The Public Service Department is pleased to share this draft of the updated Vermont Comprehensive Energy Plan (CEP). This draft includes significant contributions from other state agencies including the Agency of Agriculture, Food, and Markets, Agency of Natural Resources, Agency of Commerce and Community Development, Agency of Human Services, and the Agency of Transportation. It also reflects the extensive feedback received from Vermonters at 8 public and stakeholder meetings and through written comments submitted before drafting commenced.

We welcome public comments and suggestions for improvement as we work to finalize this plan by the end of the year. Comments are welcome in writing via the comment form at the CEP project website, http://energyplan.vt.gov until November 9, 2015.

The PSD will hold five public hearings on this draft, at which members of the public may learn more about this plan and provide formal written or oral comments. These events will be held in Lyndonville on October 7, Essex on October 13, Montpelier on October 21, Bellows Falls on October 26, and Rutland on October 29. Details for each event are on the project webpage.

The 2011 CEP established a goal of meeting 90% of the state's energy needs through renewable sources by 2050. It also proposed taking steps to virtually eliminate our dependence on petroleum. The 2011 plan spurred vibrant and ongoing discussion statewide, along with significant actions. These actions include:

- passage of Act 56 establishing a Renewable Energy Standard;
- the Thermal Efficiency Task Force and two Clean Energy Finance Summits;
- updated building energy codes and a Vermont residential building label;
- pilots of new financing programs including the Heat Saver Loan;
- signing of the multi-state Zero Emission Vehicle memorandum of understanding;
- expansion of the Standard Offer program while lowering the cost of new contracts by more than 60%; and
- expansion of net metering to 15% of peak load and an ongoing process to design a sustainable net metering program.

Since the last CEP was published in 2011, Vermont has added more than 100 MW each of wind and solar PV electric generation to the state. Implementation of Act 56 and the Renewable Energy Standard will further drive Vermont towards our interim and overall goals. We are doing all this while keeping rates stable and low. Electric rates in Vermont have increased only 4.2% since 2011, which is slower than overall inflation, while New England average rates rose 11.9% and U.S. average rates have increased 5.7%. Vermonters on average currently pay the second lowest electric rates in New England.

This 2015 CEP builds on the success of the 2011 plan. It makes specific recommendations on ways 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 expands upon the ambitious long-term goal of obtaining 90% of the state's total energy needs from renewable sources by mid-century. When combined with the statutory goal of 25% renewable by 2025 (10 V.S.A. § 580(a)), this draft CEP proposes the following set of goals:

- Reduce total energy consumption per capita by 15% by 2025, and by more than one third by 2050.
- Meet 25% of the remaining energy need from renewable sources by 2025, 40% by 2035, and 90% by 2050.
- Three end-use sector goals for 2025: 10% renewable transportation; 30% renewable buildings; and 67% renewable electric power.

The plan emphasizes the importance of efficiency and conservation. This includes efficiencies gained by using new electric technologies (heat pumps, electric vehicles) that are substantially more efficient than previous technologies. It also includes efficiency in electric generation that comes from shifting away from wasteful power plants that send heat up smokestacks, and toward wind, solar, and hydroelectric. The focus on strategic electrification reinforces the shift toward distributed energy resources that support our grid, increase resilience, and lower infrastructure costs.

The plan recognizes, however, that there is no single path for Vermont to attain these goals; instead, incremental policy changes, along with progress on education, finance, and innovation, will be required. Vermont must work with both public and private sectors and utilities to advance the objectives in cost-effective, efficient and innovative ways, and to encourage each and every citizen to do what they can to help all of Vermont achieve a transformative energy future.

We look forward to your comments on this Draft.

2015 Comprehensive Energy Plan

Public Review Draft

Contents

1 Preface

1.1 Objectives for the Comprehensive Energy Plan

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. The 2011 CEP established a goal of meeting 90% of the state's energy needs through renewable sources by 2050. Coupled with this, it proposed taking steps to virtually eliminate our dependence on petroleum. This plan has created vibrant and ongoing discussion statewide, along with significant actions, since its release, and this updated CEP builds on that ongoing dialogue. The Vermont economy has continued to grow following the financial crisis, and the state has among the lowest unemployment rates in the country, but we do face longer-term demographic challenges. Clean energy jobs, in particular, have been a source of growth for the state. 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 electric power, but also heating and transportation.

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 expands upon the ambitious long-term goal of obtaining 90% of the state's total energy needs from renewable sources by mid-century. When combined with the statutory goal of 25% renewable by 2025 (10 V.S.A. § 580(a)), this CEP establishes the following set of goals:

- Reduce total energy consumption per capita by 15% by 2025, and by more than one third by 2050.

- Meet 25% of the remaining energy need from renewable sources by 2025, 40% by 2035, and 90% by 2050.

- Three end-use sector goals for 2025: 10% renewable transportation; 30% renewable buildings; and 67% renewable electric power.

The CEP recognizes, however, that there is no single, lockstep path that may help Vermont attain these goals; 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.

This Public Review Draft of the Comprehensive Energy Plan reflects insights gained from numerous reports, meetings, and conversations with stakeholders and other members of the public since the publication of the 2011 CEP. It also draws upon input and expertise from the agencies of Natural Resources; Transportation; Agriculture, Food and Markets; Commerce and Community Development; and Human Services. It will continue to be revised based on public feedback following its release.

1.2 Statutory Goals and Requirements

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

> (1) The DPS, 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 give effect to the policies of section 202a of Title 30 to provide reliable and affordable energy and assure the State's economic vitality, it is critical to retain and recruit manufacturing and other businesses and to consider the impact on manufacturing and other businesses when issuing orders, adopting rules, and making other decisions affecting the cost and reliability of electricity and other fuels. Implementation of the State's energy policy should:

- (1) encourage recruitment and retention of employers providing high-quality jobs and related economic investment and support the State's economic welfare; and
- (2) appropriately balance the objectives of this section with the other policy goals and criteria established in this title. 30 V.S.A. § 218e

- 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 that uses natural resources efficiently and related planned energy industries in Vermont, and the jobs and economic benefits associated with such development, 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 in the State and region through the displacement of those fuels, including fossil fuels, which are known to emit or discharge pollutants.

(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) Providing support and incentives to locate renewable energy plants of small and moderate size in a manner that is distributed across the State's electric grid, including locating such plants in areas that will provide benefit to the operation and management of that grid through such means as reducing line losses and addressing transmission and distribution constraints.

(8) Promoting the inclusion, in Vermont's electric supply portfolio, of renewable energy plants that are diverse in plant capacity and type of renewable energy technology. 30 V.S.A. § 8001

The DPS 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.

The recently enacted Act 56 establishes a Renewable Energy Standard (RES) (30 V.S.A. § 8004 and 8005), which requires electric power to be:

- 55% renewable in 2017, rising 4% every three years, to 75% in 2032; and
- 1% from distributed generators supporting Vermont's electric grid in 2017, rising 0.6% per year, to 10% in 2032.

The RES also requires electric utilities to reduce fossil fuel use by their customers by an amount equivalent to 2% of retail electric sales in 2017, rising 2/3% per year to 12% by 2032.

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)

- It is a goal of the state, by the year 2025, 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.

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 nine 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. VTrans, ANR and the Public Service Board have signed on to an agreement with the eleven northeast states and the District of Columbia to reduce greenhouse gas emissions from the transportation sector through the Transportation Climate Initiative[1] (TCI).

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 greenhouse gas (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 Federal interagency *Quadrennial Energy Review* (released in April 2015).

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 The 20-year Electric Plan

Pursuant to 30 V.S.A. § 202, the 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. This CEP embodies 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.

[1] http://www.transportationandclimate.org/

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. Given the increased electrification of many energy services, especially heating and transportation, which may be necessary in order to achieve the state's energy policy objectives, a full integration of electric planning into this CEP is required.

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. Per the statutory mandate and the ongoing efforts of the Governor's Climate Cabinet, the CEP represents the collective efforts of senior leaders and staff from state agencies and departments, as well as input submitted to the DPS from Vermont citizens and stakeholders. During the course of the development of this public review draft of the CEP, the DPS received nearly 500 comments.

The DPS 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. Text and recommendations throughout this CEP rely heavily upon the subject matter expertise in these agencies.

In May 2011, Governor Shumlin formed the 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 has played an important role in implementation oversight of the 2011 CEP, and will continue that role as the CEP moves forward.

To inform the CEP, in addition to drawing on DPS and other agency expertise, we engaged the Regulatory Assistance Project to provide analytic support and expertise on future utility regulatory structures and business models, informed by their work in other U.S. and foreign jurisdictions.

1.4.1 Public Process

To update its understanding from the 2011 CEP and to engage the public regarding the state's 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 2015, and Phase II will gather input on the released draft itself.

Phase I began with release of a request for information, including a number of specific questions, in May 2015. The DPS then organized a set of four half-day stakeholder workshops in late June and early July. These workshops addressed energy efficiency and conservation; electric grid and utility issues; energy supply resources; and transportation and land use. Each meeting was framed by relevant facts and analysis, and consisted primarily of breakout group discussions focused on particular topics or sectors of relevance to the CEP update. Throughout July, meetings organized in conjunction with the Vermont Energy and Climate Action Network (VECAN), town energy committees, 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 Woodstock (July 9), Middlebury (July 16), Manchester (July 20), and St. Albans (July 23). All of the materials presented at stakeholder and public meetings were posted on the CEP website (energyplan.vt.gov)

Throughout Phase I, the DPS also collected input from the public via e-mails, letters, and a survey tool on the CEP website. The planning process resulted in comments representing a wide range of perspectives and suggestions that have informed this draft CEP. The approach has been to consider public input whether received verbally at public hearings or via e-mail and online comments.

The DPS will begin Phase II of the public engagement process with the release of this Public Review Draft CEP in September 2015 and its formal public comment period. In addition to soliciting written comments, five public hearings will be held around the state to solicit detailed suggestions for incorporation into the final plan.

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 projects. It also does not analyze specific projects that are pending before the Vermont PSB. 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. 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 the cost and GHG emission profile.

1.6 Organization of the 2015 CEP

The result of this extensive planning work is this 2015 CEP. The executive summary of the CEP summarizes the current energy picture and lays out the CEP's goals and vision for the future. The main text of the CEP contains the details behind the recommended goals, initiatives, and key programs as they relate to the energy services of heat, transportation, and electric power, and the many resources that can provide energy to meet those needs. The CEP encompasses 15 chapters 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.

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, and transportation. 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.

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 with both heat and transportation). In addition, the DPS intends to keep working closely with the Climate Cabinet, which will continue to be a steward of the CEP. The Climate Cabinet is also continuously 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 Progress toward the Recommendations and Goals of the 2011 Comprehensive Energy Plan

The four years since the completion of the 2011 CEP have seen significant progress in advancing the recommendations and goals established in that plan. Existing and new programs have continued Vermont's leadership in encouraging energy efficiency across all fuels and in fostering local development of new renewable energy supply. Throughout this CEP, recommendations reflect progress already made and identify the next steps for further implementation. Progress in the next six years will build on foundations established in the last four. This chapter summarizes the highest impact actions the state has achieved since the 2011 CEP in three energy services: heat, transportation, and electric power, following discussion of cross-cutting actions that reflect progress across multiple energy services.

The programmatic and policy progress identified below has been enabled by continued development of technologies, expanding the range of cost-effective clean energy options for Vermonters. This includes a significant decline in the cost of distributed electric generation, especially from solar photovoltaic generators, whose installed costs have fallen by almost 30% since 2011[2]. There are at least a dozen models of plug-in vehicles available today that were not available when the last CEP was published, and many more have been announced for the next couple of years. Heat pump heating systems suitable for Vermont have expanded from ground-source to a growing array of affordable cold-climate air source options. Meanwhile, electric rates in Vermont have increased 4.2% since 2011, which is slower than overall inflation, while New England average rates rose 11.9% and U.S. average rates have increased 5.7%[3].

The continued interagency partnerships established through the 2011 CEP process and the subsequent work of the Governor's Climate Cabinet have embedded joint actions, such as the ZEV Action Plan described below, across state government. The State Agency Energy Plan, developed jointly with this CEP, also draws on that interagency partnership to develop state leadership by example.

2.1 Cross-Cutting Progress

A lasting impact of the 2011 CEP is the establishment of a total energy perspective to meeting the state's energy goals. Meeting 90% of the state's energy needs from renewable sources by 2050 will require careful use of energy, and careful choice of fuels, across all end uses. The Total Energy Study brought that perspective to long-term energy analysis, while the Renewable Energy Standard in Act 56 will both increase renewable energy and reduce fossil fuel use. This updated CEP builds on this total energy foundation, while associated regional energy planning pilots bring it to the regional scale.

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[2] *Data from small-scale solar PV systems supported by the Clean Energy Development Fund.*

[3] *U.S. EIA. Comparisons are between calendar year 2011 and July 2014-June 2015, the most recent 12 month stretch available.*

2.1.1 Renewable Energy Standard (Act 56)

Act 56 of 2015 establishes a Renewable Energy Standard (RES) for Vermont electric utilities, while repealing the Sustainably Priced Energy Enterprise Development (SPEED) program. This act establishes a renewable portfolio standard requiring electric utilities to increase the portion of renewable energy they sell to Vermont customers to 55% in 2017, rising over time to 75% in 2032, referred to as the Tier 1 requirement. Tier 2 of the RES requires that an increasing portion (1% in 2017, climbing to 10% in 2032) of electric energy comes from small (< 5 MW) electric generators that are connected to and support Vermont's distribution grid or help to avoid costly transmission upgrades. An RPS with these features was an explicit recommendation of the 2011 CEP.

In addition to these electric portfolio requirements, Act 56 also creates a separate energy transformation obligation that rises from 2% in 2017 to 12% in 2032 (except that small municipal utilities will not have an obligation until 2019) referred to as Tier 3. A utility may meet this category through additional distributed renewable generation or "energy transformation" projects. Energy transformation projects result in net reduction in fossil fuel consumption by a utility's customers. Energy transformation projects may include home weatherization or other thermal energy efficiency measures; air source or geothermal heat pumps and high-efficiency heating systems; increased use of biofuels; biomass heating systems; support for transportation demand management strategies; support for electric vehicles or related infrastructure; and infrastructure for the storage of renewable electricity on the grid. While Act 56 primarily addresses electric utilities, and will have profound effects on electric power supply and demand, it is also a cross-cutting policy tool because of its potential impact on efficiency and fuel choice for heating and transportation.

While the exact paths that utilities take to meet the RES obligations, particularly Tier 3, are unknown, the DPS estimates that the RES as a whole will reduce Vermont's net energy bills by hundreds of millions of dollars and have limited electric rate impact. Strategic electrification resulting from energy transformation projects has the potential to lower electric rates by utilizing our existing electric infrastructure more completely. Meeting the RES requirements will also reduce Vermont's GHG emissions by approximately 15 million tons by 2032, putting the state on a path to meet one quarter of the state's emission reduction goal by 2050. Careful implementation of Act 56 is a prime and recurring thread throughout this updated CEP.

2.1.2 Total Energy Study

The 2011 CEP recommended that the Legislature and DPS explore the possibility of a "Total Energy Standard"; the Legislature then required[4] a two-year study of policies and programs that would meet the state's GHG and renewable energy goals in an "integrated and comprehensive manner." The resulting Total Energy Study, completed by the DPS in December of 2014, identified and evaluated promising policy and technology pathways, as well as raised questions for further analysis and consideration. The

[4] *Via Act 170 of 2012 and Act 89 of 2013*

fundamental conclusion of the Total Energy Study is that Vermont can achieve its GHG emission reduction goals and its renewable energy goals while maintaining or increasing Vermont's economic prosperity. However, to do so will require significant changes in energy policy, fuel supply, infrastructure, and technology.

2.1.3 Enhanced Regional Energy Planning

The DPS has partnered with three regional planning commissions (RPCs) – Bennington, Two Rivers-Ottauquechee, and Northwest – to advance a total energy approach to regional energy plans, consistent with the goals and approach embodied in both the 2011 CEP and this update. The project is underway, and will be complete in 2016. Each RPC, working with VEIC, will model pathways to 90% renewable energy within their region and identify particular regional actions on heat, transportation, and electric power. The updated plans will also include a mapping component, identifying promising areas for different kinds of renewable energy supply technologies. The DPS hopes that development adoption of these revised plans will enable a bottom-up approach to energy planning that will complement the state-led CEP structure.

2.1.4 Clean Energy Finance Summits

The DPS, Agency of Commerce and Community Development, and partners organized statewide summits on clean energy finance convened by Senator Bernie Sanders and Governor Peter Shumlin in April 2012 and June 2013. The primary purpose for these events was to advance clean energy development in Vermont, and build stakeholder engagement in advancing priority energy finance recommendations in the public and private spheres. Each event took the form of a working session during which participants had the opportunity to share perspectives on clean energy finance from the national level down to the local in Vermont, and offer their input on how to move ahead.

Both events contributed toward the momentum for clean energy by addressing the finance aspect of meeting the state's energy goals. Discussions covered a range of topics, such as the status of federal tax credits, the role of debt and equity in project finance, and steps needed to attract the kinds of long-term, lower cost capital to the clean energy industry found in other mature industries. While many of the issues lie within the purview of the federal government to address, others, such as development of on-bill finance models and evolving efficient technology deployment systems, are amenable to innovation at the state and local level.

2.2 Progress on Heat in Buildings and Industry

Since the enactment of Act 92 in the 2007/2008 legislative session, energy efficiency programs have facilitated building energy efficiency improvements in just under 18,300 housing units. The pace of building improvements continues to lag behind the pace required to achieve the Legislative goal of 180,000 homes by 2020. Resulting from the 2011 CEP, analysis has identified both the scale of traditional energy efficiency programs required to achieve that goal, and the power of other tools, since as building codes and new financing options, to increase the energy fitness of Vermont's buildings.

2.2.1 Thermal Efficiency Task Force

The Thermal Efficiency Taskforce (TETF) was created in 2012 to ensure an integrated and comprehensive statewide whole-building approach to thermal energy efficiency. The TETF convened as one of the recommendations from the 2011 CEP "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 forth in statute" (10 VSA § 581).

The Task Force was comprised of a wide range of diverse stakeholders with 65 members, representing 45 organizations. The Task Force was convened over the course of 2012 with an extensive report of findings and recommendations issued in January 2013.

The report includes a detailed analysis of the benefits that would come to Vermont businesses and families, and the state as a whole, if the investment to reach the building efficiency goals were achieved. The benefits include:

- An increase in Gross State Product of $1.47 for every $1 invested. Incremental energy efficiency programs alone result in an increase in Gross State Product of $1.80 for every $1 invested.
- A net increase of nearly 800 job-years within Vermont's economy.
- Prevention of 6.8 million tons of carbon dioxide equivalent emissions from entering the atmosphere, over the investment lifetime. This equates to taking 1.26 million passenger vehicles off the road for one year.

To achieve these benefits, key recommendations included:

- Implementing a statewide clearinghouse to facilitate easy access to information for consumers interested in making energy improvements.
- Increasing confidence that promised energy savings will be realized.
- Increasing the use of financing to offset upfront costs.
- Developing industry partnerships to build the trained workforce needed to scale up efficiency work.
- Increasing consistency of approach and standards across programs.

The report also included recommendations for the public funding necessary to scale up this effort. The Task Force estimated that new annual public program funding needed to meet the state building efficiency goals would range from $27 million in 2014 to $39.6 million in 2020. The Task Force developed these recommendations based on an assumption that most of the resources will need to come from private, not public, funds. Thus, the report calls for every dollar in public funding to leverage nearly two dollars of investment from the private sector. To date there has not been the public funding called for through this effort made available and it is therefore anticipated that the building efficiency goals set in statute will not be met.

2.2.2 Building Energy Codes

The DPS recently updated the residential and commercial energy codes. The update process started at the beginning of 2014 and the new codes went into effect March 1, 2015. The new codes are based on International Energy Conservation Code, and Vermont was the first state to adopt the IECC 2015. The DPS also adopted the first Vermont residential stretch code, which goes into effect December 1, 2015.[5] The DPS has also developed Commercial Stretch Energy Guidelines that will be used by the Natural Resources Board for commercial Act 250 projects.

Both Residential Base and Stretch Energy Codes incorporate renewable energy into the energy codes for the first time by enabling renewable energy to be used to meet the target Home Energy Rating Scores for compliance. Additionally, the Residential Stretch Code and Commercial Stretch Energy Guidelines have electric vehicle charging requirements for the first time. The requirement applies to multifamily developments of 10 units or more and include having a socket capable of providing either a Level 1 or Level 2 charge for 4% of the total parking spaces (rounded up to the nearest whole number).

Also, as called for in the 2011 CEP, the DPS developed an Energy Code Compliance Plan in 2012, which outlines an approach for achieving 90% compliance with energy codes by February 1, 2017. The Plan recommended a number of priorities to advance the state's energy code compliance efforts, including the use of COMcheck (software) documentation as part of the Act 250 permit process; improved coordination between the DPS and the Department of Public Safety; coordination and support of municipalities' code activities; formation of an Energy Code Collaborative; and securing funding for up to three full-time positions to support outreach, compliance, and enforcement activities. Many of the items recommended in the plan have been carried out by the DPS and other partners. Additionally, code compliance has been identified as a priority issue for discussion in the newly formed Energy Code Collaborative.

2.2.3 Building Energy Labeling

In 2013 and 2014 Building Energy Working Groups were formed for both the Residential and Commercial sectors to develop a consistent format and presentation to disclose the energy performance of buildings and to select one or more tools to generate an energy rating. Each Working Group also completed and submitted reports to the Legislature describing the comprehensive assessment and analysis completed regarding the issues related to labeling buildings for their energy performance.

The Residential Building Energy Labeling Working Group decided that an asset-based MMBtu/year based score should be used, which will be generated thorough the U.S. Department of Energy's (DOE's) free energy scoring software. A draft label has been developed and will be pilot tested in 2015 with the

[5] *The DPS was given the authority to adopt a residential stretch code through Act 89, passed in 2013. Act 89 defined "stretch code" as, "a building energy code…that achieves greater energy savings than the RBES" (the base code). Act 89 also stated that the stretch code shall apply to all Act 250 projects and can be adopted by individual municipalities.*

goal of a full launch of the label through the state Energy Efficiency Utilities and Weatherization Program by the beginning of 2016.

The Commercial Building Energy Labeling Working Group (which also includes multi-family buildings) decided to use an operational-based rating generated through EPA's Energy Star Portfolio Manager. The Working Group also recommended convening an Advisory Committee to address multiple identified issues and work towards rolling out a Commercial building energy rating and label.

2.2.4 "Heat Saver Loan" Thermal Efficiency Finance Pilot

Launched in July 2014 by Governor Shumlin, the Thermal Energy Finance Pilot project (TEF Pilot) uses funding supplied by the DPS, Vermont Low Income Trust for Electricity (VLITE). and DOE to provide interest rate buy-down and loan loss reserves to reduce credit risk at participating financial institutions. Vermont State Employees Credit Union and Opportunities Credit Union, selected via competitive solicitation in 2014, both offer the program's "Heat Saver Loan" with low-interest rates and terms up to 15 years for qualified borrowers. Borrowers must work with a qualifying contractor that participates in the Efficiency Excellence Network (EEN), a venture of Efficiency Vermont (EVT). The pilot is slated to run into 2016, after which the DPS will evaluate the impact and prospects for continuation of this and/or similar finance initiatives. For more information, see Chapter 6.

2.3 Progress in Transportation

Between 2011 and 2014, Vermonters reduced their gasoline use by nearly 6%. This was driven by a range of factors, including increased vehicle efficiency and Vermonters choosing methods beyond the single occupancy vehicle. After decades of growth and a doubling of the number of cars and trucks on Vermont roadways between 1975 and 2009, a Vehicle Miles Traveled (VMT) decrease of almost 10% has occurred between 2003 and today, including a nearly 2% decline between 2011 and 2013. Public transit ridership rose more than 5% between 2011 and 2014, along with a 17% increase in rail ridership at Vermont stations.

Electric vehicles have taken off in the state – from 88 at the first inventory in July of 2012, to 943 today. Today there are 73 EV charging stations in Vermont, including 14 "fast chargers" that can charge a car in less than half an hour.

2.3.1 Zero Emission Vehicle Rules and Action Plan

The Agency of Natural Resources updated its Low Emission Vehicle air emission rules in February 2014 to match the current California standards. These rules adopt the next generation of Zero Emission Vehicle (ZEV) requirements covering model years 2018-2025. These rules will require annual sales in Vermont of all-electric and plug-in hybrid electric vehicles to exceed 4,500 by 2025. In concert with those rules, Vermont joined 7 other states in an October 2013 Memorandum of Understanding (the ZEV MOU). Under this MOU, the states pledged to work together to get 3.3 million zero emission vehicles on the road by 2025 through coordinated and individual actions. Vermont is participating in the 8-state ZEV action plan, and also developed its own. The Vermont ZEV Action Plan identifies state-specific actions and strategies to grow the ZEV market in Vermont in a manner that is consistent with state climate and renewable energy goals, ZEV program requirements, and the commitments in the MOU. The actions pledged in that plan are reflected in the recommendations of this CEP, and include promoting the availability and marketing of electric vehicles, exploring consumer purchase incentives, and leading by example through the incorporation of electric vehicles into the state vehicle fleet.

2.3.2 Compact Land Use

Since 2011, statutory changes have strengthened the five state land use designation programs, which identify downtowns, village centers, growth centers, and neighborhoods. The improvements resulted in a surge in the number of new designations as well as new funding and partnerships to encourage and support compact development – from increased tax incentives for new and existing buildings and grants to build electric vehicle charging stations in downtowns and villages, to creating a new funding priority in the Agency of Natural Resource's Brownfield, Water, and Wastewater programs, to enhanced EVT incentives, to targeted funding and programs from the Agency of Transportation. Updates were also made to Act 250's 9(L) criterion to promote growth in compact centers and discourage auto-oriented development outside of these areas. The total number of municipal plans that meet the state's land use goals increased: all 11 regional plans were reviewed and updated to assure they meet statutory requirements, and as described above, three regional planning commissions partnered with the DPS, Vermont Energy Investment Corporation (VEIC), and their member communities to update their energy plans.

2.4 Progress in Electric Power

The largest single legislative or programmatic achievement in the electric power sector since the 2011 CEP is the passage of Act 56, described above. This Act will likely result in increased use of electricity for both heat (heat pumps) and transportation (electric vehicles). Meeting the resulting electric energy demand, and limiting the resulting impact on Vermont's electric system and associated costs, will be a continuing concern for electric utilities and their regulators in the coming years. Increased retail sales of electricity, if any required upgrades to the grid infrastructure itself are limited by effective load management, will result in lower electric rates than would otherwise occur. The last four years have advanced tools that increase the potential for such load management while simultaneously increasing cost-effective local investment in electric generation.

2.4.1 Energy Efficiency Utility Performance

Vermont's two electric Energy Efficiency Utilities (EEUs) met performance expectations in the 2012-2014 performance period. Together, their actions during that period saved over 3,500 GWh over the lifetime of efficiency measures, and delivered a 6% reduction in 2014 energy use. They also reduced Vermont's electric peak demand by 4% (42 MW), saving ratepayers in capacity, RNS, and future infrastructure costs.

Targeted energy efficiency has successfully deferred infrastructure needs in St. Albans and in the Susie Wilson Road area of Essex. The Vermont System Planning Committee, coordinating the work of distribution, transmission, and energy efficiency utilities, has shown that efficiency combined with distributed generation and demand response can explicitly avoid hundreds of millions of dollars' worth of transmission infrastructure that would otherwise be required to maintain reliability.

2.4.2 Standard Offer Program Expansion

Act 170 of 2012 expanded the Standard Offer program to 127.5 MW from 50 MW and introduced a market-based pricing mechanism, as recommended by the 2011 CEP. Prices for long-term Standard Offer contracts under the original formulation of the program exceeded 24 cents per kWh for solar photovoltaics (solar PV), while responses to the 2015 request for proposals were as low as 10.96 cents per kWh. At the same time that program costs for solar PV have fallen by more than a factor of two, the Standard Offer program has also enabled the expansion of non-solar technologies, such as hydroelectric, small wind, and food waste anaerobic digestion, as well as providing continued support for farm digesters.

2.4.3 Net Metering

Vermont's net metering program has been subject to numerous expansions and refinements since it was first established in 1999. Two Acts since 2011 have further expanded the program and established a structure that will enable the program to continue on a sustainable basis. Permitted net metered generation capacity has risen to approximately 90 MW as of mid-2015, from 18 MW at the end of 2011. Act 125 of 2012 allowed customers with demand or time-of-use rates to take greater advantage of the ability to net meter, while Act 99 of 2014 raised the program capacity cap to 15% of utilities' peak demand, from 4%. Act 99 also established a process, underway now, for the PSB to refine the now-mature program.

2.4.4 Siting Policy

Increasing in-state development of renewable energy generation will require a sustainable process for permitting and siting that generation. To that end, the Governor issued Executive Order 10-12[6], establishing the Energy Generation Siting Policy Commission to survey best practices for siting approval of electric generation projects and for public participation and representation in the siting process. The Commission published its final report[7] on April 30, 2013. The Commission proposed a package of recommendations built on robust energy planning, particularly at the regional level, along with: a simplified tiered approach to siting; increased opportunities for public participation; changes to the procedures to increase transparency, efficiency, and predictability; and updated guidelines for the

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[6] http://sitingcommission.vermont.gov/sites/cep/files/Siting_Commission/Homepage/EO%2010-12%20Energy%20Gen%20Siting%20Policy%20Commission.pdf

[7] http://sitingcommission.vermont.gov/publications

protection of health and the environment. While the Commission's recommendations have not been enacted, they have served to inform the scope of the regional planning pilot discussed above.

The Solar Siting Task Force established by Act 56 of 2015 will complete the bulk of its work while this CEP is under development, and will inform an update to this section.

3 Chapter 3 – Energy Policy in its Economic, Environmental, and Health Context

The CEP strives to further the state's economic, environmental, and human health goals, which are summarized in this chapter. It recommends taking a broad view of the positive and negative impacts of energy generation and consumption to ensure that our decisions carefully consider human health impacts and environmental issues like air and water quality along with economics, and avoid compromising them. Reaching energy goals is important, but some pathways will have greater net positive impacts than others on economic, environmental, and health objectives.

This CEP recognizes that economic, environmental, and human health ideals can be in conflict and that implementation of a particular policy or program requires striking balances. That said, when there is consistency and an action positively impacts all of these areas, it deserves greater priority. These ideals are identified with the understanding that no one set trumps another, but rather to strive to achieve all of them. When there is a conflict between principles or policies, the plan notes the need for careful deliberation to find the path that develops the greatest positive benefit and minimizes the negatives to diminish the overall conflict.

This chapter describes ideals that can be applied broadly to energy projects, technologies, or policies under consideration. The sections below provide high-level guidance intended to help decision makers consider potential impacts from energy choices and policies, and how these choices both align with and help to achieve other non-energy state policy objectives, or create tension with them.

Why does consideration of principles related to health, the environment, and the economy matter? Ideally, new energy options would generate not only the power or fuel needed for the state, but would also improve quality of life, support a robust economy, and retain fully functional, healthy ecosystems. The energy choices considered in this CEP also pose some potential trade-offs between improvements to one domain while creating some set of impacts to other domains. How do the particular impacts to human health, the natural environment, and the economy compare between energy policies or technologies? Are there options that pass muster across all three domains? What mitigation options are available?

The discussion below provides a starting place to think about these impacts, while further details related to specific potential impacts are found throughout subsequent chapters. Many energy policy options and approaches impact multiple areas; the inclusion of an action as an example in one area does not imply that it is not also relevant elsewhere.

3.1 A Vibrant and Equitable Economy

The following priorities provide lenses for considering impacts related to the vibrancy of the Vermont economy resulting from potential energy projects or policies.

Ensure an affordable and stable cost of living through improvements in the energy fitness of Vermont homes, strategic electrification, focusing development in compact villages and urban centers, and substitution of expensive and price-volatile fossil fuels with renewable alternatives that have lower long-term costs. Over the past two decades, despite very little growth in energy consumption, the cost of energy has been absorbing an increasing share of Vermonters' personal income, mostly as a result of increasing prices for the large amounts of gasoline and distillates that Vermonters rely on for transportation and heating uses. Displacing those fuels with more efficient options, including transformative electric technologies, provides the same level of energy service at lower overall cost and with less consumer exposure to commodity price swings. Locally supplied wood energy is among the most economical options for Vermonters. Lower energy bills enable greater discretionary spending that supports local employment and incomes, while also increasing the value of the home and strengthening the viability of the community. Capital access is required in order to realize the benefits of lower total cost of living. Connecting local supplies of investment and finance capital to Vermont clean energy activities can help fuel progress towards multiple state policy objectives.

Ensure an affordable and stable cost of doing business through improvements in commercial and industrial building and process energy efficiency, strategic electrification, and substitution of increasingly expensive and price-volatile fossil fuels with renewable alternatives that have lower long-term costs. In recent years, on average across industries, growth in Vermont business energy costs has begun to outpace overall business revenue growth. This is a departure from the trend over the last three decades, when sales volumes had consistently proven sufficient to cover energy cost increases. Reducing and stabilizing Vermont businesses' long-term energy costs frees up potential investment capital, enables wage increases, and improves businesses' competitive position. For example, marketing Vermont's agricultural products or reducing the costs for local farming operations via energy-related activities supports the state's overall goals of strengthening farms and food production. Economic vitality also depends on continuity of access to energy, and prompt restoration in case of interruption.

Increase entrepreneurship opportunities by supporting market demand for renewable energy and energy efficiency services. Most of the business revenue associated with Vermont energy expenditures currently accrues to out-of-state suppliers of fossil fuels. Redirecting Vermont's energy spending to in-state suppliers of biomass products, distributed power, and efficiency services invites innovation, productivity, and expansion in local businesses that can result in greater market share and export earnings. For example, expanding opportunities to market low-grade wood as an energy fuel source for clean, efficient, advanced wood heating supports existing forest products, expands opportunities for secondary forest product development, and improves the economic stability of forestland. A commitment to stewardship values enhances the Vermont brand and increases the attractiveness of Vermont for residents and entrepreneurs. Willingness to take a chance on new product, technology, or practice contributes to a healthy innovation ecosystem. Community ownership of energy infrastructure (including through cooperatives and municipal utilities) fosters local engagement and sense of having a stake in the community's future.

Improve labor market conditions by creating well-paying jobs in industries supplying renewable energy commodities and energy efficiency services. Wage growth in Vermont has slowed significantly over the past few decades, as it has across the nation, leaving households increasingly dependent on debt to maintain purchasing power. Over the past 25 years, the Vermont labor force has witnessed the replacement of tens of thousands of relatively well-compensated manufacturing jobs with a comparable number of less well-compensated service jobs in health care, social assistance, and education industries. Widespread deployment of weatherization and efficiency efforts, utilization of native biomass resources, and movement toward distributed electricity generation will each open up new employment opportunities in existing and emergent industries.

Ensure an equitable distribution of benefits and burdens by assisting those least able to pay the increasing costs of energy and the upfront capital costs for efficiency and fuel switching investments. The increase in Vermonters' energy cost burden over the last 25 years has fallen most heavily on the lowest income households. On average, Vermonters spend around 15 percent of their wage and salary earnings on purchases of energy, up from approximately 11 percent in 2000. For those with the least means, energy costs can absorb 30 percent of income or more. Renters face particular challenges, given landlords' lack of incentive to fund efficiency improvements. Reducing the energy bills of those with relatively less discretionary income increases household financial stability while enabling greater comfort and health.

Maintain revenue to support government functions by replacing the reduction in the sale of taxable fuels, such as motor fuels, with appropriate new revenue sources. As with other economic sectors, the activities related to the delivery of energy services are often a source of funding for government functions through taxation or fee collection. The most obvious of these is the tax on the sale of motor fuels to support the state's transportation infrastructure. Other less significant examples include the fees collected on the sale of heating oil for the clean-up of leaking storage tanks, the Gross Receipts Tax for the Vermont Home Weatherization Assistance Program Fund, and the Uniform Capacity Tax on solar PV generators. Vermont's path to a clean energy future will result in some fundamental shifts in several economic activities; one large shift is a reduction in the sale of taxable fuels. To counter that loss, there will be increases in the activities associated with renewable energy production and the services for supporting energy efficiency programs. As these shifts are first envisioned and ultimately implemented, the consideration of state revenues is necessary so as not to increase the burden on other existing revenue sources to support government services.

3.2 Healthy Ecosystems and a Sustainable Environment

The following priorities provide lenses for considering impacts related to ecosystem health and long-term environmental sustainability stemming from potential energy projects or policies.

Reduce GHG emissions consistent with the state's emission reduction goals by reducing fossil-fuel use and efficiently using renewable energy sources. Energy use is responsible for more than 83% of Vermont's GHG emissions. Energy project-related emissions of GHGs and other air pollutants can vary considerably depending on the fuel feedstock and/or specific technologies used, and priority should be given to those that minimize both GHG and other air pollutant emissions. Anthropogenic GHG emissions are the main driver of the climate change currently being experienced, which leads to increased precipitation events that add higher loads of sediment, nutrients, and pollutants to our waterways, while also causing economic harms. Higher temperatures associated with climate change exacerbate problems with nutrient-polluted waterways.

Reduce local air pollutants including particulates and toxins by using efficient and clean combustion technologies, along with shifting away from fossil fuels. Combustion's harmful by-products affect ecosystems and human health. Prioritize energy activities that reduce or eliminate combustion of fuels followed by low-emitting renewable fuels to diminish air-quality impacts. Efficient generation (e.g., advanced combined heat and power technologies) and efficient use (e.g., weatherization, efficient vehicles) with relatively low emissions of air pollutants are preferred over older, less efficient, higher-emitting technologies or practices.

Take a global and life-cycle perspective to the analysis of costs and benefits. Recognize that all currently viable energy technologies and fuels, both renewable and non-renewable, emit GHGs and other pollutants over their full life cycle. For global pollutants, reducing emissions anywhere along the life cycle has comparable climate benefits. Account for relative upstream/life cycle emissions and other impacts attributable to our energy choices, and use that knowledge to make choices that minimize overall emissions and other life-cycle impacts, using consistent methodology.

Retain healthy, functional forest and agricultural systems through responsible use of forest and agricultural resources for energy and non-energy-related applications. Forest health is a prerequisite to a sustainable supply of wood for fuel and other forest products, while ensuring continuation of other forest values and benefits. Sustainable forest management maintains in-forest carbon storage and uptake, while ensuring that this resource is truly renewable. This includes reducing forest fragmentation and edge conditions, retaining regional wildlife corridors and habitat connectivity, decreasing risks to forests from invasive species, and supporting species and age diversity to build resilience against climate disruption. Modern wood-energy technology uses the resource efficiently, improving energy yield and reducing emissions. Maintaining functional agricultural soils is important to produce locally grown food, support our growing value added agricultural industry, and to grow energy crops that can all benefit Vermonters.

Maintain water quality throughout Vermont's ecosystems through responsible land and water use. Land-use best practices improve water-quality by reducing erosion and storm-water runoff, while maintaining and enhancing agricultural productivity, lowering fertilizer use, and improving flood resilience. Dams, including those used for hydroelectric production, can impact water quality; investment in dams to install or increase hydroelectric production should also maintain or enhance the hydrodynamic properties of the river. Using water efficiently also reduces the energy to treat and move water.

Optimize land–use choices to minimize local and global environmental impact, including balancing land use among competing needs in the state for energy, non-energy development, housing, transportation, working lands for agriculture and forestry, and other purposes. This includes the siting of energy generation, transmission, and distribution infrastructure, as well as siting of residential, commercial, and industrial development which will require transportation energy to serve. Comprehensive state, regional, and town land-use plans address multiple goals, including minimizing energy consumption and coordinating energy and non-energy regulations and goals.

3.3 Healthy Vermonters

Energy production and use in Vermont influences our ability to address challenges associated with chronic health conditions and exposure to pollution. The following priorities provide lenses for considering impacts related to human health caused by energy projects or policies.

Encourage active lifestyles and reduced energy use through compact development and by providing safe opportunities for walking, biking, and using public transit. Compact community design, supported by safe and efficient pedestrian, biking, and transit networks, helps to reduce the amount of energy used for transportation purposes while enabling more people to travel using physically active means. Healthy lifestyles reduce obesity, diabetes, and cardiovascular disease. Measures such as education, enforcement, and infrastructure strategies (e.g., Complete Streets and Safe Routes to Schools) help reduce traffic-related injuries and deaths.

Improve outdoor air quality by reducing emissions from transportation, home and business heating and energy usage, and energy production. Using cleaner energy sources (e.g. solar, wind), improving energy efficiency, use of cleaner fuels, shifting to cleaner transportation technologies (e.g. electric/hybrid vehicles), and changing behaviors (e.g. reduced travel, transit/biking/pedestrian travel) reduce air pollution and improve overall air quality. Reducing energy-related air pollution can result in improved respiratory and cardiovascular health, and reduced Type 2 diabetes and cancer risk.

Improve the health of indoor environments and reduce energy bills through improved building weatherization and use of advanced heating and ventilation technologies. Home energy efficiency and heating system improvements can reduce energy usage, leading to cost savings, improved indoor air quality, and greater indoor comfort and yield better respiratory, psychological, and overall health. Incorporating advanced wood-burning stoves and boilers improves home-heating efficiency and reduces detrimental impacts of wood burning on indoor and outdoor air quality. Replacing old heating units with clean, advanced energy technologies especially in areas of at-risk populations reduces risk to vulnerable individuals.

Reduce negative health impacts expected to occur as a result of climate change. Climate change, which is affected by GHG emissions from energy production and usage, has been linked with health impacts related to heat illness, extreme weather events, degraded air and water quality, and vector-borne disease. A warming climate will likely increase demands for energy to cool homes, requiring thoughtful strategies to improve efficiency of cooling systems and reduce the need for cooling with appropriate building, landscape, and community design.

Assess health impacts of our energy system in order to avoid or mitigate potential negative impacts, especially for the most vulnerable population groups such as the elderly, low-income households, and those with chronic or pre-existing medical conditions. Health depends on continuity of energy services, particularly space heating and cooling, food refrigeration, and emergency services. At a minimum, we need to ensure that the most vulnerable populations are not further disadvantaged by the impacts of energy developments or strategies.

SUMMARY: Guiding Goals When Developing And Evaluating Energy Policy

A Vibrant and Equitable Economy

- **Ensure an affordable and stable cost of living** through improvements in the energy fitness of Vermont homes, strategic electrification, focusing development in compact villages and urban centers, and substitution of fossil fuels with renewable alternatives that have lower long-term costs.
- **Ensure an affordable and stable cost of doing business** through improvements in commercial and industrial building and process energy efficiency, strategic electrification, and substitution of fossil fuels with renewable alternatives that have lower long-term costs.
- **Increase entrepreneurship opportunities** by supporting market demand for renewable energy and energy efficiency services**.**
- **Improve labor market conditions** by creating well-paying jobs in industries supplying renewable energy commodities and energy efficiency services.
- **Ensure an equitable distribution of benefits and burdens** by assisting those least able to pay the increasing costs of energy and the upfront costs for efficiency and fuel switching investments.
- **Maintain revenue to support government functions** by replacing the reduction in the sale of taxable fuels, such as motor fuels, with appropriate new revenue sources.

Healthy Ecosystems and a Sustainable Environment

- **Reduce greenhouse gas emissions** consistent with the state's emission reduction goals by reducing fossil-fuel use and efficiently using renewable energy sources.
- **Reduce local air pollutants** including particulates and toxins by using efficient and clean combustion technologies, along with shifting away from fossil fuels.
- **Take a global and life-cycle perspective** to the analysis of costs and benefits.
- **Retain healthy, functional forest and agricultural systems** through responsible use of forest and agricultural resources for energy and non-energy-related applications.
- **Maintain water quality throughout Vermont's ecosystems** through responsible land and water use.
- **Optimize land use choices** to minimize local and global environmental impact, including balancing land use among competing needs in the state for energy, non-energy development, housing, transportation, working lands for agriculture and forestry, and other purposes.

Healthy Vermonters

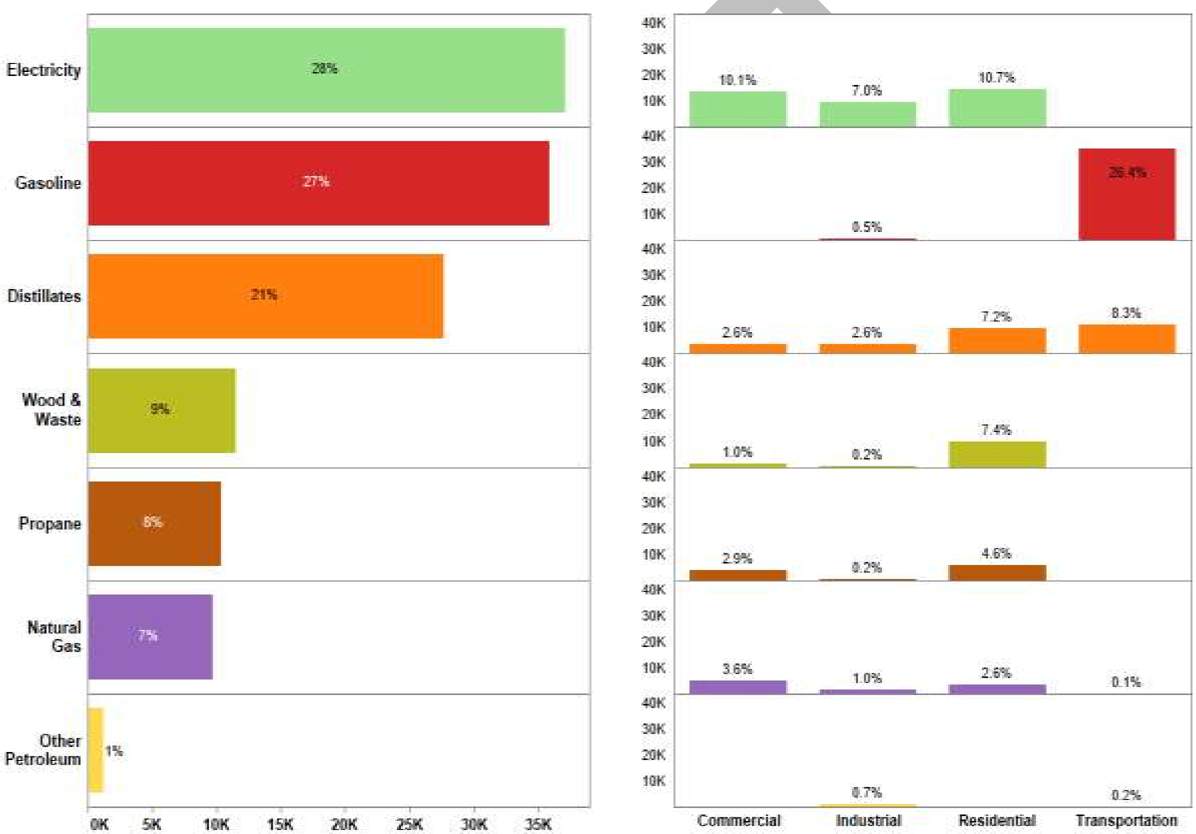
- **Encourage active lifestyles** and reduced energy use through compact development and by providing safe opportunities for walking, biking, and using public transit.
- **Improve outdoor air quality** by reducing emissions from transportation, home, and business heating and energy usage, and energy production.
- **Improve the health of indoor environments** and reduce energy bills through improved building weatherization and use of advanced heating and ventilation technologies.
- **Reduce negative health impacts** expected to occur as a result of climate change.
- **Assess health impacts of our energy system** in order to avoid or mitigate potential negative impacts, especially for the most vulnerable population groups such as the elderly, low-income households, and those with chronic or pre-existing medical conditions.

4 Energy Context

4.1 Total Energy Consumption Today

Chapter 4 of the 2015 CEP presents an overview of Vermont's historical patterns of energy use up to the present, and considers how those consumption patterns will change as the state increases its reliance on renewable sources of energy. As shown in Exhibit 4-1, fossil fuels currently play a dominant role in meeting Vermonters' demand for energy services, with gasoline and distillates (such as diesel and heating oil) alone supplying around half of all of Vermont's primary energy consumption.

Exhibit 4-1. Composition of Vermont Consumption of Primary Energy, 2013 (Billions of Btu)



Source: U.S. Energy Information Administration, State Energy Data System. Gasoline totals shown here are inclusive of ethanol

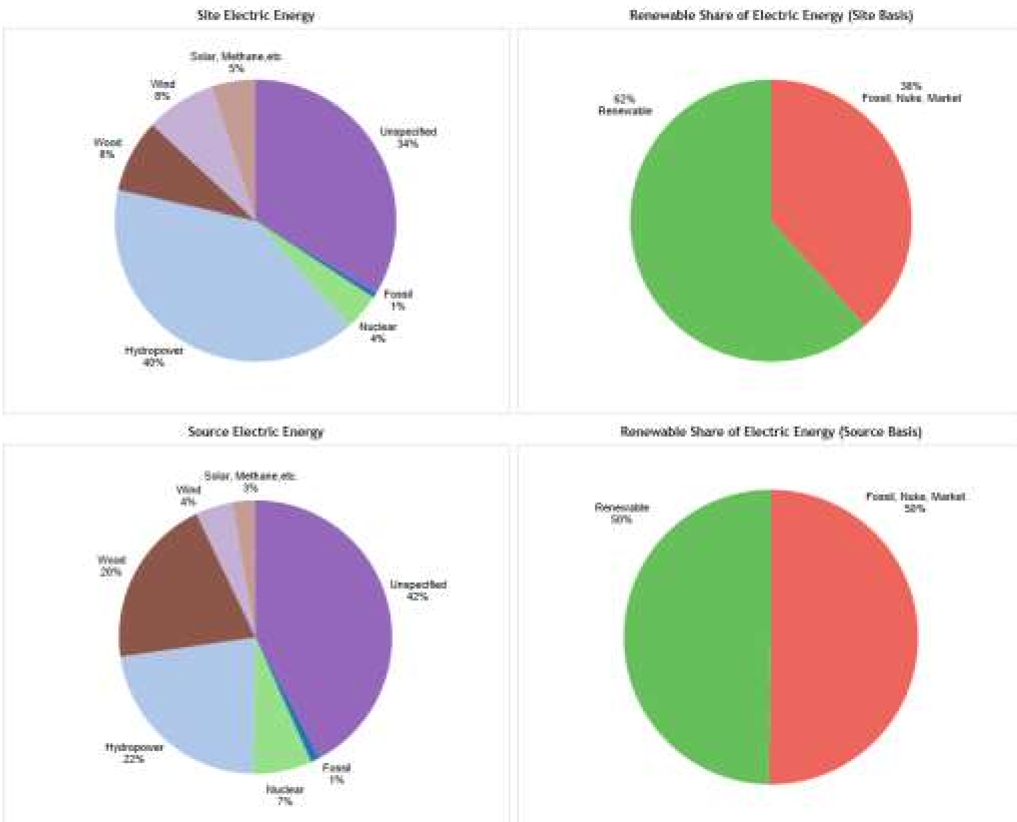
Currently, renewable energy makes up less than 20% of Vermont's total consumption of primary energy. The renewable energy that does serve Vermont comes mostly from an electric power supply that includes large amounts of hydropower, comprising around 22% of source electric energy, as well as a significant amount of generation from biomass and wind resources, respectively comprising around 20% and 4% of total source electric energy. Measured on a source basis, Vermont's electric power supply is currently around 50% renewable, as shown in Exhibit 4-2 (see below for definitions of source and site electric energy). Thus electricity consumption alone accounts for around 65% of Vermont's total consumption of primary renewable energy. Residential use of wood for home heating, and ethanol blended into gasoline stocks account for most of the remaining approximately 35% of Vermont's total primary renewable energy consumption.

