home Performance with Energy Star that utilizes a number of different market actors while minimizing the burden on the customer. Efficiency Vermont offers technical training and Building Performance Institute (BPI) certification to contractors interested in entering the energy efficiency field. Funding is used to support this contractor base and to increase the demand for retrofit services through customer marketing, financing, and incentives. Certain multifamily, mixed-use, and municipal buildings also qualify under this program. However, due to the limited funding for non-electric efficiency measures, this program is not able to service as many buildings as will be needed to meet the Act 92 goals.

Additionally, in partnership with Efficiency Vermont and the Home Performance with Energy Star program, Neighborworks of Western Vermont (NWWVT) has received ARRA funding to serve Rutland County residents with efficiency services. NWWVT has partnered with multiple organizations, including Central Vermont Public Service, EVT, local banks and colleges, local government and planning organizations, and community resident volunteers, to initiate intensive marketing and awareness efforts (including door-to-door visits), followed by a coordinated package of energy audits and recommendations, low-cost financing, incentives, and construction management services. This effort provides another example of cross-organization coordination and implementation to serve Vermont customers.

The diverse number of providers of thermal efficiency services and programs in Vermont is a strength of the current efficiency infrastructure because it provides numerous opportunities for participants to enter into an efficiency project and provides expertise throughout the state. However, this proliferation can also cause confusion and frustration for consumers and energy service providers alike. Providers may have a hard time knowing what assistance, incentives, and programs are available, and customers are unsure which organization to contact to "get the ball rolling," what incentives are possible, and whether a better deal is available somewhere else.

Recommendations

The DPS will create a task force to develop a detailed plan for facilitating a simple, integrated, and comprehensive statewide whole-building approach to thermal energy efficiency that will put us on the path toward meeting the building efficiency goals set out in statute. The task force should complete analysis and recommendations by December 2012 and address the following:

(1) Improve program delivery so that from the consumer's point of view, a smooth "one-stop" approach to energy efficiency projects occurs.

(2) Identify a stable resource of funds and financing mechanisms that need to be implemented or improved. This should include consideration of the cost of achieving the state building goals and the best mix of funding and financing to do. Consideration should also be given to tying the source of the funds to the fuel sources it is serving to reduce. The funding should be adequate to address both low-income and moderate-income populations as well as to drive demand for those who do not need incentives but still need information to make the right efficiency choices and be motivated into action.

(3) Ensure that qualified contractors and service providers are available throughout the state.

(4) *Create a strategy to encourage and enable local fuel dealers to provide energy efficiency services to their customers.*

(5) *Develop a system with stakeholders to measure progress and track results, so that the state has an accurate count of how many buildings have been improved and an accurate picture of the extent and cost of those improvements, as well as our progress toward meeting the state's building efficiency goals.*

(6) *Develop interim goals and benchmarks for meeting the state's building efficiency goals.*

7.2.1.2 Financing Energy Efficiency

Public funding is an important aspect of facilitating a significant increase in energy efficiency investment in Vermont's buildings. Although cash incentives have many advantages, including decreasing the up-front impact of an efficiency investment and grabbing the attention of customers, most of the investment made in efficiency will necessarily come from private capital. Thus, up-front incentives need to work in concert with appropriate financing options to attract investment with the least possible public contribution.

A number of financing mechanisms either are currently available in Vermont or will soon be available. A report titled "Financing Residential Energy Efficiency in Vermont" completed by the Vermont Law School for the High Meadows Fund (herein known as "the VLS report") outlined these various options.[141] It is important to have a host of cash-flow-positive finance options available so any given customer can choose the financing mechanism most appropriate to his or her particular situation. Furthermore, financing must be combined with marketing and other tools to drive the demand for these services. In addition, any financing process must be easy, including quick and convenient approval and closing processes.

- **Traditional Financing.** Generally available through banks, credit unions, and mortgage companies, traditional financing is offered through equity-based loans (such as home equity loans, mortgages, or refinancing) or personal, unsecured loans. Both home equity and unsecured loans are available to customers now; however, there has been very little demand for these services for efficiency investments, even when the loan term is long and results in a positive cash flow for the customer.

  Only customers with good credit and the willingness to take on a loan will generally be approved for traditional loans. Efforts should be undertaken to investigate risk mitigation for banks to allow for loans to be approved for those who have more modest credit scores. Risk mitigation could come in the form of loan guarantees or a loan loss reserve fund, and would allow Vermonters who would not otherwise be able to make efficiency improvements to invest in their home or commercial space.

[141] *Financing Residential Energy Efficiency in Vermont, High Meadows Fund, July 2011,* www.highmeadowsfund.org/learningresources. *Many of the descriptions of financing mechanisms that are found here are summaries of descriptions in this report.*

Similarly, more Vermonters might be able to take advantage of financing options if a revolving loan fund were established. A revolving loan fund uses the payments on current loans to replenish itself in order to issue new loans, and often provides financing when credit access is limited. Funds can provide benefits to both borrowers and lenders—borrowers can benefit from favorable loan terms and lenders can benefit from having greater security on their investments, especially if the loan fund is backed by a loan loss reserve fund.

Traditional financing can be offered through utility/efficiency provider partnerships with private lenders, as has occurred in Vermont Gas System's credit union financing program offered to customers seeking VGS efficiency services. VGS's program provides easy access to private financing for customers, and VGS guarantees lower-credit-score customers for the benefit of the credit union lender.

- **Energy-Efficient Mortgages**. An energy-efficient mortgage (EEM) is a mortgage that credits a home's energy efficiency in the mortgage itself. EEMs give borrowers the opportunity to finance cost-effective, energy-saving measures as part of a single mortgage and stretch debt-to-income qualifying ratios on loans, thereby allowing borrowers to qualify for a larger loan amount and a better, more energy-efficient home. Conventional EEMs can be offered by lenders that sell their loans to Fannie Mae and Freddie Mac. Conventional EEMs increase the purchasing power of buying an energy-efficient home by allowing the lender to increase the borrower's income by a dollar amount equal to the estimated energy savings. Both the FHA and the U.S. Department of Veterans Affairs offer EEMs.[142]

- **Property-Assessed Clean Energy (PACE) Districts.** PACE[143] provides an attractive nontraditional mechanism for financing energy improvements by allowing customers to opt in to a special assessment district created by their municipality. Efficiency improvements are then funded by taxable municipal bonds or other municipal debt, secured by a lien on the property, and repaid via property tax payments to the municipality. This mechanism overcomes the up-front cost barrier to efficiency. In addition, it doesn't necessarily create a personal debt obligation—if the property is sold, the subsequent owner acquires both the efficiency improvements and the remaining payment obligation. Of course, this financing option is limited to people who own their homes. Further, many property owners are reluctant to place a lien on their property. A state PACE loan loss reserve fund has been created by the Vermont General Assembly through Act 47 of 2011 (24 V.S.A. § 3270) that is administered by the state treasurer. This fund will diminish the risk of investment for investors. (Loan loss reserves play an important role as a credit enhancement that helps leverage

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[142] *For details, see Energy Star: www.energystar.gov/index.cfm?c=mortgages.energy_efficient_mortgages.*

[143] *Descriptions of PACE and on-bill financing are summarized from information provided in both the RAP and VLS reports. See: Residential Efficiency Retrofits: A Roadmap for the Future, Regulatory Assistance Project, May 2011. www.raponline.org/document/download/id/918. VLS report - Appendix 1: Conceptual Roadmap; see also DOE Types of Financing Programs: www1.eere.energy.gov/wip/solutioncenter/financialproducts/financingprograms.html.*

private financing. Other new finance program models may also benefit from the establishment of loan loss reserves to encourage investor participation.) All municipalities in Vermont are encouraged to become PACE districts to facilitate this financing option. More than 50 towns have expressed interest in beginning a PACE program in 2012.

- **On-Bill Tariffed Financing.** On-bill tariffed financing, a kind of nontraditional financing in which the cost of efficiency improvements is recovered through local utilities using charges that are tied to the meter instead of the customer, would allow a PACE-like structure of attaching the payment for an efficiency measure to the building or building unit in rental buildings (and their tenants). This mechanism allows utility customers to install efficiency measures without up-front capital or debt obligations. In addition, the length of these loans can be matched to the energy savings created by the efficiency measure, creating a positive cash flow for the customer. Although on-bill tariffed financing has the potential to attract a broad range of customers, it also presents many challenges. One challenge to be addressed is the possibility for electricity shutoffs due to non-payment on energy efficiency improvements. Also, many of the energy improvements needed in a building are thermal efficiency measures and therefore not tied to electric usage through a regulated utility. However, thermal improvements also reduce cooling costs (i.e., there is reduced need for electric air conditioning) in the summer, during which Vermont can experience peak electric demand. The question of whether an electric utility should be providing financing for non-electric equipment measures must be addressed. The DPS is currently in the process of exploring the opportunities for on-bill financing in Vermont, including the potential development of a statewide loan loss reserve fund to support such an initiative.

- **Specialty Financing**. Energy efficiency specialty lenders have successfully funded programs that have included the use of unsecured personal loans. Such lenders warehouse their loans and sell the loan portfolio to secondary investors that include foundations, state treasury offices, pension funds, and others.

- **Vendor Financing**. Vermont has a broad network of fuel dealers that deliver heating fuel services. Facilitating vendor financing through these dealers would have the benefit of providing a more seamless offering for thermal efficiency improvements for many Vermonters, could increase the rate of efficiency investment, and could provide fuel dealers with a new source of business as fossil fuel usage decreases in the future.

An array of other financing options are possible, including the adaptation of energy service companies (ESCOs), cooperatives, and public green banks, all of which could increase consumers' access to affordable, easily obtainable financing.

An important issue to note is that when a customer finances a home, little to no consideration is taken into account of the specific energy consumption characteristics of that home. (Loans for commercial properties appear to take energy consumption into consideration more often.) In order for rational financing decisions to be made, the value of energy efficiency improvements should be captured in appraisals and lending decisions.

Currently, the energy usage and costs of the home are not factored into the decisions about what a consumer can afford for monthly payments. If efficiency improvements were considered, they would improve the customer's monthly cash flow and at the same time make the benefits of efficiency more concrete to homeowners. A standardized method for valuing efficiency could allow efficiency investments to be factored into underwriting decisions. (Further discussion on valuing energy efficiency is presented under Section 7.2.1.4—Building Energy Disclosure.)

To be effective, financing mechanisms must be integrated into the process of improving a home's energy efficiency, so that the application and loan process are smooth and easy. New financing mechanisms alone will not substantially impact demand for services. Leverage and liquidity are important. Achieving the scale of energy efficiency required by statute will require convenient access to various forms of finance. In addition, the incipient energy efficiency finance markets need further development to leverage public funds. One challenge in the development of individual loan programs is the lack of liquidity for investors. The state could investigate loan aggregation and warehouse options to tap private lending markets, thus encouraging an increase in efficiency lending. For example, the Warehouse for Energy Efficiency Loans (WHEEL)—a venture of the Energy Programs Consortium and Pennsylvania Treasury Department—is a facility designed to pool and securitize energy efficiency loans for the secondary market. WHEEL would allow lenders to sell unsecured loans to a secondary market, then immediately put the proceeds of that loan sale into new energy efficiency lending. Loans sold into this market have to meet certain criteria, and need a credit enhancement (some sort of risk mitigation that the state could provide).

The state and some energy efficiency partners are exploring options to leverage U.S. Department of Energy (DOE) funding and Vermont's Qualified Energy Conservation Bonds (QECBs) to expand access to private capital via a new public–private partnership. A new program concept advanced by Efficiency Vermont would help open private capital markets to create a sustainable commercial energy efficiency retrofit program for businesses, thus reducing reliance on public funding to achieve energy efficiency improvements. Others are exploring models intended to harness the capital of larger banks as well as developing secondary markets to overcome the gap between pilot-scale finance and market maturity.

Recommendations

(1) Investigate the best way to facilitate the broadening of financing options, including on-bill financing available to Vermonters, when developing a comprehensive thermal efficiency program for the state.

(2) Use insights from the first set of PACE projects to increase municipal participation in PACE over the next three years.

(3) DPS should partner with the Treasurer's Office and other state and federal agencies to support development of the private capital markets to increase private investor confidence and participation in energy efficiency finance, and to leverage public funding.

7.2.1.3 Education/Outreach

A lack of effectively targeted information is a market barrier to energy efficiency improvements in the state. Efficiency programs must convey how efficiency translates into dollars saved in participants' pockets as well as describe economic benefits for the entire state. We must make the pitch in plain, effective language: Using less energy saves money.

It is vital for the whole-building approach discussed herein to have an integrated, targeted marketing campaign that reaches customers at points where they will listen. Case studies of completed projects, in all building types and involving customers of all economic and social segments of the population, should be made available. (The Vermont Energy Investment Corporation has recently released three such case studies, and NWWVT has used targeted marketing to aid in its customer service efforts; these types of communications should be continued.) Best practices must be shared across energy service providers in Vermont to transform markets and facilitate replication. Websites must be easy to navigate and contain both the basic and in-depth information building owners are seeking. Perhaps most importantly, multiple actors in the marketplace must convey a clear, singular overarching message. Successful outreach campaigns for energy efficiency using social media in other states can serve as models for how to target audiences in a user-friendly and engaging fashion that accelerates local participation.

The state has an important role to play in education and outreach, especially of publicly funded programs. Oversight and accountability for public funds are essential, and the state must evaluate and audit these funds to ensure that public dollars continue to be used appropriately, as well as communicate the benefits of these programs. As previously noted, the Department of Public Service recently completed a study that shows the economic impact of energy efficiency in Vermont through the thermal efficiency programs operated by Efficiency Vermont (see Appendix 5—Economic Impacts of Energy Efficiency Investments for the full study). The DPS plans to continue this type of analysis of efficiency programs in the future.

Marketing and outreach of programs as they are delivered is vital for successful programs. Town energy committees in Vermont are growing in number, and they are becoming a pivotal point to provide this type of outreach within communities as well as to further develop community-based projects and programs. Ensuring that such committees continue to thrive, and are expanded to even more towns throughout Vermont, will help further grassroots energy efficiency and conservation efforts. Town energy inventories and challenges, among other initiatives, should be encouraged, and successes should be widely reported. In the long run, energy efficiency consciousness should also be engrained in our public education. One example of this type of education is the Vermont Energy Education Program (VEEP), which will be expanded in the coming years through the Efficiency Vermont Energy Literacy Project (ELP) and other Efficiency Vermont/VEEP programs, including the Whole School Energy Challenge and the upcoming K-12 Energy League. The ELP builds upon the VEEP's long-standing success in promoting a deep understanding among the children it reaches of what energy is and how to use it efficiently. The program aims to reach up to 10,000 students per year. The new federal Green Ribbon Schools program may, in coming years, add to these education efforts.

7.2.1.4 Building Energy Disclosure

Building energy disclosure is used to provide energy usage information for a building. It can vary from very simple data such as utility/heating fuel consumption covering a certain period of time, the number of people in the household, building square footage, and hours of operation or use, to more complex information that details the insulation values in the building and efficiency levels of heating systems and other components of the building. A building rating takes the building energy usage information and provides a comparison with similar buildings. The building energy data and rating can be used to develop a building energy label, which can present a simple visual of the information, much like an MPG sticker on a new car.

The time of sale of a building presents an opportunity to educate potential buyers about the energy use of a home or a commercial building through building energy disclosure information.[144] This information could be useful to potential buyers as a means of comparing energy efficiency levels of various buildings and what their future energy costs might be for those buildings. This information may also encourage investment in efficiency on the part of either a prospective buyer or a seller of property. For home buyers, it also presents a potential opportunity to include any needed energy efficiency improvements in an energy-efficient mortgage.

Currently, "Seller's Property Information Reports" are commonly provided for homes that are for sale. These reports include recent heating fuel and electric usage information. However, such reports are not mandatory. A limitation of providing energy usage data for the building over only a short period of time is that it is occupant-dependent and could vary greatly by the number of people occupying a building and how they use it. For example, a four-person household with two adults and two teenagers will likely have energy usage very different from that of a two-person household in the same building. Similarly, a commercial building used for manufacturing or processing will have energy usage very different from one not used for those purposes.

Building energy disclosures and ratings can also be a tool to provide homeowners a monetized value of their energy improvements; buildings with a higher rating would likely have a higher value. The inability to monetize energy efficiency improvements is seen by many as a major obstacle to convincing homeowners to go forward with energy efficiency investments. Some studies have shown an increase in value for energy-efficient homes when they are sold. A 1998 study funded by the U.S. EPA found that there was an incremental increase in home value of $10–$25 for every $1 reduction in annual fuel bills.[145] Another study, completed in 2009, focused on certified homes in Seattle and Portland and found an increase in sale prices of between 3% and 9.6% for these homes.[146]

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[144] *In 2010 there were 8,223 residential and commercial sales in Vermont (www.state.vt.us/tax/pdf.word/excel/statistics/2010/report123110.pdf).*

[145] *"The Appraisal Journal: Evidence of Rational Market Valuations for Home Energy Efficiency," Appraisal Institute, October 1998.*

[146] *Certified homes in Seattle sold at a price premium of 9.6% and homes in Portland sold at a premium of 3% to 5%. Certified homes include homes that received an Earth Advantage New Home certification or an Energy Star or LEED for*

Valuation of energy improvements could also be addressed through voluntary programs that would allow for the marketing of the benefits of an energy-efficient home (such as an Energy Star Home). A number of voluntary building energy rating systems for new construction are currently available that certify the building has been built to above-energy-code specifications. Examples include the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) program and the U.S. DOE Energy Star program. Any building labeling system developed for existing homes should review these programs to ensure consistency and avoid redundancy. One step that has recently been taken to make energy-rated homes more easily recognized: The Home Energy Rating System (HERS) score has been added as a field to the multiple listing service (MLS) form so home rating scores can be included when available. The DPS sees many benefits in this type of voluntary rating. This could be used as a positive marketing tool for sellers and enable them to capture the value of their energy efficiency investment when selling their building. This would also enable the corresponding technical and financial assistance and unified coordination of the state efficiency services that will be necessary for investments for efficiency improvements to be put in place prior to any mandatory disclosure requirements. The expansion of voluntary programs would of course need to be complemented with outreach and education to achieve the desired results and encourage participation. A tracking system should also be developed to gather information on any increase in the value of a rated building or the speed with which it is sold. The DPS recommends developing such a tracking system as a starting point for getting a building energy disclosure system in place.

There is some precedent for building energy disclosure mandates in the United States. Currently two cities, one county, and six states have some type of building energy disclosure requirement for residential buildings. The rigor of the requirements varies from simple efficiency checklists and utility data disclosure to complex evaluations and audits. There are also seven cities and states with commercial building energy disclosure requirements in place. All use the EPA's Portfolio Manager for their commercial building rating system.[147]

The U.S. Department of Energy (DOE) is also currently developing a Home Energy Score program and is conducting building labeling pilots in 10 states. The first phase of the pilot is expected to be completed by the end of 2011 (including modifications based on the pilots). This program also includes a plan to develop a national home energy registry.[148]

Act 47, passed in the 2010–11 Vermont legislative session, created a working group to study "whether and how to require disclosure of the energy efficiency of commercial and residential buildings in order to make data on building energy performance visible in the marketplace for real property and inform the choices of those who may purchase or rent such property." The study group has been directed to consider the following:

Homes designation. "Certified Home Performance: Assessing the Market Impacts of Third Party Certification on Residential Properties," Ann Griffin, Ben Kaufman, and Sterling Hamilton. May 29, 2009.

[147] *Institute for Market Transformation, BuildingRating.org, "Comparison of U.S. Commercial Building Energy Rating and Disclosure Policies," and "Comparison of U.S. Residential Energy Disclosure Policies."*

[148] *Additional information on the DOE Home Energy Score Program is available at www.homeenergyscore.gov.*

(1) Whether there should be requirements to disclose building energy performance in a standardized manner that allows comparison and assessment of energy use among buildings.

(2) Requirements for disclosure of building energy performance that have been adopted in other jurisdictions and model codes or statutes that have been published relating to such disclosure.

(3) If requirements to disclose building energy performance were to be adopted:

- To whom should the disclosure be provided?
- When should the disclosure be required?
- Which properties, if any, should be exempt?
- Should there be a phase-in of requirements?
- What type of building energy ratings should be employed?
- Should the state subsidize the costs of energy audits, and what sources of funding would be used to support such a subsidy?

A report on these considerations is due in December 2011.

In addition to the considerations listed above, a building rating or label should be relatively easy for the consumer to understand, while being meaningful and accurate. It should also be relatively inexpensive. If an energy audit is used to provide the rating, such audits need to be standardized and should take into consideration existing auditing processes used for the state Weatherization Program and the Home Energy Rating System (HERS).

The next step beyond efficiency disclosure is the requirement for efficiency improvements to be made at time of sale. The city of Burlington has a "Minimum Rental Housing Energy-Efficiency Standards Ordinance" that requires certain efficiency measures to be installed prior to sale (with cost caps). The buyer and the seller of the property can also negotiate the efficiency improvements in the sale price. Detailed analysis of this type of requirement should be conducted before this model is considered for statewide application, because many barriers to successful implementation would first need to be addressed. Similar to building energy disclosure, potential barriers involve limits in the number of contractors available to perform the work (particularly in less populated areas), difficulties in enforcement, and an undue burden on buyers and sellers caused by increased property prices and sale requirements. If this type of requirement were passed without ensuring these barriers were sufficiently addressed, it could greatly impact the ability of someone to sell a building, or could significantly delay the sale. Additional potential problems are posed by the need to educate all potential sellers, buyers, and real estate agents throughout the state about this requirement up front to avoid lengthy delays.

Technical and other program assistance should be in place prior to any implementation of either building energy disclosure or time-of-sale efficiency improvement requirements. Consideration should also be given to instituting a phase-in period, with incentives for early compliance.

Recommendations

(1) *Investigate building energy disclosure and building rating and labeling through the appointed task force; recommendations are due by the end of 2011.*

(2) *Investigate how energy efficiency improvements could be valued in appraisals and lending decisions and propose a standardized method for valuing efficiency that could allow efficiency investments to be factored into underwriting decisions.*

7.2.1.5 Net-Zero Buildings

Net-zero buildings have zero net energy consumption, meaning that all consumption needs are met through energy efficiency and renewable energy systems. The goal is to have a highly efficient building that meets its own energy needs with renewable technologies.

Different definitions are used for *net-zero building*. Sometimes buildings are defined as net-zero only if they have enough **on-site** renewable energy to equal or exceed their energy use. In other cases, buildings may be defined as net-zero if they allow for **off-site** renewable energy generation or the purchase of renewable energy certificates. This is an important consideration when designing a program or goal for net-zero buildings—some sites will be less appropriate for some types of renewable energy systems, such as solar photovoltaic and wind. A challenge in allowing for off-site renewable energy is how to protect and ensure that those resources will remain available in the future. For both definitions, it is important to ensure that the maximum efficiency is achieved first to avoid the installation of oversized renewable energy systems (whether on-site or off-site) to compensate for unnecessary energy usage.

Another challenge in implementing a net-zero energy building strategy is the incremental cost. It has been estimated that there is an average incremental cost of $40,000–$60,000 for net-zero homes.[149] This additional cost would put home ownership beyond the reach of many Vermonters. A similar scale of incremental costs would likely apply for commercial buildings. These additional costs could deter businesses from considering locating in Vermont.

Additional considerations when pursuing a net-zero building strategy might include determining whether there should be exemptions for manufacturing and processing or other building types, whether a net-zero strategy should be considered for existing buildings, whether any conditions should be put on the type or source of the

[149] *Richard Faesy presentation, "The Vermont Comprehensive Energy Plan to include net-zero energy by 2030," June 2011.*

renewable energy (such as biomass from sustainably managed local sources), and what the health and durability of these buildings are over a longer period of time.

Several states have developed or are considering developing goals for building net-zero homes. California has a goal to build all new residential homes to net-zero design by 2020 and all new commercial buildings by 2030. A recent report from the Massachusetts Zero Net Energy Buildings Task Force (created at the direction of Governor Deval Patrick) suggests a goal for all new residential and commercial buildings to achieve net-zero energy use by 2030 through incentives, minimum energy performance standards, and workforce development.[150] Massachusetts's proposed model likely would fit well here in Vermont.

Recommendations

(1) Consider and address the potential challenges for net-zero buildings in Vermont and complete recommendations for a clear path to achieve a goal of having all new buildings built to net-zero design by 2030. These recommendations will include the mechanisms that must be instituted to achieve such a goal (such as regulatory codes, energy codes, financing and incentives, and workforce training). The DPS will work with stakeholders to develop these recommendations.

(2) Investigate what mechanisms are necessary to achieve the goal of building 60% of all new homes in Vermont to Energy Star standards or EVT's Energy Code Plus[151] and broader market penetration of net-zero energy buildings, with a goal of having 30% built to net-zero design standards by 2020 as an interim target on the way to 100% net-zero buildings by 2030. This initiative will be led by the DPS and include the state EEUs as well as other stakeholders.

7.2.2 Existing Thermal Efficiency Programs and Tools

7.2.2.1 Building Energy Standards

Vermont has both residential (RBES) and commercial (CBES) building energy standards. The residential energy code has been in effect since 1997 and the commercial energy code since January of 2007. Both standards are based on the widely used International Energy Conservation Code (IECC) produced by the International Code Council. The IECC is updated every three years, and Vermont statute calls for an energy code update process to

[150] *"Getting to Zero: Final Report of the Massachusetts Zero Net Energy Buildings Task Force," March 2009. Available at: www.mass.gov/eea/docs/eea/press/publications/zneb-taskforce-report.pdf*

[151] *Efficiency Vermont's Energy Code Plus Program requires that buildings meet the Vermont Residential Building Energy Standard plus the following: They must pass pre-drywall inspection, have air leakage of ≤4 ACH50, and have heating and cooling systems that meet Energy Star or equivalent standards; all major appliances must be Energy Star rated, and 50% of the fixtures must be Energy Star rated.*

begin promptly thereafter. The update process consists of the formation of a stakeholder working group that makes recommendations for enhancements to the code, which is then adopted following any modifications made as a result of wider participation in a state rulemaking process. There is no statewide enforcement mechanism or inspection process to enforce energy codes, but builders, architects, and engineers certify that buildings meet codes, and building owners have a right of action to recover damages if the codes are not met. A 2009 RBES Compliance Analysis found a technical compliance rate of 72%; studies by the Department of Public Service are under way that will update the RBES compliance rate and assess the CBES compliance rate.[152] The city of Burlington is the state's lone enforcement exception; energy criteria are verified in the city's building inspections for new construction.

A new RBES based on the 2009 IECC was adopted July 1, 2011, with an effective date of October 1, 2011. A new CBES was adopted October 3, 2011, with an effective date of January 3, 2012, and is based on the 2009 version of the IECC.

Additionally, the DPS is completing a statewide energy code compliance study that will outline a realistic approach for achieving 90% compliance with the energy codes by February 1, 2017. The study will address how to best implement ongoing training related to energy code updates, unified energy code enforcement measures, a process to evaluate and report annual rates of energy code compliance, and short- and long-term funding mechanisms for implementation.

Recommendations

(1) *DPS should continue to promptly initiate adoption of the International Energy Conservation Code for both commercial and residential buildings, and consider any regulatory changes necessary to assist in the expediency of this process.*

(2) *DPS should continue to encourage above-code building design, such as that laid out in Efficiency Vermont's Core Performance Guide.*

(3) *Complete an energy code compliance plan to outline a realistic approach for achieving 90% compliance with Vermont energy codes by 2017. The DPS will complete this plan by the end of 2011.*

[152]*The residential study completed in 2009 showed an estimated compliance rate of 72% (76 of 106 homes inspected passed RBES). However, six homes were on the margin of compliance (between 0% and 5% above code), and with the assumption that these homes failed to comply with RBES, 66% of homes would have complied. Conversely, seven homes were on the margin of failing compliance (between 0% and 5% below code), and with the assumption that these homes passed, then 78% of the homes would have met RBES. This study roughly indicates the type of compliance achieved by the self-certification mechanism. New residential and commercial market studies are currently being conducted and are expected to be completed in February 2012. The updated studies will assess the level of compliance with the energy codes in both sectors.*

7.2.2.2 Act 250 Energy Efficiency Criteria

Building energy codes in Vermont are supplemented by Act 250, Vermont's land use and development statute that requires review of proposed major development and subdivisions prior to construction. Before a project that falls under Act 250 is permitted, it must satisfy a number of environmental, social, and fiscal impact criteria, including criterion 9F, which applies to energy conservation. The statute states that a permit will be granted only if "the planning and design of the subdivision or development reflect the principles of energy conservation and incorporate the best available technology for efficient use or recovery of energy."[153]

As it relates to criterion 9F, the phrase *best available technology* has been interpreted to mean the best of proven design techniques and of normally accessible equipment and materials. When evaluating equipment and materials for use, the option that uses the least energy or has the lowest life-cycle costs is selected to comply with the best available technology requirement. For commercial buildings, the baseline to satisfy the 9F criterion has generally been the Vermont Guidelines for Energy-Efficient Commercial Construction, which as of January 1, 2007, is also the commercial energy code for the state. The Department of Public Service evaluates projects for compliance with the 9F criterion and can recommend above-code energy efficiency measures that the applicant should install if they are cost-effective on a life-cycle basis. For residential buildings, meeting the RBES is considered compliance with Act 250 criterion 9F. If and when the DPS recommends above-code efficiency improvements for an Act 250 permit to be granted, the agency needs to ensure that recommendations are consistent and applied evenly to provide predictability to the builders, architects, and engineers who plan and construct efficient, affordable buildings.

The New Buildings Institute Inc. created a Core Performance Guide, Vermont Edition, designed to reduce energy use in new buildings by 20% to 30% compared with the Vermont Commercial Energy Code (based on the IECC 2004 and ASHRAE 90.1–2004). Core performance requirements are most appropriate for new buildings and major renovations, but can be applied to smaller projects. This will need to be updated after the new Vermont commercial building energy standards are adopted.

Recommendation

Strengthen energy efficiency criteria by adopting uniform and transparent above-code standards that could be applied through Act 250 reviews. The DPS will facilitate the development of above-code guidelines for commercial building, such as the Core Performance Guide for commercial buildings, to be used to satisfy the Act 250 energy efficiency criteria.

[153] *10 V.S.A. § 6086.*

7.2.2.3 State Agency Energy Plan

State government consumes a significant amount of energy in its operations. Careful consideration regarding the resources consumed will benefit the state now and in the future. In considering the sustainability of the state's energy choices, we can better understand how these impact our climate, economic status, and operations. In 2010, the state completed a State Agency Energy Plan that outlines a vision of a modern state government that is more efficient and effective in its operations.[154] This vision will enable state government to set a good example for practical use of alternative energy for other large commercial and industrial users in the state. Integration of the ideas in the CEP with implementation of the State Agency Energy Plan will help to ensure that the state meets its goal of 5% continuous improvement across state energy use, as required by Act 40 of the 2011 Vermont General Assembly.

7.2.2.4 Vermont Fuel Efficiency Partnership/All-Fuels Efficiency Program

In 2008, the Vermont General Assembly established a Heating and Process Fuel Efficiency Program (aka the All-Fuels Efficiency Program) through Act 92 (30 V.S.A. § 235). In this Act, the DPS was directed to "solicit and monitor any combination of energy efficiency and conservation programs, measures, and compensation mechanisms to provide fuel efficiency services on a statewide basis for Vermont heating or process fuel consumers."

Act 92 specifies that the Heating and Process Fuel Efficiency Program shall include fuel efficiency services that:

- Produce whole building and process heat efficiency, regardless of the fuel type used.
- Facilitate appropriate fuel switching.
- Promote coordination, to the fullest practical extent, with electric efficiency programs, as well as with the state low-income Weatherization Program and any utility energy efficiency programs.

The Heating and Process Fuel Efficiency Program is funded through the Fuel Efficiency Fund. The Fuel Efficiency Fund received revenues from the sale of credits under the RGGI cap and trade program. The Vermont General Assembly later allocated the RGGI funds to be deposited into the Electric Efficiency Fund to be used by Efficiency Vermont for heating and process fuel programs and incentives.

The DPS held two stakeholder meetings to discuss the development of the All-Fuels Efficiency Program, which were attended by approximately 40 individuals representing fuel dealers, the state Weatherization Program, Efficiency Vermont, utilities, nonprofit organizations, and others in the energy field. Meeting participants were asked to identify existing resources and programs for all-fuels efficiency and gaps that currently exist in the services available. Participants were also asked to prioritize the existing gaps. The top priorities were:

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[154] *See: http://bgs.vermont.gov/sites/bgs/files/pdfs/BGS-VTStateEnergyPlan.pdf*

- Additional funding to expand weatherization services to low-income residents (including expanding eligibility beyond current income levels), lower-middle-income residents, and small businesses; offer additional funding options such as low-interest or no-interest loans.
- Workforce development (including training new professionals as energy auditors and installers, as well as training existing tradespeople) and standardization/certification.
- Coordination among all the existing and potential new programs and services, including one main organization that residents could go to for independent and accurate information, referrals to existing resources, etc.

Largely, these same priorities continue to require attention. Because of the limited funding available for all-fuels efficiency activities, the DPS significantly narrowed the scope of services in the RFP issued to select a contractor that would implement the All-Fuels Efficiency Program; the revised RFP focused on the low-income residential sector only. The DPS received four proposals from contractors to provide services under this program. The Vermont Fuel Efficiency Partnership (VFEP) was selected and awarded a contract to implement the program. A total of almost $2.8 million will be used by VFEP to provide audits, installation of efficiency measures such as insulation and heating system upgrades, outreach and education, and workforce training. A majority of the funds will be allocated either to weatherize multifamily homes for low-income Vermonters who are over the eligible income levels for the current Weatherization Program (60% of median income) but under 100% of median income, or to fund measures beyond the eligibility of the existing program.

The Vermont Fuel Efficiency Partnership (described further below) is a joint venture of the five regional weatherization assistance programs that deliver services for the state Weatherization Program. This partnership is designed to facilitate local engagement and integration of community resources in addressing priority energy efficiency needs. The partnership offers a comprehensive approach that includes coordination of weatherization services, community education and outreach, financing, and home performance monitoring and evaluation. The partnership also works with Efficiency Vermont, the Vermont Housing and Conservation Board (VHCB), and others.

7.2.2.5 Efficiency Vermont

Beginning in 2010, direct revenues from Vermont's participation in both the Forward Capacity Market and the Regional Greenhouse Gas Initiative have been allocated to Efficiency Vermont for the purpose of developing unregulated fuel energy efficiency services. Funding through 2011 totals approximately $8.7 million, and Efficiency Vermont has begun service delivery as described in the addendum to its annual plan filed with the Public Service Board in December 2009.[155] With somewhat limited resources relative to the magnitude of opportunities, Efficiency Vermont is targeting certain selected markets. In addition, Efficiency Vermont is

[155] http://efficiencyvermont.com/stella/filelib/EVT_AP10%20Addendum%20_FINAL%20.pdf

working to coordinate thermal efficiency activities seamlessly with activities funded through the electric energy efficiency charge.

Efficiency Vermont currently offers the following thermal efficiency services:[156]

- **Home Performance with Energy Star.** This program includes the delivery of thermal efficiency savings to residential customers through a network of certified contractors installing comprehensive home energy improvements. Efficiency Vermont provides contractor training, quality assurance, marketing assistance for contractors, and customer incentives.

- **Building Performance.** EVT provides incentives to assist owners of small businesses, residential rental properties, and mixed-use buildings in improving the energy efficiency, health and safety, and comfort of their buildings. The incentives are contingent upon energy audits and improvements being performed and completed by a participating Building Performance Institute–certified contractor.

- **Vermont Fuel Efficiency Partnership (VFEP).** EVT partners with the Central Vermont Community Action Council (CVCAC), the Weatherization Assistance Programs (WAP), the Vermont Housing and Conservation Board (VHCB), and the Vermont Housing Finance Agency (VHFA) to achieve deeper energy savings of at least 25% per project in qualifying multifamily residences statewide through collaborative approaches and enhanced efficiency services. Efficiency Vermont supports VFEP through a combination of funding for thermal measures and EEU funding for electrical measures.

- **Business New Construction.** This program offers both customized and prescriptive approaches to encourage and support energy-efficient design in commercial new construction projects.

- **Residential New Construction**. This offering provides incentives for Energy Star Homes and homes meeting an Energy Code Plus level. It also provides technical assistance and training.

- **Commercial Heating System Efficiency.** This program provides incentives to commercial customers for energy-efficient oil and propane boilers and furnaces in commercial buildings of up to 10,000 square feet. Incentives are based on the size of the equipment.

- **Dairy Farm Heat Recovery.** This offering provides incentives to assist dairy farms in installing heat recovery units that preheat fossil fuel hot water systems.

In addition to the above activities, EVT has also developed and maintains on its website a statewide network of certified private-sector contractors available to provide a wide range of energy efficiency services.

[156] *Excerpt from the 2011 Efficiency Vermont Annual Plan and EVT website at* www.efficiencyvermont.com .

7.2.2.6 Vermont's Weatherization Program

Vermont's Weatherization Program is administered by the Office of Economic Opportunity (OEO). The mission of the OEO's Weatherization Program is to reduce energy costs for low-income families, particularly for the elderly, people with disabilities, and children. This is achieved by improving the energy efficiency and comfort of their homes while ensuring their health and safety. Although the primary focus of the Weatherization Program is energy efficiency, its placement within the Office of Economic Opportunity speaks to the importance of the program with regard to reducing poverty among low-income Vermonters.

The Vermont Weatherization Program was started in 1976 in response to the nation's energy crisis. Funding was initially provided by the U.S. Department of Energy (DOE). This changed in 1990 when the state of Vermont established a permanent source of funding through the creation of the Vermont Weatherization Trust Fund (WTF), financed by a tax of 0.5% on all non-transportation fuels sold in the state (the gross receipts tax). On average, WTF resources account for approximately 80% of Weatherization Program funding. In 2009, the passing of the American Recovery and Reinvestment Act (ARRA) resulted in a one-time infusion into the program of approximately $16 million of weatherization funding. After the allocation of the large amount of ARRA funding, DOE raised its allowable job cost average to $6,500, which allows complete weatherization service to clients. Up until that point, DOE funds had been bolstered with state funds to allow comprehensive weatherization.[157]

As required under 33 V.S.A. § 2502, the Weatherization Program is operated consistent with DOE National Weatherization Program rules, with some specific exceptions for income and multifamily eligibility.

Vermont differs from many other states in that the Weatherization Program is administered by the state's anti-poverty agency. The OEO sub-grants the actual delivery of weatherization services to five community-based nonprofit agencies, four of which are community action agencies. This partnering of weatherization with poverty reduction social services allows for a seamless delivery system with limited redundancies. These nonprofits are able to ensure that clients are aware of the other programs they provide for low-income Vermonters, which often results in multiple services being provided to clients.

To participate in the program, households must meet income eligibility guidelines listed by the OEO—currently 200% of the federal poverty level or less (DOE guidelines) or 60% of the state's median income or less (WTF guidelines). Eligibility is determined at each regional Weatherization Program Office.

Both DOE and WTF weatherization projects have an average budget of $6,500 per unit to provide comprehensive energy retrofits. This allows for the installation of virtually all cost-effective energy-saving measures at a home as well as the ability to address and correct any related health and safety issues.

Services provided to clients include:

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[157] *Information provided by Geoff Wilcox of the Office of Economic Opportunity.*

- Comprehensive "whole-house" assessment of energy-related problems.
- Testing of every combustion appliance to ensure safe draft and carbon monoxide levels. All issues are identified at the energy audit and then addressed.
- Evaluation of home for moisture problems as well as other health and safety issues.
- Worst-case draft testing to ensure the client's home will not encounter back-drafting or combustion issues once the home is tightened.
- Auditing of the home for electric savings.

Quality control assurance is an integral part of the Weatherization Program and a major reason for its success. A quality control inspection is done at the agency level on every job prior to closure. At the state level, OEO's weatherization technician completes a rigorous review of 10% of all jobs submitted by the agency. All inspections include an infrared scan and blower door test. All work is evaluated to ensure effectiveness and quality workmanship. If there are quality-related problems on a job, the agency is directed to remediate the problem. (Vermont is fortunate to have WTF resources, because federal funds cannot be used to go back and remediate a substandard weatherization job.)

Vermont's Weatherization Program currently serves approximately 1,700 units per year (see Exhibit 7-2). The OEO works as a partner with Efficiency Vermont, Vermont Gas, and the Burlington Electric Department to provide efficiency services to these homes. Every dollar spent on efficiency implementation in these homes has returned greater benefits to customers. In 2005, for example, the return on each $1.00 was $1.98.[158] For the housing units treated in the 2005 program year, the cost/benefit ratio of 1.53 was based on the energy savings benefits alone, and was much greater once health and safety measures were included.[159]

[158] *OEO will commission an in-depth benefit analysis during the course of the state fiscal year 2012 to update this 2005 data.*

[159] *Geoff Wilcox, Office of Economic Opportunity.*

Exhibit 7-2. Funding Sources for and Number of Housing Units Served by Vermont's Weatherization Program, 2006–11

YEAR	DOE	WTF	ARRA	TOTAL	No. Units
2006-07	$1,227,269	$5,464,119		$ 6,691,388	1402
2007-08	$1,065,077	$5,686,763		$ 6,751,840	1427
2008-09	$1,210,986	$6,544,229		$ 7,755,215	1570
2009-10	$1,700,892	$3,565,311	$4,203,134	$ 9,469,337	1832
2010-11	$ 930,633	$3,581,418	$6,896,669	$11,408,720	1722

Source: Geoff Wilcox, Office of Economic Opportunity

The Weatherization Program has successfully been providing thorough and cost-effective weatherization services to low-income Vermonters for many years. However, tens of thousands of qualifying homes continue to wait in a queue to receive services. Increased funding could allow for increased program reach and also reduce the demand on the Low-Income Home Energy Assistance Program (LIHEAP).

Recommendations

(1) *Analyze and complete recommendations for additional exceptions to the U.S. DOE rules for the State Weatherization Trust Fund. The Policy Advisory Committee (PAC) formed by OEO should, at a minimum, discuss potential exceptions to the DOE rules on not providing any weatherization services for homes that have received services since September 1994 and per-unit funding limits. Recommendations should be submitted to the appropriate committees in the Vermont Legislature for consideration.*

(2) *Utilize the PAC to provide recommendations on policy involving issues such as adding vermiculite insulation in clients' homes; standardizing the multifamily home weatherization approach; and updating program policies, procedures, and standards where necessary.*

(3) *Consider allocating a portion of any additional thermal efficiency funding to the Weatherization Program.*

7.2.2.7 Vermont Gas Systems Residential and Commercial Energy Efficiency Programs

Vermont Gas Systems (VGS) provides natural gas service to more than 40,000 customers in northwestern Vermont.[160] VGS offers both residential and commercial energy efficiency programs for new and existing buildings.

VGS has residential energy efficiency programs for both existing homes and new construction. The Residential Retrofit Program focuses on larger users (homes that use at least 0.6 Ccf [hundred cubic feet] of natural gas per square foot per year) and provides free energy audits, rebates for approximately 33% of the installed costs of the recommended measures, and a zero-interest or low-interest loan for the remaining costs. When going forward with projects, customers have the choice to have VGS screen and assign a contractor to do the work or to obtain bids themselves (VGS provides the specifications needed for contractor bidding with the energy audit). VGS also offers an equipment replacement program with rebates for hot air furnaces, hot water boilers, and water heaters. The VGS residential new construction program provides technical assistance and incentives for building homes to the Energy Star home standard.

For commercial customers, VGS also provides services for both existing buildings and new construction. For existing buildings, VGS offers an equipment replacement and retrofit program. VGS conducts free energy audits, offers zero-interest or low-interest loans for energy efficiency improvements, and offers rebates for certain equipment. For new construction, VGS provides technical assistance, including reviews of building plans and energy-efficient equipment information. It also offers financial incentives in certain instances.

Public Service Board Docket 7676, consistent with 30 V.S.A. § 209(d)(4), will consider the development of one or more natural gas energy efficiency utilities for an Order of Appointment similar to the process developed for electric EEUs (Docket 7466). As with the process in Docket 7466 and subject to Public Service Board processes, the DPS expects a presumption that the incumbent efficiency provider, Vermont Gas Systems, will be provided an Order of Appointment. The DPS will work with participants to Docket 7676 to develop short- and long-term efficiency budgets and targets, and a process for rigorous, independent verification of savings claims. The building and equipment market assessments in the residential and commercial sectors currently being conducted by the DPS (and completed every three years) will have Vermont Gas–specific data, which will aid in this process. Ultimately, the appointed natural gas efficiency provider should continue to appropriately coordinate efficiency programs with Efficiency Vermont and other providers and stakeholders as may be recommended by the task force discussed under Section 7.2.1.1—A Whole-Building Approach.

[160] www.vermontgas.com

Recommendation

Work with participants involved in Docket 7676 to complete a natural gas energy efficiency utility potential evaluation. DPS will propose to the Public Service Board budgets and targets to acquire all reasonably available efficiency resources that are cost-effective.

7.2.2.8 School Energy Management Program

The Vermont School Energy Management Program (SEMP) has been assisting schools with the identification and implementation of cost-effective energy efficiency measures since 1993. Prior to the creation of this program, the Department of Public Service (DPS) operated the U.S. Department of Energy–funded Institutional Conservation Program (ICP), which provided funding to schools for energy engineering studies and implementation of measures. When the DOE discontinued the ICP, the DPS assisted with the development of SEMP to be housed at the Vermont Superintendents Association. The DPS has provided funding support since SEMP's inception.

Vermont's public schools consist of more than 17 million square feet of building space (most of the schools were built prior to 1975), and they consume approximately 1.3 billion Btu of energy at a cost of more than $30 million a year.[161]

SEMP provides the following services to schools:

- Energy audits to ascertain appropriate energy efficiency measures to implement.
- Facility operating training.
- Technical assistance on renewable energy opportunities.
- Support to the 47 schools that now utilize biomass systems.
- Assistance on utility service quality, voltage concerns, and utility billing discrepancies.
- Assistance to Vermont Energy Education Program in curriculum efforts in schools.

In the past five years, SEMP has completed almost 300 energy audits for schools and has provided consultation and training for facility managers, principals, and other school personnel.[162]

[161] *School Energy Management Program, program summary and comments submitted for the Comprehensive Energy Plan, July 8, 2011.*

[162] *School Energy Management Program, program summary and comments submitted for the Comprehensive Energy Plan, July 8, 2011.*

Recommendations

(1) *Create a process for statewide monitoring of energy use in public school buildings through a partnership of SEMP, Efficiency Vermont, the DPS, and the Department of Education to establish a baseline for use and to track progress on building efficiency improvements.*

(2) *Work with the Vermont Congressional delegation to secure additional federal funding support for the Energy Efficiency and Conservation Block Grant Program, which has provided grants to 128 Vermont schools and municipalities to complete a variety of energy projects including energy efficiency retrofits (utilizing ARRA funding).*

(3) *Investigate the options for providing long-term consistent funding for the School Energy Management Program.*

(4) *Investigate lifting the suspension on school construction aid for alternative energy projects, leaving in place the requirement that alternative energy projects meet cost-effectiveness standards.*

8 Thermal Energy Supply

Meeting the thermal energy needs of Vermonters over the next 20 years presents a wide variety of issues, challenges, and opportunities. The discussion in this section includes an analysis of the current and potential sources for thermal energy, including solar thermal, geothermal, biomass energy, biofuels, natural gas, propane, and distillates. The section also considers challenges and recommended actions for policy, finance, education and outreach, and innovation as it applies to thermal energy to help advance Vermont toward its energy goals.

8.1 Solar Thermal

Although Vermont's weather limits the amount of solar energy available in comparison with sunnier locations, there is enough sunlight to warrant an increased emphasis on this renewable energy for thermal purposes.

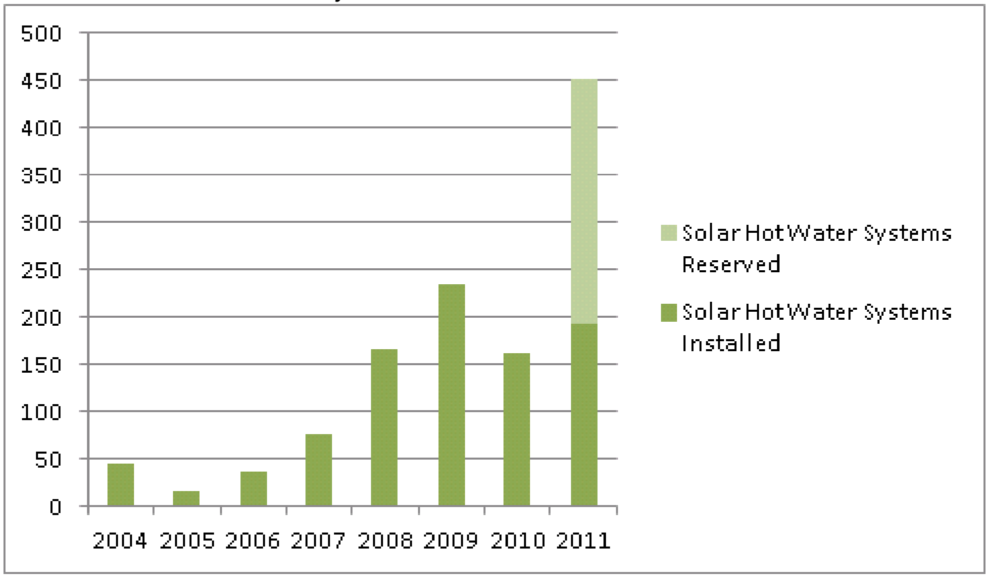
The sun's warmth and light can be captured passively though south-facing windows in our homes and businesses. Architecture that emphasizes southern exposure can help provide light and warmth. In addition to passive collection of sunlight, active collection is possible. Active systems use solar energy collectors, pumps, and heat exchangers to maximize the capture and use of solar thermal energy.

At Vermont's northern latitude, most of its annual sunlight is available in the summer, when space heating is not required but heat for water is still needed. Thus, solar energy generation in Vermont is best suited for heating domestic hot water with an active solar hot water system. A properly sited and designed solar hot water system in Vermont typically supplies 60% to 70% of the annual thermal energy needed for domestic hot water usage. Such a system can provide a reasonable rate of return[163] on the dollar investment of the solar hot water system by reducing the amount of heating fuel or electricity needed. Solar hot water systems use relatively simple technology, and the equipment could easily be manufactured or assembled in Vermont. In fact, one company, Sunward, is already assembling solar hot water systems in Vermont.

The Vermont Small Scale Renewable Energy Program has provided incentives for solar hot water systems since 2004. Even before the end of 2011, Vermont had experienced almost a 300% increase in solar thermal installations between 2010 and 2011.

[163] *John Richter, "Financial Analysis of Residential PV and Solar Water Heating Systems," 2009.*

Exhibit 8-1. Solar Thermal Systems, Vermont, 2004–11



Source: Vermont Small Scale Renewable Energy Program

8.1.1 Solar Space Heating

Given the low amount of usable sunlight in the winter when space heating needs are greatest, solar energy may not be able to contribute a significant amount toward meeting Vermont's space heating needs, although better utilization is warranted. There are some applications in which solar heating could be recommended if the systems, and particularly the heat storage components, are designed well. With improvements to thermal storage technologies, solar space heating could become more prevalent in Vermont. Active solar air heating systems can be a simple application of solar energy, because they have no storage mechanism or interconnection to other systems and can provide heat without the heat loss properties of windows. Solar air heating systems can be used either for supplemental space heating or for preheating ventilation air. However, solar air heating systems do require space on the southern side of buildings where there is often a greater desire for windows.

Recommendations

(1) *Continue rebate program for solar thermal systems.*

(2) *Create a financing system that could include the electric utilities and Vermont Gas, such as on-bill payment.*

(3) *Ensure that all new state buildings include passive solar principles in their siting and design.*

(4) *Ensure that all new state buildings that have a substantial demand for hot water include solar hot water heating systems. At a minimum, they should be built solar thermal ready so that a solar hot water system can easily be added later.*

8.2 Heat Pumps

Heat pumps use refrigeration cycles (similar to those used in air conditioners or refrigerators) to move heat from outside a building to the inside. Ground source heat pumps move heat from shallow surface rocks; air source heat pumps move heat from the ambient air outside. In both cases, the ultimate source of the heat is the warmth of the sun. Although there has been significant improvement in the cold-weather performance of air source heat pumps, ground source heat pumps (GSHPs) may be more appropriate for Vermont.

GSHPs are often referred to as geothermal energy systems. However, this name can be confusing. Geothermal energy comes from the heat emanating from the molten core of our planet; GSHPs, in contrast, use solar heat stored in the earth. In other parts of the world, geothermal heat is accessible and can be used directly for thermal applications, such as heating, or used to produce electricity. Vermont's (as well as the surrounding region's) geological structure is such that we do not have easy access to geothermal energy.[164]

GSHP technology should be an increasing part of our energy mix. Well-designed heat pump systems can be highly efficient. Heat pumps use the efficient energy transfer properties of certain gases when placed under pressure. The energy released when the gas changes form can be used for either heating or cooling/air conditioning. Because they are more energy-efficient, the CEP focuses only on GSHPs, but that is not to say that efficient air-to-air sourced heat pumps should not be used in some applications.

The most efficient use for heat pump technology is air conditioning, but it can also be used for heating. However, retrofitting existing houses with a ground source system can sometimes be a challenge. This challenge is greatly reduced where there is a relatively deep or high-performance water well on the property. Nearly 50,000 such wells are identified in the geothermal section of the Vermont Energy Atlas,[165] signifying great potential for geothermal systems across the state.

A significant barrier to widespread support and deployment of GSHPs in Vermont is the lack of agreed-upon installation standards and best practices that would help to ensure that the most efficient types of GSHPs are installed.

[164] *The potential for deeper geothermal resources in Vermont is unknown at this time; many commenters in this process suggested that Vermont make greater efforts to access geothermal resources. Some proponents believe that new drilling technologies could allow us to access this deeper geothermal energy; however, this is not an energy source that we expect will be able to cost-effectively meet any significant demand in the near future.*

[165] www.vtenergyatlas.com

Recommendations

(1) *Provide rebates through the Vermont Small Scale Renewable Energy Program through the Clean Energy Development Fund for efficient ground source heat pumps.*

(2) *Create Vermont-specific GSHP installation standards and best practices though a stakeholder process.*

(3) *Include ground source heat pumps as a technology eligible for PACE financing systems and any on-bill financing or payment programs implemented by the utilities.*

(4) *Support research on Vermont's potential geothermal resource to prepare for technological advances in the search for subsurface regimes that support economical heat recovery.*

8.3 Biomass for Thermal Energy

(See Section 5.8.1—Biomass for an introduction to biomass.)

Woody and agricultural biomass has the potential to play an increased role in meeting the thermal and electric energy needs of the state. This section of the CEP covers aspects of woody and agricultural biomass use for thermal energy. The following sections identify uses of biomass for heat, projections, potential sources of biomass, and challenges associated with developing thermal supplies. The section closes with descriptions of some ways that policymakers can help Vermonters use biomass in recognition of the forest and agriculture values of Vermont's working landscape.

8.3.1 Current Solid Biomass Use for Thermal Energy

Wood is a relatively low-cost source of thermal energy in Vermont. Wood heats dozens of commercial, industrial, and government facilities in the state, including three colleges, one hospital, state office complexes, 43 schools, and multiple businesses, along with thousands of households.[166] Although the price per unit is increasing at about the rate of inflation, the cost of wood is projected to remain significantly less expensive than other heating fuels into the future, and its pricing has been more stable through times of fossil fuel volatility. Wood chips used by schools and institutions have been even more stable, increasing in price at less than the rate of inflation. As efficiencies for wood-fired furnaces, boilers, and stoves increase, the annual fuel costs for the user are expected to decrease.

[166] *Estimated Wood Fuel Usage in the State of Vermont (hereafter, EWFU), Agency of Natural Resources, 2009.*

8.3.1.1 Residential Use

Vermont households burned an estimated 314,000 cords (~785,000 tons) of wood in 2007–08. This represented an increase of about 64,000 cords over the amount used during the 1997–98 season. In 2007–08, about 32% of Vermont households burned wood for at least some space heating, a 15% increase from the 1997–98 survey. Those using wood for primary heating consumed about 5.4 cords in 2007–08, while those using wood as a supplementary source used 2.25 cords. In that same year, Vermont households burned about 20,155 tons of wood pellets, with primary-heat-source consumers burning 3.8 tons and supplementary-heat-source consumers burning 1.2 tons for the season.[167] Combining cordwood with the 40,000 green tons needed to make pellets for residential heating required about 825,000 tons of wood. All uses of wood for fuel in 2009 totaled 1.5 million tons.[168] According to the Energy Information Administration (EIA), residential wood consumption gradually declined after 1979 but picked up again in 2005.[169] (See Exhibit 8-2.) Although EIA data shows lower residential wood use than Vermont figures, the numbers reflect peaks and valleys that generally correspond with fossil fuel price increases.

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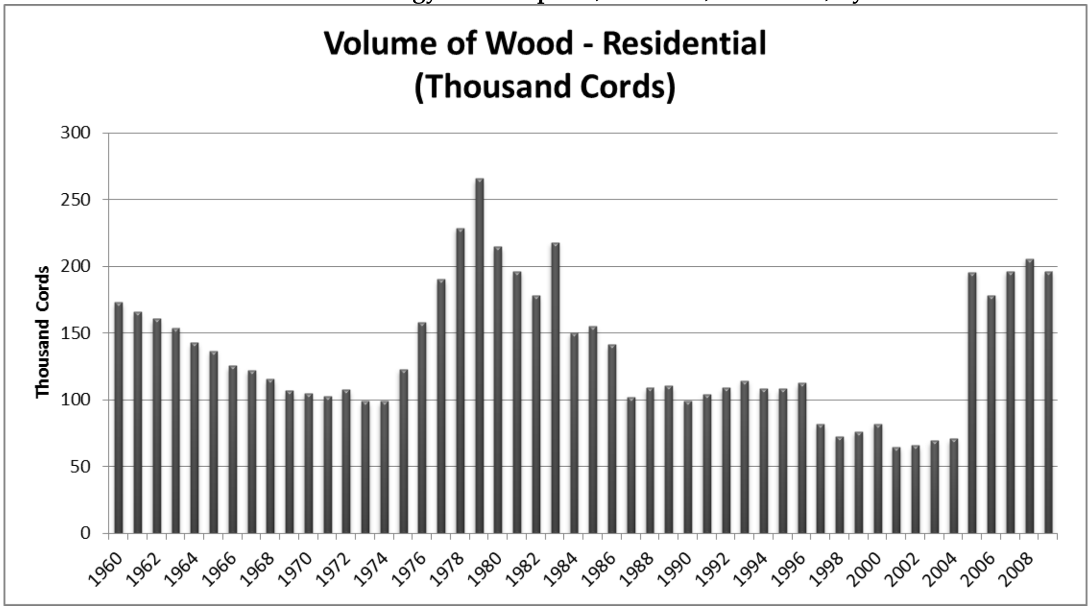
[167] *Vermont Residential Fuel Assessment for the 2007-2008 Heating Season (hereafter, VRFA), Paul Frederick, Vermont Department of Forests, Parks, and Recreation, August 2011, p. 2.*

[168] *EWFU, 2009.*

[169] *EIA State Energy Data System,* http://www.eia.gov/state/seds/sep_use/total/csv/use_VT.csv *Note: the EIA figures underestimate the volume of cordwood used in Vermont, as shown by recent surveys conducted by ANR.*

Exhibit 8-2. Residential Wood Energy Consumption, Vermont, 1960–2009, by Volume of Wood



Source: EIA

According to the Vermont DPS 2005 Appliance Saturation Survey, a survey of Vermont residents who pay for their own heat, 11% use wood or natural gas as their primary heating source. Of the respondents to the survey, 50% indicated that they use at least one form of supplemental heat in their homes, 24% have supplemental stoves fired by either wood or coal, and 13% have wood-burning fireplaces.[170] There is great potential for the utilization of more wood resources as cleaner, more efficient wood-burning appliances are installed in more homes and businesses, and with the development of district heating in communities. Home heating with firewood is not for everyone, however, as there can be a substantial amount of work associated with wood heat. If homeowners wish to supply their own firewood, they must have adequate land on which to cut the wood or access to local suppliers. Storage space is required for those who want to heat with wood, regardless of whether they cut the wood themselves or purchase bulk pellets. For those with chronic respiratory conditions, wood burning may not be an option.

Instead of firewood, homes can be heated with pellets made from biomass. During the 2007–08 heating season, 6,987 households (2.8%) burned at least some wood pellets for space heating.[171] Wood pellet stoves are increasingly popular because of their cleaner emissions, higher efficiencies, and greater ease of operation—

[170] *Final Report Phase II Evaluation of the Efficiency Vermont Residential Programs, Vermont Department of Public Service, 2005. Pp. 3-4 and 3-8.* http://publicservice.vermont.gov/pub/other/vtres%20.pdf

[171] *VFRA, p. 2.*

including the advantage of operating on thermostats, much like oil, gas, and propane systems.[172] Sales of pellet-burning appliances nationwide grew from 18,360 in 1999 to 141,208 in 2008, followed by a drop-off to 44,269 in 2010.[173] In Vermont, 8,900 households that did not already own an appliance either had installed or were planning to install a new wood or pellet stove in 2008.[174] Advances in fuel delivery capabilities and services that mimic the ease of use of fuel oil and propane increase the prospects for pellet use in the state.

At $257 per ton of wood pellets, the cost to heat with a pellet stove in September 2010 was $19.59 per MMBtu (million British thermal units)—less than that of every other fuel except cordwood. Cordwood cost $14.39 per MMBtu, while fuel oil cost $24.39/MMBtu and natural gas cost $19.75/MMBtu.[175] (See Exhibit 8-3.) One ton of pellets provides roughly the equivalent of 120 gallons of fuel oil and one cord of wood yields about the equivalent of 150 gallons.

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[172] *While wood pellets are the dominant fuel used for pellet stoves, research and development into densified grass (e.g., grass pellets, briquettes) and other agricultural biomass (e.g., corn) continues in Vermont, and these fuels are beginning to become available.*

[173] *Hearth Industry Unit Shipments, Pellet Fuels Institute, http://pelletheat.org/wp-content/uploads/2010/01/Hearth20Shipments202010.pdf*

[174] *VFRA, p. 10.*

[175] *Vermont Fuel Price Report, September 2010, http://publicservice.vermont.gov/pub/vt-fuel-price-report.html*

Exhibit 8-3. Vermont Fuel Prices

Year (September Each Year)	Cordwood, Green ($/MMBtu)	Wood Pellets, Ton ($/MMBtu)	Fuel Oil, Gallon ($/MMBtu)	Propane, Gallon ($/MMBtu)	Natural Gas, Therm ($/MMBtu)
2005	12.88	16.01	23.77	29.33	14.88
2006	12.88	16.01	23.64	32.26	17.00
2007	13.64	19.59	23.19	32.16	21.38
2008	14.39	19.59	37.39	44.67	21.38
2009	14.39	19.59	21.70	33.16	20.00
2010	14.39	19.59	24.39	36.00	19.75

Note: Cordwood=22 MMBtu/cord; pellets=16.4 MMBtu/ton. Source: Vermont Fuel Price Report

Source: Vermont Fuel Price Report (2005–10)

8.3.1.1.1 Reduction of Residential Wood Combustion Emissions

Some Vermonters are switching from fossil fuel systems to biomass systems using pellet stoves, wood furnaces, or other wood systems in part because of their desire to save costs, but also in order to help reduce dependence on foreign sources of fuel. However, when consumers switch from oil or gas to wood pellet or EPA-certified stoves, higher localized air emissions may result. In many locations, woodstoves and fireplaces form the largest source of particulate matter air pollution.[176]

Many advances have been made to improve the efficiency and reduce the emissions of residential stoves and furnaces. However, the EPA estimates that between 70% and 80% of woodstoves in use in the United States are older and inefficient. Like the rest of the U.S. population, many Vermonters continue to use older, inefficient, polluting stoves that have higher life-cycle costs and cause greater environmental harm than EPA-certified models. For example, the relative emissions of fine particles from uncertified stoves that many people use are 4.6 lb/MMBtu of heat output, whereas from newer EPA-certified stoves they are 1.4 lb/MMBtu of heat output and for pellet stoves they are 0.49 lb/MMBtu of heat output. Higher-efficiency stoves reduce wood consumed per woodstove, decrease emissions by at least 70%, and can displace other fuel sources such as oil, gas, and

[176] *Wood Facts, Air Quality Division, Department of Environmental Conservation, ANR.* www.anr.state.vt.us/air/htm/woodfacts.htm

propane.[177] The health benefits associated with reducing fine particle emissions, including wood smoke, are significant. If all the old woodstoves in the U.S. were changed out to cleaner-burning hearth appliances, the EPA estimates that at least $35 billion in health benefits per year could be realized.[178]

The DPS; the Department of Forests, Parks, and Recreation; the Department of Environmental Conservation (DEC); and the EPA cosponsored, with woodstove dealers and the Hearth Products Association, a woodstove change-out program that provided discounts toward the purchase of a new stove. The DEC Air Pollution Control Division implemented this program and did all the processing of rebate forms. The EPA is supporting three new woodstove change-out pilot programs in various parts of the country, providing rebates and incentives for customers, but none in Vermont. The DPS recommends revisiting change-out programs for old woodstoves to see if it is possible to reinstitute the program in light of the multiple efficiency and health benefits gained from upgrading.

In 2009, Vermont took measures to reduce pollution from outdoor wood boilers, a prime source of such pollution, via the Outdoor Wood-Fired Boiler Change-Out program (10 V.S.A. § 584). Older boilers sold in Vermont before March 31, 2008, create significant amounts of smoke, whereas current models emit 70% to 90% less pollution. According to the Vermont Agency of Natural Resources, many older units must be retired before December 31, 2012. The Department of Environmental Conservation currently offers incentives to help owners of such units purchase cleaner, more efficient boilers that comply with air quality standards.[179]

Given the potential for increased air pollution from certain biomass units, it is important for policymakers to keep local air quality concerns in mind when encouraging the substitution of wood for fuels like oil and propane gas. Some of the most efficient methods of using heat and options for future wood utilization are discussed below.

8.3.1.2 Commercial Use

Although wood heats dozens of commercial, industrial, and government facilities, the following sections focus on the use of wood in two areas: district heating and schools.

8.3.1.2.1 District Heating

District energy systems, which provide heat from a central source to a number of buildings, can result in significant efficiencies in heating (and cooling). These systems are widely used in Europe. The DPS has been

[177] *U.S. EPA Burn Wise,* www.epa.gov/burnwise/energyefficiency.html

[178] *Strategies for Reducing Residential Wood Smoke, EPA Document # EPA-456/B-09-001.October 29, 2009, p. 5,* *www.epa.gov/ttn/oarpg/t1/memoranda/strategies-doc-8-11-09.pdf*

[179] *Vermont Outdoor Wood Boiler Change-Out Program,* www.anr.state.vt.us/air/htm/OWBChangeOutProgram.htm

exploring the use of new, highly efficient biomass combustion technologies as a primary energy source for district energy. The state has two biomass district energy systems already in place, in the Capitol complex in Montpelier and the state office complex in Waterbury. Several colleges in the state use wood in a district system, connecting several buildings to one boiler.

Leaders in Montpelier are working to expand the system to include a portion of downtown Montpelier. The city received an $8 million grant from the Department of Energy, $7 million from the state of Vermont's capital budget, $1.2 million from the Department of Buildings and General Services, $1 million from the CEDF, and a $750,000 low-interest CEDF loan to work with the state of Vermont on the construction of a district energy plant. According to the Capital District Master Plan from 2000, an expanded district heating system in Montpelier could lead to an increase of $1.2 million of income in central Vermont with an increase in tax revenues of more than $200,000 (both in 1999 dollars). The city would save more than 100,000 gallons of heating oil per year, and at full expansion with inclusion of private buildings downtown could save an additional 500,000 gallons of oil per year. Residents approved a $2.75 million bond to fund the balance of the project that is currently moving forward.[180]

District energy systems not only have the capacity to install state-of-the-art technology in a central boiler but can eliminate the multiple sources of air pollution from individual fossil fuel–based and wood-based boilers, furnaces, and stoves. At least five other Vermont communities are considering some form of wood-heated district energy—including Brattleboro, Burlington (connecting to the McNeil plant), Middlebury, Randolph, and Lyndonville. District energy systems would displace individual points of emissions and enable better control of combustion at reduced prices.

8.3.1.2.2 Biomass Use in Schools

The Fuels for Schools program is a successful partnership made up of the Vermont Superintendents Association's School Energy Management Program, the Biomass Energy Resource Center (BERC), and the Agency of Natural Resources. The partnership promotes the development of biomass heating systems in schools. Forty-three of the 327 Vermont schools (13%, representing 30% of Vermont's K-12 public school children) heat with efficient wood-chip systems. Four others heat with wood pellets. Schools and other state institutions represent a significant market for new wood heating systems and have the potential to provide a stable source of wood fuel demand in the future. For the 2009–10 heating season, Vermont Fuels for Schools reports the use of 23,271 tons of wood chips used in Vermont schools, representing 1.43 million gallons of fuel oil saved and 15,650 tons of fossil fuel CO_2 avoided. This shift to biomass represents more than $1.7 million in savings in comparison with having derived all this energy from fossil fuels.[181]

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[180] *City of Montpelier District Energy Project,* www.montpelier-vt.org/community/99.html

[181] *Vermont Fuels for Schools Wood Fuel Survey Results, 2009–10 Heating Season, School Energy Management Program,* www.vtvsa.org/files/handout%20final.pdf

As with all biomass systems, although the cost to fuel and operate the systems presents significant cost savings over oil, the initial system costs are high, requiring capital that may be available only sporadically, if at all.

8.3.2 Biomass Availability for Thermal Energy Use

Projections of potential wood fuel availability are blind to end use for energy production. Given the largely unregulated market, it can be expected that, in general, prices paid for wood will play a dominant role in determining how much wood goes to the different energy uses. However, certain incentives at the federal level affect decisions about where to send processed biomass. For example, energy markets are influenced by federal incentives such as the 30% energy investment tax credit or production tax credits, as well as RPS incentives in other states that are available to Vermont electric generators. Such incentives do not exist for commercial thermal users, who make decisions about fuels based on market prices for alternatives to wood such as fuel oil and other factors such as convenience. Any projected or desired uses of biomass for thermal energy must account for existing incentives that may impede progress.

The CEP encourages increased thermal use of wood fuel, including densified fuels (e.g., wood or agricultural crop pellets) and school, district, or community energy systems (e.g., those using wood chips) as well as combined heat and power systems discussed in 5.8.1.1—Current Wood-Fired Electricity Generation. This priority was determined because we recognize the higher efficiency of using natural resources in space heating technologies, the higher value of displacing imported oil and propane, the need for adequate management of the air quality effects of combustion, the lack of any energy supply assurance infrastructure for space heating, and the economic benefits for rural areas associated with wood harvesting and fuel production.

Act 47 of 2011 (30 V.S.A. § 209(d)(7) and (8)) mandated that Efficiency Vermont be authorized to offer incentives for installation of woody biomass heating systems in a manner that promotes deployment of such systems. If coupled with additional incentives from the Vermont Small Scale Renewable Energy Program for biomass equipment, these initiatives have the potential to drive increased use of biomass in the state.

Devoting the entire 900,000,000 tons or so of net available low-grade wood (NALG) in the state each year to space heating would double the current use of wood heat and meet 30% of Vermont's total space heating needs. About 28% of energy used in the state is used for space heating. Solid biomass contributes about 4% of the state's total, and 14% of space heating energy. Using the estimated 314,000 cords (~785,000 green tons) of wood harvested in 2008 as a baseline, adding an additional 900,000 green tons would meet about one-third of the space heating needs in the state. Coupling residential energy retrofits that create an efficient home envelope with the use of fuel derived from local resources would move Vermont toward optimal energy usage and minimize impact on wood biomass supplies. Encouraging agricultural biomass innovations that take advantage of crop regeneration would also help.

As the state transitions toward electric vehicles and greater electric demand, the question of ultimate system efficiency emerges as one of paramount importance for any proposed scenario. The state would benefit from a robust analysis of the potential system efficiencies of competing uses for power—biomass in particular—that will be required to energize our economy in the future.

8.3.3 Potential Expanded and New Solid Biomass Thermal Sources and Uses

8.3.3.1 Wood

The residential sector offers potential for increased woody biomass use in the form of replacing home oil heating systems with wood pellet stoves, furnaces, and boilers. The spike in the price of heating oil in 2008 prompted a rush toward wood pellets, which abated when oil prices dropped. Pellet systems remain viable options for many residential and small commercial applications. Wood pellet manufacturing would also provide an efficient year-round market for woody and potentially agricultural biomass, but it is difficult to determine the appropriate number of new pellet plants given the "chicken or egg" situation with the market.[182]

The experience of Vermont's one wood pellet manufacturer, in Clarendon,[183] indicates that a demand of 10,000–20,000 tons per year of pellets (20,000–40,000 green tons) could be repeated by similar manufacturers in other parts of the state such that the transport of wood would be minimized yet the economies of scale would be sufficient to produce pellets locally and competitively. A recent feasibility study by BERC under the Vermont Sustainable Heating Initiative identified potential for developing a small pellet manufacturing facility (~19,000–78,000 dry tons per year) in Chittenden County to help meet some of the growing demand using local resources. Such a facility would require between 39,000 and 156,000 green tons per year.[184]

Only a small share of North American homes use wood as their primary heating source. Because many homes heat with other systems that could be converted to pellet systems, some analysts believe that there is a positive outlook for expansion of demand. The delivery of pellets in bags is also likely holding back the penetration of pellets into the market. Bulk delivery and automatic feed into boilers and furnaces, used extensively in Europe and beginning to develop here, would make the use of pellets much more equivalent to a homeowner's experience with oil. This step requires investment by pellet fuel dealers, who are reluctant to invest in trucks without established demand. As a result of these factors, the potential to heat homes with pellets has not been fully exploited.[185]

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[182] *Biomass Energy Development Working Group, 2011 Interim Report, January 9, 2011, p. 13.*

[183] *Vermont Wood Pellet Company LLC, www.vermontwoodpellet.com.*

[184] *A Feasibility Study of Pellet Manufacturing in Chittenden County, Vermont, Biomass Energy Resource Center, August 2011, p. 4.*

[185] *North America's Wood Pellet Sector, Henry Spelter and Daniel Toth. USDA Forest Service Forest Products Laboratory Research Paper FPL-RP-656, August 2009, p. 8.*

With respect to residential cordwood, approximately 785,000 tons per year are currently used in the state, and we expect this to remain part of the energy mix. With improved woodstove efficiencies and conversion to newer units, that tonnage will heat more homes in the future.

Pellets, wood chips, and cordwood combustion each have pros and cons. For example, cordwood may cost least to heat a home but may be burned in an old, inefficient stove that contributes substantial air pollution to the environment. Pellets, which burn cleaner and are easier to handle, require extra electricity for the stove as well as processing to form the pellets. Chips provide ease of use but require specialized machinery.

8.3.3.2 Agricultural Crops

Agricultural products for thermal energy use, including grass, are being explored and have the potential to make productive use of fallow lands while providing a renewable fuel for displacement of fossil fuels. Grass may also offer water quality buffer benefits, given its growth and harvesting patterns.

Grass as a thermal fuel is well established in European markets, but it is still an emerging technology in the United States. Grass grows well in Vermont, and infrastructure and agricultural equipment exist for grass energy production.[186] With yields ranging from 1.5 to 3.5 tons per acre, Vermont is in a good position to reduce an additional portion of its dependence on foreign oil by developing grass energy production and processing capabilities. Each ton of crop biomass fuel can displace about 100 gallons of heating oil. Under current projections, by 2025, grass biomass energy has the potential to meet nearly 2% of the state's total energy demand, replacing about 3.2 trillion Btu of fossil fuels annually. Grass can also be mixed with wood fiber to create a blended fuel pellet.

Vermont possesses good soils and infrastructure to grow perennial grasses, but in order to successfully produce and use high-yielding biomass crops such as switchgrass, miscanthus, big bluestem, and other grass and hay crops, farmers need agronomic data that is specific to Vermont. The process of using 100% grass as a heating fuel in U.S.-made combustion systems is in its early stages; more research is needed to address logistics, densification, and combustion in order to fully build the grass heating fuel market.

Marginal lands and unused acreage on home lots are good sites for perennial grass production or for harvesting native biomass that won't compete with food production. Hay that has lost its feed value can be an additional source of biomass fuel for energy production, which translates to new markets being created for low-grade material. Land assessment is needed to determine the actual amount of acreage potentially available. Current estimates vary from 30,000 to more than 100,000 acres of suitable land that could yield from 90,000 to more than 300,000 dry tons of grass biomass fuel annually. However, there are competing uses for land and grass resources. The cost of production for hay also raises questions—specifically, can farmers net a profit growing hay for combustion that is priced competitively with wood?

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[186] *Vermont 25 x '25 Initiative Preliminary Findings and Goals. Spring Hill Solutions, 2008,* www.vermontagriculture.com/energy/index.html

The development of grass energy faces many challenges. Because of the chemistry of burning grass—which is acidic and high in silicates—grass fuels may be better suited for larger systems at an industrial or community scale. Some smaller stoves and boilers have been shown to burn grass effectively, but additional research and development is needed. Some of the models on the market designed to burn corn—another source of thermal energy in the state—have also been used by some to burn grass (and commenters in the CEP planning process advocated for their expanded use). Typically, wood pellet systems do not efficiently combust pure grass fuels; this is a function of the equipment and its intended use, and not the fuel itself.[187] Other challenges include the high volume-to-weight ratio of the raw material (which creates some transportation and material handling challenges); the current cost (grass burning is currently more expensive than burning wood chips, although it is about the same price as wood pellets); and availability (currently only one commercial-scale grass pelletizer exists in Vermont). Ongoing efforts of the Vermont Grass Energy Partnership are identifying key elements to successful deployment of grass energy strategies. These activities are in their early stages. If they are to achieve their promise in fulfilling the identified portion of the state's energy demand, continued financial and technical support is needed. Agricultural biomass for thermal uses offers potential that warrants continued exploration by the state.

8.3.4 Further Development of Solid Biomass for Thermal Energy

One advantage of thermal applications is that they can work at a scale that matches the ability of local harvesting to meet demand. The fact that thermal applications also tend to displace more expensive fossil fuels provides an opportunity to increase the value of harvesting for such purposes throughout the supply chain, from the landowner to the farmer, forester, and logger, while still saving the user considerable money over the displaced oil or propane. In the areas where natural gas service exists, the cost savings are not as great. Thus, priority should be given to displacing the more expensive heating oil and propane through thermal applications. Although these savings are often easily achieved when using biomass for thermal applications, the capital cost of new equipment or systems may still be too high a hurdle to overcome in some circumstances.

Section 5.8.1—Biomass discusses resource-related challenges for biomass electricity generation that also apply here. Appendix 6—Forest Management for Bio-Energy also addresses these issues.

Recommendations

(1) *Encourage the sustainable use of wood energy for heating and process applications. Wood biomass and multi-fuel-burning energy systems provide reasonable options for supplying a portion of the state's residential and commercial electric and thermal energy requirements. Other forms of biomass might also offer viable options in the future. Given the complexities of forest health and dynamic markets, the*

[187] *Technical Assessment of Grass Pellets as Boiler Fuel in Vermont, 2011. Vermont Grass Energy Partnership;* *www.biomasscenter.org/images/stories/grasspelletrpt_0111.pdf*

state would benefit from carefully reviewing the recommendations of the BioE working group to be released in January 2012.

(2) *Set standards and policies for the design of new renewable energy from biomass that promote sustainable, efficient, local, and fair use of biomass supplies. For example, disperse appropriately scaled new wood and other biomass pellet manufacturing facilities throughout the state.*

(3) *Open the Vermont Small Scale Renewable Energy Program to biomass equipment to complement recent mandates regarding biomass heating systems in Act 47, including multi-fuel systems. The DPS recommends that prior to obtaining an incentive, applicants implement cost-effective energy efficiency upgrades to decrease the amount of biomass fuel required per building.*

(4) *Evaluate the effectiveness of including wood and agricultural biomass energy efficiency programs as part of statewide thermal efficiency services; if the results are positive, take steps to incorporate such programs.*

(5) *Evaluate the costs and benefits of re-initiating woodstove change-out programs. If results are positive, reinstate the program at ANR.*

(6) *Evaluate the costs and benefits of new biomass stoves, pellet stoves, and pellet-fueled central heating systems that can be used with various fuels. This information can be used as part of a woodstove change-out program at ANR to increase the number of clean-burning, high-efficiency stoves and systems.*

(7) *Encourage use of wood fuel and other biomass options for space heating, including densified fuels (pellets) and wood chips, in district energy thermal or thermal-led CHP systems for appropriately sized community energy systems*

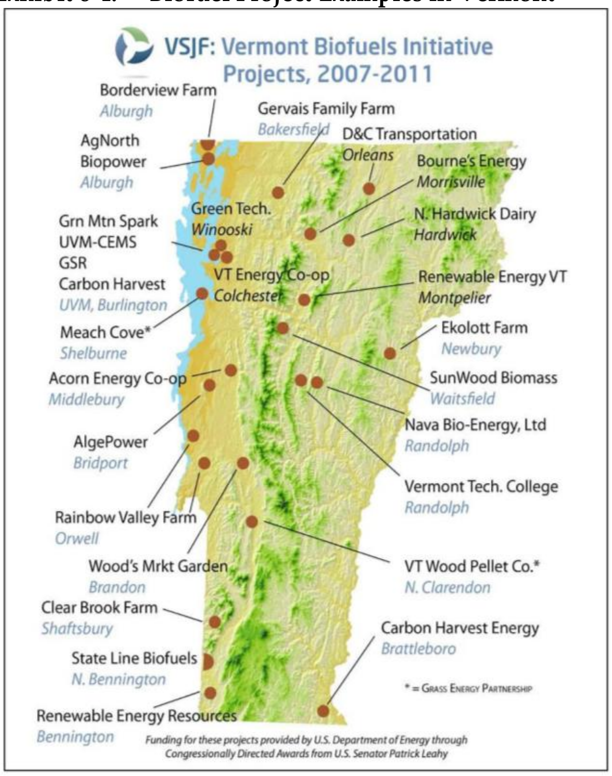
(8) *Encourage advanced emission control technologies and monitoring of emissions on biomass thermal energy units, particularly at schools and other sites where susceptible people are exposed, so as to identify maintenance needs that could improve performance and avoid unhealthy conditions. Work with the Vermont Legislature, federal government, and private sector to identify and establish capital funding mechanisms to overcome the initial cost hurdle of implementing district energy systems in communities, institutions, and business complexes.*

(9) *Over the next five years, focus grass biomass energy R&D on cost of production, agronomic best practices, crop establishment, combustion, and pilot projects at farms, businesses, and institutions.*

8.3.5 Biofuels for Thermal Energy

In addition to having sources of woody and agricultural biomass available for thermal applications, Vermont has the opportunity to expand the production and use of agriculturally derived biofuel products to heat homes, offices, and commercial spaces. During the past 10 years, many Vermonters have worked to introduce liquid biofuel products and develop viable production systems that foster the emergence of new bioenergy technologies and markets. (See Exhibit 8-4.)

Exhibit 8-4. Biofuel Project Examples in Vermont



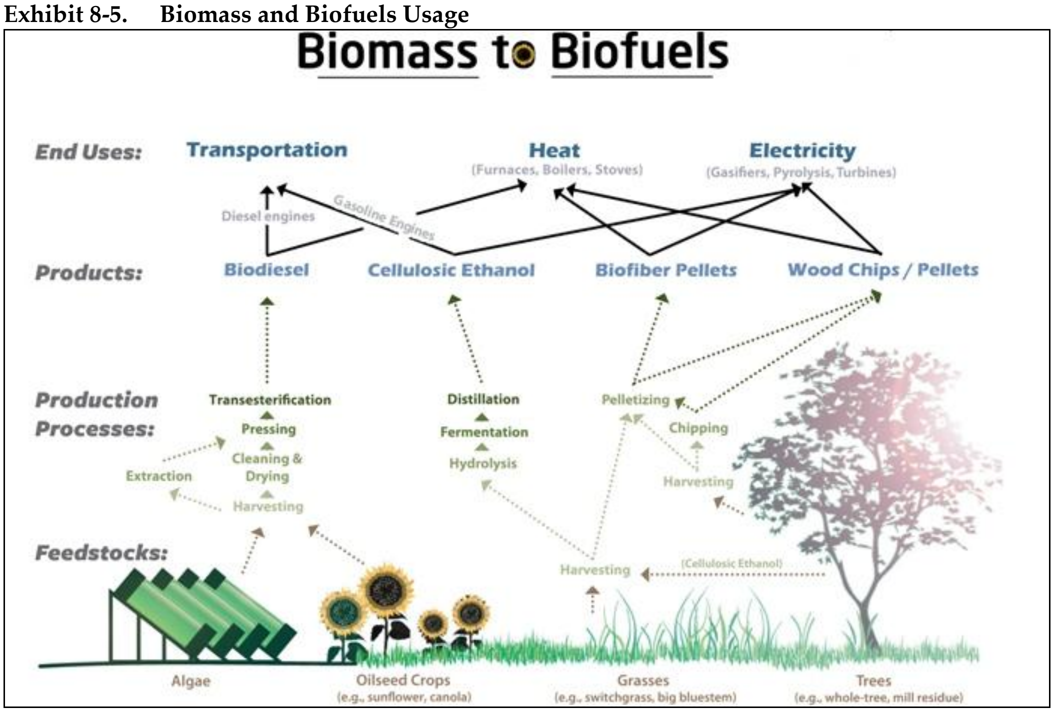
Source: Vermont Sustainable Jobs Fund

This section will focus on liquid biofuels used for thermal applications in the state. However, it is not always convenient to separate certain biofuel products, especially biodiesel, when evaluating their use for heating and transportation purposes. Therefore, the data on biodiesel presented below will include volumes and recommendations that are also applicable to its use for transportation purposes. For reasons of scale, discussed below, we are not including a discussion of cellulosic ethanol here or in Section 9—Transportation and Land Use. Although it has received a great deal of attention and investment on the federal level, we do not believe it will play a role in the use of Vermont's biomass resources.

Biofuels can displace fossil fuels, support local economies and job growth, and lead to lower greenhouse gas emissions (compared with petroleum fuels). In addition to reducing our dependence on foreign oil, greater utilization of biodiesel can help Vermonters reduce air and groundwater pollution by lowering the amount of petroleum products released into the environment.

The sustainable production of bioenergy feedstocks and fuels is part of an emerging integrated perspective of farm-based productivity that yields a variety of food, fiber, and fuel products for local use. *Sustainable production* here refers to best management practices that do not exceed the long-term productive capacity of the land base; that protect and enhance biodiversity, soil, air, and water quality; that are profitable; and that work at scales appropriate for Vermont. (See Exhibit 8-5.)