Site vs. Primary Energy

When discussing Vermont's total energy consumption it is important to understand how the physical quantities of the various fuels consumed in Vermont are converted into common units that can then be meaningfully compared and summed to an overall total. This conversion is done using the heat content of a fuel, measured in British Thermal Units (BTU). For electricity, heat content can be measured on a site basis, which captures only the BTU of the kilowatts delivered to end-users, or on a source basis, which captures the additional BTU of the fuels used to generate those kilowatts. In this chapter, when the terms **total end-use energy consumption** or **total site energy consumption** are used, it indicates that the electricity component of the total was measured on a site basis.. When the term **total primary energy consumption** is used, it indicates that the electricity component of the total was measured on a source basis. Further, in calculating electric power source energy totals, DPS assumes that the heat content of renewable generation sources (solar, wind, hydro, and methane) are equivalent to the heat content of the kilowatts delivered to end users by those generators (where one kilowatt-hour is equivalent to 3,412 British thermal units). This differs from EIA practice, which assigns the kilowatts delivered by renewable generators a fossil-equivalent source heat content (where one kilowatt-hour is generally equivalent to 5 to 10,000 British thermal units). All representations of total primary energy consumption in this chapter are calculated by the former method. The table below provides the heat content of the different generation fuels in Vermont's power supply mix that were used to make these calculations.

	Natural Gas	Distillate	Nuclear	Wood	Wind	Solar
Heat Rate	7.9	10.7	10.4	15.0	3.4	3.4

Exhibit 4-2. Generation Fuel Mix of Vermont's Electric Power Supply, 2014 (before REC sales or purchases)



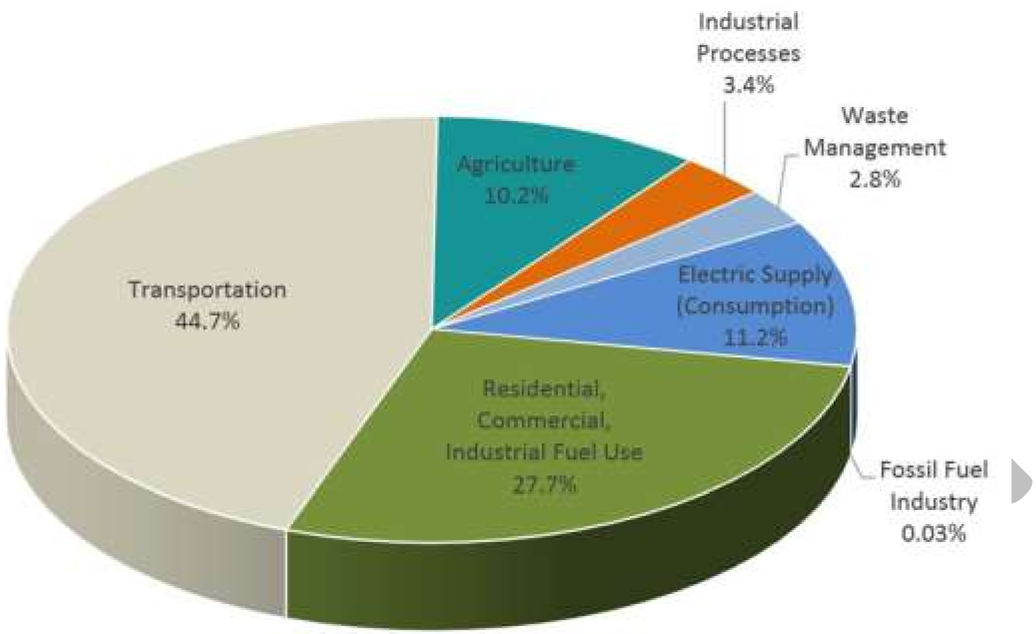
Source: Vermont Department of Public Service. Fuel shares in Exhibit 4-2 are calculated before adjustments made to account for utility holdings of Renewable Energy Certificates. The "Unspecified" category represents power purchased either directly from the market or through a market intermediary, the generation fuel of which was not known to the utility. These power purchases are assigned a heat content equivalent to that of natural gas generation, the fuel that is currently most likely to be used to generate the marginal electric energy acquired from the ISO-NE energy market.

4.1.1 Sources of GHGs

Worldwide, climate change poses serious risks to economies, public health, and the environment. In Vermont, we are already experiencing the impacts of a changing climate such as an increase in extreme weather events and flooding, changes in seasonal patterns, and the migration of new pests into forests and lakes. While the CEP is not intended to present climate risks and impacts in Vermont in detail, the state's commitment to reduce emissions of GHGs within its borders is one of the primary rationales for developing a comprehensive energy plan that accelerates progress towards a clean energy future.

According to the state's annually published emissions inventory, in 2012, transportation, space heating, and electricity generation account for more than 80% of Vermont's statewide emissions of these gases annually, largely mirroring end-use energy consumption patterns. As shown in Exhibit 4-3, transportation accounts for 45% of GHG emissions, and is the state's largest contributing sector. Residential, commercial, and industrial fuel use accounts for nearly 30% of emissions.

Exhibit 4-3. Vermont GHG Emissions by Source, 2012



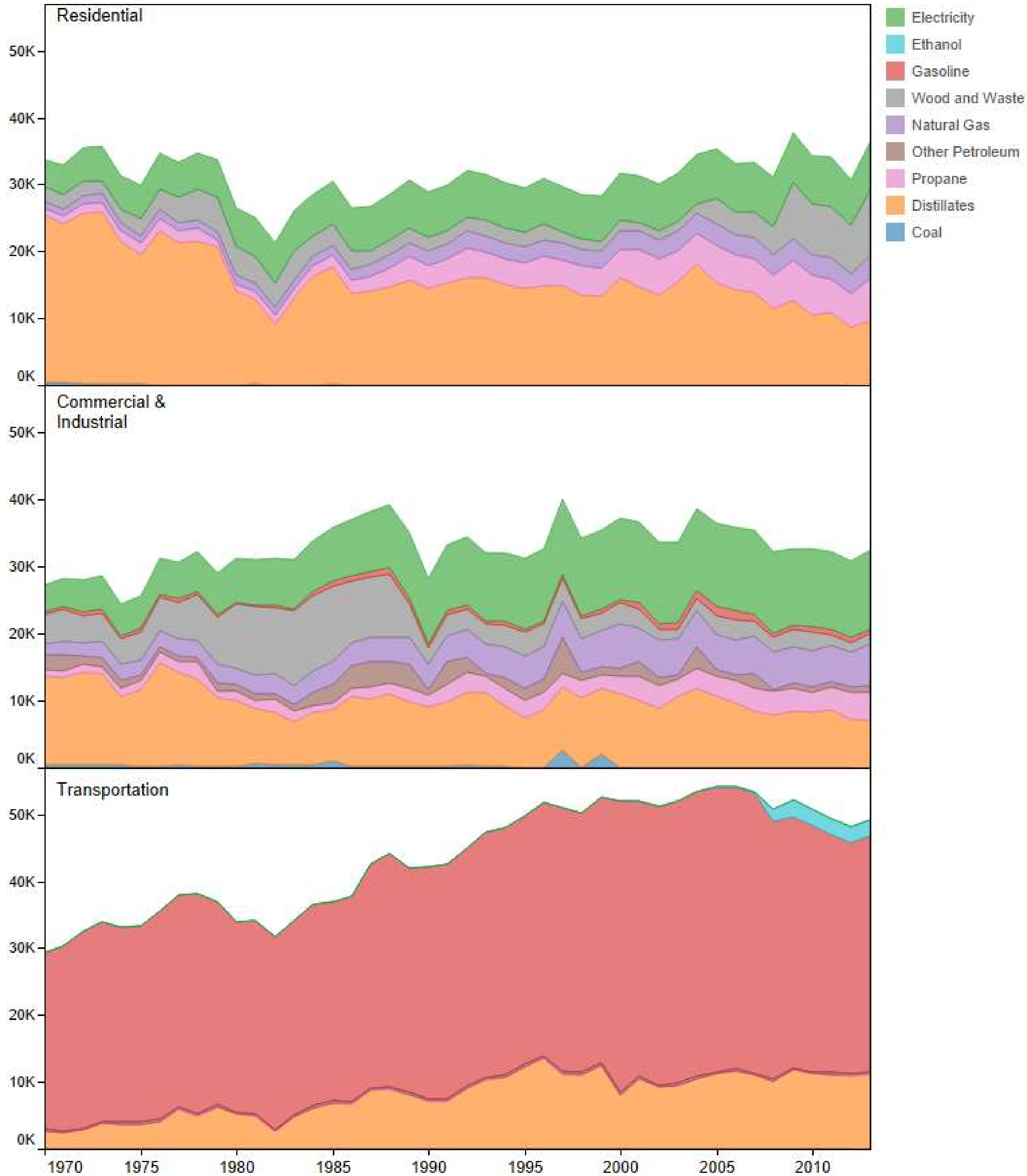
Source: Vermont Agency of Natural Resources

4.2 Energy Consumption Past to Present

Over the last four and half decades, overall demand for energy in Vermont has grown at a relatively modest pace. As shown in Exhibit 4-4, the majority of this growth has been driven by transportation uses of gasoline; business uses of electricity and natural gas; and residential uses of propane, wood, and electricity. Consumption of distillates has remained relatively flat over the last four decades.[8] This is due to a steady decline in residential use that has only partially been offset by an increasing use of diesel for transportation purposes.

[8] *Distillates includes both fuel oil used for heating (currently accounting for around 60% of total distillate end-use) and diesel used mostly for heavy-duty transportation (currently accounting for around 35% distillate end-use)*

Exhibit 4-4. Energy Consumption of End-Use Sectors, 1970-2013 (Billions of Btu)



Source: U.S. Energy Information Administration, State Energy Data System

Since 1970, total end-use energy consumption has increased at an average rate of around half a percent per year.[9] Over the same period, Vermont's population has grown at an average rate of around 0.8% per year. This means that Vermont consumes about as much site energy per capita today as it did in 1970. Even so, by a number of measures, the Vermont economy is significantly larger now than it was four decades ago. Gross State Product has increased at an average rate of around 3% per year since the late 1970s, in real terms. Since 1975, the number of employed has grown by around 2% per year on average, and real wage and salary earnings have grown at an even faster pace.

In more recent years, since around 2000, Vermont's overall demand for energy has moderated somewhat, even as the population and economy continued to grow (albeit more slowly than in the decades before 2000). Total energy end-use is now 5% lower than it was fifteen years ago, and per capita site energy consumption now appears to be on a slight downward trend, having decreased by around a half a percent per year on average since 2000. This shift is mainly attributable to declining consumption of gasoline, electricity, and distillates, the three largest components of Vermont's total primary energy consumption. Most of the decrease in gasoline consumption is easily explained by a 10% decrease in vehicle miles travelled, but increasing average vehicle fuel economy and an aging population both also likely played a role. It is likewise possible that some amount of the decrease was induced by the generally escalating gasoline price environment (See Exhibit 4-9). Electricity end-use is estimated to have been reduced by over one percent each year over this period through the efficiency programs run by Vermont's electric energy efficiency utilities. Fuel oil heating equipment efficiencies have also improved in over the last 20 years.

Over the last decade, Vermont has also made progress in reducing GHG emissions. As shown in Exhibit 4-5, 2012 levels were approximately 14% lower than the 2004 emissions peak. However, DPS recognizes that Vermont fell short of its 2012 goal of reducing GHG emissions to 25% below 1990 levels and that further steep emissions reductions would be required to meet the 2028 goal (50% below 1990 levels).[10]

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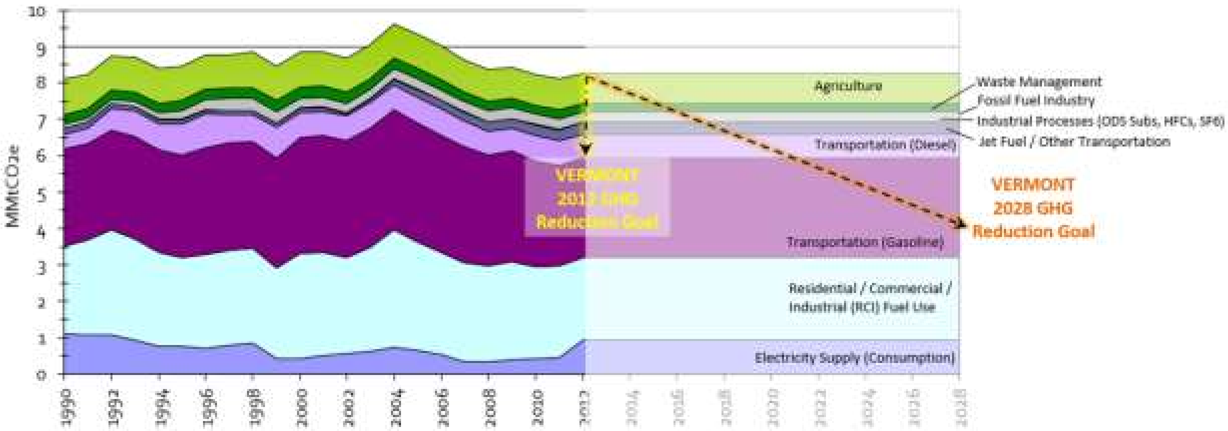
[9] *All average annual growth rates identified in this chapter are computed as compound annual growth rates*

[10] *Vermont Greenhouse Gas Emission Inventory Update (1990-2012) (see: www.anr.state.vt.us/anr/climatechange/Vermont_Emissions.html).*

Exhibit 4-5. GHG Emissions by Source, 1990-2028 (Millions of Metric Tons)



Source: Vermont Agency of Natural Resources

4.3 Goals for 2025 and Beyond

In 2014-2015, at the request of the Legislature, the DPS conducted the Total Energy Study (TES), an extensive modeling exercise that analyzed the viability of a variety of technology and policy "pathways" that could increase the share of renewable energy consumed in Vermont's to 90% of all primary energy used by 2050. The Total Energy Study yielded many insights about the scale, immediacy, and direction of the near-term changes in energy consumption patterns that will be necessary for the success of such a long-term transition. That analysis supports this CEP's adoption of a set of interim goals set for 2025 that will serve as guideposts along the way to 2050. Specifically, these 2025 goals are:

1. **Reducing per capita primary energy consumption by 15**%. The work done for the TES revealed that total primary energy consumption will have to decrease by one third or more by 2050 in order to bring the 90% renewable goal into reach. Amplifying the recent trend toward lower per capita site energy consumption will be critical to the achievement of Vermont's renewable energy goals.
2. **Increasing renewable energy to 25% of primary energy consumption.** In the modeling scenarios composed for the Total Energy Study, it was shown that Vermont will need to look increasingly to electricity and biofuels (both liquid and solid) to meet its 90% by 2050 goal[11]. DPS has concluded that achieving an interim 25% by 2025 goal could require cumulative increases in electricity end-use of 10 to 15%, and cumulative increases in biofuel end-use by as much as 20%, over the next 10 years.

[11] *Unless specified, wherever the term biofuels is used in this Chapter, both woody biomass (cord wood, pellets, and chips) and liquid forms (ethanol and biodiesel) are included in the definition.*

There are a variety of ways in which changes in future sector-specific energy consumption patterns could combine to meet these 2025 benchmarks. DPS has developed an illustrative scenario, detailed further in Section 4.4, in which in which renewable energy consumption in building and transportation sectors different trajectories. In this scenario, achieving an overall 25% renewable by 2025 goal depends specifically upon:

1. **Increasing the share of renewable energy used in buildings to 30% of primary building energy use, up from around 20% today.** Energy use in non-industrial buildings (both residences and commercial business places) currently makes up over 45% of total end-use consumption, a share which has been generally stable over the last four decades. Heat energy represents around 70% of overall building site energy requirements (space and water heating combined). About three quarters of this demand for heat energy is met with fossil fuels, primarily distillates, but increasingly over the past two decades also with propane and natural gas, which currently supply 25% and 15% of all building heat, respectively. Wood heat supplies around a quarter of non-industrial building site heat energy, mainly households, up from only 10% in the nineties. Electricity currently supplies very little of building site heat energy. Increasing adoption of heat pumps and wood heating technology has the potential to displace a significant amount of the fossil fuels Vermonters rely on for space and water heating.[12]

2. **Increasing the share of renewable transportation uses of primary energy to 10% of transportation primary energy use, up from around 5% today**. Currently, transportation uses make up almost 45%of total energy end-uses, a share that has risen steadily since the 1970s, when it stood at around 30%. Gasoline provides the overwhelming majority of end-use transportation energy and has for the last 4 decades, though the share provided by diesel has gradually increased from around 10% four decades ago to more than 20% in 2013. Since the mid-2000s, ethanol blends have reduced the amount of motor gasoline consumption by 5 to 7%. Higher concentrations of liquid biofuels in gasoline and diesel stocks have the potential to displace a significant amount of the petroleum that Vermonters rely on for heavier duty transportation. Increasing adoption of electric vehicles has the potential to displace a significant amount of the gasoline Vermonters rely on to fuel their light-duty transportation.

In achieving these 2025 benchmarks, the electricity consumption by each sector will be increasingly sourced from renewable generation. Under Act 56, electric utilities are required to have 75% of their retail electricity sales supplied by renewable resources by 2032. Electric power supply will be more than 55% or

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[12] *In the scenario presented in section 4.4, renewable energy use for industrial purposes follows a similar trajectory as the non-industrial buildings sector, reaching 30 % renewable by 2025. This is achieved mostly as a consequence of normal growth in non-heating electric consumption, which is supplied by increasingly renewable source energy. This path is distinct from the commercial and residential sectors, who meet their 30 % benchmark targets in part by growing their electric heat loads. In addition there is a moderate amount of displacement of industrial fossil fuels with biofuels. But because of the highly variable nature of industrial energy use and the large amount of uncertainty regarding the substitutability of various process fuels, hitting the overall interim goals in DPS's illustrative scenario does not depend critically on changes in industrial energy end use patterns.*

more[13] renewable in 2017, rising more than one percent per year for the following 15 years, passing through about 67% in 2025. As the renewable share of Vermont's electric power supply increases, the contribution of electricity end-uses to the achievement of the 2025 benchmarks also grows.

Section 4.4.2 of this chapter looks more closely at the individual sector pathways to 2025 described above, and the role that electrification plays in making them more achievable.

4.3.1 Revisiting GHG Targets

The State of Vermont has long been among the U.S. states and subnational jurisdictions setting the most aggressive goals for reducing the emissions of carbon dioxide and other pollutants that disrupt climate.

In 2001, before Vermont or any of the other New England states had developed a climate plan, the New England Governors and Eastern Canadian premiers jointly embraced a regional goal to reduce the total emissions from the participating states and provinces to 1990 emissions levels by 2010; 10% below 1990 levels by 2020; and 75% to 85% below 2001 levels by 2050.

In 2006, Vermont's Legislature set a long term goal of reducing the state's own GHG emissions by 75% below 1990 levels by 2050. Interim targets were also set for the years 2012 and 2028. In 1990, Vermont emitted just over 8 million metric tons of GHGs.

Since then, better information both about the current status of emissions and the potential effectiveness of different energy solutions has created a better understanding of the levels of emissions reductions we could achieve in the near- and long term.

The Total Energy Study has shown that the state's 2028 goal will be extremely difficult to achieve, but the 2050 goal is achievable if Vermont keeps pursuing policies and investments that support a rapid transition to clean, efficient, and renewable energy.

Vermont's leaders are continuing to embrace bold, long-term goals for reducing GHG emissions, motivated by the seriousness of the climate crisis and the economic benefits that will accrue to those jurisdictions that make earlier transitions to low-carbon economies. These goals are well-aligned with the energy goals established in the 2011 and in this draft 2016 CEP.

In the spring of 2015, Vermont joined the first group of signatories, along with jurisdictions from seven countries and three continents, to sign California's bold "Under Two Memorandum of Understanding." The parties to the MOU jointly agreed to pursuing emissions reductions consistent with a trajectory of 80 to 95% below 1990 levels by 2050, and/or achieving per capita annual emission goal of less than two metric tons by the same year. By signing the MOU, Vermont strengthened its 2050 goal beyond its initial statutory goals established nearly a decade ago.

[13] *Burlington Electric Department and Washington Electric Cooperative have expressed an intention to remain 100% renewable.*

In the summer of 2015, the Northeastern Governors and Eastern Canadian Premiers (NEGECP) passed a new climate resolution. Under the resolution, Vermont and governors of the other northeastern states joined with Canadian premiers to jointly reaffirm the original 2050 goal set back in 2001, and to commit to making bigger reductions sooner. The resolution established a regional 2030 "progress marker range" of 35 to 45% below 1990 levels by 2030. This interim goal is closely aligned with the trajectory necessary for meeting the longer-term goals in the California MOU. In short, the multiple goals and agreements all line up on a very similar pathway to a sustainable, low-carbon future.

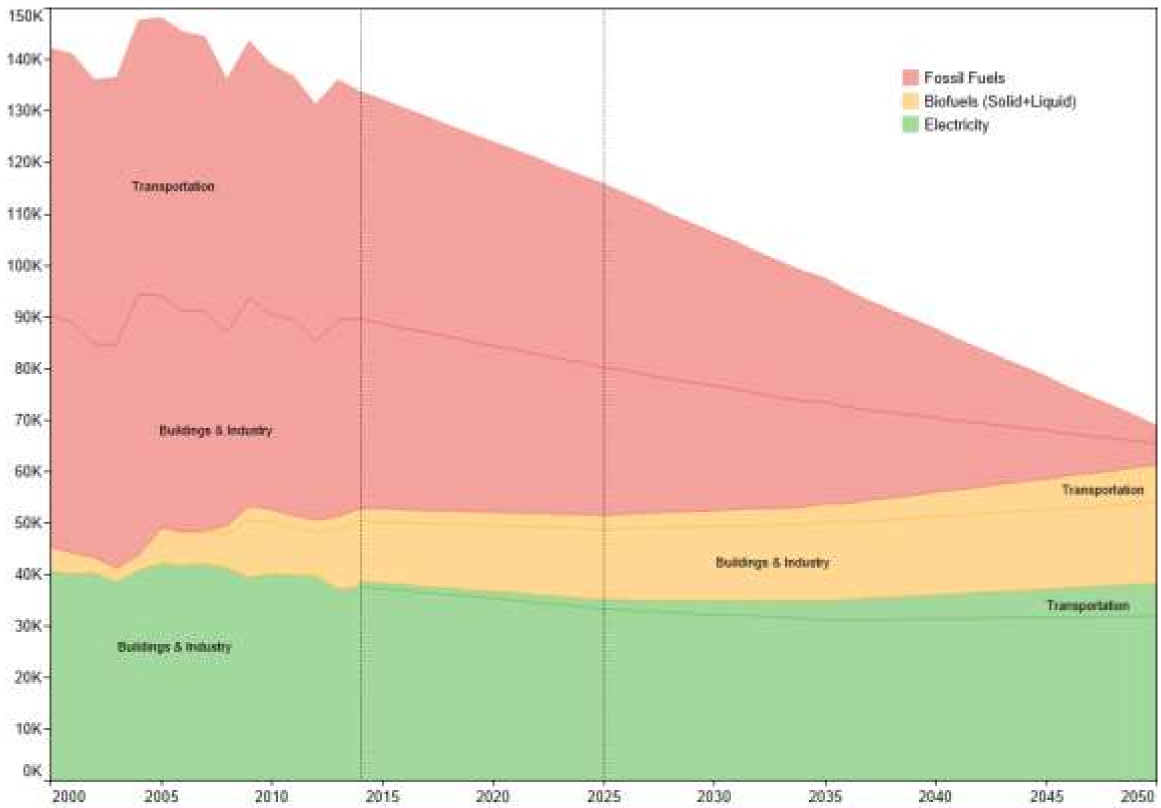
Informed by this progress on GHG reduction goals, this CEP establishes two goals for reduction in GHG emissions from Vermont's energy use, which are consistent with the renewable energy and energy use goals also established here:

- **40% reduction below 1990 levels by 2030**
- **80% to 95% reduction below 1990 levels by 2050**

4.4 Getting to 25 Percent Renewable Energy by 2025

This section presents the analysis that informs DPS's recommended sector-specific 2025 benchmark targets introduced above. Exhibit 4-6 depicts an energy future scenario in which the level of consumption of electricity and biofuels (liquid and solid) in 2050 are each more than 75% greater than current levels, implying growth rates in usage of those fuels of more than 2% per year. This means that by 2050, electricity consumption makes up more than 45% of total end-use across all sectors, compared to only 20% today. Likewise consumption of biofuels (liquid and solid both) in 2050 makes up more than one-third of total end-use, compared to less than 15% today.

Exhibit 4-6. Sector Uses of Primary Energy, Projected to Meet 2050 Goals and 2025 Benchmark Targets (BBtu)



Sources: Federal Energy Information Administration, Vermont Public Service Department. Projections are based on results of Total Energy Study. Vertical reference line at year 2013 marks end of historical data. Vertical reference line at year 2025 marks benchmark 25% renewable target.

4.4.1 Ways of Reducing Energy Usage

In year 2025 of the Exhibit 4-6 scenario, Vermonters are consuming around 20 trillion Btu less primary energy than they consume today. The majority of this reduction – around 60% – is attributable to changes in non-industrial building energy use. Around 35% is attributable to changes in transportation energy use. Usage reduction across sectors is a consequence of three factors:

1. ***Continuing improvements in demand side thermal and electric efficiency***, *accounting for 20% of the reduction in primary energy consumption*. In the Exhibit 4-6 scenario, efficiency neutralizes the effects of increases in population, building space square footage, and industrial output over the projection period. The largest efficiency impact comes from improvements in building shells, which reduce the need for building heat be delivered by any means.

2. ***Fuel switching away from combustion technologies to more efficient electric powered technologies***, *accounting for 40% of the reduction in primary energy consumption*. The current generation of heat pump and electric vehicle technology is capable of supplying the same level of energy service as their combustion based counter parts with a third or less of the site energy

requirements. In the Exhibit 4-6 scenario, increasing adoption of these substitute electric technologies is the most significant driver of the decrease in per capita site energy consumption.

3. ***Declining source energy requirements of electricity generation****, accounting for 40% of the reduction in primary energy consumption.* As more of the state's electric power supply is generated by solar, wind, and hydro resources, which do not produce the unusable waste heat associated with combustible generation fuels, the overall source energy requirements to power new heat pump and electric vehicle loads also declines. Thus with the growing consumption of electricity shown the Exhibit 4-6 scenario, even as per capita site energy consumption is driven down by use of the more efficient electric technologies and continued demand-side improvements – on the order of 1% per year – per capita consumption of *primary energy* declines even faster, by almost 2% per year in the Exhibit 4-6 scenario, compared to only a 1% annual decreases in per capita site consumption.[14]

Implications of Act 56 on Future Electric Source Energy Consumption Totals

In 2013, Vermont's consumption of site electric energy totaled around 19 billion Btu, approximately 15% of total energy end use. The current renewable share of site electric energy is around 60% (See Exhibit 4-2). This corresponds to a total annual consumption of source electric energy of around 37 billion Btu, making up nearly 30% of total primary energy consumption. This means that the current supply of Vermont electric power wastes about as many units of heat energy as are delivered to end users i.e. for every unit of electricity delivered to end-users, there is another unit of energy lost to the combustion process. By 2032, the renewable share of site electric energy is expected to be 75% under the requirements of Act 56. Growth in electricity consumption will likely be significant over this time frame if consumers are incentivized to take advantage of the efficiencies of heat pumps and electric vehicles. In the Exhibit 4-6 scenario, electricity end use rises by more than 500 gigawatt-hours by 2025, an approximately 10% increase over current retail sales levels. Yet with that much more renewable generation powering this load growth, total consumption of source electric energy will have declined from 2013 levels. This is because for every unit of electric energy delivered to consumers in 2032, there is only half a unit of additional energy lost to the combustion process. Thus by 2032, even with significantly increased consumption of electricity, the total source energy used to supply that electricity might only be 32 or 33 billion Btu, around 15% lower than today.

Demand-side Efficiency

[14] *Other inefficiencies inherent in electric power delivery, such as line losses, are also reduced as more electric source energy comes from renewable distributed generators and storage facilities sited closer to end-user load sites; however these benefits were not examined in detail by the TES and are not reflected in the reductions in primary energy consumption shown in the Exhibit 4-6 scenario*

Thermal

In 2013, the average size of an annual residential heating load in Vermont was in the range of 80 to 100 million Btu, the same size as 35 years ago. Average commercial building heating loads are slightly larger, in the range of 100-120 million Btu per year. [15] A typical weatherization investment in either sector can reduce an individual building's heating load by 20 to 30%. In the Exhibit 4-6 scenario, primary energy used by buildings declines by more than 10 trillion Btu cumulatively by 2025. Around 20% of this reduction is attributable to improvements in commercial and residential building shells over the next 10 years

Electric

In 2013, the average size of a residential building electric load in Vermont was around 20 to 25 MMBtu of electric site energy, around a third smaller than it was 20 years ago. The average commercial building electric loads are significantly larger, around 700 to 800 million Btu per year, but have likewise declined over the last 20 years. In the Exhibit 4-6 scenario, around 10 % reduction in primary energy used by buildings is attributable to improvements in the demand-side efficiency of non-heating uses of electricity. This magnitude of reduction is consistent with the level of past end-user savings that have been attributed to the efforts of the state's energy efficiency utilities.

Fuel Switching Efficiency

Electric Heating

A modern heat pump is capable of supplying the majority of a typical building's 80 to 120 million Btu heating load with only around 30 to 50 million Btu of site electric energy, leaving around 10 to 20 million Btu of heat energy that could be supplied with back up combustible fuels. While the current generation of heat pumps are only likely to serve as the sole source of heat for the most thermally efficient buildings, the potential heat energy savings as a primary source for buildings with even average quality envelopes are significant. In the Exhibit 4-6 scenario, around 20% of the reduction in primary energy used in buildings is attributable to the replacement of fossil fuel burning heating equipment with electric powered heat pumps as the primary space heating method.

Electric Vehicles

The average gasoline burning passenger vehicle uses around 75 to 100 million Btu of energy per year to travel a distance of 10,000 to 12,000 miles. A modern electric passenger vehicle can drive the same annual distance using only 10 to 30 million Btu of electric site energy. In the Exhibit 4-6 scenario, transportation primary energy declines by 7.5 trillion Btu by 2025. The vast majority of this reduction in is attributable to the replacement of light-duty gasoline vehicles with passenger electric vehicles.

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[15] *Federal Energy Information Administration, State Energy Data System and Residential and Commercial Energy Consumption Surveys*

Renewable Generation Efficiency

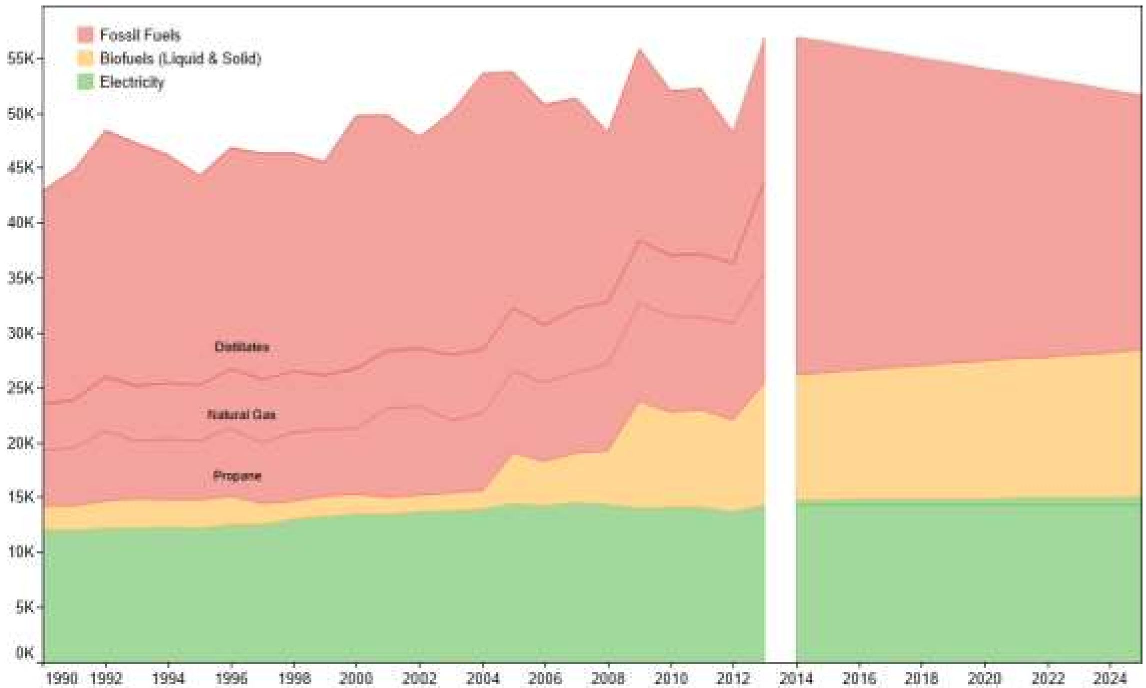
With Vermont's current mix of generation resources, where 60% of all end-user kilowatts are delivered without any conversion losses , it takes around 70 to 80 million Btu of source energy to supply the typical 7 to 8 megawatt-hours needed annually to power heat pump technologies. In 2025, when around 66% of delivered megawatts are expected to be without conversion losses, the same heating load would require only around 50 to 55 million Btu of source electric energy. In 2032 when Act 56 requires the electricity supply to be 75% renewable, it would require only 40 to 45 million Btu of electric source energy to serve this load, around half as much as today. Similarly, the 30 to 40 million Btu of electric source energy it now takes to power a typical electric vehicle for a year, will be as little as 10 to 20 million Btu by 2032.

4.4.2 Sector Paths to 2025

4.4.2.1 Buildings

Exhibit 4-7 depicts the future changes in energy end-uses of the buildings sector over the first 10 years of the projection period in the Exhibit 4-6 scenario. Over this time frame the buildings sector is able to meet a 30% renewable energy benchmark target by increasing the share of its heat energy demandthat is supplied by electricity to around 3%, up from virtually zero today. At the same time, the share of on-site building heat supplied by biofuels rises to around more than a quarter%, up from around 20% today. This could mean around 35 to 40 thousand heat pump installations cumulatively by 2025, representing between 10 and 15% of Vermont's total non-industrial building stock. Similarly if the entire increase in biofuel end-use shown in Exhibit 4-7 was met with woody biomass, it could mean more than 60,000 buildings using cord wood or pellets as their primary heating fuel by 2025, around 15 to 20% of the non-industrial building stock. If the increase in biofuel consumption was supplied completely with liquids, it could mean blends of fuel oil with bio-content as high as 15% by 2025.

Exhibit 4-7. Building Energy End-Use Since 1990 With Projections Meeting 25% Renewable Goals (BBtu)



Sources: Federal Energy Information Administration, Vermont Department of Public Service. Projections beginning in 2014 are based on results of Total Energy Study

Because of the superior efficiencies of substitute heat pump technology, the moderate increase in electricity consumption from heat pump loads is accompanied by a much more pronounced decline in consumption of fuel oil, propane, and natural gas. In addition, thermal and electric efficiency improvements help to keep the overall demand for building site heat energy from growing along with population. In Exhibit 4-8, by 2025, thermal efficiency improvements have reduced the average building heating load by around 10%. With a typical energy savings of 10 to 30 million Btu per building, this could require more than 10 thousand building shell improvements per year, an annual turnover of as much as 5% of Vermont's entire non-industrial building stock. Similarly, continuing improvements in electric efficiency of end-uses like lighting and other plug loads reduces average building non-heat electric consumption by around 5% cumulatively by 2025.

4.4.2.1.1 Illustrative Economics of Electric Heat Pumps, Efficiency, and Biomass

<u>Customer Economics</u>

A typical Vermont residence heating their home with a distillate-burning furnace or boiler will spend around $2,500 to $3,000 annually on purchases of fuel oil to meet a winter heating load of around 100 million Btu. Using cold climate heat pumps as the primary source of heat energy, that same level of demand can be met with about $1,500 to $1,600 in annual fuel costs (around $250 to $550 of which might be spent on back up fossil heat sources). Advanced wood stoves and central pellet systems are capable of serving this heating load with $1,500 to $1,800 in annual fuel costs. Combining any of these renewable heat options with an investment in weatherization can further reduce annual heating fuel costs to $800 to $1,100.

While these fuel bill savings are compelling, potentially amounting to more than $2,000 per year, the upfront capital costs necessary to realize them are generally high enough to discourage most income groups from making such investments. Access to finance at reasonable terms will be critical for most building owners. In the case of low temperature heat pumps or modern wood heat stoves, loans can generally be easily arranged with vendor financing packages. Central pellet heating systems and weatherization investments, however, can cost more than $10,000, while a "whole building approach" that couples heating system replacement, weatherization, and electric appliance efficiency can amount to a $30,000 to $50,000 investment. Recent innovations in financing that link bill payments, home equity, and public sector incentives may provide critical tools to help building owners access the cost-savings of these larger investments. The coordination of energy services and financing may lead to a business model similar to the Energy Service Companies that currently link finance with energy services installations. Examples of a successful whole building approach will be a key to ultimately providing a large number of building owners the access to building improvements necessary to meet the state's long term energy goals.

<u>Macroeconomics</u>

Fuel Oil Spending

Realizing the customer fuel cost savings described above will necessarily reduce the sales of Vermont fuel oil distributors, which currently employ between 1,000 and 1,500 workers who are paid an average wage of more than $45,000 a year.[16] These wages, plus other operating costs and retailer profits, represent only around 20% of the retail price of fuel oil paid by end-use customers. The vast majority of retail customer dollars spent on fuel oil, around 80%, goes to pay wholesale commodity costs to out of state suppliers and do not circulate as local income in Vermont.

Electricity Spending

In contrast, DPS estimates that only 40 to 50% of the Vermont retail customer's purchases of electricity goes to pay for power supplied by out of state generators. Around 10 to 15% goes to pay for power supplied by in state generators that employ Vermont workers and own plant and equipment based in Vermont. As more distributed generation resources like solar and wind are built to replace power from more remote, less labor-intensive central power stations, the share of retail customer electricity spending flowing to Vermont-based labor and capital will likely increase. For example, the 2015 Vermont Clean Energy Industry report identifies around 2,000 workers involved with the installation and operation of

[16] *Federal Bureau of Labor Statistics*

solar and wind generation facilities, with growth in solar related jobs paralleling the roughly 20% increase in solar installations over the last year.[17]

Much of the remainder of the customer dollars spent on electricity, roughly 40 to 50%, goes to pay for the local labor employed directly by utilities – more than 2,000 workers who are paid an average annual wage of between 80 and 90 thousand dollars.[18] As a monopoly provider with established scale economies, electric uutilities are not likely to need to significantly expand hiring in response to any future increase in electricity sales associated with electric heating and vehicle load growth. There are however new income-earning opportunities opening up for potential utility partners who are capable of supplying the labor and expertise needed to tackle the ongoing challenge of integrating distributed energy resources into utility grid management operations.

Biomass Spending

Even more so than Vermont's electricity supply, cord wood is sourced almost entirely from in-state producers whose largest cost is the local labor they employ. This is not currently the case for wood pellets, which except for one in-state production plant, are supplied to Vermont retail customers by producers in Quebec and Northern New England. Thus, as for retail purchases of fuel oil, the local employment supported by spending on wood pellets consists mostly of retail and distribution operations. Currently there are around 2,500 to 3,500 workers employed in the forestry and wood products manufacturing industries.[19] Historically, less than 2% of Vermont workers have found employment in this industry space, which for most is only a seasonal source of income. A future in which as much as one third of building site heating demand is met with biomass sourced from Vermont forests would present far greater opportunities for employment, innovation and profit in the harvesting, processing, and delivery of wood products to Vermont homes and businesses.

Efficiency Investment

Investments in thermal efficiency improvements also provide income-earning opportunities for workers and entrepreneurs in Vermont's growing building performance industry. Anywhere between 30 and 50% of the cost of a typical building weatherization project goes to pay wages of locally hired construction labor. Currently there are less than 15,000 workers employed in the Vermont construction industry, down from a mid-2000s peak of more than 17,000. According to data collected for the Vermont Clean Energy Industry Report, weatherization activities over this time helped to employ several hundred construction industry workers that would have otherwise lost their jobs as the housing investment boom deflated and the construction share of the labor force returned to its historical norm of around 7%. Today around 1,000 homes are built in Vermont each year. A future in which each year potentially more than 10,000 homes are weatherized, and as many more are outfitted with heat pumps or wood heating systems, will present

[17] *Vermont Clean Energy 2015 Industry Report*

[18] *Federal Bureau of Labor Statistics, Vermont Department of Labor*

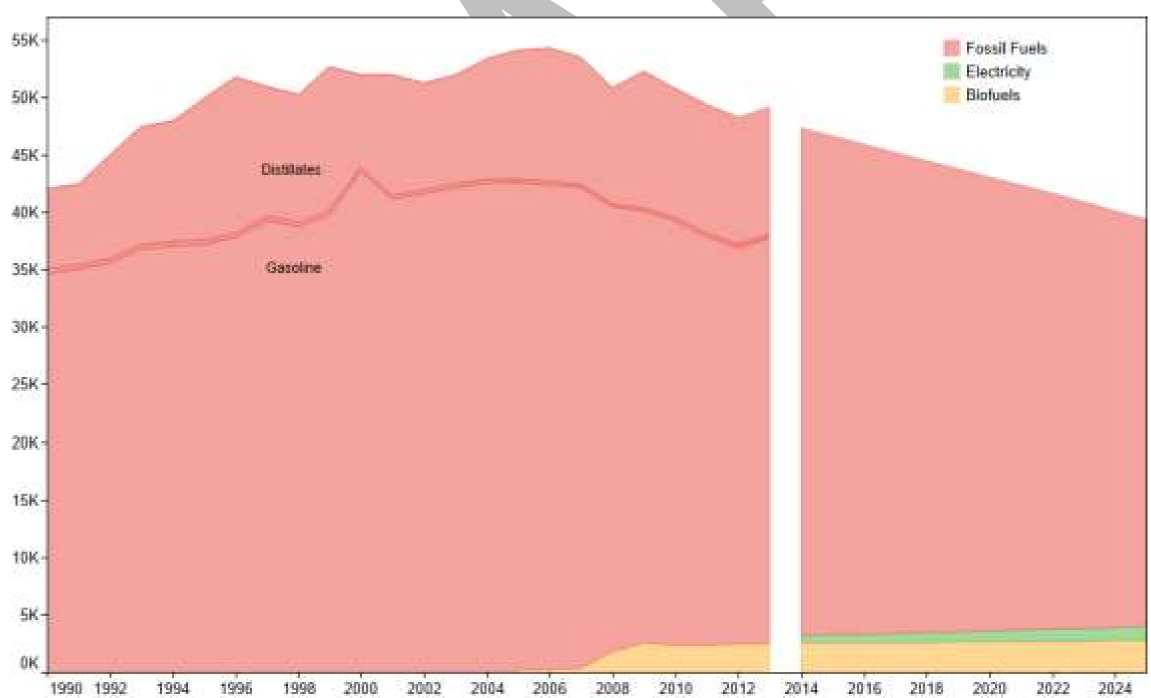
[19] *Federal Bureau of Labor Statistics, Vermont Department of Labor*

significant growth opportunities for employment, innovation, and profit in the construction and building performance industry.

4.4.2.2 Transportation

Exhibit 4-8 below depicts the future changes in transportation energy end-use that correspond with the first 10 years of the projection period in the Exhibit 4-6 scenario. Over this time frame the transportation sector is able to meet a 10% renewable energy target by increasing the amount of electric energy used in light-duty vehicles to around 3% of all transportation energy end use. This is accomplished with only slight increases in the bio content of gasoline and diesel, up to around 8%, not much greater than the amount of ethanol consumed in recent years. An increase in electric vehicle use on the scale depicted in Exhibit 4-8 would mean the replacement of around 115 to 120 thousand gasoline burning passenger vehicles, amounting to between 15 and 20% of the stock of light-duty vehicles by 2025. While future site energy consumption in the buildings sector is largely held flat by heat pump fuel switching, the transportation sector is able to its total end-use consumption significantly with increased use of electric vehicles, by more than 15% cumulatively by 2025.

Exhibit 4-8. Transportation Energy End-Use Since 1990 With Projections Meeting 25% Renewable Goals (BBtu)



Sources: Federal Energy Information Administration, Vermont Department of Public Service. Projections beginning in 2014 are based on results of Total Energy Study

4.4.2.2.1 Illustrative Electric Vehicle Economics

Customer Economics

The typical driver of a conventional gasoline burning passenger vehicle spends around 1,000 to 1,500 dollars a year on fuel to travel around 10,000 to 12,000 miles. The same number of miles can be driven in an electric passenger vehicle at an annual fuel cost of around $400 to $600, less than half the amount as for conventional passenger vehicle. Converting to an electric vehicle can thus save a customer as much as $1,100 in annual fuel costs. However the retail prices of electric vehicles are significantly higher than equivalent internal combustion cars, by as much as $10,000 before federal tax credits. Assuming that an electric vehicle can be financed with the same terms as a conventional auto loan, the fuel cost savings realized at current gasoline prices are not generally large enough to cover the higher loan repayments that accompany an electric vehicle purchase without tax credit incentive. The current federal tax incentive is generally built into EV leases.

Macroeconomics

Vermonters currently spend around $1 billion dollars on retail gasoline purchases.[20] Around 70% of this total goes to pay for the wholesale commodity supplied by out of state producers and marketers, and does not circulate as income in the Vermont economy. A little less than 15% of gasoline spending goes to cover the costs and profit of retailing operations based in Vermont, which includes a wage bill of around $68 million, paid out to approximately 3,000 to 4,000 gasoline station workers (an average annual wage of less than $25,000). Around 6% of retail customer gasoline spending goes to pay the federal gas tax and around 10% is collected into the state transportation fund. Replacing conventional vehicles with electric vehicles on the scale depicted in Exhibit 4-9 will thus reduce the expenditures for transportation fuel going out of state, but also, under current transportation funding arrangements, will pose a challenge to the state's ability to fund transportation infrastructure maintenance and improvements. Over time this shift would likely lead to reductions in employment at retail gasoline stations.

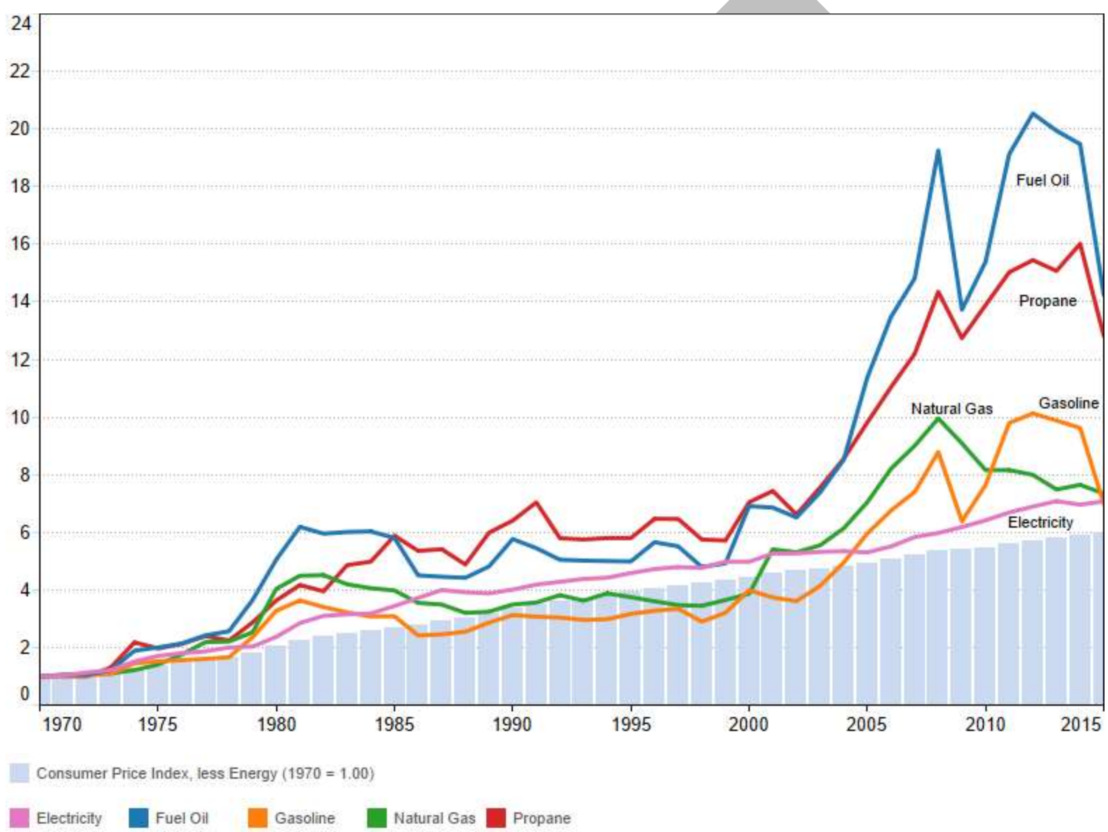
4.5 Policy Tools to Drive Change

Each of the policy pathways modeled for the Total Energy Study can be characterized as a market-based or a price-based policy. A market-based policy, such as a carbon tax, a renewable energy standard, or cap-and-trade systems like the Regional Greenhouse Gas Initiative and the Western Climate Initiative, is intended to send a price signal to end-use consumers that would encourage consumption of an otherwise less cost-competitive renewable alternative. In the energy futures modeled for the Total Energy Study, price signals are sufficient in themselves to drive fuel consumption behavior toward renewable substitutes. In reality, there are many reasons why the supply of renewable energy cannot be expected to automatically expand in response to increasing fossil fuel prices.

[20] *Federal Energy Information Administration, State Energy Data System*

As shown in Exhibits 4-9 and 4-10, since 2000, prices of fossil fuels used for heating and transportation have increased almost three-fold while consumption of those fuels remained flat. For households, who as a whole have simultaneously experienced a slow-down in wage growth over this period, this has resulted in a significant increase in the share of income going to purchases of energy, up from approximately 11% in 2000 to around 15% today.[21] The energy cost burden for the lowest income households is now greater than 25% of income[22]. Businesses have also begun to see energy bills increasing faster than revenues because of increasing fossil fuel prices, a possible departure from past reality when firms as a whole were consistently able to grow their revenues at least as fast as their energy costs. Small businesses with lean budgets are particularly vulnerable to increasing energy costs.