Exhibit 8-5. Biomass and Biofuels Usage



Source: Vermont Sustainable Jobs Fund

There are three main classes of agricultural bioenergy crops: oil-based crops such as soy, canola, and microalgae for biodiesel production; starch- or sugar-based crops such as corn and cane for conventional ethanol; and crops and residues high in cellulose such as switchgrass used to produce solid fuels or cellulosic ethanol.

Biofuel feedstocks may be used for multiple purposes. For example, oilseed crops such as canola, sunflower, and soybean can be used to produce biodiesel for transportation and heating purposes, lubrication for motors, and biodegradable oil for chainsaws, as well as food-grade oil or feed for livestock. Similarly, grass crops can be used as forage for livestock or compressed into pellets or briquettes for heating in multi-fuel appliances and industrial boilers.

8.3.5.1 Current Biodiesel Contribution for Thermal Energy

Biodiesel is a clean-burning renewable fuel alternative to or additive to petroleum-based diesel. It is derived from soybean, sunflower, or canola oils; animal fats; waste vegetable oils; or microalgae oils. As a heating and process fuel, biodiesel is easy to use, biodegradable, nontoxic, and sulfur free, and it can be blended with petroleum diesel in any amount. Over the last several years, successes in various Vermont pilot studies have proven that with proper blending, storage, and use, biodiesel can be an effective fuel in compressors; snow removal, construction, and farm equipment; and residential, commercial, and institutional heating systems.

The reduced pollution and greenhouse gas emissions from biodiesel (compared with using petroleum diesel) are well documented, and the use of biodiesel as a fuel additive or replacement for fossil fuels in transportation and heating applications is also well established in Vermont. Numerous studies have concluded that biodiesel produces fewer atmospheric pollutants and has a low carbon intensity compared with petroleum diesel, resulting in lower greenhouse gas emissions at the point of combustion and on a full life-cycle basis.

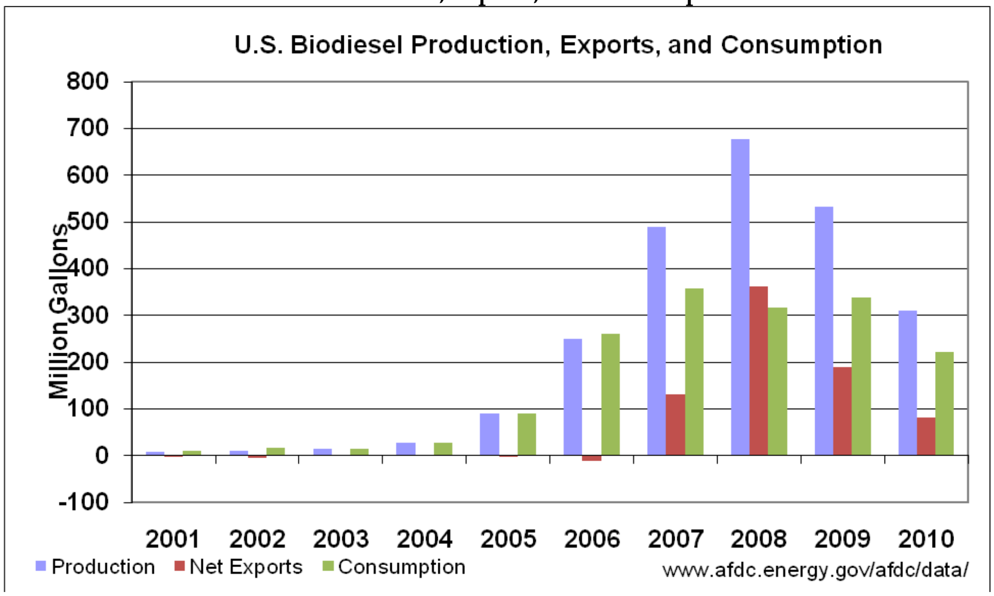
Neat (pure) biodiesel contains no petroleum, but it blends easily with distillate petroleum products like No. 2 heating oil, diesel, and kerosene. Thus, biodiesel can be added to these products for heating or transportation. Biodiesel blends are concentrations of biodiesel between 2% and 99% (called "B2" to "B99"; the number following the "B" indicates the percentage of biodiesel in a gallon of fuel, and the remainder is petroleum diesel).[188]

Commercial sales of biodiesel greatly increased in 2005, when about 100 million gallons were produced in the United States. The number peaked in 2008, when nearly 700 million gallons were produced, only to fall back to 315 million gallons in 2010. (See Exhibit 8-6.) In response to continued interest in fuel security, the Obama administration announced a major initiative in August 2011 to spur the biofuels industry with an investment of up to $510 million during the following three years in partnership with the private sector. The initiative responds to a directive from President Obama issued in March as part of the Blueprint for a Secure Energy Future, the administration's framework for reducing dependence on foreign oil.[189]

188 *Report to the Legislature on Biodiesel Production and Use in Vermont, Prepared for the Vermont Department of Public Service by Vermont Sustainable Jobs Fund, August 31, 2009, p. 3.*

189 *President Obama Announces Major Initiative to Spur Biofuels Industry and Enhance America's Energy Security, the White House Office of the Press Secretary, August 16, 2011.* *www.whitehouse.gov/the-press-office/2011/08/16/president-obama-announces-major-initiative-spur-biofuels-industry-and-en*

Exhibit 8-6. U.S. Biodiesel Production, Exports, and Consumption



Biodiesel sales to commercial and institutional customers began in Vermont in 2004 and followed the national trend. By 2008, 18 fuel dealers in the state sold biodiesel, and the volume of biodiesel blends rose from 275,000 gallons in 2005 to approximately 5.6 million gallons in 2008, then dropped to 1.9 million gallons and eight dealers in 2009 as the recession unfolded and the federal biodiesel tax credit evaporated. Approximately 78% of the 5.6 million gallons was consumed as heating fuel and about 22% was used for transportation. By the peak in 2008, biodiesel blends made up approximately 3% of Vermont's total distillate fuel sales (diesel, kerosene, and heating oil), but that subsequently dropped to 1%.[190]

If we convert from percentage blends (e.g., B20) to pure biodiesel (B100 equivalent), we calculate that approximately 480,000 gallons of pure biodiesel were sold in 2008, indicating a displacement of 1,417 barrels of crude oil and more than 3,800 tons of CO_2 emissions avoided. During that year, biodiesel blends constituted 18% of the fleet fuel purchased by the Vermont Agency of Transportation. [191] Although the blend purchased by the Vermont Department of Buildings and General Services was higher (B20 compared to an average of B5 at the AOT), biodiesel blends accounted for only one-tenth of 1% of BGS fuel purchased in 2008.[192] In 2009, the number of gallons of pure biodiesel dropped to 252,275; seven dealers who had previously sold the product indicated that they no longer sold it, for a variety of reasons.[193] (See Exhibit 8-7.)

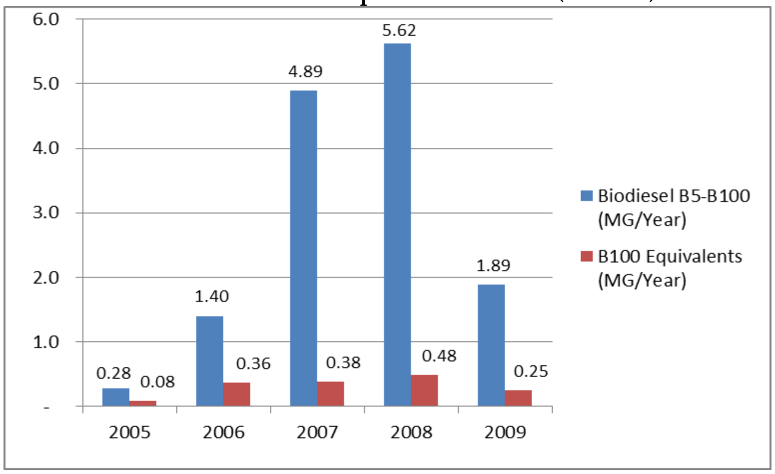
[190] *Vermont Biodiesel Supply Chain Survey, prepared for Vermont Sustainable Jobs Fund by Spring Hill Solutions, LLC. April 28, 2011, pp. 2-4.*

[191] *Report to the Legislature on Biodiesel Production and Use in Vermont, DPS, p. 7.*

[192] *Ibid, p. 4.*

[193] *Vermont Biodiesel Supply Chain Survey, p. 4.*

Exhibit 8-7. Biodiesel Consumption in Vermont (2005–09)



Source: Vermont Sustainable Jobs Fund

8.3.5.2 Projected Biodiesel Production in Vermont

According to estimates prepared for the Vermont 25 x '25 Initiative, Vermont has the potential to produce about 4 million gallons of B100 per year from in-state agriculture lands over the next 14 years, representing an eightfold increase from 2008.[194] If that number is realized, much of this fuel is likely to be used for off-road vehicles (farm and construction equipment) and for heating purposes.

Vermont has a long history as an agricultural state and has the opportunity to begin a new era in agriculture by supporting farms that add bioenergy crops to their rotations. Vermont's land area consists of 5.9 million acres, of which approximately 1.23 million (21%) are classified as farmland. Of the 1.23 million acres, approximately 517,000 acres are in cropland, of which 433,000 acres are harvested.[195] This leaves approximately 84,000 acres of unused or underutilized cropland potentially available for biofuel production. Assuming average yields and use of approximately 60,000 acres of the available land for oilseed production, using the above scenario, an annual production of approximately 4 million gallons of biodiesel from crop-based feedstocks in Vermont is possible by 2025 (see Exhibit 8-8).[196] This would be enough to replace all distillate sold (for both transportation and heating) in Vermont with a 2% biodiesel (B2) blend. However, it is not likely that every unharvested acre could be economically harvested or that all yield rates would be reached. Nevertheless, preliminary investigation suggests there is reason to be optimistic about Vermont's biofuel energy potential.

[194] *It is assumed in this estimation of Vermont's agricultural biofuels potential that land use patterns remain as they currently exist, that no deforestation occurs, and that current production rates of existing crops remain the same.*

[195] *USDA Census of Agriculture—2007 Census Publications: Vermont,* *www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Vermont/vtv1.pdf*

[196] *This calculation uses Vermont 25 x '25 Initiative 2008 baseline assumptions updated with current data from the 2007 Agriculture Census and VSJF.*

Exhibit 8-8. Estimation of Agricultural Biofuels Potential in Vermont

	Yield (per Acre)		Btu/gallon	Acres	Energy Yield (Gallons)	Energy Yield (Billion Btu)
Oil Seed Crop	65	gal	130,000	61,000	4,000,000	520
Algae	200,000	gal per algae unit acre	130,000	100 algae unit acres	20,000,000	2,600

Source: VSJF, updated Vermont 25 x '25 Initiative data

As of 2009, the 252,275 gallons of B100 used translates into approximately 0.33 billion Btu. To achieve the goal of the Vermont 25 x '25 Initiative from this base, the state would need to expand use of biodiesel 16-fold from in-state or out-of-state sources. On the basis of recent input from key stakeholders actively building the state's biodiesel capacity, the goal has been recalibrated to 1 million gallons of in-state production by 2020, then up to 4 million gallons by 2025. This would require about 16,000 acres and represent 15% of all diesel used in Vermont's agriculture sector. Currently 2.8 million gallons per year of biodiesel production capacity exists among seven Vermont farms, but actual production is less than 10,000 gallons annually.

In 2010, it cost $2.81 per gallon, on average, to produce biodiesel in Vermont's on-farm facilities.[197] Ramping up production to meet more aggressive goals would entail bringing more acres into production, developing the potential of algae-based biodiesel production, or both. It is estimated that algae-to-biofuel processes and enterprises can replace 3% of the state's distillate fuel consumption, or about 12.5 million gallons annually, by 2020. An array of pilot projects and prototypes are advancing in Vermont with anticipated full commercialization of algae-to-biofuel pathways estimated in less than 10 years.

8.3.5.3 Potential Expanded and New Sources of Biodiesel for Thermal Uses

Biodiesel production began to grow in Vermont in 2005; several farms now produce their own fuel (in Shaftsbury, Alburgh, and Orwell), and there is one small-scale commercial facility in Brookfield. However, given the challenging economy, the introduction of this carbon-reducing fuel has experienced its own set of bumps in the road. The number of dealers selling the fuel grew to 18 in 2008, then dropped back down to eight in currently.[198] In January 2008, Vermont's first large commercial-scale production facility, "Biocardel Vermont," which was formed by a Quebec company, began selling biodiesel from its processing plant in Swanton, Vermont. To locate and produce in Vermont, Biocardel received payroll and capital investment tax credits. However, owing to expiration of federal tax credits in December 2009, increases in commodity prices, and

[197] *Vermont Sustainable Jobs Fund (VSJF) grantee data and VSJF Oilseed Profit/Loss Calculator.*

[198] *Vermont Biodiesel Supply Chain Survey, p. 15.*

technical and financial difficulties, the facility closed in August 2010 after selling a very limited amount of biodiesel.

Just as local production has climbed and descended over the past five years, so too has production at the national level. Although the number of producers has decreased, more than 130 companies continue their efforts to supply renewable fuels nationwide.[199] Now, biodiesel supplier White Mountain Biodiesel LLC, located in nearby North Haverhill, N.H., provides 5,000 gallons per week through local distributors.[200] Other suppliers exist in neighboring states. Given the early stage of the bioenergy market, the number of production and distribution facilities fluctuates over time.[201]

A number of Vermont fuel dealers and the Northeast oil heating industry have embraced a biodiesel/ultra-low-sulfur heating oil blend known by the trademarked name Bioheat to provide a cleaner burning fuel and create a solution to the diminishing market share that the oil heat industry faces. Two dealers (in Morrisville and Derby) have installed state-of-the-art biodiesel blending equipment to offer customers a range of biodiesel and Bioheat blends, with their biodiesel product coming from White Mountain Biodiesel and other large commercial producers. As demand and production increase, local fuel marketers have the capacity to expand the volume of biodiesel blends offered to Vermont customers, potentially displacing upward of 20 million gallons of fossil fuels by 2020. The state helped move in this direction with the passage of the Vermont Energy Act of 2011 (Act 47), which includes a timeline and mechanism for a transition to a biodiesel blended, ultra-low-sulfur heating oil.[202] The future of biodiesel blended heating oil will depend on a number of factors, including whether or not Congress approves continuation of the $1 per gallon blenders tax credit, which is due to expire on December 31, 2011.

8.3.5.4 Challenges to Expanded Development of Biofuel Use and Production

Biodiesel is still in an emerging phase of development in Vermont, and large production facilities are relatively scarce. It will be essential, however, for biodiesel produced in Vermont to keep up with national quality standards (such as the ASTM specification) to maintain high performance and compliance with warranties.

In a survey conducted for the Vermont Sustainable Jobs Fund, seven of the 18 commercial end users indicated that they had used biodiesel in the past but were no longer doing so. The reasons given included biodiesel price premiums, technical difficulties, erratic availability, and inconvenient use. Some former users stated that they

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[199] *For a current listing of biodiesel producers, see National Biodiesel Board,* www.biodiesel.org/buyingbiodiesel/plants/showall.aspx

[200] *See White Mountain Biodiesel,* www.whitemountainbiodiesel.com/news.php

[201] *Current sources of bioenergy can be identified via interactive maps located at:* www.afdc.energy.gov/afdc/pdfs/biodiesel_plants.pdf *and* www.biodiesel.org/buyingbiodiesel/plants/biomaps/biomaps.shtm#

[202] *10 V.S.A. § 585.*

would return to biodiesel under circumstances such as availability of biodiesel at a price on par with (or lower than) straight diesel; assurance that technical problems could be addressed; reliable supply including "automatic" delivery; and improved on-site fuel storage and pumping infrastructure in the state.[203]

The loss of the federal tax credit in December 2009 acted as a barrier to the development of commercial-scale production in Vermont. This was cited as one of the reasons for the closure of Biocardel in Swanton in 2010.[204] Other challenges:

- **Early-Stage Markets.** Difficult conditions and experiences often emerge during the pioneering stage of a new product or service. Success hinges not solely on the ability of a single entrepreneur but rather on the combined efforts of a wide array of participants, including researchers, entrepreneurs, technical assistance providers, funders, and policymakers. To continue progress with biodiesel development, Vermont requires additional investment and coordination among this array of players.

- **Sustainable Fuels.** During the initial years of biofuel development and European Union renewable fuel mandates, a situation emerged in which agricultural and forest lands in many countries were converted or cleared to make way for biofuel feedstock production, typically in the form of palm oil plantations. The deforestation and displacement of indigenous people and practices evoked a powerful response internationally that tarnished the public perception of biofuels. When advocates challenged the net energy values for biofuels (e.g., ethanol and biodiesel), many consumers and policymakers stepped back from the initial rush toward biofuels. The confusion prompted attempts to define sustainable biofuel production and create standards needed to assure consumers that biodiesel is produced in a way that does not harm the environment or reduce the amount of arable land available for international food crops.[205] Vermont has opportunities to provide leadership in the emergent sustainable biofuels sector by demonstrating best practices and supporting third-party sustainable biofuel certification of feedstock growers and bioenergy producers.

- **Ensuring a Sustainable Biofuels Supply**. Increases in the consumption of biofuels can drive up the demand for energy crops as well as the prices for those crops connected to international commodity markets. This can lead to both positive and negative changes in the U.S. and global economy. On one hand, many farmers who are equipped to grow energy crops receive a steady demand for their products, and local economies benefit from the boost to the farm industry. On the other hand, an increase in crop prices can also have an impact on the cost of food and create pressure on farmers,

[203] *Vermont Biodiesel Supply Chain Survey, p. 7.*

[204] *"Vermont's Biocardel Biodiesel Plan Shuts Down, Citing Economics," Biofuels Digest,* http://biofuelsdigest.com/bdigest/2010/08/24/vermonts-biocardel-biodiesel-plant-shuts-down-citing-economics

[205] *See Biodiesel Sustainability Task Force, National Biodiesel Board,* www.biodiesel.org/resources/sustainability/pdfs/Sustainability%20Principles.pdf *and Round Table on Sustainable Biofuels (RSB), an international initiative among stakeholders,* www.rsb-services.org

especially in economically unstable countries, to clear more forested land to produce energy crops. Obtaining biofuels from sustainably grown crops is an important issue that policymakers need to take into consideration. Although biofuels can help Vermont move toward clean energy goals and reduce the negative impact that energy consumption has on the environment, policymakers should be aware of all the consequences of biofuel policies and work toward ensuring a sustainably produced biofuels supply for Vermont consumers.

- **Perception of Energy Values.** Part of the public perception challenge facing biofuels, biodiesel in particular, stems from the conjoining of ethanol production with biodiesel production. Citing the relatively low to negative net energy balance—the so-called "energy in, energy out" balance—for ethanol, critics of ethanol claimed that biofuels yielded low energy balances and questioned the development of biofuels in general to save energy. As one of many biofuels, biodiesel had to distinguish itself from ethanol production. Early research conducted by the USDA and U.S. Department of Energy indicated that biodiesel had a fossil energy ratio (FER) of 3.2, meaning more energy out than energy in. Recent research released by the USDA and University of Idaho indicates that soy biodiesel has a much higher fossil energy ratio, 5.5, compared with the previously calculated ratio.206 To continue to advance, biodiesel must overcome this perception.

- Scale. Part of the challenge facing Vermont bioenergy developers is that the model employed in the state differs from traditional commodity-scaled systems funded elsewhere. For example, the Vermont Bioenergy Initiative consists of an array of public and private partners working to identify and produce locally grown feedstocks that are then turned into biodiesel.**207** Proponents are looking at the future of development not from a single product or sector perspective, but rather with an integrated approach. This approach spans agriculture and forest products, and includes oilseeds providing fuel, feed, food, and revenue; grass energy for heating greenhouses and/or as biodigester substrates to produce electricity; and methane digesters as waste management tools to provide a source of revenue for farms (that is, selling electricity) and provide nutrients for algae oil production. Development of such multifaceted systems requires long-term commitments to funding for R&D that will enable Vermont researchers, farmers, and businesses to explore and adapt the lessons to the rapidly changing economic and environmental conditions of our day.

- At the federal level, much attention has been given to and investment made in developing cellulosic ethanol as a transportation fuel. Even if it is demonstrated to be commercially viable, which has not yet happened, this biofuel requires a scale that may be inappropriate for Vermont—it would require more than 1 million green tons of wood per production facility, while not making a significant contribution to the state's transportation fuel demand.

[206] *Energy Life Cycle Assessment of Soybean Biodiesel Revisited, Transactions of the American Society of Agricultural and Biological Engineers; A. Pradhan, D.S. Shrestha, A. McAloon, W. Yee, M. Haas, J.A. Duffield, vol. 54(3), pp. 1031–39;* www.uiweb.uidaho.edu/bioenergy/EnergyLCAJune2011.pdf

[207] *See Vermont Bioenergy Initiative for more details at* www.vsjf.org/projects/1/vermont-biofuels-initiative

8.3.5.5 Tools to Meet Expected Demand for Biofuels

8.3.5.5.1 Financing

The Vermont Bioenergy Initiative (VBI), a bioenergy sector development program of the Vermont Sustainable Jobs Fund, receives funding from the U.S. Department of Energy via a Congressional appropriation request from the Office of Senator Patrick Leahy and local foundations. The primary VBI collaborators are the University of Vermont; Vermont Fuel Dealers Association members; the Vermont Agency of Agriculture, Food, and Markets; and more than two dozen grantees and subcontractors (farms, businesses, researchers, and academic institutions).

The Vermont Sustainable Jobs Fund has provided $2.1 million in grant funding for bioenergy processes, products, and markets for research and development since 2005. During this same period, the Vermont Agency of Agriculture, Food, and Markets also made grants for farm energy projects. This funding supports improvements to oilseed cropping best practices; algae-to-biofuels research; and economic models, feasibility studies, and data designed to help entrepreneurs and others gain insights into the practical elements needed to produce and use bioenergy feedstocks and fuels in Vermont. These government sources have leveraged significant private-sector investments, leading to the development of on-farm and community-scale distributed bioenergy production systems with capacity to produce nearly 3 million gallons of biodiesel per year.

Because there is a two-year moratorium (at least) on federal earmarks, new funding sources and sustained technical assistance are needed to continue this momentum. And although processing capacity for biodiesel exists, feedstock supplies need to be increased to meet consumer demand. Moving to the next level of sector development will require ongoing technical support in the form of agronomic, engineering, and marketing expertise. Outreach and education are needed regarding the public benefits of local production of bioenergy for local use. Finance tools including tax credits, loan guarantees, and grants are also necessary for new in-state biofuel blending facilities, to accommodate increases of in-state biodiesel production.

8.3.5.5.2 Policy and Regulation

- **25 x ’25 Initiative**. The Vermont 25 x ’25 Initiative is a broad coalition of agricultural, energy, and policy professionals. This state-level alliance functions within the framework of the national 25 x ’25 program. Supported by a resolution from the Vermont Legislature, the initiative aims to develop a plan for providing 25% of Vermont’s total energy needs from in-state renewable resources by the year 2025—primarily from Vermont’s farms, forests, and working lands. The Vermont 25 x ’25 Initiative has begun the work of determining specifically how Vermont can achieve these objectives from in-state resources, but further analysis and state leadership will be needed to meet this goal.

- **Act 47**. During the 2011 Vermont legislative session, the Legislature passed the Vermont Energy Act of 2011, which set requirements for the addition of biodiesel to heating fuels beginning in 2012. The statute requires all heating oil sold within the state for residential, commercial, or industrial uses, including space and water heating, to ramp up from 3% (by volume) biodiesel on July 1, 2012, to at least 5% by 2015 and 7% by 2016. These requirements may be waived by the governor if supplies prove inadequate.[208] The effective date is qualified with language that requires the surrounding states of Massachusetts, New York, and New Hampshire to adopt requirements that are substantially similar to or more stringent than the content requirements set forth in 10 V.S.A. § 585(c) as determined by the attorney general.

- **Low-Carbon Fuel Standard**. An ongoing regional effort seeks to set standards for low-carbon fuels. A Low-Carbon Fuel Standard (LCFS) is a full life-cycle greenhouse gas rating system that requires the mix of emissions from transportation fuels to be reduced to a specified level within a certain timeframe. It aims to reduce the greenhouse gas intensity of fuels by regulating fuel providers through flexible credit trading mechanisms. Current efforts focus on transportation fuels, but could be expanded to include heating fuels (see Section 9—Transportation and Land Use for additional discussion).

- **Federal Incentives.** The federal government offers several incentives for biodiesel, including the volumetric blender tax credit, the small agricultural producer tax credit, and the alternative fuel refueling infrastructure tax credit.

8.3.5.5.3 Outreach and Education

Current efforts to develop Vermont's agriculturally derived biodiesel differ from those of large-scale commodity-driven systems, yet they are strongly influenced by the investment strategies, policies, and commodity speculation that affect the broader marketplace. Targeted outreach to inform the public about Vermont's farm-based and distributed approach would differentiate the state's organizational efforts from those made by others on the national stage. Such strategies are consistent with the state's overall focus on retaining the working landscape and its commitment to small farmers.

Part of this effort should entail the description of emerging appropriately scaled bioenergy production systems, such as those in Vermont, as part of a new model of agriculture that promotes sustainable production of food and energy cropping systems to meet local demands. The state would benefit from a unified message regarding the values and benefits of bioenergy as they are being advanced by Vermonters. Such an approach would stand in contrast to those taken elsewhere, and will require a sustained commitment from state government to promote and grow bioenergy options.

Some of the technical challenges experienced by the early adopters of biodiesel in the state could be overcome by providing a step-by-step guide describing how to handle, store, and use biodiesel, along with a description of Vermont's permitting requirements.

[208] *10 V.S.A. § 585.*

To address concerns about the potential impact of biodiesel production, consumers would benefit from accessible information that helps differentiate Vermont's small-scale, farm-based systems from industrial-scale models employed internationally. Such efforts could tie in with other ongoing activities such as the Farm-to-Plate Initiative.

Educational initiatives undertaken by the UVM Cooperative Extension to engage farmers have proven vital to building awareness, capacity, and participation in growing this new sector. The Vermont Sustainable Jobs Fund's *Renewable Energy Atlas* also provides useful information regarding the extent of renewable development in the state. This tool has the potential to be used for additional purposes to assist with expansion of renewables and energy efficiency in Vermont.

8.3.5.5.4 Innovation and Economic Development

The Vermont Bioenergy Initiative and its related programming serves as a catalyst and coordinating body through which farmers, fuel dealers, state agencies, and university researchers are testing strategies for expanding the production and use of biodiesel in Vermont. Current biodiesel production on Vermont farms is far less than capacity. The average cost to produce a gallon of biodiesel at these on-farm facilities (fixed and variable costs combined) is just $2.81, at a time when the average cost of petroleum diesel is $4.00 per gallon.

Although on-farm biodiesel production costs are lower than diesel prices, the challenges of growing new oilseed crops dampen willingness among financially stressed farmers to experiment. However, researchers are learning more about viable plant varieties and cropping strategies for Vermont farms each year, thus increasing the potential for achieving substantial savings. With increased acres of oilseeds in rotation with other grains and grasses, and more of Vermont's installed biodiesel production capacity in use, the potential savings in fuel costs alone for Vermont farms are considerable (for example, $1.19 savings per gallon x 2.8 million gallons per year = $3,332,000). Such efforts can help participants in the current fossil fuel markets transition toward renewable energy.

Efforts under way in Brattleboro at Carbon Harvest Energy, LLC, are pioneering the use of algae for biodiesel production in Vermont. This initiative aims to increase biodiesel production by supplying high-oil-content species of algae with the CO_2 they require from the gen-set and nutrients from the aquaculture wastewater. Projections for the amount of algal oil that can be extracted from the Carbon Harvest Energy systems exceed 15,000 gallons per 10-acre parcel per year. Other Vermont businesses, such as Algepower, GSR, and Green Mountain Spark, are also making headway in algae-to-biofuels R&D with promising results. Most estimates place the full commercialization of this technology at close to 10 years out.

Recommendations

(1) *Develop a sustainable, statewide, and distributed bioenergy industry in Vermont to enable the production and use of biofuels for electric generation, local transportation, and agricultural and thermal applications.*

(2) *Use the 25 x '25 Initiative to guide and track bioenergy development in the state and progress toward meeting the state 25 x '25 goals. With adequate leadership, staff support, and an outreach plan, the Vermont 25 x '25 Initiative has shown itself to be an effective public–private convener, advocate, central clearinghouse, and monitor of information and progress. Create a bioenergy development committee within the Vermont 25 x '25 Initiative tasked with enhancing the growth and development of Vermont's bioenergy industries while maintaining and improving soil, water, and air quality; forest health; and food security.*

(3) *Increase and sustain outreach, education, funding, technical assistance, and strategic partnerships to continue building the state's knowledge and experience base related to development of biofuel crops and production in the state.*

(4) *Pursue financial support for construction of new in-state biodiesel blending facilities.*

(5) *When economic conditions allow, revisit the viability of offering biodiesel incentives such as the rebates and fuel tax reductions introduced in the 2007 Vermont legislative session.*

(6) *Increase public–private collaboration: The Vermont DPS; the ANR; and the Vermont Agency of Agriculture, Food, and Markets are encouraged to work with Congressional delegation staff to help identify and secure funding for R&D and project development, and to build public–private partnerships (similar to CVPS Cow Power) to drive development.*

(7) *Undertake proactive public outreach. A sustained commitment from state government is needed in the form of positive outreach and messaging regarding the values and benefits of bioenergy.*

(8) *Continue working with other Northeast states on developing a Low-Carbon Fuel Standard framework for the region that includes biodiesel blends.*

(9) *Expand energy cropland: The Vermont Agency of Natural Resources and Agency of Agriculture, Food, and Markets should evaluate the costs and benefits of expanding certain areas of land to growing energy crops.*

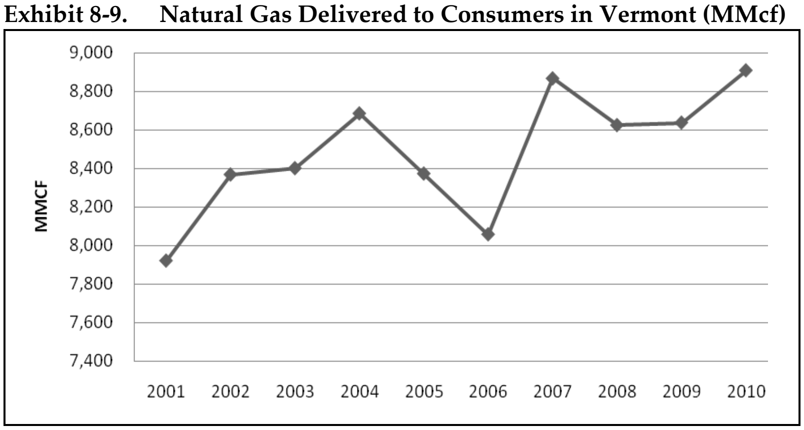
8.4 Natural Gas

Natural gas is an odorless, colorless gas that consists mostly of methane, but also contains ethane, propane, butane, and pentane. The exact mixture of gas received by distribution companies varies, because natural gas is a fossil fuel that is extracted from different places all over the world. Most natural gas contains added sulfur to give it a characteristic smell that allows for the easy detection of leaks.

In Vermont, natural gas is available only in the northwest corner of the state, in portions of Franklin and Chittenden Counties. Vermont has a single natural gas distribution company, Vermont Gas Systems (VGS), which, as of 2010, serves more than 43,000 customers.

Natural gas accounts for a relatively small portion of Vermont's total energy use because of its current limited availability, Vermont's population dispersion, and its small industrial base. Major applications for natural gas in Vermont include residential and commercial space heating, water heating and cooking, and various industrial processes. A small amount is used for electric generation. However, efficient new technologies such as natural gas–powered cooling systems and heat pumps are beginning to compete with electricity in other end uses. In addition, the use of natural gas for electric power generation has become increasingly environmentally friendly and cost-effective due to the advent of combined cycle and fuel-cell technologies from large-scale generation to small-scale residential systems. Gas-fired CHP also has great potential for benefiting both system expansion and the thermal host. Natural gas has also attracted attention as a vehicle fuel as cities look for cleaner transportation options.[209]

Exhibit 8-9. Natural Gas Delivered to Consumers in Vermont (MMcf)



Source: EIA[210]

In 2010, Vermonters consumed 8,909 MMcf of natural gas, accounting for about 6% of the state's total delivered energy use. The residential sector consumed about 37% of the state's total natural gas, the industrial sector consumed 33%, and the commercial sector consumed 29%. The electric power sector consumption accounted for

[209] *Natural Gas Basics: 101,* http://www.eia.doe.gov/basics/naturalgas_basics.html

[210] http://www.eia.gov/dnav/ng/ng_cons_sum_dcu_SVT_a.html

less than 1% of statewide natural gas usage. The residential sector uses natural gas primarily for space and water heating; an estimated 11% of Vermont households use natural gas as their primary space-heating source and 14% use it as their primary water-heating source during the heating season.[211]

8.4.1 Supply and Price

VGS obtains its natural gas from Canadian supplies in Alberta, and it is transported to Vermont via the TransCanada pipeline. VGS also has liquefied propane gas (LPG) supply for use in VGS's propane air facility during seasonal peak demand periods. The LPG is mixed with natural gas during the peak periods when demand is greater than what the natural gas pipeline can supply. This allows VGS to supply more customers without costly contracts or expansion of its pipeline.

Vermont, along with other New England states, participated in an Avoided Energy Supply Costs (AESC 2011) study to develop reasonable cost estimates of fuel consumption. The AESC 2011 study forecast shows that New England natural gas prices are expected to increase by approximately 43% between 2011 and 2040 in real terms.[212] Increased production of shale gas has resulted in an overall lowering of prices for gas; this is particularly true in the Northeast, because nearby shale gas developments will lower the price differential faced by New England, which is at the end of the pipeline.

8.4.2 Air Emissions and Environmental Issues

Among fossil fuels, natural gas generally emits the lowest levels of almost all pollutants per unit of energy used.[213] Nitrogen oxide emissions from natural gas and LPG are nearly the same and are higher than the level of NO_2 emissions from distillate fuel or wood use. Natural gas emissions are very low in sulfur oxides and low in particulates, carbon monoxide, and volatile organic compounds. Carbon dioxide emissions per unit of energy used are significant; however, CO_2 from natural gas is emitted at the lowest level of any fossil fuel energy source (see Exhibit 8-10.)

Additional environmental impacts from natural gas can include drilling and pipeline construction impacts and gas leakage from distribution systems (usually small amounts). These impacts include both short- and long-term disruption of wetlands, streams and rivers, water supplies, fields, woodlands, and endangered species habitats. Methane leakage from natural gas distribution systems can have serious environmental consequences because methane is a potent greenhouse gas. However, the leakage rate of methane from natural gas pipelines is

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211 *2005 Appliance Saturation Survey, "Phase II Evaluation of the Efficiency Vermont Residential Programs."* http://publicservice.vermont.gov/pub/other/vtres%20.pdf

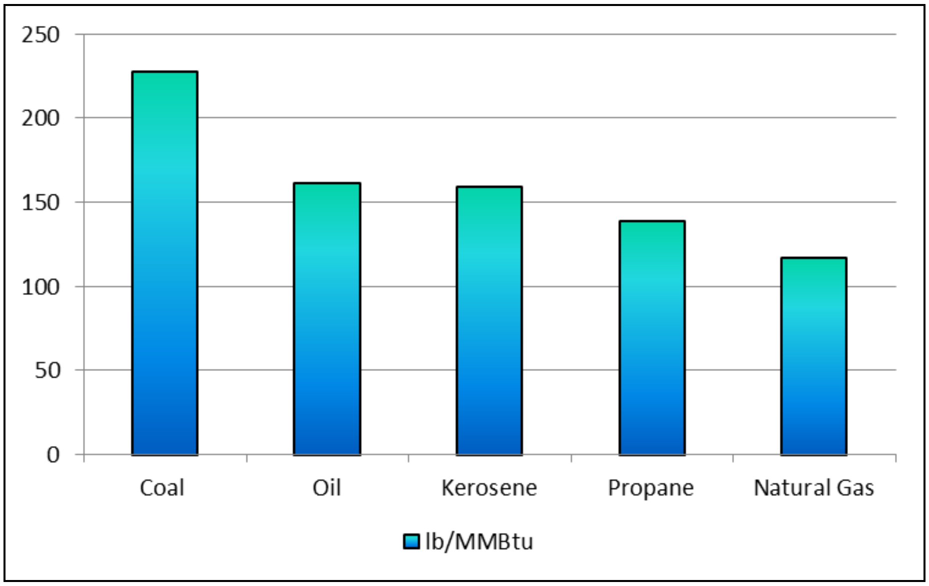
212 *"Avoided Energy Supply Costs in New England: 2011 Report"* http://www.synapse-energy.com/Downloads/SynapseReport.2011-07.AESC.AESC-Study-2011.11-014.pdf

213 *EIA, "Natural Gas 1998: Issues and Trends,"* http://www.eia.gov/oil_gas/natural_gas/analysis_publications/natural_gas_1998_issues_and_trends/it98.html

estimated to be very small in most U.S. cities. In Vermont, VGS has replaced all its cast-iron and bare steel mains, elements that are a significant source of leaks in other states.

Despite the important concerns about its environmental impacts, overall, the utilization of additional natural gas can result in an improved environmental profile for Vermont if it is used to replace coal or oil.

Exhibit 8-10. CO_2 Emissions (lb/MMBtu)



Source: EIA

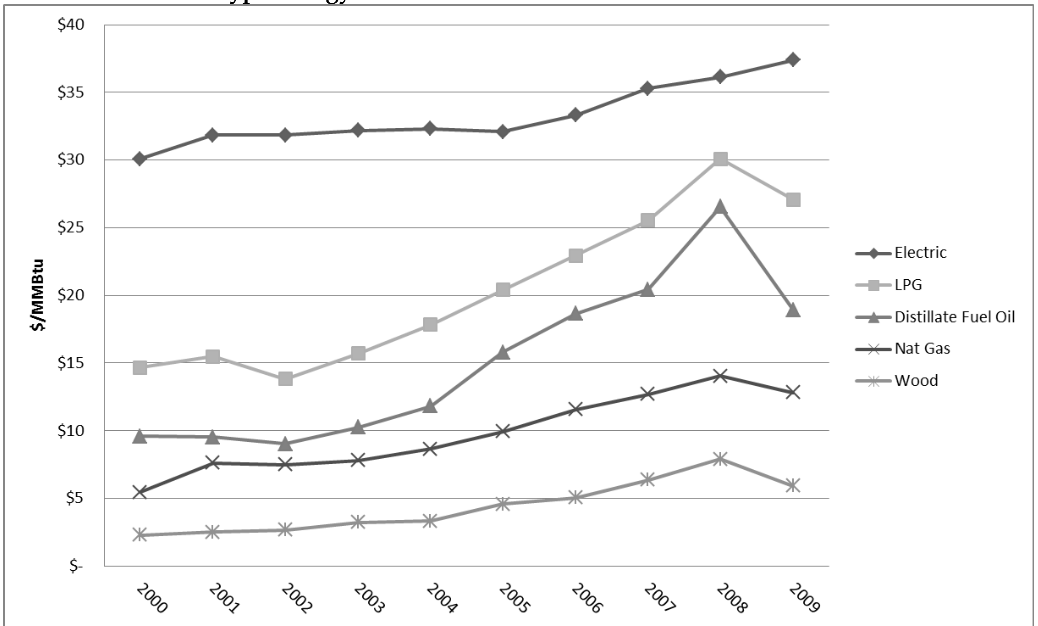
Another area of uncertainty is the potential impact of the environmental costs of producing shale gas from hydraulic fracturing. Concerns have been raised regarding the need for additional regulation of hydraulic fracturing in order to minimize its environmental impacts on groundwater, surface water, and air emissions and the potential impact of such changes in regulation on shale gas production quantities and cost.

8.4.3 Natural Gas Substitution for Other End-Use Fossil Fuels

Vermont should encourage the increased use of natural gas by supporting economically viable expansion of the natural gas service territory, promoting attachments to the current distribution system, encouraging the development of appropriately sized and strategically located natural gas electric generation, and promoting the use of natural gas vehicles.

Natural gas is a relatively clean and inexpensive fuel and should be used as a substitute for other fossil fuels when it is cost-effective to do so. By switching to natural gas, customers who use electricity for heating and hot water can reduce their energy bills. Natural gas prices have often been lower than those of other fossil fuels, except coal. Although market prices can be volatile, VGS engages in a comprehensive hedging program, which limits the company's (and in turn its customers') exposure to short-term price volatility.

Exhibit 8-11. Fuel Type Energy Price



Source: EIA[214]

Other advantages of natural gas use include lower levels of many types of emissions in comparison with other fossil fuels; efficient delivery through pipelines (instead of delivery trucks); and efficient technologies to utilize natural gas in homes, businesses, power plants, and even cars. Natural gas is also viewed as an economic development tool in those communities that can offer this service to the public, if it remains price-advantaged compared with other fossil fuels.

Disadvantages include the need for additional infrastructure in Vermont to bring natural gas to new customers. Natural gas also suffers from the same environmental and economic concerns applicable to liquid fossil fuel sources, including concern about its long-term supply sustainability and high price volatility (although because natural gas is a tariff service, the volatility of its retail price is dampened modestly compared with oil and propane). Because long-term sustainability is a concern, natural gas may appropriately be viewed as a bridge to a more sustainable, renewable long-term energy future. Once pipeline infrastructure is in place, natural gas that is consumed will be available to displace other fossil fuels that are traditionally delivered by truck, thus reducing wear and tear on Vermont's roads and reducing vehicle emissions.

8.4.4 Geotargeted Areas

Switching customers in the capacity-constrained areas of Chittenden County and St. Albans to natural gas may help reduce the need for costly electric transmission upgrades.

[214] EIA http://www.eia.gov/state/seds/sep_prices/notes/pr_print2009.pdf

8.4.5 Incentives

Currently, the energy efficiency utilities offer customized incentives for switching to gas to customers using electric space and water heating in the natural gas service territory. VGS also offers incentives for higher-efficiency furnaces, boilers, and water heating systems.

Recommendations

(1) Foster opportunities to substitute natural gas for other fossil fuels.

(2) Continue offering support from the DPS and the PSB for the marketing and development efforts of Vermont Gas Systems to enable cost-effective service expansion and increase consumer opportunities for greater choice.

(3) Continue to provide incentives from the energy efficiency utilities and Vermont Gas for fuel switching from electric to natural gas, and from fuel oil and propane, particularly older systems, to natural gas.

8.4.6 Encouraging Greater Fuel Choice through Expansion of the Natural Gas System

In response to customer growth and system reliability, in 1994 VGS began a multi-year project to expand the capacity of its transmission system. Phases one through three of the system expansion resulted in a looping of the system from the U.S.–Canada border to Beebe Road in Swanton, approximately 9.1 miles. The fourth and fifth phases of this project that extended the system from Swanton to Nason Street in St. Albans were completed in 2004. In the summer of 2007, VGS constructed an expansion of its distribution system to make natural gas available to 650 homes and a number of businesses in Jericho village. VGS also expanded to Hinesburg and Underhill, and is expanding into Richmond. VGS is in the preliminary stage of considering expansion into the Middlebury/Vergennes area.

There is great potential for expanding the use of natural gas to fuel more of Vermont's energy needs. Expanding the natural gas service territory will provide all sectors with another heating fuel choice. It will also make more widely available a fuel that many industries would require if they were to locate in Vermont. Finally, encouraging natural gas expansion throughout the state would increase the competitiveness in the fuels market. As the natural gas service territory expands, natural gas will help keep prices for other fuels lower throughout Vermont.

Recommendations

(1) Encourage expansion of and upgrades to natural gas infrastructure to enhance system reliability, reduce costs, and expand natural gas service to more Vermonters.

(2) *Urge VGS to continue to evaluate the long-term feasibility of building new pipelines to connect Vermont with U.S. pipeline systems.*

8.5 Propane and Distillates

According to the DPS potential study, fuel oil holds the largest market share in Vermont, accounting for approximately 52% of the overall unregulated fuel consumption. It is most commonly used for space and water heating in residential households. Kerosene, used primarily for space heating where fuel tanks are outside, but also in stand-alone space heaters and to blend with off-road fuel to prevent gelling in cold weather, makes up a small portion of Vermont's residential energy consumption. Approximately 87 million gallons of distillate is sold annually for residential consumption. Liquefied propane gas (LPG), used in space and water heating along with its use as a fuel for cooking appliances and clothes dryers, is expected to continue its strong growth. Approximately 54 million gallons of LPG fuel is sold annually for residential consumption.

Commercial enterprises sometimes use distillate and LPG for space heating, but also use them for air conditioning, refrigeration, cooking, and a wide variety of other equipment. Total commercial consumption in Vermont consists of 25 million gallons of distillate and 32 million gallons of LPG.[215]

Industrial enterprises typically use distillate and LPG for manufacturing (or on the farm, in the forest, on the construction site, etc.) and almost never for space heating. Industrial consumption in Vermont consists of 22 million gallons of distillate and 7 million gallons of LPG.[216]

Approximately 200 heating fuel dealers serve Vermont customers. The vast majority of these companies are small second- or third-generation family-owned businesses.[217]

As mentioned previously, the Vermont Energy Act of 2011 set requirements for the addition of biodiesel to heating fuels beginning in 2012. The statute requires all heating oil sold within the state for residential, commercial, or industrial uses to ramp up from 3% biodiesel on July 1, 2012, to at least 5% by 2015 and 7% by 2016. The existing equipment and delivery infrastructure will allow the heating fuel industry to easily transition to this renewable fuel. Removing sulfur from heating oil and blending biodiesel into the supply will improve the efficiency of existing equipment and allow for installation of high-efficiency condensing oil heat boilers. Once the biodiesel market is established and production in the region is brought to scale, heating oil can be

[215] *2011 VFDA Heating Fuel Fact Sheet, Energy Information Administration,* http://www.eia.doe.gov/states/state.html?q_state_a=vt&q_state=VERMONT, *2008 data. The percentage of commercial sales used for non-heat applications is not determined in EIA data.*

[216] *2011 VFDA Heating Fuel Fact Sheet, Energy Information Administration,* http://www.eia.doe.gov/states/state.html?q_state_a=vt&q_state=VERMONT, *2008 data.*

[217] *Matt Cota, Vermont Fuel Dealers Association, 2011 VFDA Heating Fuel Fact Sheet.*

domestically produced, and a renewable fuel can displace 20 million gallons of fossil fuels—approximately one-fifth of Vermont's current heating oil consumption—by 2020.[218]

8.5.1 Challenges to Fuel Accessibility

Potential challenges to fuel accessibility include events as diverse as weather and international and domestic disruptions. Weather events could occur far from Vermont, such as in the Gulf of Mexico, and disrupt supply, or could occur in or near Vermont and affect the distribution of fuels to or within Vermont. International and domestic events that could affect supply of fossil fuels include political turmoil in the Middle East, domestic terrorism, or a domestic trucking strike. All of these events could also affect the price of fuel, which could exacerbate fuel inaccessibility to a portion of the population.

8.5.2 Emergency Preparedness

Emergency preparedness processes have been developed to address the challenges just mentioned. New England states and fuel dealers participate in regularly scheduled conference calls to discuss any issues related to liquid fuel supplies. In addition, if a situation were to occur that could lead to or that did result in a fuel supply disruption, these same conference calls would be instigated to discuss the status of the fuel supplies, and what would need to be done to restore fuel supplies.

The DPS received a federal grant to develop by August 2012 a statewide Energy Assurance Plan (EAP), the purpose of which is to ensure that Vermont has an adequate supply of energy. The EAP will also include an energy supply disruption tracking process, which will be used to collect data on supply disruption events in an effort to learn from these events and minimize the disruption of future events. The Department of Public Service is the lead agency for State Support Function 12 (Energy), which includes thermal energy. SSF12 is responsible for providing information to Vermont Emergency Management on the status of fuel supplies during an emergency. The DPS is working to closely coordinate SSF12 and the EAP in one effective process.

[218] *Matt Cota, Vermont Fuel Dealers Association, 2011 VFDA Heating Fuel Fact Sheet.*

9 Transportation and Land Use

Transportation and land use choices are inextricably intertwined, and they significantly affect Vermonters' daily energy demand and pocketbooks. A great deal of energy and money is spent moving from home, to work, to shopping, and to other activities. Demands on the transportation system are linked to land use decisions and where Vermonters choose to live, work, go to school, shop, or recreate. In order to achieve greater transportation system efficiency, land use and transportation planning must be successfully integrated. The state of Vermont is well positioned to take on the challenge of reducing energy demand in the transportation sector, by shifting to renewable sources of energy to power transportation, by working to make its vehicles more efficient, and by giving Vermonters transportation choices and alternatives to single-occupancy vehicle trips. This section focuses first on transportation policies and then on a complementary discussion of specific transportation energy–related land use strategies.

9.1 Transportation Introduction

Transportation is vital to the economic well-being of Vermont. It provides for the movement of people and goods, and is a requirement of modern living. The choices we make when taking the numerous trips in our daily lives—whether we walk, bike, ride share, take a bus, or drive alone in a truck or a hybrid car—affect demand on the transportation system. This in turn dictates the public and private costs of the system; the nature and extent of roads, parking lots, rail lines, and other physical infrastructure; the quality of life and economic opportunity in our communities; and the energy costs to individual households, businesses, and the state as a whole.

Transportation fuel accounts for the largest portion of Vermont's total energy consumption. Vermont consumes more fossil fuels than any other energy source. Gasoline and diesel account for more than a quarter of all energy consumed in Vermont, across all energy sectors. Gasoline and diesel consumption is twice that of fuel oil and kerosene used for heating. Petroleum combustion in the transportation sector is also the state's largest contributor to greenhouse gas emissions.[219]

Transportation in Vermont and throughout the U.S. is subject to price volatility and potential supply disruptions due to uncertainty in petroleum markets. Vermont residents and businesses spend a higher percentage of their income on transportation than the rest of the country. Due to the state's rural character, Vermonters travel farther from their homes to employment, services, and shops than many other Americans. Consumption of petroleum results in a tremendous outflow of wealth from our state. In 2010, Vermonters spent $1.1 billion on gasoline and diesel fuel for transportation.[220] The costs of gasoline and diesel are predicted to

[219] *Vermont Agency of Natural Resources.*

[220] *The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007,* http://www.uvm.edu/~transctr/trc_reports/UVM-TRC-11-007.pdf.

increase as demand increases and available supplies decrease worldwide. Reliance on imports means missed opportunities for generating Vermont jobs, and ultimately weakens our economic security for current and future generations.

For a thriving Vermont economy and quality of life, Vermonters need to move toward alternative sources of transportation energy, and to use what they have more efficiently. The net effect will be a healthier environment, healthier citizens, and a healthier economy with more dollars in Vermonters' pockets. Moving to a new transportation energy future will require state and regional transportation planners, the Vermont Legislature, businesses, and Vermonters to shift the way transportation is planned, funded, and used. Integrated state-level policies and actions at all levels are needed to achieve the following goals in the coming decades:

- **Reduce Petroleum Consumption.** We can reduce consumption by replacing current transportation energy—nearly exclusively petroleum fuel–based—with more sustainable, cleaner, and renewable fuel alternatives, such as electricity and natural gas, while increasing vehicle efficiency.
- **Reduce Energy Use in the Transportation Sector.** We can redesign our transportation system to include more efficient transportation options and land use patterns that maintain mobility for all and for the movement of goods, in order to ensure a thriving Vermont economy and quality of life.

The transportation section of the CEP has a number of subsections. The first describes Vermont's current transportation energy demand, and explains why the state should take action to reduce its dependence on petroleum by promoting alternative means of fueling our vehicles and increasing transportation efficiency. We then describe the state's advantages, opportunities, and challenges in pursuing changes to the transportation system. The concluding subsections outline measurable objectives and strategies aimed at achieving the goals of reducing petroleum consumption and increasing transportation energy efficiency. The final subsection addresses land-use initiatives and recommendations pertaining to statewide and local planning and regulation.

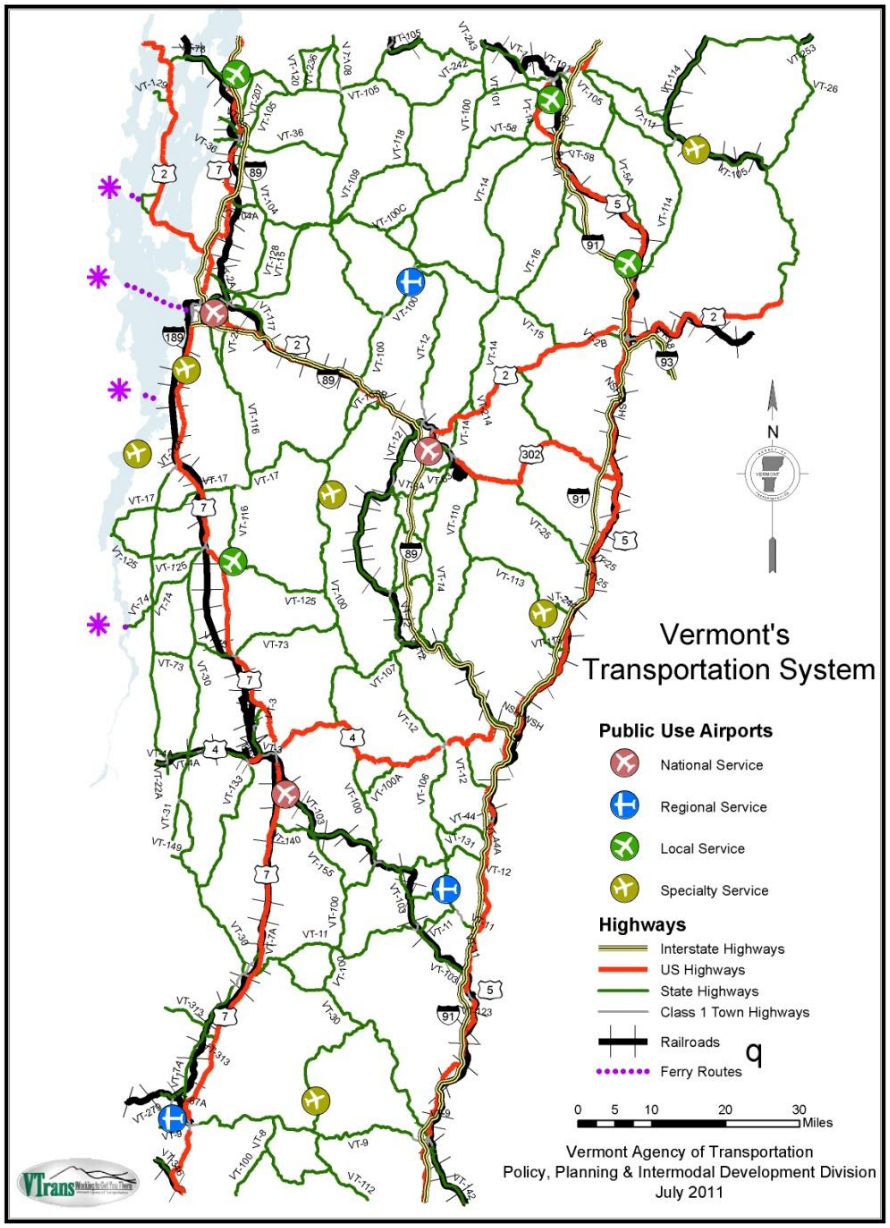
9.2 Vermont's Demand for Mobility and Transportation Energy

Vermont's transportation system includes:

- 14,135 miles of roadways maintained by the Agency of Transportation (VTrans) and municipal governments, including 320 miles of interstate highways and 693 miles on the National Highway System.
- 601 miles of rail serving both freight and passenger needs.
- 16 public-use airports.
- 10 regional transit providers that provide more than 100 transit routes throughout the state.

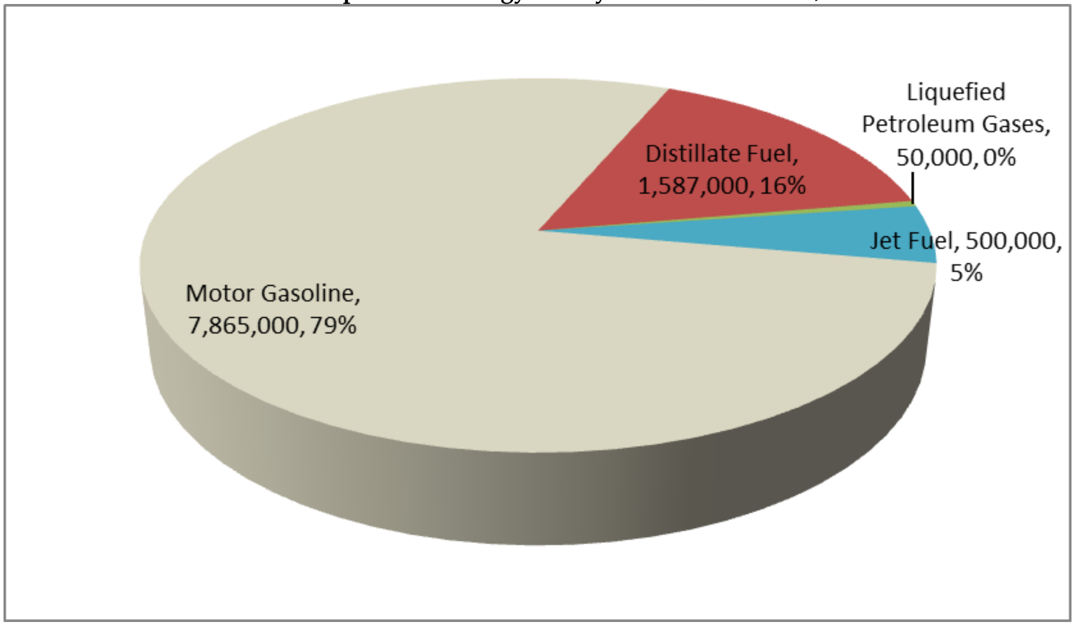
The transportation system also includes infrastructure and services to support biking, walking, and ride sharing. (See Exhibit 9-1; see also VTrans Fact Book 2011,)

Exhibit 9-1. Vermont's Transportation System



Motor gasoline accounts for the vast majority (79%) of transportation energy use, followed by distillate fuel (16%) and jet fuel (5%) (see Exhibit 9-2).

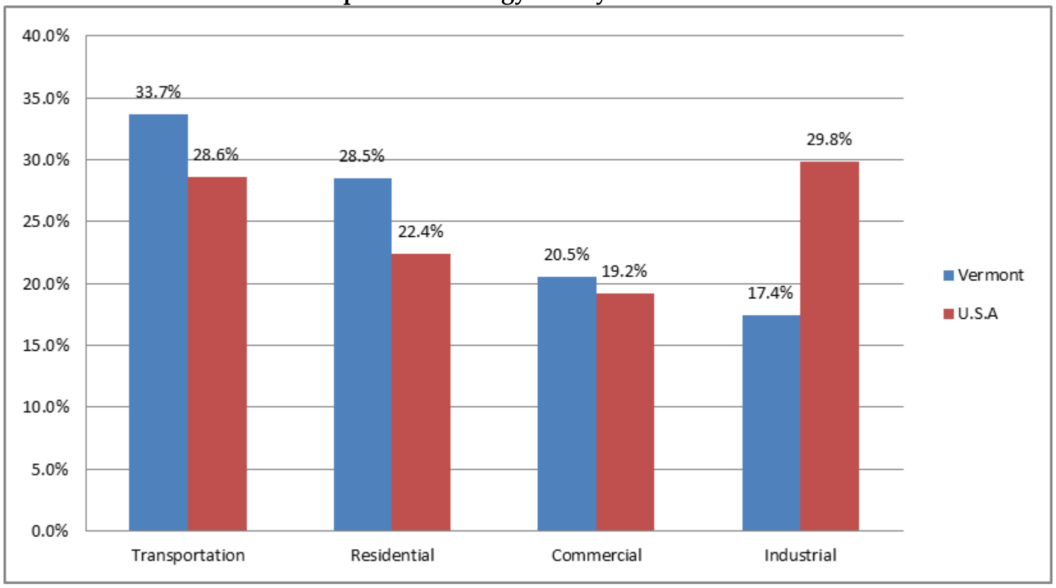
Exhibit 9-2. Vermont's Transportation Energy Use by Source (in barrels), 2009



Source: U.S. Energy Information Administration State Energy Profiles

Transportation accounts for the highest share of overall energy use in Vermont, at 33.7%. This contrasts with the national average, in which industrial energy use, at 28.6%, accounts for the highest share (see Exhibit 9-3). This difference can be attributed to Vermont's higher dependence on automobile transportation due to the state's rural character, as well as a proportionally smaller industrial base.

Exhibit 9-3. Vermont's Transportation Energy Use by Source



Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

The petroleum products used in the transportation sector fuel 99% of the state's 565,920 registered vehicles (see Exhibit 9-4). Although the percentage of hybrid vehicles has grown substantially since 2006, the composition of the state's registered vehicles remains dominated by vehicles powered solely by gasoline and diesel.

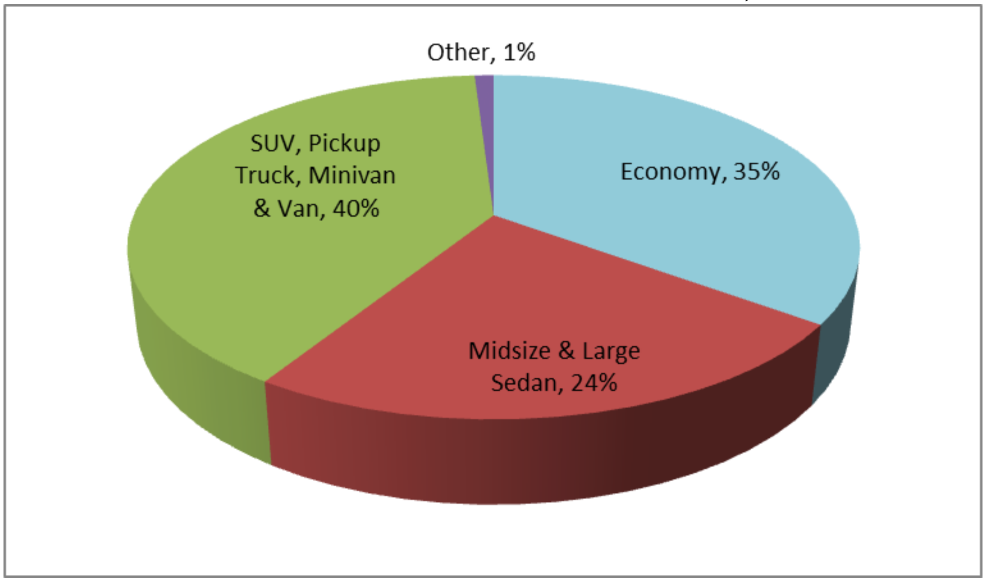
Exhibit 9-4. Vermont's Registered Vehicles by Fuel Type, 2007–10

	Registration Period				
	2007	2008	2009	2010	% Change 2007–10
Hybrid	3,651	4,565	5,473	6,335	73.5%
Electric	106	101	94	77	-27.4%
Propane	93	75	69	40	-57.0%
Diesel	31,648	32,140	30,724	25,025	-20.9%
Gasoline	583,568	578,881	528,930	514,894	-11.8%
Total	***619,066***	***615,762***	***565,290***	***546,371***	***-11.7%***

Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

New purchases in 2009 highlighted a preference for larger, less fuel-efficient vehicles (see Exhibit 9-5). More than 40% were SUVs, pickup trucks, and vans. Just over a third of recently purchased vehicles were in the economy class.

Exhibit 9-5. Vehicle Class of New Vehicles Purchased in Vermont, 2009



Source: The Vermont Transportation Energy Report 2009, Vermont Clean Cities Coalition, August 2010, TRC-10-017

9.2.1 Reasons for Action

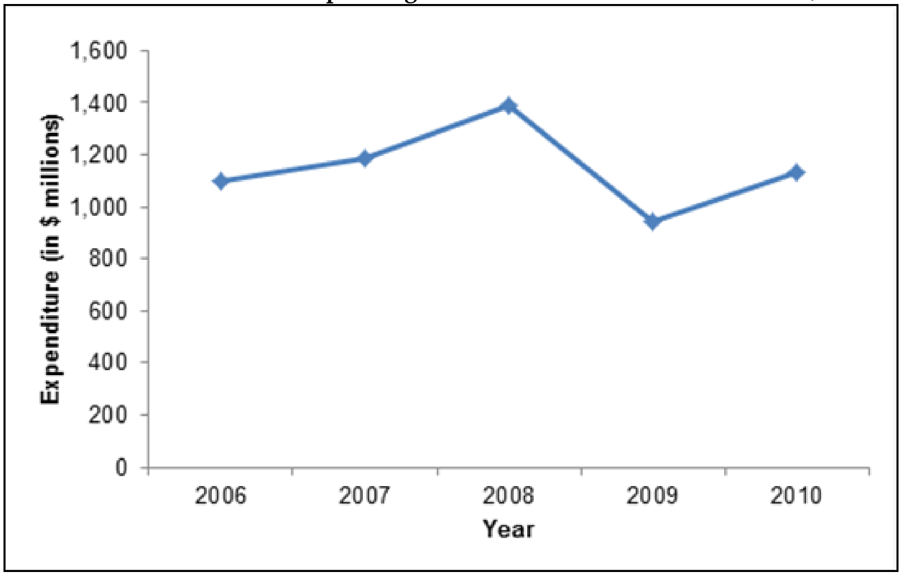
9.2.1.1 Reducing the Costs of Transportation for Vermonters and Businesses

Transportation is the second largest expense for American households, costing more than food, clothing, and health care. Even before the recent run-up in gasoline prices, Americans spent an average of 18 cents of every dollar on transportation, with the poorest fifth of families spending more than double that figure.[221] The vast majority of this money, nearly 98%, is for the purchase, operation, and maintenance of automobiles.

Addressing the cost of transportation is particularly important in rural states like Vermont, where residents spend a higher amount of their income on transportation than the national average. In 2010, approximately $1.1 billion of gasoline and diesel was sold in Vermont, a rebound from the 2008–09 decline, which is attributable to the nation's economic recession. (See Exhibit 9-6.) This sales number includes tourists and through-traffic fueling up in Vermont, which influences Vermont's energy demand. Without clear gasoline and diesel consumption projections to indicate otherwise, and considering the 2010 rebound, we assume that consumption patterns will return to their pre-2009 levels and rise accordingly as the economy recovers.

[221] www.completestreets.org/complete-streets-fundamentals/factsheets/transportation-costs/

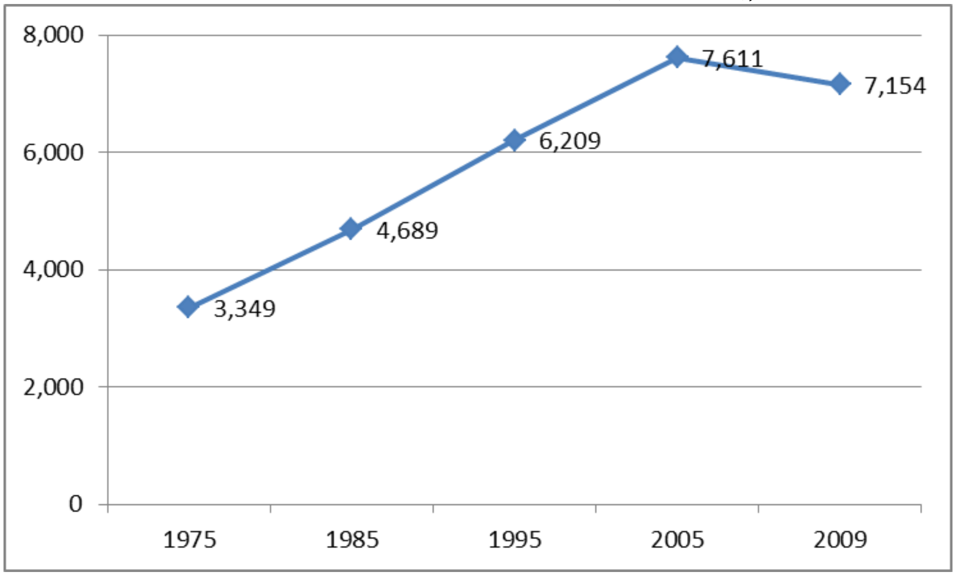
Exhibit 9-6. Total Annual Spending on Gasoline and Diesel in Vermont, 2006–10



Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

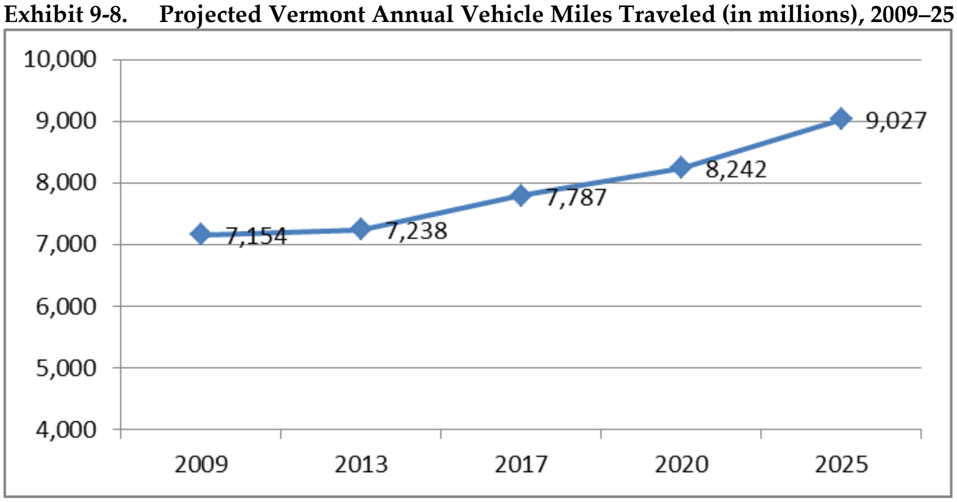
The increase in gasoline purchases also reflects significant growth in vehicle miles traveled (VMT). Travel on Vermont's roadways more than doubled between 1975 and 2009 (3.3 billion VMT in 1975 to 7.1 billion VMT in 2009), although small declines in later years are evident (see Exhibit 9-7). A slower but steady rise in VMT is predicted for the coming years, if current policies and usage trends continue (see Exhibit 9-8). Rising VMT has traditionally been an indicator of a strong and growing economy.

Exhibit 9-7. Vermont Annual Vehicle Miles Traveled (in millions), 1975–2009



Source: Vermont Agency of Transportation, Annual Vehicle Miles of Travel Historical Chart

Exhibit 9-8. Projected Vermont Annual Vehicle Miles Traveled (in millions), 2009–25



Source: Vermont Agency of Natural Resources

Our per capita VMT rates demonstrate Vermonters' automobile dependency. Per capita vehicle miles traveled in Vermont in 2009 was 12,297—a full 27.9% above the national average, putting Vermont sixth in the nation (see Exhibit 9-9).

Exhibit 9-9. Per Capita Vehicle Miles Traveled by State, 2009

Rank	Miles
1. Wyoming	17,580
2. Mississippi	13,695
3. New Mexico	12,944
4. Oklahoma	12,747
5. North Dakota	12,606
6. Vermont	*12,297*
7. Indiana	11,930
8. Alabama	11,906
…………	
46. Nevada	7,739
47. Hawaii	7,700
48. Alaska	7,063
49. New York	6,831
50. District of Columbia	6,017
National Average =	***9,620***

Source: FHWA Highway Statistics Series (2009) www.fhwa.dot.gov/policyinformation/statistics/2009/ and U.S. Bureau of the Census State Population Estimates (2009) www.census.gov/popest/estbygeo.html; Calculations by VTrans

Vermont's VMT numbers are greatly influenced by external factors that are beyond the state's control. Significant traffic passes through the state, including trucks serving New England's national markets, Canadians passing through to the eastern U.S., and Americans crossing northern New England.

Vermont is a rural state and, owing to a myriad of economic and cultural factors, has grown in such a way that people now often drive long distances to access important functions such as work, school, medical care, and shopping, compared with a generation ago. Although efforts are already under way to change this trend—by developing local economies and compact settlement patterns surrounded by rural countryside, and by providing transportation alternatives—reducing travel demand and VMT in a rural state such as Vermont is extremely challenging.

Another large portion of Vermont's VMT is tourist traffic coming into the state from all directions. Direct spending by tourists for goods and services totals approximately $1.42 billion.[222] A healthy tourism sector is

[222] *Data provided by Vermont Agency of Commerce and Community Development.*

extremely important economically. The state is working to increase tourism visits via passenger rail, intercity bus, and air service, and to improve intermodal connections and transit service so that cars are not needed when visitors arrive at their destination.[223] Nevertheless, these alternatives cannot in the near term address the state's tourism transportation demand. The state's rural nature and dispersed attractions, the prevailing car culture, and the state's heavy reliance on tourism make reducing VMT in the tourism sector a challenge.

Any specific Vermont VMT reduction goals should be targeted to that portion that can be influenced by state actions, such as commuter work trips and access to services. In addition, reducing the *rate of VMT growth* as a whole is a realistic strategy given that there is a significant portion of VMT over which the state has little influence or that should not be reduced at this time because of economic considerations such as tourism. Finally, considering VMT on an annual per capita basis makes sense.

Historically, Vermonters pay the national average for gasoline, but more for diesel (see Exhibit 9-10). In the past three years, diesel prices have been an average of $0.25 higher in Vermont than in the rest of the nation.

Exhibit 9-10. Average Annual Costs of Petroleum in Vermont and the U.S., 2006–10

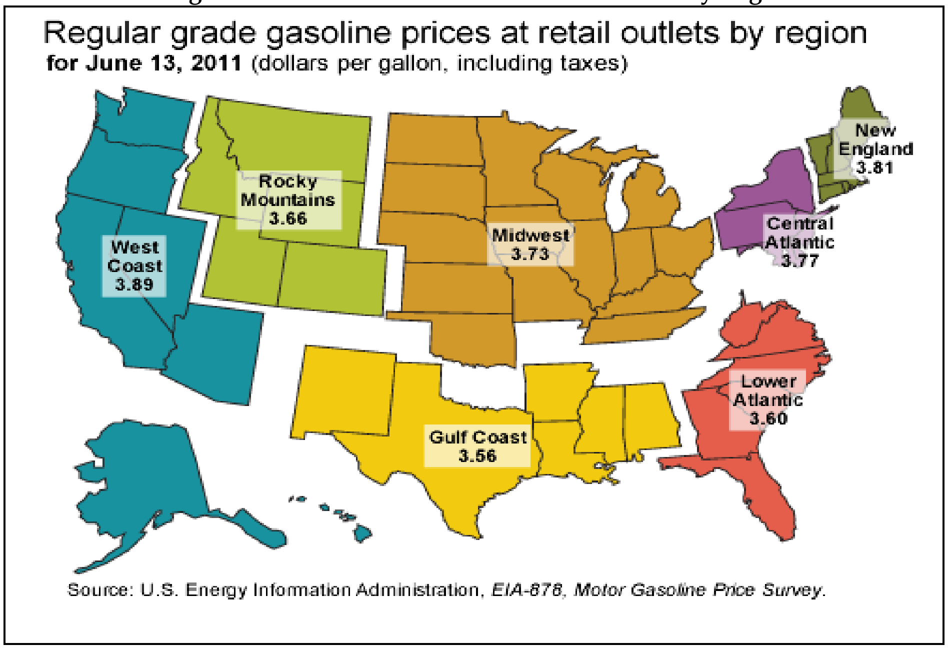
		Per-Gallon Price				
		2006	**2007**	**2008**	**2009**	**2010**
Vermont	Gasoline	$2.59	$2.81	$3.35	$2.34	$2.83
	Diesel	$2.86	$3.02	$4.13	$2.70	$3.16
U.S.	Gasoline	$2.62	$2.84	$3.29	$2.41	$2.83
	Diesel	$2.71	$2.89	$3.81	$2.47	$2.99

Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

Higher fuel prices are an issue throughout New England. The region pays the second-highest gasoline prices in the nation, after only the West Coast (see Exhibit 9-11).

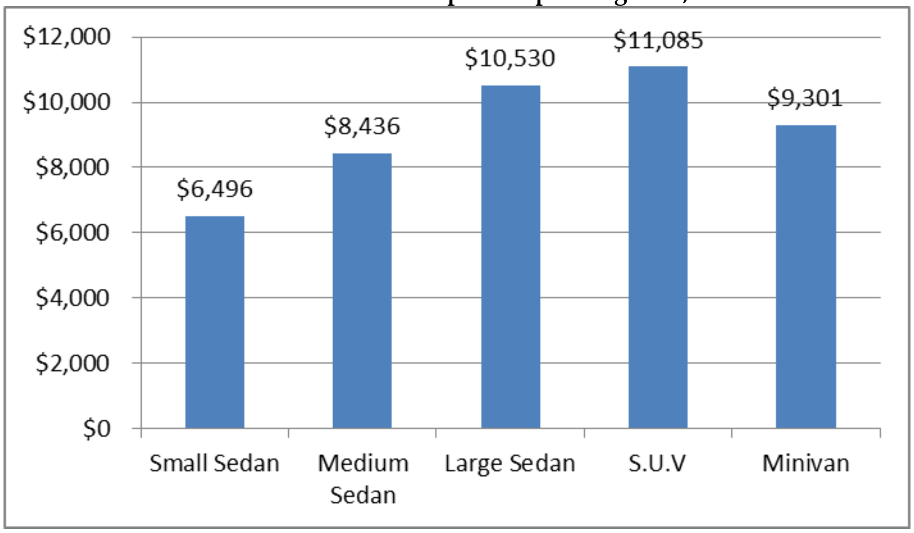
[223] *The Vermont Department of Tourism and Marketing is currently integrating transportation maps onto its website to help tourists plan multimodal transportation from location to location. Accommodating bicycle tourism has also been elevated as a priority, given Vermont's excellent reputation among bike enthusiasts from around the world.*

Exhibit 9-11. Regular Grade Gasoline Prices at Retail Outlets by Region



Gasoline and diesel prices contribute to the already high cost of vehicle ownership. Exhibit 9-12 displays ownership and operating costs for five vehicle classes. Not surprisingly, SUVs ($11,805) and large sedans ($10,530) have the highest ownership costs. Besides having poor fuel economy, these vehicle classes tend to carry higher maintenance and insurance costs.

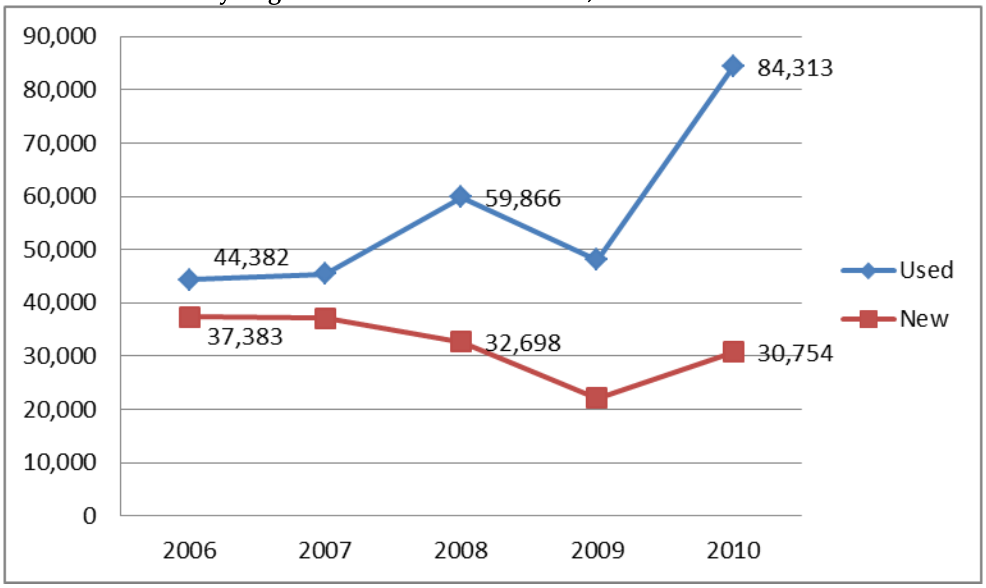
Exhibit 9-12. Annual Vehicle Ownership and Operating Cost, 2010



Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

The mounting cost of car ownership, compounded by the weakened economy, is reflected in vehicle purchase trends. The number of new vehicles purchased between 2006 and 2010 declined by 6,629, or 17.7% (see Exhibit 9-13). In 2005, 46% of all vehicles sold in Vermont were new vehicles. By 2009, this percentage had fallen to 27%.

Exhibit 9-13. Newly Registered Vehicles in Vermont, 2006–10



Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

9.2.1.2 Minimizing the Risks Posed by Petroleum Dependency

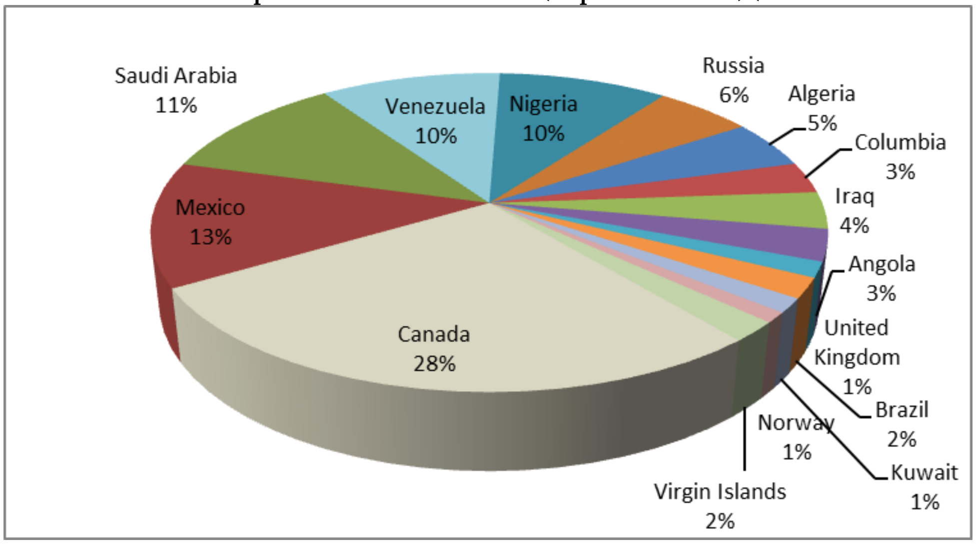
In 2009, the United States imported 11.7 million barrels per day (MMbd) of crude oil and refined petroleum products.[224] Nationally, gas prices have risen dramatically in the last several years. In January 2007, the average price of gasoline was $2.29 per gallon. By July 2008, it had increased to $4.11 per gallon.[225] Prices fell at the start of the economic recession, but they have since risen again. The trend toward higher gas prices has sensitized the public to the possibility of high long-term fuel prices, and has had several noticeable recent effects related to highway travel and use of public transportation.

Vermont, like the nation as a whole, is highly dependent on imported petroleum to fuel its transportation system. Just under 50% of petroleum products consumed in the U.S. are imported. As of May 2011, Canada (28%) and Mexico (13%) accounted for the highest share of U.S. oil imports (see Exhibit 9-14). A significant portion of oil imports come from parts of the world that have suffered political instability and supply disruptions.

[224] www.eia.gov/energy_in_brief/foreign_oil_dependence.cfm

[225] http://oilprice.com/Energy/Gas-Prices/Gas-Prices-Hit-Record-Levels-for-February.html

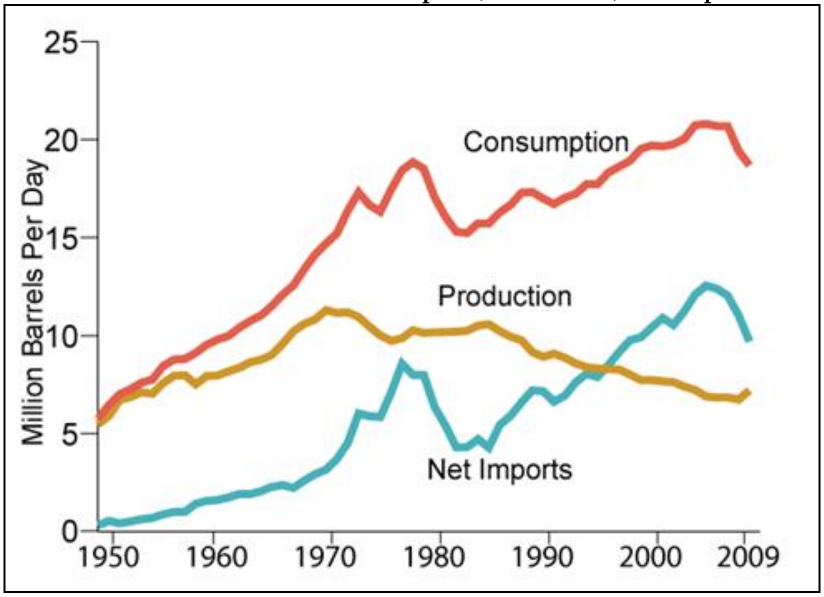
Exhibit 9-14. Total Imports of Petroleum to U.S. (Top 15 Countries) (Thousands of Barrels per Day), YTD 2011



Source: U.S. Energy Information Administration, Crude Oil and Total Petroleum Products,

Dependence on imports is related to both domestic consumption and domestic production. Since the 1970s, domestic petroleum production has remained relatively flat, while both consumption and imports have increased considerably (see Exhibit 9-15).

Exhibit 9-15. U.S. Petroleum Consumption, Production, and Import Trends, 1949–2009



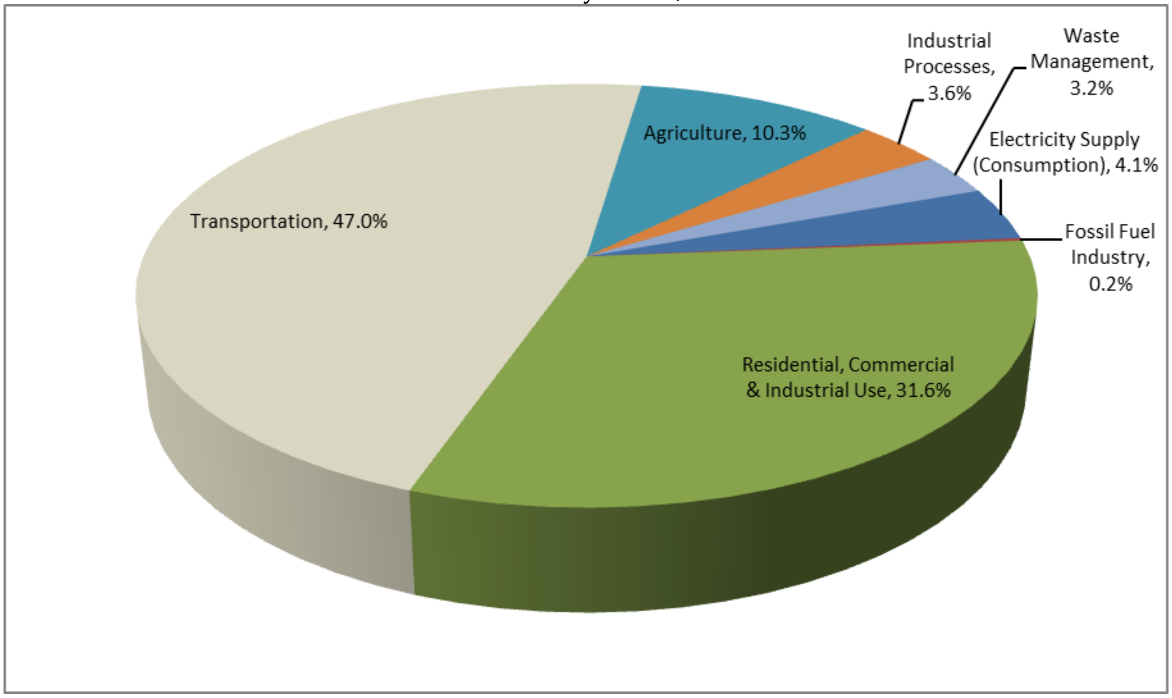
Source: U.S. Energy Information Administration, Annual Energy Review (2009)

9.2.1.3 Reducing Greenhouse Gases and Improving Our Air Quality

Reduction in petroleum consumption in the transportation sector will not only reduce the risks and costs of petroleum dependency but also significantly help reduce Vermont's greenhouse gas (GHG) emissions and improve the state's air quality. Our transportation energy choices and our impact on climate change are intertwined. By coupling the increased use of clean renewable fuels with more efficient transportation choices, Vermont can make progress toward its climate change goals and put itself on a path to a more sustainable future.