Exhibit 4-9. Average Retail Fuel Prices Paid by Vermonters, 1970-2015 (1970=1.00)



Sources: U.S. Energy Information Administration; Federal Bureau of Labor Statistics; Vermont Department of Public Service

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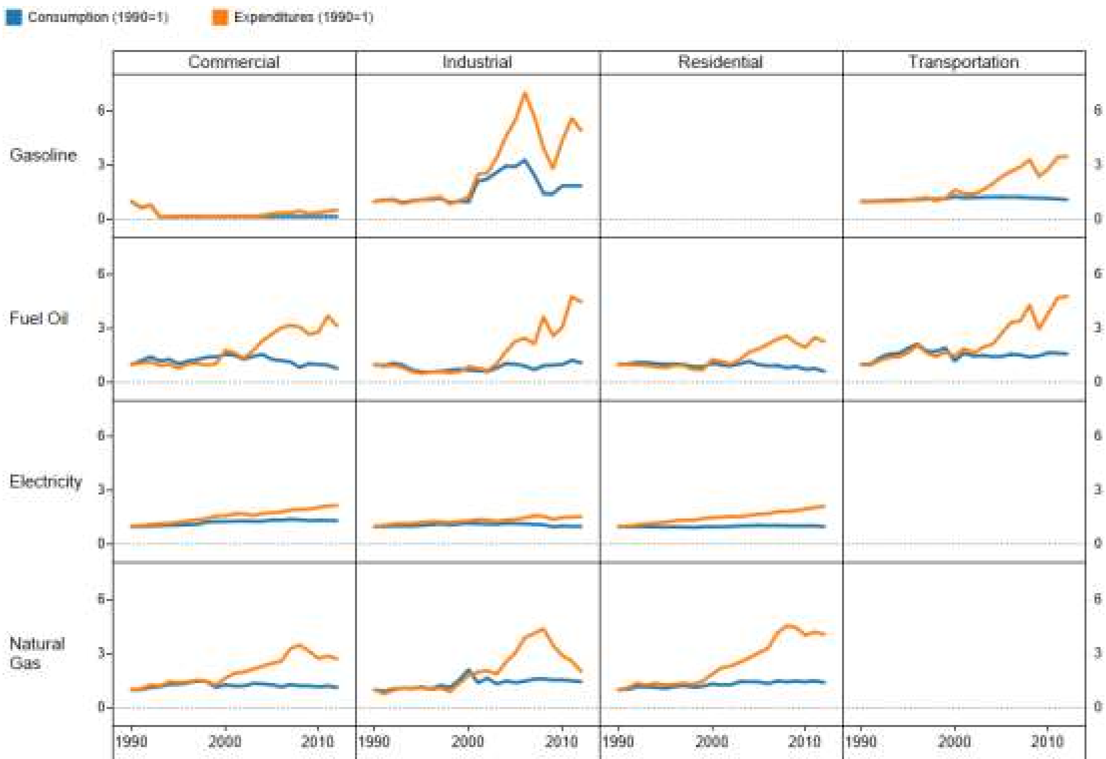
[21] *Federal Energy Information Administration and Federal Bureau of Economic Analysis*

[22] *http://www-assets.vermontlaw.edu/Assets/iee/VLS%20IEE%20Energy%20Burden%20Report.pdf*

Exhibit 4-10. Fossil Fuel Consumption and Spending, 1990-2012 (in nominal dollars)



Source: U.S. Energy Information Administration, State Energy Data System

During this period of rising fossil fuel prices, it appears there has been some substitution by residential and commercial sectors toward wood heating (see Exhibit 4-4), and at least some of the reduction in gasoline consumption is likely price induced. Yet even though the generally higher petroleum price environment has improved the customer economics of renewable heat and transport energy, practical barriers to the development of a dependable renewable energy supply remain. This section of Chapter 4 identifies some of those barriers and explains of the role that non-price -based policy instruments can play to encourage the development of a functioning renewable energy marketplace in Vermont. Without such complimentary policies, market-based policies that rely exclusively on often erratic price signals to guide consumer behavior are unlikely to ensure that lower lifetime cost renewable alternatives will be available for households and business to take advantage of.

4.5.1 Complimentary Policy for Market-Based Policy Instruments

There are three general types of these complimentary policies: information and access, strategic investment, and codes and standards.

Information and access policies address real-world shortcomings of a market-based policy instrument. These policies enhance markets by providing information, technical assistance, or access to capital, as well as addressing problems of misaligned incentives such as between landlords and tenants. They are aimed at ensuring efficient markets where consumers can easily identify and act upon least cost options.

The technological pathways identified in the Total Energy Study modeling could result from adoption of the policies modeled, however strategic investment may be required to spur and shape the early adoption of new technologies and their markets. Research and development may yield examples to build upon. Policies can build markets for nascent technologies, such as Vermont's programs supporting development of farm methane digesters, small-scale solar photovoltaic deployment, and bulk wood pellet infrastructure through the Clean Energy Development Fund, or multi-state efforts to advance electric vehicles through the Zero Emission Vehicle Action Plan. Strategic investment that is directed at the highest-cost necessary technologies for achieving Vermont's goals can reduce those costs, or achieve those emission reductions through mechanisms other than price alone. This allows price-based policies to drive optimization without unreasonable direct price impacts.

Codes and standards, such as building energy codes, appliance efficiency standards, vehicle fuel economy rules, and land use plans, serve to avoid lost efficiency opportunities in long-lived products and infrastructure using established technology. Such rules commonly require actions that are demonstrated to have a positive lifecycle economic benefit and lock in economic savings for consumers. Enforcement of these policies ensures that savings occur and gives consumers confidence in the legitimacy of alternatives.

4.5.2 Designing Market-Based Policies

In addition to well-designed complementary policies, market-based policies themselves must be well-designed to be effective and sustainable. The CEP establishes the following guidelines for the development of market-based policies in Vermont:

- **Revenue Recycling:** When considering a market-based policy, a fundamental choice is whether that policy should be designed to generate net revenue for the state, which could then use that revenue to implement the complementary policies above, or otherwise advance state energy goals. For example, the Regional Greenhouse Gas Initiative program results in net revenue for energy efficiency programs. The other possibility is that other revenue sources could be replaced. Policy design should strike an appropriate balance, limiting and targeting net revenue to advance state policies.

- **Pace:** The pace of change in policy-driven energy pricing should be commensurate with the time that consumers (whose behavior is supposed to be modified) require to change their behavior and the time it takes to build the infrastructure necessary to support those new behaviors. Poorly timed implementation of price-based policy may result in unavoidable increases in energy cost burdens if consumers have no practical ability to transition their energy use. . Different sectors may have different timelines over which customers can effectively respond, as well as in the relative costs of those changes (and their distribution into capital and operating). For example, vehicle choice is made on a once-a-decade time scale; buildings last much longer, but unlike vehicles can be retrofitted. The location of a building, and thus its impact on transportation energy use, is practically unchangeable once the building is constructed, and the pace of development is slow. The transportation energy use associated with the location of new construction is not similarly path-dependent. Electric utility portfolios can change quite quickly by comparison with any of these other sectors.

- **Equity:** Energy use, including transportation, does not vary strongly with household income. As a result, a price-based energy policy can be relatively regressive in price, when compared with other government policies or programs. Any market-based program should use revenue created by market-based policies (e.g. through allowance auctions or carbon tax revenue) to offset more regressive (rather than more progressive) taxes or other programs. Such a program should also consider equity among sectors (residential, commercial, industrial, transportation), to minimize cross-subsidization.

- **Competitiveness:** Government revenues and expenditures influence the cost of doing business in different jurisdictions. A market-based policy has the potential to shift those costs for businesses and resident in Vermont, and attract or dissuade firms considering locating or expanding in Vermont. Where possible, Vermont should pursue policies that advance the state's attractiveness for business formation and growth. Regional or national market-based policies would reduce differences between Vermont and its neighbors, when compared to Vermont acting alone. Regional consistency could also ameliorate concerns near Vermont's borders with other states.

4.5.3 GHG Accounting and Sustainability

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 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 GHG 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 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 energy wood and biofuels. As a result, careful consideration will need to be given to all the values of our forests, including ecosystem integrity, wildlife habitat, air and water quality, forest health, recreation, wood products, food crops, etc. Energy wood and biofuels can fill an important role as a local, renewable energy source. Done correctly, an improved energy wood 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 wood use (sequestration vs. emissions) can vary substantially depending on specific type of biomass fuel, its growth rates, harvesting practices, transport distances, and the end uses of the fuel.

5 Land Use and Siting

As we move toward generating more of our energy renewably and closer to home, it's no surprise that tensions between competing land uses will arise. For one thing, the "power density" – or amount of energy per given unit of volume, area, or mass – of existing renewables is orders of magnitude less than it is for fossil fuels; therefore renewables require much more space on the landscape than traditional, centralized generators. For another, renewable electric sources need to be sited where the renewable resource (wind, sun, water) exists and where they can be cost-effectively built and connected to the grid, which often means greater visibility, at least when compared with the large, centralized, conventional generation to which we've become accustomed. And, if sited far from load, electric sources must be connected with adequate transmission, which is both a limiting factor to siting renewables as well as a siting challenge unto itself.

5.1 Land Use Choices

Every time we change or restrict uses on a piece of land – be it for energy production, residential or commercial development, agriculture, roads, and so on – we are making a decision that often precludes alternative uses (or preservation). These choices may affect the character and functionality of the landscape and environment for decades to come.

Flat, sunny, open lands are optimal for capturing solar energy, which can grow food for humans and livestock, power our cars and heat for our buildings, or generate electricity for our homes and businesses. Those same lands are also attractive for conversion into those same shelters and workplaces. And, if left undeveloped, they may serve as important habitats for songbirds and other wildlife that comprise an important part of the biodiversity that supports us all.

Our hill- and mountaintops allow access to the strong and steady winds necessary for the scale of wind energy production that will make a significant contribution to our energy supply. But those same peaks capture rainfall and store snowpack that feeds our headwaters, dropping into the rivers that nurture fish and plants. Mountain ridgelines and peaks tend to sit in the center of our most significant habitat blocks, serve as important travel corridors for a range of species, and also offer unique resilience functions necessary for native plant and animal species to adapt to a warming and crowded planet, not to mention solace and sense of place to Vermonters and visitors alike.

Forests – especially in large, unfragmented blocks – offer critical habitat to many of our plant and animal species, and filter air, sequester carbon, and contribute to flood resilience by absorbing large volumes of rainwater. Seventy-eight percent of the state is forested, and when managed properly, our forests also offer significant recreational and economic potential. Many Vermont homes, businesses, and institutions are heated with wood or pellets, and our extensive forest resources offer the potential to expand the use of wood for heat and combined heat and power to many more Vermonters, offsetting significant volumes of imported fossil fuels while keeping more of our dollars circulating in the local economy. However, as with fossil fuels, burning wood releases emissions of harmful pollutants to the air we breathe, making it absolutely necessary to ensure that we rely on the most efficient and cleanest combustion technologies to minimize health and environmental impacts.

The use of watercourses in Vermont is not exempt from these competing priorities. Rivers are vital to fish, as nurseries, spawning grounds, and habitats. Those fish attract anglers, while the rushing rapids and meandering pools attract boaters and other recreationalists. And we are reminded with every major rain event – increasing in frequency as of late – of the importance of natural river corridors for flood resilience. Rivers traditionally served as the lifeblood of fledgling New England economies, powering our early mills. But the powering of our human needs has often compromised aquatic life, due to the damming and impoundment of watercourses, effectively isolating fish populations above and below dams and affecting the amount of oxygen and type of food and habitat left for the survivors. Modern hydropower facilities at existing dams have the potential to offer significant generation that can balance intermittent renewables such as wind or solar, but face significant permitting challenges designed to protect the other vital functions of rivers.

The uses and values imparted to our land and water resources may seem to be in stark competition, and sometimes that is the case. But more often than not, there are complementarities and acceptable compromises to be found, if we are up to the challenge. That involves working together to name the competing uses and values and (much harder) ultimate priorities for a given parcel of land or landscape, infuse those priorities into our land use planning, and translate that planning into regulations and siting guidelines and processes. It also involves thinking holistically not only about other societal values in our energy decisions, but about energy implications of our other societal decisions – where we put our homes and businesses, how we power and heat those buildings, and how we move people and goods among those places.

5.2 Regulatory Context

There are two primary state-administered permitting pathways for developments in Vermont: 10 VSA § 6086 (Act 250) and 30 VSA § 248 (Section 248). Act 250 – Vermont's Land Use and Development Act, passed in 1970 – regulates non-energy generation and transmission development, including most commercial, industrial, and subdivision development. Nine district commissions comprised of citizens appointed by the Governor, and assisted by a District Coordinator, review applications for compliance with ten statutory criteria, found in 10 VSA § 6086.

Section 248 evolved out of utility regulatory statutes governing public utilities and dating back as far as the late 1800s. Today, Section 248 generally regulates electric generation and transmission as well as natural gas facilities. The statutory criteria that must be considered by the PSB (Board) – the three-member, quasi-judicial board with public utilities oversight – are defined in Title 30. In 1988, the bulk of the criteria defined in 10 VSA § 6086 (the "Act 250 criteria") were incorporated into Section 248, in order to provide a framework for review of the environmental impacts of energy projects. The Board is directed to give due consideration to the Act 250 environmental criteria in determining whether an energy project poses an undue adverse impact to the natural environment. In addition to these environmental criteria, the Board reviews projects for their economic impacts and costs, impacts on electric system stability and reliability, compliance with the state energy plan, public health and safety, and GHG impacts. However, certain criteria – such as "need" and GHG impacts – are waived for smaller-scale renewable generation projects. The Board also has the discretion to review environmental impacts above and beyond the specific environmental criteria adopted from Act 250.

Despite their similarities, there are substantial differences between Act 250 and Section 248, both in terms of criteria of review and the regulatory process. These have been explored in recent years, by the legislature[23] and Governor's Energy Generation Siting Commission[24], as both bodies sought to review and compare the strengths and weaknesses of the two processes in order to design improvements – especially in terms of the weight given to town and regional plans.

5.3 The Importance of Planning

Decisions made about the location, scale, and design of a project are not created in a void, but rather in response to a suite of disparate levers, from incentives at the federal and state level to siting parameters imposed by the physical environment and available infrastructure as well as those generated by a deliberate planning process translated into regulatory constraints. Also important is the extent to which planning feeds into regulatory review and approval. In Act 250, for instance, a development project must be in conformance with the town and regional plan, along with a number of other criteria. In Section 248, town and regional plans are given due consideration as the Board determines whether a project, on balance of the criteria, is in the public good.

As energy projects become more distributed across the landscape, the role of town and regional plans naturally assumes greater relevance; and yet these plans tend to primarily address non-energy development – where they have greater regulatory weight – in any detail. Various attempts have been made over the years to address this, with varying levels of success. In 1988, the Vermont legislature passed Act 200 - the Growth Management Act – in an attempt to create a statewide land use plan and as a complement to Act 250. The Agency of Commerce and Community Development wrote a report in 2003[25] analyzing reasons for the ultimate failure of the parts of Act 200 designed to foster both coordinated planning among state agencies as well as vertical integration of state, regional, and local planning. At the end of the day, the complexity involved in this type of multi-dimensional planning proved too insurmountable a challenge.

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23 http://legislature.vermont.gov/assets/Documents/2016/WorkGroups/Senate%20Natural%20Resources/Reports%20and%20Resources/W~Sen.%20Bray~Comparison-%20%2010%20Chapter%20151%20(Act%20250)%20and%2030%20VSA%20Section%20248~1-20-2015.pdf

24 http://sitingcommission.vermont.gov/sites/cep/files/Siting_Commission/Publications/Comparison%20Table%20248-250.pdf

25 http://accd.vermont.gov/sites/accd/files/Documents/strongcommunities/cd/planning/ACT200_15Years.doc

5.4 Energy Siting Reform Initiatives

In response to the growing pains that have emerged as the state begins to move toward the realization of a clean energy portfolio, smaller-scale initiatives to examine ways to improve planning and siting processes in Vermont have emerged. The Governor's Energy Generation Siting Policy Commission produced a report in 2013[26] containing a comprehensive package of reforms to address concerns with siting and permitting of larger-scale (> 500 kW) energy generation projects. While legislative action to adopt the recommendations has not yet been taken – making it impossible to gauge their effectiveness – state agencies have begun to address many of the recommendations not requiring statutory change.

Notably, the DPS has used limited available funds to embark on a two-year pilot program to address the first three recommendations of the Siting Commission, which all focused on enhanced energy planning by the Regional Planning Commissions (RPCs). Three RPCs – Bennington County, Two Rivers-Ottauquechee, and Northwest – are currently working with the towns in their regions and a variety of stakeholders to ascertain their regions' renewable energy potential as well as comprehensively addressing their energy needs (electricity, heat, and transportation) through 2050. The towns that comprise each region will determine the ultimate success of the energy plans, and should the effort prove fruitful and funding be made available, it could be expanded statewide. The more active towns and regions become in energy planning, the greater the opportunities for addressing and minimizing potential land use conflicts before they arise.

Per Act 56, a Solar Siting Task Force has convened and is working throughout the summer and fall of 2015 to study the design, siting, and regulatory review of solar electric generation facilities and to provide a report to the Legislature in the form of proposed legislation. While the Task Force's work is specific to solar, it may provide insight into improving the siting for other energy resources. The "Meeting Electric Demand" and "Energy Supply Resources" chapters of this Plan will explore siting challenges to each of those resources in depth, as well as offering insights into the land use impacts of various potential 2050 electric portfolios for the state.

An obvious solution to address the natural tensions that are emerging as our energy resources become visible has not yet materialized. At least Vermont is in good company, as our neighboring states, nation, and other countries similarly attempt to transform the way we use and consume energy. A 2011 paper from Rutgers professor Clinton Andrews et al, *Alternative Energy Sources and Land Use*, offers some perspective[27]. Globally, they expect energy demand between 2010 and 2030 to increase from 140,000 terrawatt-hours per year (TWh-yr) to 199,000 TWh-yr. The researchers group energy sources into three categories based on land intensity, or land area required for delivering 1 TWh-yr. The least land intensive resources are all either non-renewable or extremely limited in Vermont: nuclear, geothermal, coal, solar thermal, and natural gas. In the middle of the pack come most of the renewables: solar PV, petroleum,

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26 http://sitingcommission.vermont.gov/sites/cep/files/Siting_Commission/Publications/FinalReport/Final%20Report%20-%20Energy%20Generation%20Siting%20Policy%20Commission%2004-30-13.pdf

27 http://i.i.cbsi.com/cnwk.1d/i/tim//2010/05/29/LandUseAndrews.JPG

hydropower, and wind. The most land-intensive resources are all biofuels, which they assert will preclude these resources from becoming an important energy source.

5.5 Siting and Land Use Principles

Although this Plan does not attempt to solve the tensions inherent to energy development in land use planning and regulation, the following set of principles attempts to capture complementary land use opportunities or, in the presence of unresolvable conflicts, offer a framework for analytical decision making:

1. Energy and non-energy land use planning should be integrated as much as possible at the local, regional, and state levels.
2. Energy (30 V.S.A. 248) and non-energy (Act 250) land use regulatory processes should be complement each other to the extent practicable.
3. Energy elements of Act 250 criteria, and land use elements of Section 248 criteria, should reflect the integrated planning and complementary regulatory review principles.
4. Energy development that meets needs while avoiding or mitigating negative impacts on other state, regional, and local goals and priorities, including economic, environmental, and health priorities identified in Chapter 3, and that takes statewide land use goals[28] into account, should be promoted.
5. Energy development that enhances other state, regional, and local goals and priorities, including reduction in the state's and region's GHG footprint, improvement in air quality, and opportunities to develop local economies, should be prioritized.

[28] *Local and regional planning processes are guided by Vermont state law (24 V.S.A., Chapter 117) to not only direct development so as to maintain the historic settlement pattern, but also to protect natural and historic resources including significant natural and fragile areas; outstanding water resources, significant scenic roads, waterways, and views; and important historic structures, sites, or districts.*

6 Energy Financing

Advancement toward the goals established in the CEP will require expanded access to funding and financing to support project development as well as investment in clean energy businesses in the state. The 2011 CEP identified a range of finance-related recommendations, and much progress has occurred since then. Follow-on activities including the 2012 Thermal Efficiency Task Force, two Governor-sponsored Clean Energy Finance Summits, strategic planning for the Clean Energy Development Fund, and others have contributed toward this progress. This chapter will provides updates on progress, a review of relevant finance tools and policies, and recommendations on priority strategies that will help further expand access to project finance in the coming years.

6.1 Magnitude of the Challenge

Meeting the finance challenge associated with renewable energy and energy efficiency goals in the near term will entail a substantial infusion of capital, with estimates ranging from $500 million above the current baseline invested to reach a target of $1 billion invested by 2020[29] to $28.7 billion needed by 2030.[30] A more recent analysis developed by the Energy Action Network (Exhibit 6-1) puts this figure at over $33 billion in total needed to achieve the state's energy goals. For comparison, Vermonters spent over $3.26 billion on total energy expenditures in 2013 (EIA).

Vermont had the 16th highest expenditure on energy in the U.S. at $5,041 per capita despite the low energy use of only 206 million Btu per capita, or 46th in the nation in 2012.[31] The state's high energy expenditure per capita provides opportunity for cost savings and stimulation of the local economy from investment in clean energy.

Moving forward will require not only new energy policies and programs such as those created by Act 56 of 2015 but also further development and application of finance tools that expand the range of available options. Some finance products currently in use, such as solar leases and cash-flow-positive commercial energy efficiency loans, make sense economically for the customer and offer immediate savings. As more finance institutions gain experience with renewable technologies and energy efficiency upgrades, the ability to assess risk and develop new finance products will improve, thus contributing toward greater access to affordable capital. However, there are a wide range of finance tools and policies either in use, in development, or under consideration, both in Vermont and the U.S. It makes sense for the state to invest

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[29] *State of Vermont 2020 Comprehensive Economic Development Strategy,* Vermont Agency of Commerce and Community Development, *http://accd.vermont.gov/sites/accd/files/VT%202020%20CEDS.pdf* ; Pg. 28, Accessed July 29, 2015

[30] *Mobilizing Capital to Transform Vermont's Energy Economy*, Wasserman, N. and Barton, B. Energy Action Network, October 2012; Pgs. 13-18.

[31] 2012 Energy Information Administration, *www.eia.gov/state/rankings/?sid=US#/series/225* and *www.eia.gov/state/rankings/?sid=US*; Accessed July 29, 2015

Exhibit 6-1. Potential Scope of Financing Needed in Vermont by 2050

	Selected Technologies		Total Current Installed Capacity	Total Potential Market	Total Unfilled Potential Cost
1	Wind		214 MW	329 MW	$312 M
2	Solar PV		87 MW	2,248 MW	$6,000 M
3	Energy Efficiency	Electric	993 GWh	5,219 GWh	$1,884 M
		Thermal	218,000 MMBtu	32,000,000 MMBtu	$9,699 M
4	Bioenergy Electric Generation[1]		88 MW	132 MW	$158 M
5	Transportation		801 EVs 43 Public EVSE	400,000 EVs 127,000 Bio Vehicles 20,000 Bio Trucks 500 Public EVSE	$415 M for Vehicles $779 M for EVSE $1,194 M Total
6	Thermal Fuel Switching		N/A	20,000,000 MMBtu	$6,898 M
7	Electric Grid Upgrades[2]		N/A	N/A	$7,034 M
	TOTAL		N/A	N/A	$33,322 M

coalition for green capital

Energy Action Network

Notes & Sources: (1) Only includes power generation. Does not include bioenergy used for end-use efficiency. (2) Includes end-user smart-grid technology, and grid investments. Potential markets based on analysis by EAN. 1

Source: Energy Action Network

in some of these potential areas, whereas others may be better advanced by states with greater capacity in the near term.

A major issue related to clean energy finance looms on the horizon with the potential decrease of the federal Business Energy Investment Tax Credit (ITC) slated to drop from 30% to 10% for equipment that uses solar energy on January 1, 2017, and expire for others.[32] The current tax credit provides a key finance component for renewable projects. The expiration of the tax credit is projected to yield a substantial drop in the amount of clean energy investment for 2017, a reality that would cost jobs and slow progress on reducing GHG emissions.[33] Although the effects of this decrease may hit the residential more than the commercial sector due to the latter's economy of scale, the combined effects will dampen prospects for achieving the state's goals. State tax credits for installation of renewable energy equipment are directly tied to the federal credit and will decline from 7.2% for solar, fuel cells and small wind placed in service on or before December 31, 2016, to 2.4% for solar (except hybrid solar lighting), geothermal, micro-

[32] See *Business Energy Investment Tax Credit (ITC)*, US DOE *http://energy.gov/savings/business-energy-investment-tax-credit-itc*; Accessed July 29, 2015

[33] EIA projects "solar photovoltaic (PV) capacity in the residential sector grows by an average of about 30%/year from 2013 through 2016, compared with 9%/year for commercial sector PV, driven by the recent popularity of third-party leasing and other innovative financing options and tax credits. Following expiration of the 30% federal investment tax credit at the end of 2016, the average annual growth of PV capacity in residential and commercial buildings slows to about 6% in both sectors through 2040." Annual Energy Outlook 2015, EIA; http://www.eia.gov/forecasts/aeo/pdf/0383(2015).pdf, Pg. 15, Accessed July 29, 2015

turbines, and combined heat and power.[34] The potential for the federal tax credits to expire at the end of 2016 warrants serious consideration in advance.

The state, through the DPS and other entities directly involved with finance activities such as the Office of the Treasurer and VEDA, continues to monitor trends and explore opportunities regarding clean energy finance that arise. Subsequent sections will review progress regarding finance, examine current finance tools and policies, and review the prospects for applying others to help meet the growing demand for affordable capital.

6.2 Background on Finance for Clean Energy

Public funding remains central to facilitating increases in energy efficiency investment in Vermont's buildings as well as deployment of renewable energy production technologies. Cash incentives provided by the state help stimulate demand by decreasing the up-front cost of an investment, but cannot cover the full price. Ultimately, most of the investments made in efficiency and renewables will necessarily come from private capital, either from savings or financing. Well-designed up-front incentives that work in concert with financing options can attract sufficient investment with the least possible public contribution. This section looks at recent trends, activities, and progress related to clean energy finance.

National Markets Ramping Up

Investments to support clean energy projects have increased substantially in the U.S. since the 2011 CEP. Clean energy investment in all classes reached $51.8 billion in 2014, five times higher than a decade before, and totaling $265 billion from 2010 to 2014.[35] In Vermont in just one part of the clean energy industry, the state added 38 megawatts (MW) of solar electric capacity, representing a $76 million investment across the state, a 63% increase over the year before.[36]

As demand for renewable energy and energy efficiency products and services grows – spurred by state and national policies, concerns about climate change, and investor interest – innovation is occurring in capital markets to provide lower cost, scalable finance tools. There is activity on asset-backed securitization, yieldcos, bonds, and other financial products along with policies that include credit enhancement and warehousing.

Achieving the scale of investment needed to reach Vermont's and other states' energy goals will require reductions in soft costs, including costs of financing. A recent report by the National Renewable Energy Laboratory (NREL) stated that unlocking long-term investment in clean energy will require access to

[34] *32 V.S.A. §5822; See http://programs.dsireusa.org/system/program/detail/3428*

[35] Sustainable Energy in America, 2015 FACTBOOK, Bloomberg New Energy Finance and Business Council for Sustainable Energy, February 2015. Total clean energy investment in the US across all asset classes (asset finance, public markets, venture capital/ private equity) as well as corporate and government R&D, and small distributed capacity (rooftop solar). www.bcse.org/wp-content/uploads/2015-Sustainable-Energy-in-America-Factbook.pdf; Accessed July 28, 2015

[36] Vermont Posts Significant Gains in Solar Capacity in 2014. Solar Energy Industries of America, April 2, 2015; www.seia.org/news/vermont-posts-significant-gains-solar-capacity-2014; Accessed July 28, 2015

private investment historically unavailable to RE project finance: pension funds, mutual funds, and private wealth accounts with assets that are primarily invested in debt and equity securities that are liquid, tradable, and priced by the market. Traditionally, renewable energy investment is project-financed and does not have these characteristics, which limits the supply and raises the cost of investment capital.[37] Similar circumstances also apply to energy efficiency investment.

Progress toward lowering costs will entail addressing the perceptions of risk that limit investor confidence and thus participation. These risks may relate to the performance of any particular technology over time, regulatory policy uncertainty, and creditworthiness of participants. Success in the long-term will depend upon demonstration that assets perform at expected levels and develop a track record that documents the history.[38]

The overall transition towards market maturity is in its early stages. However, there has been notable progress recently with development of new finance products including the solar industry's first securitization[39] and the Warehouse for Energy Efficiency Loans (WHEEL).[40] These initial steps herald the emergence of secondary markets with new asset classes. There has also been progress with formation of yieldcos (publicly traded yield companies), which are now available and traded on public exchanges. At this stage, securitization and yieldcos favor larger players with substantial development pipelines.

Other instruments, such as Real Estate Investment Trusts (REITs) offer limited possibility for investors seeking to participate in the emerging markets for clean energy investment. Making REITs more available for investment in clean energy will require a ruling by the IRS or legislative action. Similarly, Master Limited Partnerships (MLPs) offer another potential avenue for investment, but use of MLPs will also require new legislation.

Interest in green bonds or climate-aligned bonds is growing rapidly. According to the Climate Bonds Initiative, the total climate-aligned bonds universe stands at $597.7 billion, a 20% increase from last year. $51 billion of this total comes from the United States and almost a third of this year's increase ($95 billion) was due to the rapid growth of the labelled green bond market. Although this universe is made up from bonds issuers spanning buildings and industry, agriculture and forestry, waste and pollution, water, transportation, and energy, the latter two lead the way. Among the entrants in this field is a $150 million AAA-rated green Asset-Backed Security issued by the Hawaii State Department of Business, Economic Development and Tourism. Proceeds will go to support the department's Green Energy Market

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[37] *Credit Enhancements and Capital Markets to Fund Solar Deployment: Leveraging Public Funds to Open Private Sector Investment, Michael Mendelsohn and Marley Urdanick, NREL; February 2015; http://www.nrel.gov/docs/fy15osti/62618.pdf; Pg. 2, Accessed August 10, 2015*

[38] *Mendelsohn and Urdanick, Pg. iv*

[39] *SolarCity Completes Industry's First Securitization of Distributed Solar Energy, Solar City, Press Release, November 21, 2013; http://investors.solarcity.com/releasedetail.cfm?ReleaseID=808982; Accessed July 28, 2015*

[40] *Citi and Renew Financial Announce First Ever Energy Efficiency Loan Asset-Backed Security Transaction, MarketWatch, June 15, 2015; www.businesswire.com/news/home/20150615006147/en/Citi-Renew-Financial-Announce-Energy-Efficiency-Loan; Accessed August 5, 2105*

Securitization (GEMS) program for loans to consumers to fund the installations of solar photovoltaic panels and solar connectors such as storage, advanced inverters, and monitoring devices.[41]

While much of the innovation with financing is occurring with large-scale companies and financial intermediaries, there are potential implications from these activities for Vermont. Technological advances coupled with the use of emerging finance tools will remain central to establishing mature clean energy markets.

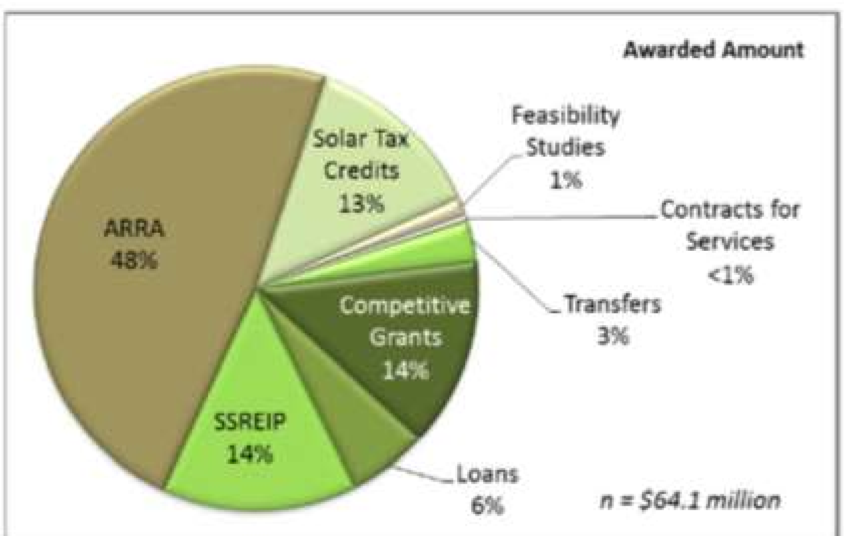
6.3 Recent State of Vermont Clean Energy Finance Activities (2012–2015)

For a brief review of key clean energy finance-related activities under taken by the State of Vermont since the release of the 2011 CEP, see Chapter 2. Other subsequent activities of importance follow below.

Clean Energy Development Fund Strategic Plan (2012 - 2015)

The CEDF is one of the state's primary vehicles for providing resources to support advancement of clean energy. Historically, the bulk of the funding went to the Small Scale Renewable Energy Incentive Program (SSREIP). Recent decreases in funding required a re-prioritization for how funds would be allocated. In 2012, the CEDF issued a 5-year Strategic Plan, which was adopted by the Clean Energy Development Board to provide the new focus.

Exhibit 6-2. CEDF-Awards by Funding Types (2006-2013)



[redacted]

From 2006 to 2013, the CEDF deployed $64.1 million via 3,983 awards for investment in clean energy technologies and projects around the state. Awards included competitive grants, loans, tax credits, incentive payments, feasibility studies and contracts for services from State and American Recovery and Reinvestment Act (ARRA) resources (Exhibit 6-2). While this investment was, and continues to be, important to the advancement towards state energy goals, the resources and outcomes leveraged by CEDF activities are

[41] Bonds and Climate Change: The State of the Market in 2015, Climate Bonds Initiative; July 2015; www.climatebonds.net; Accessed August 11, 2015

even more important. Overall, the fund generated over $196 million in additional private sector investment for a leverage ratio of 3.2 to 1 and a total of over $260 million for the state's clean energy industry.[42]

Since its formation, the CEDF invested over $15 million in clean energy resources through the SSREIP and leveraged an additional $88 million.[43] Insights gleaned from this success story highlighted the need to gradually taper incentive payments for more mature technologies and apply resources toward finance strategies for solar PV, and focus incentive resources on other viable technologies in emerging local markets.

Building on this insight, the CEDF 2015 work plan included new finance programs using credit enhancements that would help finance institutions gain more experience with financing of renewable energy technologies. This new direction led the fund to provide credit enhancements to foster finance for solar PV in Windham County ($300,000) and for community solar statewide in 2015 ($125,000). These new programs complement the $700,000 in credit enhancements supplied to financial institutions via Thermal Energy Finance Pilot project initiated by DPS in July, 2014 which the CEDF also supports. The CEDF also deployed $200,000 to support credit enhancements for the Residential PACE program as well as over $255,000 in credit enhancements for the loan program run by NeighborWorks® of Western Vermont.

<u>Thermal Efficiency Task Force (2012-2013)</u>

The Thermal Efficiency Taskforce (TETF) created in 2012 to ensure an integrated and comprehensive statewide whole-building approach to thermal energy efficiency included a focus on funding and financing. The TETF's Finance and Funding Subcommittee was charged with making recommendations regarding the amount of money needed to achieve the State's thermal efficiency goals found in 10 V.S.A. § 581, and to identify financing mechanisms and funding sources to achieve those goals. The group recognized that reaching the state's building energy efficiency goals will require a combination of funding and financing tools along with appropriate risk mitigation features, with an assumption that a significant majority of the resources will come from private, not public, resources.[44]

Full implementation of the ideas and recommendations laid out in the TETF report between 2014 and 2020 were estimated to cost about $1 billion with funding from various public sources estimated at about $356 million and $687 million in private sector financing and investment. The budgets required to meet the state's building efficiency goals showed that a significant majority of the overall resources would come from financing, not funding. In 2014, every dollar in funding was expected to leverage about $1.40

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[42] *Evaluation of the Vermont Clean Energy Development Fund, NMR Group, Inc. & Energy Futures Group, Inc., February 25, 2015; Pg. V*

[43] *Evaluation of the Vt. CEDF, Pg. 56*

[44] *Thermal Efficiency Task Force: Analysis and Recommendations – A Report to the Vermont Legislature, Thermal Efficiency Task Force, January 2013; Pg. 79*

in financing or private funding. The task force projected this rate to increase from 1.40 to 1 in 2014 to 2.60 to 1 by 2020, averaging 1.90 to 1 over the full term.[45]

The TETF Funding and Finance Subcommittee developed a list of recommendations in tiers representing those most likely to offer near term benefits, including:

Tier One

1. *Private activity bonds* – Bonds used to finance an IRS-defined set of activities, including qualified residential rental projects, public educational facilities and green building / sustainable design projects.

2. *Energy-aligned leases* or *green leases* – Commercial leases that specify how costs and benefits of energy improvements will be shared.

3. *On-bill financing* – Finance provided to customers repaid through the utility or fuel bill; the assessment may or may not stay with the meter or house.

4. *Energy-efficient mortgages* (EEMs) and e*nergy improvement mortgages* (EIMs) – Mortgages that consider energy savings as income in calculating the debt-to-income ratio and allow the inclusion of energy improvement costs to be rolled into the purchase mortgage.

5. *Public purpose performance contracting* – A variation on Energy Service Contracting through which smaller and/or less profitable non-residential buildings benefit from comprehensive energy upgrades; might include aggregation strategies to bundle groups of buildings.

6. *Private financing with performance guarantees* – Loan products backed by a performance guarantee should a retrofitted building fail to live up to its cost savings projections.

Tier Two

1. *Bonds* – Greater use of state allocation of tax subsidy bonds such as Qualified Energy Conservation Bonds (QECBs).

2. *Expanded PACE* program to include commercial sector including multi-family properties.

3. *Linked deposits* – A mechanism through which the state provides financial incentive for private lending institutions to make more efficiency/renewables loans.

4. *Crowdfunding* – A new investment strategy intended to generate many small investments authorized through the federal JOBS Act of 2012.

5. *Managed Energy Service Agreements (MESA) and Efficiency Service Agreements (ESA)* – Like power purchase agreements (PPAs), but for energy efficiency products and/or services (e.g., energy-efficient furnaces).

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[45] TETF, Pg. 80-81

Tier Three

1. *Lending/loan purchase program/secondary market* – A mechanism through which the state or other financial institutions buy private loans.

The Subcommittee concluded at the end of 2012 that:

> *…many financing products were poised and available for multiple markets, buildings and customer types that are significantly under-used for energy efficiency improvements. Consumer demand is not sufficient to drive new approaches to financing energy efficiency. A significant part of any effort in support of the TETF goals will need to be the enlistment and engagement of lenders to offer financing for participants.* ***Partnerships between program administrators and lenders will be a key component of a successful initiative [emphasis*** added***]****. But consumer interest must first be galvanized by other program activities, public policies, customer outreach and sales and financial incentives addressed in this report.*[46]

One aspect of finance-related progress since the TETF is the Thermal Energy Finance Pilot program, which provides affordable finance for home thermal energy upgrades with a focus on low- and modest-income Vermonters. The pilot includes creation of an on-bill repayment option through which homeowners can repay loans for the upgrades via their fuel dealer's regular bill. As of August 2015, the new on-bill repayment feature was under development between the Opportunities Credit Union in Burlington and select fuel dealers (See TEF Pilot below for details).

Since July 2014, customers of Green Mountain Power (GMP) have had the opportunity to pay for home energy improvement loans from NeighborWorks® of Western Vermont via an on-bill repayment option with GMP. The service allows GMP customer to access loans from NeighborWorks and make monthly installment payments when they pay their GMP bill. Loans may be for thermal and electric efficiency measures, renewable energy, and other services that advance the energy plan of thestate. Any GMP customer anywhere in Vermont who owns a home or apartment building, up to four units, may participate. Loans are up to $15,000, with up to 10 years to pay back.[47]

VEIC has also advanced the public purpose ESCO (PPESCO) recommendation from the TETF with the entrance of Commons Energy, which is now operating in Vermont. (For additional information on PPESCOs, see below; for more on the TETF, see Chapters 2 and 7.)

<u>Vermont Sustainable Energy Loan Fund (2013)</u>

The Vermont Economic Development Authority (VEDA) has provided $27.8 million in financing for commercial and agricultural energy generation and efficiency projects, supporting a variety of

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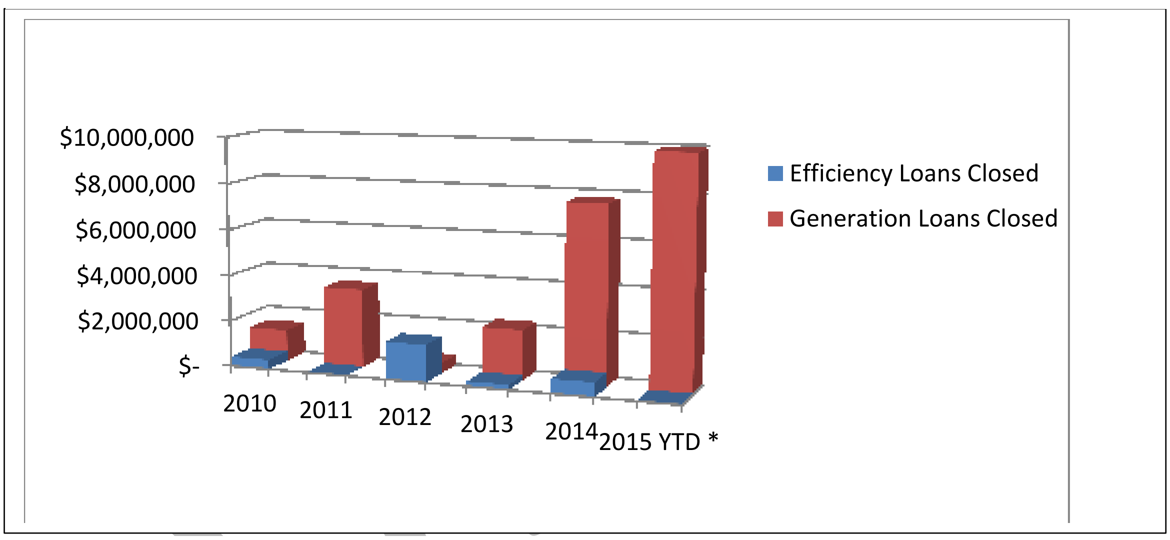
[46] *TETF, Pg. 98*

[47] *Note that the NeighborWorks Energy Loan is available statewide, but only customers of GMP have access to the on-bill repayment option. New On Bill Program Makes it Easier for Vermonters to Make Energy Improvements and Pay for Renewable Energy, NeighborWorks® of Western Vermont, July 29, 2014; http://www.nwwvt.org/bill-repayment-energy-improvements/ ; and http://heatsquad.org/affordable-financing/ Accessed August 4, 2015*

investments in efficiency, hydropower, solar photovoltaic, wind, digester, and biomass initiatives since 2010 (Exhibit 6-3). With loans for renewable energy generation part way through 2015 already topping the 2014 total, VEDA has significantly increased its financing for clean energy projects around the state.

VEDA expanded its capacity to provide financing for clean energy during the 2013 legislative session when the Authority and numerous other organizations worked with the Legislature to secure passage of H.395 (Act 87 of 2013). This enabling legislation provided for new financing for commercial, small business and agricultural sustainable energy projects through the ***Vermont Sustainable Energy Loan Fund***. According to Statute, the purpose of the new Fund is to enable VEDA "to make loans and provide other forms of financing for projects that stimulate and encourage development and deployment of sustainable energy projects in the State of Vermont," with "sustainable energy" defined as energy efficiency, renewable energy, and technologies that enhance or support the development and implementation of renewable energy or energy efficiency, or both.[48]

Exhibit 6-3. VEDA Cumulative Efficiency & Generation Loans (2010 to 2015 YTD)



** Includes $8,901,486 in Energy Generation loans approved in 2015 YTD with closings pending;*
Source: Vermont Economic Development Authority

The Sustainable Energy Loan Fund has four separate programs:[49]

- *Small Business Energy Loan Program* – Loans up to $350,000 for smaller qualifying commercial sustainable energy projects
- *Commercial Energy Loan Program* – Loans up to $2.0 million for relatively larger qualifying sustainable energy projects

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[48] *10 VSA §280cc*

[49] *New Sustainable Energy Financing Available at VEDA, Vermont Economic Development Authority, www.veda.org/press-releases/sustainable-energy-financing-available; Accessed July 30, 2015*

- *Agricultural Energy Loan Program* – Loans for qualifying agriculture and forest product-based sustainable energy projects
- *Energy Loan Guarantee Program* – Loan guarantees to participating financial institutions that enroll loans made to businesses to improve the businesses' overall energy efficiency.

In addition to Sustainable Energy Loan Program products, VEDA also offers an Electric Vehicle Charging Station Loan program.

During the time period when H.395 was developed, VEDA worked with EVT and DPS on a DOE–funded initiative to build what became the Energy Loan Guarantee Program, which is backed by a VEDA-funded reserve and a DOE-funded reserve through the DPS. Initially, the program investigated Qualified Energy Conservation Bonds (QECBs) as a key feature in providing capital for loans to commercial energy efficiency projects.[50] However, the terms for QECBs were not workable, and the participants worked with VEDA to identify an alternate pathway. Because VEDA maintains capacity to sell bonds to fund its loans, and continues to serve as a central organization helping to advance clean energy finance activities in the state, future efforts should engage VEDA and the Treasurer's Office in exploring options for using the state's allocation of tax subsidy bonds such as QECBs or other relevant bond finance options. Experience with the DOE-funded effort may provide insights into the challenges that would need to be overcome to do so.

<u>Local Investment Advisory Committee (2013-2015)</u> – During the 2013-2014 session, the Legislature passed S.220 (Act 199 of 2014), which authorized the use of up to 10 percent of the state's average daily cash balance to be disbursed for local investments at the state Treasurer's discretion consistent with the Uniform Prudent Investor Act, with recommendations from the Local Investment Advisory Committee (LIAC). The Advisory Committee was specifically charged to "invite regularly State organizations, citizens groups, and members of the public to Advisory Committee meetings to present information on needs for local investment, capital gaps, and proposals for financing; and to consult with constituents and review feedback on changes and needs in the local and State investment and financing environments.[51]

Among the activities completed, the Treasurer's Office was authorized to extend a line of credit to VEDA to support their activities including commercial energy efficiency and renewable energy capacity. This was intended to lower VEDA's reliance on outside investment bank financing and lower the cost for entities financing through VEDA, supporting Vermont jobs and economic development, with a

[50] QECBs are bonds that enable qualified state, tribal and local government issuers to borrow money at attractive rates to fund energy conservation projects. See: *Qualified Energy Conservation Bonds,* Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy, *http://energy.gov/eere/slsc/qualified-energy-conservation-bonds*; for addition information on bonding tools, see: *http://energy.gov/eere/slsc/bonding-tools;* Accessed August 14, 2015

[51] *Report on the Findings and Recommendations Required by Section 220 of Act 199 of 2014*, Office of the State Treasurer, January 15, 2015; *www.vermonttreasurer.gov/sites/treasurer/files/pdf/misc/LIAC%20Report.1.15.2015.pdf*; Pg. 1, Accessed July 30, 2015

significant focus on commercial energy. The commitment was for up to $10 million in financing in terms acceptable to the Treasurer and with a guaranteed repayment. The following other measures were taken:

- A residential energy credit facility was implemented with a maximum commitment of $6.5 million.
- $2 million was committed to NeighborWorks® of Western Vermont for their statewide residential energy efficiency program .
- A VHFA multi-family energy financing strategy received $2.8 million for VHFA's 2014 Multifamily Bond transaction, which included energy efficiency improvements.
- Up to $8 million was allocated, pursuant to the 2014 Capital Bill (Act 178 if 2014, Section 41) to create a state energy revolving fund for loans to be used to make cost-effective energy. improvements that focus on bringing older State buildings up to Energy Star standards or better
- Activities to stimulate local investment included the application of existing moral obligation authority to the VHFA multi-family financing taken in conjunction with the energy initiatives cited above, and the development of a loan program, for public and private groups, to develop electric vehicle charging stations using funds from the State Infrastructure Bank, to be administered by VEDA.[52]

As one example of progress, VFHA commenced in 2014 with energy efficiency projects at affordable rental units for low-income seniors around the state with its share of the local investments.[53]

These activities and subsequent activities to deploy residual funds demonstrate a commitment on the part of the state to help identify gaps in finance markets and use its resources to spur clean energy related activities. However, there are limits to the terms under which the Office of the State Treasurer can effectively operate. For example, any local investments must consider the need to have ample cash to meet the state's obligations during "low" periods, requiring maturity periods to be kept somewhat conservative for the investment portfolio.[54]

<u>Thermal Energy Finance Pilot Project</u>

The Thermal Energy Finance Pilot project (TEF Pilot) is sponsored by the DPS and VLITE in partnership with EVT, the Vermont State Employees Credit Union (VSECU) and Opportunities Credit Union (OCU). The program provides access to affordable finance for home thermal energy upgrades with a focus on low and moderate income Vermonters. Using $700,000 in funding supplied by the DPS, VLITE and DOE, the pilot provides credit enhancements including interest rate buy-down and loan loss reserves to reduce credit risk at participating financial institutions. The two credit unions, selected via competitive

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[52] *Report on the Findings and Recommendations Required by Section 220 of Act 199 of 2014, Office of the State Treasurer, January 15, 2015; www.vermonttreasurer.gov/sites/treasurer/files/pdf/misc/LIAC%20Report.1.15.2015.pdf; Pg. 2, Accessed July 30, 2015*

[53] *Smart financing promotes smart energy use in Vermont, Vermont Housing Finance Agency, February 5, 2014; http://www.vhfa.org/node/7860; Accessed August 5, 2015*

[54] *Section 220 Act 199 Report, Pg. 4*

solicitation in 2014, offer the program's "Heat Saver Loan" with interest rates as low as 0% and terms up to 15 years for qualified borrowers. Home heating technologies and services eligible for finance include efficient oil or gas-fired furnaces and boilers, wood pellet furnaces, cold climate heat pumps, solar hot water systems, and home weatherization activities. Borrowers must work with a qualifying contractor that participates in the Efficiency Excellence Network (EEN), a venture of EVT. The EEN is a designation given to participating residential contractors that meet additional EVT training requirements.

Initial response from participants has been positive, and numerous fuel dealers and energy contractors are actively promoting access to the new finance product to their customers. This new model is being driven by companies interested in selling energy efficiency products and services, and partnerships between the energy efficiency companies and fuel dealers who see new opportunities in the market. Access to finance becomes a selling feature, which can help customers envision a low cost pathway to making energy upgrades to their homes.

The pilot is slated to run into 2016, after which the DPS and program partners will evaluate the implications from the initiative in the context of other department activities and priorities laid out in this CEP update. Understanding the role that finance plays in emerging clean energy markets is an essential element given the limited public funds available to achieve energy goals.

6.4 Related Activities

This section synopsizes some recent non-governmental efforts focused on finance for clean energy.

<u>Energy Action Network (2012-2015)</u>

Beginning in 2012, the Energy Action Network (EAN) convened stakeholders interested in clean energy finance through its Capital Mobilization Working Group. They set a goal to mobilize capital on a large scale to fund transformative investments in energy efficiency and renewables across all energy sectors in Vermont, including public-private partnerships and innovative finance models.[55] EAN commissioned a report, "*Mobilizing Capital to Transform Vermont's Energy/Economy*" that detailed a range of projections on financing known technologies and behaviors. The report describes a need for over $28.7 billion in financing to meet a 2030 goal of 80% of the state's energy needs, including $14 billion for the purchase of electric vehicles; $5.9 billion to retrofit existing buildings ($3.77 billion for residential, remainder for commercial); $2 billion for utility-owned and in-state distributed solar, wind, biomass, and hydroelectric generation; $1.95 billion for the purchase and installation of efficient pellet and wood burners; $1.7 billion each for small in-state distributed renewable energy systems and solar thermal systems; and $750 million for the purchase and installation of residential and commercial geothermal systems.[56]

Mobilizing Capital highlights the attributes of over two dozen mechanisms including government policies, tolls and user fees, expanded use of existing funds managed by government and foundations, alternate

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[55] *Capital Mobilization Projects website, Energy Action Network, http://eanvt.org/capital-mobilization; Accessed on August 3, 2015*

[56] *Wasserman and Barton, Pg. 2*

financing structures and products, better promotion and use of existing financing mechanisms, coordinated service delivery models, enhancements and alternative approaches to both repayment collection, and project ownership.

Key criteria deemed necessary to successfully mobilize capital include the recognition that programs and mechanisms must be of a sufficient scale and standardization to attract conventional equity and debt and minimize the demand on public-sector budgets, and that public funds should be used to reduce risk and leverage private investment.[57]

Clean Energy Finance Initiative

Beginning in 2014, the EAN continued its focus on financing by engaging the Coalition for Green Capital (CGC) along with a set of state agencies to assess the needs and opportunities for increased clean energy financing in the state. The CGC – a 501(c)(3) non-profit – is an advocate and advisor on the creation of public clean energy finance authorities that use public-private partnerships for clean energy financing. These structures use limited public resources to offer targeted, financing, public dollars to leverage far greater private investment. Such financing techniques can preserve tax dollars, drive private investment, and enable citizens to access cheaper, cleaner, and more reliable energy with no upfront cost.

The CGC conducted interviews of key stakeholders, program managers and policy makers around the state to analyze the financing needs and options in Vermont. The CGC's analysis found that the financing needs are significant, with updated estimated amounts of capital currently provided and needed to meet the 90% by 2050 energy goal topping $33 billion. To achieve this, the assessment found that new institutional capacity is needed within the state to drive the required market transformation. They also observed that most programs offered by the state are grants, not financing; public dollars and programs are fragmented across agencies; no single entity has responsibility for market development; and some existing funding sources have major limits to expansion.