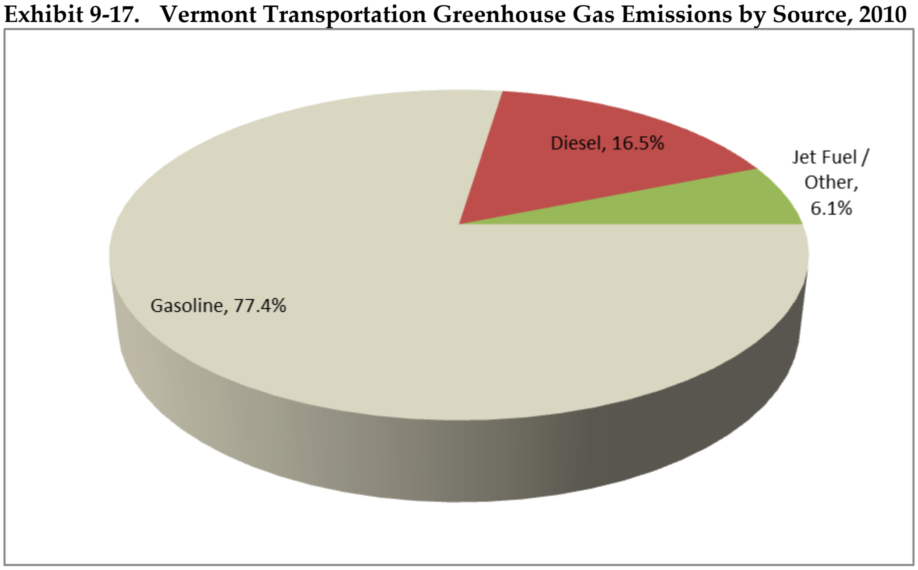
Exhibit 9-16 provides a breakdown of Vermont's greenhouse gas emissions by source. Transportation accounts for 47% of GHG emissions, and is the state's largest contributing sector. Approximately 94% of transportation GHG emissions are derived from the burning of gasoline and diesel (see Exhibit 9-17).

Exhibit 9-16. Vermont Greenhouse Gas Emissions by Source, 2010



Source: Vermont Agency of Natural Resources

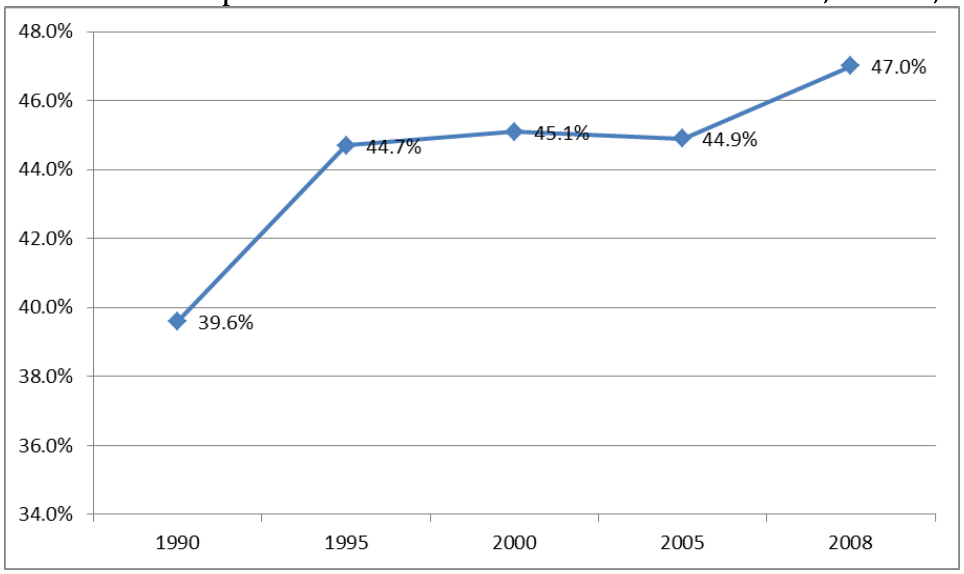
Exhibit 9-17. Vermont Transportation Greenhouse Gas Emissions by Source, 2010



Source: Vermont Agency of Natural Resources

Transportation's contribution to Vermont's greenhouse gas emissions has been steadily increasing since 1990. In 1990, the sector's contribution to overall greenhouse gas emissions was 39.6%. By 2010, it had increased to 47% (see Exhibit 9-18).

Exhibit 9-18. Transportation's Contribution to Greenhouse Gas Emissions, Vermont, 1990–2008



Source: Vermont Agency of Natural Resources (2010)

The combustion of transportation fuels emits not only greenhouse gases, but also a suite of other pollutants that are detrimental to air quality, the environment, and human health. On-road motor vehicles are the largest emissions source of many pollutants in Vermont. Each year, on-road motor vehicles traveling in Vermont emit:[226]

- More than 17 million pounds of volatile organic compounds (VOC) and 19 million pounds of nitrogen oxides (NOx), which together contribute to increased ground-level ozone concentrations that can trigger asthma attacks, harm the respiratory system, and cause widespread damage to crops and forests.
- Nearly three-quarters of a million pounds of particulate matter (PM), which, when combined with ground-level ozone and other gases, leads to haze that reduces visibility and harms human health.
- Approximately 210 million pounds of carbon monoxide (CO), an invisible, odorless gas that interferes with the delivery of oxygen to the body's organs and tissues.

[226] *Data provided by the Vermont Agency of Natural Resources.*

- Almost a quarter of a million pounds of sulfur dioxide (SO2), which, along with NOx, contributes to acid precipitation and causes adverse respiratory effects.

- More than 4 million pounds of hazardous air pollutants (HAP), all of which have toxic effects on human health and the environment. Many of these HAPs are also known or suspected to cause cancer.

What can be done to limit emissions from the vehicles we drive, while also helping curb the risks and costs of our dependence on petroleum? There are four key strategies that help save fuel costs and reduce air pollution emissions from motor vehicles, all of which have co-benefits related to energy efficiency and are directly related to strategies outlined in the CEP:

- **Clean Cars.** Continuing advances in motor vehicle emissions control technologies make it possible to reduce the amount of air pollution a motor vehicle emits. The Vermont Low Emission Vehicle (LEV) program plays an important role in making sure the new vehicles sold in Vermont meet stringent emissions standards. The LEV program also promotes clean advanced technology vehicles such as hybrid electric and battery electric vehicles.

- **Good Maintenance.** Cleaner cars retain their low emissions profiles only if they are properly maintained. Conventional vehicles also lower their emissions and fuel costs when everyday maintenance practices are followed. Vermont's vehicle inspection program, which includes evaluation of vehicle emissions control systems and requires repairs when problems are identified, is important in ensuring that vehicles continue to meet these stringent emissions standards throughout their useful lives. Additional benefits include enhanced vehicle performance and reliability.

- **Clean Fuels.** New fuel blends and alternative fuels have the potential to produce less air pollution than conventional fuels such as gasoline and diesel.

- **Wise Use.** The simplest way to reduce emissions from motor vehicles is to use them less. It is also important to consider the efficiency of various modes of transportation when moving people and goods from place to place. Efforts such as carpooling, taking public transit (bus, train, etc.), bicycling, and walking are all effective strategies in reducing air pollution.

Keeping motor vehicle air pollutant emissions in check is also a crucial step in ensuring Vermont's attainment and maintenance of federal national ambient air quality standards (NAAQS) for criteria pollutants (CO, NO_2, ozone, PM, SO_2, and lead). Historically, Vermont has had a few instances when NAAQS were violated; however, the state has met the NAAQS since the early 1980s. The Clean Air Act requires periodic review of the NAAQS and the associated scientific evidence to determine whether they need to be adjusted to adequately protect public health and the environment. More stringent standards for pollutants such as ozone will make it challenging for Vermont to avoid future violations of the NAAQS. More stringent NAAQS combined with the fact that annual VMT is expected to rise in the future underscore how important it is for Vermont to continue pursuing rigorous emissions reduction strategies for the state's transportation needs.

9.2.1.4 Positioning Vermont for Economic Growth

By shifting dollars over time from the $1 billion presently going out of state for purchase of petroleum fuels, Vermont has a tremendous opportunity to stimulate its economy. In addition to retaining more dollars in state to support other economic activity, a push toward a more renewable, sustainable transportation infrastructure in Vermont will spur in-state jobs and economic growth. Some of the fuel and vehicle technologies, such as innovative fueling infrastructure, needed to solve Vermont's transportation energy problems can be developed, manufactured, and deployed in-state. Supporting the market for these innovations will provide direct benefits to new and existing Vermont companies. In a transition to a cleaner transportation future, Vermont will also be able to retain, expand, and recruit clean energy and transportation companies. With strategic investments and smart policies, Vermont will become an exporter of advanced technologies and expertise to other states and countries, rather than depending on imports from abroad.

9.3 Opportunities to Meet Demand for Mobility and Reduce Transportation Energy

9.3.1 Policy Leadership and Willingness to Innovate

Vermont is well positioned to take on the challenge of reducing energy demand in the transportation sector and shifting to renewable sources of energy to power transportation. This policy direction is well established in existing policies and law.

The state has a track record of innovation in addressing environmental problems. Act 250 protects natural resources and ensures that infrastructure, including transportation, is available to support new development.

Vermont's Municipal and Regional Planning and Development Act (Act 200 amended Chapter 117) details specific land use goals and planning elements, including energy efficiency, with an overarching goal to "plan development so as to maintain the historic settlement pattern of compact village and urban centers separated by rural countryside." The Act also created two funding streams to support planning: (1) the Municipal Planning Grant program, which currently grants $400,000 to support municipal plans, bylaws, infrastructure planning, and related activities; and (2) regional planning funds, which provide $2.5 million for regional planning commissions to support regional planning, and for municipal planning technical support.

The Downtown Development Act recognizes the importance of downtowns, villages, growth centers, and neighborhoods. The designation processes for these areas ensures that they are appropriate for, and have planned for, compact and mixed-use development. The Act establishes programs in support of these areas—transportation grants, rehabilitation tax credits, Tax Increment Financing districts, and relaxed Act 250 thresholds—and directs a number of state funding programs to give priority to these areas.

"Complete Streets" legislation passed in 2011 requires that state and local transportation projects either meet the Complete Streets standards, or document why it is not feasible to do so. Complete Streets is a concept in which transportation planning and design safely accommodate motorists, bicyclists, public transportation users, and pedestrians of all ages and abilities. This standard supports compact development and thus alternative modes of transportation. Increased pedestrian access in smart growth locations such as downtowns and walkable neighborhoods have been shown time and again to be an economic development strategy that works.

Integrated transportation and land use planning connects VTrans's planning efforts with all the regional planning commissions in an organization known as the Transportation Planning Initiative (TPI) as well as with those of Chittenden County, which benefits from federal transportation planning resources because of its designation as a Metropolitan Planning Organization.

Most importantly, Vermonters themselves are passionate about environmental issues. There are active grassroots efforts acting on issues such as water quality protection, land conservation, renewable energy, and energy efficiency at the local and state levels. Hundreds of municipalities have official energy committees appointed by their selectboards to support municipal energy conservation efforts, including transportation. Some committees have contributed to the energy chapter of their town plans, and others are organizing local ride sharing programs, or are helping educate the public about energy challenges and opportunities at the household level.

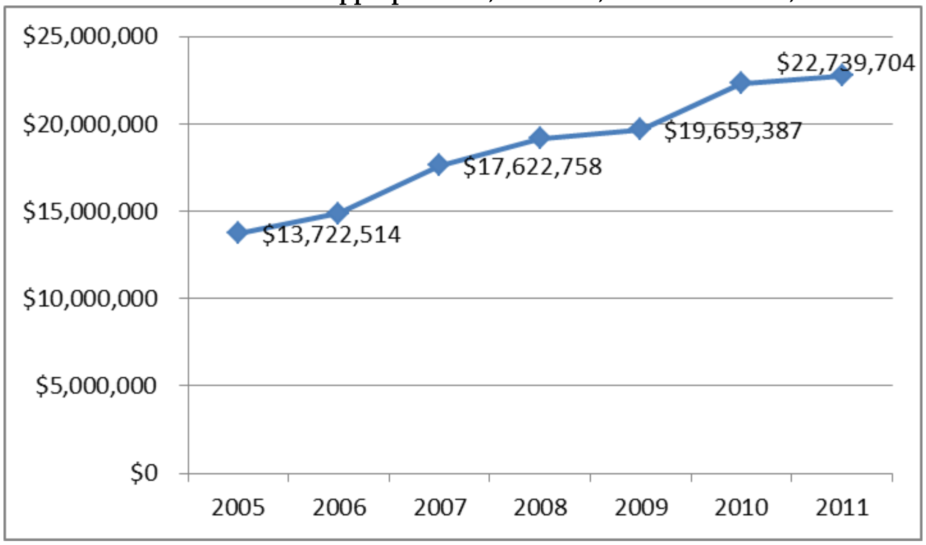
9.3.2 Transportation Efficiency Initiatives and Programs

9.3.2.1 Public Transit

Vermont spends a significant portion of its transportation budget on the capital and operating needs of the state's nine public transit providers. Local transit providers offer a range of services, including fixed and deviating routes, commuter transport, and demand response.

Vermont is recognized as a national leader in the provision of rural public transit, not only devoting substantial levels of state funding, but also "flexing" highway funds into transit (see Exhibit 9-19). For Fiscal Year 2011, VTrans's public transit budget is $22,739,704, representing a 65.5% increase from Fiscal Year 2005 levels. U.S. DOT discretionary funding in the past two years has resulted in approximately 80 new transit vehicles, replacing close to a quarter of the state's transit fleets.

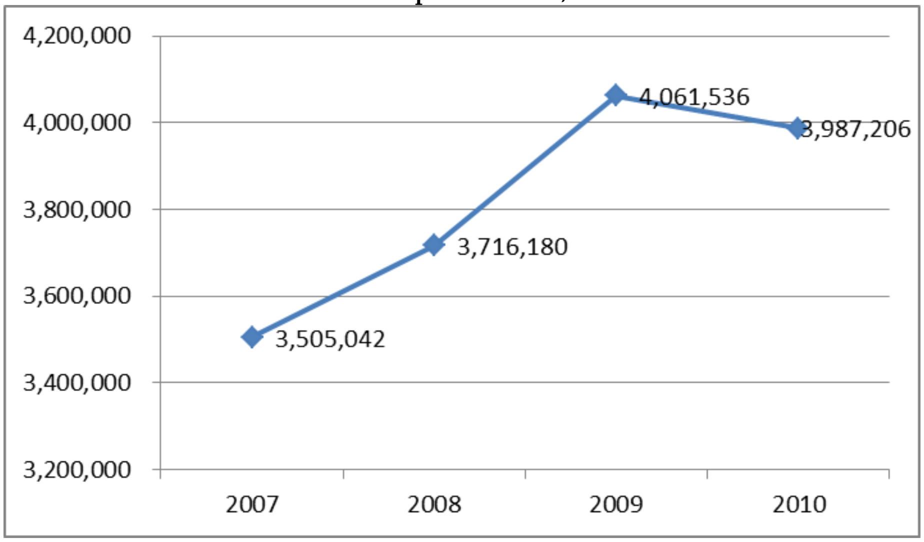
Exhibit 9-19. Public Transit Appropriations, Vermont, State Fiscal Year, 2005–11



Source: Vermont Agency of Transportation

The investments made in public transit have facilitated increased use. Ridership has increased by 482,640 trips, or 13.8%, since 2007 (see Exhibit 9-20). High fuel prices have also contributed to increased ridership, as commuter ridership growth has outpaced that of all other transit segments. Vermont also avoided reducing transit services in the wake of the recent recession as many other transit systems and states were forced to do.

Exhibit 9-20. Public Transit Ridership in Vermont, 2007–10



Source: Vermont Agency of Transportation; Chittenden County Transportation Authority

9.3.2.2 Go Vermont

Go Vermont is a free online public service and provides ride share, vanpool, public transit, and Park-and-Ride matches in seconds. It also serves as a web-based clearinghouse for alternative transportation programs in the state.

The Go Vermont program (www.ConnectingCommuters.org) replaced the Vermont RideShare program in 2009. Expanded services include the establishment of a statewide vanpool program, coordination with Maine and New Hampshire DOTs in order to implement a shared automated ride-matching software program, and the addition of the state's public transit routes to the ride share matching process.

There are currently 4,071 registered users in the Go Vermont program (up from 2,600 in October 2009). The average distance for users' trips to and from their worksite is 45.2 miles. Assuming 20%[227] of the registrants are participating in a carpool, vanpool, or public transit route, the program has resulted in the reduction of more than 9.7 million VMT, savings of $5.2 million in commuting costs, and avoidance of 9.2 million pounds of CO_2 emissions.

All Go Vermont registrants qualify for the "Guaranteed Ride Home" benefit and can obtain parking passes for designated carpool and vanpool spaces. In the event of an emergency (sickness, childcare, working late, etc.), the "Guaranteed Ride Home" benefit reimburses an individual up to $70 for an alternative way home, such as a taxi or car rental. This benefit is available twice a month and up to six times per year. However, fewer than 10 such guaranteed rides have been requested in the last three years of the program.

Go Vermont accounts for only a small percentage of the ride sharing taking place each day. Most people sign up for this program either to expand their search results or to qualify for the Guaranteed Ride Home benefit.

9.3.2.2.1 Go Vermont Vanpool Program

Go Vermont also offers a vanpool program in partnership with VPSI Inc., the leading vanpool provider in the country with more than 5,000 vanpools on the road in almost every state. The Go Vermont program subsidizes vanpools for up to $700 per month per vanpool, to offset the per-seat costs of its participants.

Vanpools are created by having eight to 15 people express interest. The group determines the likely route, potential drivers, and who would be the coordinator to collect the checks and receive van information from VPSI Inc. VTrans then meets with the group and provides an overview of the program. A 30-day automatically renewed contract (to avoid long-term commitments) is included. There are several van options—minivans and 12- or 15-passenger vans with some seat options—and a maintenance book included in the program. Service is scheduled with a local shop and is funded directly by VPSI Inc. The program also includes a gas card for fueling, and assistance in determining options for number of people, mileage, and price. Once a group agrees to and signs a vanpool contract, a new van is delivered within 14 days and a safety video is provided. Participants pay between $60 and $100 per month and enjoy saving more than 60% on their daily commute.

9.3.2.2.2 Other Go Vermont Programs

In addition to offering the vanpool program, Go Vermont staff began working with businesses in 2011. Efforts focus on communicating directly with employers and employees to promote awareness of commuting options and assistance in setting up programs for those who would like to save money and reduce their environmental footprint. More than 200 employers have been contacted, and more than 30 have thus far distributed the Go Vermont materials and promoted the program within their organizations.

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[227] *This is the national average calculated by the software provider.*

In the fall of 2011, Local Motion and the Vermont Energy Investment Corporation (VEIC) started working with three high schools to identify their existing transportation costs and environmental footprint, and appropriate actions the schools can take to reduce their costs and footprint. The group will measure the results of these efforts, and the schools will compete to have the greatest footprint reduction. Once this work is completed, it will be presented as a case study for other schools to use for their own transportation program. In 2012, we expect that the project will be expanded to include grammar schools.

The Go Vermont program is also currently providing a one-time $500 grant to municipal energy committees to help promote Go Vermont at the grassroots level. Promotional materials are being placed in municipal buildings and presented at energy fairs and similar events so that this state program is effectively marketed at the local level and the public becomes better informed with respect to their transportation choices.

In addition, the Go Vermont program subsidizes the annual Way to Go Challenge and other events that have raised public awareness of and commitment to reducing single-occupancy vehicle travel and reducing energy use and GHG emissions.

9.3.2.3 Telecommuting and Remote Conferencing

Telecommuting is a work arrangement in which employees enjoy flexibility in working location, thereby eliminating commute distance restrictions. Many work from home; others, occasionally also referred to as web commuters, utilize mobile telecommunications technology to work from other locations.

Analyses suggest that more than 50 million U.S. workers (about 40% of the working population) could work from home at least part of the time, yet in 2008 only 2.5 million employees (not including the self-employed) considered their home their primary place of business. Occasional telecommuters—those who work remotely—totaled 17.2 million in 2008.

Long-distance telework is facilitated by such tools as groupware, virtual private networks, conference calling, videoconferencing, and Voice over IP (VoIP). It can be efficient and useful for organizations because it allows staff and workers to communicate over a large distance, saving significant amounts of travel time and cost. As broadband Internet connections become more commonplace, more and more workers have enough bandwidth at home to use these tools to link their home office to their corporate intranet and internal phone networks.

The early adoption of local area networks promoted sharing of resources, and client–server computing allowed for even greater decentralization. Today, telecommuters can carry laptop PCs around which they can use both at the office and at home (and almost anywhere else). The rise of cloud computing technology and Wi-Fi availability has enabled access to remote servers via a combination of portable hardware and software.

Telecommuting offers benefits to communities, employers, and employees:

- **Communities**. Telecommuting can result in more employment opportunities (particularly for people living in remote areas), reduce traffic congestion and traffic accidents, relieve the strain on transportation infrastructure, reduce greenhouse gases, and reduce energy use.
- **Businesses**. Telecommuting expands the talent pool, reduces costs, increases productivity, reduces businesses' carbon footprint and energy usage, improves employee morale, and provides a continuity of operations strategy for employers during emergency conditions.
- **Individuals**. Telecommuting improves work-life balance, reduces people's carbon footprint and fuel usage, frees up the equivalent of 15 to 25 workdays a year—time workers would otherwise have spent commuting—and saves travel and work-related costs. When gas prices average $3.00 per gallon, the average full-time employee who commutes five days per week spends $138.80 per month on gasoline. If 53% of white-collar employees could telework two days a week, they could collectively save 9.7 billion gallons of gas and $38.2 billion a year.

Telecommuting gained more ground in the United States in 1996 after the Clean Air Act amendments were adopted with the expectation of reducing carbon dioxide and ground-level ozone levels by 25%. The Act required companies with more than 100 employees to encourage carpools, public transportation, shortened workweeks, and telecommuting. In 2004, an appropriations bill was enacted by Congress to encourage telecommuting for certain federal agencies. The bill threatened to withhold money from agencies that failed to provide telecommuting options to all eligible employees. On December 9, 2010, President Obama signed H.R. 1722, the Telework Enhancement Act of 2010, into law.

If the 40% of the U.S. population who hold telework-compatible jobs and want to work from home did so half the time, the nation would save 280 million barrels of oil annually. That savings would be the equivalent of taking 9 million cars permanently off the road.

No data is currently available on the number of Vermonters who telecommute. The 2000 Census identified 17,651 Vermont residents who work at home, but this includes primarily those who own their own business. The same Census data identified that 13.4% of Vermont's workers commute for 40 minutes or more to work. If even half of this group telecommuted, there would be a substantial decline in petroleum consumption and overall energy use.

9.3.2.4 Park-and-Ride Facilities

There are 27 state Park-and-Ride lots in Vermont, encompassing 1,142 spaces (see Exhibit 9-21). In addition, dozens of municipal lots are located throughout the state, many of which have been supported by the popular state municipal Park-and-Ride program, and there are many more informal places where drivers meet to ride share. Average utilization rates for state Park-and-Ride lots have increased from 60% to 70% since 2007.

Utilization rates at one-quarter of state Park-and-Ride lots exceed capacity. Park-and-Ride lots reduce energy use by increasing the efficiency of each vehicle, because the more passengers per vehicle, the more efficient the trip. The number of cars on the road is also reduced. In addition, Park-and-Ride lots support public transit by providing locations where passengers from distant rural neighborhoods can park their vehicles and meet the bus.

Exhibit 9-21. Vermont's Park-and-Ride Lots

Source: Vermont Agency of Transportation

9.3.2.5 Car Sharing

Car sharing is a neighborhood-based, short-term rental service that makes vehicles available on a per-use basis. Until recently, it was a trend largely restricted to urban areas, where alternatives to driving are more readily available. In 2008, CarShare Vermont launched in Burlington, demonstrating that car sharing works in nonurban areas. The impacts of car sharing are significant. A recent study of North American car sharing organizations conducted by the Mineta Transportation Institute shows that households that participate in a car sharing program reduce their emissions by 0.82 tons per year and reduce their driving by 40% to 60%. Further, each shared vehicle put into circulation is shown to remove an average of 13 from the road as people opt to shed excess vehicles. CarShare Vermont cites a number of individual and community benefits, including GHG reductions, cost savings, reduced traffic congestion, better land use, increased use of alternative transportation, and social equity.[228]

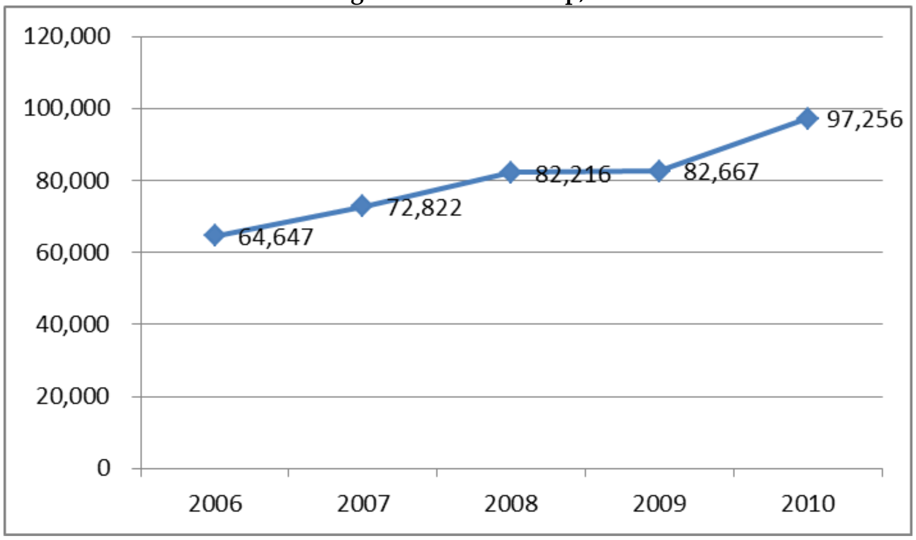
9.3.2.6 Passenger Rail

Vermont has been very active in supporting intercity passenger rail, providing approximately $4 million in annual operating subsidies for two Amtrak lines. The Ethan Allen Express provides daily service, one round trip a day, from New York City to Rutland, Vermont, by way of Albany, N.Y. The Vermonter provides daily service from Washington, D.C. to St. Albans, Vermont, offering connections to Baltimore, Philadelphia, and New York. One southbound and one northbound trip are provided each day. Other stops within Vermont include Essex Junction, Waterbury, Montpelier, Randolph, White River Junction, Windsor, Bellows Falls, and Brattleboro.

Intercity passenger rail trips in Vermont have increased by 60% to more than 97,000 since 2006 (see Exhibit 9-22). Vermont was recently awarded a $52.7 million Federal Railroad Administration high-speed and intercity passenger rail (HSIPR) grant to improve track speeds to 59–79 mph along the Vermonter route.

[228] http://www.carsharevt.org/green-benefits

Exhibit 9-22. Vermont Boardings Amtrak Ridership, 2006–10



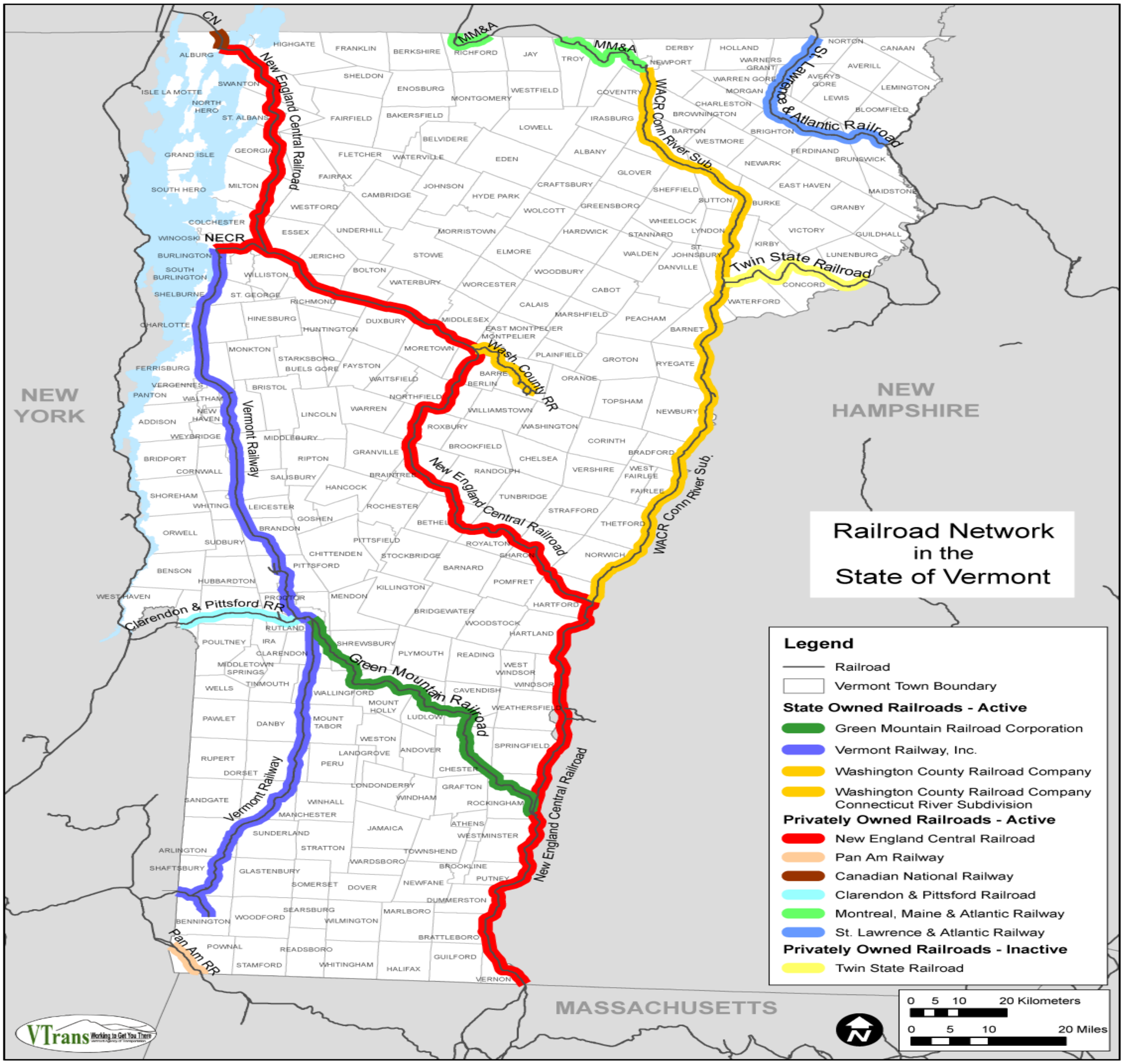
Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

9.3.2.7 Freight Rail

Freight rail is one of the most energy-efficient modes for moving goods. According to the Association of American Railroads, freight railroads can transport a short ton (2,000 lb) approximately 436 miles on a gallon of fuel.[229] Vermont has a comprehensive freight rail network of approximately 749 miles (of which 453 miles are state-owned). Ten short lines and regional railroad companies are operating or have trackage rights in Vermont (see Exhibit 9-23).

229 www.aar.org/NewsAndEvents/Press-Releases/2010/04/042110-EarthDay.aspx

Exhibit 9-23. Vermont Railroad Network



Source: Vermont State Rail & Policy Plan (2006)

In 2007, 68.5 million tons of freight was transported from, to, and through Vermont, 9 million (or 13%) by freight rail.[230] According to calculations from freight demand data included in Vermont's Freight Plan (draft pending), rail freight tonnage will increase by 46.5% to 13.2 million tons by 2039.

[230] www.aot.state.vt.us/planning/Documents/Planning/VermontFreightPlanTask4_31032010a.pdf

There are some challenges in increasing freight rail use. Most freight carried into or through Vermont originates out of state, is short-hauled on trucks, and is intended for use by private industry in wholesale and retail distribution systems called "just-in-time" delivery systems. Private industry owns much of the rail network in Vermont, and businesses' freight decisions are based on cost and timing. In addition, many of Vermont's railroad tracks and bridges have a weight limit of 263,000 pounds per railcar, whereas nationwide, the industry standard is 286,000 pounds. Some Vermont customers have to "light load" their railcars (meaning they are not loaded to capacity) to meet the required weight limit. Furthermore, many bridges across the state are in need of rehabilitation, and a number of areas need modification to allow for proper height clearance so railroad cars can be double stacked. A major investment would be necessary to remedy these deficiencies. According to the State Rail Plan Update (2005), more than $138 million would be needed to upgrade bridges and track in Vermont to safely accommodate 286,000-pound railcar loading.

These infrastructure limitations have received considerable attention from the U.S. Department of Transportation in the last three years. A renewed federal focus on rail has made significant numbers of discretionary grants available for freight projects. Both the HSIPR program (passenger rail) and TIGER Program (freight rail) have made more than $7 billion available for competitive grants to the nation's railroad companies and state DOTs. As noted above, Vermont has already been awarded one grant under the HSIPR program to make passenger rail improvements along the Vermonter route. In addition to increasing track speed to 59–79 mph, this project will improve tracks and bridges to the 286,000-pound standard, thereby ensuring a continuous 286,000-pound service from St. Albans, Vt., to Connecticut.

In addition to capital projects, a number of policy and institutional initiatives are under way to advance freight rail. The 2007 Conference of New England Governors and Eastern Canadian Premiers put a focus on freight rail by creating a Transportation & Air Quality Committee, tasked with engaging the private sector in a public–private partnership to study and develop the long-term interconnectivity of freight networks and facilities that could reduce the emissions impact of freight movement. In addition, the Northeast Mid-Atlantic States' Regional Transportation & Climate Initiative is taking a close look at freight movement and the associated GHG and energy implications of shifting from trucks to rail and short sea shipping. The results of these efforts, along with infrastructure improvements in Vermont, will lead to an increase in the proportion of freight that is carried by rail instead of trucks.

9.3.2.8 Biking and Walking

Biking and walking do not require petroleum or other energy sources and are proven to have health and quality-of-life benefits. In addition, access to walking and biking contributes to the economic vitality of downtowns and the state's outdoor recreation opportunities and tourist economy. Biking and walking are dependent on a complex network of trails, paths, sidewalks, and roads. This infrastructure network ranges from primitive trails on private or public property, to municipally maintained downtown sidewalks, to the paved shoulders of the state's major arterial roads.

VTrans supports biking and walking infrastructure in several ways. Grants are provided through the agency's local facilities programs to municipalities for bike and pedestrian infrastructure improvements. State paving and other safety improvements to the state roadway network make trips smoother and safer for cyclists and pedestrians as well as vehicles. "Complete Streets" legislation passed in 2011 requires that state and local transportation projects either meet the Complete Streets standards or document why it is not feasible to do so. Complete Streets is a concept whereby transportation planning and design safely accommodate motorists, bicyclists, public transportation users and pedestrians of all ages and abilities.

VTrans also administers the federal "Safe Routes to School" program. Safe Routes to School encourages children to walk and bicycle to school, enjoy the outdoors, and be more physically active. The program provides funding for infrastructure improvements such as new sidewalks and crosswalks, safety education, and enforcement of safety laws.

In 2009, the U.S. Department of Transportation performed a national household transportation survey (NHTS), a comprehensive survey of personal travel patterns. In Vermont, approximately 1,600 households were surveyed, and data was collected from at least 22 households in every county. Vermont's and the nation's walking and biking frequencies were estimated based on this data. Surveys were conducted throughout the year to avoid any seasonal bias. Trips included one-way journeys for any purpose (such as work, recreation, school, shopping, or physical exercise). Vermont rates were similar to those in other parts of the nation. Biking was a relatively rare activity, but between one-quarter and nearly one-third of people reported taking more than five walking trips a week (see Exhibit 9-24).

Exhibit 9-24. Vermont Bicycling and Walking Trips in the Previous Week

	Bike		Walk	
# Trips in Past Week	Vermont	National Average	Vermont	National Average
0	85.40%	87.20%	24.60%	32.10%
1-2	6.90%	8.20%	16.90%	16.20%
3-5	4.20%	4.40%	26.30%	24.10%
5+	3.60%	2.20%	31.60%	26.60%

Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

9.4 Fuel Efficiency and Emissions Programs: Current Status and Opportunities

9.4.1 Vermont Low Emission Vehicle (LEV) Program

Vermont has a long history of regulating automobile emissions to the greatest extent allowable under the federal Clean Air Act. Under that Act, Vermont has the option of accepting the U.S. Environmental Protection

Agency's motor vehicle emissions standards or adopting California's motor vehicle emissions standards. Vermont first adopted California's low emission vehicle (LEV) standards in 1996 because the California program placed more stringent standards on vehicle emissions than the EPA's program. Initially, Vermont established a low emission vehicle program to reduce smog-forming emissions and to stay in compliance with the National Ambient Air Quality Standards.

Since then, Vermont has amended its LEV rules periodically to remain consistent with California's rules. Subsequent amendments have included adoption of California's zero emission vehicle (ZEV) requirements and GHG emissions standards—both of which are significant elements of Vermont's climate change mitigation strategy, given that motor vehicles are the greatest source of GHG emissions in Vermont.

Most of the Northeastern states have also elected to adopt California's standards, as part of a regional effort to reduce air pollution and help mitigate climate change. The California vehicle emissions standards, which apply to new vehicles sold in Vermont and the other states that have adopted the standards, have helped spur technological developments, resulting in hybrid electric, full electric, and hydrogen fuel cell vehicles, as well as continuing advancements in significantly cleaner internal combustion engines. To meet the state's climate change goals and its goal of reducing transportation-related petroleum consumption, these types of vehicles must be introduced more rapidly in Vermont. Developing complementary policies to address infrastructure needs and to provide incentives to early purchasers will be essential to promoting the proliferation of these vehicles in Vermont.

9.4.2 Regional Clean Fuel Program

For the past two and a half years, Vermont has been part of an 11-state[231] group exploring a prospective clean fuel program for the Northeast/mid-Atlantic region.[232] A possible element of that program that has received significant attention from the group is a Clean Fuel Standard (CFS, sometimes called a Low-Carbon Fuel Standard or LCFS) that sets a target for lowering the level of greenhouse gases (GHGs) emitted from fuels sold within the region. Fuel suppliers would comply by demonstrating that GHG emissions from the products they sell in the region meet an annual GHG reduction target or by acquiring credits from low-carbon fuel producers. This allows suppliers to determine the most cost-effective combination of fuels and strategies necessary to

[231] *The New England states are Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island. The mid-Atlantic States are New York, New Jersey, Pennsylvania, Delaware, and Maryland.*

[232] *The Northeast States for Coordinated Air Use Management (NESCAUM) has posted its report "Economic Analysis of a Program to Promote Clean Transportation Fuels in the Northeast/Mid-Atlantic Region." The report looks at the potential effects of a program that would encourage the production of lower-carbon-intensity transportation fuels into the region. The report states that establishing a clean fuel standard for these 11 states could reduce gasoline consumption by as much as 30%, spur job growth, and save customers billions of dollars over the 10-year life of the program. See* www.nescaum.org/topics/clean-fuels-standard.

achieve the target. The group is looking at a program designed primarily to address transportation fuels, but the program could be applied to other related fuels and sectors (such as fuel oil for heating) as appropriate.

A CFS evaluates a fuel's life cycle GHG emissions per unit of energy ("carbon intensity," or CI) and over time reduces the average CI for fuels sold in the region from the current levels for the regional gasoline/ethanol blend and low-sulfur petroleum diesel fuels currently in use. Life-cycle analysis requires accounting for emissions from all aspects of a fuel's life cycle, including cultivation or extraction, production, processing, transport, delivery, and combustion. "Per unit of energy" is used as a standard in order to account for the difference in energy content of different fuels. Examples of lower CI fuels that are expected to be used for compliance are liquid biofuels such as cellulosic ethanol or biodiesel, natural gas, and electricity.

An important feature of a CFS is that it is designed to reduce the *intensity* of GHG emissions from fuels on a per-unit basis, rather than to cap transportation emissions in an absolute sense. For this reason, a CFS is most effective when deployed in conjunction with complementary state and regional policies such as the low emission vehicle (LEV) program, vehicle miles traveled (VMT) reduction strategies, and policies aimed at the electricity sector, such as cap and trade, energy efficiency, and renewable portfolio standards (RPS). All of these complementary programs are already in existence within the state and across the region.

A CFS requiring a 10% reduction in the carbon intensity of transportation fuel over a 10-year period in the Northeast could result in a reduction of 30 million tons of GHGs annually compared to business-as-usual projections.[233]

In addition, a successful CFS would reduce the region's dependence on imported petroleum, reduce the price volatility of energy, and encourage the development of a regional low-carbon fuel economy.

9.4.3 The Shift Ahead: Transportation Fuel Sources and Vehicles in Vermont

Federal policy is helping push market changes to lower petroleum consumption and emissions. During the 2011 summer, President Obama announced standards covering cars and light-duty trucks manufactured between 2017 and 2025. The standards require that by 2025 all new vehicles perform at an average of 54.5 mpg, with emissions of 63 grams per mile, or the equivalent. For the first time, fuel efficiency standards are also being set for medium-duty and heavy-duty trucks.

The DOE is leading a cooperative partnership, called U.S. DRIVE,[234] made up of technical experts from DOE, national laboratories, and industry, to advance the strategic development of clean, energy-efficient technologies

[233] *"Introducing a Low Carbon Fuel Standard in the Northeast: Technical and Policy Considerations," Northeast States Center for a Clean Air Future, July 2009.* www.eenews.net/public/25/12072/features/documents/2009/08/10/document_cw_02.pdf

[234] http://apps1.eere.energy.gov/news/progress_alerts.cfm/pa_id=532

for cars and light trucks as well as the supporting infrastructure. The goal is to protect American families from gas price volatility and to reduce dependence on imported petroleum.

Technologies to develop increased vehicle efficiency are part of the mix. In addition, alternative fuels, fueling infrastructure, and vehicles are being developed for deployment in the marketplace. Certainly in the future, fuels and vehicle technologies will be more diversified than they are today. Vermont's small market may require that we follow rather than lead technical vehicle innovation, except where we create clout in partnership with other New England states. With many developing technologies competing for national market control of the transportation sector, Vermont needs to be especially skillful and make savvy investments in technologies, both transitional and long-term, that position the state for the future.

The state considers that the conversion of Vermont's vehicle fleet to plug-in electric vehicles, including hybrids, is the best long-term path to reduce transportation fuel consumption by light-duty vehicles.[235] Vermont has a particular mix of early investment and expertise with renewable electric and smart grid technologies, plus resident PEV researchers, that would allow the state to be a national forerunner in the integration of these technologies.

In order to steer Vermont's market toward affordable, stable (in price and supply), energy-efficient, renewable, and low-emitting technologies, the state will support programs that result in well-timed adoption of alternative vehicles and fuels across Vermont. The following section presents background and discussion on promising alternative fuel and vehicle technologies.

9.4.3.1 Conventional Diesel Fuel

Of the 546,371 personal vehicles registered in Vermont during 2010, 94% were fueled by gasoline and 5% by diesel.[236] Most diesel fuel is consumed by heavy-duty vehicles, such as buses and commercial trucks. Environmental Protection Agency (EPA) rules in effect as of 2006 require "ultra low sulfur diesel" (ULSD) fuel to be used in 2007 and newer diesel vehicles. This fuel contains 97% less sulfur than conventional diesel and produces fewer particulate emissions. Further, the fuel enables the use of advanced emissions control technologies that are feasible and effective only with diesel fuel with very low sulfur content. The gains achieved with the ULSD requirement are a step in the right direction, but there is room for further environmental progress in the realm of diesel fuel use.

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[235] *Advancement in battery technology will determine when medium and heavy-duty vehicles can also be switched to electric.*

[236] *Personal vehicles include cars, SUVs, minivans, pickup trucks, and vehicles used for business and government purposes. Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011,TRC-11-007.*

9.4.3.2 Biodiesel and Diesel Vehicles

Biodiesel can be used as a fuel or an additive for all existing petro-diesel equipment. It is a cleaner burning renewable fuel. In colder climates, special steps are needed to use diesel, including biodiesel at 20% blends (B20) and higher—specifically, the use of cold flow additives or fuel heaters. To avoid potential problems with biodiesel blends, a 5% biodiesel blend (B5) is often used in the winter months, and a higher biodiesel percentage blend in the summer. When using B20, vehicles may have a 1% to 2% reduction in performance (power, torque, fuel economy); however, this difference is not generally discernible in day-to-day operations. As a benefit, biodiesel can reduce wear on engines, owing to its greater lubricity.

About a third of the biodiesel consumed in Vermont is used for transportation purposes, including off-road agriculture vehicles. The rest is blended with heating oil (typically a B5 blend) to meet a portion of our thermal needs. Biodiesel from oilseeds (soy, canola) is generally produced on farms for on-farm energy use and for sale in the immediate market, and it is not a primary farm product. Biodiesel from algae is in research and development; this technology is being tested for large commercial production and markets, which includes fueling on-road transportation. (See more on biodiesel production in Section 8.3.5.2—Projected Biodiesel Production in Vermont.)

Since the expiration of a federal tax credit in 2009, the production and use of biodiesel has shrunk.[237] Retail price comparisons for on-road transportation still favor petro-diesel. However, B5, used for on-road purposes, is the most widely available biodiesel blend and typically has only a 2- to 5-cent price premium per gallon.[238] Biodiesel is a desirable alternative to petro-diesel, especially when its market development is prioritized along with efforts to reduce all fuel consumption through transportation efficiency.

Exhibit 9-25. Diesel Sales in Vermont (millions of gallons), 2006–10

	Period					
Fuel Type	**2006**	**2007**	**2008**	**2009**	**2010**	**% change 2006–10**
Biodiesel	0.8	1.1	1.2	--	--	--
Diesel	72	70	64	59	60.5	-16%

Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

A number of barriers exist in the effort to increase demand for biodiesel in Vermont. Although the American Society for Testing and Materials (ASTM) designed a standard for pure biodiesel fuel blend stock (D-6751) in

[237] *Vermont Biodiesel Supply Chain Survey, Prepared for the Vermont Sustainable Jobs Fund.*

[238] *Report to the Legislature on Biodiesel Production and Use in Vermont, prepared for the DPS, by Netaka White, Vermont Sustainable Jobs Fund.*

2001, equipment and vehicle manufacturers are in different stages of testing, review, and revision of their warranties and owner's manuals.[239] Most major manufacturers now permit the use of B20 blends (and lower percentage blends) under their equipment warranties; however, guidelines and conditions vary. These inconsistencies and the potential to overstep the bounds of manufacturer warranties has led to consumer caution and uncertainty toward biodiesel blends in general.

Another barrier to greater use of biodiesel in Vermont is its availability. Biodiesel is currently available from only a handful of retail fueling stations around the state. The initial cost of adding a separate tank (although that is not necessary if all fuel is blended), along with uncertainties in the siting and permitting process, can dissuade fuel dealers or private companies from adding biodiesel to their fuel options. Technical assistance describing handling, storing, and using biodiesel, along with a description of Vermont's permitting requirements, could help expand biodiesel retail siting. A differential in the biodiesel fuel tax rate or a fuel tank installation incentive could also encourage more dealers to offer biodiesel.

At the height of Vermont's biodiesel sales in 2008, 22% of the 5.6 million gallons sold was used for transportation.[240] It was consumed primarily to fuel off-road, heavy-duty, and fleet vehicles, especially on farms. There is a great interest in helping Vermont farms become more sustainable and self-sufficient by increasing their ability to source their own energy through renewable resources. The Vermont Transportation Research Center noted that 967 vehicles registered in 2010 were farm trucks, and there are likely many more agricultural vehicles that are off-road and not registered. In 2010, the agricultural sector consumed 7 million of the 60.5 million gallons of conventional diesel sold.[241]

As of 2010, the average cost to produce biodiesel from oilseed crops grown on Vermont farms was $2.81 per gallon (this reflects all fixed and recurring costs). At current average retail diesel prices of $3.85 per gallon, farmers could save $1.04 per gallon on average by producing their own biofuel.[242] This cost savings is significant.

Even with favorable pricing for biodiesel, a number of challenges exist. Any combination of these factors could have a favorable impact on in-state biodiesel production and its use for transportation:

[239] *The National Biodiesel Board (NBB) provides comments on OEM information on standards and warranties:* *www.biodiesel.org/resources/oems/*

[240] *Computed based on data in two reports: (1) Report to the Legislature on Biodiesel Production and Use in Vermont, prepared for the DPS, by Netaka White, Vermont Sustainable Jobs Fund, and (2) The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007,* *www.uvm.edu/~transctr/trc_reports/UVM-TRC-11-007.pdf*

[241] *The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007,* *www.uvm.edu/~transctr/trc_reports/UVM-TRC-11-007.pdf*

[242] *Calculation based on the average of seven farms reporting cost of production data for 2010. Netaka White, Vermont Sustainable Jobs Fund.*

- Rising fuel costs.
- National or state policies that push markets to increase the use of low-carbon-intensity fuels.
- Increased public education about the positive economic, societal, and environmental attributes of biodiesel.
- Investments in biofuel sector development.
- Addressing the agricultural issues related to growing oilseeds in Vermont's northern and wet climate, which have resulted in the situation in which Vermont has more biodiesel production capacity than there are acres currently planted in oilseeds.

9.4.3.3 Ethanol 85 (E-85) Compatible Vehicles

Ethanol is primarily used as a gasoline additive in lower blends (up to 10% ethanol, 90% gasoline) to reduce emissions and increase octane. All car manufacturers have approved the use of lower blends of ethanol in their vehicles. Most gasoline sold in Vermont contains 10% ethanol. Ethanol can also be used in specially designed vehicles at higher blends (up to 85% ethanol, 15% gasoline). E-85 compatible vehicles have special hoses, valves, fuel lines, and fuel tanks that resist alcohol corrosion. The vehicles also have a fuel sensor to detect the amount of ethanol in the fuel tank.

Ethanol is produced by converting starches and sugars in biomass feedstocks such as corn. U.S. ethanol production has increased 10-fold since 2000 to 10.7 billion gallons in 2010,[243] making ethanol the most widely consumed biofuel in the U.S.

The Department of Energy has made significant policy and financial investment in the research and development of "cellulosic ethanol." These systems, still in the R&D stage, involve large-scale refineries and use the same fuel delivery model as gasoline. However, that model is subject to inherent market volatility and centralized control. One commercial-scale cellulosic ethanol plant requires more than 1 million tons of wood per year.[244] Vermont will use any national blend of ethanol in fuels; however, Vermont should not use its limited biomass resources for the production of ethanol.

9.4.3.4 Natural Gas Vehicles

Vermont has opportunities to realize the benefits of compressed natural gas (CNG) use for larger, heavy-duty vehicles and other commercial fleet vehicles, including transit, refuse, and taxis. Vermont has a natural gas pipeline that extends through Franklin and Chittenden Counties. There are plans to expand the pipeline into

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[243] *U.S. Energy Information Administration, Fuel Ethanol Overview, 1981–2009,* *www.eia.gov/totalenergy/data/annual/txt/ptb1003.html*

[244] *Data supplied by the Vermont Agency of Natural Resources.*

Addison County. In the communities served by the VGS pipelines, natural gas is used primarily for heating or cooling, cooking, and industrial purposes. Customers along the system could also use natural gas to fuel vehicles. Natural gas vehicle (NGV) deployment has been concentrated in and around population centers because of the availability of distribution infrastructure and the desire in populated areas to reduce emissions and air pollution. There are significant environmental and economic advantages to using natural gas, rather than gasoline and diesel, to fuel vehicles: At the source, emissions are lower; long-term operating costs are lower; maintenance intervals are less frequent; and supply markets have made natural gas more affordable than traditional petroleum-based fuels.

NGV benefits:

- **Emissions.** Compared with conventional light-duty gasoline vehicles, NGVs release 25% less carbon dioxide, 90% to 97% less carbon monoxide, and 35% to 60% less nitrogen oxide; particulate discharges are virtually eliminated.[245]
- **Price.** As of the summer of 2011, natural gas costs are $2.39 per gasoline gallon equivalent and $2.58 per diesel gallon equivalent. This represents a savings of almost 65% over conventional fuels.
- **Vehicle Availability and Maintenance.** Nearly every major U.S. medium and heavy-duty manufacturer offers factory-made NGVs, light-duty NGVs will become increasingly available as fleet owners adopt the technology, and existing vehicles can be converted.[246] Because natural gas is a cleaner and drier fuel, NGVs tend to go longer periods of time between maintenance. Some natural gas vehicle owners report service lives that are two to three years longer than gasoline or diesel vehicles.
- **Market Influences.** Crude oil markets have been volatile, resulting in gasoline price increases of 250% in the last 10 years.[247] Meanwhile, because natural gas markets are increasingly domestic and in many cases regulated, prices are typically more predictable. Over the same 10 years, natural gas prices have *decreased* 40%.[248]
- **Supply/Cost.** Current forecasts call for stable prices in the near term, due to increased supply projections. The impacts on price, from supply and evolving regulations on natural gas extraction,

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[245] *U.S. Environmental Protection Agency, 2002, Clean Alternative Fuels: Compressed Natural Gas,* www.afdc.energy.gov/afdc/pdfs/epa_cng.pdf

[246] *NGV America, public comment submitted November 4, 2011,* www.ngvamerica.org

[247] *American Petroleum Institute, 2011, U.S. Gasoline Situation Update,* www.api.org/aboutoilgas/gasoline/upload/gasoline-situation-update.pdf

[248] *U.S. Energy Information Administration, 2011, U.S. Natural Gas Wellhead Price (1973–2011),* www.eia.gov/dnav/ng/hist/n9190us3m.htm

need to be closely monitored.[249] Refer to Section 5.8.5—Vermont's Electric Supply—Natural Gas and Section 8.4—Thermal Energy Sources—Natural Gas for more discussion on natural gas supply and price in Vermont.

NGVs are most often used for buses and heavy-duty trucks. Internationally, natural gas vehicles are common—Brazil has more than 1.6 million, and India has nearly 1.0 million, natural gas vehicles.[250] The United States is shifting to natural gas vehicles for public transportation. As of 2009, about 18.6% of the nation's public transit fleet was powered by natural gas; 1,112 NGV buses were in service in New York City alone.[251] In January 2011, the transit authority of Los Angeles "retired" its last diesel bus; it now has 2,221 natural gas–powered buses.[252] Today, one out of every four buses ordered in the nation is powered by natural gas.[253] Vermont's northwest region served by VGS is also home to the state's more concentrated population centers. In the mid-2000s, Burlington and South Burlington collectively added six natural gas–powered trucks and cars to their fleets. The University of Vermont continues to transition its bus fleet to natural gas, and more than 50% of its fleet is now powered by natural gas. Casella Waste Systems recently added a private NGV fuel station to its Chittenden County operations, and acquired four trucks for its local fleet. Finally, Vermont Gas Systems currently has 10 NGVs for company use.

NGVs are more expensive than gasoline- and diesel-powered vehicles because natural gas storage cylinders are more expensive than gasoline fuel tanks. NGVs can be *bi-fuel*, that is, they can operate on natural gas as well as gasoline or diesel, or *dedicated*, that is, operate only on natural gas. Typical price premiums for NGV heavy-duty trucks and buses are $30,000 to $50,000; light-duty NGVs can be around $6,000 more expensive than those powered by conventional fuels.[254] Casella Waste Systems estimates that the incremental costs for its natural gas trucks will be made up in less than five years, because of the lower prices of natural gas. Until its expiration on December 31, 2010, natural gas vehicles qualified for a federal tax incentive that helped defray these incremental costs. In 2011, Congress has considered the "NAT GAS Act," which would encourage the use of natural gas in the transportation sectors through incentives for vehicles and infrastructure. This legislation has not yet been passed.

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[249] *Colorado School of Mines Potential Gas Committee, PGC Natural Gas Supply Report News Release, 2011,* *www.potentialgas.org/*

[250] *www.iangv.org/tools-resources/statistics.html*

[251] *American Public Transportation Association, 2011 Public Transportation Fact Book, p. 18,* *www.apta.com/resources/statistics/Documents/FactBook/APTA_2011_Fact_Book.pdf*

[252] *www.metro.net/news/simple_pr/metro-retires-last-diesel-bus/*

[253] *NGV America, Facts about Natural Gas Vehicles,* *www.ngvc.org/about_ngv/*

[254] *U.S. DOE/EERE, (2007) "Alternative Fuel Vehicles."* *www.eere.energy.gov/afdc/afv/gas_vehicles.html* *Estimates, including the Casella example, typically do not factor in the cost of stations.*

Filling stations for NGVs use natural gas from the distribution pipeline system. There are currently fewer than 1,000 natural gas filling stations nationwide,[255] making natural gas filling stations relatively rare. For these reasons, natural gas is currently best suited for fleet applications that can have access to a centralized station in a defined territory.

There are two forms of NGV filling stations: "fast-fill" and "time-fill." "Fast-fill" stations take gas from the distribution pipeline system, run it through a compressor, and store it in pressurized tanks at the filling station. Refueling an NGV at a "fast-fill" station takes about the same amount of time as refueling a traditional gasoline or diesel vehicle. "Time-fill" stations take natural gas from the distribution system and run it through a compressor directly into the NGV; there are no on-site storage tanks. As a result, time-fill stations are less expensive than fast-fill stations. However, to completely refill a depleted NGV from a time-fill station can take several hours. These stations are therefore best suited for fleets that return to a central refueling station.

Vermont currently has four natural gas filling stations in Chittenden County, none of which are open to the general public. Two are maintained by the Burlington Department of Public Works, one by Vermont Gas Systems, and one by Casella Waste Systems. In 2010, a total of 2.6 million cubic feet of CNG was sold at these stations, the equivalent of 20,000 gallons of gasoline or 19,500 gallons of diesel.[256] VGS has announced its strong interest in adding others, particularly a public station, as demand rises.

9.4.3.4.1 Renewable Natural Gas Fuel

Renewable natural gas (RNG) has limited potential in Vermont for fleet vehicles; it is not currently produced or used for transportation.[257] This biogas fuel is derived from organic waste (from landfills, wastewater treatment, or animal waste) and is produced through anaerobic digestion. Biogas is then purified to a high methane content to create RNG, which can power natural gas vehicles.[258] RNG also can be injected into natural gas pipelines. A 1998 DOE study concluded that about 1.25 quadrillion Btu of RNG could be produced; this volume would reduce gasoline consumption by 10 billion gallons per year.[259]

Vermont's numerous farm biogas digesters, which have been designed to produce electricity, could be retrofitted to produce RNG for farm vehicles and other vehicles in the area. In the near term, Vermont's small

[255] *U.S. Department of Energy: Alternative Fuels & Advanced Vehicles Data Center, 2011, Alternative Fueling Station Total Counts by State and Fuel Type, www.afdc.energy.gov/afdc/fuels/stations_counts.html and www.census.gov/newsroom/releases/archives/county_business_patterns/cb08-96.html*

[256] *The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007, www.uvm.edu/~transctr/trc_reports/UVM-TRC-11-007.pdf*

[257] *A renewable natural gas symposium was held October 17, 2011, hosted by the Vermont Clean Cities Coalition.*

[258] *Department of Energy Clean Cities Promise and Challenge of Renewable Natural Gas as a Vehicle Fuel, www1.eere.energy.gov/cleancities/pdfs/ngv_wkshp_neandross_intro.pdf*

[259] *Department of Energy, Biogas for Transportation Use: A 1998 Perspective, 1998.*

farms are not likely to produce enough RNG to offset the cost of the technology. Landfills could produce fuel for fleet vehicles, in particular for waste haulers.

9.4.3.5 Plug-In Electric Vehicles

The plug-in electric vehicle (PEV) is viewed as a promising advance in the transportation sector, and has been the subject of significant investment and market development in recent years. In February 2011, the Obama administration announced a goal of reaching 1 million PEVs on the road by 2015. The capabilities of the technology and consumer interest are steadily increasing. Developing and integrating the PEV market is key to reaping the greatest rewards from PEVs.

A number of Vermont state agencies and NGOs are part of the Transportation and Climate Initiative (TCI), which is a partnership of the state energy, environment, and transportation agencies from the Northeast and mid-Atlantic states and Washington, D.C., and 16 of the region's Clean Cities Coalitions. TCI has addressed PEV infrastructure planning as its principal project and has formed the Northeast Electric Vehicle Network. TCI has been awarded a DOE planning grant to accelerate infrastructure build-out for a network of PEV charging stations throughout the Northeast and mid-Atlantic region. The UVM Transportation Research Center also has a number of projects under way to study the potential impacts of increasing the penetration of PEVs in Vermont.

By 2009, Vermont had the fourth highest per capita number of hybrid vehicles in the U.S.,[260] leading to the possibility that Vermonters will be early adopters of plug-in electric vehicles. Vermont can position itself as an attractive candidate for funding to guide creative solutions for issues discussed below and to test aggressive adoption of PEVs in a rural environment.

9.4.3.5.1 PEV Market

If President Obama's goal of 1 million PEVs on the road by 2015 is met, PEVs would represent about 0.4% of all light duty vehicles nationwide and 1.6% of light duty vehicle sales between now and 2015.[261] Every major vehicle manufacturer is already producing or planning to release a PEV. These vehicles will encompass a variety of makes and models, including passenger cars, trucks, and commercial vehicles.[262]

Today, there are a number of PEV technologies, including plug-in hybrid electric vehicles (e.g., Toyota Prius and Chevy Volt) and battery electric vehicles (e.g., Nissan Leaf). An increasing number of medium- and heavy-

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[260] *Behind D.C., California, and Washington.* www.hybridcars.com/hybrid-sales-dashboard/december-2009-dashboard.html

[261] *EIA, Annual Energy Outlook 2011,* www.eia.gov/forecasts/aeo/

[262] *For more information, review the Department of Energy Clean Cities' Plug-In Electric Vehicle Handbook for Consumers,* www.afdc.energy.gov/afdc/pdfs/51226.pdf

duty PEVs are available. In Vermont, because of the need for cabin heat and defrosting during cold weather and the mountainous and often rugged terrain, extended-range plug-in hybrid electric vehicles will likely be the vehicle of choice, until substantial advances in battery technology hit the marketplace.

A major concern of consumers considering a PEV purchase is the limited mileage range of a fully charged vehicle. This concern is especially relevant until more public and employer charging sites are installed. Vehicle ranges continue to increase with advancements in vehicle and battery technology. Regardless, analysis of travel patterns indicates that even in rural Vermont, 69% to 84% of travel to and from home in a day is less than 40 miles,[263] and this is within the 30- to 50-mile capability of current extended-range PEVs. (See Exhibit 9-33 and the associated discussion.)

The greatest challenge for PEV markets is the higher up-front cost. The purchase price premium of a Chevy Volt compared to a Honda Civic is currently $15,000, even accounting for federal tax credits.[264] However, consumers who are well informed of the relative lifetime costs and environmental benefits may be more likely to switch to PEVs, especially if initial costs can be decreased.[265]

9.4.3.5.2 PEV Penetration in Vermont

Exhibit 9-26 shows that as of 2010, hybrid and electric vehicles made up approximately 1% of light-duty vehicles in Vermont. This followed a 73% increase in purchase of hybrid vehicles since 2007; the purchases of all other vehicle types over that same time span decreased. These trends appear to be motivated by Vermonters' environmental values; as prices become lower, Vermonters may increasingly favor electric vehicles.

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[263] *Aultman-Hall et al., "Travel Demand and Charging Capacity for Electric Vehicles in Rural States: A Vermont Case Study," Transportation Research Center, Aug. 1, 2011*

[264] *Michael J. Scott et al., Impact Assessment of Plug-In Hybrid Vehicles on Electric Utilities and Regional U.S. Power Grids: Part 2 Economic Impacts 4, November 2007*

[265] *Kurani et al., Plug-in Hybrid Electric Vehicle (PHEV) Demonstration and Consumer Education, Outreach, and Market Research Program: Volumes I and II. Institute of Transportation Studies, University of California, Davis, 2010*

Exhibit 9-26. All Vehicles Registered in Vermont by Fuel Type

Fuel	2010	%	Change 2007–2010
Hybrid	6,335	1%	73%
Electric	77	0%	-27%
Propane	40	0%	-56%
Diesel	25,025	5%	-21%
Gasoline	514,894	94%	-11%
Total =	***546,371***		

Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

Vermonters buy a new vehicle on average every nine years. Extrapolating current trends, preliminary estimates made by ANR indicate that by 2030, there will be approximately 10,000 PEVs, representing a rather modest 2% of all light-duty vehicles registered in Vermont.[266] However, current trends soon may be impacted by multiple factors, including the expanding availability of affordable PEVs, increased consumer discomfort with petroleum price volatility, and comparably lower costs per mile for electric charging. A forecast of PEV sales by the Center for Entrepreneurship & Technology at the University of California, Berkeley, estimates that PEVs will make up 64% of sales and 24% of all light-duty vehicles in the U.S. by 2030.[267] The Transportation Research Center's study on PEV vehicle market penetration estimated that from 50,000 to more than 100,000 PEVs, about 15% of our fleet, could be in Vermont by 2030.[268]

9.4.3.5.3 PEV Fueling Costs

Electric vehicles have a distinct advantage over internal combustion engine (ICE) vehicles, which operate at about 30% efficiency—70% of the energy of the fuel is wasted through heat loss in ICEs. Conversely, PEVs have one-tenth the number of moving parts that an ICE has and can transfer about 80% to 95% of their fuel energy into turning the wheels.[269] Electric vehicles can also recapture energy from braking. Converted to ICE

[266] *ANR projections were based on available vehicle registration data from the Vermont DMV and New England light-duty vehicle sales projections made by the U.S. Department of Energy—Annual Energy Outlook 2011 (AEO2011).*

[267] *Becker et al., "Electric Vehicles in the United States: A New Model with Forecasts to 2030," Aug. 24, 2009, Center for Entrepreneurship & Technology, University of California, Berkeley.*

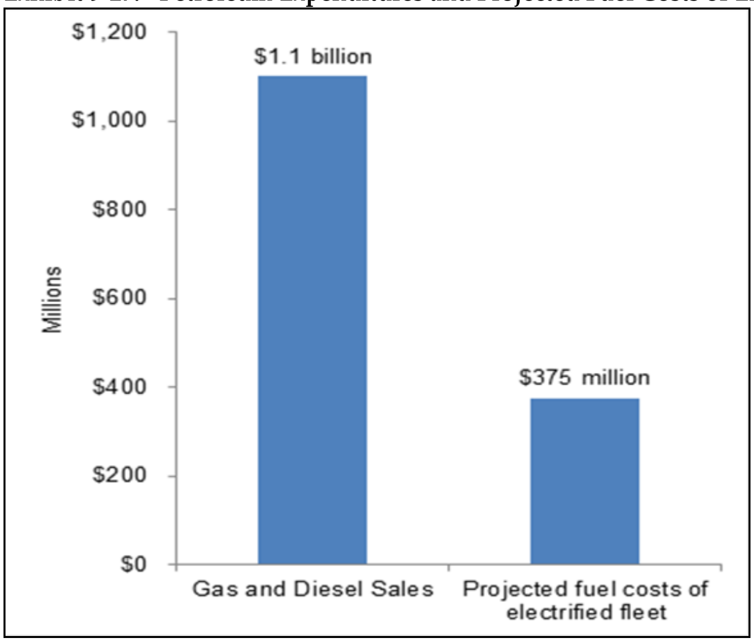
[268] *UVM Transportation Research Center, Plug in Hybrid Electric Vehicle Research Project: Phase II Report, 2010, UVM TRC Report # 10-00.*

[269] *However, if one considers line losses and other inefficiencies when calculating PEV efficiency, the number is significantly reduced because the electric transmission system actually loses about 50% of the energy generated.*

equivalents, a PEV can go about 112 miles per gallon of gasoline.[270] That is, PEVs are roughly three times more efficient than ICEs, in terms of energy consumption. The result is significant fuel savings and reduced emissions.

Exhibit 9-27 shows the theoretical savings from conversion to PEV, calculated in a recent study based on a certain set of assumptions; it shows that PEV charging may cost less than a third of the amount spent on petroleum fuels.[271]

Exhibit 9-27. Petroleum Expenditures and Projected Fuel Costs of Electrified Fleet (at December 2010 $/kWh)



Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

Except for the installation of charging stations, the infrastructure for supporting PEVs is available through the electric grid. However, the effect of increased loads will have to be accounted for and met. Because electricity is supplied through regulated utilities, PEV charging prices will be subject to the scrutiny of the Public Service Board.

9.4.3.5.4 EV Charging Infrastructure

Electric charging stations can be 120v, 240v, or higher voltages for fast charging. If planned correctly using advanced metering technology and efficient rate design, most charging could be done at home during off-peak

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270 www.saxton.org/EV/efficiency.php

271 *The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007,* www.uvm.edu/~transctr/trc_reports/UVM-TRC-11-007.pdf, *p. 5.*

hours. Proper installation of at-home chargers must be addressed; in addition, as PEVs gain in popularity, utilities will have to know where such vehicles will be charged to ensure proper load support and balance. Planners will have to address the needs of urban dwellers and housing complexes where PEV owners are less likely to own a specific parking spot. The build-out of electric vehicle charging stations at public sites and worksites is essential to the adoption of this technology.

Exhibit 9-28. Costs for Charging Options

Charging Type	Capital Costs
Home 110v–120v	Most likely minimal
Home 110v–120v	Most likely minimal
Home 240v	$1,000–$2,000
Public 240v	$10,000–$20,000
Public DC Fast Charge	~$100,000(?)

$1.00 per kWh equates to $8.00 per gallon of gasoline.
Source: James Robb, Northeast Utilities, "Plug-in Electric Vehicles: Putting the Fundamentals in Place," June 2011

A growing number of charging stations are available on the market. The systems include online and smartphone applications to direct customers to stations, make reservations, and monitor charging status. The owner of the station also has access to data used to analyze the charging patterns of all users. Today's typical PEV requires about four hours to fully charge (example: a Chevy Volt on a 240v charge).

Vermont currently has five charging stations—two public station owned by GMP at Saint Michael's College in Colchester and Healthy Living Market in South Burlington, one public and one private station owned by the Burlington International Airport, and one public station owned by CVPS in Rutland.

Alternatives to distributed single charging stations are battery swapping and battery refilling. Swapping entails exchanging depleted batteries for fully charged batteries. Refilling involves replacing the battery's liquid. These developing technologies aim to reduce the time required for customers to regain a fully charged battery; the goal is to match or beat conventional refueling times. In addition, these technologies could lead to exchange stations modeled after our current gas station infrastructure.

9.4.3.5.5 PEV Impact on Vermont's Electric Grid

An Oak Ridge National Laboratory study[272] suggests that vehicle penetration across New England of 2.64 million cars by 2030 can be accommodated with available grid capacity and without significant impact on peak

[272] *Hadlew, S.W. and A. Tsvetkova. Potential Impacts of Plug-in Hybrid Electric Vehicles on Regional Power Generation. ORNL/TM-2—7/150, Oak Ridge National Laboratory (2008).*

demand, if night charging is the norm. Evening charging does increase peak demand, but within the limits of available capacity (except during summer peak, when an additional 4% of electric capacity is required).

A Vermont-specific study by the Transportation Research Center also concluded that the Vermont grid can accommodate a large number of PEVs if vehicle charging is timed during evening and early morning hours; 200,000 vehicles could be charged with Vermont's existing electric capacity.[273] Another study by the Transportation Research Center[274] concluded that with modest PEV penetration of 100,000 by 2030, Vermont's existing electric infrastructure could accommodate load levels from vehicles charging during nighttime off-peak hours. With the addition of advanced metering technology and further innovations, PEVs may also be able to feed electricity back to the grid during peak hours, acting as distributed generation. PEVs charged at night, when rates are lowest, could feed the grid during peak rates and earn $1,000 to $2,000 of credits or reimbursements every year. The study authors estimated that PEV owners could provide 300 MW of generation to the grid with a storage capacity of 1,000 MWh.

A proof of concept demonstration on PEVs feeding electricity back to the grid (known as vehicle-to-grid or V2G) is currently under way through the Mid-Atlantic Grid Interactive Car Consortium (MAGICC). "The University of Delaware is a leading member of MAGICC and currently has several all electric conversions with V2G capabilities under the direct control of PJM, the regional grid operator. Researchers…have demonstrated that the highest value markets for V2G services are providing ancillary services, particularly frequency regulation. Grid operators have dedicated generators that can ramp up or down to correct for the instantaneous [mismatch] between supply and demand for power to meet the standard 60 Hz. frequency of the power grid. PEVs can provide this service, both discharging and charging from the grid in response to commands from gird operators. While PEVs can store low-cost energy at night and discharge that power during peak power prices, regulation is a much more valuable service and minimizes the wear and tear on the on-board battery systems. The ability to unlock the value of PEVs as distributed energy sources is a key to addressing the higher first cost and thereby accelerate their adoption to reap the environmental and energy security benefits that PEVs promise."[275]

To understand the environmental benefits of switching from petroleum to electric fueling, one must compare the environmental costs of petroleum to the costs of the electric grid fuel sources at the time the vehicle is charged. If Vermont achieves an electric portfolio with an even greater portion of generation from renewable

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[273] *UVM Transportation Research Center, Plug-In Hybrid Vehicles and the Vermont Grid: A Scoping Analysis, 2008: UVM TRC Report # 08-006.*

[274] *UVM Transportation Research Center, "Plug-in Hybrid Electric Vehicle Research Project, Phase Two Report", April 2010.*

[275] *Information in this paragraph is derived from Dr. Steven Letendre's (Green Mountain College in Poultney, Vermont) public comment submitted November 4, 2011. Findings are published in "A Test of Vehicle-to-Grid (V2G) for Energy Storage and Frequency Regulation in the PJM System: Results from an Industry-University Research Partnership,"* www.udel.edu/V2G/resources/test-v2g-in-pjm-jan09.pdf. *Dr. Letendre is a member of the research team.*

sources as suggested in the CEP, PEV charging can match the benefits of the renewable daytime mix (solar, hydro, wind, biomass) or the renewable nighttime mix (hydro, wind, biomass). Community and building renewable installations can be sited to accommodate the power needs of PEVs.

A high draw during peak load would reduce some of the environmental benefits of switching to PEVs if ISO-NE reserve generators are switched on line, because these generators are fueled by fossil fuels and have a higher GHG profile than baseload generation sources. Nonetheless, PEVs charged from natural gas sources still produce environmental gains compared to petroleum-fueled vehicles.

It will be important to continue investing in electric efficiency targeted at reducing both annual energy and peak demand consumption in order to facilitate a significant increase of PEVs connecting to the electric infrastructure grid. Even so, we may choose to add to our load in the coming decades to accommodate more aggressive adoption of PEVs, if the costs and benefits warrant it. Furthermore, pricing, regulations, and smart meter software need to be established to control charging at different times of day, especially during seasonal peaks. These mechanisms need to be tested while PEV penetration is still low; once PEV penetrations reach 10% of Vermont's fleet, these mechanisms become more critical. There will be additional costs for generation, transmission, and distribution if PEVs cause Vermont's load to grow beyond current forecasts.

Scenarios for daytime and nighttime charging, with different distributions and concentrations of PEVs across Vermont, have not been extensively modeled. Concentration will certainly occur earlier in communities where hybrid vehicles are prevalent and where business fleets are likely to adopt the new technology. Vermont's strategies for rolling out renewable electric generation, smart meters, and transmission upgrades need to incorporate planning based on carefully crafted PEV scenarios. We have the time to do this planning, if we press for it now.

9.4.3.5.6 PEV Environmental Impacts

The conversion to electric vehicles reduces emissions only to the extent that the emissions profile for all sources feeding the grid is cleaner than the emissions generated from traditional transportation fuels. Because Vermont's electric portfolio generates low emissions compared with those of many other states, the conversion from petroleum fuels to electric could be extremely beneficial in term of reductions for GHG and other pollutants. It is important that utility investments and resource plans carefully consider the impact and market acceptance of PEVs, in order to secure contracts from low- or zero-emissions sources that can meet PEV electric demand.

Home and business owners installing renewable electric systems will have the option of including their transportation energy needs in their goal to achieve a net-zero energy balance. For example, GMP has installed a solar PV system to feed the St. Michael's College charging station. PEVs use lithium-ion batteries. Manufacturing these batteries is expected to be a $100 billion industry within 20 years, and the main chemical used by lithium-ion batteries is ranked by the EPA in the same category of toxicity as mercury and asbestos.[276] Research and development is necessary to address these upstream environmental issues.

9.4.3.5.7 PEV Challenges

Today, the major barriers to electric vehicle sales are cost, consumer concerns about range limitations, and, in Vermont, availability. All major vehicle manufacturers are working on battery technology that will lower the sales price of current models and extend driving range. Cars will be rolled out to Vermont showrooms in the coming months.

To facilitate Vermont's careful but accelerated investment in PEV technology, issues that need to be studied and acted upon include:

- Charging price tariffs based on time of use, including fees that may be paid to customers for allowing PEVs to fuel the grid.
- Regulations related to connectivity and interface to the utility.
- Impact to local transmission capabilities (peak load and local PEV charging concentrations) and transformer aging (due to overload, night use, and use during hot weather).
- To what extent PEV customers, and to what extent public funds, will pay for infrastructure build-out.
- Integration of regulatory and pricing mechanisms across jurisdictions at all levels.

These are significant issues that will require coordination both in-state and regionally. We believe, however, PEVs will be—and should be—a significant and important part of Vermont's transportation future. We therefore recommend Vermont now engage in the planning and investment required to prepare.

9.5 Vermont's Transportation Challenges: Barriers to Change

9.5.1 Challenge: Transportation Funding

As stated previously, the transportation sector is dependent on petroleum as a source of energy. Most of Vermont's and the country's transportation programs are funded, directly or indirectly, through petroleum use via fuels taxes, vehicle registration and other motor vehicle fees, and the vehicle purchase and use tax.

[276] *The Green Highway, "Toronto company makes a non-toxic battery for green cars," by Michael Vaughan, July 15, 2011,* http://www.theglobeandmail.com/globe-drive/green-driving/news-and-notes/toronto-company-makes-a-non-toxic-battery-for-green-cars/article2096274/

The current transportation funding levels are not adequate to address the required maintenance of the existing transportation system. These funding limitations will be exacerbated in the future, as Vermont must simultaneously transform the system to reduce petroleum dependency, operate more efficiently, and meet climate change goals. Federal and state transportation funding mechanisms will need to recognize these priorities.

Vermont faces another dilemma as it moves forward to achieve the ambitious goals outlined in the CEP. Reducing petroleum consumption through the increase of alternative fuels, increasing the efficiency of existing vehicle technology, and providing efficient transportation options such as rail and transit services will all reduce revenues going to the state's transportation fund. The more diesel and gas that is sold, the more revenues go to the fund.

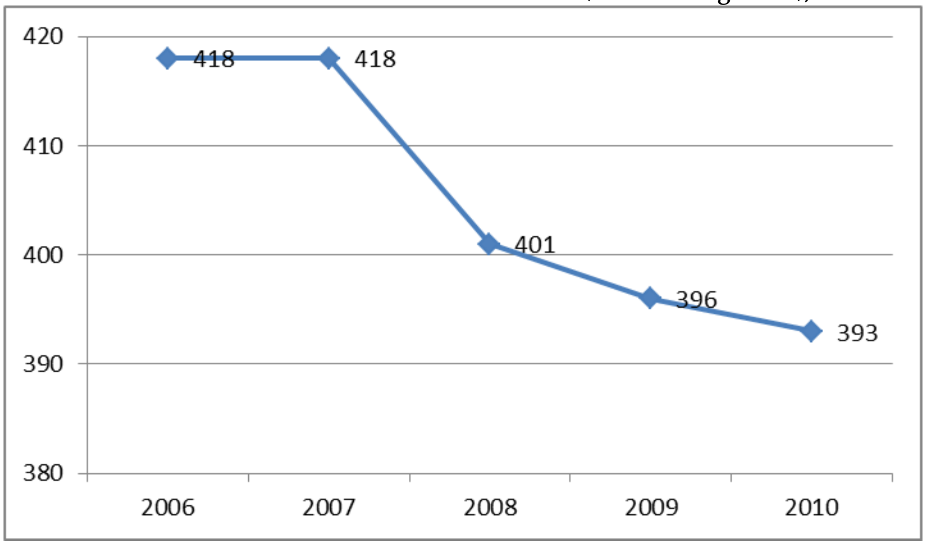
Funding levels are needed today to simply maintain roads and bridges in a state of good repair, and more will be needed to improve these facilities for vehicles, bikes, and pedestrians, as well as to grow rail and transit services. Achieving the CEP's objective of having 25% of all vehicles be powered by renewable sources by 2030 will mean a state transportation fund that is 12% less than today's budget, a level that will not address the state's transportation needs.

Basic maintenance cannot be ignored. Transportation infrastructure is inextricably linked to economic development and was developed in large part to allow businesses to function and to transport goods and services. Failure to keep up with infrastructure maintenance will result in Vermont businesses' losing their ability to compete.

Plan implementation must be coupled with changes in transportation revenue policy, specifically a shift from a fuel tax to a vehicle miles traveled (VMT) or other demand-based system. The same transportation challenge is being faced at the federal level, and some solutions may make sense at a multi-state regional level. Vermont must be a leader on this issue and not ignore the funding reality that transportation now faces and that will be exacerbated in the future as the state works to reduce petroleum consumption.

Exhibit 9-29 highlights how dependence on petroleum products can threaten the state's transportation fund. Gasoline and diesel sales in Vermont have declined by 25 million gallons, or 6%, since 2006.

Exhibit 9-29. Gasoline and Diesel Sales in Vermont (millions of gallons), 2006–10

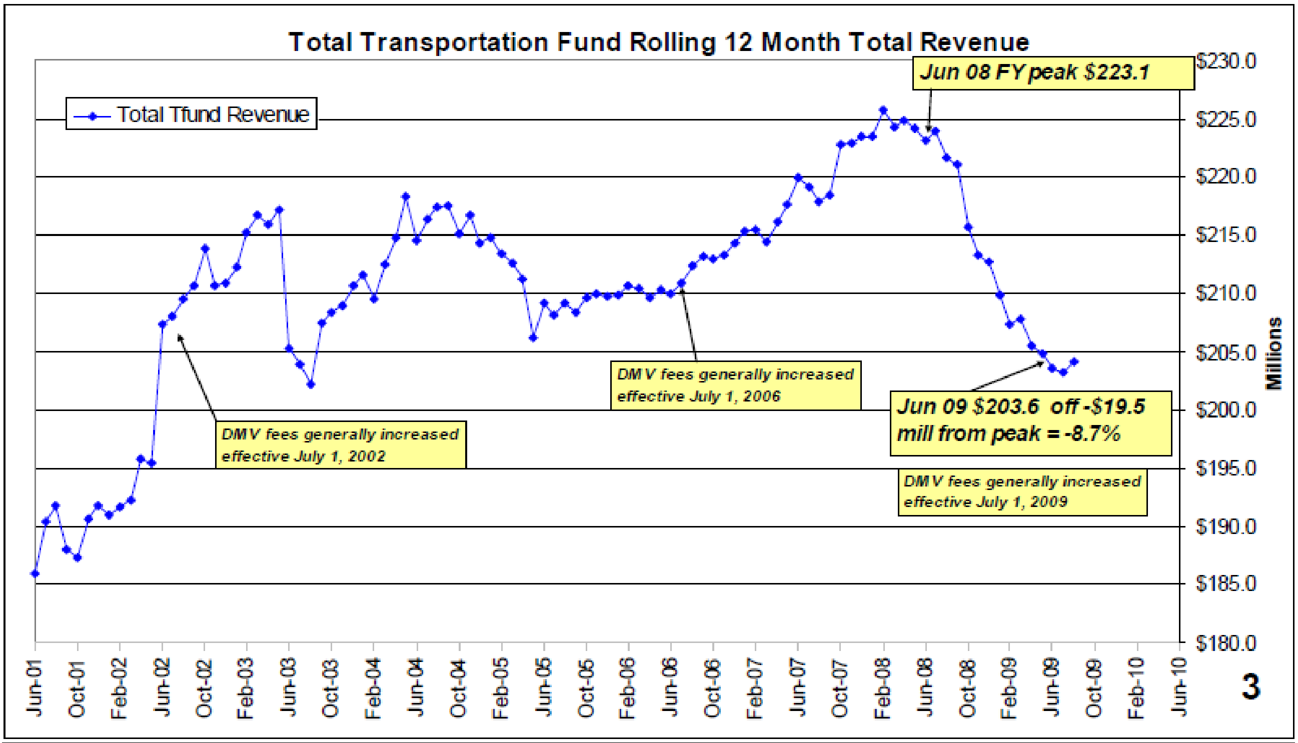


Source: The Vermont Transportation Energy Report 2010, Vermont Clean Cities Coalition, August 2011, TRC-11-007

Vermont's Joint Fiscal Office issued a report titled "Vermont's Transportation Funding: An Ongoing Dilemma" in October 2009.[277] The long-term problems identified in the report include an anemic revenue base and aging infrastructure. Exhibit 9-30 and Exhibit 9-31 show the state's historical transportation funding and gasoline tax levels since 2001. In both cases, there has been a substantial decline since 2008, leading to concerns about the future maintenance of the state's transportation facilities. Even prior to the 2008 decline, transportation fund revenue growth was modest at best.