In its comments to the DPS for this CEP update, the CGC called for strategies to overcome institutional gaps and significant barriers to market growth that can be addressed through financing and optimized program design, including:

- Clear responsibility in the state for marketing financing and tailoring it to consumer's real needs;
- Clear ownership within the state for the management of combined energy analysis for whole-building solutions;
- Better alignment between state energy needs and the use of state funds;
- Coordinated engagement and a government willingness to take the first dollar of risk to attract private investment; and
- Project aggregation, which is critical across markets to attract capital.

[57] Wasserman and Barton, Pgs. 5-6

The CGC suggested that policy makers explore the experience of other states with clean energy financing, and consider the options.

6.5 Investments for Clean Energy Business Growth

The clean energy industry in the state continues to grow, with more than 15,000 clean energy workers identified. While a large amount of capital is needed to finance clean energy projects in the state, there is also continued need for capital for entrepreneurs with clean energy technology and service businesses in this rapidly evolving landscape. Companies need financing to help with projects, but also growth capital and support systems that help them succeed. Investment in small clean tech enterprises can be hard to come by, with projects often slow to reach market and facing numerous risks along the way. Below are examples of organizations that are working to overcome such challenges to in Vermont.

VSJF Flexible Capital Fund, L3C

The Vermont Sustainable Jobs Fund's Flexible Capital Fund provides risk capital to early stage entrepreneurs using an innovative royalty finance model that allows for income and upside to the fund's investors while preserving ownership and mission of the founder entrepreneurs.[58] The fund provides an important source of capital during critical growth stages to companies including energy firms located in the state.

Vermont Center for Emerging Technologies

Emerging tech entrepreneurs needing assistance can turn to the Vermont Center for Emerging Technologies (VCET) for active coaching, education, co-working space, and potential investment from the Vermont Seed Capital Fund, a revolving $5 million venture capital fund for select high opportunity businesses including investments in clean energy in the state.[59]

Vermont Climate Change Economy Council

The Vermont Council on Rural Development convened a group of business, non-profit and community leaders, elected officials, public policy advocates, students, and interested residents to frame policy and investment strategies to advance the development of the Vermont Climate Economy. Summit participants generated recommendations covering a wide range of topics including formation of the Climate Change Economy Council with a one-year mission to develop a structured plan with practice actions to reduce carbon emissions and stimulate green economic development in Vermont. Focus areas included seeding a climate investment strategy, spurring research and development for new technologies in Vermont, and advancing next stage in efficiency and conservation. The Climate Change Economy

[58] *Flexible Capital Fund, www.vsjf.org/what-we-do/flexible-capital-fund; Accessed August 12, 2015*

[59] *Vermont Center for Emerging Technologies, http://vermonttechnologies.com; Accessed August 14, 2015*

Council will convene throughout 2015 to develop a platform of actions to help advance the state's climate change economy. [60]

Vermont Low Income Trust for Electricity

Created out of the merger of CVPS and GMP in 2012, VLITE is working with the DPS, the Agency of Commerce and Community Development, and other energy stakeholders to further the energy policies of the state.

6.6 Finance Tools and Policies

The markets for clean energy financing are evolving with more organizations seeking access to finance resources and more institutions offering products. A number of financing mechanisms are currently available in Vermont and others are in development. Further evolution of clean energy markets will benefit from access to a diversity of cash-flow-positive or -neutral finance options so any given customer can choose the financing mechanism most appropriate to his or her particular situation. Access to finance alone will not supply the drive towards CEP goals. Financing must be combined with marketing and other policy tools to drive the demand for these services.[61] However, insufficient access to affordable financing can dampen rates of energy efficiency and renewable energy investment.

Below are summaries of finance products currently used to deploy energy efficiency and/or renewable energy projects.

Financial Institution and Credit Enhanced Lending

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 loan products for renewables and energy efficiency are available to customers now. Some Vermont financial institutions also offer energy loans with special features. (Exhibit 6-4)

Exhibit 6-4. Finance Products for Renewables/Energy Efficiency in Vermont

Financial Institution	Description
Brattleboro/Springfield Savings and Loan	Home equity and personal loans
KeyBank	Go Green Auto Loan
National Bank of Middlebury	Green Advantage energy improvement loan;

[60] Summit Report: Creating Prosperity and Opportunity Confronting Climate Change, Vermont Council on Rural Development, February 18, 2015; http://vtrural.org/programs/summits/2015-climate-economy-report; Pg. 3, Accessed August 12, 2015

[61] Although low cost finance products are essential to the successful deployment of renewable energy and energy efficiency activities in Vermont, so are other elements of a financing package. These include tax credits, tax deductions, rebates, energy policies such as the Standard Offer, development of standardized contracts, aggregation strategies such as Solarize that achieve local economies of scale to reduce purchasing prices for consumers, and others. Details of these elements are beyond the scope of this section but remain key elements of successful financing.

	finance provider for PACE
Northfield Savings Bank	Home equity and personal loans
People's United Bank	Home equity and personal loans
TD Bank	Home equity and personal loans
Union Bank	GreenLend for energy efficiency and renewables
Green Mountain Credit Union	Energy improvement loans for energy efficiency and renewables
Members Advantage Community Credit Union	Energy Loan Plus for energy efficiency and renewables
New England Federal Credit Union	Energy Smart Loan
Opportunities Credit Union	Reduced rate Heat Saver Loan for energy efficiency and select renewables
Vermont Federal Credit Union	Freedom Home Loan for energy efficiency
Vermont State Employees Credit Union	Reduced rate Heat Saver Loan for energy efficiency and select renewables; VGreen loans for energy efficiency and renewables; Windham Solar Loans; Community Solar Loans
NeighborWorks® of Alliance of Vermont	Home Repair/Energy Loans via five regional member organizations

Note: Partial listing based on sampling of financial institution websites

In the wake of the Great Recession, lenders are making more loans. Generally, customers with good credit and the willingness to take on a loan will be approved for loans. However, efforts to reduce credit risk for financial institutions such as the Heat Saver Loan, PACE financing, NeighborWorks® of Western Vermont Energy Loan and CEDF-supported Solar Loans at VSECU (all of which include credit enhancements) help borrowers with lower credit scores gain access to financing that reduces the up-front impact for energy efficiency and/or renewable energy technology investments.

Traditional financing can also be offered through utility/efficiency provider partnerships with private lenders, as has occurred in Vermont Gas System's (VGS'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.

On-Bill Tariffed Financing and On-Bill Repayment

On-bill tariffed financing, a kind of non-traditional 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, allows attachment of payment for efficiency measures 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.

The recent passage of Act 56 of 2015 includes Energy Transformation Projects in Tier 3, through which retail electricity providers are required to achieve fossil fuel reductions. Utilities are currently investigating options that can be employed to meet this requirement, potentially coupled with on-bill tariffs or on-bill repayment mechanisms for cost recovery. The PSB is commencing with planning for implementation of Act 56 during 2015. Issues related to failure by a customer to repay an obligation, and access to a utility's bill by unrelated fuel dealers, renewable energy vendors and energy efficiency contractors, are among the topics for consideration.

The state has an interest in creating and testing a variety of financing mechanisms that meet the different needs of energy customers. Along with anticipated development of on-bill tariffed financing, Vermont now has examples of on-bill repayment. For example, Green Mountain Power (GMP) customers who obtain an energy loan from NeighborWorks® of Western Vermont, or schools and municipalities in the former CVPS territory that receive financing via the GMP Evergreen Fund, can opt to repay loans via their regular electricity bill. GMP customers can also make lease payments for heat pumps directly through their regular GMP utility bill. Customers of Burlington Electric Department also have access to an on-bill financing option for electric energy efficiency improvements.

In addition, as previously described, the DPS is also working with Opportunities Credit Union and some fuel dealers on a new on-bill repayment option where heating fuel customers who obtain a Heat Saver Loan can make payments via a fuel dealer's regular monthly bill. Having a viable fuel bill repayment model would help provide coverage where a fuel dealer's territory cuts across multiple utility service territories, of which only a subset opt to create an on-bill plan.

<u>Property Assessed Clean Energy (PACE)</u>

PACE was designed and created in 2009 by Act 45 to provide an alternative mechanism that would allow homeowners to finance their energy improvements by opting into a special assessment district created by their municipality. Efficiency improvements would then be funded by arrangement with a private financial institution, taxable municipal bonds or other municipal debt. PACE financing is an assessment on the property which in the event of default allows for collection of past-due payments via the municipality's property tax collection process. Communities may decide to run the program, or elect to have EVT act at the Program Administrator, in which case payments can be billed monthly via a financial institution rather than via the property tax bill. This enables the town to offer PACE financing without the burden of billing and processing payments. PACE was designed to overcome 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.

A State PACE Reserve Fund was created by the Vermont Legislature through Act 47 of 2011 (24 V.S.A. §3270) administered by the State Treasurer. All municipalities in Vermont are encouraged to become PACE districts to facilitate this financing option. As of 2015, 35 towns have adopted PACE and 18 others are in the process.[62] To date there are seven completed projects with two more in the construction phase.

[62] For a list of current PACE towns and requirements, see: *www.efficiencyvermont.com/For-My-Home/Financing/Financing/PACE-Overview*

EVT is the administrator for PACE in Vermont. Despite much effort, Vermont's PACE program has been slow to take off. The presence of other competing finance products makes it more difficult to find customers, and issues associated with verifying a clean title on the property continue to require attention.

To help spur participation, EVT conducted community forums and financing workshops in 2015, and waived the application fee. For a limited time, some applicants may qualify for an interest rate buy down (IRB).[63] In addition, the previous every-other month subscription period was changed to allow applications any time, and interest rates for the IRB are now limited to $15,000 of eligible project measures, which was increased from $10,000 per project.

Energy Service Companies/Public Purpose Energy Service Companies

Energy Service Performance Contracting (ESPC) is a budget-neutral approach to make building improvements that reduce energy and water use and increase operational efficiency. By partnering with an energy service company (ESCO), a facility owner can use an ESPC to pay for today's facility upgrades with tomorrow's energy savings–without tapping into capital budgets. State and local governments can implement ESPC projects in their own facilities or support ESPC programs.[64]

ESCOs provide energy efficiency related and other value-added services for which ESPC is a core part of its energy efficiency business. In a performance contract, the ESCO guarantees energy and/or dollar savings for the project and ESCO compensation is therefore linked in some fashion to the performance of the project.[65] ESCOs have operated in commercial markets since the 1970s. As of 2011, revenues in this sector pegged in at $5.3 billion, with about 85% of those revenues coming from energy efficiency services.

ESCOs typically work on larger scale projects to obtain the economics needed to make the project viable. One challenge with application of the ESPC model in Vermont is that ESPCs are generally used for projects valued at over $1 million. Vermont, with its dearth of larger facilities, has limits to the number of projects suited to this tool. The Department of Buildings and General Services finished energy upgrades to the Waterbury State Office Complex in 2011 through a performance contract; however, the damage to the complex from Tropical Storm Irene compromised the benefits from the energy investments.

Vermont now hosts a Public Purpose Energy Service Company (PPESCO) known as Commons Energy L3C, a wholly-owned subsidiary of the VEIC. A PPESCO is an integrated comprehensive total energy solution to accomplish deep energy savings for owners of small to mid-size public purpose buildings in multifamily affordable housing, education, health care and municipalities without access to capital, technical skills, and implementation services.[66] This innovation provides the opportunity to apply the

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[63] *For details, see: www.efficiencyvermont.com/For-My-Home/Financing/Financing/The-PACE-Process*

[64] *Energy Savings Performance Contracting, Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy, http://energy.gov/eere/slsc/energy-savings-performance-contracting; Accessed August 14, 2015*

[65] *Larson, et al, cited in The U.S. ESCO Industry: Recent Trends, Current Size and Remaining Market Potential; Elizabeth Stuart, Charles A. Goldman, Peter H. Larsen, Donald Gilligan; 2014 ACEEE Summer Study on Energy Efficiency in Buildings, Pg. 3-284*

[66] *How to Create and Build a Public-Purpose Energy Services Company, http://www.ppescohowto.org/*

functionality of ESPC to currently under-served markets in Vermont. The PPESCO model was recommended by the Thermal Efficiency Task Force particularly for providers of affordable multi-family housing. The Task Force reported that while providing the benefits of traditional ESCOs, a PPESCO would also fund all cost effective measures, rather than those with the greatest return on investment; include renewables; and provide a long term financing structure to enable cash flow positive benefits to affordable housing providers.[67]

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 Federal Housing Administration and the U.S. Department of Veterans Affairs offer EEMs.[68]

Net Metering Credit Purchase Agreements

A Net Metering Credit Purchase Agreement is a financing structure that enables property owners or tenants, including state and local governments, to realize the benefits of renewable energy generation without having to own the equipment and pay the upfront capital cost. State and local officials can use these Agreements to finance their own projects, and can also help fellow agencies and consumers understand their value and mechanics. The "buyer" (property owner or tenant) enters into a long-term contract where they agree to pay a predetermined rate for the value of the net metering credits delivered from a renewable energy asset. The length of the contract varies depending upon the type of energy improvement, but typically ranges from 10 to 20 years. The payment is typically fixed or pegged to a floating index that is on par with or below the current electricity rate being charged by the local utility company. The renewable energy developer utilizes the contract to attract private investors who are comfortable with the customer's ability to make payments over the term of the agreement. This enables investors to realize their target return on investment for providing the initial capital. Individual investors determine the value of specific Agreements based upon criteria ranging from the term, value of energy delivered, creditworthiness of the counterparty, and other contract details. If the net metering credit payments over the life of the contract plus any other incentives produce a desirable return on investment, investors will provide the upfront capital to finance the project.[69]

Lease Arrangements

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[67] *TETF, Pg. 65*

[68] *For details, see Energy Star: www.energystar.gov/index.cfm?c=mortgages.energy_efficient_mortgages*

[69] *Adapted from: Power Purchase Agreements, Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy, http://energy.gov/eere/slsc/power-purchase-agreements; Accessed August 14, 2105*

Leasing energy-related improvements, especially the use of tax exempt lease-purchase agreements for energy efficient-equipment, is a common and cost-effective way for state and local governments (as well as commercial property owners) to finance upgrades and then use the energy savings to pay for the financing cost. Leases often have slightly higher rates than bond financing. However, leases are a faster and more flexible tool than many other options, including bond financing, and are an important tool for public entities to finance improvements in their own buildings. Leases are contracts that allow an entity to obtain the use of (or to purchase) equipment or real estate. They are similar to long term rental agreements where the lessee uses the equipment for a period of time in return for regular payments to a third party (lessor). Leases come with a purchase option that can be exercised at the end of the lease period.[70]

Along with Net Metering Credit Purchase Agreements, leases provide a means for individuals to access distributed power generation such as solar PV via third-party ownership. The recent entrance of this finance mechanism in the market has helped to spur substantial increases in solar deployment, in both the residential and commercial market segments. Net Metering Credit Purchase Agreements and leases offer consumers a way to afford systems such as rooftop solar with relatively high costs of installation and low cost of operation. In this model, a private firm will arrange financing, then install and maintain the system on a site provided by the consumer who buys the output over some period of time. It is possible in some cases for the consumer to have payments that are less than the cost of the energy displaced. Some companies also allow the customer to purchase the system at the end of a lease term. There are numerous companies offering lease options and power purchase agreements for solar in Vermont.

Revolving Loan Funds

Revolving loan funds (RLFs) are pools of money from which loans can be made for clean energy projects. As loans are repaid, the capital is recycled into another project. Government sponsored RLFs, which may have lower interest rates or longer terms, play an important role with organizations that cannot afford market-rate credit. RLFs 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.

Some RLFs are established as internal finance vehicles such as the University of Vermont's Energy Revolving Fund ($13 million), Middlebury College RLF ($1 m), and Vermont State Colleges Green RLF ($2 m). Others can be accessed by outside applicants. In 2013, Green Mountain Power established the Evergreen Revolving Fund for the former CVPS territory as an initiative under the Community Energy and Efficiency Development (CEED) Fund. The Evergreen Fund provides interest-free capital for investment in energy efficiency projects in K-12 schools and municipal buildings featuring on-bill financing through GMP. Loans are structured so that the value of the annual energy savings from the

[70] *Leasing Arrangements, Office of Energy Efficiency & Renewable Energy, U.S. Department of Energy, http://energy.gov/eere/slsc/leasing-arrangements; Accessed August 14, 2015*

project equals or exceeds the annual loan repayment amount. Loan repayments to the CEED Fund are used to support the next round of projects in additional schools.[71]

The State of Vermont supports RLFs for energy upgrades through the State Resource Management Revolving Fund (SRMRF) and the State Energy Revolving Fund (SERF) managed by BGS. The SRMRF, formed in 2004 with $1.5 m of capital, 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 can 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. Applications for this fund are received, reviewed, and monitored by BGS staff, and 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. The SERF, created in 2014 via Act 178, has an $8 million credit facility established by the State Treasurer. The credit facility is available for the purpose of financing energy efficiency improvements and the use of renewable resources anticipated to generate a cost-savings to the state.[72]

Until recently, the CEDF provided loans through its RLF for renewable energy projects. As of 2015, the CEDF was receiving payments from loans made previously and re-using these funds for other program activities.

6.7 Challenges and Opportunities

Expanding the amount of clean energy in Vermont is going to take a substantial amount of investment of time and financial resources to achieve state energy goals. Numerous challenges and opportunities lie along the path toward that goal. Among the challenges include:

- High upfront costs for renewable energy and energy efficiency investments impede projects;
- Low deal flow;
- Patchy understanding of the technical, financial and market risks involved with financing and investing in clean energy in the state;
- Immature markets for clean energy investment needed to replenish capital resources;
- Lack of sufficient public resources needed to support new public-private financing mechanisms and institutional arrangements;
- Patchy coverage by financial products in market segments across the state;
- The potential end to the federal Investment Tax Credit.

As the state marshals resources, several opportunities form a silver lining:

- Transitioning from an incentive model to a combined incentive-plus-finance model will leverage substantial amounts of private capital to support new renewable and energy efficiency projects.

[71] *Community Energy & Efficiency Development Fund 2015 Annual Plan, Green Mountain Power. November 14, 2014; Pgs. 10-11*

[72] *Act 178 of 2014, Section 41*

- Supporting investment in clean energy projects offers the prospect for a vibrant clean energy industry with thousands of well-paying jobs.
- Replacing expenditures on fossil fuels which largely leave the state with local investments will retain resources in the state's economy.
- As national clean energy financial markets evolve and mature, Vermont will be poised to participate as appropriate to the state's scale.

Strategies and Recommendations

Vermont has made considerable progress in advancing clean energy since the 2011 CEP was released. However, there are substantial hurdles, both within the state and in the broader finance and investment universe that must be overcome to bring sufficient financial resources to bear. Some of the recent progress has been incremental and some has been a change to the fundamentals of energy financing, with the introduction of new legislation and new finance programs for energy efficiency and renewables at small scales coupled with increased coordination between governmental and non-governmental actors. Over the next five years, the CEP puts forward the following strategies to advance finance for clean energy in the state, and recommends the following priorities for implementation.

Finance Sub-Goal – Increase the use of affordable financing to accelerate progress toward the 2050 goal of 90% renewable energy

Strategy One: Building on existing and prior initiatives, convene and task a working group of experienced finance leaders with charting a viable pathway towards expanded clean energy financing in Vermont.

Recommendations

(1) *Catalog finance tools currently in use and their effectiveness in expanding renewable energy and energy efficiency.*

(2) *Characterize financing needs in Vermont and review the experience of other states to identify tools and deployment strategies used to expand financing.*

(3) *Continue to engage the public and private finance community to identify options, study the feasibility, develop targets/benchmarks, and generate recommendations to scale up access and deployment of renewable energy and energy efficiency technologies and services using finance in the state.*

Strategy Two: Continue to test and evaluate new finance tools to build local experience and capacity

Recommendations

(1) Focus on continual improvement with finance tools and mechanisms currently in use.

(2) Continue with pilot projects to obtain firsthand experience with potentially scalable finance tools.

(3) Expand the number of companies offering renewable energy and energy efficiency technologies and services with financing options provided by utilities, municipalities, and financial institutions.

(4) Evaluate the effectiveness of renewable energy and energy efficiency technologies, services, and their respective financing tools in meeting accessibility, volume, and acceleration metrics

Strategy Three: Continue using established tools as part of successful financings

Recommendations

(1) Bridge funding to enable the Clean Energy Development Fund to provide incentives, grants and credit enhancements to advance adoption of renewable technologies; continue supporting EVT's incentives for energy efficiency investments; and coordinate both sets of activities to meet near-term needs, acknowledging that stable long-term funding is expected should proposed transmission projects come to fruition.

(2) Continue the State's leadership by example through continued investments in renewable energy systems and energy efficiency upgrades at state facilities.

(3) Support Office of the Treasurer, VEDA and VFDA investments and financing for renewable energy and energy efficiency.

7 Heat for Buildings

7.1 Overview

Thermal Energy Use

Thermal energy use in buildings accounts for approximately 30% of Vermont's total site energy consumption. This thermal use is largely from fossil fuels: fuel oil, kerosene, natural gas, and propane. Biomass (cord wood and pellets, and wood chips in some commercial applications) and bioheat (blend of no. 2 heating oil and biodiesel) makes up a smaller portion of the thermal energy use in Vermont. The residential sector accounts for 60% of the thermal fuel consumption, commercial 29%, and industrial 11%.[73]

Approximately 68 million gallons of heating oil is sold annually for residential consumption. Propane, also referred to as liquefied petroleum gas (LPG), used in space heating, water heating, and cooking, is expected to continue its strong growth. Approximately 67 million gallons of propane is sold annually for residential consumption. Wood is widely used in residential heating in Vermont. An estimated 15% of homes use wood as a primary or secondary heat source. Wood heat has also increased in popularity in schools as a replacement for fossil oil fuel, and pellet use has jumped as small commercial buildings convert to pellet boilers.

Commercial enterprises sometimes use heating oil and propane for space heating, as well as for air conditioning, refrigeration, cooking, and a wide variety of other equipment. Total commercial consumption in Vermont consists of 24 million gallons of heating oil and 43 million gallons of propane.

Industrial enterprises typically use heating oil and propane for manufacturing and almost never for space heating. Industrial consumption in Vermont consists of 21 million gallons of heating oil and 4 million gallons of propane.

Thermal Energy Costs & Efficiency Energy Savings

In 2013, Vermonters paid over $500 million to import and use fossil-based heating fuels.[74] Most of this money left the Vermont economy. Further, prices are expected to continue to rise. These price increases will affect both homes and businesses. The increase in fossil fuel-based prices also creates an opportunity for the adoption of substitute biofuels, such as bioheat. Currently, on a Btu equivalent basis, biofuels are more expensive than fossil fuels.

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[73] *Energy Information Administration.*

[74] *The Residential sector spent $262M on Fuel Oil, $54.2M on Natural Gas, $203M on Propane, and $18M on Kerosene. Energy Information Administration.*

Although weather conditions have always been a factor in Vermont heating, volatile weather effects play an important role in how buildings can cost-effectively be heated. Vermonters have a significant opportunity to save on their heating costs by weatherizing their homes and businesses. Comprehensive and rapid weatherization of Vermont's buildings will bring significant benefits to homes and businesses including: (1) Vermont ratepayers will be less vulnerable to volatility in the fuel market and to effects from dramatic weather fluctuations; (2) more money will stay within the Vermont economy; and (3) Vermonters will reap the health benefits from living and working in more efficient buildings.

Investing in thermal efficiency improvements – primarily air sealing, insulation, and heating system replacements – can dramatically reduce heating energy use in a building and increase affordability. At current fuel prices, thermal efficiency investments in a home can bring significant savings, and the value of those savings continue to increase as fuel prices rise. As each year passes in which investments in thermal efficiency are not made, cost burdens must be borne by individual Vermonters, businesses, and property owners – collectively burdening the Vermont economy as a whole.

A typical Vermont residence heated with no. 2 heating oil will spend around $2,000 to $3,000 annually to meet a winter heating load of around 100 MMBtu. Average commercial building heating loads are somewhat larger, around 120 to 150 MMBtu, and annual fuel oil costs for businesses can be substantially higher. If cold climate heat pumps are used as the primary source of heat, that same level of demand can be met with about $1,500 to $1,600 in annual fuel costs ($200 to $600 of which might be spent on back up fossil heat sources). Advanced wood stoves and central pellet systems are capable of serving this same heating load with between $1,500 to $2,000 in annual fuel costs.[75] An investment in weatherization can further reduce annual heating fuel costs to between $800 to $1,100, assuming a 20% to 30% reduction in heating load, and when done in conjunction with replacement of heating equipment can also reduce overall system capacity needs.

Efficiency Potential

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. However, as unregulated fuel prices have become more volatile and generally increased, fuels that are not regulated, such as fuel oil, kerosene, and propane, 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.

[75] *Average residential heating load is calculated with data from the Energy Information Administration's State Energy Data System. The corresponding fuel costs are calculated using a weighted average price per MMBtu that ranges from $20 to $30. Weights are determined by each fuel's share of the state's total heating fuel use. The $10 range in per MMBtu prices is consistent with the range of retail prices seen since 2013, when the average price of NG has declined from around $15.60 per mcf to $14.30 per mcf, the average price of propane has declined from $2,79 per gallon, to $2.17 per gallon, and the average price of fuel oil has declined from $3.87 per gallon to around $2.30 per gallon. See Vermont fuel price report at http://publicservice.vermont.gov/publications/fuel_report.*

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 2015 on the energy efficiency potential of oil, propane, kerosene, and wood. The study selected appropriate energy savings measures to determine the total achievable cost-effective potential energy savings in unregulated fuels.

"Achievable cost-effective potential" is defined as the potential for the realistic penetration of energy-efficient measures that are cost-effective[76] 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 35.2% for petroleum products, and 16.3% 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.

Exhibit 7-1. Energy Efficiency Achievable Cost-Effective Potential by Sector and Fuel Type (2016)

Sector	Petroleum	Wood
Residential	9.7%	3.8%
Commercial	8.8%	--1.3%
Total	***9.3%***	***-3.3%***

NOTE: The Commercial Wood percentage is negative due to fuel switching to wood heat.[77]

The reported public funding necessary to acquire the savings shown above is significant: around $200 million over 10 years, or $20 million per year on average.[78] This figure does not include program participant costs, which add another $100 million to the overall investment over the next 10 years. The investments were found to provide net present value savings to Vermont of approximately $472 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.

Economic, Environmental, and Health Benefits From Reducing Thermal Energy Use

Fuel switching and weatherization, as discussed above, not only saves Vermonters money but also has broader economic benefits. For example, cord wood is supplied overwhelmingly from in-state suppliers

[76] 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/

[77] The reason commercial wood savings are negative is because the modeling allowed fuel switching into wood and those fuel switching measures were cost-effective enough to actually increase wood consumption to levels that are greater than the baseline forecast.

[78] Assuming a 2% future rate of inflation

whose largest cost is local labor and transportation.[79] Currently there are around 2,500 to 3,500 workers employed in forestry and wood products manufacturing industries. Historically, less than 2% of Vermont workers have found employment in this industry space. A future in which as much as one-quarter of home heating demand is met with biomass sourced from Vermont forests would present far greater opportunities for employment, innovation, and profit in the harvesting, processing, and delivery of wood products.

Investment in thermal efficiency improvements also provides income-earning opportunities for workers and entrepreneurs in Vermont's growing building performance industry. Anywhere from 35% to 50% of the cost of a typical building weatherization project can go to pay wages of locally hired construction labor. Currently there are fewer than 15,000 workers employed in the Vermont construction industry, down from a mid-2000s peak of more than 17,000.[80] According to data collected for the Vermont Clean Energy Industry Report, weatherization activities over this time helped to employ several hundred construction industry workers that would have otherwise lost their jobs as the housing investment boom deflated and the construction share of the labor force returned to its historical norm of around 7%. Today around 1,000 homes are built in Vermont each year. A future in which each year potentially more than 10,000 homes are weatherized, and as many more are outfitted with heat pumps or wood heating systems, will present significant growth opportunities for employment, innovation, and profit in the construction and building performance industry.

It is also important to note that thermal energy use is the second-largest contributor to Vermont's GHG emissions; therefore, curbing emissions will require significant reductions in fuel use in existing buildings. Retrofitting, reusing, and recycling older architecture and historically significant buildings can also substantially reduce GHG emissions in Vermont. According to the National Trust for Historic Preservation, "The construction, operation, and demolition of buildings account for 48% of the United States' GHG emissions." Improving the efficiency of buildings is a critical component in addressing climate change.

In addition to reductions in energy use and expenditures and GHG emissions reductions, thermal efficiency improvements can also provide substantial health benefits. Thermal efficiency improvements typically result in better indoor air quality and comfort levels, with benefits for respiratory and mental health, and reduced impacts of extreme heat or cold on health. Energy cost savings also provide indirect health benefits by improving housing affordability, thereby leaving more financial resources available for groceries, healthcare, and other health-related expenditures.

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[79] *This is not the case for wood pellets, which except for one production plant that employs around 60 workers, are supplied to Vermont retail customers by out-of-state producers. Thus, like for fuel oil, the local employment supported by purchases of pellets consists mostly of retail and distribution operations.*

[80] *Vermont Department of Labor, Federal Bureau of Labor Statistics*

7.2 Challenges of Heating Vermont's Buildings & Achieving Comprehensive Thermal Efficiency

There are a variety of challenges in heating buildings and obtaining comprehensive thermal efficiency improvements in Vermont.

One challenge when it comes to heating a building is the construction of a thermally efficient building shell and the installation of an appropriately sized heating system to meet the demands of the structure. Additionally the more efficient a heating system the more it costs to purchase. For hot water generation there are a number of challenges stemming from fuel availability, size of anticipated hot water demand, and space to install equipment. Initial capital investment costs and payback for the installed equipment are another consideration.

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 older buildings); and need for 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 7.4.

7.2.1 Challenge: Customer Barriers for Thermal Energy Efficiency

Despite significant cost-effective energy efficiency opportunities, consumers regularly underinvest – or don't invest at all – in energy efficiency. There are numerous customer barriers, many of which are summarized below.

<u>Multiple Entities Delivering Efficiency Services in Vermont</u>

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 and adequately serve consumers' needs. 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 for consumers and energy service providers alike. Service 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. There's often an additional hassle if customers want to incorporate both renewable energy and energy efficiency into a project, as there are currently very few companies that can address and/or coordinate both. If customers choose to prioritize installing a renewable energy system before completing all reasonable energy efficiency measures, they may also be paying for a bigger system than they would need if they improved the energy efficiency of their building first. An additional complication is that there are typically separate funding sources for electric efficiency, thermal efficiency, and renewable energy programs, so customers may need to participate in multiple separate programs to address and then receive incentives for different types of measures and system installations. 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.

<u>Split Incentives</u>

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, but it directly effects the affordability of the unit for the renter. Additionally, energy costs may not be disclosed up front to potential tenants, or if they are disclosed it may not be in a format that is easily comparable to other rental property options. This hinders the ability to make an informed decision on choosing a particular rental property based on the *total* costs to live there, versus just a comparison of rent charged. About 29% of Vermont households (74,000 households) are renters.[81] About 47.5% of renters are cost burdened (they pay more than 30% of their household income for housing costs, which includes heating costs).[82] A second example is when building owners are not sure that they will remain in the building long enough to earn a 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.

<u>Up-Front Costs and Financing Access & Aversion</u>

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. Market research conducted in partnership with EVT, VGS, DPS, and the High Meadows Fund in 2012[83], revealed that those who had not participated in these programs perceived the overall or up-front cost of energy efficiency improvements as the main barrier in completing efficiency upgrades. Survey respondents also said that "confidence that estimated energy savings would be realized" would be a valuable program offering to encourage participation. This indicates that people perceive a risk that

[81] "Thermal Efficiency Task Force Analysis and Recommendations: A Report to the Vermont Legislature – Meeting the Thermal Efficiency Goals for Vermont Buildings", Vermont Thermal Efficiency Task Force, January 2013.

[82] "Vermont Housing Needs Assessment", Prepared for Department of Housing and Community Development by Bowen National Research, February 24, 2015.

[83] The market research was conducted as part of an evaluation of the Home Performance with Energy Star Program and the VGS Retrofit Program.

investments in efficiency upgrades won't deliver the promised payback in cost savings. Some financing options currently exist (see Chapter 6 – Energy Financing); 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 the non-energy benefits that result from energy efficiency improvements, such as increased comfort and safety, into decisions to go forward with improvement projects. 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. Some also view higher-cost energy audits as a barrier for customers starting the process towards energy efficiency upgrades. Yet having customers receive information, including a comprehensive roadmap to improve their buildings, is a crucial first step.

7.2.2 Challenge: Lack of Funding to Achieve Desired Thermal Efficiency Improvement Pace

Currently, no comprehensive funding source exists that is large enough to facilitate meeting the state's goals for building thermal efficiency. A variety of entities deliver thermal efficiency services/programs including: the Vermont Weatherization Program (WAP) for low-income residents, EVT, Neighborworks of Western Vermont, and Vermont Gas Systems. Many of the thermal efficiency programs received direct dollars and/or an indirect boost from funding through the American Recovery and Reinvestment Act (ARRA). A total of approximately $34.5 million of ARRA funding was available for energy efficiency retrofits for the period of 2009-12.[84] This enabled a substantial increase in completed efficiency projects and workforce development. However, now that those funds are spent, the number of completed building efficiency projects is decreasing.

Under current conditions, it would take the WAP more than 50 years to weatherize its targeted population. Delaying weatherization for this population places more pressure on other public resources such as the Low-Income Heating Assistance Program (LIHEAP).

For Vermont families not eligible for WAP, as well as for Vermont businesses, thermal efficiency offerings are constrained by funding structures and allocations for thermal efficiency. Moreover, the existing funding sources in Vermont, directed to thermal efficiency (the Regional GHG Initiative [RGGI] and the New England Forward Capacity Market [FCM]) rely on auction revenues that are subject to annual

[84] *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.*

fluctuations. Regulated thermal efficiency programs offered by VGS are available only in its service territory, which is concentrated in the Lake Champlain region.

Meeting Vermont's thermal efficiency building goals will require a significantly increased level of investment compared to current levels of activity. The Thermal Efficiency Task Force (TETF) report included an estimate that $1 billion of both public and private investment would be needed to fully implement the plan set forth in its report and to meet the statutory building efficiency goals by 2020. The TETF recommended numerous policy, program, and regulatory changes to achieve these goals. The TETF estimated that about $267 million in new funding over a seven-year period would be needed (annual program funding was estimated to range from $27 million in 2014 to $39.6 million in 2020) to expand the program infrastructure and incentives offered to motivate homeowners, property owners and businesses to complete the targeted building efficiency improvements between 2013 and 2020. 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. (See Chapter 6 for more information on financing efficiency.) The total public investment (current plus incremental) would leverage $687 million in private financing and investment, a leverage ratio of 1.9 to 1. It is clear that if Vermont is to adequately progress on its thermal efficiency goals, a significant amount of both public and private investment is important for facilitating a significant increase in energy efficiency investment in Vermont's buildings.

7.2.3 Challenge: Insufficient Services for Low-Income Household Efficiency Improvements

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 and financing opportunities for 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.[85] Low-income households are often put in the position of either prioritizing paying for energy expenditures before health related expenditures like groceries, or forgoing appropriate heat or cooling for other expenditures.

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

[85] *"Affordable Heat: Whole-Building Efficiency Services for Vermont Families and Businesses," Regulatory Assistance Project, June 2011.*

they are to remain cost-effective and available for subsidized low-income housing. As mentioned previously, for non-subsidized rental housing where tenants pay the energy bills, the landlord may not be motivated to invest in efficiency improvements because they will not directly benefit from them. This is one reason it has been a challenge for efficiency programs (including the Weatherization Program) to motivate landlords of private rental properties to make energy efficiency improvements on their buildings.

An additional component of this challenge is that lower-income households are less able to access capital and/or take on debt if it is available (many still can't afford even low monthly payments). Although there have been recent attempts to provide subsidized financing for lower-income populations, such as the Heat Saver Loan program, discussed further in Chapter 6 – Energy Financing, this will not be an option for all lower-income households.

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 2014-15 program year, 1,042 housing units received energy efficiency services. It is estimated that there are almost 50,000 households eligible for weatherization services in the state.[86] (See more information in Section 7.4.6.5 – Vermont's Weatherization Program.)

A comprehensive thermal efficiency program needs to address the considerable gap in energy efficiency services and funding available for low-income Vermonters who do not qualify for the existing Weatherization Program.

7.2.4 Challenge: Implementing Efficiency in Older Buildings

Many of Vermont's buildings are old and have not been renovated or retrofitted in many years. In fact, approximately 76,800 homes (30% of the total number of homes in Vermont) were constructed before 1940.[87] Since many of these structures have been built, technology, materials, and best practices have changed. Owners can improve energy efficiency of these older buildings, but like any renovation process, it can seem like a daunting and expensive task. Some of these older buildings are significant, telling the story of Vermont's past – how buildings were used, communities developed, or times changed through architecture and design. The key to a successful project is to understand and identify the character-defining features that tell the story and ensure they are preserved, as well as to understand existing energy-efficient aspects of the historic building and how they function.

Improving a home for energy efficiency may result in the need for lead or asbestos abatement, or other code improvements. One such challenge when implementing efficiency upgrades is the presence of vermiculite insulation with asbestos. Almost all vermiculite insulation used in buildings between 1919

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[86] *Estimate is based on 2010 Census.*

[87] *Eric Phaneuf, Vermont Association of Realtors, Presentation: "Working Group on Building Energy Disclosure," August 2011.*

and 1990 contained asbestos,[88] which can cause significant health risks if it becomes airborne. Inhaling asbestos can cause cancer as well as other lung-impairing diseases.[89] When vermiculite insulation is discovered in a building, it should be assumed to contain asbestos due to uncertainties with testing. If spot testing comes up negative, it does not mean a bag of insulation emptied in another area didn't contain asbestos. Vermiculite is costly[90] to remove and must be done by a certified asbestos abatement contractor. The Vermont Weatherization Program for low-income households recently started a pilot program to address homes with vermiculite insulation. (Previously any home where vermiculite was present was deferred from receiving weatherization services.) See Vermont's Weatherization Program, Section 7.4.6.5 for more information.

When developing strategies for upgrading the efficiency of the existing building stock in Vermont, such as revisions to the energy codes, it is important to consider potential difficulties and limitations for older and historic buildings. For example, the new Vermont Residential and Commercial Standards require historically significant buildings to comply with the standards unless an exemption request is submitted to the State Historic Preservation Office (SHPO) demonstrating that compliance with a particular provision would threaten, degrade, or destroy the historic design, materials, or workmanship of the building. Additionally, the new Residential Energy Standard exempts existing ceiling, wall, or floor cavities exposed during renovations from meeting insulation R-value requirements and instead just requires the cavities be filled with insulation. This avoids setting an unrealistic expectation for upgrades in existing homes that may not have been originally constructed in a way that can easily be brought up to particular R-value thresholds. These are the type of considerations that need to be contemplated when developing strategies for improving efficiency in existing buildings.

7.2.5 Challenge: Fuel Choice and Technology Limitations

Vermont home and business owners are limited in the types of fuel they can choose to meet their energy needs because of existing capital investments and limitations in delivery infrastructure. Energy consumption serves a variety of end uses in different types of processes and buildings. The choice of energy fuel and technology should match end use application and space with the most efficient, renewable, affordable, and stably-priced option that serves the end use fully. For example while wood stoves may adequately heat homes, many commercial spaces require central forced hot air because of their size and the way they are configured. That forced hot air may be powered by an oil furnace or a gas furnace which is more or less efficient.

Once owners invest in equipment to heat a space or manufacture a good, they will generally use that equipment until the end of its life. Even if the fuel that powers that technology becomes more expensive or the price becomes volatile, making business planning difficult, the investment in equipment "locks" the user into a certain fuel type.

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[88] *"Energy Advice for Owners – Historic and Older Homes," National Trust for Historic Preservation, pg. 24.*

[89] *Ibid.*

[90] *Costs range from $7,000 - $12,000.*

Although wood heating may be more affordable in any given year, or natural gas may offer substantial money and energy savings, most users do not have the flexibility to switch between fuels to heat spaces, cool spaces, or manufacture goods. Providing flexibility in fuel choice would require greater capital investment, but may yield substantial money and energy savings in some cases.

Current Investments in Petroleum Infrastructure

In Vermont, many homes and businesses are heated with petroleum products due in part to substantial investments in oil or propane furnaces or boilers. Many manufacturers, which require a great deal of heat energy to be available on demand, have invested in equipment powered by petroleum products. Only a small portion of the state is covered by pipeline-delivered natural gas, so many users to do not have access to this fuel option. In residential heating, 33% of homes are heated with heating oil, 21% with propane, 12% with natural gas, and 33% with biomass or other alternative fuels.[91] In commercial heating the breakdown is 25% heating oil, 29% propane, 35% natural gas.[92]

Investment in petroleum infrastructure at a societal level also hinders fuel choice. From funding highways over railways, to zoning low-density suburbs, public policy at the local, state, and national levels has assumed continued, affordable access to petroleum products. As a result, billions of dollars nationally have been invested in public infrastructure and privately owned equipment that supports or relies on unregulated, petroleum-based fuels. Boosting access to renewable fuels, natural gas, and electric heating and cooling options will take substantial efforts on the part of national, state, local, and private stakeholders.

Petroleum fuels contribute substantially to climate change and to air quality challenges faced by the state. The prices for petroleum products, while currently low, are more volatile than renewable fuels or regulated natural gas. Even the most efficient fuel oil systems are only 92% efficient. Propane is more widely available and benefits from the same high-efficiency heating equipment as natural gas. However supplies can be constrained by heavy demand in the agricultural sector, and price volatility can result from this excessive demand.

When demand for petroleum fuels is high, especially in winter for heating, prices tend to spike, which cuts into the bottom line for manufacturers that rely on these fuels. Moving away from petroleum products to more renewable, efficient, stably priced alternatives in building heating and manufacturing is a policy priority in Vermont, but will be difficult due to existing capital investments.

Tensions in Up-Front Costs and Operating Costs in Fuel Choice

[91] http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_sum/html/sum_btu_res.html
[92] http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_sum/html/sum_btu_com.html&sid=US

Builders match fuels and technologies to their end use applications to make sure that energy needs are fully met. Builders are also balancing the cost of installing a system with the cost of operating it. Initial capital investment costs and payback for the installed equipment are another consideration.

One challenge when it comes to heating a building is the construction of a thermally efficient building shell and the installation of an appropriately sized heating system to meet the demands of the structure. The major components to creating an efficient building shell are sufficient insulation and minimizing the amount of air that escapes while maintaining adequate ventilation to keep the building habitable. For heating systems, the challenge is to install an efficient system that will meet the maximum heat load required for a building but not be oversized. Generally, gas boilers and furnaces are more efficient than fuel oil. Additionally, the more efficient a heating system, the more it costs to purchase. For water heating, there are a number of challenges stemming from fuel availability, size of anticipated hot water demand, and space to install equipment.

<u>Limited Access to Natural Gas</u>

Natural gas offers many advantages, but many Vermont homes and businesses do not have access to natural gas. Natural gas can provide a more efficient, less polluting, more stably priced alternative to petroleum fuels for some users. Natural gas is relatively clean burning and systems can reach as high as 98% efficiency. It is a regulated and stably priced fuel where it is provided via pipeline. Where is it provided via tanker truck, it is an unregulated fuel with price fluctuations driven by the market. It results in fewer greenhouse gas emissions than other fossil fuels.

However, only a relatively small percentage of the state's population (50,000 customers) can access to the natural gas distribution network. Access to natural gas is limited to customers mostly within Chittenden County, so customers with large thermal fuel demands outside this region must use unregulated, petroleum fuels to meet their requirements. Compressed natural gas is a relatively new, unregulated fuel in the marketplace in Vermont, which may offer the benefits of long-term price stability, although prices are not regulated by the state.

In some cases switching from propane or fuel oil to compressed natural gas would lower fuel costs, introduce price stability, and potentially reduce greenhouse gas emissions. However this conversion may not be cost-effective at this time for commercial and industrial thermal processes using other fuel types, because petroleum prices are low. Also, some systems are difficult to convert to compressed natural gas, and others are outside the compressed natural gas delivery area. There may be some processes that are not compatible with using compressed gas as a fuel source.

<u>Limitations of Heat Pumps and Renewable Sources</u>

Although moving toward renewable sources in building heat and manufacturing is a high priority for the state, renewable sources will not adequately meet the demands of some large industrial and commercial users. It is critical that energy needs for these users be met adequately. Particularly in manufacturing, there are few renewable sources that can provide large amounts of heat energy, on demand, at an affordable and stable price. Providing access to a wide variety of fuel choices will allow these users to select the most effective fuel for their particular application.

For space heating, some users may be able to transition to cold climate air source heat pumps. However, that technology has its limitations and drawbacks as well, such as a current inability to meet maximum heat load demands during extreme low temperatures experienced in the state. A study recently commissioned by the DPS is currently evaluating the effectiveness, cost, and efficiency of heat pumps in meeting needs for space heating and cooling.

<u>Health Impacts of Fuel Choice</u>

Fuel choice also has important implications for health. Energy is critical to protecting the health of Vermonters who use energy in heating, air conditioning, and medical care. Some types of energy consumption also negatively impacts health because they can worsen indoor and outdoor air quality, and lead to climate change.

Both indoor and outdoor air quality are influenced not only by the choice of fuel but also by the equipment used, and any installed mitigation measures, such as catalytic converters. For all fuels, choosing modern, efficient equipment with high standards for mitigation is important. Having access to fuel choice is important to protect vulnerable individuals who have special needs for cleaner burning options due to health issues such as asthma.

Electricity in particular provides services critical for health, including air conditioning, which is an effective mitigation option for reducing heat-related health impacts, especially for vulnerable individuals such as older adults or the chronically ill. As the climate warms, providing reliable ways to cool buildings will become more important to protect vulnerable individuals. Vermont should strive to provide critical building-cooling services while keeping peak electric demand as low as possible. Some strategies to address this issue are choosing the most efficient technologies possible, whether heat pumps or AC units, and passive cooling strategies such as shade, ventilation, cool roofs, urban forestry, and minimizing impervious surfaces.

7.3 Goals

<u>Building Efficiency Goals</u>

The following building efficiency goals were established in the 2007/2008 Vermont legislative session through Act 92 (10 V.S.A. § 581):

(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 Fund.

Since the enactment of this law, Vermont has made some progress but is behind pace in achieving the goals. Energy efficiency was improved in just under 18,300 housing units as of 2014, leaving an additional 61,700 housing units (or 77% of the total) to complete by 2020. The PSB was directed in Act 89, passed in 2013, to establish annual interim goals starting in 2014 to meet the 2017 and 2020 building efficiency goals. In February 2014 the PSB issued an order establishing the following annual goals:

	2008-2013	2014	2015	2016	2017	2018	2019	2020	TOTAL
# of units	17,000	8,864	10,512	11,402	12,224	6,666	6,666	6,666	80,000

Through 2013 15,683 units were completed, which was well off the mark of the first interim goal. In 2014 2,609 units were completed, again significantly short of the established goal.

Act 89 also required the PSB to monitor and select a methodology for tracking progress toward the building efficiency goals. The DPS formed a Working Group to make recommendations on how the tracking should be conducted. The Working Group recommendations included:

- Projects from the Home Performance with Energy Star program, the VGS Home Retrofit program, the Weatherization Assistance Program, and the Vermont Fuel Efficiency Partnership ("VFEP") program will be tracked to monitor progress toward the goals.

- Tracking and reporting will focus on the 25% average reduction in fuel use and not on a reduction in fuel bills.[93]

[93] *Due to the difficulty in measuring fuel bill reductions given such factors as price volatility, uncertainty associated with predicting future fuel costs, and fuel switching. The working group further argued that a focus on fuel bill reduction might have the consequence of promoting the pursuit of near-term cost reductions instead of long-term energy savings.*

- Fuel use reductions will be reported at the household unit level, for projects completed in the reporting year, using actual fuel usage data when available and reasonable estimates when fuel usage data is unavailable.[94]

- Project reporting will include incentive amounts, total project costs, and carbon emission reductions. Both comprehensive shell retrofits and equipment-only replacements will be reported, but only comprehensive projects will be counted toward the savings goals.[95]

- Programs will report the individual household unit fuel savings, including those achieving less than a 25% reduction, as well as the average fuel savings of units completed across the entire program. Progress toward meeting the goals will be determined based on the average achievement across all four efficiency programs.[96]

- The DPS will file project and program savings from the five program administrators annually with the PSB.

All the Working Group recommendations were approved and adopted by the Board on 4/23/15.

Completing the weatherization of the remaining 61,700 housing units will require a significant ramp-up of thermal efficiency programs and services, and of private investment. For the state's other building efficiency goals to be met, an additional significant ramp-up of energy programming will need to be put in place for weatherization projects with commercial and industrial customers that use unregulated fuels. It is important to note that these customers have had a relatively low number of efficiency services available to them to date.

<u>90% by 2050 Related Targets</u>

The definition of the 90% by 2050 target in the 2011 CEP did not directly include energy efficiency. The 2015 CEP has established a complementary goal of reducing total energy consumption by 1/3 or more by 2050 from our current level, through increased efficiency in energy production and use.

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[94] The working group recommended that program administrators report the average fuel usage reduction for projects completed annually and not attempt to track projects that span multiple years as not all program administrators have the ability to track projects over multiple years and would incur potentially significant costs to do so.

[95] The working group contended that while equipment-only retrofits may achieve significant fuel savings (over 25 percent reduction), they do not appear to meet the statutory intent of comprehensive savings.

[96] Under this approach, the number of housing units determined to be meeting the annual goal would include: (1) individual housing units with a 25 percent fuel reduction or greater; and (2) any additional individual housing units with fuel reductions less than 25 percent that still result in an average reduction of 25 percent or greater across the four efficiency programs. The working group contends that the achievement of goals based on average fuel usage recognizes that completion of a comprehensive project may in some instances result in less than a 25 percent reduction because the calculation of any net reduction depends on the cost of the efficiency measures and the existing building energy efficiency level.

Other goals for heat used in buildings and industry include: 30% of heat from renewable sources in buildings and 25% in industry, recognizing that heat is distinct from other (almost entirely electric) end uses in both buildings and industry. An energy service goal, such as these heat goals, could include both electric and non-electric means of delivering that service.

One possible mix that the Department has estimated would likely meet the goals for renewable energy by sector is as follows:

- Buildings - 30% renewable heat could look like:
  - Maintain electric use for purposes other than heat at current level (while the number and total size of buildings grow).
  - Improve the energy efficiency of building shells so that the required heat delivered falls by 14% on average.
  - Use 35,000 cold-climate heat pumps (using an assumption that each displaces the equivalent of 350-400 gallons of heating oil per year and the electricity serving the heat pump will be on the trajectory of 90% from renewable sources by 2050).[97]
  - Increased use of renewable bio-derived fuels by 20%, though a mix of increased use of wood and liquid biofuels blended into heating oil. (If this were met only with wood it would imply a roughly 20% increase in the use of wood for heat; if met with liquid bioheat it would imply the use of bio blends on average between 8% and 10%.)
- Industry - 25% renewable heat could look like:
  - Increase electric use for purposes other than heat by 10% (while production grows by more than 10%).
  - Maintain the current demand for heat.
  - Increase use of renewable bio-derived fuels by 35%, though a mix of increased use of wood and increased use of liquid biofuels blended into heating oil. (If this were met only with wood it would imply a roughly 35% increase in the use of wood for heat; if met with liquid bioheat it would imply the use of bio blends on average of between 8% and 10%.)

7.4 Strategies and Recommendations

This section discusses a suite of strategies, including programs, that have a goal of reducing demand for heating fuels and/or switching to renewable fuels, including building energy standards and an enhanced Weatherization Program that complements a statewide thermal efficiency program. The strategies should lead to a reduction in both energy expenditures and emissions.