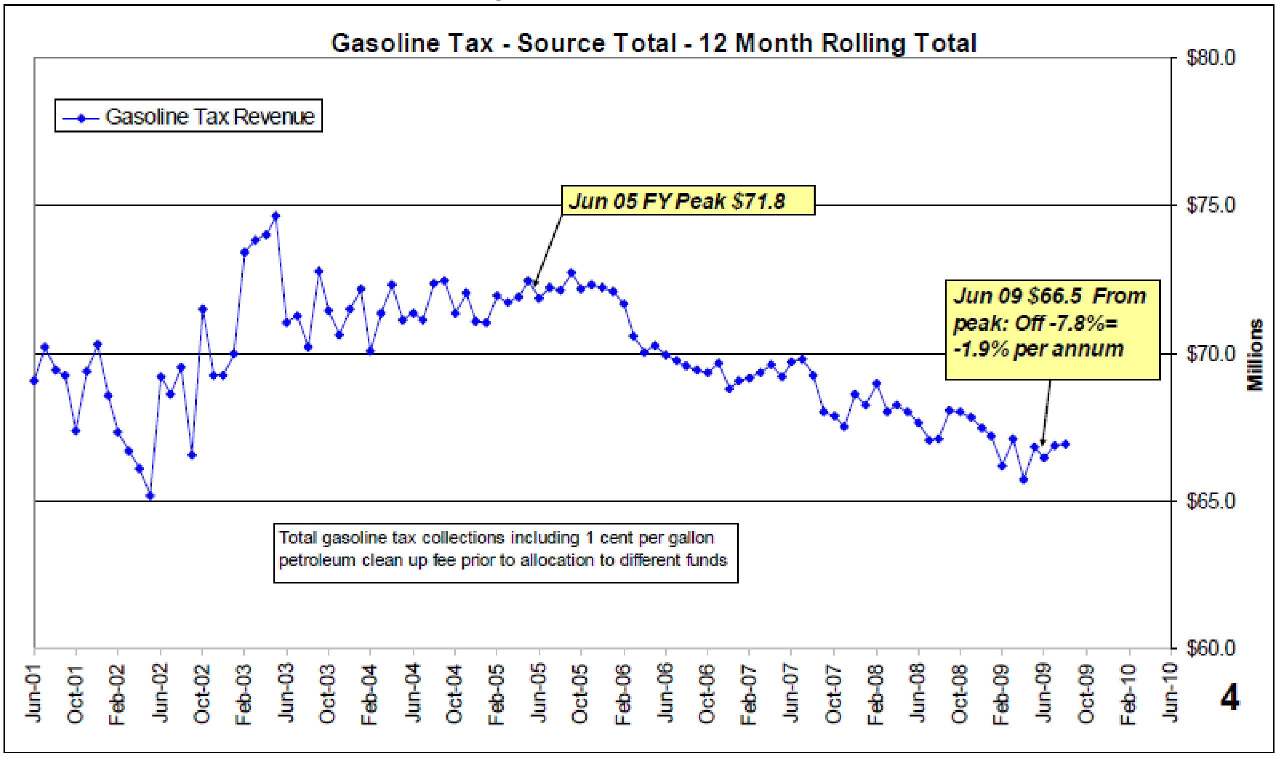
[277] www.leg.state.vt.us/jfo/issue_briefs_and_memos/Transportation%20Funding%2010-2009.pdf.

Exhibit 9-30. Total Transportation Fund Rolling 12-Month Total Revenue



Source: Vermont Joint Fiscal Office, Vermont's Transportation Funding: An Ongoing Dilemma (October 2009), www.leg.state.vt.us/jfo/issue_briefs_and_memos/Transportation%20Funding%2010-2009.pdf

Exhibit 9-31. Gasoline Tax, 12-Month Rolling Total



Source: Vermont Joint Fiscal Office, Vermont's Transportation Funding: An Ongoing Dilemma (October 2009)
www.leg.state.vt.us/jfo/issue_briefs_and_memos/Transportation%20Funding%2010-2009.pdf

Although the recent federal ARRA stimulus funding resulted in a number of important projects, Vermont is still faced with two important challenges: (1) the federal highway trust fund is in the red, and (2) even with new federal revenue streams, Vermont is having problems generating the state match required to draw down federal formula funds.

Aging infrastructure is another major problem. Highways and bridges are costly networks that age and need to be replaced. Vermont's highway system was built in two concentrated periods of investment: (1) in the 1920s and '30s when the national highway system was constructed and (2) in the 1950s and '60s when the interstate system was completed. The bridges built in the 1920s and '30s are now approximately 80 years old and approaching the end of their useful lives. They need to be replaced; simultaneously, the bridges built in the 1950s and '60s are now more than 40 years old and hitting the midlife point when they require major rehab work if their useful lives are to be extended and maximized.

The Joint Fiscal Office estimates that just to maintain the existing infrastructure in serviceable condition would require spending $415 million a year for the next 30 years. Our current level of spending on infrastructure preservation is $211 million, leaving a spending gap of $203 million. The consequences of this will be deteriorating conditions and higher repair costs, unless we proactively address it now.

9.5.2 Challenge: Dispersed Land Use Patterns and Automobile Dependency

The state's long-standing land use planning goal is to plan development so as to maintain the historic settlement pattern of compact village and urban centers separated by rural countryside. This requires the encouragement of concentrated mixed-use development in our community cores, while protecting natural resources and working landscapes outside those areas—the state's traditional land use pattern.

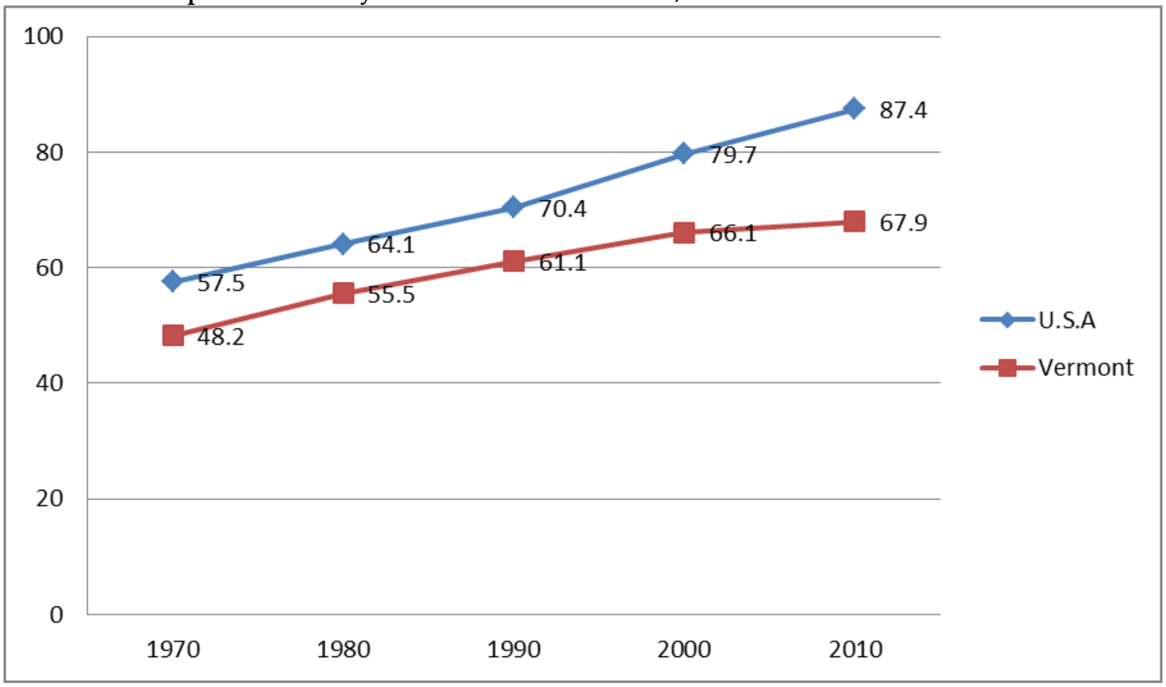
This goal is integral to a variety of public interests, including reduced development pressures on agricultural, productive forest, and natural resource lands, strong community centers, and economic development in those centers. The goal also has a major influence on the functionality of the transportation system, and as a result, on energy consumption.

Because much of the state's energy budget is spent on moving people from homes to work, shopping, school, or social gatherings, a compact development pattern helps reduce the energy used in moving those people. Compact development encourages more people to walk, bike, and use alternative modes of transportation to reach destinations within the community. And people are drawn from surrounding areas to the compact center, making interlinking regional transit systems and carpooling viable along common routes. Conversely, sprawl reduces transportation options and leads to reliance on single occupancy vehicles.

In planning for our energy future, therefore, it is critical that the state regional planning commissions and municipalities plan for development that takes place within a sustainable land use pattern. Vermont's rural towns and villages are largely intact. Vermont's 23 designated downtowns are home to 30% of the state's population. And our citizens are exhibiting increasing support for the institution of "smart growth" principles in town and regional development. However, the 2010 Census reported that most of the 23 designated downtowns grew at a slower pace than the state average, indicating that growth is going outside the core areas. This statistic is also evidenced by sprawl beyond our core centers and a concomitant greater reliance on cars for basic transportation needs.

The demands on the transportation system are influenced in large part by local land use decisions. Destinations and the distance from home to work, stores, and schools dictate the length and nature of trips. Although land use planning authority in Vermont fundamentally resides with local governments, the transportation sector plays a role in support of these efforts and works to ensure that the transportation implications of specific local plans are appropriately considered. In order to achieve greater energy efficiency within local and regional transportation systems, we should take steps to better integrate land use and transportation planning. Exhibit 9-32 highlights the changing population density of Vermont. Traditionally, Vermont's population density has been below the national average, a trend that persists today. The lack of a large urban area combined with its rural nature has resulted in lower population densities. (See Section 9.7—Land Use for further discussion and specific recommendations.)

Exhibit 9-32. Population Density in Vermont and the Nation, 1970-2010



Source: U.S. Census Bureauhttp://2010.census.gov/2010census/data/apportionment-dens-text.php

Despite below-average population densities in the state, a sizeable percentage of work trips (43.7%) are less than five miles from residents' homes (see Exhibit 9-35).

9.6 Conclusions and Recommendations—Goals, Objectives, and Strategies

9.6.1 Overview

Reducing petroleum-based energy use in the transportation sector is a complex problem with no silver-bullet strategy. To meet the state's energy goals, many strategies enacted together will maximize the effectiveness of any one strategy.

Energy use in transportation is also not a problem the state agencies can solve alone. Multiple partners must work together—the federal government, economic development interests, private-sector actors, the state's utilities, other alternative fuel providers, regional planners, municipal interests, regulators, environmental activists, neighboring states and provinces, and individual Vermonters and businesses making transportation choices.

In order to reach the goals and objectives outlined in the CEP, a change in consumer expectations and behavior will be needed. Some Vermonters have begun to change their transportation behavior as the price of fuel has risen in recent years, but a majority continue with business as usual and are paying increasingly more to maintain that convenience.

A number of specific strategies are outlined below that are designed to achieve three important goals.

- Reduce the state's transportation-related petroleum consumption through increasing the use of alternative fuels—most notably electricity from renewable sources and compressed natural gas (CNG)—and through increasing the efficiency of existing vehicle technology.
- Reduce energy use in the transportation sector by supporting a transportation system that provides more energy-efficient movement of people and goods and that includes options such as ride share, mass transit, and rail freight. How the state grows in the future—the locations of housing, jobs, commercial enterprises, and services, and the pattern of that development—will dictate the feasibility of more efficient mode choices.
- Ensure sufficient funding for appropriate transportation infrastructure as Vermont works to achieve the ambitious goals outlined in the CEP.

9.6.2 Goal #1: Reduce Petroleum Consumption in the State of Vermont

Because transportation accounts for the highest share of energy use in Vermont, policies that address this sector have a proportionately larger impact on the state's overall energy consumption. Most transportation sector consumption is in gasoline and diesel fuels, both petroleum-based sources of energy. The shift to renewable and non-petroleum-based power for the transportation sector will occur at a slower pace than it will in other sectors. The slower pace is due in part to the limited control the state has over vehicle technology and regulations. States are preempted by the federal government from setting their own fuel economy standards, for example.

In order to make significant progress toward the state's overall energy consumption goal of 90% renewable energy by 2050, the Vermont Agency of Transportation has set a goal that 25% of all vehicles registered in Vermont be powered by renewable energy sources by 2030 (this includes electric vehicles and plug-in hybrids). The 25% target will not be achieved linearly—small gains now facilitated by aggressive policies and infrastructure development will lead to exponential results as transportation efficiency strategies take hold.

Meeting the state's overall renewable goal will be dependent on private-sector innovation to provide critical technological breakthroughs. Government will have to commit to maintaining aggressive federal fuel economy requirements and to establishing a clean fuel program. Consumers will have to do their part by embracing new technology and increasing their rate of adoption. Business-as-usual projections for electric vehicles and plug-in hybrids are modest. However, there are a number of reasons to believe that the next 20 years will be different from business as usual.

Technological innovation in vehicle engineering, particularly as it relates to batteries, has been occurring at a rapid pace. Vermont may be poised at the beginning of a vehicle technology revolution, similar to the Internet era, in which the introduction of computerized communication products spurred demand that resulted in rapid development of new products. Ten years ago, smartphones with sophisticated mobile applications and hundreds of thousands of applications were unheard of. It is possible, and some say probable, that fuel prices, automobile industry productivity requirements, concern about greenhouse gas emissions in the U.S., and climate change regulations in Europe will combine to quickly create an environment in which transportation vehicle technology development will occur as quickly as did communications technology in the Internet era.

9.6.2.1 Measurable Objectives to Meet This Goal

- Ensure that 25% of all vehicles registered in Vermont are powered by renewable sources by 2030.
- Determine the combined average fuel economy of the vehicle fleet registered in Vermont. Improve it to meet the national average fuel economy set by the federal CAFE standards currently in effect, or improve it by 5%, whichever is greater, by 2025.[278]
- Increase the number of medium- and heavy-duty vehicles powered by biodiesel or CNG by up to 10% by 2030.

9.6.2.2 Strategies

Fuel production, regulation and promotion of alternative fuels, and the oversight of vehicle efficiency standards are not currently within the realm of transportation agencies. Transportation agencies do, however, consume a considerable amount of fuel in building and maintaining the transportation network, and fuel taxes support the planning, design, and maintenance of the transportation network. Suggesting policies and creating new programs to reduce the carbon content of fuels is a cross-cutting issue involving several state agencies (including VTrans, the Agency of Natural Resources, and the Department of Public Service) as well as private-sector entities such as the automobile industry and the purveyors of renewable energy, including the electric sector.

Renewable and non-petroleum-based fuels and vehicle technologies are at various stages of deployment—from research and development (such as with fuel cell technology or CNG for light-duty use), to early market penetration (such as with plug-in hybrids), to options readily available for consumers today (such as with conventional hybrids). In order to reach the state's energy goals, initiatives that facilitate adoption of vehicles that are more efficient and powered by renewable fuels will be balanced with initiatives to expand and diversify mobility options.

[278] *The federal CAFE standards represent an average that applies to the national vehicle fleet, with the likelihood of variability for individual states.*

The following strategies will be undertaken by key ***partners*** to reduce petroleum consumption in Vermont.

(1) Identify future renewable electricity demand for the transportation sector needed to meet the 25% renewable objective by 2030, and work with utilities to help ensure the demand can be met. Regulators and utilities need to define statewide time-of-use pricing tariffs and permitting processes for connecting PEV charging stations, as well as smart meter applications that allow utilities and PEV owners to control charging. Regulators and utilities need to develop economic and electric capacity models for PEV penetration, prepare for local concentrations of PEVs in the near term, and develop a legal framework to direct the extent to which PEV customers versus public funds will pay for infrastructure build-out of transmission and generation. Community planners need to define siting and design guidelines for charging infrastructure that accounts for factors such as smart land use, consumer demographics and travel patterns, and recreational and tourist travel. (***DPS, ANR, UVM, the state's electric utilities, regional and municipal planners***)

(2) Investigate and develop joint partnership funding proposals for the state to lead the way in switching to PEVs through a demonstration project involving PEV charging in state parking lots connected to Vermont renewable generation via smart grid infrastructure. A complementary research effort is needed to analyze the capability of battery technology to adequately power vehicles for Vermont's rural roads along rugged terrain under all weather conditions. (***DPS, BGS, TRC, VTrans, Green Mountain College, utilities***)

(3) Investigate the expansion of PACE to cover costs to install PEV charging stations in homes. (***DPS***)

(4) Support the continued development of the Vermont biodiesel industry without adding a burden to agricultural systems related to food production. (***VSJF, VAAFM, ANR, VFDA, Vermont legislature***) (See also Section 8.3.5.5.4 for additional biodiesel recommendations.)

- Investigate potential sources of funding for technical assistance to Vermont farmers who produce biodiesel for on-farm use and to supply local markets. Assist local planners to study land use patterns that ensure stable local food markets. (***VAAFM, ANR, VSJF***)

- Investigate potential sources of funding for technical assistance to producers and dealers pertaining to best practices for handling, storing, and using biodiesel, as well as Vermont's permitting requirements. (***VSJF, VFDA, ANR, VAAFM***)

(5) Identify Vermont's fueling infrastructure needs and partner with the utilities, municipal interests, electric sector, automobile industry, fleet operators, private retail sector, University of Vermont, and others to create an electric fueling network that will meet local, regional, and through-traffic fueling demand. (***DPS, ANR, VTrans, UVM, state electric utilities***)

(6) Collect sufficiently detailed vehicle data to facilitate measurement, modeling, and analyses of key variables such as the average combined fleet fuel economy for Vermont registered vehicles and off-road vehicles for agriculture and other key industries; the market share of alternative fuel–

powered and advanced technology vehicles; fleet age distribution, etc. (***DMV, VTrans, ANR,VAAFM, DPS***)

(7) Explore incentives to increase the number of alternative fuel–powered and more efficient vehicles, as well as disincentives that will discourage the purchase of the least efficient models in any vehicle class. For example, in a "feebate" program, purchasers of the least efficient vehicles pay a fee at the time of purchase and purchasers of the most efficient vehicles, including hybrids, receive an incentive, or rebate. Feebates have been proposed in a number of areas around the country, including Massachusetts, but have yet to be implemented. They could be an important tool in meeting the objective for the Vermont-registered fleet to meet or exceed the national average fuel economy set by the CAFE standards. However, concerns regarding equitable treatment of Vermonters who are least able to afford technologies that are currently more expensive must be honored. (***DPS, ANR, VTrans, Secretary of Administration***)

(8) Maintain the state's commitment to the Vermont low emission vehicle (LEV) program, including its zero emission vehicle (ZEV) requirements. (***ANR***)

(9) Maintain the state's commitment to the establishment of a Clean Fuel Standard (CFS) for the Northeast region. Standards for alternative fuels such as biodiesel, CNG, and electricity, including the fuel's upstream contributions of carbon, will help provide price signals to encourage the production, distribution, and use of the less-carbon-intensive fuel options in Vermont. (***ANR, DPS***)

(10) Provide state support of eco-driving program.[279] (***Vermont Clean Cities Program, VEIC, VECAN***)

(11) Support legislation and/or regulations prohibiting unnecessary idling of vehicles.[280] (***VTrans, DMV, ANR***)

(12) Support employer-sponsored and other fleet owner initiatives to reduce petroleum consumption and demonstrate the use of new and emerging fuels and vehicle technology, including state, municipal, and regulated entities, such as schools, taxis, transit companies, etc. (***Vermont Clean Cities Coalition, ANR, DPS, VAAFM, fleet operators including BGS***)

(13) Encourage large commercial fleets to leverage their purchasing power to stimulate the markets and explore development of employee buying clubs for alternative vehicles, including financing options. (***Vermont Clean Cities Coalition, ANR, DPS, fleet operators including BGS***)

(14) Encourage fleet operators to institute policies and programs for eco-driving, anti-idling, and fuel-efficient vehicle maintenance policies and programs. (***Vermont Clean Cities Coalition, ANR, DPS, VAAFM, fleet operators including BGS***)

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[279] *Transportation Research Center, Eco-Driving, http://www.uvm.edu/~transctr/?Page=cleancty/ecodriving.php*

[280] *idlefreevt.org*

9.6.3 Goal #2: Reduce Energy Use in the Transportation Sector

9.6.3.1 Measurable Objectives

(1) Keep VMT annual growth rate to 1.5% (half of the national average) or less for that portion controlled by the state.

(2) Keep VMT per capita level with the 2011 base year, or lower.

(3) Increase public transit ridership by 110%, to 8.7 million annual trips by 2030.

(4) Quadruple passenger rail trips, to 400,000 Vermont-based trips by 2030.

(5) Triple the number of state Park-and-Ride spaces, to 3,426, by 2030.

(6) Double the amount of rail freight tonnage in the state from 2011 levels by 2030.

(7) Reduce share of SOV commute trips by 20% by 2030.

(8) Double bicycle and pedestrian share of commute trips, to 15.6%, by 2030.

(9) Double ride share commute trips, to 21.4% of all commute trips, by 2030.

9.6.3.2 Strategies Overview

Moving into a new transportation energy future will require the Agency of Transportation, the Vermont Legislature, the private sector, and individual Vermonters to shift the way transportation is planned, funded, and used from being a physical infrastructure issue dominated by accommodating automobiles and freight on roads and bridges to an energy efficient and sustainable transportation system that provides mobility options for all and serves drivers as well as passengers, pedestrians, and cyclists.

Today, transportation priorities at the state and municipal levels are focused primarily on maintaining roads and bridge infrastructure so that cars and trucks can travel safely throughout the state. This function must continue if the state is to thrive. But other mobility options will be needed in the future as traditional energy sources become scarcer and costlier.

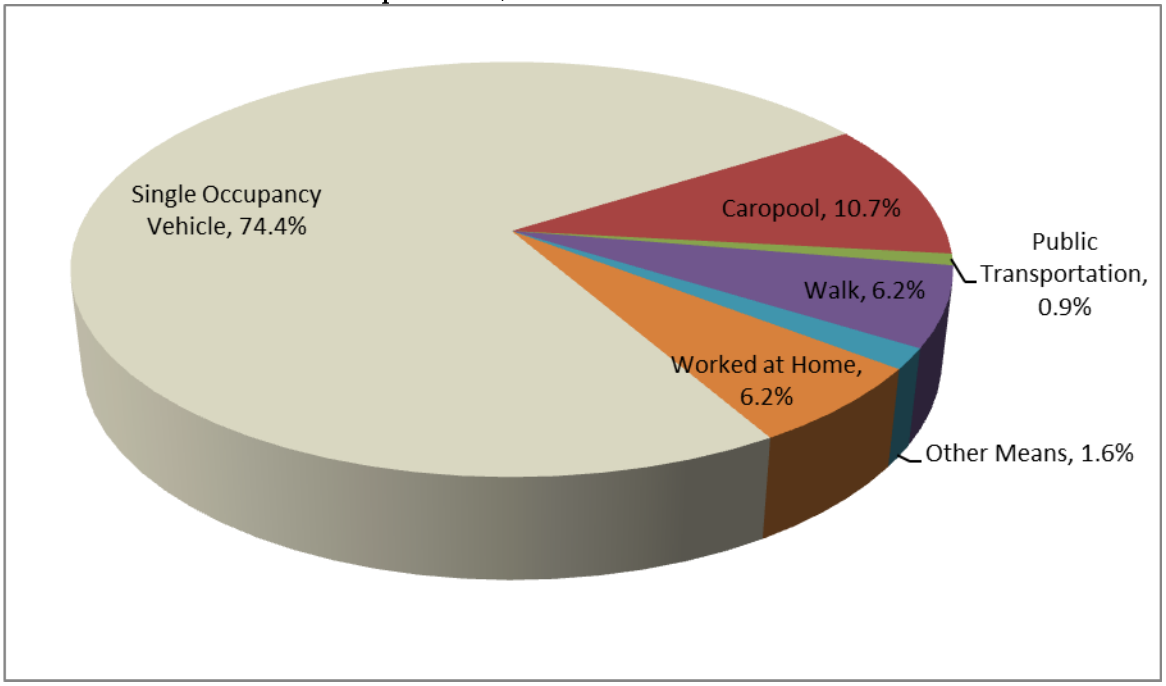
The energy-efficient and sustainable system of the future will provide more efficient alternatives to single-occupancy vehicles for most trips. Transit options will be available for commute trips in areas where land use density warrants it. Ride sharing and car sharing supported by innovative technologies and Park-and-Ride and other facilities will become the way to get around for commuters and suburban and rural families. Intercity rail and bus service will seamlessly connect passengers to regional urban centers and airports. A significant number of Vermont tourists will not only leave their worries and cares behind when they come to Vermont—they will also be able to leave their cars behind and still enjoy all that the state has to offer. All Vermont roadways will safely accommodate bicycles and pedestrians. New development and job growth will be focused in "smart growth" locations, where land use density and the mix of uses will support shorter trips and transit and bike and pedestrian alternatives. Vermont's village centers and downtowns will include bike and pedestrian improvements, not only to make these communities more livable, but also to be a catalyst for economic development. Communities will host local agricultural systems that will result in reduced travel for the exchange of agricultural products, especially nutritious food. Vermont will be part of a regional and national freight network that includes mode shifts to rail and short sea shipping. Truck freight will utilize the latest logistics technology to minimize trips, and the trucks themselves will be clean-burning and energy efficient.

As indicated previously, transportation funding sources are insufficient to meet current and future roadway infrastructure preservation and maintenance needs. Funding demands related to options such as increased rail and transit services should not compromise addressing the need to preserve and maintain basic infrastructure. There must be creative use of existing sources and new sources of revenue in order to build this new mobility system.

9.6.3.2.1 Commute Trips

Commute trips to work account for the highest share of transportation energy consumed. According to the American Community Survey (2005–09), Vermont has 320,723 workers 16 or older, of whom 93.7% commute to work (the remainder work from home). Currently, commute trips are primarily driven by single-occupancy vehicles, which account for 74.4% of all work trips, followed by carpooling (10.7%) and walking (6.2%). Public transportation accounts for the smallest share of work trips, at 0.9% (See Exhibit 9-33).

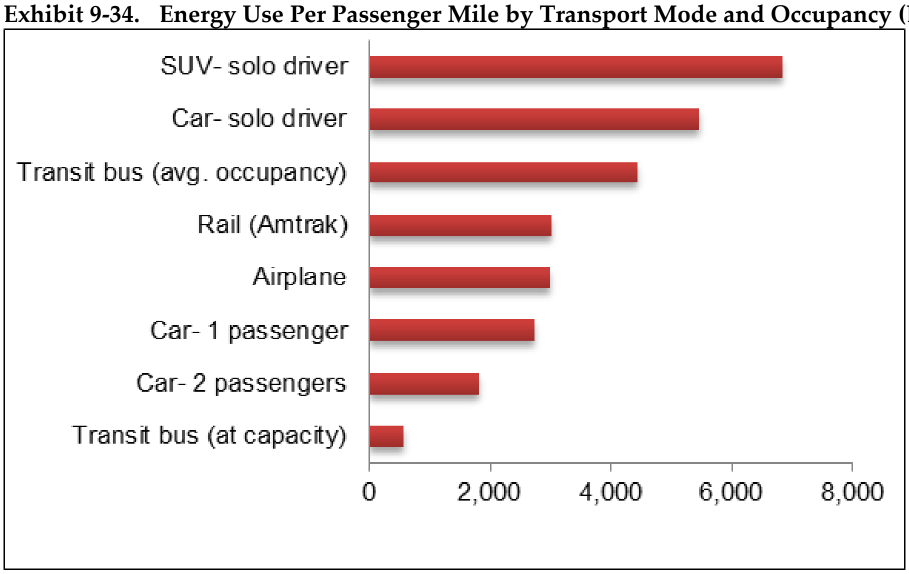
Exhibit 9-33. Vermont Commute Trips to Work, 2005–09



Source: American Community Survey, Vermont Profile (2005–09)

Exhibit 9-34 indicates the passenger-mile energy use of various transportation choices.

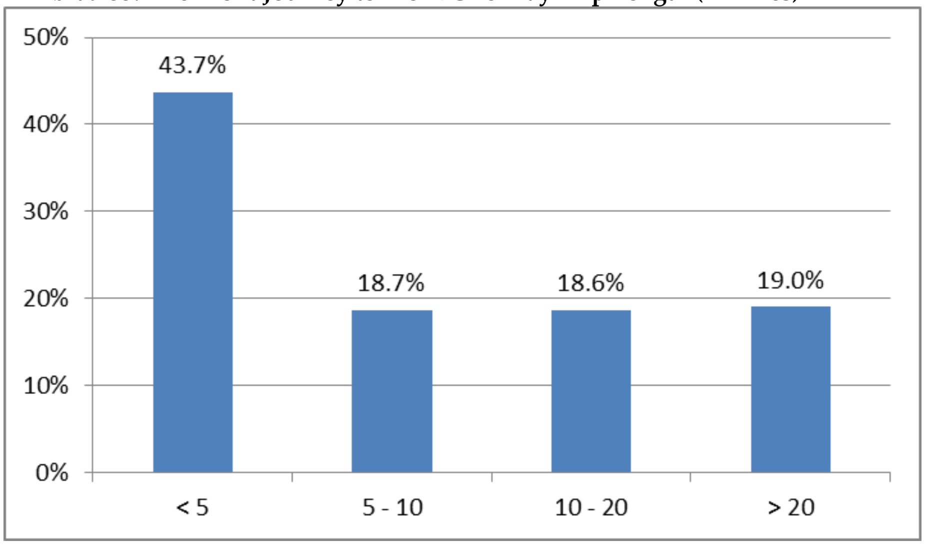
Exhibit 9-34. Energy Use Per Passenger Mile by Transport Mode and Occupancy (Btu per passenger mile)



Source: The Vermont Transportation Energy Report 2009, Vermont Clean Cities Coalition, August 2010, TRC-10-017

Despite our rural character, a sizeable percentage of work trips (43.7%) are less than five miles from residents' homes (see Exhibit 9-35). This is good news; it presents opportunities to shift these short work commute trips away from SOVs.

Exhibit 9-35. Vermont Journey to Work One Way Trip Length (in miles)



Source: The Vermont Transportation Energy Report: Vermont Clean Cities Coalition, August 2010, TRC-10-017

The objectives and strategies identified below focus on commute trips because driving to work is such a large portion of the state's transportation energy demand, and commuting to and from work is a repeated and predictable trip with consistent origin and destination points. Commuting trends are also more easily measured thanks to Census and other data. Additionally, shifting commute trips from SOV to ride share and other alternatives poses fewer challenges for transportation consumers than shifting trips associated with activities such as shopping or recreation.[281]

9.6.3.2.2 Strategies

The following strategies will be undertaken by key ***partners*** to reduce energy use in the transportation sector in Vermont.

[281] *The Upper Valley Transportation Management Association (UPTMA), Upper Valley Trails Alliance, Campus Area Transportation Management Association, and Local Motion are examples of organizations that have been successful in working with employers to develop and promote commuting options. The UPTMA reports that in one year, its Smart Commute Project engaged 13 workplaces with about 10,000 employees. These workplaces have decreased SOV commuting 8%, increased carpooling 4%, and increased transit ridership 4%, saving $1.3 million in fuel costs for the participating employees. For every $1 of funding, the organization estimates, $6–$10 was saved on commuting costs.*

Integrated Planning

(1) Improve interagency coordination and support, and coordination with regional planning and municipal planning efforts. State agencies must work in sync with regional planning commissions and municipalities as encouraged in state planning law. State, regional, and municipal plans; regulations; and expenditures should provide efficient and sustainable transportation options. Develop local goals and measurable objectives in order to monitor the contribution of local initiatives to the statewide objectives.

For example, state traffic experts might inform regional planning commissions as to where commuters are traveling within the region. The regional planning commission can take this information and identify where a network of Park-and-Rides functionally makes sense, but it's up to the town to embrace the need for sustainable mobility options and determine through its land use planning process where the lots, funded with assistance from the state, should be located within the town's boundaries. State and local regulatory processes might also be amended as appropriate in order to streamline the review of these projects. (***All agencies, RPCs, municipalities***)

Multistate Regional Planning and Initiatives

(2) The state of Vermont is a geographic crossroads for both road and rail regional systems. Vermont must act regionally with surrounding states and provinces to address intercity transportation of people and freight by road and rail. Recognizing the interdependency of passenger rail transportation systems, the New England states have committed to work together to support collective passenger rail efforts. The New England states have developed the *Vision for New England High-Speed and Intercity Rail Network*. The regional passenger rail network is viewed as a catalyst for economic development as well as providing mobility options, reducing dependence on already congested roadways and airport infrastructure, and reducing greenhouse gas emissions.

Support the *Vision for New England High-Speed and Intercity Rail Network,* which includes extending Vermonter passenger rail service to Montreal and developing service in western Vermont by linking Burlington, Rutland, and Bennington with new or additional connections to Albany, N.Y., and New York City. (***VTrans, Congressional delegation, Northeast states, province of Quebec***)

(3) Participate actively in Northeast and mid-Atlantic multistate regional planning efforts. The Transportation and Climate Initiative (TCI), the I-95 Coalition, the Northeast Association of State Transportation Officials (NASTO), the New England Governors/Eastern Canadian Premiers Conference (NEGC/ECP), Northeast States for Coordinated Air Use Management (NESCAUM), and Coalition of Northeastern Governors (CONEG)—are all involved in numerous research and policy initiatives to better understand the extent of the GHG emissions and energy efficiency and renewable solutions for the region as well as policy and program initiatives such as the establishment of a regional electric vehicle fueling network, a Clean Fuel Standard, rail planning,

and freight movement and mode shift. Vermont agencies must monitor and participate in this work in order to address the state's many transportation challenges that don't end at the state's borders. (***ANR, DPS, VTrans, Northeast states, province of Quebec***)

Reducing SOV Trips

(4) Ensure that Park-and-Rides are funded at a level adequate to meet the objective of tripling the number of spaces in the state Park-and-Ride program to 3,426 by 2030. (***VTrans***)

(5) Support the regional planning commissions and municipalities in creating a network of Park-and-Rides on municipal, collector, and arterial routes to complement state Park-and-Ride facilities that are located primarily on the interstates and the national highway system. (***VTrans, RPCs, municipalities***)

(6) Provide support for new and emerging CarShare programs, including exploring the feasibility of making the state fleet available for car sharing when the fleet is not in use, such as on weekends and evenings. (***VTrans, CCRPC, CarShare programs***)

(7) Evaluate the use of regional intercity bus services and identify opportunities to increase the use of these services. (***VTrans***)

(8) Expand the Go Vermont website and include additional features to increase the number of registered participants, including the use of Go Vermont ride share matching for large events. (***VTrans***)

(9) Increase direct marketing of Go Vermont and vanpool programs to the state's large and medium-sized businesses. (***VTrans***)

(10) Increase the investment in transit to areas with land use density necessary to support it and to key corridors that link commuters to their jobs. (***VTrans, state's transit providers***)

(11) Meet the requirements of the Complete Streets law passed in 2011. VTrans will identify how the principles will be met through implementation strategies such as design standard changes, project planning and funding prioritization, and coordination with local and regional officials. (***VTrans***)

(12) Increase telecommunications infrastructure necessary to increase the opportunity to telecommute throughout the state and encourage employers to adopt policies, develop systems, and train staff in best practices for telecommuting and alternative conferencing options. (***ACCD, DPS, BGS, AOA***)

(13) Continue to identify and advocate for implementation of transportation opportunities for tourists, especially for single destination resort visitors. (***ACCD, VTrans, RPCs, tourist industry***)

(14) Support employer-sponsored initiatives that encourage commuters to increase transportation efficiency.[282] (*VTrans, RPCs, VEIC*)

Outreach and Education

(15) Study and put in place effective marketing[283] to accelerate consumer understanding of transportation efficiency, alternative fuels and vehicles, and the energy, costs, and health benefits of various options. (***DPS, VTrans, CCRPC, VEIC, UVM, High Meadows, AHS***)

(16) Support grassroots organizations such as town energy committees to assist in their planning, outreach, and education efforts related to transportation alternatives and energy use. (***VTrans, ACCD, ANR, DPS***)

(17) Increase the use of new technology tools to improve transit passenger experience, ride share opportunities, and consumer education, and to change behavior (***VTrans, DPS, VEIC***)

(18) Create a statewide organization focusing on research and outreach related to transportation and energy efficiency. (***VTrans, DPS, ANR, VEIC, UVM***)

(19) Develop Transportation Energy Assessments for individuals and businesses that are included with home energy audits, and develop curriculum to train home and business energy auditors to include transportation energy in their assessments. (***VEIC***)

9.6.4 Goal #3: Address Transportation Funding

The transportation funding goals are to establish revenue sources to support Vermont's entire transportation system—roads, bridges, rail facilities, transit services, and the like—in a state of good repair.

9.6.4.1 Strategies

Transportation revenues are currently inadequate to address basic transportation infrastructure needs and grow an energy-efficient and sustainable transportation system of the future. In addition, the state gas tax, a primary revenue source for transportation, is dependent on use of gasoline and diesel. This transportation plan is aimed at reducing that use through more efficient and renewably powered vehicle technologies, and meeting transportation demand through more efficient trips. Alternative means of raising revenues for transportation should be considered.

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[282] *The Smart Commute Project run by the Upper Valley Transit Management Association is a model. http://www.vitalcommunities.org/smartcommute/about.cfm.*

[283] *The principles and practices of community-based social marketing have been recommended and have demonstrated success in programs such as the Smart Commute Project run by the Upper Valley Transit Management Association.*

(1) Research and analyze changes in transportation revenue policy, including a shift from a fuel tax system to a VMT system, another demand-based system, or an alternative fuel fee system, and propose policy improvements to the Vermont Legislature and other policymakers. (***VTrans***)

(2) Coordinate with federal and regional state partners regarding changes to transportation revenue policies. Similar challenges are being faced at the federal level. Federal activities related to the issue should be closely monitored, and Northeast regional solutions merit investigation. (***VTrans in coordination with regional state partners, organizations, and the Vermont Congressional delegation***)

9.6.5 Goal #4: Measure and Evaluate

If we are to achieve our goals, we must measure and evaluate our progress and adjust it on the basis of data, not just broad policy. Therefore, at least every five years, VTrans and other relevant state agencies as assigned by the Vermont Climate Cabinet in the implementation of the CEP will review data collected by the Agency and the U.S. Census Bureau (see Exhibit 9-36) to determine progress in meeting objectives. A summary report will be produced detailing progress levels in relation to targets and an explanation of whether the objectives are being met or not. As a part of the review, the state will review any objective that is not on track and draft a strategy for achieving the objective by the next five-year review. (***Climate Cabinet, all relevant agencies including VTrans***)

Exhibit 9-36. Plan Implementation Monitoring and Measurement

Objective	Data Source to Monitor	Frequency/Interval
25% of all vehicles registered in Vermont will be powered by renewable sources by 2030.	DMV Registration Records	5 years
Improve the combined average fuel economy of the Vermont vehicle fleet to meet the national average fuel economy set by the federal CAFE standards, or improve it by 5%, whichever is greater, by 2025.	DMV Registration Records	5 years
Increase the number of medium- and heavy-duty vehicles powered by biodiesel or CNG by up to 10% by 2030.	DMV Registration Records	5 years
Slow VMT annual growth rate to 1.5% (half of the national average) for that portion controlled by the state.	VTrans Highway Research Section	5 years
VMT per capita will not increase from a 2011 base year.	VTrans Highway Research Section	5 years
Reduce share of SOV commute trips by 20% by 2030.	American Community Survey (U.S. Census)	5 years
Increase public transit ridership by 110%, to 8.7 million annual trips by 2030.	VTrans Public Transit Section and Chittenden County Transportation Authority	5 years
Double the bicycle and pedestrian share of commute trips to 15.6% by 2030.	American Community Survey (U.S. Census)	5 years
Double the carpooling to work share to 21.4% of commute trips by 2030.	American Community Survey (U.S. Census)	5 years
Quadruple passenger rail trips to 400,000 Vermont-based trips by 2030.	Amtrak	5 years
Double the amount of rail freight tonnage in the state from 2011 levels by 2030.	Freight Analysis Framework	5 years
Triple the number of state Park-and-Ride spaces to 3,426 by 2030.	VTrans Local Transportation Facilities Section	2 years

Source: Vermont Agency of Transportation

9.7 Land Use

The state's development rules and patterns have a major influence on the amount of energy used in Vermont, both in our buildings and in transporting people and goods from place to place. When people live far from the places that they work, shop, bank, etc., more energy is required. Land use is also impacted by the energy generation siting choices that we make for Vermont. In planning for our energy future, therefore, it is critical that we include a vision for sustainable development in our communities. To be successful, we must balance transportation and energy needs with the impact on our economy and on our natural resources and environment to build strong, healthy communities that last. For a sustainable future, we should look to the past: to our traditional development pattern of downtowns and villages surrounded by a working landscape. If residential growth can be better tied to developed community centers, we can limit the impact on our natural resources and achieve integrated and holistic energy strategies through land use choices.

9.7.1 Compact Centers

The state has a long-standing goal of encouraging concentrated mixed-use development in and around community cores, while protecting natural resources and working landscapes outside those areas. This traditional land use pattern supports a variety of public interests, including reduced development pressures on agricultural, productive forest, and natural resource lands; increased housing options; continued use of our historic resources; a strong Vermont brand; economic efficiency; and active community centers.

This land use pattern also reduces the demand for energy to move people from their homes to work, shopping, school, or social gatherings. Within an area of compact development:

- More people can walk to their destination.
- More opportunities exist for biking and other alternative modes of transportation.
- More effective transit systems are possible, both within communities and between communities, because successful transit systems depend on having a large and concentrated ridership base in core community areas.
- Commuters have a relatively common origin and common destinations, increasing carpooling opportunities.

Although the state has been subject to significant development pressures over the past decades, it has not experienced the same degree of sprawl and disconnected rural development as have other states around the country. Vermont's downtowns and villages remain largely intact, and public interest in and support for "smart growth" has been increasing. In fact, although it is widely seen as a rural state, much of Vermont's population resides or works in its core communities—the 23 municipalities that host one of Vermont's designated downtowns account for more than 30% of the state's population.

That said, we have not been unscathed by increased development pressures. The 2010 Census reported that three-quarters of those 23 communities grew at a slower pace than the state average, indicating that growth continues at a higher rate of development outside our core areas. There are multiple potential reasons for this, but the result has been continued development outside our core areas in a low-density, automobile-dependent fashion. It has created strip development and large lot subdivisions which in turn require more vehicle miles traveled to meet basic needs, and ultimately, higher energy costs for the transportation sector—a trend we must reverse.

9.7.2 Framework to Reduce Transportation Energy Use Through Compact Land Use Patterns

Our current statutory framework includes a variety of state and local directives and programs that collectively support a compact development pattern. The state offers programs to designate smart growth areas, and directs state funding for capital improvements. Municipalities have been vested with the primary land use regulatory authority, as well as controlling investments in capital infrastructure projects. In order to reduce the energy expenditures for transportation, it will be important to fully use the following tools to support smart growth:

- Vermont's Municipal and Regional Planning and Development Act (24 V.S.A. Chapter 117) includes specific land use goals and required plan elements. Most relevant is the goal to "plan development so as to maintain the historic settlement pattern of compact village and urban centers separated by rural countryside." The act enables municipalities to adopt zoning, subdivision, and other tools to regulate development. The Act also created the Municipal Planning Grant (MPG) program, which currently grants $400,000 to support municipal plans, bylaws, infrastructure planning, and related activities. Municipalities must continue to focus on meeting this goal, and MPG funding must be used to support a more compact development pattern, supporting our community centers.

- The Municipal and Regional Planning and Development Act provides for the creation of regional planning commissions, and requires the development of regional plans—including a land use element and an energy element. It also enables these commissions to undertake a wide variety of other activities—including participation in Act 250, transportation planning, support of municipal land use planning and regulations, and a wide variety of other planning activities. These regional commissions currently receive substantial state funding, and it is important for these funded activities, including training of municipal officials, to continue to support a compact development pattern.