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

[97] *This may change based upon results from the year-long DPS study on the use of heat pumps in Vermont.*

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. Program incentives, and more recently low-interest loans and on-bill financing, have also spurred investment in energy efficiency among unregulated fuels. Although this chapter of the CEP discusses thermal renewable energy and energy efficiency; the DPS believes all energy investments should be considered holistically.

7.4.1 Comprehensive Building Efficiency (Buildings as Systems)

Achieving the state's ambitious goals for energy efficiency and 90% renewable energy by 2050 will require an integrated approach and new policies for whole-building approaches using simplified mechanisms that include easy access to incentives and 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 energy improvements in a simple, hassle-free manner. At the same time, coordination among the many stakeholders involved with efficiency delivery as well as renewable energy services and programs will need to be strengthened to meet the state's goals. However, a balance may need to be struck between comprehensive whole building projects and customers desire to tackle projects in smaller, more affordable pieces.

7.4.2 A Whole-Building Approach

A whole-building approach 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 EVT, Burlington Electric Department (BED), and VGS. EVT and BED focus primarily on electric savings, given that their mandate is to acquire electric resources and their main funding source is electric ratepayers. VGS was recently appointed by the PSB to serve as the natural gas energy efficiency utility in their current service territory, although they've been operating efficiency programs for many years. There are also separate program offerings for renewable energy systems. Despite the offerings of programs at these entities, there is still only a small amount of funding currently available for thermal measures. Yet, thermal measures represent a majority of the energy savings opportunity in many buildings (particularly homes). The result is that much of the potential energy savings remains unaddressed.

The state Weatherization Program for low-income residents is one state energy efficiency program that has succeeded in a whole-building efficiency 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, or 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 for efficiency can be taken even when a variety of funding incentives and opportunities are utilized. The program will also soon be piloting a new initiative to install wood pellet stoves in residences that have recently received, or are in the process of receiving, weatherization services. Wood pellet stoves will be installed if the characteristics of the home and the clients meet certain criteria. The program will be evaluated through post-installation phone interviews and review of pre-and-post heating bills (after one full heating season).

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. EVT 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 serve as many buildings as will be needed to meet the Act 92 goals.

Additionally, in partnership with EVT and the Home Performance with Energy Star program, Neighborworks of Western Vermont (NWWVT) serves Rutland County residents with efficiency services. NWWVT has partnered with multiple organizations, including Green Mountain Power, EVT, local banks and colleges, local government and planning organizations, and community resident volunteers, to initiate intensive marketing and awareness efforts, 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 for consumers and energy service providers alike.

The Thermal Efficiency Task Force report made the following recommendations regarding collaboration and coordination among program implementers and service providers.

- Build the industry. Develop partnerships to encourage heating service companies, building performance contractors, and renewable energy installers to work together to provide customers with a comprehensive roadmap for improving their building energy use.

- Leverage the existing home improvement market to promote comprehensive solutions. Consumers could be making more effective (and cost-effective) decisions if energy service providers could be coordinated to "upsell" more energy efficiency services at the same time, particularly high-quality air-sealing

- Program implementers should offer recognition and benefits to service providers who meet high standards for technical excellence and comprehensiveness.

- Make it simple for consumers. Implement a statewide clearinghouse for easy access to information on consumer-level energy improvements and provide coordination across thermal efficiency programs and providers.

EVT has created an "Efficiency Excellence Network" (EEN) to encourage contractors to identify and promote energy efficiency equipment and opportunities in their work.

The Efficiency Excellence Network (EEN) is a designation given to participating residential contractors that meet additional EVT training requirements. EEN contractors are experts in discovering energy saving opportunities that help guide Vermonters to make effective energy saving improvements.

Benefits for EEN participating Contractors include: Promotion of EEN contractors by EVT; marketing resources and materials; training and support; and leads and referrals.

All EEN fuel dealers receive training in home efficiency, to enable them to conduct home energy checkups and provide advice to customers looking for ways to reduce their heating bills. Additionally, full service fuel dealers collaborate with energy efficiency contractors, who are qualified to provide more in-depth guidance on energy usage, and complete comprehensive home energy projects. All comprehensive projects completed through EEN contractors and EVT's programs are eligible for incentives from EVT.

Recommendations

(1) Improve program delivery so that from the consumer's point of view, a smooth, "one-stop" approach to energy projects occurs.

(2) Consider the best mix of funding, financing, and informational approaches to achieve the building efficiency goals established in statute and in this plan. Identify stable sources of public and private capital for the required funding and financing mechanisms. Consideration should be given to funding programs from sources tied to the impacted fuels. The funding and financing should be adequate to, and be designed to, address the needs of both low-income and moderate-income populations as well as to address barriers faced by those who do not need incentives but still need information or access to capital 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) Continue to work on coordination and partnerships between heating service companies, building performance contractors, and renewable energy installers to provide customers with a comprehensive roadmap for improving their building energy use.

7.4.3 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 buildings." 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 PV and wind. A challenge in allowing for off-site renewable energy is how to track and ensure that those resources are sufficient and 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. [98] 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 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 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.[99] Massachusetts is in the process of piloting 44 net zero homes as proof of concept and in 2014 created the Massachusetts Pathways to Zero Grant Program, which offers grants to people constructing net zero buildings. Massachusetts's proposed model may fit well here in Vermont.

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[98] *Richard Faesy presentation, "The Vermont Comprehensive Energy Plan to include net-zero energy by 2030," June 2011.*

[99] *"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*

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 should 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[100] 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.

7.4.4 Opportunities in Fuel Choice and Technology

As discussed in the "Fuel Choice and Technology Limitations" section of this chapter, Vermonters do not have the flexibility to switch between fuels to respond to changing prices or environmental performance objectives because of existing capital investments and limitations to infrastructure.

To respond to this challenge and improve access to fuel choice, the state plans to encourage use of the most efficient, renewable, and cost-effective technology that will meet users' end needs. This includes implementing rigorous building standards in new construction, reducing heat loss in existing construction, and encouraging the adoption of renewable fuels in building heat and cooling as well as in industrial processes.

Specifically, the state plans to deploy 35,000 cold climate heat pumps, improve access to renewable bioenergy, invest in thermal performance and efficiency, and move users away from petroleum to natural gas where fossil fuels are still necessary. In applications where wood or sustainable biofuels are not appropriate, natural gas is being used to move away from petroleum products, and pipeline gas is not available or planned, compressed natural gas transported via tanker truck may offer economic and environmental advantages for large commercial, institutional, and industrial users.

Builders and building managers must balance a variety of objectives and limitations when making capital investment and design decisions that affect fuel type. For all fuel types, when possible, builders and building managers should choose the most efficient system to deliver heating and cooling. This decision should be based upon anticipated needs, including any plans for increase in demand in the future, the

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[100] *EVT'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.*

cost and environmental performance of available fuels and technologies, building layout, upfront capital costs, operating costs, and maintenance expenses.

7.4.4.1 Residential Recommendations

In the residential sector, expanding fuel choice means increasing homeowners' access to technologies that allow the use of renewable energy sources, decreasing dependence on non-renewable energy sources, and increasing the overall thermal efficiency of building shells and heating systems.

In new construction, improved building codes as well was voluntary stretch building codes are an effective leverage point for ensuring efficiency and providing fuel choice. For example, a well-insulated building with passive heating and cooling measures, a heat-pump, and back-up efficient modern wood heating will provide a variety of options for homeowners. This example illustrates how homeowners should be able to meet their energy needs by "flexing" between passive, electric, and wood sources for heat and cooling depending on their needs, price, the weather and other factors.

New construction should take advantage of technologies such as heat pumps, both ground and air-sources, and biomass pellet systems to decrease overall energy use. When coupled with efficient construction and renewable generation, these buildings can be highly cost effective to operate.

Improving access to fuel choice in existing residential structures is a particular challenge due to the age and condition of Vermont's housing stock. As heating and cooling systems reach the end of their useful life, homeowners should choose to replace systems with the most efficient and renewable system available. Efficient and renewable systems, for example a well-insulated house heated with a pellet stove and thermal storage, are generally more expensive up front but less expensive to operate and therefore often have lower total lifetime costs. Another major leverage point for existing homes is improved disclosure about energy performance at the time of sale.

For existing homes, the timing of intervention is particularly important. Incentive programs must reach the homeowner at the time they are considering a replacement for their existing system or major renovations. When retrofitting buildings, contractors should conduct an energy audit and determine where best to save energy; in some cases it may be through a combination of thermal shell improvements and replacing outdated HVAC equipment. Cost drives decisions about retrofitting, so improvements may need to be spaced out over several years depending on financing. In these cases, thermal shell improvements should be carried out first if possible. Improving access and terms of financing for energy-related renovations is an important component of the state's strategy for fuel choice in existing homes. See Chapter 6 for more details about the state's plan for energy financing.

Builders and homeowners should strive to select technologies that, first and foremost, meet their end use objectives, but also take into account environmental performance and renewability. The following are recommendations specific to particular types of fuel.

Biomass (Pellet): Systems with efficiencies greater than 96% should be installed. These systems can heat space only or include a hot water system. Thermal storage for these systems is recommended.

Air Source Heat Pumps: These systems use electricity to transfer thermal energy for the outside into a home or in the case of cooling to remove it from a home. They are considered to be extremely efficient and have the potential to meet most of the thermal demands of a home. The average efficiency is approximately 240% but this varies due to temperature and could drop as low as 80% in extreme cold. The costs for these systems range for $3,000 to $12,000 depending on the chosen system and number of internal heads. Currently the DPS is conducting a study to evaluate the technology and assess its advantages and limitations when used in Vermont.

Ground Source Heat Pumps: These systems share the same basic technology as air source heat pumps but take the thermal heating and cooling energy from the ground. As a result these systems maintain a high level of efficiency year-round. These are extremely efficient systems for heating a building and will operate in all the extremes of Vermont's weather, they do however require the installation of ducts, so it is more cost effective to install during construction than to retrofit to a building. The system requires significant up-front capital investment, either to install the requisite closed loop piping or the drilling of several additional wells to provide the water for the system to operate. These systems cost $15,000 to $25,000 to install but have a long operational lifetime and maintain efficiency even in low temperatures.

Natural Gas/Propane: Builders and homeowners should choose high-efficiency condensing boilers or furnaces that range between 96% and 98% efficient. These condensing boilers can include on-demand hot water or a thermal storage tank. Generally systems that include thermal storage are more efficient and should be considered first.

Fuel Oil: Systems that range up to 92% for efficient boilers and 95% efficient furnaces should be chosen. These systems should include thermal storage for hot water and be placed to minimize hot water pipe length to reduce heat loss in pipes.

7.4.4.2 Commercial and Industrial Recommendations

Providing adequate and renewable energy for commercial and industrial thermal processes and building heat and cooling is a particular challenge in the state. In order to meet the 90% renewable by 2050 goal, conducting efficiency improvements and developing renewable alternatives in commercial and industrial applications is critical.

Improving fuel choice for commercial and industrial users has many economic and environmental benefits. Most of these processes currently rely on fossil fuels, especially petroleum fuels. Although petroleum products are currently competitively priced, short-term price spikes in winter, as well as longer-term upward trends, create an economic drag on commercial and industrial sectors. The environmental performance of these fuels is also a concern. Many industrial processes require large amounts of energy delivered on demand, which is currently unrealistic for intermittent renewable energy sources.

Firstly, commercial and industrial managers should improve the overall efficiency of thermal processes to lower consumption of fossil fuels while still providing the same thermal energy performance on demand. Secondly, users should consider switching to biomass and/or biodiesel to provide space heating, hot water, and power for industrial processes. Thirdly, commercial and industrial managers should consider installing heat pumps to provide space heating coupled with the use of solar PV to offset increased electric use. Finally the strategic and efficient use of compressed natural gas transported via tanker truck may be the most environmentally and economically appropriate choice for some end uses in some areas of the state.

Developing renewable natural gas, which can generate large amounts of heat on demand, may offer one path toward renewable alternatives in this sector. The state may have a significant role to play in fostering the development of renewable natural gas.

For non-renewable fuels, the thermal potential study identified measures for each non-renewable fuel source, these are summarized below. [101]

Stack heat recovery: Reduce fuel use and cost by recovering heat from flue gases with a stack economizer. This recovered heat can be used to heat to preheat boiler feedwater or ventilation intake air to reduce heating requirements. These systems can reduce heat lost through the stack by up to 80%, increasing the overall efficiency of the system.

Natural gas and compressed natural gas: For natural gas consumers, the DPS's"Potential for Natural Gas Fuel Efficiency Savings in Vermont" report identified measures that were deemed to be cost effective. These can be summarized into three major recommendations: building design focused on energy efficiency, high efficiency boilers/furnaces, and the installation of commercial heat pump water heaters.

Petroleum fuels: For unregulated fuels consumers, the DPS's "Potential for Unregulated Fuel Efficiency Savings in Vermont" report identified additional measures that were deemed to be cost-effective. These have been summarized here into three main recommendations: the installation of indirect water heaters, retro-commissioning of combustion equipment to ensure it is working optimality at all times, and upgrading the thermal shell to reduce heat loss.

Biomass: The "Potential for Unregulated Fuel Efficiency Savings in Vermont" report identified several cost-effective biomass measures. The three main recommendations were: retro-commissioning of combustion equipment to ensure it is working optimality at all times, building design focused on energy efficiency, and upgrading the thermal shell to reduce heat loss.

Fuel switching: There were a number of cross-cutting fuel switching recommendations developed in both the natural gas and unregulated fuels potential studies. These can be summarized as: switching to biomass heating for space heating and switching to heater pump water heaters and solar hot water to offset non-renewable fuel use. The largest potential, for both commercial and industrial customers, is in

[101] *http://publicservice.vermont.gov/topics/energy_efficiency*

reducing their space heating/cooling energy requirements relative to their water heating energy requirements.

Large thermal process heat requirements are best served through a combination of fuel switching, where appropriate, and either the installation and commissioning of high efficiency boilers and furnaces or the retro-commissioning of existing boilers and furnaces.

High Efficiency Boilers/Furnaces for Industry (Process Heat)

Energy efficiency for industrial boilers is a highly boiler-specific. Four factors are critical for assessing energy efficiency in industrial boilers/furnaces. These are fuel type, combustion system limitations, equipment design, and the type of load being served.

The type of fuel used to power the system has the greatest impact on system efficiency. Where pipeline gas is not available or planned, and renewable sources cannot adequately meet demand, industrial managers should consider compressed natural gas to provide process heat when they are installing new systems or substantially renovating existing systems. Natural gas provides lower cost, price stability and reduced emissions. All efforts should be made to incorporate the use of renewables and waste heat recovery systems into the design.

Recommendations

(1) Identify the potential challenges for industry to transfer from traditional unregulated fuels such as heating oil and propane to compressed natural gas. Provide recommendations and potential incentives to promote this move.

7.4.4.3 District Energy Systems

District energy allows residential, commercial, and institutional users in relatively dense towns to be supplied with heating and cooling energy, and power, via underground energy distribution systems. Connection to a district energy network removes the need for individual boilers, chillers, and plant rooms. A range of fossil and renewable fuel-based generating plants can be used to supply the system. These systems can incorporate combined heat and power systems, thermal storage, and heat pumps to maximize the efficiency of the unit's ability to meet both heating and cooling demands well as part of electric demand. These systems can be run cost effectively on biomass, and in some cases, domestic household waste. They require a certain population size and density as well as a high enough total energy demand to make them cost effective.

In Montpelier, a new district heating plant provided reliable, cost-effective heat to over 20 buildings during the 2015 winter heating season with planned expansion in future years. The project was financed with bond money as well as public and funding including support from the DPS.

More information on district heating systems can be found in Chapter 13.

Recommendations

(1) Identify the potential challenges for district energy systems in Vermont and complete recommendations for a clear method to identify potential communities for the deployment of this technology and how to address the first cost capital costs of construction. These recommendations should 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 should work with stakeholders to develop these recommendations.

7.4.4.4 Combined Heat and Power (CHP)

Combined Heat and Power (CHP) plants can be found in two sectors: the electric power sector (plants whose primary purpose is to produce electricity for public sale); and the industrial and commercial sectors (where the CHP facility is usually intended to provide electricity and steam to the host facility, such as a factory). Roughly 65% of fuel energy content entering a conventional electricity generating station is released as heat. CHP systems use most of this heat, increasing total system efficiency to 80% or higher.

CHP application involves the recovery of otherwise-wasted thermal energy to produce useful thermal energy or electricity. CHP's higher efficiency comes from recovering the heat normally lost in power generation or industrial processes to provide heating or cooling on site, or to generate additional electricity. CHP's inherent higher efficiency and elimination of transmission and distribution losses from the central power plant results in reduced primary energy use and lower greenhouse gas emissions. More than 85% of all generating capacity sited at industrial and commercial facilities uses CHP technology.

Industrial applications with constant thermal and electric demand are ideal candidates for CHP. In the industrial sector, CHP is most likely to be found in energy-intensive manufacturing. In the commercial sector, CHP is often used for building or campus heating and air conditioning, such as at college campuses and hospitals.

CHP systems operate with a wide range of fuels. Natural gas, however, is the most common primary energy source used, followed by coal and biomass. CHP systems outside of the VGS distribution system generally use biomass or to petroleum fuels. With the availability of compressed natural gas, industrial and commercial users have the opportunity to implement CHP plants at their locations and access the low prices and price stability offered by natural gas when compared to other fuels.

Recommendations

(1) Identify the potential challenges for CHP systems in Vermont and complete recommendations for a clear method to identify potential customers for the deployment of this technology and how to address the first cost capital costs of construction.

7.4.5 Outreach/Consumer Information

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.

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. (VEIC has released three some 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.

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.

7.4.5.1 Thermal Energy Clearinghouse

Act 89, which was passed in 2013, directed the SB to establish a statewide information clearinghouse enabling effective access for customers and coordination across thermal efficiency programs, per the recommendation in the TETF report.

The Clearinghouse is intended to serve as a portal for customers to access TEPF efficiency services and for coordination among state, regional, and local entities involved in the planning or delivery of such services, making referrals as appropriate to service providers and to entities having information on associated environmental issues.

The PSB opened a proceeding to establish a TEPF statewide information clearinghouse, and issued an Order that established the framework of the Clearinghouse, including a webpage-based portal to enable access to Clearinghouse information and the development and distribution of Clearinghouse promotional materials. In this Order, the PSB required the DPS to issue a request for proposals (RFP\) for expert assistance and technical services necessary to develop the TEPF Clearinghouse.

The DPS issued an RFP, which required applicants to provide a budget that included the costs for the development of a Clearinghouse website and promotional materials, and any ongoing promotional and distribution-related costs. The RFP also specified that the Clearinghouse webpage-based portal include at least the following items:

- A directory of materials about TEPF efficiency and thermal renewable energy services and resources;
- Direct links to qualified service providers; and
- Information/links regarding associated environmental issues.

While the focus of the Clearinghouse is TEPF efficiency, thermal renewable energy shall also be included in the Clearinghouse as part of a comprehensive building approach, in tandem with efficiency, to achieve the state's building efficiency goals.

Other functions of the Clearinghouse include enabling effective access for residential and commercial customers and coordination across programs, serving as a portal for customers to access services, coordination among state, regional, and local entities involved in the planning or delivery of such services, and making referrals as appropriate to service providers and to entities having information on associated environmental issues.

Other objectives for the Clearinghouse include:

- Meet consumers of all types, whether residential or commercial, where they are in the thermal energy awareness and investment spectrum, and connect them with appropriate programs and services.
- Guide next steps and identify available and appropriate technical and financial assistance.
- Enable effective coordination across programs.
- Enable partners, contractors, and customers to keep track of all available rebates, incentives, financing options, and other program services.

To serve the function of the Clearinghouse and to achieve these objectives, the Clearinghouse shall include at least a directory of materials, links, and referrals regarding TEPF and thermal renewable energy resources, services, service providers and entities having information about associated environmental issues.

In addition to providing program- and service-related information that refers customers to these appropriate resources, the Clearinghouse should also elevate consumers' general knowledge about thermal efficiency and thermal renewable energy. To this end, the Clearinghouse shall include general information about thermal efficiency/renewable energy, including but not limited to measure and retrofit options and importance and benefits of thermal efficiency/renewable energy.

Following its review of responses to the RFP, the DPS submitted recommendations to the PSB on June 30, 2015 for selection of a particular contractor to create, promote, and maintain the TEPF statewide information clearinghouse and to establish a $300,000 budget. On 8/21/2015 the PSB issued an Order selecting the contractor and establishing the recommended $300,000 budget for the clearinghouse, as recommended by the DPS.

7.4.5.2 Building Energy Ratings & Labeling

Building energy ratings and labeling can be 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.

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 ratings and labels 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.

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 DOE Energy Star program. One step that has been taken to make energy-rated homes more easily recognized is 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.

Act 89 of 2013 called for the creation of a “Disclosure Tool Working Group” to “develop a consistent format and presentation for an energy rating that an owner of a building may use to disclose the energy performance of the building or a unit within the building to another person, including a potential purchaser or occupant" and to develop or select "one or more tools that can be used to generate the energy rating." Act 89 also required the DPS to submit a report to the Legislature by December 15, 2013, with regard to the development of a residential building energy disclosure tool; and by December 15, 2014, regarding a commercial building energy disclosure tool. The Act additionally required that the DPS submit a report by December 15, 2016 evaluating the use of the tool and recommend whether building energy disclosure requirements should be made mandatory.

<u>Residential Building Energy Labeling Working Group</u>

A working group was formed that included the DPS, EEUs, Weatherization Assistance Program representatives, and other Vermont organizations with an interest in residential building energy efficiency. The Working Group met regularly throughout 2013 and performed a comprehensive assessment and analysis of relevant issues related to labeling buildings for their energy performance. Multiple stakeholders – including Realtors, the regional Multiple Listing Service (MLS) organization, home performance contractors, DOE, and others – were also engaged in reviews of proposed scoring metrics and label designs. Draft building energy labels went out for public comment in August 2013, followed by two rounds of Vermont consumer testing.

The Working Group decided to use DOE's free and nationally recognized energy scoring software to generate the energy ratings to be incorporated into a Vermont designed building energy label. The Working Group focused on developing a label that could simply and accurately convey the energy performance of a home and that could be provided as part of a sale or rental transaction. Multiple scoring metrics and different information that should – and should not – be included on a label was discussed and analyzed. In the end, the Working Group decided four primary pieces of information should be presented on the Vermont Home Energy Score label, which include:

1. An asset-based, total MMBtu /year projected energy consumption score;
2. Projected energy costs by fuel type;
3. DOE's Home Energy Score; and
4. A general description of the home.

An "asset-based" score was chosen to allow for consistent comparisons regardless of who had previously lived in the house and how they had operated it. Projected energy costs were chosen to be included as that was a measure that would be easily understood by all homeowners. Consumer testing validated that including the DOE logo and score gave credibility to the label and also allowed access to the free scoring software tool.

In December 2014, Vermont was awarded a $458,500 grant from DOE to advance building energy labeling, benchmarking, and disclosure in Vermont and New Hampshire through policy, implementation, and stakeholder engagement approaches and creation of a national model for building energy labeling, benchmarking, and disclosure.. These funds have allowed the efforts to implement a residential building energy rating and label to move forward with a goal of having ratings and labels issued to EEU and Weatherization Program participants by the beginning of 2016.

Commercial and Multifamily Building Energy Labeling Working Group

A Commercial Working Group was formed in 2014, made up of the DPS, EEUs, Weatherization Assistance Program representatives, and energy efficiency experts.

The Working Group came to consensus on near-term and longer-term approaches for labeling commercial, multifamily, and mixed-use buildings. Near-term recommendations included:

- Use EPA's ENERGY STAR Portfolio Manager ("ESPM") as the tool to benchmark buildings and generate an energy rating and label;
- Use actual operational energy consumption data, with Energy Use Intensity ("EUI", measured in kBtu/square foot/year) as the primary metric;
- Engage and work with the private sector through EEU programs to deliver and implement benchmarking and labeling services to Vermont building owners and managers.
- The PSB should initiate proceedings to address customer energy data access; and aggregation, standardized formatting, and storage of data.

For the longer-term, the Working Group identified a number of issues that a subsequent Advisory Committee would need to address, including the following:

- Budgets for supporting these recommendations
- Schedule that addresses development, label design, and field testing
- Quality Assurance (QA) provider
- Public Access to labeled building results
- Tenant lease language

As a next step the Working Group recommended convening an Advisory Committee to develop and implement an overall benchmarking and labeling plan to provide coordination between EEUs to develop and test the energy label, develop and coordinate software to generate the labels, and design the storage database.

Efforts to promote and support benchmarking and labeling programs will require a concerted and ongoing focus in order to break into the market, gain awareness, earn recognition, and increasingly drive opportunities to save energy.

Recommendations

(1) Continue the steps necessary to implement both residential and commercial building ratings and labeling in Vermont, including convening the Advisory Committees.

(2) Complete an evaluation of the voluntary building rating and labeling efforts once they've been implemented for at least one year and submit a report and recommendation to the Legislature on whether building energy ratings and labeling should be made mandatory.

7.4.6 Existing Thermal Efficiency Programs and Tools

7.4.6.1 Energy Transformation in the Renewable Energy Standard

One of the newest "tools" for thermal efficiency is the Energy Transformation (Tier 3) requirements of the Renewable Energy Standard (RES) enacted through Act 56 of 2015. These requirements provide an opportunity to bring electric distribution utilities (DUs) as new partners into the building and industrial heat sector. The DUs have obligations, beginning in 2017, to help their customers reduce fossil fuel use – fossil fuels burned for building and process heat are likely to be targets of their actions. DU annual fossil fuel savings obligations begin at a level defined as 2% of their retail electric sales, and rise 2/3% per year, to 12% in 2032 (converted to Btu equivalents as though the fossil Btu were burned in an average power plant).

The PSB has only recently opened a proceeding to establish the rules for the program, so DUs have not yet established partnerships and programs to meet this obligation, and measures such as heat pump retrofits are not yet fully characterized. However, initial analysis can shed some light on the potential of the programs. DPS modeling suggests that the 2% obligation for 2017 could be met through the installation of about 1,100 residential and commercial heat pumps (each displacing the equivalent of about 350-400 gallons of fuel oil), the retrofit of about 500 homes to reduce heat demand by 20% paired with heat pump installation in those homes, and about 700 electric vehicles sold. Each additional year's obligation rises from this level. By 2032, this path would lead to about 45,000 homes weatherized and more than 90,000 heat pumps installed.

DUs bring new kinds of resources, as well. For example, they have ongoing relationships with their customers that can open the door to new ways of marketing energy efficiency and clean fuel options. They can aggregate demand from their customers to buy in bulk. Their monthly bills can be used for on-bill financing or lease programs, potentially including financing that stays with the meter rather than the tenant, thereby helping to address the split incentives inherent in landlord-tenant situations.

Chapter 11 discusses the RES, including Energy Transformation program design, in more detail.

Recommendations

(1) Ensure that all ratepayers have an equitable opportunity to participate in, and benefit from, energy transformation projects regardless of rate class, income level, or provider service territory.

(2) Ensure the coordinated delivery of energy transformation projects with the delivery of similar services, including low-income weatherization programs.

7.4.6.2 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 begin promptly thereafter. The update process consists of review of the new IECC, presentation and discussion of the new IECC provisions at public and stakeholder meetings to gather recommendations for Vermont specific modifications to the IECC, which is then adopted following any modifications made as a result of wider participation in a state rulemaking process.

The DPS updated the residential and commercial energy codes in 2014 (starting the public process in February and adopting the new codes in November), which are based on IECC 2015 and went into effect March 1, 2015. Vermont was the first state to adopt the IECC 2015. The DPS also adopted the first Vermont residential stretch code, which goes into effect December 1, 2015. The DPS was given the authority to adopt a residential stretch code through Act 89, passed in 2013. Act 89 defined "stretch code" as, "a building energy code…that achieves greater energy savings than the RBES" (the base code). There's not requirement for it to achieve a certain percentage of greater efficiency. Act 89 also stated that the stretch code shall apply to all Act 250 projects and that it can also be adopted by municipalities. The DPS has also developed Commercial Stretch Energy Guidelines that will be used by the Natural Resources Board for commercial Act 250 projects. One benefit of having these defined stretch codes and standards is if a municipality wants to adopt an above base code standard, this provides an option that can maintain consistency across the state (versus each municipality choosing different above code standards such as Energy Star or LEED). The same is true for maintaining consistency throughout the state with various Act 250 district commissions.

In addition to more stringent insulation and air leakage requirements, the Residential Base and Stretch Energy Codes also allow renewable energy to be used for the first time to meet the target Home Energy Rating Scores for compliance. There was also a change for historic buildings, which previously was exempt from the energy codes. In the new energy codes, historic buildings must comply with the standards unless a "Historic Building Exemption Report" has been submitted to SHPO demonstrating that compliance with a particular provision would threaten, degrade, or destroy the historic form, fabric, or function of the building. The SHPO will then review and validate the exemption request. This change encourages the implementation of efficiency improvements when appropriate, while allowing for exemptions when necessary, with the goal of an overall improvement in the efficiency of older buildings in Vermont. Additionally, the Residential Stretch Code and Commercial Stretch Energy Guidelines have Electric Vehicle charging requirements.[102] The requirements include having a socket capable of providing either a Level 1 or Level 2 charge for up to 4% of the total parking spaces (the percentage varies in the Commercial Guidelines based on the type of facility).

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[102] *The Residential Stretch Code requires the electric vehicle charging for multifamily developments of 10 units or more.*

There were also changes made to the Residential Energy Code to provide more clarity on the requirements for additions, alterations, and repairs to existing homes. Existing home requirements were condensed into one chapter with further clarity on what was considered “additions,” “alterations,” and “repairs”; what standards needed to be met; and the exceptions for complying with the energy code. Further, only portions of a building that are being altered must be brought into compliance with the code, not the entire building. The new code also specifies that existing ceiling, wall, or floor cavities exposed during renovations do not need to meet the insulation R-value requirements, the cavities just need to be filled with insulation.

As part of the energy code update process, the DPS facilitated an economic analysis on the proposed new residential energy code, with assistance from EVT and input from some Vermont builders. The analysis compared the minimum base requirements for the 2015 RBES to the 2011 RBES for typical single-family new construction. Estimates were completed for the following benefit-cost perspectives: Simple Payback, Return on Investment, Savings to Investment Ratio, and Cash Flow. Across the four benefit-cost perspectives, incremental costs associated with Base Code and Stretch Code, as compared to 2011 RBES requirements ,are offset through the significant energy savings that accrue. The analysis didn’t take into account escalating fuel costs, so saving projections are likely to be conservative, with the payback being lower than estimated.

Below are the four benefit-cost perspectives with weighted energy savings across all 2015 Base and Stretch Code Prescriptive Packages, along with high and low energy cost savings based on various fuel types (which included heating oil, propane, natural gas, and electricity/assuming heat pumps) for each Prescriptive Package.

Simple Payback Results (incremental cost divided by annual energy savings)

- 5.3 years for Base Code (individual fuel-specific scenarios range from 4.3 to 12.4 years)
- 7.4 years for Stretch Code (individual fuel-specific scenarios range from 6.6 to 15.8 years)

Return on Investment (annual energy savings divided by incremental cost)

- 19% for Base Code (individual fuel-specific scenarios range from 8% to 23%)
- 13% for Stretch Code (individual fuel-specific scenarios range from 6% to 15%)

Savings to Investment Ratio (annual energy savings divided by incremental cost, times the lifetime of the energy measures)

- 4.7 for Base Code (individual fuel-specific scenarios range from 2 to 5.8)
- 3.3 for Stretch Code (individual fuel-specific scenarios range from 1.6 to 3.8)

Cash Flow (annual energy savings minus incremental mortgage cost of the energy measures)

- $440 Annual Net Positive Savings for Base Code (individual fuel-specific scenarios range from $68 to $590)
- $591 for Stretch Code (individual fuel-specific scenarios range from $15 to $730)

As shown in the Cash Flow perspective, when the incremental costs for base or stretch code are included in a mortgage, which would typically be the case for most home purchases, there is net positive savings on an annual basis.

Compliance

The energy codes are verified through a self-certification process, which requires the builder – or for commercial structures, builder and architect – to certify that the building was designed and built to code. There is no statewide inspection process to enforce energy codes, but towns that have code officials may conduct inspections for compliance. Building owners also have a right of action to recover damages if the codes are not met.

Municipalities are responsible for receiving and recording the energy code certificates in the town land records; providing energy code information to applicants seeking a municipal land use permit that will include building a structure (if it will be heated or cooled); and receiving a copy of the energy code certificate prior to issuing a certificate of occupancy (if they have a COO requirement).

In 2012 the DPS developed an Energy Code Compliance Plan, which outlines an approach for achieving 90% compliance with energy codes by February 1, 2017. The Plan recommended a number of priorities to advance the state's energy code compliance efforts, including:

- Focus primarily on commercial and residential new construction initially, followed by renovations and remodeling in subsequent years.
- Require that COMcheck (software) documentation be submitted.
- Coordinate efforts between the DPS and the Division of Public Safety.
- Coordination and support of cities and towns code compliance activities.
- Secure funding for up to three full-time positions to support outreach, compliance, and enforcement activities.

Many of the items recommended in the plan have been carried out by the DPS and other partners. Additionally code compliance has been identified as a priority issue for discussion in the newly formed Energy Code Collaborative (see description below).

The DPS has measured compliance with RBES and CBES in the Market Assessments conducted every three years, which were completed in February, 2013 and December, 2012 respectively. The technical compliance rate (meaning the building met the technical code requirements) for residential was 74% and for commercial was 88%. The rate for meeting the administrative requirement of completing and posting the energy code certificates in the building was much lower. However, the market assessment was conducted prior to the requirement that municipalities receive an energy code certificate prior to issuing a certificate of occupancy and its anticipated that certificate completion rates have likely increased due to that requirement. The DPS has started the process to update our Market Assessments, which are expected to be completed December 2015.

Energy Code Collaborative

The DPS started working with the Northeast Energy Efficiency Partnerships to form an Energy Code Collaborative at the end of 2014 and held the first kick-off meeting in May 2015. The Vermont Energy Code Collaborative is a stakeholder group interested in working towards common goals relating to the adoption and compliance of building energy codes. The Collaborative will provide a forum to address stakeholder concerns and find appropriate solutions. Part of the Vermont Code Collaborative mission includes "to facilitate compliance with the State's building energy codes statewide and serve as a reliable and unbiased source for information on building energy codes and code compliance in Vermont." The Collaborative will meet on a regular basis to enable a deeper dive into particular concerns, issues, and the development of solutions.

<u>Training/Outreach</u>

EVT provides trainings to builders, town officials (including zoning administrators and code officials), architects, design and construction professionals, and market partners (real estate professionals, mortgage lenders, appraisers, attorneys) on the energy codes requirements to increase compliance. The outreach to realtors has been particularly successful in making sure energy code compliance certificates are in place as they will require this when representing a buyer of a building before a transaction is completed. EVT, in partnership with DPS, has conducted several trainings on the new energy codes and provided outreach to towns regarding the requirement to provide information on the energy codes when people submit building permit applications as well as obtaining code compliance certificates prior to issuing Certificates of Occupancy. EVT also maintains an Energy Code Assistance Center with a toll free # to provide assistance with the codes, including how to fill out the certificates.

Recommendations

(1) DPS should continue to promptly initiate adoption of the International Energy Conservation Code as it is updated, for both commercial and residential buildings.

(2) DPS should map out a path for Vermont energy code progression to achieve the goal of having all new buildings constructed to net-zero design by 2030.

(3) The DPS should continue to measure energy code compliance rates and work with the Energy Code Collaborative on prioritizing and implementing recommendations in the Vermont Code Compliance Plan to continue to increase statewide compliance.

(4) The DPS should work with municipalities considering adopting beyond base code standards and encourage the adoption of the stretch code versus other standards to maintain consistency across the state.

7.4.6.3 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."[103]

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 Commercial Building Energy Standards, which replaced the Guidelines for Energy Efficient Commercial Construction, as of January 1 2012 and was subsequently updated and enacted on March 1, 2015 (and is also the commercial energy code for the state). The DPS is currently working with the Natural Resources Board to develop Commercial Stretch Energy Guidelines that can be used by Act 250 district commissions to determine what meets the test of "best available technology." For residential buildings, meeting the RBES is considered compliance with Act 250 criterion 9F, until December 1, 2015 when buildings will have to meet the Residential Stretch Code.

7.4.6.4 Energy Efficiency Utilities

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 EVT and BED for the purpose of developing unregulated fuel energy efficiency services. Actual funding from 2010 through 2014 totals approximately $23 million. Forecasted funding for 2015 through 2018 is approximately $19.5 million.[104] EVT and BED file annual plans with the PSB every November on what programs and activities will be undertaken with the funds. Currently thermal efficiency services are offered to homeowners (for existing homes) and to owners of small businesses, multifamily residences, residential rental properties, and mixed-use buildings. In addition, EVT and BED coordinate these thermal efficiency programs with activities funded through the electric energy efficiency charge such as the residential and commercial new construction programs and heating system incentives.

EVT also provides contractor training; quality assurance and marketing assistance for contractors; and maintains a statewide network of certified energy efficiency service contractors on their website.

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[103] *10 V.S.A. § 6086.*

[104] *Forecasted estimate reflects the proposal filed June 5th 2015 which hasn't been approved by the Board to date. The official 2015-2017 TEPF budgets are still the Board approved budgets issued July 9, 2014 (which are $800,000 less).*

Recently, the Vermont PSB also appointed Vermont Gas Systems (VGS) to serve as the natural gas energy efficiency utility in their current service territory, although they've been offering efficiency services for approximately 20 years.[105] VGS provides natural gas service to more than 40,000 customers in northwestern Vermont and offers both residential and commercial energy efficiency programs for new and existing buildings.

Their 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. 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 existing commercial 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.

Recommendation

(1) Work with participants involved in EEU 2015-02 to complete a Transition Period Plan for 2016 and 2017 for the natural gas energy efficiency utility. DPS will propose to the PSB budgets and targets to acquire all reasonably available efficiency resources that are cost-effective.

7.4.6.5 Vermont's Weatherization Program

Vermont's Weatherization Program is administered by the Office of Economic Opportunity (OEO). The mission of OEO's Weatherization Program is "to help low income Vermonters save energy, thus money, by improving the energy efficiency and health and safety of their homes." 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 DOE. This federal funding was augmented in 1990 when the state of Vermont established a permanent source of state funding through the creation of the Vermont

[105] Order in Docket 7676, dated April 20, 2015. In accordance with that Order, the Board commenced a new proceeding EEU 2015-02 to devise a Transition Period Plan to develop short- and long-term efficiency budgets and targets; a process for rigorous, independent verification of savings claims; and mechanisms and a schedule conform the administration of natural gas energy efficiency services to the process currently used by existing EEUs.

Weatherization Trust Fund. This is now called the Vermont Home Weatherization Assistance Program Fund (HWAP). This state funding is financed by a tax of 0.5% on all non-transportation fuels sold in the state (the gross receipts tax). On average, state resources account for approximately 80% of Weatherization Program funding and DOE funds account for the other 20%. In 2009, the passing of the American Recovery and Reinvestment Act (ARRA) resulted in a one-time infusion into the program of approximately $21 million ($16 million Weatherization, $5 million SERC funds) of Weatherization funding over 3 years. After the allocation of the large amount of ARRA funding, DOE raised its allowable job cost average to $6,500, which allowed complete weatherization service to clients. Up until that point, DOE funds had been mixed with state funds to allow comprehensive weatherization.[106]

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 go backs and multifamily eligibility.

Vermont differs from many other states in that the Weatherization Program is administered by the state's anti-poverty agency, OEO. 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 help and assure this important leveraging, in 2014 Vermont became the first State Weatherization Program in the country to refer its clients to the other available Health, Housing and Social Programs. This is done via the One Touch Software to ensure personalized follow up from each Partner Program. The Vermont Weatherization Program funded and implemented this Statewide Healthy Homes initiative to ensure its clients would benefit the most from their participation in the Weatherization Program.

To participate in the Weatherization program, households must meet income eligibility guidelines listed by the OEO – currently 200% of the federal poverty level or less (DOE guidelines) or 80% of the state's median income or less (HWAP guidelines). Eligibility is determined at each regional Weatherization Program Office.

The DOE average budget is now $7,100 per unit (a unit is the same as or another word for a household) for energy efficiency measures, and $1,000 per unit for health and safety measures. The State Weatherization funds allow a budget of $8,500 per unit (total of energy efficiency and health and safety costs). 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 the related health and safety issues.

However, Vermont has some of the oldest housing stock in the country and the low-income folks that apply for Weatherization live in the poorest housing stock in the state. Major structural issues preclude Weatherization at many homes until outside funds or help alleviate the situation. Vermiculite insulation

[106] *Information provided by Geoff Wilcox of the Office of Economic Opportunity.*

is found in 10% of the clients homes that apply for Weatherization each year. Prior to July 2014, this meant deferral of services to anyone with vermiculite due to the high probability of the presence of asbestos in the vermiculite. The Weatherization Program in conjunction with the Department of Health and VHCB's Healthy Homes Program has found strategies to deal with vermiculite. These strategies have been implemented at a handful of clients' homes and paid for with some recent funding from the Vermont Low Income Trust for Electricity (VLITE). This has given hope to many with vermiculite, however the number of Weatherization clients waiting for help far outstrips available vermiculite funding. There are still over 400 families on the vermiculite list, and VLITE funding is only adequate to treat 60-80 of those homes in the next year. The development of the "hybrid" approach / treatment has given an alternative option to abatement at a significantly lower cost, however it is still an expensive endeavor that can't be funded by normal Weatherization funds. More rehab/vermiculite funding is drastically needed or many families in need won't be able to receive Weatherization.

Services provided to clients include:

- An initial visit to the household by an "Efficiency Coach." The coach is the first person in the client's door and explains the Weatherization process, provides home energy conservation "coaching," provides Electrical Saving Measures and strategies, and performs the "ONE TOUCH" Referral Survey. The coach also talks with each household how their "new home" will require different operation to ensure they get the most out of the energy efficiency and health and safety measures installed.

- Comprehensive "whole-house" assessment of energy-related problems. This assessment done by the energy auditor ranks the most important and effective measures to be installed. This ensures the Program gets the "best bang for its buck."

- Installation of energy saving and health and safety measures by each agencies Weatherization Crew. Heating system tune ups, repairs and sometimes replacements are performed by private heating contractors hired by and inspected by the five Weatherization Agencies.

- Testing of every combustion appliance to ensure safe draft and carbon monoxide levels. All issues are identified at the energy audit and then addressed before insulation and air sealing occurs.

- 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.

- Evaluation of the home by the Efficiency Coach for electric savings, and installation of cost effective appliances and lighting. Funded by EVT.

Quality control and 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 Energy Services Program Officer completes a rigorous review of 10% of all jobs reported as complete by each agency. All inspections include an infrared scan and blower door test and interview with the client. 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.

The Vermont Weatherization Program in the last year, has implemented (statewide) a web-based data management system. All five Weatherization Agencies and OEO use this system for daily operation of the Weatherization program. The agencies use the system for all Weatherization activity from eligibility to final reporting to OEO with the system, and OEO has live access to this information. This has improved the efficiency of administering the state and local programs, and allows OEO to use the data and information to better monitor, manage and improve the Weatherization Program.

Vermont's Weatherization Program currently serves approximately 750 units per year (see Exhibit 7-5). The OEO works as a partner with EVT to provide efficiency services to these homes. Every dollar spent on efficiency implementation in these homes has returned greater benefits to customers.

Exhibit 7-5. Funding Sources and Number of Housing Units Served by Vermont's Weatherization Program. Figures are Funds Spent by 5 WAPS and units/households weatherized

YEAR	DOE	WTF / HWAP**	TOTAL	# Units Weatherized
2012-13	$447,003	$10,138,906	$10,585,909	1066
2013-14	$549,443	$11,403,815	$11,953,258	1175
2014-15	$1,015,925	$9,465,957	$10,481,882	1042
2015-16*	$1,000,000	$7,000,000	$8,000,000	751

Source: Geoff Wilcox, Office of Economic Opportunity
* Budget for current year.
** The name "Weatherization Trust Fund" (WTF) was changed to "Home Weatherization Assistance Program (HWAP). Includes GMP funding.

The Weatherization Program has successfully been providing thorough and cost-effective weatherization services to low-income Vermonters for many years. However, thousands of qualifying homes continue to wait in a queue to receive services. Increased funding would also help Fuel Assistance funds go farther for its clients who are prioritized Weatherization service.

Recommendations

(1) Provide housing rehab funds for low income clients who live in and own their homes. These funds are needed to address the many structural issues at low income clients homes such as leaky roofs, excessive

moisture in basements, etc.. These conditions and others prohibit many struggling Vermonters from receiving Weatherization Service.

(2) Provide dedicated funding to help clients who have vermiculite insulation in their homes treat this material to then allow Weatherization to occur at their homes.

(3) Any additional thermal efficiency funding should 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. Investigate 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.

8 Transportation

8.1 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 use and costs to individual households, businesses, and the state as a whole.

Transportation fuels account for the largest portion of Vermont's total energy consumption including more fossil fuels than any other energy source. Gasoline and diesel account for more than 35% of all energy consumed, across all sectors. Petroleum combustion in the transportation sector is also the state's largest contributor to GHG emissions – 47%.[107]

Shifting to renewable and less carbon intensive fuels such as electricity, biofuels and CNG to power cars and truck will have a significant effect on transportation GHG emissions and in reaching the state's renewable energy goals.

Due to the state's rural settlement pattern, Vermonters travel farther from their homes to employment, services, and shops than many other Americans.

Where Vermonters chose to live, work and recreate and the location of commercial services, schools and healthcare and the associated land use patterns affect the transportation system and traffic levels. More compact settlement patterns have been shown to reduce transportation system demand overall by facilitating transit use, biking, waking and other options that have the potential to reduce traffic congestion, emissions and energy use.

In 2013, Vermonters spent almost $1.5 billion to purchase gasoline and diesel fuel and almost 70%[108] of these expenditures left the state for the purchase of these products from the global petroleum market. Reductions in the use of gasoline and diesel purchases reduce the outflow of dollars.

For example, increased ride sharing or use of transit reduce the overall use of energy associated with transportation and the dollar savings are available to be spent within the local economy. When switching

[107] *Vermont Agency of Natural Resources.*

[108] *This statistic is developed in chapter 4.*

from gasoline-powered to electric vehicles, the source of energy changes, locally generated electricity keeps economic activity in Vermont compared to petroleum purchases with a large proportion of petroleum profits going out of state.

Vermonters' transportation choices are often market-based and when it makes economic sense for the consumer. State programs and policies should not interfere with those decisions. When the market is slow to transition to more efficient and renewable transportation options, the additional calculations of public economic and environmental benefits should help policy makers determine the use of public resources.

Moving to a new transportation energy future, one that will reduce the transportation sector's contribution of GHGs in Vermont will require three types of actions under which the CEP's recommendations and strategies are considered:

1. Transportation system energy efficiency through:
    a. Land use and development patterns that reduce commute and other trip distances;
    b. Transit, passenger rail, ridesharing, vanpooling, car sharing, biking, walking, and other transportation options that are less energy intensive then single occupancy automobiles as well as shifting from truck to rail freight; and
    c. Home-based work and telecommuting.
2. Increased energy efficiency through improved vehicle technology.
3. Increasing the use of renewable and less carbon intensive fuels, such as electricity, bio-fuels and CNG.

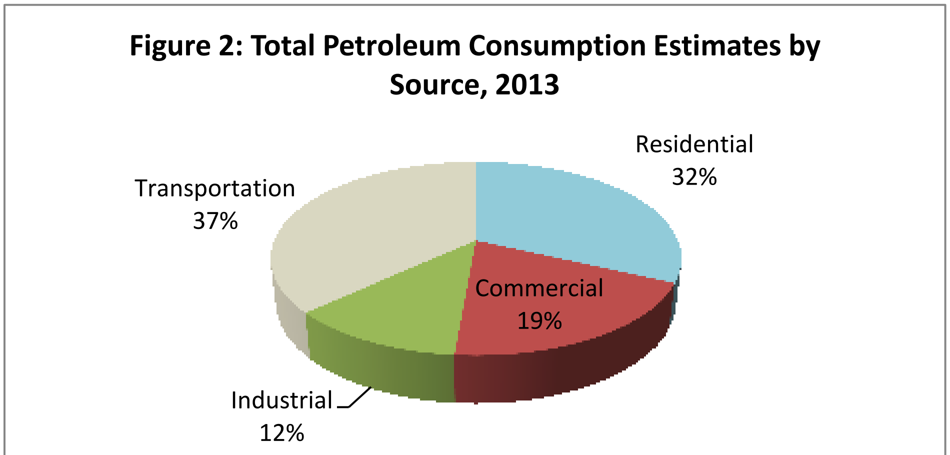
The following pages provide background information on Vermont's transportation energy use, goals, opportunities, challenges and recommendations to advance the actions described above.

8.2 Transportation and Vermont's Energy Use

8.2.1 Petroleum Consumption

The exhibit below shows transportation petroleum consumption in Vermont compared to other uses.

Exhibit 8-1. Use of petroleum in Vermont, by sector



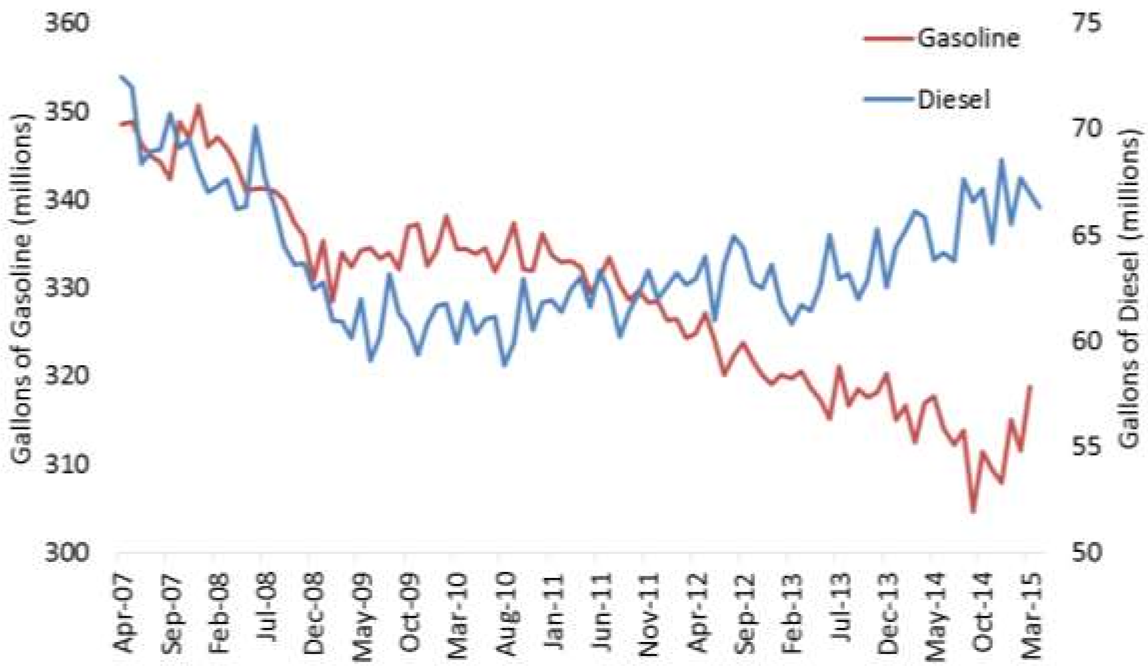
Gasoline sales have fallen steadily since 2007 while diesel has risen, as illustrated in the chart below. The gasoline sales trend mirrors the fall in VMT over this period and reflects improvements in the overall fuel efficiency of the Vermont light-duty vehicle fleet.

Exhibit 8-2. Liquid Fuel Sales in Vermont, 2005-2014

	2005	2008	2010	2011	2012	2013	2014
Gasoline	360	336	332	328	320	318	309
Diesel	67	62	62	62	63.6	62.6	68.6
Biodiesel	0.054	0.392	--	--	--	--	--
CNG	--	0.015	0.025	0.054	0.104	0.143	0.146

Notes: Gasoline, diesel and biodiesel sales are reported in millions of gallons. CNG sales are report in millions of gallons of gasoline equivalent.
Sources: VLJFO, 2015; White, 2009; Vermont Gas, 2015

Exhibit 8-3. Gasoline and diesel sales in Vermont, rolling 12-month total, 2007-2015

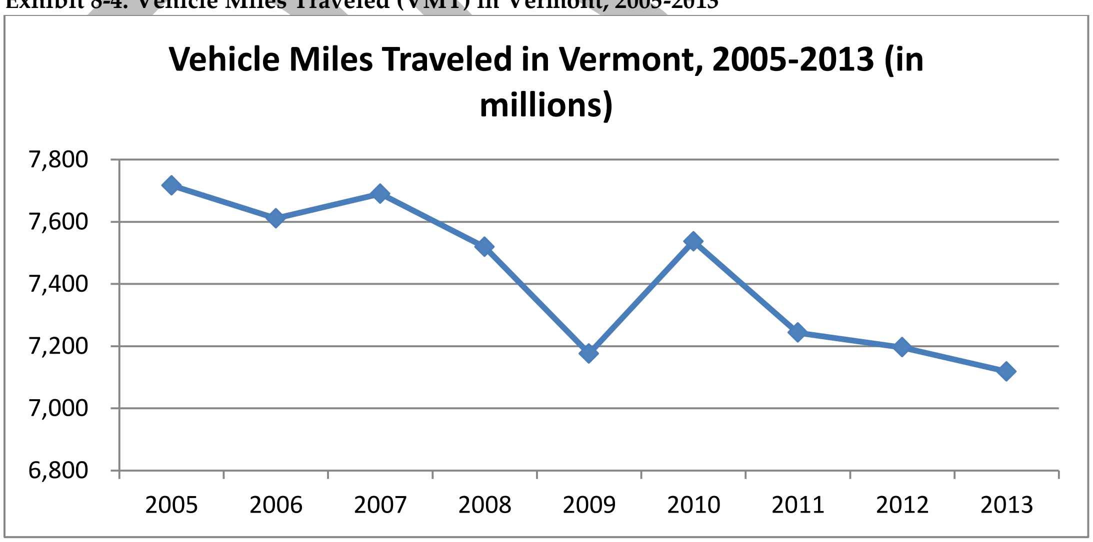


Source: Joint Fiscal Office, 2015

8.2.2 Vehicle Miles Traveled (VMT) - The Number of Cars and Trucks on Vermont Roadways

VMT (Vehicle Miles Traveled) is the number of miles traveled within Vermont and a common measure of all the cars and trucks on the state's transportation system. It is estimated annually by VTrans.

Exhibit 8-4. Vehicle Miles Traveled (VMT) in Vermont, 2005-2013



Source: VTrans Highway Research

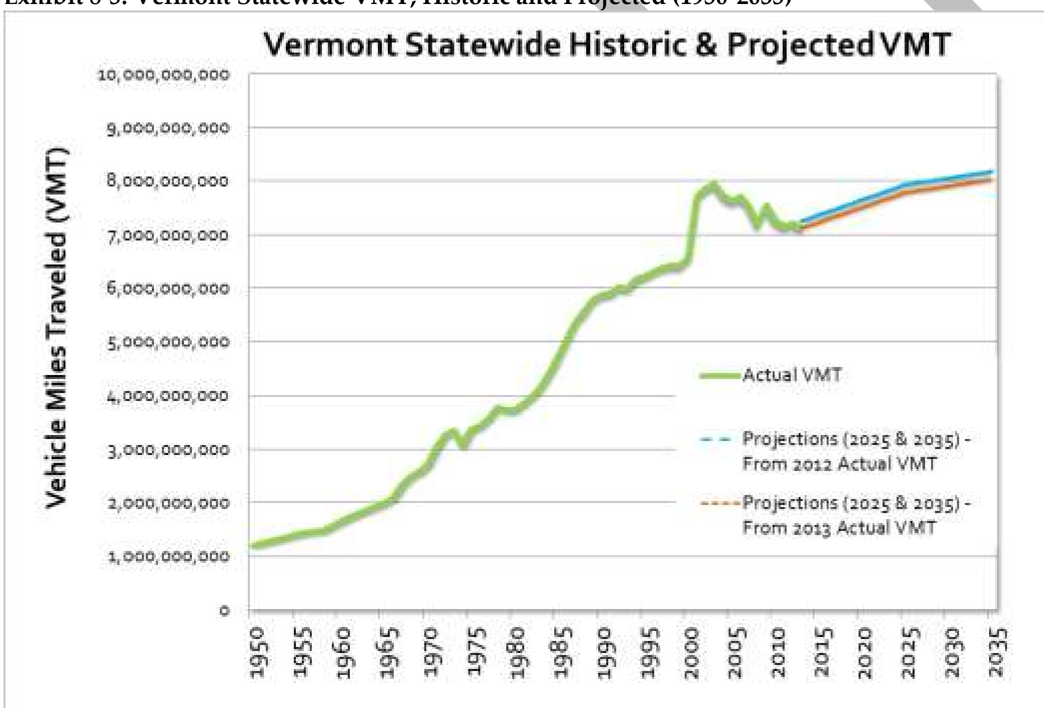
After decades of growth and a doubling of the number of cars and trucks on Vermont roadways between 1975 and 2009 (3.3 billion VMT in 1975 to 7.1 billion VMT in 2009), a VMT decrease of almost 10% has occurred between 2003 and today.

This decline is believed to have been caused by a variety of factors - the economic recession starting in 2008, sustained high gas prices also starting in 2008 that resulted in behavioral changes – people adapted their commute/utilitarian trips (i.e. carpooling, use of public transit, etc.), changing travel preferences, particularly among teens and young adults and the aging population in Vermont. Recent gas price declines may reverse this trend.

As this plan looks to the future, total energy use is going to depend on the future trend VMT. A slower but steady rise in VMT is predicted for the coming years, if current policies and usage trends continue.

Projections are indicated in the graph below.

Exhibit 8-5. Vermont Statewide VMT, Historic and Projected (1950-2035)



Source: ANR Air Quality Division

8.3 Goals for Transportation Energy Use Reduction and Increase in Renewable Energy

Reduce total transportation energy use by 20% from 2015 levels by 2025 – to be accomplished through transportation system energy efficiency and land use and development that reduces daily trips, home-based work and telecommuting, shifting to transit, passenger rail, ridesharing, vanpooling, car sharing, biking, walking and other transportation options that are less energy intensive then single occupancy automobiles, and increased energy efficiency through improved vehicle technology.

Objectives for 2030 based on a 2011 baseline to help assess progress in reducing transportation energy use include:

- Hold VMT per capita to 2011 levels
- Reduce the share of single occupancy vehicle (SOV) commute trips by 20%.
- Double the share of bicycle and pedestrian commute trips to 15.6%.
- Triple the number of state park-and-rides spaces to 3,426.
- Increase public transit ridership by 110% to 8.7 million trips annually
- Quadruple Vermont-based passenger rail trips to 400,000 trips annually.
- Double the rail freight tonnage in the state

Increase the share of renewable energy in transportation to 10% by 2025 and 80% by 2050 by increasing the use of renewable and less carbon intensive fuels, such as electricity, biofuels and CNG.

Objectives to help assess progress in increasing the share of renewable energy in transportation include:

- 10% of the fleet are EVs by 2025
- 10% renewably powered heavy-duty by 2025

Reduced consumption and increased renewables combined to reduce GHGs emitted from transportation by 30% by 2025 to be accomplished by undertaking the strategies above and keeping biofuels carbon neutral.

8.4 Transportation Efficiency through Land Use Strategies

Where Vermonters choose to live, work, go to school, shop, or recreate affects the amount of energy and money that are spent moving across the landscape and thus contributes to the state's total VMT. In order to achieve greater transportation system efficiency, land use and transportation planning must be successfully integrated.

Compact development patterns have the potential to reduce the number of miles between daily travel destinations and also make alternative travel options (walking, biking, car pooling and transit) more viable. Vermont's long standing land use goal is to plan development to maintain the historic settlement pattern of compact village and urban centers separated by rural countryside (24 V.S.A. Chapter 117).

Beyond the energy savings realized by reduced VMTs in compact centers, studies also show that the further away housing is from centers, homes become larger and the housing types are much more likely to be single family homes[109]. According to a study undertaken by Reid Ewing and Fang Rong[110], similar

[109] *Glaeser, Edward L., and Matthew E. Kahn. 2003. Sprawl and Urban Growth. Discussion Paper No. 2004. Harvard Institute of Economic Research.*

households are likely to choose homes 23% larger in less compact areas and 7 times less likely to live in multi-family housing. Compared with households living in multifamily units, otherwise comparable households living in single-family detached units consume 54 percent more energy for space heating. Using a county sprawl index[111], the authors estimate that energy use associated with housing for similar households in compact vs. sprawling counties will be 20% less due to size and type differences. These studies also do not take into account the reduction in electric transmission and distribution losses made possible by compact development.

Planning the state's energy future thus depends on local and regional planning entities planning for development that takes place within a compact, mixed use and thus sustainable land use pattern. While the focus on downtowns, villages and neighborhoods has the potential to contribute to the recent decrease in VMT, 70% of recent housing development is still taking place outside of designated growth areas[112].

Higher density alone is not the answer. Studies have revealed that the biggest determinants in whether or not people decide to walk or bike instead of using an automobile can be categorized as: design, density, destination accessibility, diversity of uses, access to transit and free parking availability[113]. Lowering vehicle miles traveled by getting people out of their automobiles requires investment in careful planning and design that accounts for all these factors.

The Federal Highway Administration presented a report reflecting 2009 travel patterns and at the national level, almost 30% of household vehicle miles traveled were associated with commuting and more than 30% were associated with shopping and other personal errands. About 25% of household vehicle miles traveled were for social and recreational trips[114].

8.4.1 Commute Trips

Driving to work is 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 single occupancy vehicles (SOV) to ride share and other alternatives poses fewer challenges for transportation consumers than shifting trips associated with activities such as shopping or recreation.

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[110] *Ewing, R., Rong, F., 2008. The Impact of Urban Form on U.S. Residential Energy Use, Housing Policy Debate 19(1).*

[111] *Ewing, R., R. A. Schieber, and C. V. Zegeer. 2003. Urban sprawl as a risk factor in motor vehicle oc-cupant and pedestrian fatalities. American Journalof Public Health 93(9): 1541–1545.*

[112] *Source to come*

[113] *Campoli, J. (2012). Made for walking: Density and urban form. Cambridge, MA: Lincoln Institute of Land Policy.*

[114] *National Household Travel Survey, 2009*

Despite Vermont's rural character, a sizeable percentage of work trips (43.7%) are less than five miles from residents' homes[115]. This is good news and presents an opportunity to shift these short work commute trips away from SOVs.

The U.S. Census Bureau performs annual surveys since 2005 that track changes in commuting behaviors. The table below represents Vermont and Chittenden County commuting data.

Exhibit 8-6. Commute trip data for Vermont and Chittenden County (presented as state/county)

	Avg. commute time (min.)	Percent responses >30 min. commute	Percent using public transit	Percent walking	Percent biking	Percent working at home	Percent driving alone
2005	21.2/*19.3*	26.7/*19.7*	0.9/*1.6*	5.2/*6.8*	0.5/*1.3*	5.5/*4.7*	75.8/*74.6*
2006	21.2/*20.2*	27.6/*22.9*	0.8/*1.8*	6.1/*8.8*	0.5/*1.0*	5.4/*3.7*	75.1/*73.8*
2007	21.2/*19.9*	27.6/*22.1*	0.9/*2.1*	6.2/*7.1*	0.5/*1.5*	6.4/*4.9*	74.6/*72.8*
2008	21.9/*19.9*	28.4/*23.8*	0.9/*2.6*	6.3/*8.9*	0.6/*1.7*	6.7/*5.2*	73.3/*71.0*
2009	21.9/*20.4*	28.7/*22.7*	0.9/*2.1*	5.4/*6.7*	0.8/*1.7*	7.2/*5.8*	74.8/*73.7*
2010	21.7/*19.1*	28.0/*20.9*	1.3/*3.1*	5.5/*7.5*	0.6/*1.4*	7.4/*7.4*	74.9/*70.8*
2011	21.9/*20.3*	27.9/*20.1*	1.4/*3.1*	6.3/*7.2*	0.8/*2.0*	6.2/*5.5*	74.3/*72.7*
2012	23.1/*20.4*	30.6/*21.7*	1.2/*2.1*	6.1/*7.6*	1.0/*2.5*	7.3/*7.5*	73.5/*70.6*
2013	22.5/*20.6*	29.7/*24.6*	1.2/*2.5*	5.3/*6.9*	0.9/*2.5*	6.8/*6.9*	75.4/*71.5*

Source: American Community Survey

While many of the trends during this time period are not significant, it is worth noting that driving alone is the predominant mode of travel throughout the state and only bike riding and transit are showing any significant increases. It is also notable that biking, walking and transit commuting are more common in the more densely populated Chittenden County region.

Also during this time, overall population growth rates were higher in Chittenden County than in other parts of the state having two implications. The fact that a greater diversity of transportation options are available to a greater number of residents, along with the attractiveness of more densely populated areas, may be a factor in new Vermonters choosing their homes.

Other than commuting, there is no easily captured statistic to gauge the trends in vehicle use. However, the overall relationship between the rural nature of a state and the increased use of vehicles cannot be explained by commuting alone and a qualitative assessment of travel patterns shows that more rural areas have greater distances to travel for shopping, schools, and appointments. When just reviewing data showing per capita VMT in different Vermont counties, the greater VMT for less densely populated states is apparent. Data reported by the Governor's Highway Safety Program[116] shows that road travel in

[115] *Source to come.*

[116] *http://ghsp.vermont.gov/sites/ghsp/files/Reports_and_Data/County%20Breakdown%20Annual%20VMT%202011.pdf*

Chittenden County is between 10 and 50% fewer miles per capita than other counties. The commuting data (note the "average commute time" statistic) suggests that only a small part of that can be attributed to home-to-work travel.

Many Vermonters travel as a part of their job, not just between home and work, but travel between businesses for sales and service, or courier activities for deliveries. In addition, the bulk transportation of goods, largely via truck but also with train adds a significant factor to the transportation demand in Vermont.

Just as with commuting and daily activity travel, the distance between destinations for commercial transportation is dependent on the density of the businesses and services. While much of the transportation may be between cities and towns, at least a portion of the travel demand has the potential to decrease with greater settlement density.

8.4.2 Strategies

As Vermont looks to reduce VMT, smart growth land use planning is an obvious and valuable tool to get us there.

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 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 24 municipalities that host one of Vermont's designated downtowns account for more than 30% of the state's population.

While changing land use through the planned location of new development is a slow process, the results will last for decades.

Future development that is focused in designated downtowns, villages, and growth areas will reduce the demand for travel miles in the future as well as helping to accomplish the many other goals supported by smart growth including job growth and healthy lifestyles.

The strategies for reducing transportation-related energy are the same as the state's existing set of policies for compact land use.

Supporting policies presented in the 2011 Comprehensive Energy Plan include:

- 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.

- 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.

These supporting policies remain in effect. Lessons learned and successful programs implemented since the 2011 CEP have highlighted other policy and program recommendations:

- Direct additional public sector funds, if and when available, to downtown redevelopment in order to control the long term costs for supporting energy services and infrastructure related to sprawl development.

- Increase funding for Municipal Planning Grants to help municipalities develop integrated plans and policies and Restore Municipal Education Grants. Because all residential development in Vermont is subject to local regulations, helping to improve municipal bylaws to allow for greater densities, better design, diversity of uses and lower parking requirements - all proven to be effective in lowering vehicle miles traveled. ACCD's forthcoming Planning Manual update will help municipalities work towards such improvements and Municipal Planning Grants have continued to prioritize projects that work on the creation of walkable centers

- The state currently invests in several programs that coordinate transportation and land use investments that promote walkable, bikeable environments, including Strong Communities, Better Connections and the Neighborhood Development Area (NDA) Designation Program. Working together, VTrans and ACCD developed a new program, Stronger Communities, Better Connections, which used existing funding to create a joint grant program to help communities coordinate transportation and land use planning and prioritize investments that meet multiple goals. The NDA program has been updated in recent years to focus on increasing housing in walkable neighborhoods and to respond to improvements suggested by local municipalities and developers. Continuing the Stronger Communities, Better Connections and expanding to include ANR in natural resource planning and continued investment in benefits for NDAs would provide support for local communities in helping create an environment where alternatives to SOV are safe and available.

- One of the biggest incentives to drive alone to work in the United States and in Vermont is an enormous untaxed benefit that that most employers offer their employees: free parking. Whether its employers or taxpayers paying for it, parking is of course never free. Studies show that, on average, shifting parking costs from employers to employees reduces single occupancy vehicle use by 25%. Given that most commuters consider free parking a basic right, charging for parking when employees current pay nothing could be challenging. One successful alternative to shifting parking costs is to have employees choose cash instead of a free parking space, a practice known as "cash-out." The State of California has made parking cash-out required for employers with greater than 50 employees. Studies of employers who have switched to a cash-out system have experienced an average VMT reduction of 12%. As the biggest employer in the Vermont, has an opportunity to employ this strategy to help reduce VMTs and should consider a pilot a parking subsidy 'cash-out' program in high demand locations.

8.5 Reduce VMT through Increasing Transportation Choices and Increasing Transportation Efficiency

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.

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.

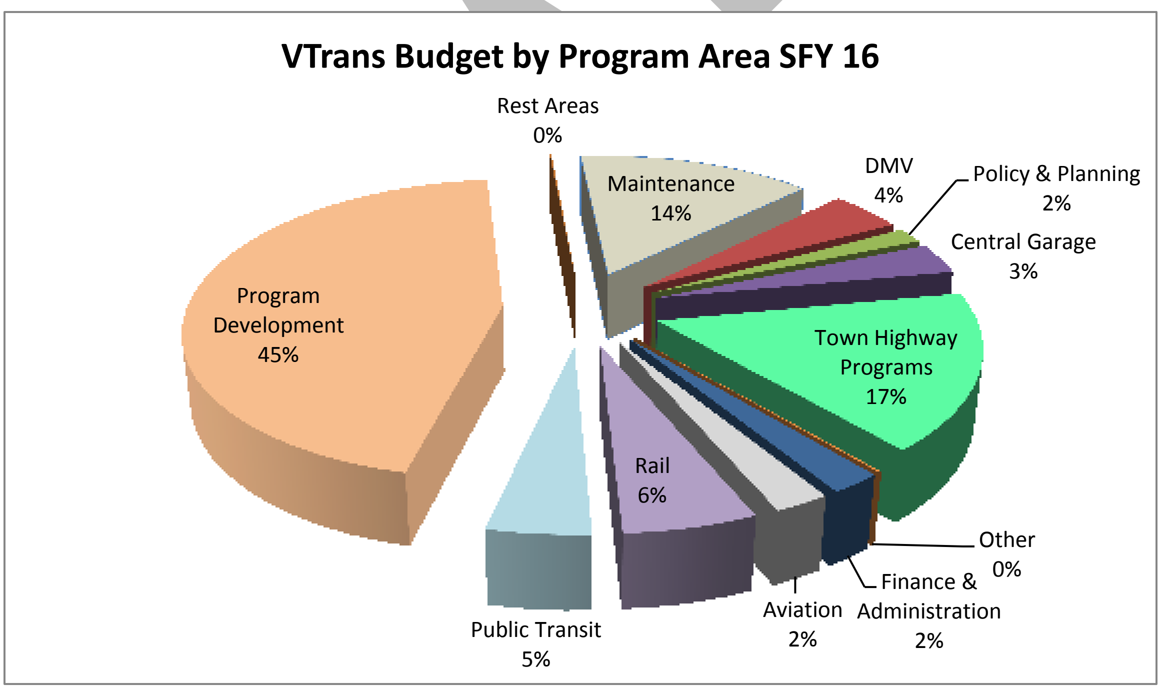
Vermont's transportation system includes:

- 14,266 miles of roadways maintained by the Agency of Transportation (VTrans) and municipal governments, including 320 miles of interstate highways and 765 miles on the National Highway System;
- 601 miles of rail serving both freight and passenger needs;
- 16 public-use airports; and
- 10 regional transit providers that provide more than 100 transit routes throughout the state.

In addition there are infrastructure and services to support biking, walking, and ride sharing and private sector partners including inter-city bus services, Amtrak, taxis, Uber, and other services.

The state investment in transportation is reflected in the VTrans 2016 budget shown in the figure below. This does not include the significant municipal contribution to transportation which is primarily for road and bridge upkeep and maintenance.

Exhibit 8-7. VTrans Budget by Program Area, Fiscal Year 2016



Source: VTrans

Program Development is primarily state roadway and bridge design and construction although a small portion, 2%, is for bicycle and pedestrian facilities.

Transit, passenger rail, walking, biking, car sharing, ridesharing - that are less energy intensive then single occupancy vehicles are a state priority. This priority is reflected in VTrans' strategic vision for: *A* *safe and efficient multi-modal transportation system that promotes Vermont quality of life and economic well-being*. The support has shown results by increasing transit and passenger rail ridership and use of Go Vermont's rideshare services.

Transit options and increased walking and biking paired with smart growth have shown to have economic and other benefits including healthier communities. There are indications nationally that robust passenger services and walkable/bikeable communities are what young people desire and that also have benefits for an aging population.

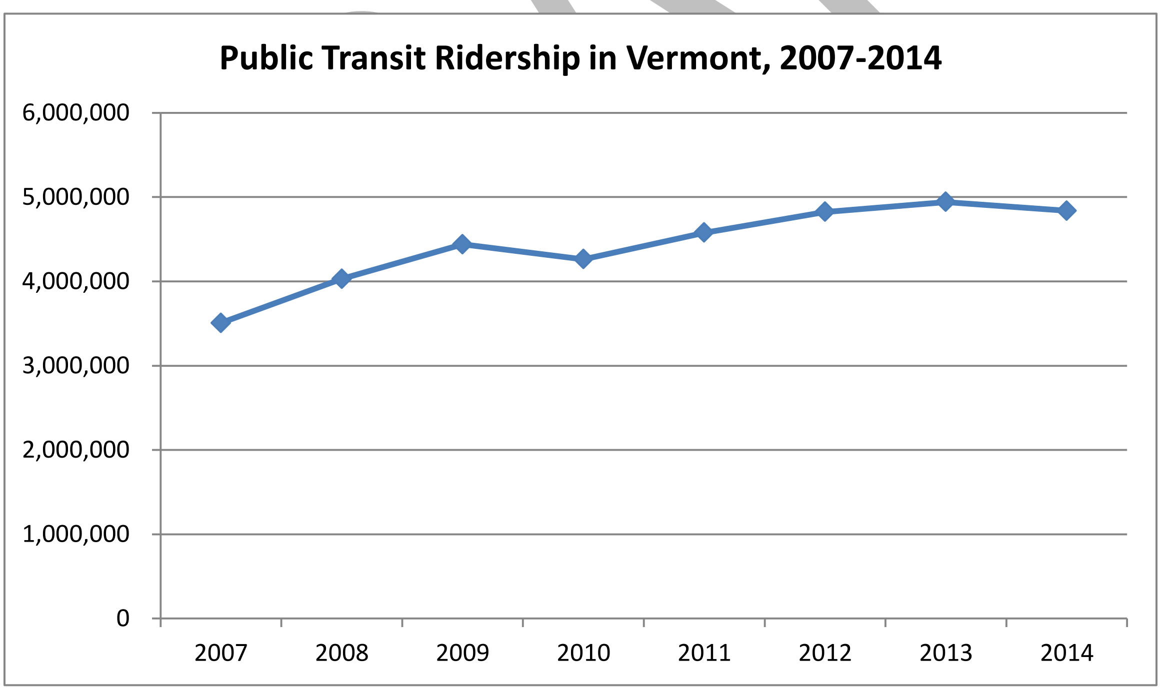
8.5.1 Public Transit

The state spends a generous 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.

Transit ridership trends are indicated in the figure below.

Exhibit 8-8. Public Transit Ridership in Vermont, 2007-2014



Source: VTrans

The State of Vermont will continue its commitment to transit by flexing federal funds, partnerships and innovation and increasing transit investment to areas with the land use density necessary to support it and to key corridors that link commuters to their jobs.

VTrans is entering into partnerships with national companies and groups to move into web based ridership availability platforms both to improve information about available services and to increase the use of available seats in all types of transit. This includes demand response, carpool and vanpool trips as well as possible feeder services to fixed route systems in a micro-transit atmosphere.

In addition, VTrans has made significant investments in upgrading its public transit infrastructure with new maintenance facilities; new dispatch and billing software that will allow the use of AVL (automatic vehicle locators), modern fare collection technology, cross regional ridesharing and stronger coordination; and GTFS mapping of all fixed routes in the state so all available commercial trip planners can provide information on available trips in Vermont.

8.5.2 Inter-City Bus

Vermont leadership, businesses and residents recognized that with the reduction in Greyhound services connecting Vermont to the rest of the bus riding world, more connections needed to be forged. A planning study of the need for Intercity bus service conducted in 2012 identified a number of potential intercity routes which might meet the need of the traveling public. Two of these routes were designed and put out to bid resulting in connectivity to Albany New York from Colchester along the old Greyhound run on Vermont's RT 7. Connectivity across the state was achieved with a connection along RT 4 from Rutland to White River Junction.

With one year of service completed, ridership on RT 7 is meeting projections. Ridership on RT 4 is less than predicted. Expansion is being considered to connect the Northeast Kingdom to the national intercity bus routes. The challenges for the NEK intercity service are those balancing the potential ridership given the low population with the needed investment and the fitting of the right type of service to serve such a rural area. Planning is ongoing on the design of such service. Additional marketing changes are being analyzed to increase the ridership on all services.

8.5.3 Go Vermont, Rideshare, Vanpool, and Car Sharing

Travelers are increasingly demanding easy to navigate tools and information to help facilitate their transportation choices. Go Vermont is a free online public service sponsored by VTrans that provides ride share, vanpool, public transit, and Park and Ride matches in seconds. It also serves as a web-based clearinghouse for Vermont's alternative transportation programs.

There are currently 3,685 registered users in the Go Vermont carpooling program. The average distance for Go-Vermont users' trips to and from their worksite is 45.2 miles. Assuming 20%[117] of the registrants are participating in a carpool, vanpool, or public transit route, the program has resulted in the reduction of more than 9.6 million VMT, savings of $5.2 million in commuting costs, and avoidance of 1.6 million pounds of CO_2 emissions.

The Go Vermont program also subsidizes vanpools for up to $700 per month per vanpool, to offset the per-seat costs of its participants. Participants pay between $60 and $100 per month and enjoy saving more than 60% on their daily commute.

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.

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.

Car sharing is a neighborhood-based, short-term rental service that makes vehicles available on a per-use basis. In 2008, CarShare Vermont launched in Burlington. 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.[118]

Recommendations

(1) *Expand the Go Vermont website and increase its use for events.*

(2) *Research a state pilot program for parking cash-outs to decrease single occupancy vehicle commuting.*

(3) *Continue supporting employer programs to encourage carpooling, vanpooling transit, walking, and biking for employees' commute trips.*

(4) *Continually investigate software and other technology improvements to make taking transit easier and increase rideshare, vanpool, carshare, and other options.*

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[117] *This is the national average calculated by the software provider.*

[118] http://www.carsharevt.org/green-benefits

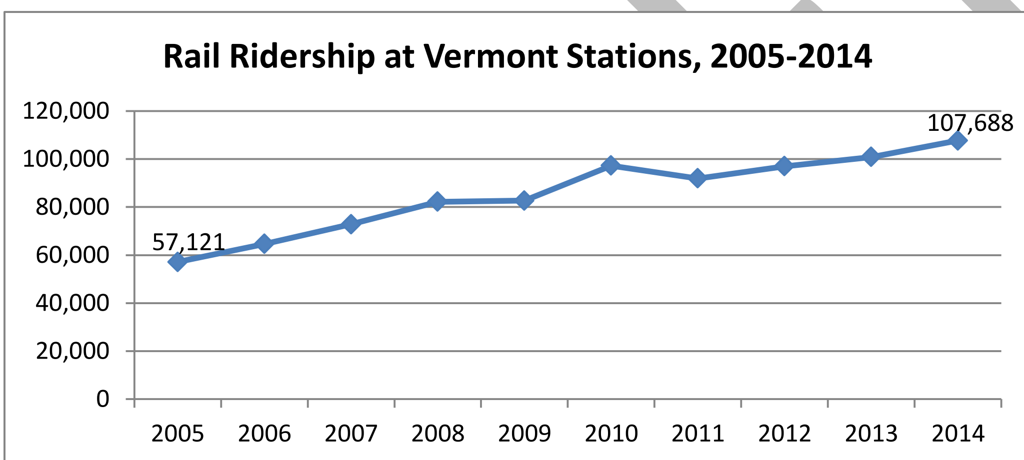
8.5.4 Park and Rides

Park and Ride lots facilitate ridesharing and transit use by providing a safe place for travelers to leave their cars and meet each other or the bus. There are 27 state Park-and-Ride lots in Vermont, encompassing 1,380 spaces representing average of 60 spaces per year since 2011. 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. VTrans will continue funding park and rides at a level adequate to meet CEP objectives.

8.5.5 Passenger Rail

Intercity passenger rail trips in Vermont have increased by 60% to more than 97,000 since 2006. 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.

Exhibit 8-9. Rail ridership at Vermont stations, 2005-2014



Source: Amtrak

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.

Recommendation

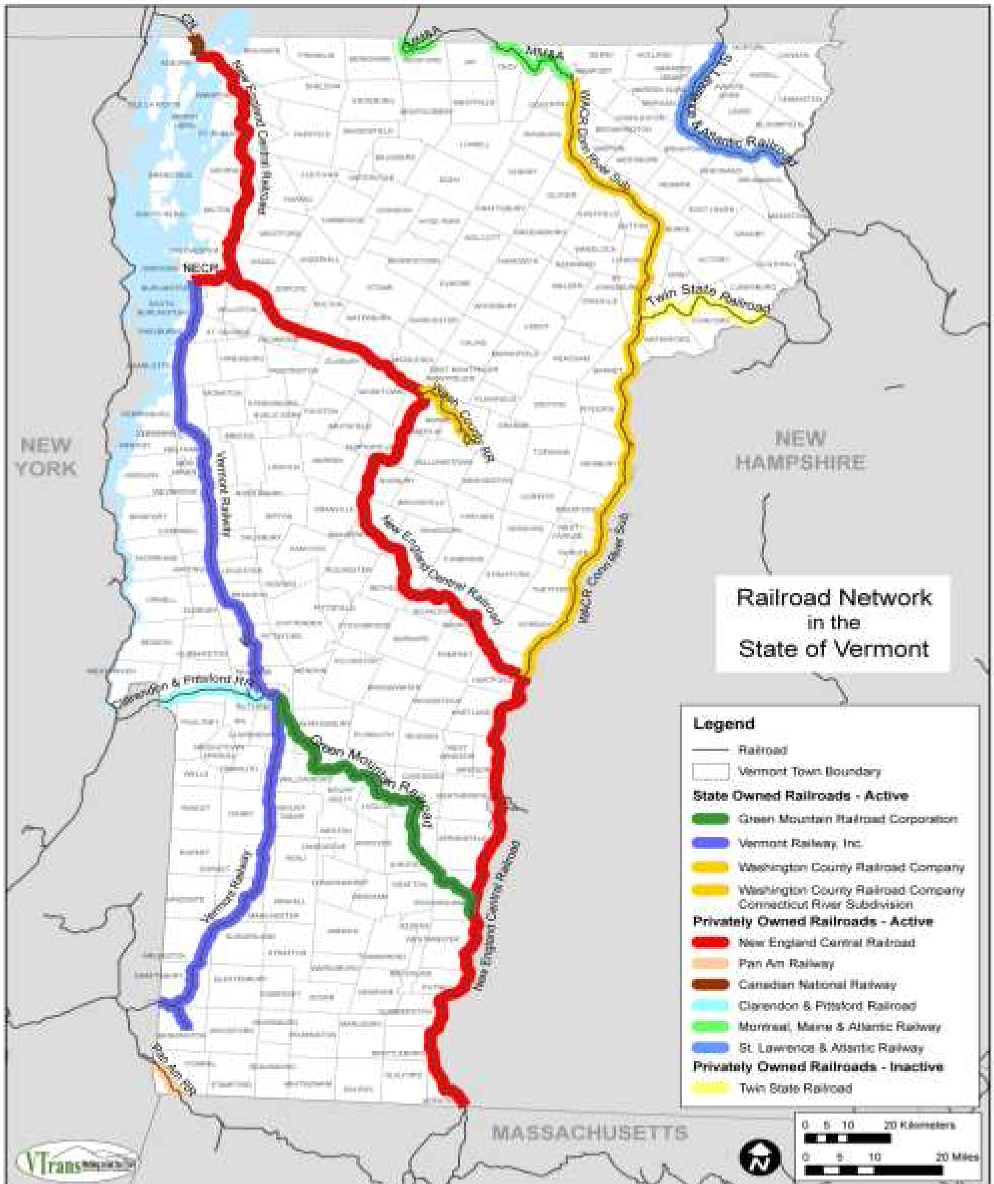
Continue state efforts to extend the Ethan Allen service from Rutland to Burlington and bring the Vermonter service to Montreal.

8.5.6 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.119 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.

[119] www.aar.org/NewsAndEvents/Press-Releases/2010/04/042110-EarthDay.aspx

Exhibit 8-10. Vermont Railroad Network



Source: Vermont State Rail & Policy Plan

In 2011, 6.6 million tons of freight was transported from, to, and through Vermont, 9 million (or 13%) by freight rail.120 By 2035, total rail freight over Vermont's rail system is projected to increase by 57% to 10.4 million tons.

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

[120] *Draft State Rail Plan 2015*

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.

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. The current Draft Rail Plan estimates a need of $203.7 million to bring bridges along the state-owned rail lines to 286,000 lbs railcar loading.

These infrastructure limitations have received considerable attention from the U.S. Department of Transportation in the last several years resulting in passenger rail operating speeds are now 59-79MPH along the entire Vermont portion of the route and work to ensure a continuous 286,000-pound service from St. Albans to Connecticut.

8.5.7 Active Transportation – Biking and Walking

Biking and walking do not require petroleum or other energy sources and have health and quality-of-life benefits. Access to walking and biking also contributes to the economic vitality of downtowns, outdoor recreation opportunities and the 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 sidewalks and shared use paths, to paved shoulders on both state and local roads.

The state of Vermont supports biking and walking infrastructure in several ways. Grants are provided through VTrans Local Projects section 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 the planning and construction of state and local transportation projects either consider Complete Streets principles 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. The Vermont Department of Health has provided grants to community coalitions to improve access to places to be physically active, including bicycle and pedestrian facilities. These funds have been used to educate and mobilize the community as well as for small projects such as improved signage, bicycle racks, and cross walk improvements. The Health Department Offices of Local Health continue to provide support for municipalities' active transportation projects, as needed.

Active transport tendencies of Vermonters, shown in the table below, were taken from the 2009 NHTS data. Of the nearly 10,800 unique trips recorded from the Vermont 2009 NHTS data set, 39% are less than 2 miles and 28% are less than 1 mile. Of all trips of length under 2 miles, roughly 87% percent were made by motor vehicle. Given the national average bicycling trip length of 2 miles and walking trips of 1 mile, many of these short trips have the potential to be shifted from SOV to either walking or bicycling.

Exhibit 8-11. Vermonters' and Nationwide Biking and Walking Tendencies, 2009

Number of Trips in the Past Week	Vermonters		Nationwide	
	Bike	Walk	Bike	Walk
0	85.4%	24.6%	87.2%	32.1%
1-2	6.9%	16.9%	8.2%	16.2%
3-5	4.2%	26.3%	4.4%	24.1%
5+	3.6%	31.6%	2.2%	26.6%
	100%	100%	100%	100%

Source: USDOT, 2010

Safety concerns present a major challenge in encouraging more Vermonters to walk or bicycle. Many roads in Vermont do not have bike lanes, adequate shoulders, sidewalks, or safe crossing opportunities. Even where these facilities do exist, pedestrians and bicyclists may not feel safe sharing roads with motor vehicles, especially where vehicles are traveling at high speed. Hilly topography and inclement weather are also significant barriers.

Ongoing recommendations to address these challenges are a continued focus on education of all road users and continued funding of infrastructure projects with an emphasis on addressing safety concerns and completing bicycling and walking networks. Design treatments to provide greater separation between bicyclists and adjacent traffic have been shown to both increase safety and make people more likely to try bicycling. Traffic calming and road or streetscape modifications can also slow motor vehicle traffic. Compact development patterns help reduce travel distances and make walking and biking more attractive options. Even for those who live too far away to reasonably walk or bike to work, working in a compact community allows for mid-day trips to be made on foot or by bike.

While the Complete Streets legislation has raised awareness about the concept, there is a need for continued education at both the state and local level to ensure that the concept translates to action.

8.5.8 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 work from other locations. A survey conducted by the DPS in 2014, however, showed that only 13% of respondents telecommuted every day and that 53% never telecommuted.

The state of Vermont is working to Increase telecommunications infrastructure necessary to increase the opportunity to telecommute throughout the state. For over a decade, the state has recognized the need for the ubiquitous availability of advanced telecommunications services as critical to Vermont's economy and culture. Broadband can increase worker productivity by offering remote access to information, and provide additional opportunities to work remotely, whether at home or in the field. These productivity gains can help reduce Vermonters' transportation needs.

At the end of 2013 every Vermont E-911 residential and business location had availability of high-speed internet access (defined as a connection of at least 768/200 Kbps) or a funded solution in place. With the goal of bringing high speed Internet access to every Vermonter met, the state has turned to improving those connections. In 2014 the state set a goal of supporting measures designed to deploy infrastructure that can support connections with 100 megabits per second(Mbps) symmetrical by 2024. As the quality of Vermonters' broadband connections improve, the opportunities for telecommuting may also increase.

High-speed internet access is necessary, but not sufficient to promote telecommuting. Businesses must educated managers about the benefits of telecommuting, improve the ability of managers and employees to use technologies for ensuring continuity of office functions such as remote meeting software and equipment, and develop methods for ensuring accountability and productivity. These barriers are not insignificant. To promote telecommuting as a way to reduce driving, the state and private employers must overcome these hurdles.

8.6 Alternative Transportation Fuel Sources and Vehicles in Vermont

Transitioning Vermont's transportation from a heavy dependence on fossil fuels towards a reliance on cleaner, renewable electricity and more renewable fuels is a key pathway to a new sustainable energy future. Since transportation fuels account for the single largest portion of Vermont's total energy consumption and fossil fuels are the main source of that energy, Vermont cannot meet its energy goals without a transformation in how we power the vehicles that move Vermonters from place to place. Likewise, meeting aggressive state goals for reducing the state's contribution to global GHGs will necessitate major changes in the vehicle fleet.

Transforming the efficiency of vehicles in Vermont is an economic as well as an environmental imperative. Vermonters are currently spending over $1 billion a year on motor fuels. If all cars and light trucks shifted to electric drive systems the equivalent cost of electricity would fall to $315 million, a savings of about $700 million annually. Those funds and a large portion of the electricity cost would remain in Vermont and with consumers, making the cost of living more affordable.

First and foremost, the state should work on reducing vehicle miles travelled by encouraging shifts in transportation modes and through the other strategies identifies above. Complementing those efforts, increasing the number of light-duty electric vehicles on Vermont's roads is a critical shift that the state must make in the next five years to significantly increase the efficiency of its fleet and replace fossil fuel with renewable sources. As of July 2015, there were 943 electric vehicles registered in the state, a small fraction of the more than 600,000 vehicles registered. However, there has been a steady rate of increase in electric vehicles among new car sales since the last CEP in 2011, and with many new and improved electric vehicle models soon to be introduced to the national automobile market, there is real opportunity to substantially grow the electric vehicle market during the period of this updated plan.

Increasing the use of liquid biofuels in certain areas of Vermont's transportation sector can also support the state's efforts to increase the efficiency of vehicles. Biofuels can be especially useful for improving vehicle efficiency where electric technologies are not yet readily available, such as in heavy-duty fleets used to transport cargo. They may also provide a good alternative way to fuel vehicles that perform specific on-site functions such as agricultural or forestry work. Their use in these applications can be increased without any new investments in specialized vehicles, equipment, or infrastructure.

Many factors shape the number, type, and relative efficiency of the vehicles registered in Vermont, including federal and state vehicle efficiency standards, the development and sale of new technologies (such as batteries that can increase EV range), the diversity and quantity of vehicles available in new and used markets, the price of gasoline or other fossil fuels, and evolving consumer knowledge of vehicle technologies and consumer preferences.

While the pace of the transformation of vehicle markets is a complex process driven by many factors, the market for electric vehicles is still very new, and state government and partner organizations can play a critical role in spurring its growth by developing supportive policies and programs that both increase consumer awareness and demand and ensure adequate supply of new technologies and models in the Vermont vehicle marketplace.

This section proposes a set of strategies and recommendations that can quicken the pace of the electrification of the transportation sector and transition to greater use biofuels in heavy-duty fleets, public transit, and specialized uses. The section begins by reviewing key elements of the policy and regulatory context governing vehicle emissions, including existing federal regulations for GHG emissions and average fuel efficiency, and state requirements governing the availability of advanced vehicle technologies. It then focuses on actions needed to promote the electrification of passenger vehicles, and specifically:

- Describes the state's participation in a multi-state ZEV Task Force comprised of eight New England and Western state and its development of a ZEV action plan for Vermont; and
- Provides the highest-priority strategies and recommendations for supporting and accelerating the growth of the electric vehicle market in Vermont.

The latter half of this section on cleaner vehicles and alternative fuels focuses in on recommended approaches to increases the targeted use of biofuels. It:

- Presents a brief overview of the range of biofuels available and their particular uses and applications;

- Reviews the evolution of federal and state regulations governing the sale and distribution of biofuels; and
- Provides the highest-priority recommendations for increasing Vermont's use of biofuels in those areas of the transportation sector where electrification is a less feasible or affordable alternative.

8.6.1 Federal Emissions and Fuel Economy Standards

Federal policy is helping push market changes to lower petroleum consumption and emissions. The U.S. Environmental Protection Agency (EPA) and the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) jointly regulate vehicle GHG (GHG) emissions and fuel economy. EPA has established national GHG emissions standards under the Clean Air Act, and NHTSA has set Corporate Average Fuel Economy (CAFE) standards under the Energy Policy and Conservation Act, as amended by the Energy Independence and Security Act (EISA). CAFÉ standards set fuel economy requirements for classes of vehicles sold by vehicle manufacturers.

The most recent revisions to these standards for passenger cars and light-duty trucks are projected to result in an average industry fleet-wide level of 163 grams/mile of carbon dioxide (CO_2) in model year 2025, which is equivalent to 54.5 miles per gallon if achieved exclusively through fuel economy improvements. In addition, CAFÉ standards for medium and heavy-duty vehicles are currently being established by EPA and will provide a major impetus to the improvement of engine technologies to improve fuel efficiency in trucks.

Because states are preempted by the federal government from setting their own fuel economy and GHG standards, Vermont's options are somewhat limited. However, Vermont can monitor the average efficiency of vehicles sold in Vermont and can implement non-regulatory strategies to promote the purchase of the most fuel efficient vehicles available.

8.6.2 Vermont's Low Emission Vehicle Program

Vermont has a long history of regulating automobile emissions to the greatest extent allowable under federal law. Under the federal Clean Air 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 vehicle emissions 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.

8.6.3 Vermont's Efforts to Spur the EV Light-duty Market

As noted above, achieving significant reductions of GHG emissions and fossil fuel consumption from Vermont's transportation sector will necessitate a large-scale transformation to alternatively fueled vehicles that reduce petroleum usage and related emissions with advanced technologies and fuels (such as plug in electric vehicles, pure battery electric vehicles and fuel cell electric vehicles. Indeed, Vermont's 2011 CEP identified vehicle electrification as a primary pathway to enable the state to meet its renewable energy goal and set an objective to have 25 percent of vehicles registered in the state powered by renewable sources by 2030.

Vermont's primary focus in the last five years has been on promoting the development of the market for plug in electrics (PHEVS) and pure battery electrics (BEVs). This is due to the fact that fuel cell vehicles (FCEVs) are earlier in their development, with just a few models currently available nationally and none being sold yet in Vermont. Furthermore constructing the infrastructure required to provide for convenient fueling of fuel cell vehicles by hydrogen fuels would take considerable time in Vermont (there are no hydrogen fueling stations within the state at present) and entail a level of capital investment that may not be achievable, at least in the near future, in this rural state.

Widespread adoption of electric vehicles in Vermont would advance multiple state priorities, including protecting public health and the environment by reducing transportation-related air pollution and GHG emissions, enhancing energy diversity, saving consumers money, and promoting economic growth.

EVs operating in the electric mode have no direct emissions. The overall air quality and GHG benefits of ZEVs compared to conventional gasoline and diesel vehicles are a function of the source of the electricity or hydrogen they use as fuel.

Vermont has very clean sources of electricity, which means even when you take into account the emissions associated with the fuel used to power the vehicles, electric vehicles outperform even the best gasoline hybrids. Moreover, when powered by renewable resources such as solar power, the total emissions of a battery powered electric vehicle is nearly zero. Thus, Vermont's efforts to increase renewable energy sources of electricity will further increase the environmental and public health benefits of electric vehicles over time.

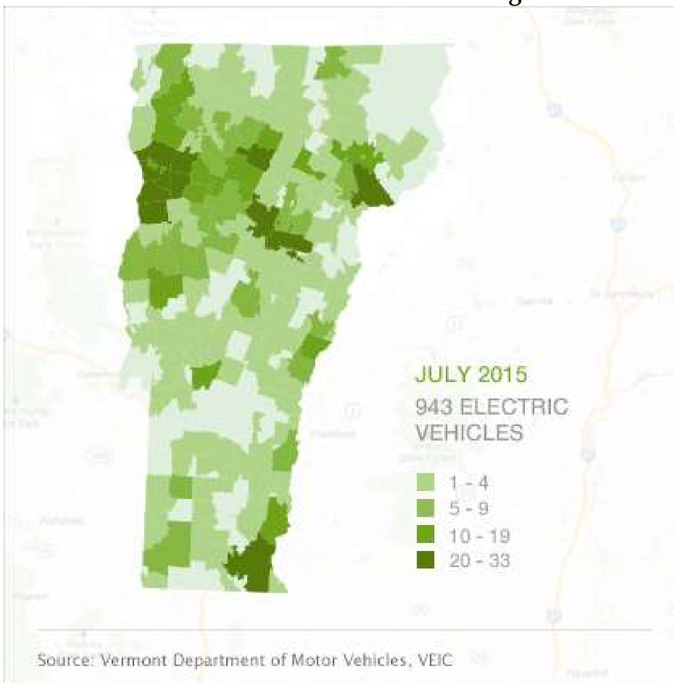
EVs can also meet the imperative to address the cost of living for Vermonters and the cost of doing business here. On average, electricity costs about one-third as much as gasoline or diesel on a per-mile basis. That gap is expected to widen over time with oil prices projected to rise as global demand increases, while electricity prices are expected to remain relatively stable. Expanding choices in vehicle technology and fuels can help lower the cost of transportation for individuals and businesses, as ZEVs already have a lower cost of ownership than comparable conventional vehicles for many households. If all of Vermont's vehicles were EVs, we would save over $800 million in gas every year.

Finally the Zero Emissions Vehicle program adopted by California and by other states including Vermont recognizes that regulations governing the sale of electric vehicles are "technology forcing." As these vehicles are developed and sold by auto manufacturers, the research and development performed to develop new models will also support the development of more fuel efficient conventional vehicles. The evolution of market demand for EVs will over time also shift general consumer preferences towards vehicles that perform well on efficiency.

8.6.4 Today's EV Market

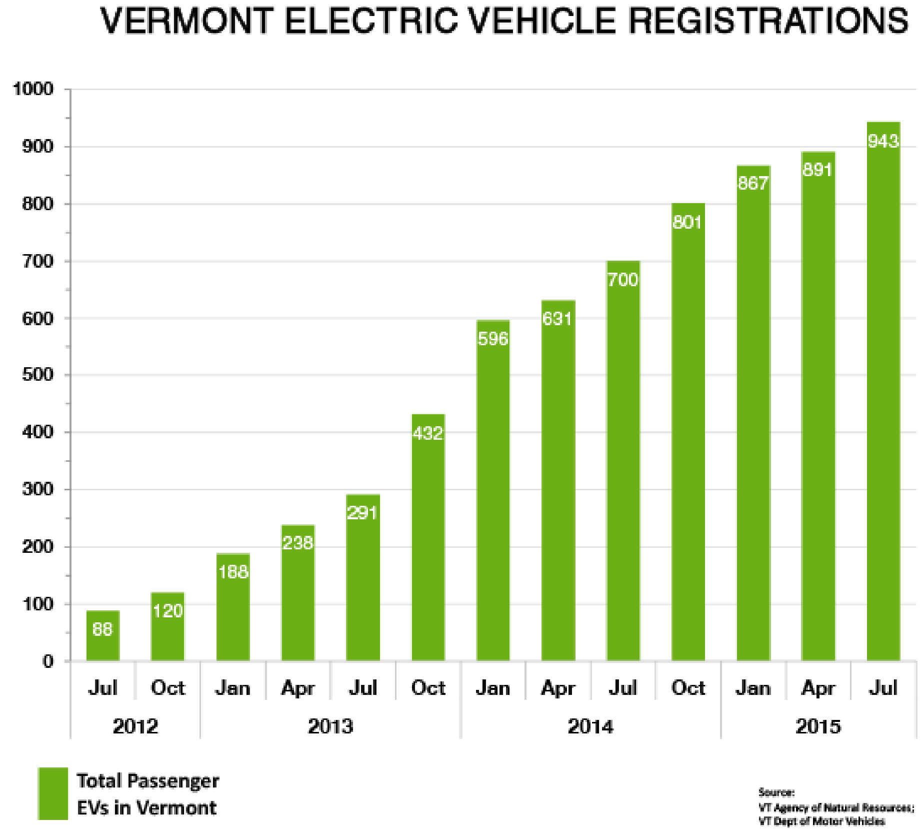
The number of electric vehicles registered in Vermont was 943 as of July, 2015 according to data provided by the Department of Motor Vehicles. This represents a 35% increase during the previous twelve month. Vermonters across the state have been purchasing both plug-in and pure battery models, and more than sixteen models are available for sale in dealerships. As of July 2015, EVs were registered in 64% of Vermont municipalities, with Chittenden County showing the most EVs registered at 323.

Exhibit 8-12. Distribution of electric vehicle registrations in Vermont



While the number of these vehicles on Vermont roads has increased substantially since they were introduced, the rate of increase in market demand has slowed during the last twelve months, most likely due to a range of factors including recent declines in the price of gasoline. In the year preceding July 2015, plug-in vehicles have comprised about 1% of new passenger vehicle registrations. Leasing EVs has also increased in popularity.