- Municipal capital budgets (24 V.S.A. § 4430) provide for sewer, water, road, parking, pedestrian/bike facilities and other municipal improvements. The kind of compact development pattern anticipated in statute is not possible without investments in such improvements. It should be noted that these improvements can also be used to promote sprawl and strip development, so it is vital to maintain investment focus on supporting well-planned, dense-growth areas proximate to the community core.

- Act 250 (10 V.S.A. Chapter 151) is a statewide permitting process that protects a wide variety of natural resources—water, soils, habitat, aesthetics—and ensures that public infrastructure, such as transportation, water, and wastewater systems, is adequate to serve proposed development. Development proposals must demonstrate that energy will be used efficiently, and that the development will not place an unreasonable burden on utilities. In addition, applications must be in compliance with municipal and regional plans, which would include provisions in those plans that relate to energy.

- The Downtown Development Act (24 V.S.A. Chapter 76A) was created to revitalize the state's downtowns and village centers. Subsequent changes to the Act created programs to support new development in growth centers and neighborhoods. The designation processes for all these programs ensures that the designated areas provide for compact, mixed-use development. The Act provides dedicated support of these areas—including transportation grants, rehabilitation tax credits, Tax Increment Financing districts, modified Act 250 thresholds—and directs a number of state funding programs to give priority to these areas. These programs could be strengthened and better integrated, providing a more comprehensive foundation for the state's smart growth strategies.

- Complete Streets legislation (19 V.S.A. § 10b and 19 V.S.A. § 309d) was passed in 2011 to ensure that Vermont's roads are safe for all uses, requiring transportation planning to take into account the needs of motorists, bicyclists, public transportation users, and pedestrians of all ages and abilities. Implementation of this new law is now beginning to help focus state investments on our community core areas.

- State infrastructure expenditures are enormously influential in supporting growth. Other states are increasingly focusing state investments to support compact, smart growth areas, and it is critical for Vermont investment policy to do a better job of directing such funding to community centers. These investments also make financial sense, serving more users in a smaller area while supporting a development pattern that minimizes single occupancy vehicle dependence.

9.7.3 Framework for Land Use Planning and Energy

The narrative above has primarily addressed the connections between transportation and land use. However, the connection between land use and energy policy extends more broadly to include the planning and permitting of energy facilities and energy savings.

- The Municipal and Regional Planning and Development Act includes specific responsibilities and limitations related to energy. Both municipal plans (24 V.S.A. § 4382) and regional plans (24 V.S.A. § 4348a) are required to have energy elements, that "may include an analysis of energy resources, needs, scarcities, costs and problems within the [region or municipality], a statement of policy on the conservation of energy and the development of renewable energy resources, and a statement of policy on patterns and densities of land use and control devices likely to result in conservation of energy." This energy planning is done as part of a comprehensive planning process that includes transportation, natural resources, infrastructure, housing, land use, and other matters, with the goal of balancing the competing interests. These plans are implemented, using various regulatory and non-regulatory tools, by the municipality, by local energy committees, and via ongoing work at each of the regional commissions. They also form the policy basis for municipal participation in the state's Section 248 regulatory process for permitting energy facilities, if they contain clear standards.

- Statute provides for the appointment of a municipal energy coordinator, and hundreds of communities have also created energy committees, providing significant capacity to support local energy conservation and energy generation initiatives.
- All energy projects connected to the grid are regulated by the Public Service Board through the Section 248 process, including small net-metered generators such as solar panels and small wind turbines. Act 250 and municipal jurisdiction for these projects is superseded by Section 248 review. As a result, consideration of the impacts of regulated projects on agricultural soils and flood-prone areas—which are normally considered in local and Act 250 reviews—are not a factor in the Section 248 process.
- Finally, municipalities do retain the authority to regulate energy-generating installations that are not connected to the grid, to the extent that they have adopted specific standards. And they are enabled to protect access to renewal energy resources such as solar and wind through the subdivision and site plan review.

9.7.4 Recommendations for Land Use

In order to ensure further progress in meeting our compact development and smart land use goals, and reducing energy needs, the following recommendations are made.

(1) Goal: Ensure state programs recognize and encourage compact development patterns, which over the long term will reduce transportation-related energy use.

(1a) **Strategy:** Strengthen and streamline the state "designation" programs to ensure consistency, efficiency, and improved function to encourage new growth in and around our centers.

Measure:

- Completed program review and proposed improvements, amendments, and revisions by July 31, 2012.
- 2020 Census shows above average growth in designated areas.
- Increased participation in designation programs:
  - ☐ Downtowns—maintain current number of designations.
  - ☐ Villages—increase designations by 15% in five years.

- ☐ Growth centers—after statute revised, increase by 30% in five years.
- ☐ Neighborhoods—after statute revised, increase by 50% in five years.

(1b) **Strategy:** Review state agency programs and funding sources that are linked, or could be linked, to state designation programs—including wastewater, water supply, transportation, Municipal Planning Grants, and other infrastructure programs—to better support growth in smart growth locations rather than outside designated areas.

Measure:

- As part of strategy (1a) above, funding criteria are reviewed and revised by December 2012 to give priorities to projects within designated areas.

(1c) **Strategy:** Review and develop recommendations on how the state's permitting programs—including Act 250 and ANR programs—support or impede development within designated areas and other smart growth locations.

Measure:

- Statutory changes are considered that would incorporate smart growth principles (24 V.S.A. § 2791(13)) into the Act 250 and Section 248 processes.

(1d) **Strategy:** Develop training and implement Complete Streets legislation in partnership with Department of Economic, Housing and Community Development, VTrans, AARP-VT, Vermont League of Cities and Towns, Vermont chapter of the American Institute of Architects, and others.

Measure:

- At least three workshops are held in 2011–12 to explain the requirements to the varied interests.
- VTrans and municipal projects report compliance by March 2012.

(1e) **Strategy:** Ensure that transit investments focus both on areas with development density necessary to support them, and on key corridors that link commuters to their jobs.

Measure: A model is developed that assesses different land use scenarios and their impact on transportation and energy use.

(2) Goal: Increase awareness and strengthen local and regional land use planning for smart growth.

(2a) **Strategy:** Strengthen emphasis on smart growth through education programs for municipal officials. This particularly includes a focus on stronger policies in municipal plans, more aggressive implementation of those policies in municipal bylaws, and stronger use of other tools like capital improvement plans to direct and support growth in appropriate places.

Measure:

- The Vermont Department of Economic, Housing, and Community Development conducts at least three statewide workshops each year on policies and tools that support compact development.
- The DPS continues to work with regional planning commissions to deliver training on smart growth.
- The DPS continues to work with other partners, such as VTrans, ANR, the Vermont Department of Health, Vermont League of Cities and Towns, and Vermont Natural Resources Council to develop stronger municipal capacity to support compact development.

(2b) **Strategy:** Work with RPCs to strengthen emphasis on well-designed and appropriately scaled development through regional planning activities, and in their work with municipalities.

Measure:

- Revised municipal consultation process is adopted.
- Annual consultations between RPCs and municipalities are completed.
- Revised confirmation process is consistently applied statewide by each RPC.
- Town plans meet the statutory goal of compact settlement pattern surrounded by working lands.
- No loss in the number of confirmed communities over the next five years.

(3) Goal: Coordinate energy and land use planning.

(3a) **Strategy:** RPCs will review regional plans for consistency with state's Comprehensive Energy Plan.

Measure:

- Each region has reviewed the CEP for consistency with its regional plan by July 2012, and has developed recommendations for changes to both the state and regional plans.

(3b) **Strategy:** The DPS and regional planning commissions will provide data and other support to local energy committees to increase their knowledge of the individual, business, and municipal tools available to decrease energy use through community development, behavior change, and transportation options. Because energy conservation is highly dependent on individual actions, having the local capacity to reach out to individuals becomes critical.

Measure:

- Increased training opportunities for local energy committees.
- Increased number of local energy committees involved with municipal planning.
- Increased number of local energy committees involved with marketing/promotion of mobility options.

(3c) **Strategy:** Because the Section 248 review of energy projects preempts Act 250 and municipal regulations, a number of issues normally considered in permitting processes—such as impacts on agricultural soils—are exempt from review. These permitting processes should be better coordinated, ensuring that all competing interests can be balanced in the permitting process.

Measure: The permitting process for energy projects is amended as necessary to ensure that siting under Section 248 reviews all the appropriate criteria that would be used under Act 250.

10 State Energy Action

10.1 Summary

Last spring, Governor Shumlin and Vermont legislative leaders called for the state to lead by example regarding its own energy usage, and set a specific 5% energy savings goal for state government. That 5% goal became law in the capital bill (Act 40 of 2011, Section 47). This new 5% reduction goal will help inform the implementation and updating of the State Agency Energy Plan (SAEP) last released in January 2010.[284] The Vermont Department of Buildings and General Services is leading the way by creating its own strategic plan for energy savings that will be used as a model for other state agencies and departments. As a short-term, concrete step, all agencies and departments convened to review the BGS strategic plan and the CEP plan in the fall of 2011, focusing specifically on the challenges of energy savings in leased buildings. Of course, state government can effectively improve the way it traditionally conducts business through further efficient use of resources and improved energy efficiency, reducing costs and impacts of state energy usage. This approach will enable the state government to "get the job done" in a cost-effective, technically sound manner. Three areas in particular will remain the focus of state government operations:

(1) The state government infrastructure footprint will continue to be evaluated for efficient use of space as well as efficient use of energy and level of emissions. Overall building conditions will be considered when evaluating a building's use and future projects involving the building. State government has a large inventory of historic and aging buildings that will pose a challenge to staff when they attempt to improve efficiency, and many of the improvements in these buildings may need to involve staff behavioral changes. Already, state government has seen the energy use dropping in utility bills, and it will be working on increasing its renewable energy portfolio. The state will actively share this experience—becoming a leader in efficient overall energy usage.

(2) State government will see challenges in transportation reduction due to the rural nature of the state and scattered land use pattern. However, opportunities are available, and will require the assistance of all state agencies. The Department of Buildings and General Services (BGS) and the Agency of Transportation (VTrans) should coordinate to effectively engage all agencies on state transportation use.

(3) State government must continually evaluate the options available in today's market to ensure that it purchases the most cost-effective products necessary to conduct state government business. Consideration of energy, environment (including considering recycled and mercury content), and length of life of the product through the use of state government contracts will be part of the process whenever practical. The BGS will move toward standardization of purchases involving

[284] *State Agency Energy Plan*, http://bgs.vermont.gov/sites/bgs/files/pdfs/BGS-VTStateEnergyPlan.pdf

contracts despite the challenges that occur as the process becomes more complex. Other agencies that do not purchase products via BGS should follow suit.

10.2 Background

This section describes the current status of state agency energy use and recommends implementation of various opportunities to improve energy use.

Careful consideration regarding the source of natural resources consumed will benefit the state government now and in the future. By considering the sustainability of the natural resources, the state government will begin to better understand how resource choices affect our climate, economic state, and operations. Utilizing sustainable resources will broaden the state government's focus beyond the initial purchase to the useful life of the resource. If a non-sustainable natural resource has to be used, efficiency is the key to ensuring that this resource is not wasted.

Over time, there has been a dramatic change in the way business is conducted. During the early 1900s, transportation and equipment use was non-motorized. By the mid-1900s, the majority of transportation and work was powered by fossil fuels and electricity, and by the turn of this century, the computer age was in full swing. Office equipment, which once consisted of paper and pencil, has evolved today to computers, printers, and copiers. Some staff had difficulty with the technology transition, as evidenced by the underused furniture, equipment, and boxes of papers from the past that litter state offices and archives. The world of technology increased at such a rapid rate that occupational processes became stuck in various stages and the staff was left trying to adapt to the conditions.

Just as with many businesses, as systems age and staff become occupied with competing priorities, efficiency starts to suffer. The focus on efficiency requires attention and leadership support. Reuse of natural resources is the last stop for many resources before the landfill. As technology and staff operations change, products become obsolete. At this time, the products have been paid for and used but still have some life left. Other agencies may need these products, or BGS Surplus could sell them to the public. This gives the products a second chance at life and delays the final step, which can become recycling or disposal. Recycling is a way for the equipment or materials to take on a new life as other products or as newer versions of their former selves. Disposal means the product will be placed in a landfill, where time and money is spent trying to store, manage, and monitor its deterioration (if possible) to ensure it does not contaminate the natural resources surrounding it.

Buildings themselves have suffered over the years from the changes in technology and design. Buildings were once lit by natural daylight and a few lamps. The building climate was controlled by carefully designed site orientation and floor plans, as well as operable windows and landscaping. The construction of the buildings included thick walls and stairwells to create a chimney effect for cooling. As technology became more readily available, however, renovations started to alter the original intent of the designs. In the 1970s, many commercial buildings were constructed; now that the buildings are reaching a critical anniversary, the effects of the many retrofits to date are becoming evident. The buildings have undergone multiple phases of renovation and various generations of each technology, leaving the buildings with incompatible systems. This drives up the utility use and causes discomfort for the staff who occupy the buildings as well as the staff maintaining the buildings.

The vision of a modern state government is more efficient and effective in its operations. This vision will enable state government to set a good example for practical use of alternative energy for other large commercial and industrial users in the state.

10.3 Identify Opportunities for Efficient Use of Resources

10.3.1 Building Infrastructure Development

Maintenance of the current inventory of infrastructure in state government has become a challenge owing to the age and condition of the buildings. The maintenance requirements of the structures, systems, and grounds are increasing, as are the costs of utilities within the buildings. As the needs of state government change, each agency must give additional consideration to the added maintenance burdens of new infrastructure prior to requesting different or additional space. Increasing the footprint of state government without increasing the funding to maintain the infrastructure is not a sustainable path, and the buildings will suffer as a result.

BGS will continue to work on the standard for sizing workstations in new construction and help develop a guideline for existing buildings. These standards and guidelines are dependent upon the job position assigned to the office to ensure efficient use of space. Consideration for the work done within the space is necessary to ensure a proper workspace, meeting space, and storage for the job position assigned to the workstation. As moves occur or renewal negotiations of leased space occur, compliance to the sizing of the spaces is reviewed and adjusted to the standard with consideration to the architecture of the building. Agencies review the current inventory of space before inquiring about space moves. Use of existing, state government–owned infrastructure for space moves is the first consideration, and acquiring or leasing new space in downtown locations is a secondary consideration. If new space is unavoidable, preference is given to existing infrastructure in downtown and growth center locations accessible by public transportation, walking, and biking.

10.3.2 Transportation

State government's transportation energy demand includes employees commuting from home to their workstations or job sites; on-the-job travel in light-duty vehicles to meetings with district offices, customers, and clients; and site inspections, as well as construction and maintenance activities associated with the state's transportation network. State employee commuting from home to work for state government staff is addressed in a separate section of the CEP. Business travel energy demand can be addressed through better evaluating employees' need to travel, making use of conferencing technologies, making sure the right-sized vehicle is used for the job, including the most energy-efficient and cost-efficient vehicles available in the state fleet, and demonstrating the use of renewable fuels such as plug-in electric vehicle technology.

Agencies will continue to contract for use of phone, web, and videoconferencing so that meetings not requiring on-site participation can be comfortably convened in the individuals' offices, thereby eliminating the need to drive to the location. Conference phones are available in some conference rooms to provide convenient dial-in participation at meetings.[285] Headsets are also available for employee use in some agencies.

The use of web-based applications such as Go Vermont to coordinate business travel ride sharing to meetings requiring on-site participation will be explored.

Agency representatives will travel to meetings in accordance with the policies set in place with respect to the BGS Fleet Management Program. This program provides right-sized vehicles for travel to and from meetings.[286] Agency representatives also have the option to lease right-sized vehicles for their mission through BGS to eliminate the need to register with BGS each time an agency staff person is required to travel. These leases include passenger and non-passenger fleet.

VTrans has several strategies in place to address the energy use associated with the state's diesel truck fleet. These include:

- Roadway maintenance operations at an appropriate level. These services are already at or near minimum levels acceptable to the traveling public.
- Truck idling reduction through policy requirements, information, education, and automatic vehicle controls.
- Use of the right-sized vehicle for the job. Fuel efficiency is a consideration in vehicle specification and assignment. Fuel costs are allocated to the users, thus encouraging them to select the most efficient vehicles.
- Ongoing modernization of the VTrans fleet with more efficient and cleaner-burning equipment. The majority of VTrans's vehicles and equipment are within their cost-effective service.
- Maintain the fleet in good mechanical condition and operate it as efficiently as designed through information and education of mechanics, operators, and drivers.

[285] *Based on the Third Biennial Report of the Climate Neutral Working Group, May 2009, Chapter IV – Recommendations and Next Steps, sixth "globe," p. 23.*

[286] *Based on the First Biennial Report of the Climate Neutral Working Group, January 2005, Chapter V – Recommended Actions to Begin Reducing Carbon Dioxide Emissions from Vermont State Government Activities, Transportation Recommended Action #1, p. 27.*

10.3.3 Purchasing

The most effective way to conserve and reduce the waste generated by the state government is to properly specify the product to be purchased. Well-researched specifications will ensure that the products being used follow environmentally preferable purchasing (EPP) standards and meet the efficiency standards of the state. Such specifications enable agencies to make purchasing decisions that are informed and in conformance with the statutes and policies in place for various energy and environmental initiatives. Agencies will continue to work toward standardization of purchases through contracts to ensure that the products meet energy and environmental requirements developed by the state government. The terms and conditions of the current state government construction and renovation contracts emphasize the importance of waste management planning.

At the end of their use for state government activities, the products will be evaluated by BGS Surplus Property. If the product has not reached the end of its useful life, it is reused in another agency, sold, or auctioned off at its fair market value to the public, and the revenue is collected. This program ensures that the products are reused instead of being sent to the landfill or abandoned from lack of use. By making products available to other agencies, this program reduces the multiple purchases over time of similar products by different agencies.

10.3.4 Monitoring Resource and Energy Use

Each agency is responsible for monitoring infrastructure and transportation owned by that agency. Electricity, heating fuel, and transportation fuel are monitored for costs and British thermal unit (Btu) usage and compared to previous fiscal years. Agencies that own infrastructure will communicate with state government staff and tenants who occupy state government buildings and will assist in identifying many of the issues that cause an increase in energy use. For example, as staff and tenants place work orders to address areas that are too warm or too cold, a potential for savings may be found. Leaks in steam traps, bad thermostats, dampers that no longer work, and other inefficiencies are found during the troubleshooting involved in responding to work orders. A scheduled preventive maintenance plan is an easy way to monitor the condition of the buildings and to prevent inefficiencies from forming due to clogged filters, dirty light fixture lenses, and other easy-to-fix items. Agencies will monitor the preventive maintenance plan to ensure they are followed. This will save energy and prevent loss of efficiencies. The State Resource Management Revolving Fund (SRMRF)[287] will continue to be implemented through BGS. The applications for this fund are received, reviewed, and monitored by BGS staff. These projects must show a payback that is acceptable for the given technology to the BGS staff. The projects will also need to show significant savings to repay the revolving fund after the completion of the project.

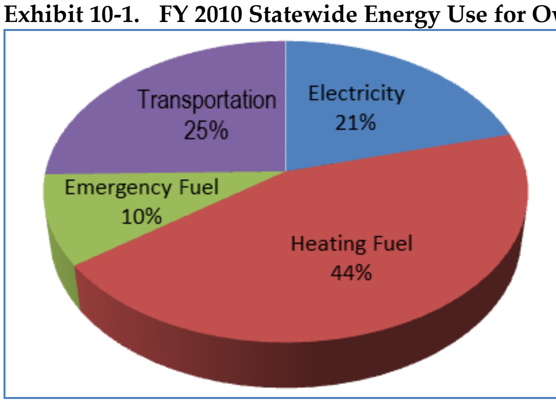
[287] *Based on the First Biennial Report of the Climate Neutral Working Group, January 2005, Chapter V – Recommended Actions to Begin Reducing Carbon Dioxide Emissions from Vermont State Government Activities, Infrastructure Recommended Action #2, p. 26.*

10.4 Identify Opportunities for Saving Energy and Reducing Pollution

10.4.1 Investments in Energy Efficiency

According to the Fiscal Year (FY) 2010 statewide energy totals in Exhibit 10-1, heating accounts for the majority of the energy use in state government–owned buildings. This makes the efficiency of the heating systems and their controls critical to achieving energy savings. The load on the heating, ventilating, and air conditioning (HVAC) equipment directly affects the efficiency of the equipment. Equipment that is overloaded or under-loaded will operate at a reduced efficiency.[288] Therefore, proper design is essential to ensure the efficiency of the equipment and conserve the energy used to heat state government–owned infrastructure.

Exhibit 10-1. FY 2010 Statewide Energy Use for Owned Buildings and Transportation (in MMBtu)



Projects that involve energy-efficient designs provide savings on the utility costs while potentially reducing maintenance costs. Energy-efficient designs provide the additional attention to detail for the specification, design, and maintenance of the equipment that will in turn reduce operating and maintenance costs.

Multiple studies and audits (with many levels of rigor) have been conducted on state building energy consumption in recent years. Agencies should review the recommendations from these reports and compile a single list of currently feasible recommendations for implementation. No-cost or low-cost (defined as projects with payback within the first year or two and savings of 5% to 15%[289]) projects have been the largest share of the energy projects in state government thus far, with a gradual increase in the projects that are requiring careful engineering and recommendations. Upgrades to lighting systems and substitution of motors and drives with variable-speed or high-efficiency motors and drives have been the majority of the measures that begin an agency's experience in saving energy. As agencies have become more comfortable with the upgrade process,

[288] *Energy Management Handbook, Sixth Edition, Wayne C. Turner and Steve Doty, 10.5.7 HVAC Equipment, Equipment Efficiency, p. 267.*

[289] *Moderate cost is defined as projects with payback of between three and five years and savings of 15% to 30%; long term is defined as higher-cost projects involving more engineering, and 30% to 50% savings. Classifications based on Energy Management Handbook, Sixth Edition, Wayne C. Turner and Steve Doty, figure 1.1 Typical Savings Through Energy Management, p. 3.*

they are looking at larger, more involved projects to not only save energy, but also increase their use of renewable fuels like geothermal, solar, wind, and biomass systems.

Workshops will continue to be conducted by various agencies to ensure that the staff has the latest information on technology available for saving energy. Brochures, newsletters, and knowledgeable energy staff at each agency are available as resources for information on what is being implemented within the agency and at the state government level. The SRMRF has been beneficial for the implementation of energy projects that would otherwise go unfunded. Agencies have found this fund to be a comprehensive process and have been making the repayments to ensure the continuation of the fund. This fund will continue to improve the efficiency of infrastructure by funding projects above the $5,000 threshold needed to be eligible for application.

10.4.2 State Government Architects/Engineers and Hired Contractors

The planning stage of construction or renovation of a state building is a critical time to consider the efficiency of the building and the systems within the building. It is essential that all agencies make the design teams aware of the importance of the efficient use of resources, energy efficiency, and the environment. Some education may be necessary, and workshops are available throughout the state. State government supervisors will be tasked to encourage attendance for all state government staff who require a working energy-related knowledge base for their job. When the state is hiring consultants, experience with Energy Star and EPP products within the building will be part of the hiring process point system. Experience with the proper recycling and disposal of construction waste will also be part of the hiring process point system.

Agencies under BGS will develop guidelines on the purchase, design, and construction of state government projects to be used internally by staff engineers and externally by all awarded parties. If guidelines already exist, the guidelines will be reviewed for appropriateness and accuracy by BGS.

BGS has a reference for use during design and construction projects called the BGS Design Guidelines. These guidelines will be extensively reviewed and rewritten as appropriate to demonstrate the commitment to energy and environmental conservation in all state government construction projects. All agencies that design or oversee construction projects without BGS will review the BGS Design Guidelines and consider incorporating the language into their own guidelines or adopting the guidelines as part of their process.

10.4.3 Building Infrastructure Development

State government has, in the past, reviewed the feasibility of using biodiesel as a heating fuel to reduce the use of fossil fuels and emissions released by those fossil fuels. Due to the evolving industry, studies will need to continue to provide current data on the cost-effectiveness and feasibility of biodiesel in the state government. Studies on the feasibility of biodiesel use in state government infrastructure will continue to be conducted on a case-by-case basis owing to variations in availability of biodiesel, location of buildings, emission control, and condition of the storage tank and heating system. Plans to overcome these potential barriers will be developed and reviewed by state government project managers. This should prove to reduce the fossil fuel use by state government and to expand the market of biodiesel use within the state. Agencies will continue to use biomass for heating of infrastructure to reduce the dependency on fossil fuels and the impact of emissions from fossil fuels. Various complexes, facilities, and single buildings are currently heated by wood chips, chunk, and pellet fuel. BGS has reviewed the use of No. 6 fuel oil in state government infrastructure, especially the two major BGS complexes, and the worth of fuel switching is dependent on the funding of boiler plant upgrades. Included in the review is the upgrade to the physical plant and cleaner-burning replacement fuel options, plus their costs and availability. The operational costs, location of the plant, and emissions generated will also be considered.[290]

Currently, the renewable energy portfolio for state government has a variety of different types. Several agencies are using biomass; wood chips, wood pellets, and wood chunk. BGS has a photovoltaic array. A couple of agencies have wind turbines, biodiesel, geothermal, and solar hot water collectors. The use of renewable energy systems will be carefully reviewed for cost-effectiveness with consideration for the reduction of the impact of fossil fuels and emissions on the environment. This will also increase the diversity of the state government infrastructure portfolio. The screening of cost-effectiveness will depend on the type of technology, the estimated useful life of the equipment, and the funding used to purchase the technology. Consideration of the best rate of investment for a renewable energy project will include the conclusion that the less expensive energy efficiency opportunities have already been exhausted at the building. The use of solar photovoltaic systems and wind turbines will be reviewed for feasibility of generating electricity that is either individual or group net-metered with the local utility. These systems sell the electricity generated back to the utility and reduce the overall utility bill for the state government. The use of solar collectors and geothermal systems will heat water as well as heat and cool buildings through the heat exchange generated by the sun and the local aquifer. These systems will provide heating and cooling without the use of fossil fuels.

BGS has agreed to participate in the SmartVT program with Green Mountain Power as part of the kickoff to the integration of advanced metering infrastructure in Vermont, and will discuss opportunities with the utilities that incorporate this technology into their infrastructure and general practice as feasible. State government will review the applicable facilities within the given utility territories on a case-by-case basis for feasibility of incorporating smart metering into facilities operations.

10.4.4 Transportation

The investigation of hybrid and low-emission technologies and renewable fuels is ongoing for BGS and throughout state government. The BGS Fleet Management Program currently has hybrid and partial zero emission vehicles (PZEV) as part of its inventory. BGS will monitor the cost, energy efficiency, and emissions benefits of the current fleet annually and adjust new vehicle purchases on the basis of monitoring results and improvements in vehicle technology. Agencies will investigate the use of alternative-fuel vehicles such as natural gas and plug-in hybrid electric vehicles (PHEVs). Agencies will investigate the suitability of state

[290] *Based on the Third Biennial Report of the Climate Neutral Working Group, May 2009, Chapter IV – Recommendations and Next Steps, eighth "globe," p. 24.*

facilities for fueling infrastructure such as electric vehicle charging stations, and the feasibility of incorporating advanced metering infrastructure at key facilities.

10.4.5 Purchasing

Agencies will consider the energy and environmental impacts when writing requirements for the BGS Office of Purchasing and Contracting used to solicit competitive bids. Standard language in bid specifications includes requirements for Energy Star products; EPP products; and no or low volatile organic chemical materials, mercury content, and recycled content. Standardization of purchases through statewide commodity contracts as well as one-time bid and buy opportunities, all of which are issued through the BGS Office of Purchasing and Contracting, has ensured that the products meet environmental and recycled requirements developed by the state government.

10.4.6 Financing Options

Energy and environmental improvements are funded a number of ways, depending on the scope of the intended improvement. Some are added as a line item on the capital bill; others are prioritized in a list of major maintenance projects. Either way, the energy and environmental projects are competing for funding with safety and security as well as general annual purchases. When the improvements are not funded through these traditional means, an application process exists for funding through a revolving fund. As mentioned above, the SRMRF is available, and is applicable for projects that have a minimum cost of $5,000 and show energy savings and a payback appropriate for the given technology. Agencies will use this as a funding mechanism for cost-effective energy projects. Repayment to the revolving fund ensures the continuation of the available funds for future projects.

10.4.7 Cost Efficiency and Savings

Education of state government staff is the key to the efficient use of costs. All staff, from leadership on down, need to understand the importance of efficiency. Leadership, especially supervisory leadership, needs to project a positive attitude regarding efficiency and savings. This will create efficiency habits needed to make a difference. Leadership buy-in is crucial to reinforce the initiatives. Leadership provides a role model aimed at continuing education and promotion of efficient practice and the associated savings. State government construction project managers serve as role models for consultants and supporting staff to conserve and save costs where feasible. Supervisors will explain why projects are being completed and provide the resources for the staff to identify ways to save energy in their day-to-day business. Brochures, newsletters, and workshops explaining new technologies and techniques to work more efficiently and save will be effective resources for staff. Supervisors will meet with utilities early in the project to identify the potential savings and payback on the energy improvements and explain what qualifies for incentives and rebates through their program (multiple utilities may be involved).

Agencies will review their infrastructure and transportation footprint and compare it to their utility bills. This will identify challenges in tracking the savings. For example, some buildings will not have individual meters; some accounts should have been transferred to another agency or disconnected; some utility bills are being coded incorrectly in the accounting software, resulting in artificially low or high totals. It is crucial for the agencies to understand where and when the majority of their energy is being used and what emissions are being created before they can identify the opportunities to save. Agencies will monitor the utility bills to identify billing errors or avoidable penalties and fees. Agencies will continue to install meters and/or sub-meters to track the consumption of the utilities and compare to the billed use. Consumption is the most accurate way to compare the energy use. In order to track and understand progress toward meeting these goals, the state will use the U.S. Environmental Protection Agency (EPA) Portfolio Manager, which has an interactive energy management tool to track energy consumption and greenhouse gas emissions. Agencies will designate a staff member to participate in any Portfolio Manager trainings and to become familiar enough with the EPA website to accurately benchmark the agencies' buildings. The use of this program will identify suboptimal performance and give priority for performance upgrades such as comprehensive HVAC upgrades, building envelope improvements, and window improvements.[291]

10.5 Goals for Projects

10.5.1 Implementation of Energy Projects

Each building that is evaluated via the above method will have a goal of achieving 75 points (or the level as amended by the EPA) on the EPA national energy performance rating system as determined by the Energy Star Target Finder tools. If a particular agency finds that some buildings do not meet the target, then these buildings will be prioritized for cost-effective energy improvements for the following year. All buildings identified by the agency will be updated annually using EPA Portfolio Manager, with 100% completion by October of each year. The EPA Portfolio Manager will be reviewed at least annually to make sure the targets compare to the previously posted targets for the EPA Portfolio Manager.

Electric utility savings is an important consideration. In the case of the electric bill, reduction in peak use could result in more savings than just the costs per kilowatt-hour. Review of the electric bill could find a demand charge or a power factor penalty that could represent a savings opportunity. The demand charge is based on the peak hourly use of electricity during the billing period. This peak use is then used to set the costs of the electric bill for the next 11 months (in most cases). The power factor penalty is added to a utility account when there is equipment in operation that causes a disturbance in the electric distribution. Each utility company allows for some disturbance, but if the building it serves exceeds the allowable disturbance, the power factor penalty is added to the electric bill. This can be corrected by hiring a consultant to review the equipment and making

[291] *Based on the Third Biennial Report of the Climate Neutral Working Group, May 2009, Chapter IV – Recommendations and Next Steps, ninth "globe," p. 24.*

adjustments to the way it operates or by adding a device in-line that will correct the disturbance. Cost-effective savings can be achieved by addressing either of these areas.

10.5.2 Leadership-Level Support

Statewide involvement and support will be necessary to accomplish implementation of the objectives of the CEP. All agencies and officers will need to be involved in varying degrees. Even if the agency does not own infrastructure or transportation, its staff still uses state government infrastructure and transportation. The message should be sent and supported throughout to ensure a unified, single message is received. This will establish the trust needed to begin changing the culture of state government and, in turn, changing how energy is used and emissions are avoided.

10.5.3 Project-Level Support

To create and complete energy projects, the technology will need to be reviewed to ensure that the most cost-effective and reliable solution is being proposed. Staff input and support will also ensure that the new systems perform as designed, thus achieving the efficiency and full usable life specified by manufacturers. Bulk upgrades or renovations should be undertaken as one project to reduce mobilization costs for similar tasks as well as achieving greater energy savings.

Training of state government staff will be crucial to the success of the project as well. Agencies responsible for acquiring funding for projects will specify that the cost of hands-on training and any necessary operations and maintenance (O&M) manuals be included in the project costs. The installation of any new equipment includes all O&M manuals and hands-on training for the staff responsible for the maintenance of the equipment after project completion.

10.6 Education

10.6.1 Statewide Leadership by BGS

A single statewide contact, a BGS environmental engineer, is available as a resource for all the energy staff selected in the various agencies/departments. The BGS environmental engineer will provide information on upcoming conferences, trainings, and workshops to develop the knowledge base of the energy staff. Resources will be available on the BGS energy website for use by the state government. An energy newsletter will be posted every other month to provide new technology information, explain results of energy projects, and highlight the accomplishments of different state government staff. Past energy newsletters will be archived on the website for future access. Various brochures will be posted to provide tips on saving energy in various work settings. An electronic copy of the State Agency Energy Plan will be available for viewing on the website as well as any other relevant plans or executive orders.

Periodic meetings will be held as necessary for hands-on training or presentations. Web conferencing, phone conferencing, or teleconferencing will be used whenever possible for other meetings. The BGS environmental engineer will keep in touch with the energy community to identify what information and presenters will be necessary for the trainings and presentations. A recognition program is an important component in the implementation of this plan. Recognition programs can be on a department-wide or an individual basis. Submitting articles and comments for the energy newsletter will get the attention not only of other agencies, but also the members of the public who regularly read the newsletter on the energy website.

10.6.2 Agency/Department Leadership Involvement and Support

As conferences, trainings, workshops, or general information on new technologies becomes available, the BGS environmental engineer will send these resources to the energy staff. The energy staff will be responsible for educating the leadership, who will, in turn, educate the rest of the staff on the opportunities to save and the results of the savings.

Leadership that takes an active role in the energy savings implementation will dramatically affect the implementation in a positive manner. Likewise, lack of leadership support will lessen the desire for implementation. Agencies will provide a single contact, an energy staff member, as a resource for the agency. The energy staffer will be in constant contact with the BGS environmental engineer, which will increase the staffer's knowledge base and enhance his or her abilities to disseminate information within the agency.

10.6.3 Encouraging Ride Sharing for Job-Related Travel

Staff should always try to ride share with colleagues for site visits, meetings, and other field work whenever possible. BGS will add a check box on the state fleet reservation asking if the person is willing to carpool during job-related travel. If so, he or she will be matched with other employee(s) traveling to the same location and willing to ride share. When a state government building conference room is reserved, BGS will remind participants to ride share. In addition, meeting organizers should encourage ride sharing whenever possible.

10.6.4 Building Design Features to Attain Passive Heating and Cooling

For all new construction and major renovation projects, consider the shading opportunities on the south and west side of the building. The shading could be constructed or natural. Some types of constructed shading to consider are awnings, light shelves, and screens. If it is natural shade, be sure that the trees are deciduous to maximize the solar gain in the winter.

New construction projects also have the opportunity to orient the building in a way that provides shading through site location. Locate any large openings such as large bay doors or the main entryway away from the north side of the building to prevent the cold north wind from cooling the building in the winter. Enclosed breezeways and double doors should be considered if large openings cannot be moved from the north side of the building. Ensure that large areas of glazing located on the south side have proper shading and protection to prevent overheating in the summer and overcooling in the winter. If that is not possible, the necessity of large amounts of glazing should be reviewed and the opportunity to rotate the building so the glazing is not facing south should be a consideration.

Abbreviations Used	
Abbreviation	Definition
ACCD	Agency of Commerce and Community Development
AEO	Annual Energy Outlook
AESC	Avoided Energy Supply Costs
AHS	Agency of Human Services
AMI	Automated Meter Infrastructure
ANR	Agency of Natural Resources
AOA	Agency of Administration
AOT	Agency of Transportation
ARRA	American Recovery and Reinvestment Act
ASHREA	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
BED	Burlington Electric Department
BERC	Biomass Energy Resource Center
BGS	Buildings and General Services
BLS	Bureau of Labor Statistics
BOD	Biological Oxygen Demand
BPI	Building Performance Institute
BURDES	Burlington Electric District Energy System
CAFE	Corporate Average Fuel Economy
CAP	Community Action Partnership
CBES	Commercial Building Energy Standards
CCRPC	Chittenden County Regional Planning Commission
CDAAC	Capital Debt Affordability Advisory Committee
CEDF	Clean Energy Development Fund
CEDO	Community and Economic Development Office
CELT	Capacity, Energy, Loads, and Transmission
CEP	Comprehensive Energy Plan
CFS	Clean Fuel Standard
CHP	Combined Heat and Power
CNG	Compressed Natural Gas

Abbreviations Used	
Abbreviation	Definition
CONEG	Coalition of Northeastern Governors
CPG	Certificate of Public Good
CPI	Consumer Price Index
CVCAC	Central Vermont Community Action Council
CVPS	Central Vermont Public Service
DEC	Department of Environmental Conservation (part of ANR)
DMV	Department of Motor Vehicles
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPS	Department of Public Service
DSM	Demand-Side Management
DUP	Distributed Utility Planning
EAP	Energy Assurance Plan
ECP	Eastern Canadian Premiers
EEC	Energy Efficiency Charge
EEM	Energy-Efficient Mortgage
EEU	Energy Efficiency Utilities
EIA	Energy Information Administration
EISPC	Eastern Interconnection States Planning Council
ELP	Energy Literacy Project
EPA	U.S. Environmental Protection Agency
EPP	Environmentally Preferable Purchasing
EPRI	Electric Power Research Institute
EVT	Efficiency Vermont
FCM	Forward Capacity Market
FER	Fossil Energy Ratio
FERC	Federal Energy Regulatory Commission
FHA	Federal Housing Administration
FHWA	Federal Highway Administration
FOMC	Federal Open Market Committee

Abbreviations Used	
Abbreviation	Definition
GCCC	Governor's Commission on Climate Change
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMP	Green Mountain Power
GSHP	Ground Source Heat Pumps
GSR	General Systems Research, LLC
HAN	Home Area Network
HAP	Hazardous Air Pollutants
HERS	Home Energy Rating System
HQUS	Hydro-Quebec US
HRU	Heat Recovery Units
HSIPR	High-Speed & Intercity Passenger Rail program
HVAC	Heating, Ventilating, and Air Conditioning
IBT	Internal Bilateral Transaction
ICE	Internal Combustion Engine
ICP	Institutional Conservation Program
IECC	International Energy Conservation Code
IRP	Integrated Resource Plans
IRS	Internal Revenue Service
ISO	Independent System Operator
LCFS	Low-Carbon Fuel Standard
LEED	[U.S. Green Building Council] Leadership in Energy and Environmental Design
LEV	Low Emission Vehicle
LIHEAP	Low-Income Home Energy Assistance Program
LLC	Limited Liability Company
LPG	Liquefied Propane Gas
MAGICC	Mid-Atlantic Grid Interactive Car Consortium

Abbreviations Used	
Abbreviation	Definition
MDMS	Meter Data Management System
MLS	Multiple Listing Service
MPG	Miles Per Gallon
MTAP	Municipal Technical Assistance Program
NAAQS	National Ambient Air Quality Standards
NALG	Net Available Low-grade Growth
NASTO	Northeast Association of State Transportation Officials
NAT GAS Act	New Alternative Transportation to Give Americans Solutions Act
NEGC	New England Governors' Conference
NEIL	Nuclear Electric Insurance Limited
NERC	National Electric Reliability Council
NESCAUM	Northeast States for Coordinated Air Use Management
NESCOE	New England States Committee on Electricity
NGV	Natural Gas Vehicle
NHTS	National Household Travel Survey
NHTSA	National Highway Traffic Safety Administration
NICE	Northeastern International Committee on Energy
NRC	U.S. Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NREL	National Renewable Energy Laboratory
NTA	Non-Transmission Alternatives
NWWVT	Neighborworks of Western Vermont
NYPA	New York Power Authority
NYSERDA	New York State Energy Resource and Development Authority
OEO	Office of Economic Opportunity
OES	Occupational Employment Statistics
PAC	Policy Advisory Committee
PACE	Property Assessed Clean Energy [Districts]
PASNY	Power Authority of the State of New York

Abbreviations Used

Abbreviation	Definition
PBR	Performance-Based Ratemaking
PEV	Plug-In Electric Vehicle
PHA	Public Health Assessment
PLC	Power Line Carrier
PPA	Power Purchase Agreement
PSB	Public Service Board
PSD	Public Service Department
PURPA	Public Utility Regulatory Policies Act
PZEV	Partial Zero Emission Vehicle
QCEW	Quarterly Census of Employment and Wages
QECB	Qualified Energy Conservation Bonds
QPI	Quantifiable Performance Indicators
RAP	Regulatory Assistance Project
RBES	Residential Building Energy Standard
REAP	Rural Energy for America Program
REC	Renewable Energy Certificate
REMI	Regional Economic Models Inc.
RFP	Request For Proposal
RFS	Renewable Fuel Standard
RGGI	Regional Greenhouse Gas Initiative
RGGR	Regional Greenhouse Gas Registry
RNG	Renewable Natural Gas
RNS	Regional Network Service
RPC	Regional Planning Commissions
RPS	Renewable Portfolio Standard
SAEP	State Agency Energy Plan
SED	Stowe Electric Department
SEMP	The Vermont School Energy Management Program
SOV	State of Vermont

Abbreviations Used	
Abbreviation	Definition
SPEED	Sustainably Priced Energy Enterprise Development
SQRP	Service Quality Reliability Plans
SRMRF	State Resource Management Revolving Fund
TCI	Transportation and Climate Initiative
TES	Total Energy Standard
TIGER	Transportation Investment Generating Economic Recovery
TPI	Transportation Planning Initiative
TRC	Transportation Research Center
ULSD	Ultra Low Sulfur Diesel
USDA	U.S. Department of Agriculture
UVM	University of Vermont
VAAFM	Vermont Agency of Agriculture, Food, and Markets
VBI	Vermont Biofuels Initiative
VCRD	Vermont Council on Rural Development
VEC	Vermont Electric Cooperative
VECAN	Vermont Energy Climate Action Network
VEDA	Vermont Economic Development Authority
VEEP	Vermont Energy Education Program
VEIC	Vermont Energy Investment Corporation
VELCO	Vermont Electric Company
VEPP	Vermont Electric Power Producers
VFDA	Vermont Fuel Dealers Association
VFEP	Vermont Fuel Efficiency Partnership
VGS	Vermont Gas Systems
VHCB	Vermont Housing and Conservation Board
VHFA	Vermont Housing Finance Agency
VJO	Vermont Joint Owners
VLS	Vermont Law School
VMT	Vehicle Miles Traveled

Abbreviations Used	
Abbreviation	Definition
VOC	Volatile Organic Compounds
VPPSA	Vermont Public Power Supply Authority
VSJF	Vermont Sustainable Jobs Fund
VSPC	Vermont System Planning Committee
VYNPC	Vermont Yankee Nuclear Power Corporation
VWTF	Vermont Weatherization Trust Fund
WAP	Weatherization Assistance Programs
WDC	Watts Direct Current
WEC	Washington Electric Cooperative
WHEEL	Warehouse for Energy Efficiency Loans
YTD	Year to Date
ZEV	Zero Emission Vehicle

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