Exhibit 8-13. Passenger electric vehicle registrations have grown from 88 in July 2012 to 943 in July, 2015

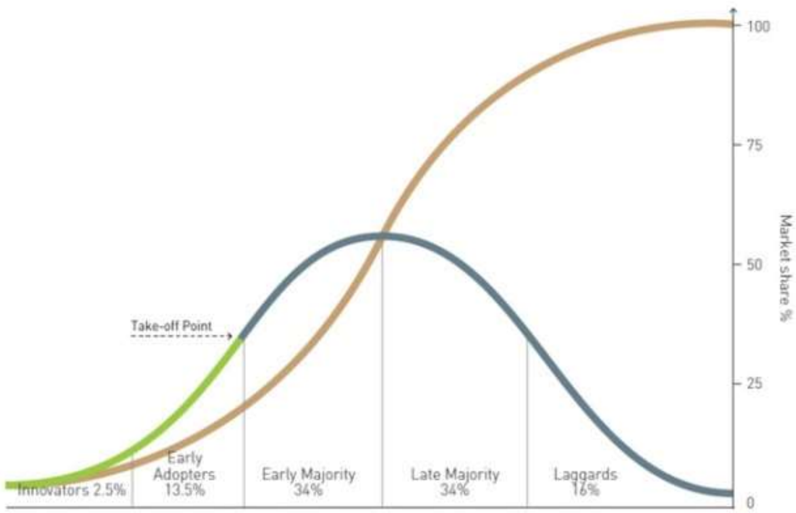


Source: DMV and VEIC

As the number of electric vehicles in Vermont has increased, availability of electric charging infrastructure has also increased. This includes public charging infrastructure in downtown locations and at Park and Rides.

Importantly, however, the EV market is still at a very early stage of development. Innovation diffusion theory, first developed in 1962 by sociologist Everett Rogers, explains how populations adopt new technologies – very slowly at first, and then rapidly as markets reach a tipping point and the new technology becomes the norm. In Vermont, less than 2% of new vehicle sales are electric vehicles, indicating that their reach has not extended beyond the “early adopters” (Exhibit 8-14).

Exhibit 8-14. Innovation diffusion, illustrated



Source: Wikipedia[121]

In 2015, the rate at which new registrations of EVs in Vermont is growing slowed down considerably. Whereas previously new sales of EVs had reached nearly 2% of new sales, in 2015, market share was just over 1%. There are many reasons for this, including dramatic reductions in the price of gasoline at the pump and continuing lack of consumer awareness about what EVs are, how they work, and what the benefits of ownership or lease are. Survey data collected by VEIC, discusses in section 8.6.6.2 below, shows that vehicle cost, including the cost of fuel saved, is a primary consideration for the electric versus gasoline vehicle purchase choice in Vermont. National data on EVs reveals similar trends and points to the need to scale up education and outreach about EVs and their benefits.

To ensure that the market for electric vehicles moves through this phase and reaches a period of sustainable growth, during which the majority of Vermonters will choose a plug-in hybrid electric vehicle or a pure battery electric when shopping for a new or used vehicle, Vermont has entered into a formal collaboration with other New England states equally intent on electrifying their transportation sectors and identified specific goals and actions to support and accelerate the sales of EVs in the state.

8.6.5 Multi-state ZEV Task Force and Vermont ZEV Plan

The Agency of Natural Resources administers the state's Low Emissions Vehicle Program established by California. In this role the agency oversees specific program requirements related to the sale of "zero emission" or electric vehicles in Vermont. The regulations require auto manufacturers to meet sales targets for electric vehicles on a designated timeframe. In the year 2018, these requirements scale up considerably.

[121] https://en.wikipedia.org/wiki/Everett_Rogers

While the ZEV regulations are a key part of Vermont's approach to supporting the development of a robust electric vehicle market in the state, the administration has long recognized that regulations alone are not enough to support this market evolution. California's state government collaborates closely with private and nonprofit partners to support the development of market demand for electric vehicles with public outreach and education, policies, and financial incentives for consumers and organizations installing charging infrastructure. The goal is to ensure that market demand evolves quickly so that auto manufacturers can not only achieve compliance but also profit from the new sales so that the market is sustainable. California has demonstrated that EV-friendly policies and investments make a difference – there are more than 100,000 EVs registered in the state[122].

On October 24, 2013, the governors of California, Connecticut, Maryland, Massachusetts, New York, Oregon, Rhode Island, and Vermont signed a memorandum of understanding (MOU) committing to coordinated action to ensure the successful implementation of their state ZEV programs. Collectively, these states are committed to having at least 3.3 million ZEVs operating on their roadways by 2025. The MOU identifies joint cooperative actions the signatory states will undertake, and additional actions that individual jurisdictions are considering, to build a robust market for ZEVs.

Pursuant to a directive in the MOU, a multi-state ZEV Program Implementation Task Force (hereinafter "Task Force") was formed to improve regional collaboration. Its first action was to publish a "Multi-State ZEV Action Plan." While the Action Plan is designed to guide inter-state coordination and inform state-specific action to accomplish the goals of the ZEV MOU, it is not intended to provide a uniform pathway for all states to follow. In 2014, Vermont's Climate Cabinet released a Vermont ZEV Action Plan identifying strategies and actions that best address Vermont's own needs and our unique opportunities to achieve the commitments made by Governor Shumlin in the ZEV MOU.

The multi-state Task Force created by the ZEV MOU will serve as an ongoing forum for coordination and collaboration to ensure effective and efficient implementation of our state ZEV programs. As we have seen through other multi-state initiatives, such as the Regional Greenhouse Gas Initiative, collaborating with other states makes our programs more effective.

Vermont's plan[123] includes 11 priority strategies, with recommendations under each. It makes recommendations for the state's use of EVs in its own operations, new policies and programs that could support further development of the market, and ways in which partners such as the Drive Electric Vermont coalition, formed in 2014, can further plan goals.

8.6.6 Challenges and Opportunities

8.6.6.1 Recent Progress

[122] http://www.pevcollaborative.org/sites/all/themes/pev/files/CPEV_annual_report_web.pdf

[123] http://www.anr.state.vt.us/anr/climatechange/documents/FinalVTZEVActionPlan_080114.pdf

There has been a considerable increase in the number EVs on our roads since the 2011 CEP was released. Sales of new electric vehicles – including plug-in hybrids and pure battery electric vehicles – have steadily increased in this period. From July 2012 through July 2015, the number of plug-in passenger car registrations went from 88 to 943. Moreover, the number of Vermont communities with EVs has more than tripled to more than 150.

The new Multi-state Task Force and Multistate ZEV Action plan have identified clear priorities and steps for actively supporting the growth of a market that still represents a tiny fraction of all light-duty vehicles sold in the region (less than 2% in all Task Force states). Vermont's own action plan creates a clear road map for how agencies can work together and with private and non -profit partners develop the policies and infrastructure necessary to support evolving light-duty EV technologies and support the growth of market demand beyond a small group of early adopters.

The launch of Drive Electric Vermont (DEV) has also positioned the state to support a more rapid acceleration of market demand than would be likely without such a forum in place. Founded in 2012 through the adoption of a Memorandum of Agreement (MOA) between the State of Vermont and the VEIC (VEIC), DEV engages stakeholders from electric utilities, automobile dealerships, and regional planning organizations, along with state and local government representatives, in order to facilitate the adoption of electric vehicles across Vermont. VEIC coordinates the coalition. Many other states in the multi-state Task Force are following Vermont's lead and establishing their own EV stakeholder partnerships.

DEV is a well-organized organizational champion for meeting Vermont's EV goals as quickly as possible, and can leverage efforts across multiple organizations in the service of those goals. Stakeholders gather quarterly and additional working groups meeting more frequently. DEV hosts and participates in events around the state to educate Vermonters about electric vehicle technology and its benefits to our transportation sector. It also seeks to boost the adoption of EVs by:

- Offering programs and incentives to help Vermonters purchase and charge their electric cars;
- Providing guidance on charging infrastructure growth opportunities and best practices; and
- Serving as an objective third party resource providing information to a range of external constituents (from local governments to Vermont residents) on buying an electric car in Vermont.

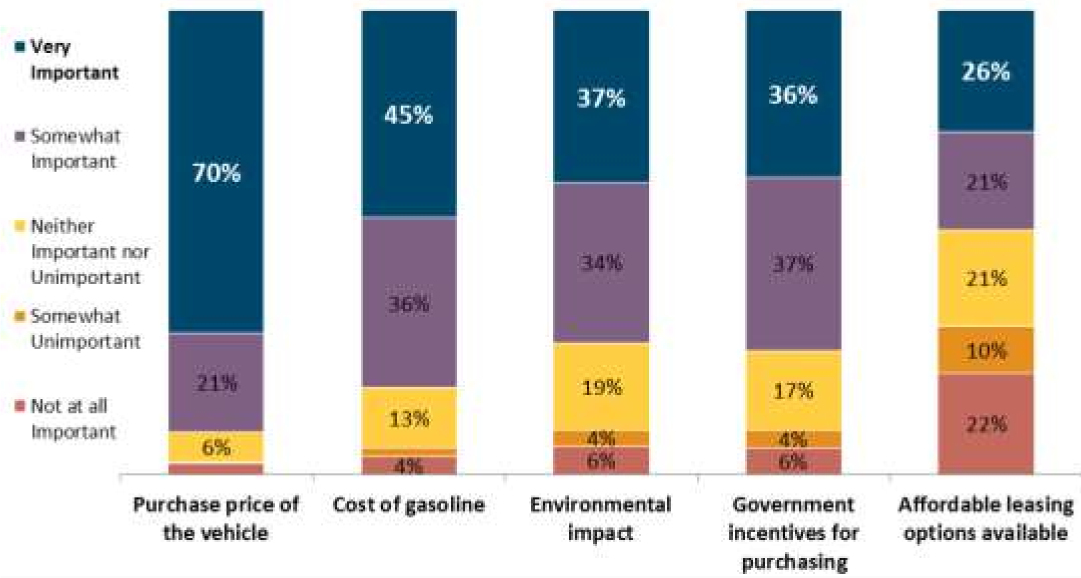
Finally, the development of the Multistate Task Force, the Vermont ZEV Action Plan and Team, and Drive Electric Vermont create a strong organizational foundation for rapidly accelerating the adoption of electric vehicles and guiding the development of adequate infrastructure to support that transformation in the light-duty market. One of the biggest achievements in the last two years has been the increase in available public charging infrastructure in Vermont. There are currently 73 EV charging stations in Vermont. This includes a number of workplaces and businesses that are leading by example by installing charging equipment for the use of their employees and guests.

8.6.6.2 Limited Consumer Interest

Despite these successes, there are significant challenges ahead for reaching a sustainable path of growth in the market, and bold strategies and actions are needed to ensure we can overcome them.

The first is the limited awareness among Vermonters of the benefits of owning and driving these vehicles. A statistically valid survey of 495 Vermont consumers performed by the MSR group in 2014 highlights the obstacles to increasing interest among Vermonters in purchasing or leasing electric vehicles. The survey suggests that over 90% of the population has some general awareness of EV, but many potential consumers need greater familiarity with the options available. Vehicle cost is the most common barrier to considering EV purchases, followed by concerns over limited vehicle range and charging infrastructure. Purchase cost was also cited as the most important issue to motivate consumers to purchase or lease an EV, as shown in the chart below.

Exhibit 8-15. Vermonter Motivating Factors to Purchase an Electric Vehicle



Source: MSR Group, 2014

Cost is the most important factor determining consumer interest in buying or purchasing new EVs with more than 90% of Vermonters identifying this as a very or somewhat important consideration for them. Compounding this challenge is the fact that a $7,500 federal income tax credit for purchasing new EVs is set to expire after 2016. This tax incentive has been a pivotal support to the increases in consumer demand seen over the last several years, and it is unclear whether it will be renewed by Congress.

8.6.6.3 Limited Supply of Vehicles and Caution Among Dealerships

Since the 2011 CEP, auto manufacturers have introduced and begun marketing and distributing a variety of new light-duty vehicle models. These companies are all keenly aware of the scale-up in ZEV regulations that will occur in 2018 in states that have adopted California's Low Emissions Vehicle Program and the associated ZEV requirements for the volume and timeline of electric vehicles sales. While they vary in how they are planning to achieve compliance with these new requirements, most auto manufacturers are actively developing new EV models with a range of costs to spark consumer demand.

In Vermont, there are now 16 unique models of plug-in cars registered in the state. And as of July 2015, 20 Vermont auto dealers had at least one new or used plug-in model available in inventory. This represents significant progress over the last five years, but the availability of a diverse set of models that Vermonters can afford to lease or purchase is still very limited. Due to the "pooling" requirement built into the ZEV regulations and set to expire in 2018, manufacturers can meet their fleet requirements by offering light-duty EVs for sale anywhere in the United States; there are no state-by-state requirements. This leads companies to target states with the most developed EV markets for distribution, principally California.

Two other factors make it difficult to build the supply of EVs available in Vermont that are well suited to meet consumer preferences. First, even when auto manufacturers are interested in distributing new models in Vermont, dealerships are sometimes reluctant to carry them in their inventory due to uncertainty about how they will sell. This creates a chicken-or-egg problem; its challenging to create adequate opportunities for Vermonters to learn about the cars if a limited set of models are available in Vermont dealerships

Second, Vermonters often purchase used cars. There are almost no used plug-in hybrid vehicles and no all-electric vehicles available in Vermont dealerships at present. As leased vehicles become available to used car distributors in the next year and beyond, Vermont can seek to develop a robust used EV market here, a step that will assist in overcoming the cost barriers to EV ownership and build the market segment that will appeal most to the kind of cars we like to drive and can afford.

8.6.7 Strategies and Recommendations

Vermont's 2011 CEP identified vehicle electrification as a primary pathway to enable the state to meet its renewable energy goal and set an objective to have 25 percent of vehicles registered in the state powered by renewable sources by 2030.The next five years will be critical to getting the EV market in Vermont on a sustainable trajectory of growth. The Vermont ZEV Action Plan calls for nine actions and details many recommendations for achieving these action steps. Below are identified the three most important priorities for the next five years as agreed by the state's Climate Cabinet and the DPS.

8.6.7.1 Catalyzing Market Demand with Incentives

Surveys of Vermonters show that cost considerations are likely both the principal barrier to wider interest in owning EVs and a potential leverage point to increase EV sales. Vermonters identify cost as the number one consideration influencing their decisions about whether to buy or lease an electric vehicle.

Survey data indicates that most Vermonters know these kinds of cars are available, but they may lack awareness of their "total cost of ownership," which can be lower than conventional vehicles since the cost of traveling in an EV is equivalent to spending one dollar per gallon of gasoline, and they require less maintenance. Electricity's stable rates also contribute to the cost difference between EVs and conventional vehicles.

Since the total cost of ownership can be lower than conventional vehicles, these vehicles can help to significantly lower ongoingtransportation costs for the people who own and lease them. As a wider range of models at different costs become available in the next few years, EVs could bring significant economic benefits to middle and lower income Vermonters. They could also reduce exposure to air pollutants that cause respiratory and other health problems. The cost benefits increase the farther the distances travelled, so families living in rural areas would benefit substantially.

Developing financial and non-financial Incentives is a top recommendation in the Vermont ZEV Action Plan. It has proven effective in California, which has seen a dramatic increase in EV sales since incentives have been put in place. Many other states are now adopting EV incentives. Usually delivered as point of sale tax breaks or tax credits, they are making the up-front cost of purchasing or leasing light-duty EVs more affordable and attractive.

In Vermont financial incentives in the form of tax credits or rebates, or other kinds of incentives such as preferential parking, could help to catalyze market demand beyond the early adopters and help the EV market move into a phase of sustainable growth. It would also increase interest among manufacturers and in-state auto dealerships in selling and actively marketing a diversity of models within the state during this period when they can meet ZEV requirements by selling electric vehicles in any state that has adopted the ZEV rules, rather than meeting required levels of sales state by state ("the pooling provision").

Drive Electric Vermont recently ran a small incentive program providing rebates of up to $500 to Vermonters who purchased a new vehicle and incentive payments of $200 to dealerships that sold them. This program may continue for another year or two, but the incentives are likely to be relatively small in comparison to those offered by other states. Creating a new financial incentive at the state level – such as a limited Purchase and Use Tax holiday or other tax-based incentive – could generate considerably more interest, especially if it applied by to both new and used models. Regional incentives could also be offered by the utilities as a strategy for achieving requirements for "Tier 3" investments under the new Renewable Energy Standard approved by the state legislature in the spring of 2015. Any potential funding source should be evaluated with consideration of the other energy and climate solutions that could be funded with that source, and the relative impacts and benefits of those options.

Local incentives might also be put into place by municipalities and private businesses. Many municipalities in California have sought to incentivize the adoption of electric vehicles by reducing the costs of parking them and providing preferential access to parking when it is in short supply. These kinds of incentives, along with access to HOV lanes, are a key strategy for building the market.

Any kind of new incentive could be developed to meet a number of principles that have informed their design in other states.

Ensure access by those who can most benefit and for whom cost is a real barrier. Several states have structured eligibility for incentives to ensure that the benefits are targeted toward low- and moderate-income households. A common way to achieve this is by capping the program for income level or vehicle cost. In the case of Vermont where many households rely on used cars, ensuring that incentives are available for both new and used models is important.

Align the timing for offering incentives with the stage of development in the market. Innovation diffusion theory suggests that once new technologies are sought by 15% of the potential users or consumers, markets can grow on their own. Incentives that require public resources should only be used in the very early stages of market development. State budget planners concerned about dwindling transportation revenue as a result of more fuel efficient cars have pointed out that EV users should be assessed a fee (such as a larger registration fee) to ensure they support their fair share of the costs to maintain the road network because they pay less into the system through the purchase of gas. Time-limited incentives could be instituted to catalyze the market to a certain point in its evolution and then new fees could kick in at the point when demand has reached a stable and sustainable level.

Create incentives that are understood at the point of sale. Experience in many states has shown that potential buyers of EVs are most responsive to incentives that are delivered during the transaction.

Make program administration as efficient as possible. To ensure that public resources devoted to incentives are targeted and efficient, there must be an organization responsible for managing the program efficiently. Organizations such as the CEDF or EVT could be considered. Another option used by other west coast and northeastern states is to hire a contractor to manage an inventive program. California, Connecticut, and Massachusetts have all used the same contractor

Recommendations

(1) Evaluate potential ways to incentivize the purchase and lease of EVs in this early stage of market development, including developing a statewide income tax credit or tax holiday, and/or encouraging utilities to develop regional incentives as they implement the RES. Coordinate this evaluation with efforts to identify new sources of transportation revenue to address declining gas tax revenues.

(2) Work with nonprofit partners such as VECAN and VLCT and private-sector organizations to encourage broader implementation of incentives such as free or reduced parking costs for EV owners and to create preferential access to spaces to parking limited in supply.

(3) *Carefully time any increases in EV fees designed to ensure that EV owners contribute to the costs of maintaining road networks, so that they phase in as consumer demand reaches a more sustainable threshold, and thus won't work at cross purposes with efforts to grow the market.*

8.6.7.2 Promoting Consumer Awareness of the Benefits of EVs and Fuel Efficient Vehicles

While there are more EVs in Vermont than ever before, there are still under one thousand registered EVs in Vermont communities. This means EVs are not often seen, and many Vermonters do not know someone who drives one. Though there are numerous benefits of owning an EV – such as less exposure to air pollutants, an equivalent cost of travel at about $1 a gallon, and nearly no maintenance – most Vermonters are not seeking EVs when they want to replace their vehicles..

State agencies can raise the profile of advanced technology vehicles such as EVs and other highly efficient models in a range of ways. State leaders can emphasize that the adoption of electric and more fuel efficient vehicles is a critical pathway for achieving state and energy goals. Agencies can also call attention to the benefits of efficient light-duty vehicles on web sites, and can use recognition and awards program to call attention to the expanding market and its champions.

Nonprofit partners such as Drive Electric Vermont play a critical role in supporting effective social marketing to spread the word. As a stakeholder coalition, DEV has the ability to leverage its broad network to increase interest in these vehicles and motivation to support the coming transformation in the vehicle market using a variety of media types and media channels. Other nonprofit organizations such as the Energy Action Network are key partners for this work.

Auto dealerships are also a leverage point. These dealerships and the salespeople they employ are the mid-stream element of the auto value chain and play a critical role in the consumer purchase decision process. National research and local Vermont experience proves auto dealers and sales people who are well trained and versed in electric vehicles have much greater success in selling EVs. Many less-informed auto dealers are not "selling" EVs and are only making them available on the lot, or in some cases have actively steered consumers away from consideration of plug-in models. Good training programs are needed to support dealerships in preparing their sales force.

Finally, as major institutions lead by example in the adoption of EVs and the installation of charging infrastructure, many more Vermonters will come into contact with the vehicles, learn about them and take note of the implied "vote of confidence" in EVs by organizations they trust. As Vermont's largest employer, the state has a special role to play in leading by example. The Buildings and General Services Department, which manages the fleet pool, and other state agencies are collaborating to support rapid transformation of the state fleet. The State Agency Energy Plan identifies specific recommendations for expanding the use of visible EVs (identified by a common feature) and building out charging facilities, as well as other strategies such as right sizing fleets and ensuring the most efficient vehicles possible are deployed for specific trips.

Recommendations

(1) The state should lead by example by significantly increasing in its fleet both plug-in hybrid electric vehicles and all-electric vehicles where appropriate given state transportation needs.

(2) State agencies should maintain funding support for Drive Electric Vermont, and collaborate with DEV on social marketing that supports EV adoption and work with dealerships to increase the availability of a wide array of new and used EVs for consumers to learn about and experience.

(3) High-visibility events and recognition/awards programs such as the Governor's annual environmental awards should showcase Vermonters and Vermont organizations that are helping to propel the state's transition to electric vehicles, as well as other strategies for reducing the energy used in transportation.

8.6.7.3 Deploying Infrastructure at Workplace and Key Public Locations

Electric charging infrastructure deployed at strategic locations is critical for reducing the "range anxiety." As they become more common most people who own or lease one will rely principally on home charging. After home charging, however, workplace stations are the most commonly used charging infrastructure. Charging at work is convenient and easy. A study by DOE has shown that employees whose workplaces provide charging infrastructure are 20 times more likely to own an EV than employees whose workplaces do not. This may be because workplaces with infrastructure act as showrooms for the vehicles, showing people how they work and providing opportunities to interact with their proponents.

Likewise publically owned infrastructure in downtown locations can help generally familiarize Vermonters with EVs and reduce range anxiety. The number of public EV charging stations has increased rapidly in the last five years, aided by a state grant program that provides funds for installing infrastructure in designated downtowns. There are currently 73 EV charging stations in Vermont. However some areas of the state still have very few or no public charging stations available.

Recommendations

(1) Partner with DEV to continue and expand the Drive the Dream Vermont campaign and organize a periodic event to celebrate and showcase employer investments in EV-friendly workplaces.

(2) Promote and fund the installation of DC fast charging infrastructure at locations strategically located along major travel corridors and in transit hubs such as park and rides. Work with other ZEV Task Force states to address statutory obstacles to developing charging stations in federal rights of way.

8.6.7.4 Assessing and Improving Average Fuel Efficiency in Vermont's Fleet

In Vermont, the average length of ownership for light-duty vehicles is nine years. The pace at which the state can achieve the electrification of light-duty vehicles will be constrained by the pace of turnover in the fleet.

In the transitional period, strategies to encourage the selection of highly fuel efficient conventional vehicles, and to encourage more efficient driving habits (such as reducing driving speed, eliminating idling, and keeping vehicles well maintained) can have a dramatic impact on the energy used in daily transportation and the GHG and other air pollutants emitted.

The state gathers data about registrations of electric vehicles, but does not have methods for evaluating the efficiency of Vermont's total light-duty fleet. Developing baseline data and tracking trends over time would enable state agencies and their partners to measure progress towards promoting greater efficiency through consumer choices when buying vehicles and through greater adoption of practices long known to improve fuel economy. The latter represent a set of actions that all Vermonters can take today, contributing to progress in meeting energy and climate goals, reducing air pollution that affects our communities, and saving money.

Financial incentives could spur greater average fuel efficiency. For example fees charged at the time of registration can be structured so that more efficient vehicles receive an incentive, or rebate, or less efficient vehicles receive a higher fee. Feebates can be designed to be revenue neutral, or alternatively, can be designed to raise revenue which in turn can be used to provide purchase incentives for plug-in hybrid and battery electric vehicles. Implementation of any financial incentive or disincentive would need to be designed to minimize or eliminate financial impacts on Vermonters who are least able to afford alternative technologies that are more expensive than conventional ones.

Recommendations

(1) Identify options and develop methods for assessing progress over time in improving the fuel efficiency of vehicle transportation in Vermont.

(2) Evaluate potential strategies for promoting the purchase of more fuel-efficient vehicles and more fuel efficient driving and vehicle maintenance practices, such as expanding education and outreach through programs like Go Vermont, and establishing incentives using tools such as rebate and feebate programs.

8.6.8 Alternative Fuels

While electrification for Vermont's light-duty fleet is a viable option, and some heavy-duty freight transportation needs can be met by shifting freight to rail, there are many heavy- and medium-duty applications where there are no electric or rail options available. In those applications, alternative fuels offer a lower-carbon alternative to gasoline and diesel. Alternative fuels including biodiesel, ethanol, and compressed natural gas offer significant GHG savings. While biodiesel is preferred to natural gas for heavy- and medium-duty applications, both biodiesel and natural gas are preferred to fossil petroleum products.

Liquid biofuels offer a unique opportunity to reduce the GHG emissions of Vermont's vehicle fleet without any new investments in specialized vehicles, equipment, or infrastructure. They can be blended with gasoline and diesel and used in existing vehicles.

For a more detailed discussion of biofuels including sustainability, commercial availability, price and appropriate applications, see the Liquid Biofuels section of Chapter 13. Compressed natural gas also offers GHG savings above gasoline and diesel, but is currently a non-renewable resource. For a more detailed discussion of natural gas including market dynamics and environmental concerns, see Chapter 14.

8.6.8.1 Biodiesel

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. Biodiesel can reduce wear on engines, owing to its greater lubricity.

The federal Renewable Fuel Standard program and the renewal of the federal biodiesel blenders' credit have boosted national production of biodiesel dramatically in the past five years. The federal standard requires a minimum amount of biodiesel to be blended annually by refineries and importers. Obligated parties can either buy the biodiesel directly and blend it at the refinery level or purchase RINs (Renewable Identification Number) for biodiesel produced elsewhere. Refineries are not required to notify wholesale or retail buyers if the blend is B5 or less.

As the federal requirement for biodiesel production has increase, the price of RINs has been very high. This has stimulated a national biodiesel market even in the face of low diesel prices. Because the price for biodiesel plus the price of RINs has been higher than the wholesale price for diesel, it is likely that biodiesel is being blended high in the supply chain. Unfortunately there is no way to track how much biodiesel is being blended into diesel transportation fuel being sold in the state.

Although biodiesel blends of B5 and below are likely being sold throughout the state, retail customers have no way to know that they are supporting biodiesel, and the biodiesel is purchased on the national commodity market rather than from local supply chains. Labeled biodiesel is currently available from only two retail fueling stations. 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 refueling stations. A differential in the biodiesel fuel tax rate or a fuel tank installation incentive could also encourage more dealers to offer biodiesel.

Farmers in Vermont produce a very limited amount of biodiesel locally from oilseed crops such as sunflower and canola. Biodiesel 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. 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. As of 2012, the average cost to produce biodiesel from oilseed crops grown on Vermont farms was $2.13 per gallon (this reflects all fixed and recurring costs). At current average retail diesel prices of $2.66 per gallon, farmers would hardly break even producing biodiesel.[124] The economic incentives do not currently align for local biodiesel production in Vermont.

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 2001, equipment and vehicle manufacturers are in different stages of testing, review, and revision of their warranties and owner's manuals.[125] Most major manufacturers now permit the use of B20 blends (and lower percentage blends) under their equipment warranties; however, guidelines and conditions vary. Some blends of B20 – especially those high in saturated fats such as waste animal fats and palm oil – can gel in Vermont's wintery conditions. These inconsistencies and the potential to overstep the bounds of manufacturer warranties has led to consumer caution and uncertainty toward biodiesel blends in general.

8.6.8.2 Ethanol

Ethanol is ethyl alcohol which can be blended with gasoline and used in any vehicle that uses regular gasoline. It is derived from the fermentation of agricultural products including corn, sugar, or grains to form starch ethanol or from the fermentation of agricultural wastes, grasses, or wood to produce cellulosic ethanol. In the U.S. (and by extension Vermont) most ethanol is starch ethanol derived from corn.

Ethanol can be blended up to 10% with gasoline to form E10 and used in any engine that takes regular gasoline. In blends greater than 10%, specialized adaptations (or flex fuel vehicles) are necessary because ethanol corrodes rubber fuel system parts. Ethanol is suitable for use in light-duty transportation applications. In the US 95% of gasoline is already an E10 blend, meaning the US is reaching what is called the "blend wall" or the maximum amount of ethanol that can be added to gasoline without significant changes to the light-duty fleet.

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[124] *Vermont On-Farm Oilseed Enterprises: Production Capacity and Breakeven Economics. Vermont Bioenergy Initiative. Netaka White and Chris Callahan. Last retrieved on 9/15/2015 at*

[125] *The National Biodiesel Board (NBB) provides comments on OEM information on standards and warranties: www.biodiesel.org/resources/oems/*

Ethanol can also be used in specially designed vehicles at higher blends (up to 85% ethanol, 15% gasoline). E-85 compatible vehicles (also called flex fuel vehicles) have special hoses, valves, fuel lines, and fuel tanks that resist alcohol corrosion.

Environmental concerns about corn ethanol make this fuel less desirable than biodiesel. Advanced cellulosic ethanol, especially when produced from agricultural waste, is significantly more environmentally sustainable than current ethanol stocks. See the Liquid Biofuels section of Chapter 13 for a more detailed discussion of the environmental impact of ethanol. Because of doubts about the environmental sustainability and energy balance of ethanol, Vermont will not promote the deployment of E-85 flex fuel vehicles or E-85 refueling stations in the state.

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 one million tons of wood per year.[126] Vermont will use any national blend of ethanol in fuels; however, Vermont should not use its limited biomass resources for the production of ethanol. If sustainably produced cellulosic ethanol eventually replaces corn ethanol on the national market, Vermont may reconsider its position on E-85 flex fuel vehicles and E-85 refueling stations.

8.6.8.3 Natural Gas

Natural gas used in transportation applications must be compressed under pressure to either form Compressed Natural Gas (CNG) or Liquefied Natural Gas (LNG). Both of these fuels require specialized vehicles as well as specialized refueling stations.

Natural gas offers several advantages over diesel vehicles for medium- and heavy-duty applications. Natural gas is preferable to gasoline, diesel, or propane fueled vehicles especially in medium- and heavy-duty applications where electrification is currently not possible. Lifecycle GHG emissions for CNG and LNG in medium- and heavy-duty applications are lower than gasoline and diesel counterparts. Increasingly stringent regulations of tailpipe emissions for new gasoline and diesel vehicles have resulted in newer engines for those vehicles that are nearly on par with natural gas in emissions of hydrocarbons, oxides of nitrogen (NOx), carbon monoxide (CO), as well as carbon dioxide (CO_2).[127] The main advantage of natural gas over gasoline and diesel fuel is cost and price stability, not necessarily environmental benefits in light of new tailpipe emissions regulations.

[126] *Data supplied by the Vermont Agency of Natural Resources.*

[127] *Department of Energy Alternative Fuel Data Center. Natural Gas Vehicle Emissions. Last retrieved on 9/4/2015 at http://www.afdc.energy.gov/vehicles/natural_gas_emissions.html.*

Natural gas is still a fledgling transportation fuel in Vermont constituting only .1% of the state's natural gas usage. National trends in vehicle manufacturing and cost will drive the adoption of natural gas as a transportation fuel in the state.

A lack of refueling infrastructure is another limitation on the use of natural gas for longer trips. Fleet vehicles with regular local or circular routes or vehicles used for local public transportation are prime targets for natural gas deployment. Where there are opportunities to foster the use of natural gas to replace diesel or gasoline in medium or heavy-duty applications, the state should seek to do so.

8.6.8.4 Strategies and Recommendations

Effective utilization of alternative fuels in transportation will require strong state and regional-level markets. Although national trends in production, price, and engine manufacturing are driving the adoption of alternative fuels, there are several actions that the state of Vermont can take independently to stimulate the adoption of alternative fuels to reduce our GHG emissions and improve air quality. A lack of refueling infrastructure for biodiesel blends higher than B5, compressed natural gas, and liquefied natural gas is a major barrier to adoption. The relatively low price of gasoline and diesel is another major barrier. To overcome these barriers, the state should encourage demand by switching to some alternative vehicles in its own fleet and encourage other fleets to do so where it is economical. In order to build out additional refueling infrastructure when such infrastructure is less economical because of low petroleum prices, the state should consider whether there are ways to encourage new refueling stations such as public-private partnerships to share costs of new stations. For example, in dense areas where there may be larger private fleets using compressed natural gas, public transportation fleets could also be converted to natural gas and share the costs of developing new stations.

Recommendations

(1) *Support the development of additional refueling stations for alternative fuels for both private and public transportation fleets by sharing station development costs between public and private interests.*

(2) *Continue working with other regional partners on analyzing a low-carbon fuel standard framework for the region that includes biodiesel blends.*

(3) *Investigate the feasibility and cost of moving state fleet medium- and heavy-duty vehicles to biodiesel blends, focusing in particular on cost and the availability of refueling stations throughout the state.*

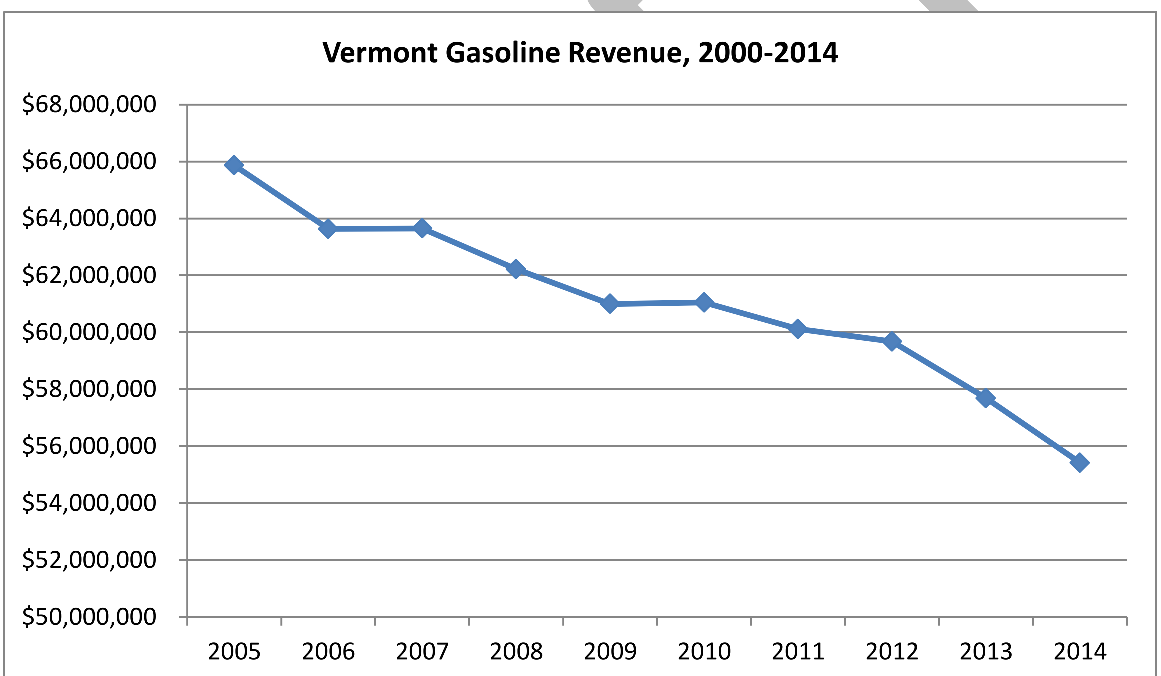
(4) *Work with the Clean Cities Coalition to encourage large fleets to switch to natural gas use where biodiesel is impractical.*

8.7 Transportation Funding Dilemma

The transportation sector is almost wholly dependent on gasoline or diesel fuels. Most of Vermont's and the country's transportation programs are funded, directly or indirectly, through via petroleum fuels taxes, vehicle registration and other motor vehicle fees, and the vehicle purchase and use tax.

Vermont's Joint Fiscal Office issued a report titled "Vermont's Transportation Funding: An Ongoing Dilemma" in October 2009."[128] The long-term problems identified in the report include an anemic revenue base and aging infrastructure. The reports show the state's historical transportation funding and gasoline tax levels since 2001. There has been a substantial decline since 2008 in both gasoline tax and overall transportation fund revenue, 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.

Exhibit 8-16. Vermont gasoline revenue, 2005-2014



Source: Vermont Joint Fiscal Office, Gas & Diesel Revenue and Gallons Report

These funding limitations will be exacerbated in the future, as Vermont must simultaneously transform the system to reduce petroleum dependency, operate more efficiently, address Vermonters' shifting transportation demands, and meet the state's renewables and GHG reduction goals. Federal and state transportation funding mechanisms will need to recognize these important priorities.

[128] www.leg.state.vt.us/jfo/issue_briefs_and_memos/Transportation%20Funding%2010-2009.pdf.

Funding levels are needed to 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 reducing transportation energy by 20% and meeting 10% of the need with renewable energy will result in reduction in taxed fuel sales, resulting in a state transportation fund that is significantly 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.

Vermont is faced with another major transportation challenges. The federal highway trust fund is in the red and Congress has not indicated a willingness to find a long term transportation revenue source.

Highways and bridges eventually need to be replaced. The state'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.

Transportation challenges are being faced at the federal level, and some solutions may make sense at a multi-state regional level. Vermont must be a leader and not ignore the funding reality that transportation funding challenges that will be exacerbated as the state works to reduce petroleum consumption.

CEP implementation must be coupled with changes in transportation revenue policy. ***VTrans is currently undertaking a study on future transportation revenue, and the final CEP will reflect the results of that study.***

9 Electric Power

This portion of the CEP addresses 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.

This chapter contains an overview of electric usage and demand and explains the shifting context in which electric planning now operates. Two approaches work together to provide the state's projected electricity service: managing demand and meeting it with supply. Chapter 10 addresses the state's ability to manage electric energy demand through energy efficiency, load management, and electric energy storage. Chapter 11 discusses tools and technologies available to cost-effectively meet electric demand while advancing state policy objectives, such as the Renewable Energy Standard and robust planning frameworks, including both land use planning for siting new generation and integrated resource planning. That chapter concludes with a discussion of future utility regulatory models and other changes necessary to prepare for a fully modernized and dynamic electric grid.

On the electric grid, energy supplied must balance, moment by moment, with energy consumed or lost. Today, the grid is in the midst of a transformation. Historically, when operating the grid, demand at any given moment was taken as given, and generators were controlled in order to meet exactly that demand. Demand was forecast for the day or month ahead in order to plan for generator operations and dispatch, and over longer time periods to determine when new generation or transmission might be required. As energy efficiency and demand response have matured as resources, efficiency has shown that it can change long-term forecasts, while demand response can be dispatched, like a generator, to meet peak loads.

Even more recently, more generation has come online from variable resources, such as wind and solar power, which also have no marginal cost and are therefore "must take" resources in least-cost grid operations. These generators are generally smaller in capacity than combustion-based plants, and are distributed in many locations around the distribution grid. Electric energy storage technologies are maturing quickly, as are technologies for automating and aggregating control of many different kinds of end uses (beyond the water heater controls that have been deployed for decades). Electric vehicles and heat pumps present new challenges and opportunities. These challenges, taken as a whole, present a new grid paradigm in which both demand and supply have both controllable and non-controllable (but forecastable) aspects. The integrated grid is possible due to the proliferation of information technology tools throughout the grid – at supply, on the grid itself, and at the end use. This provides the opportunity to optimize the grid in a way not possible before – with significant but uncertain potential to contain overall and per-unit costs. This paradigm informs Vermont's approach to both managing and meeting electric service demand, as described in this CEP.

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."[129] 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 both 33% or more in total energy use reductions and meeting 90% of our remaining consumption from renewable sources by mid-century. This CEP incorporates the renewable electric requirements established by Act 56 of 2015, and establishes a goal of 67% renewable electricity by 2025 on the way to 75% or more by 2032.

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 second lowest, on average, in New England, and is far more stable than in other states. Part of this price advantage is related to long-term contracts entered into by Vermont's utilities. 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.

Retail electric costs are more than the moment-by-moment or long-term costs of energy, however; they are also the costs of building and maintaining transmission and distribution infrastructure, generation capacity for peak times, and utility operations. In the case of for-profit utilities, it can also include a limited return to the investor. Utility regulation by the PSB establishes the structure and process for determination of total utility revenues and how those revenues are collected from each customer. The design of rates for each customer class is intended to reflect the costs caused by those customers' use of the electric system – this avoids subsidization of any customer class by other classes and is considered economically efficient. Utilities and their regulators are guided by the policies established in Vermont law, which include at their core a goal of least-cost electric service, including economic and environmental costs, consistent with the principles identified in Chapter 3 of this CEP. Per-unit electric rates reflect all of these costs and their allocation, divided among all of the customers, kilowatt-hours of energy, and kilowatts of power delivered. Seeking the lowest electric rates and bills, therefore, includes:

- Reducing electric use and acquiring least-cost energy and capacity, to avoid energy costs;

[129] *30 V.S.A. § 202(a).*

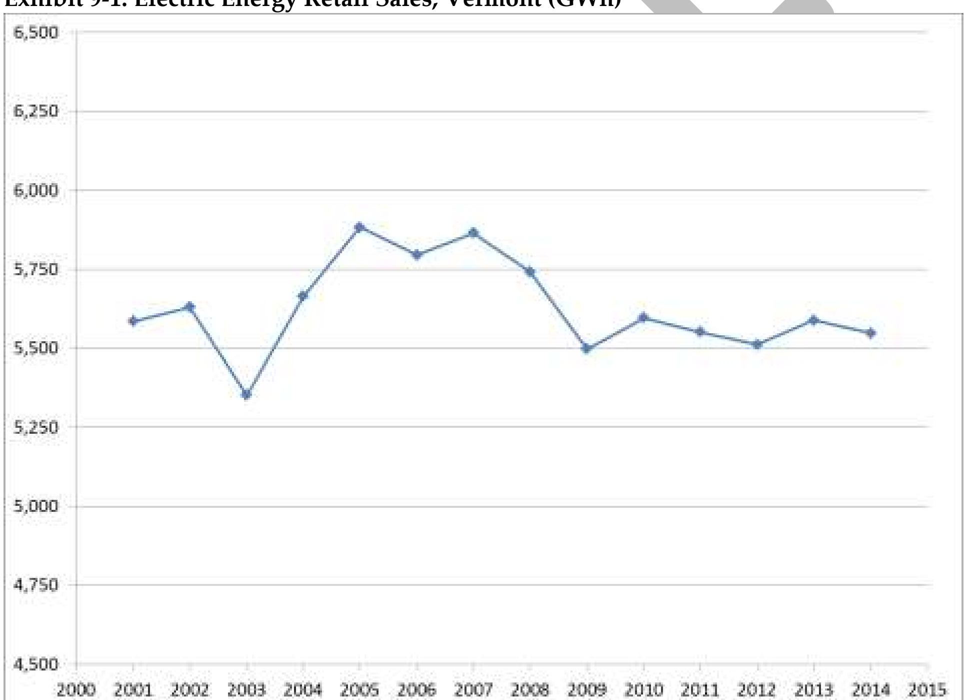
- Lowering peak energy use and distributing generation close to load, to reduce Vermont's share of regional transmission costs and avoid the need to build new electric infrastructure; and
- Using existing electric transmission and distribution infrastructure to the fullest, to share the cost of this infrastructure over as many energy units as possible and thereby lower rates.

9.1 Historic and Current Demand and Prices

9.1.1 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 24 years. Exhibit 9-1 shows the state's annual electric energy consumption. Since 2005, 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 portion of the CEP.

Exhibit 9-1. Electric Energy Retail Sales, Vermont (GWh)

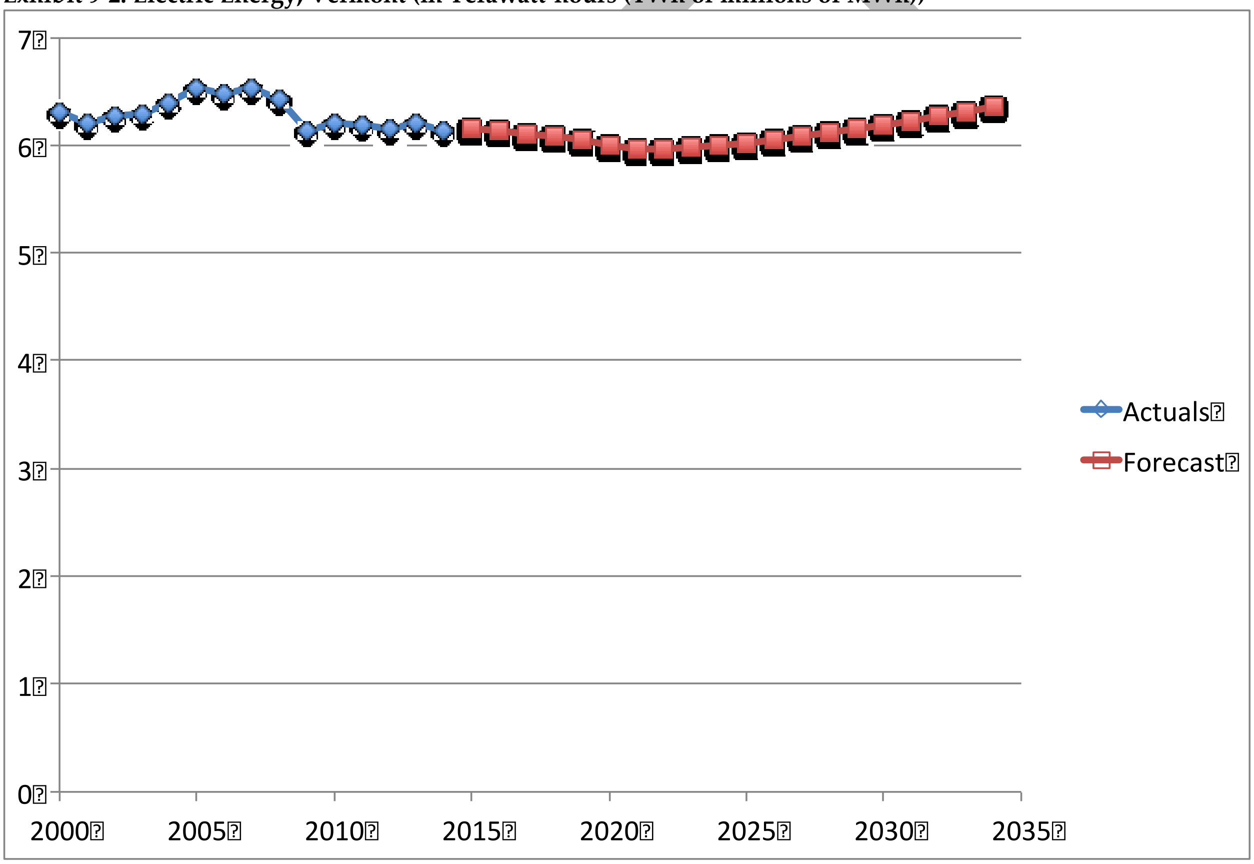


Source: U.S. Energy Information Administration

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 DPS, and representatives of the general public. The long-term VELCO demand forecast is based on 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 EVT.

Overall, the VELCO forecast projects an average annual electric use decline of 0.3% through 2024, followed by an average increase of 0.6% per year through 2034. The VELCO forecast is a thorough, business-as-usual snapshot of projected electric load growth. VELCO's forecast accounts for net metering up to 15% of each utility's peak load, as well as other generation that is "behind-the-meter" as far as the regional grid operation, and an estimated deployment of heat pumps and electric vehicles. As such, it does not include either additional net metering as might be deployed under the new rules under consideration by the PSB, or changes in transmission-level electric demand driven by the additional distributed generation or end-use electrification resulting from Act 56.

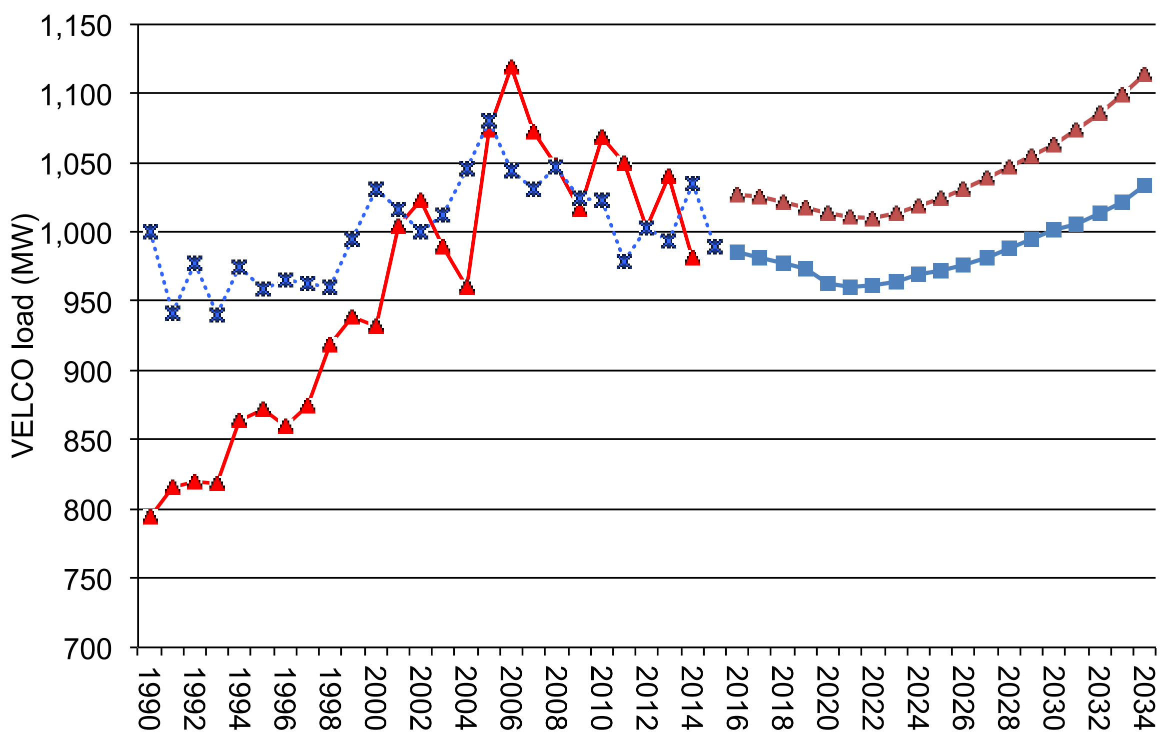
Exhibit 9-2. Electric Energy, Vermont (in Terawatt-hours (TWh or millions of MWh))



Source: VELCO

Exhibit 9-2 illustrates the winter and summer peak demand since 1990, along with VELCO's recent long-range forecast. VELCO's system was winter-peaking until 2002, when the summer peak first exceeded the winter. Winter peaks have been controlled in large part by use of increasingly efficient lighting and reduction in the use of electric resistance heat, while summer peaks rose with increased use of air conditioning. System summer peak demand is forecast to decline to just over 1,000 MW by the early 2020s, then increase to approximately 1,100 MW by 2033. 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 falling level through the early 2020s, then rising past 1,000 MW by 2030.

Exhibit 9-3. Vermont Summer Peaks (red) and Winter Peaks (blue), 1990–2015, with VELCO Forecast to 2034

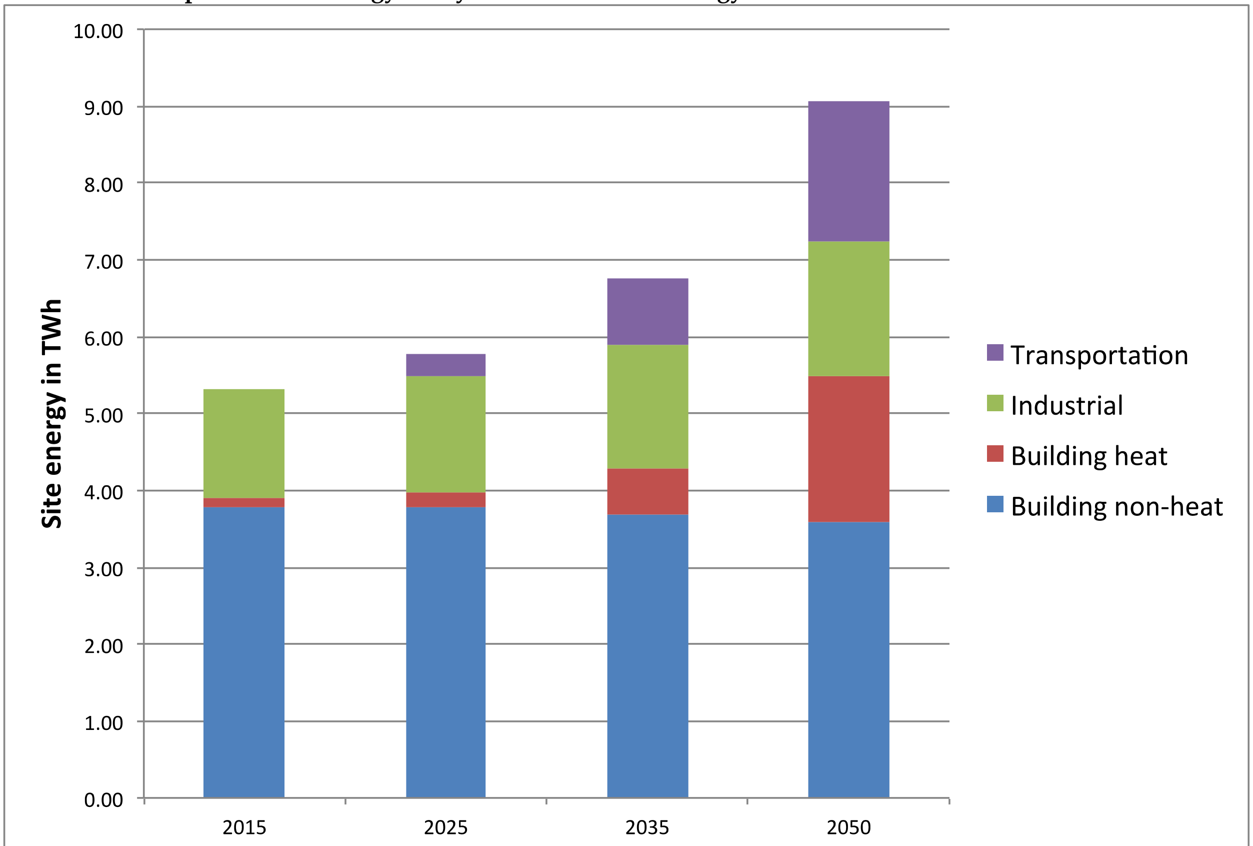


Source: VELCO

9.1.2 Electric Demand for 90% Renewable Energy: Total Energy Study Modeling

The DPS's 2014 Total Energy Study (TES) modeled the economy-wide transition to 90% renewable energy. While the TES modeling encompassed several scenarios for achieving the 90% goal, all showed a significant increase in electric demand from current levels, and higher levels of electric energy use than the TES business-as-usual case and the VELCO forecast shown above. Exhibit 9-4 shows the electric energy use from a composite scenario that uses electricity rather than liquid biofuels for both light-duty vehicles and building heat (modeled as efficient EVs and cold climate heat pumps; wood energy use remains roughly level with current use). Given the possibility for increases in efficiency and for the increased use of wood or sustainable biofuels for renewable heat and transportation, this should be considered a higher-end estimate of possible 2050 electric demand. TES model cases which assume widely available and inexpensive biofuels, however, still indicate electric demand at about 80% of this level, or more than 1/3 higher than current use.

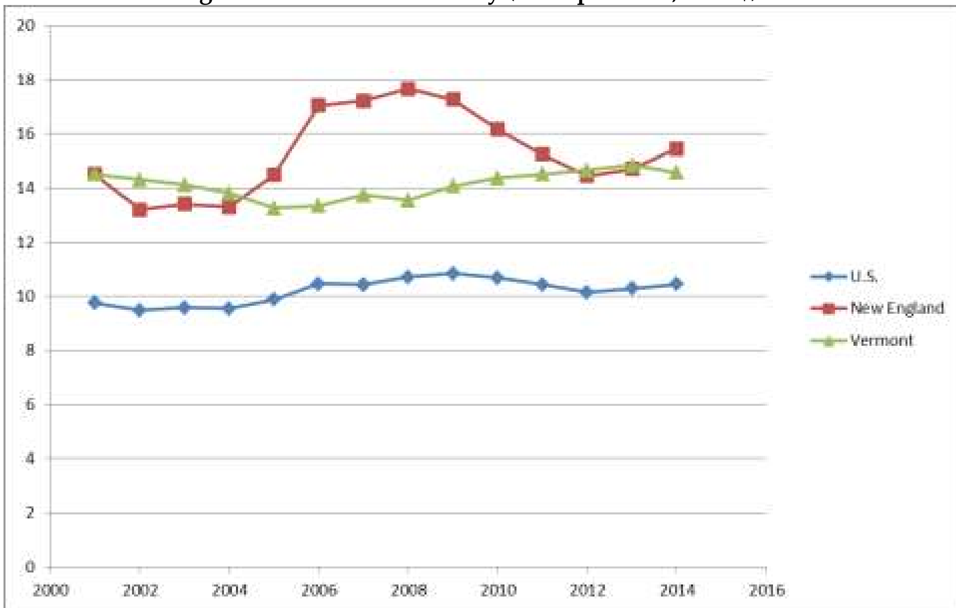
Exhibit 9-4. Composite Total Energy Study Modeled Electric Energy Use (TWh)



9.2 Electric Prices

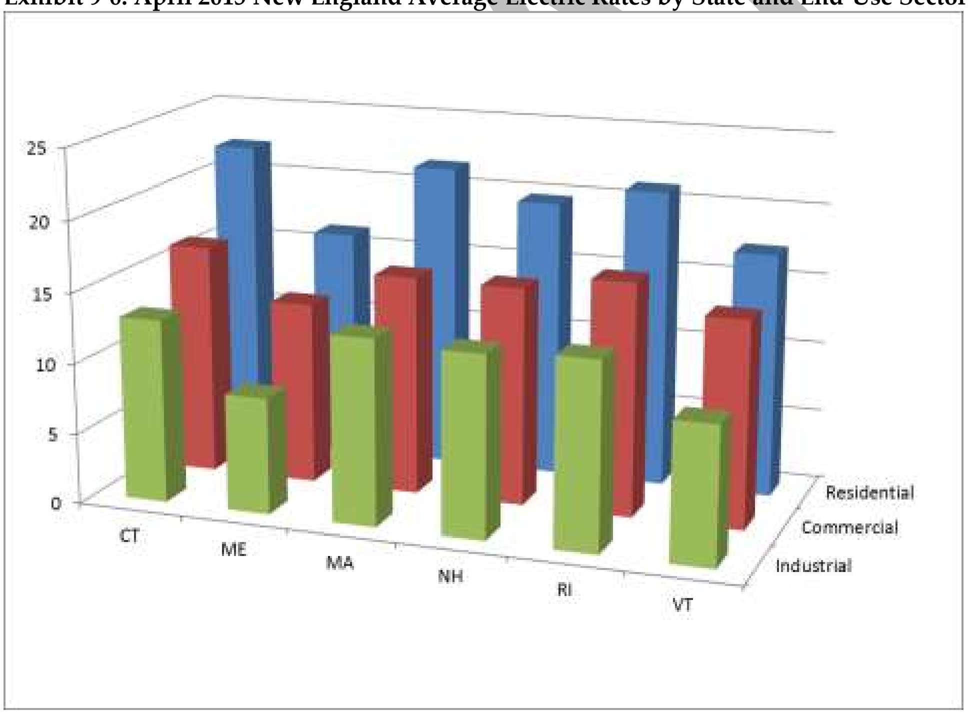
As shown in Exhibit 9-5, Vermont's average price per kWh for retail electricity sales has remained relatively flat on an inflation-adjusted basis for the last several decades. Compared to the region as a whole, Vermont has had favorable electric rates over the last decade. Exhibit 9-6 shows a snapshot of recent New England and Vermont electric rates. Vermont currently maintains a modest price advantage compared with the region on average, although rates vary by end use sector and by utility.

Exhibit 9-5. Average Retail Price of Electricity (cents per kWh, 2014 $)



Source: U.S. Energy Information Adminsitration

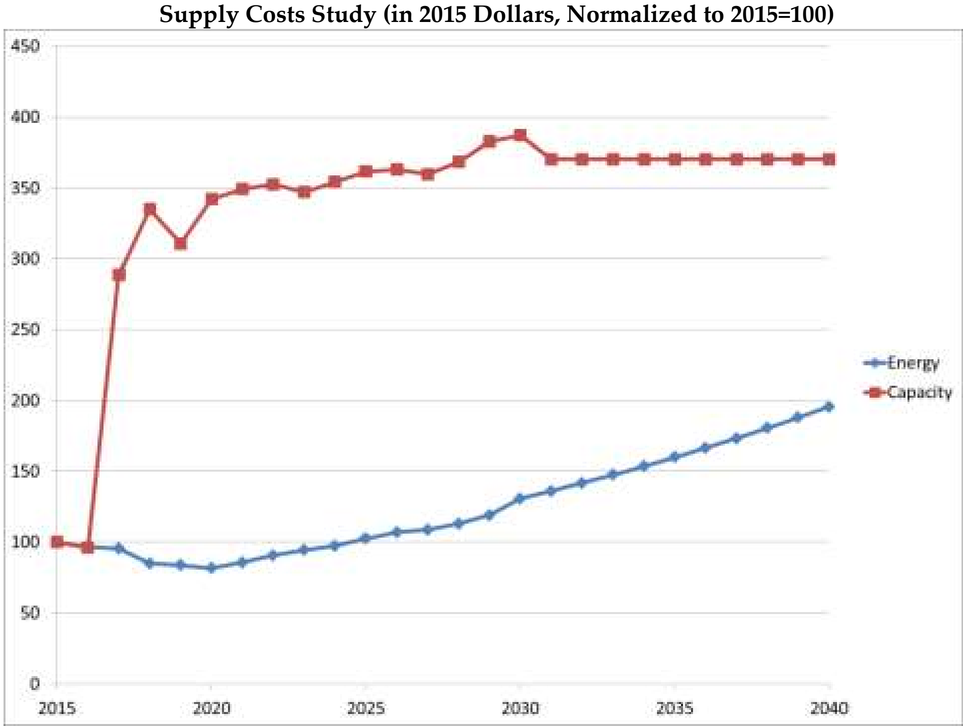
Exhibit 9-6. April 2015 New England Average Electric Rates by State and End-Use Sector ($/kWh)



Source: U.S. Energy Information Adminsitration

While Vermont utilities have significant long-term power contracts with various pricing mechanisms, reducing our exposure to the regional markets when compared with other states, electric rates will continue to be impacted by the dynamics of those markets. On a periodic basis, the six New England states jointly produce an Avoided Energy Supply Costs study, for use in screening cost-effectiveness for energy efficiency programs. The most recent forecast, whose results are summarized in Exhibit 9-7, indicates an expectation of relatively low wholesale energy market prices for the next decade or so; this projection assumes the resolution of winter natural gas capacity constraints that have driven up recent winter energy prices. Capacity market prices are projected to remain high, reflecting a continued need for additional generation capacity at times of peak demand. This need is driven both by rising summer peaks in the region as a whole and the retirement of older generators throughout the region.

Exhibit 9-7. Wholesale Energy and Forward Capacity Market Price Projections from the 2015 Avoided Energy Supply Costs Study (in 2015 Dollars, Normalized to 2015=100)



Source: Avoided Energy Supply Costs, 2015

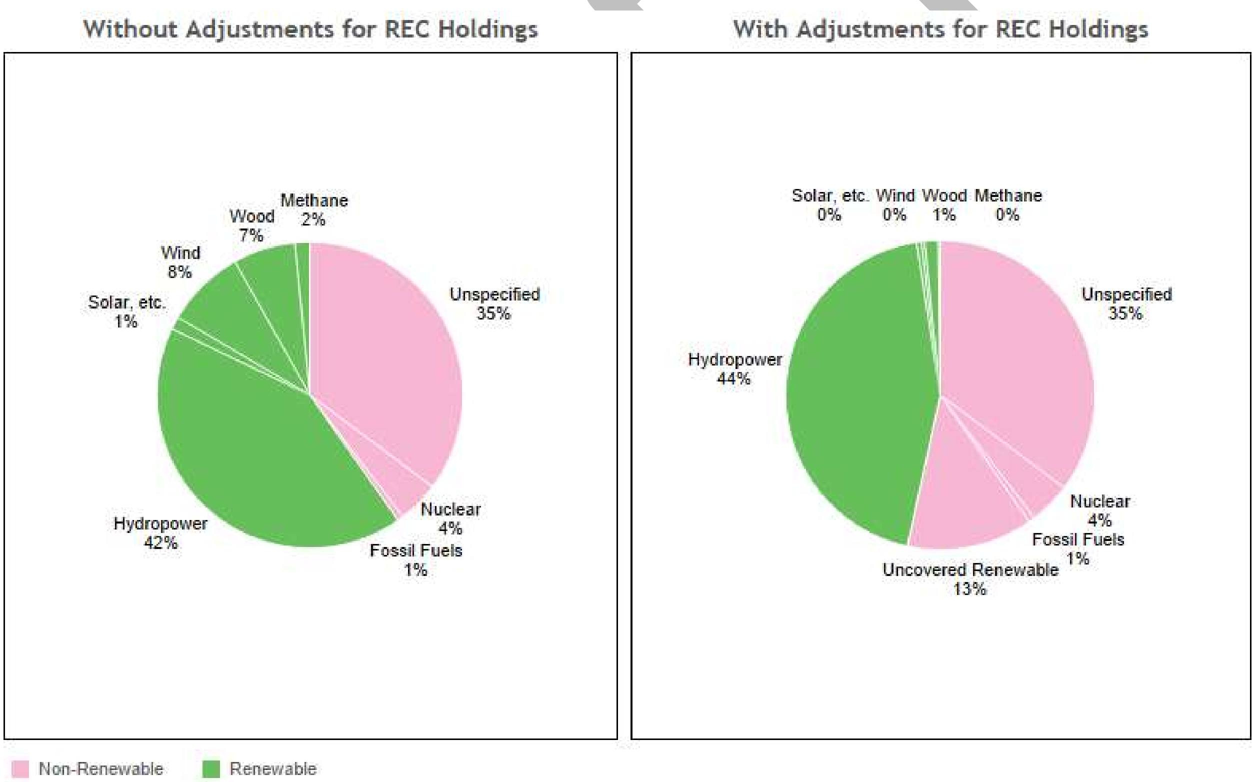
Wholesale marginal electricity prices in New England are dependent upon the regional natural gas price. Even though there is little significant gas-fired generation owned or directly contracted by Vermont utilities, Vermont's utilities often must rely on the regional market for shorter-term contracts; 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; separation in winter rates is driven by natural gas constraints. 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 market costs described above.

9.3 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 approximately 20% has been from Vermont-based resources. Exhibit 9-8 shows the mix of sources that supplied electric energy to end users in 2014. The data are presented both before and after any sales and purchases of renewable energy credits (RECs). The Renewable Energy Standard enacted in Act 56, described in more detail in Chapter 11, will result in significant changes in the net disposition of RECs in utility portfolios.

Exhibit 9-8. Vermont Electric Energy Supply, 2014, before and after REC sales and purchases



This supply mix is currently dominated by stable long-term commitments from a number of sources – primarily Hydro-Quebec (HQ), the Seabrook nuclear facility in New Hampshire, and renewable energy generators owned by or under contract to Vermont utilities, which together will supply between half and two-thirds of the electricity used in the state in the coming years. Utilities are in a period of transition between two HQ contracts; one phases out in stages between 2012 and 2020, while the other phases in over a similar time period. The new contract was signed with HQ by a coalition of Vermont utilities for 218 MW of power, for 16 hours per day, making it roughly 1/3 smaller than the previous contract.

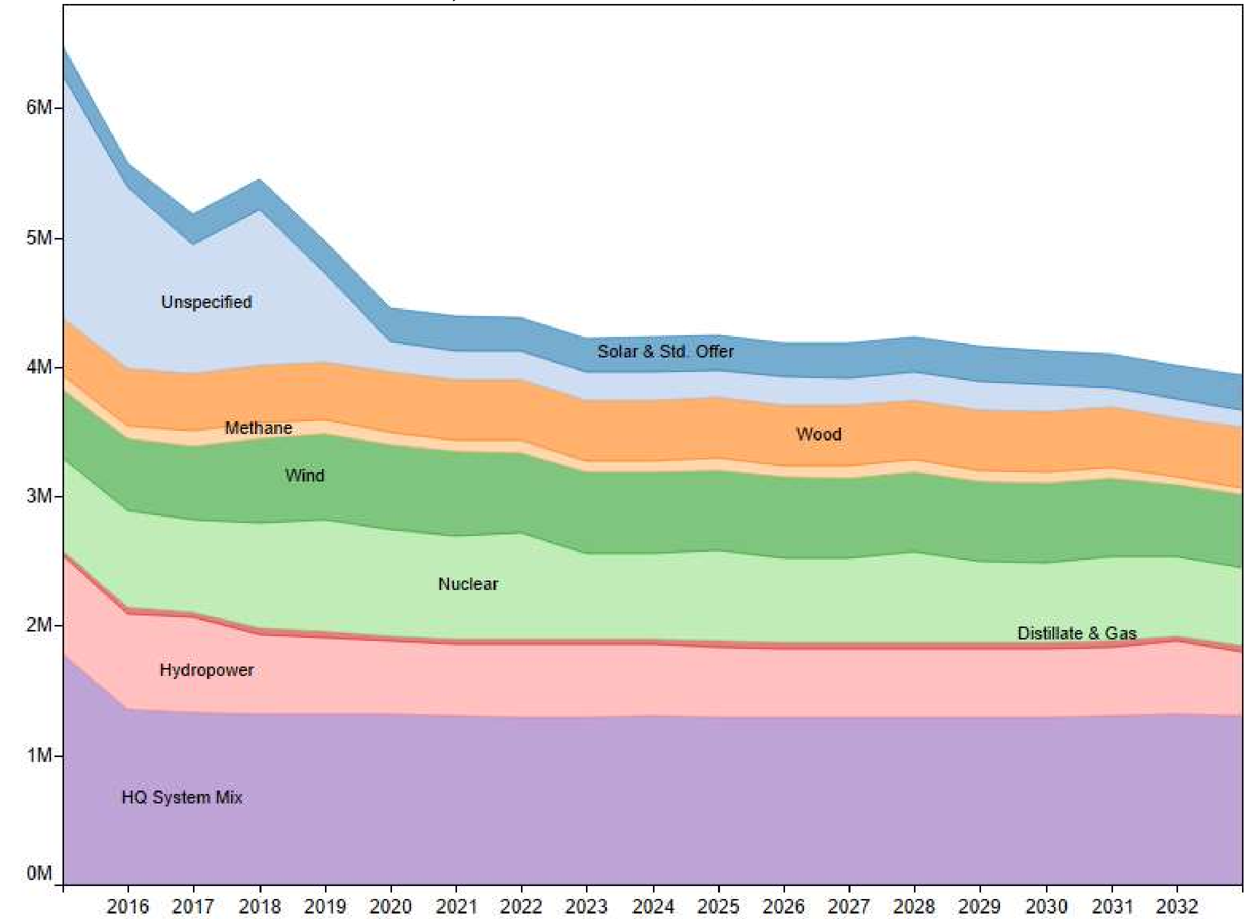
A significant portion of electricity supplied to end users in Vermont is currently from renewable resources. In 2014, in-state hydroelectric power accounted for 11% of supply, and other in-state renewable generation accounted for approximately 2%.[130] Further, power generated from renewable resources under contract to or owned by Vermont utilities, with renewable energy certificates sold to other utilities accounts for another 16% of Vermont's electric supply, for a total of nearly 30%.[131] When the renewable power from Hydro-Quebec, which has been approximately 30% of supply, is counted, nearly 60% of the power supplied for purposes of Vermont end-use consumption is presently from renewable sources, before REC sales. While not downplaying the challenges and efforts necessary, we believe this fact shows that a goal of acquiring an increasing fraction of our electric supply from renewable sources is reasonable and attainable.

As shown in Exhibit 9-9, there is a gap between contracted supply and expected demand. 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.

[130] *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 electric generation also varies from year to year based on market prices for electricity.*

[131] *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.*

Exhibit 9-9. Committed Electric Resources, in millions of MWh (TWh)



9.4 Electric Generation in Vermont Today

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, in the context of increasing the total renewable generation sources in the state's power mix to at least 75% by 2032, with new distributed generation connected to Vermont's distribution grid growing to 10% of retail electric sales over the same time frame. This section summarizes the current resources in the electric portfolio, while Chapter 10 addresses changes in that portfolio between now and 2050.

Generators can be divided into classes based on their size and how they connect to the grid. The CEP uses four classifications: utility-owned generation; independent power producers (IPPs) that operate under power purchase agreements (PPAs) with Vermont utilities; independent power producers (IPPs) that operate under the Standard Offer or Rule 4.100/ Public Utility Regulatory Policies Act (PURPA) programs; and customer-owned net metered generators. Distributed generation is defined to include generators under 5 MW in capacity that is tied to utilities' distribution circuits; this could be any classification. Distributed generation reduces the load on transmission systems by meeting load on a distribution circuit with generation on that or a nearby circuit. With the closure of the 620 MW Vermont

Yankee Nuclear Power Station (Vermont Yankee) in Vernon, Vermont no longer has any large-scale centralized electricity generation.

9.4.1 Utility-Owned Generators

Utility-owned generators include the McNeil Generating Station (50 MW, wood biomass), Kingdom Community Wind (63 MW), VPPSA's combustion turbines in Swanton (40 MW), Burlington Electric's gas turbine (25 MW), Washington Electric Coop's Coventry Landfill methane plant (8 MW), Searsburg wind facility (6 MW), and a number of small hydroelectric facilities (totaling 110 MW) and solar PV generators (totaling 4 MW[132]).

9.4.2 Power Purchase Agreements

In addition to utility-owned generators, Vermont has several generators owned by private merchant producers under contract to deliver power to our utilities. Recently permitted or constructed examples include the Sheffield wind project (40 MW) and the Georgia Mountain wind project (10 MW) as well as more than 7.5 MW of solar PV (6.6 MW of which is located in the Rutland area).

9.4.3 PURPA and the Standard Offer

The PSB's Rule 4.100 and the Standard Offer program both establish statewide structures under which generators' output is distributed among Vermont's utilities according to their load.

Many 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 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 (a role filled by Vermont Electric Power Producers Inc. (VEPP 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. The fifteen remaining Rule 4.100 renewable energy projects and their capacity can be found in Exhibit 9-10. As can be seen, many of these projects have contracts ending soon. Several projects' contracts have already expired;

[132] *4 MW of awarded CPGs. CPG applications have been received for an additional 13 MW of utility-owned solar PV.*

these generators are independently participating in the Independent System Operator of New England (ISO-NE) wholesale markets or have transitioned to the net metering program. One former Rule 4.100 project, the Ryegate wood biomass plant (20 MW), operates under an agreement subject to the structure of 30 V.S.A. § 8009. Recently several possible new projects, both wind and solar PV, have expressed interest in contracts.

Exhibit 9-10. Rule 4.100/PURPA generators

Project[133]	Capacity[134] (kW)	Contract Ending Date
Barnet	490	Oct. 31, 2016
Comtu	460	Dec. 31, 2018
Dewey's	2,790	Jan. 31, 2016
Dodge	5,000	Dec. 14, 2020
Emerson	230	Oct. 31, 2015
Killington	100	May 31, 2016
Moretown 8	920	Jan. 31, 2019
Nantana Mill	220	Mar. 31, 2020
Newbury	270	Oct. 31, 2017
Ottauquechee	2,180	Aug. 31, 2017
Sheldon Springs	26,380	Mar. 31, 2018
Slack Dam	410	Oct. 31, 2017
Winooski 8	910	Dec. 31, 2015
Woodside	120	Apr. 30, 2017
Worcester Hydro	170	Oct. 31, 2016

The Standard Offer program began in 2009 with the offering of fixed prices for up to 50 MW of capacity from small (2.2 MW or smaller) renewable generators. Output from these projects is purchases by VEPP, Inc., and distributed to the utilities, similarly to the Rule 4.100 structure. The program has since expanded to both encompass many "cow power" anaerobic digesters and to allow for an increasing annual allocation of new capacity, awarded via competitive solicitation. To date, contracts have been awarded to 68 generators with a total capacity of 71.8 MW. This includes 38 solar PV systems totaling 59 MW, six small wind projects totaling 520 kW, six hydroelectric projects totaling 4.9 MW, two woody biomass CHP projects totaling 1.2 MW, one landfill methane project of 560 kW, and 15 farm methane projects totaling 5.4 MW. Fifty-one projects totaling 52.6 MW are operating.

9.4.4 Net Metering

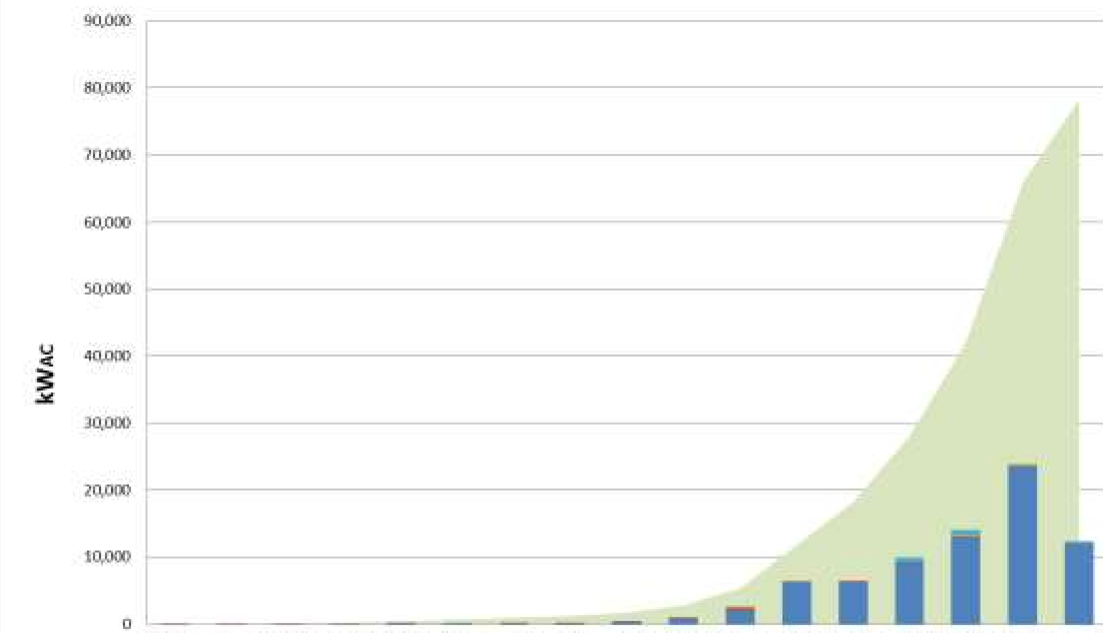
More than 78 MW of net metering generating systems have received certificates of public good. Exhibit 9-11 shows the sharply increasing trajectory of permitting and cumulative capacity of such projects in the

[133] *All the operating Rule 4.100 projects are hydroelectric plants.*

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

last several years. Net metered projects are limited to 500 kW or less, outside of several exemptions for larger projects (up to 5 MW) allowed under Act 99 of 2014.

Exhibit 9-11. Net Metered Permitted Capacity by Year and Type



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cumulatve Capacity	49.82	98.55	175.51	228.45	441.05	674.62	985.71	1261.19	1756.62	2807.21	5322.89	11779.8	18184.7	28047.6	42056.5	65935.0	78283.5
Hydro	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.25	0.00	0.00	716.15	664.25	0.00	360.00
Methane	0.00	0.00	0.00	0.00	0.00	65.00	0.00	0.00	0.00	19.00	39.00	126.75	0.00	0.00	248.00	292.50	0.00
Wind	31.91	9.50	27.95	30.95	98.50	71.94	124.15	101.51	148.03	157.94	482.41	153.99	238.70	65.53	124.88	98.00	99.00
Solar	17.91	39.24	49.00	21.99	114.10	96.64	186.94	173.97	347.41	873.65	1976.02	6176.24	6166.15	9081.26	12971.7	23488.0	11889.4

10 Managing Electric Demand

The state's first and best least-cost option to meet expected electric energy demand is demand-side management (DSM). This chapter 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 chapter concludes with discussions of the challenges of further increases in efficiency and the potential for Smart Grid technologies to create new DSM opportunities as well as load management strategies and integration of storage.

DSM programs and policy considerations in Vermont have traditionally focused on utility resource decisions and investments. However, energy efficiency options encompass all categories of fuel, including electricity, motor gasoline, and fuel oil for heating and process needs. This chapter considers electric energy efficiency as an electric resource acquisition strategy; however, it is imperative to recognize that energy efficiency investments for all fuels should be considered holistically. Energy consumers base decisions on total building energy bill and consumption patterns, of which electricity usage is just one important part. Chapter 7 discusses thermal efficiency options, considering strategies for encouraging energy reductions on a "whole-building" basis as well as industrial process heat. Thus, the electric efficiency chapter is limited to discussing resource acquisition implications of electric energy efficiency, other DSM options, load management, and storage.

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 strategically. As other chapters 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, Chapter 8 calls for policies that will facilitate increases in plug-in electric vehicles, and Chapter 7 discusses a hypothetical fuel mix for meeting the 90% renewable goal by 2050 whereby some existing fossil fuel heating is switched to electric heating, which would require an increased penetration of cold climate heat pump technology. Electric DSM is not at odds with such policies and concepts; 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 have potential to save Vermonters money on their electric bills and provide significant economic and societal benefits to the state.

Electric demand management encompasses a range of service alternatives that include *energy efficiency* and *load management* strategies. *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. *Load management* is generally associated with strategies and technologies focused on reducing demand during peak demand times to shift usage from peak to off-peak periods. For example, *demand response* and *smart rates* are load management strategies whereby electric customers are compensated for not using electricity during specific peak demand period when capacity is constrained. Electric energy efficiency, and load management strategies are the subject of the bulk of this chapter.

Many of the strategies and recommendations in this chapter seek to reduce electricity consumption during peak periods. Peak periods are hours of the year when demand for electricity is at its highest. The transmission and distribution systems must be sufficiently robust to accommodate this demand, and there must be sufficient generating capacity to meet peak demand even if those "peaking" generating units are only turned on for a few hours each year. Were it not for those few hours, we would need fewer generating stations and fewer investments in transmission and distribution infrastructure. These few peak hours drive many costs associated with the electric system including charges for transmission and future capacity build-outs at the regional level (RNS and capacity charges) and local investments in distribution and sub-transmission infrastructure. The highest peak demand usually occurs in the summertime, on the hottest days, during the afternoon hours.[135] Electricity used during peak times provides critical services including air conditioning, which is an effective mitigation option for reducing heat-related health impacts especially for vulnerable individuals such as older adults or the chronically ill. As the climate warms, providing reliable ways to cool buildings will become more important to protect vulnerable individuals. Vermont strives to provide critical building-cooling services while keeping peak demand as low as possible. Equipment and appliances that respond to smart rates or utility signals offer such an opportunity and are discussed in greater detail below under Load Management.

10.1 Managing Vermont's Electricity Demand (Goals and Objectives)

Vermont law sets forth certain standards and criteria that the PSB must consider when determining budgets for energy efficiency programs. Under 30 V.S.A. §209(d)(3)(B), when establishing the amount of the energy efficiency charge and its allocation, the PSB has to determine the appropriate balance among eight stated objectives, with "particular emphasis" given to the first four objectives:

1) Reducing the size of future power purchases;
2) Reducing the generation of GHGs;
3) Limiting the need to upgrade the state's transmission and distribution infrastructure;
4) Minimizing the costs of electricity;
5) Reducing Vermont's total energy demand, consumption, and expenditures;
6) Providing efficiency and conservation as part of a comprehensive resource-supply strategy;
7) Providing the opportunity for all Vermonters to participate in efficiency and conservation programs; and
8) Targeting efficiency and conservation efforts to locations, markets, or customers where they may provide the greatest value.

In addition, the following additional statutory goals and objectives related to electric energy efficiency include:

[135] *Because of distributed solar generation, which has the effect of meeting demand as it occurs in the distribution system, peak consumption as it affects resource acquisition and transmission investments may be shifting later in the day.*

1) §209(d)(3)(b) The [energy efficiency] charge shall be reviewed by the Board for unrealized energy efficiency potential and shall be adjusted as necessary in order to realize all reasonably available, cost-effective energy efficiency savings. "
2) §30 V.S.A. §209(f)(14) requires that the Board consider the impact of energy efficiency programs on retail electric rates and bills and the impact on fuel prices and bills.
3) §218c related to least cost integrated planning, Regulated Utilities must meet the public's need for energy services at lowest present value life cycle costs.
4) §202 (a) related to state energy policy, 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. Also 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.

10.2 Strategies to Address Electric Demand

10.2.1 Electric Energy Efficiency

10.2.1.1 Background; Historic and Current Demand Reduction; Future Trends

The Vermont Legislature 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.[136]

In 2000, Vermont began administering electric energy efficiency programs through energy efficiency utilities (EEUs). To accomplish this, EVT was created, and operated under a contract with the PSB for all electric service territories other than Burlington.[137] 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.

[136] *See PSB Order in Docket 5270 and DPS, "Vermont Electric Plan 2005."*

[137] *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. Vermont Gas Systems (VGS) operates natural gas energy efficiency programs under a Board approved Order of Appointment to serve as an EEU since April 2015.*

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. Vermont currently acquires electric energy savings through investments in energy efficiency at a pace that leads the nation. As summarized in a recent national benchmarking study commissioned by the DPS, Vermont's electric EEUs deliver electric energy efficiency savings above the median savings as a percent of sales at the median levelized cost of energy saved cost of $0.03 per kWh (see Exhibit 10-1 below).[138]

Exhibit 10-1. 2012 Benchmarking Results

	Spending as % of Revenue	Energy Savings as % of Sales	Summer Peak Demand Savings as % of Peak Demand	Retail Cost of Energy $/kWh	Cost of First Year Savings		Levelized Cost of Energy Savings *	Cost of Lifetime Savings **
					$/kWh	$/kW	$/kWh	$/kWh
All Benchmarked Median	2.70%	1.70%	0.90%	$0.12	$0.25	$1,825	$0.03	$0.02
EVT	4.00%	2.40%	1.30%	$0.15	$0.24	$1,705	$0.03	$0.02
BED	3.60%	1.90%	1.20%	$0.14	$0.26	$2,254	$0.03	$0.02

* Levelized cost of energy includes a capital revcovery factor.
** Cost of lifetime savings is annual spending divided by lifetime savings.

[138] *For example, see "Benchmarking of Vermont's 2011 and 2012 Demand Side Management Programs" (Navigant Consulting for the DPS) and the most recent"State Energy Efficiency Scorecard" (ACEEE).*

Also, Exhibit 10-2 shows the incremental annual MWh savings achieved by the electric EEUs. Recent savings from electric energy efficiency investments for EVT and BED combined translate into an annual total load growth savings of more than 2% per year.

Exhibit 10-2. Annual Incremental MWh Savings (2000–14)

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	80,600
2010	110,524
2011	101,282
2012	110,179
2013	85,582
2014	91,146

10.2.1.2 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 $7 billion regionally (in addition to

the more than $4 billion of investment planned for the next ten years).[139] 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 2016, avoided RNS costs are expected to be approximately $.015 per kWh saved.[140] In addition, the need for ancillary services provided by ISO-NE is shared across the region – another $.0066 per kWh saved. Taken together, each kWh saved avoids more than 2 cents in RNS and ancillary charges alone.

- 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 $100 per ton of CO_2 equivalent.[141]

- 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.

- 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 associated with investing in electric energy efficiency (as of the writing of this draft), the DPS is in the process of estimating the

[139] *ISO-NE 2015 Regional System Plan at 7.*

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

[141] *Avoided Energy Supply Costs in New England: 2015 Report page 4-28*
http://publicservice.vermont.gov/sites/DPS/files/Avoided%20Energy%20Supply%20Costs%20in%20New%20England%202015%20Final.pdf

economic value of Vermont's investment in electric energy efficiency since 2000, in terms of both dollars saved as a result of investing in energy efficiency and what the impact on electric rates would be today but for the investment.

An analysis of the estimated economic value of the investment in electric energy efficiency is not complete at this time; however, a summary is planned to be included in the final draft of the CEP.

In 2011 the DPS 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 EEU electric energy efficiency investments. Many of the above factors cited above as benefits were included, as were the immediate negative economic effects of the rate impact of the state's energy efficiency charge. 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.

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 10-3. 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 as of 2011 that for every kWh of electricity saved, Vermont avoids approximately $0.021 of 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 of the Economic Impacts of Energy Efficiency Investments study can be found in at the DPS's web site[142].

Recommendations

(1) The DPS should collaborate with energy efficiency utilities and other stakeholders to better document and communicate the benefits of electric efficiency investment to the Vermont Legislature, ratepayers, and other stakeholders.

(2) The DPS should perform economic impact studies at least every three year budget cycle to measure effects of efficiency investments.

(3) When advocating for changes to the energy efficiency charge (EEC) to the PSB, as per §209(d)(3)(b) and §30 V.S.A. §209(f)(14), the DPS should continue to review the EEC for unrealized energy efficiency potential and adjust the EEC as necessary in order to realize all reasonably available, cost-effective energy efficiency savings while also taking into consideration the cost impact of energy efficiency programs on retail customer rates and bills.

10.2.1.3 ISO-New England and Forward Capacity Markets

Although there is currently more than adequate generation capacity to serve the region, that was not always the case. The 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. Revenues from participating in the market far exceed the costs of participating, including compliance with rigorous measurement and verification standards. These revenues have been directed by the Legislature to be used to support unregulated heating and process fuel efficiency programs (see Chapter 7).

Energy Efficiency is a valuable capacity resource in the FCM because it is embedded in the system and is not intermittent. In planning for the region's capacity requirements, ISO-NE forecasts annual and peak energy consumption 10 years into the future. Regional discussions continue 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. Currently ISO-NE collects actual measure level kWh and kW

[142] http://publicservice.vermont.gov/sites/DPS/files/Topics/Energy_Efficiency/EVT_Performance_Eval/Economic%20Impacts%20of%20EE%20Investments_2011.pdf.

installation data from regional Program Administrators to help improve forecasting through the ISO-NE Energy Efficiency Forecasting Working Group. There may be ways to further optimize Vermont's participation in the FCM. For example, it may be possible to optimize FCM revenues and mitigate rising RNS charges by placing a greater emphasis certain measures. Such a strategy could include deploying measures that save energy at peak times and weighting peak demand reduction goals and financial incentives for the EEU's appropriately as part of their Quantifiable Performance Indicators (QPIs).

The FCM is designed to ensure that there are sufficient resources to meet expected peak demand and the necessary reserve margin by paying resources – which can include generation, energy efficiency, and demand response – to be available when called upon. The costs associated with the FCM are assigned to each utility based upon its contribution to the system wide peak hour each year. To the extent that energy efficiency measures limit growth in peak demand, FCM charges to Vermont utilities will be less than they would have been otherwise. Even measures that do not qualify to bid into the FCM as a resource, such as peak shaving resulting from smart rates or volt/ var reductions, reduce capacity charges to utilities to the extent that these measures coincide with systemwide peak.

Recommendations

(1) Maintain the DPS's and electric EEUs' participation in ISO-NE efficiency forecasting efforts to ensure efficiency is appropriately reflected in ISO-NE's long-term planning.

(2) The DPS should advocate to the PSB for the appropriate weight and financial incentives for summer/winter peak savings goals in electric EEU's QPI's.

10.2.1.4 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 RNS 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 PSB in 2006 modified the guidance provided to EVT – 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. In the 2012-2014 timeframe the St. Albans and Susie Wilson Road areas were targeted.

The DPS completed an evaluation of GT impacts in 2011.[143] 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.

Ongoing results have shown the GT program should continue, but there remains room for improvement. Since initiating GT, the 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. In addition, to streamline the Demand Resource Plan proceeding the funding of GT is to be considered, to the extent possible, in the triennial EEU budget setting process[144]. 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 North American Electric Reliability Corporation (NERC) reliability standards.

The concept of geographically targeting energy efficiency also applies to the natural gas system as well. VGS's Order of Appointment for delivering natural gas energy efficiency requires VGS to participate in the VSPC on an as-needed basis and reduce natural gas capacity requirements through peak day and base load reduction and management in targeted areas, if applicable. The tools and process developed by the VSPC to identify potential electric GT areas may have value for identifying and deferring natural gas transmission investments.

Recommendations

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

(2) The DPS and other stakeholders should utilize the expertise of the VSPC for determining appropriate methods for estimating the benefits of avoided distribution and transmission costs that are used in cost-effectiveness screening.

(3) The DPS should facilitate VGS's initial participation in the VSPC, as needed, and investigate the benefits of modifying the VSPC's tools for identifying and selecting GT areas for use on the natural gas system.

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[143] *"Process and Impact Evaluation of EVT's 2007-2009 Geotargeting Program," Navigant Consulting for the DPS, January 2011.*

[144] *Public Service Board order of September 22, 2014 in EEU 2013-05 revisions to the Process and Administration of an Energy Efficiency Utility's Order of Appointment Section II.1.A.c "To the extent possible include consideration of the effects on overall DRP budgets and QPIs of geographically targeted energy efficiency budgets and services that may address distributed utility Supply Problems and/or transmission Reliability Deficiencies."*

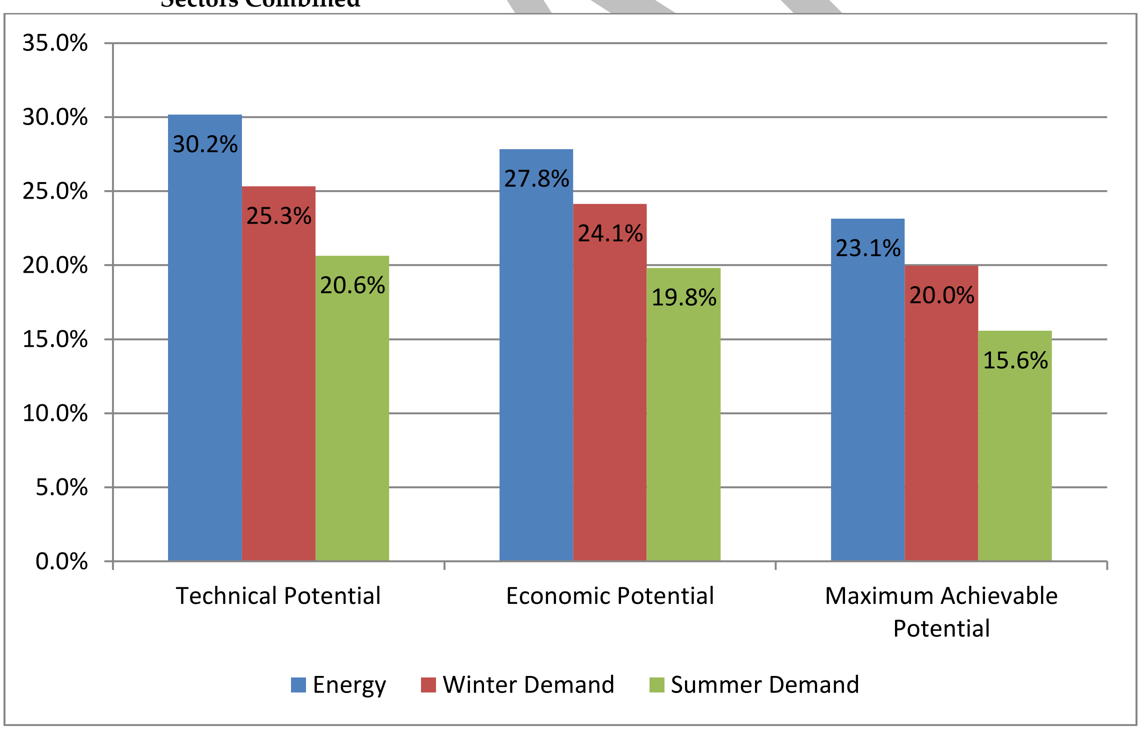
10.2.1.5 Sources of Electric Efficiency and Efficiency Utility Funding

Funding for electric efficiency program delivery is collected through ratepayers' electric bills, 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 2014, to set firm budgets for the 2015-17 program cycle and prospective budgets for 2015 through 2034.

The PSB balances a number of legislatively directed considerations when it determines the three-year budget and approves efficiency programs delivered by EEUs. As cited above in the Goals and Objectives subsection, 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 GHGs; 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 update to its energy efficiency potential study (originally completed in 2011). The update determined that cost-effective achievable energy efficiency potential is 23.4% of forecasted 2033 MWh sales (see Exhibit 10-4).[145]

Exhibit 10-4. Electric Energy Efficiency Potential (Percentage of Forecast 2033 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

[145] *"Electric Energy Efficiency Potential for Vermont," prepared for the DPS by GDS Associates, March 2014.*

offerings. Vermont already offers many programs via the EEU model, and the DPS works with the EEUs to support continued innovation and design of the most effective programs to assist ratepayers in achieving efficiency savings.

In the 2013-14 PSB Demand Resource Plan proceeding to develop electric efficiency budgets, the PSB ordered a modest increase in budgets for the three year period 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 resource acquisition focused research and development budgets to allow for thorough consideration and piloting of behavior and conservation programs intended to leverage digital meter data and the advanced metering infrastructure (discussed below). The energy efficiency utility budgets approved for collection via the EEC since 2001 and projected through 2034 are shown in Exhibit 10-5.[146]

[146] *Total budgets include funds collected from ratepayers for program delivery by both EVT and Burlington Electric Department, evaluation, efficiency fund management, and compensation. Forward budgets are approved on a three-year basis (2015–17 budgets are firm, whereas future budgets are subject to revision based on future Demand Resource Plan proceedings).*

Exhibit 10-5. Electric Energy Efficiency Utility Budgets Collected Via the Energy Efficiency Charge (2000–34)

Historic		Board Approved		Projected	
Period	Amount	Period	Amount	Period	Amount
2000	$8,674,914	2015	$52,217,314	2018	$58,327684
2001	$10,760,991	2016	$56,212,779	2019	$59,389,517
2002	$13,141,733	2017	$58,736340	2020	$61,013,058
2003	$14,000,000			2021	$63,987,570
2004	$16,224,477			2022	$64,952,892
2005	$17,500,000			2023	$66,668,424
2006	$19,500,000			2024	$69,973,773
2007	$24,000,000			2025	$71,064,244
2008	$30,750,000			2026	$72,841,863
2009	$30,688,000			2027	$75,879,971
2010	$33,485,000			2028	$76,960,210
2011	$38,500,000			2029	$78,884,927
2012	$40,100,000			2030	$82,655,394
2013	$42,800,000			2031	$85,302,626
2014	$45,900,000			2032	$85,158,869
				2033	$88,779,400
				2034	$89,576,446

10.2.1.6 Self-Managed Programs

Most companies are well served by the Energy Efficiency Utility structure, in which they pay an energy efficiency charge (EEC) and are able to take advantage of technical and financial assistance from EVT and BED. For a smaller number of firms, retaining control over energy efficiency spending while forgoing some EEU assistance is more appropriate. There are two significant current programs to address this second group of firms, and ***the DPS is investigating these options in a study this fall, required by Act 199 of 2014.***

<u>Energy Savings Accounts</u>

The Energy Savings Account (ESA) option allows eligible business customers the option to self-administer their own energy efficiency efforts instead of participating in the statewide services and initiatives provided by the EEUs. As required by Vermont law, in 2009 the PSB established a process by which an electric customer who pays an average annual EEC of at least $5,000 may apply to the Board to self-administer energy efficiency through the use of an energy savings account. The customer pays their EEC as usual, and can then apply to reimbursement of qualified expenses from their own funds. The law provides that the energy savings account contain a percentage of the customer's EEC payments for use in making energy efficiency investments, and the remaining portion of the charge be used for system-wide benefits. (These provisions are codified in 30 V.S.A. § 209(d)(3)(B).) ESA program participation requirements and guidelines are posted on the Board's website[147] and were revised in 2014. The Energy Savings Account (ESA) program recognizes that certain large business customers already may be committed to, and possess considerable expertise regarding, energy efficiency.

Customers that are approved by the PSB to self-administer energy efficiency projects using an ESA may be reimbursed from funds collected through EEC payments for "Qualified Expenses" associated with energy efficiency projects provided that total "Qualified Expenses" in any period does not exceed 100% of "Available Funds." Qualified expenses may be incurred in the following project categories: market driven, retrofit, planning, and prescriptive.

"Available Funds" to a customer participating in an ESA are currently defined as 70% of the EEC that the customer has paid since its ESA start date, or is projected to pay to its distribution utility through the EEC, for a three-year maximum period, net of taxes. Following the successful completion and verification of at least four projects and at least two, three-year ESA periods, a customer may apply to the PSB to increase the percentage of the EEC that may be considered Available Funds. While the ESA program offers benefits and may be of interest to potential participating customers, not all potential interested ESA customers have the capacity to administer and navigate the ESA program. Participation in the program requires both energy efficiency expertise (including how to use various tools developed for use by the EEUs, such as the cost-effectiveness screening tool) and administrative capacity to handle the extensive requirements regarding how funds may be used and how savings are documented.

<u>Self-Managed Energy Efficiency Programs</u>

The Commercial and Industrial Self-Managed Energy Efficiency and Customer Credit Programs recognize that certain commercial and industrial customers already may be committed to, and possess considerable expertise regarding, energy efficiency. These programs allow eligible firms to forego paying 90% or more of the EEC, on the commitment to spend an appropriate amount on energy efficiency in their own facilities. At this time, GlobalFoundries is the sole eligible participant in the SMEEP program and Omya, Inc. participates in the Customer Credit Program. Both programs require ISO-14001 certification. ISO 14001-Environmental Management Systems is a family of standards related to environmental management that exists to help organizations minimize how their operations (processes, etc.) negatively affect the environment, comply with applicable laws, regulations, and other environmentally oriented requirements.

[147] http://psb.vermont.gov/sites/psb/files/orders/2014/2014-06/Attachment%20A%20ESAprogramDesign2014.pdf

As part of the DPS's research on self-managed efficiency programs required by Act 199 of 2014, the DPS is considering recommending an additional option beyond (or in place of) the SMEEP and CCP options for firms with a commitment to energy efficiency. Under this option, firms which meet the ISO-50001 energy management standard and a verified level of performance in the DOE's Superior Energy Performance (SEP) program could be exempt from paying the EEC for the duration of time the SEP level is achieved. System-level energy benefits from the firm's efficiency performance would be shared with all ratepayers, while the firm benefits from the system-level benefits provided by the EEU programs.

ISO 50001-Energy Management Systems specifies the requirements for establishing, implementing, maintaining, and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy security, energy use, and consumption. The standard aims to help organizations continually reduce their energy use, and therefore their energy costs and their GHG emissions. Facilities certified to Superior Energy Performance[148] are leaders in energy management and productivity improvement. The facilities in SEP have met the ISO 50001 standard and have improved their energy performance up to 25% over three years (Platinum on the performance track) or up to 40% over 10 years (Platinum on the mature energy track). Silver, Gold, or Platinum levels of certification correspond to levels of demonstrated performance. The SEP program requires third-party certifiers to use regression-based tools to verify savings. These tools account for changes in facility production, allowing firms to receive credit not just for reductions in overall use but also for reductions in per-unit energy. Participation in the Continuous Energy Improvement programs now underway and offered by EVT would provide firms interested in this option the foundation they need to begin to excel.

Recommendations

(1) *As part of its Act 199 report, the DPS should investigate ways to increase availability and understanding of the Energy Savings Account program, including consideration of changes in the ESA program structure to allow it to work for a greater variety of firms.*

(2) *As part of its Act 199 report, the DPS should work with stakeholders to determine whether the ISO-50001/Superior Energy Performance option will advance the state's energy and economic policies, and if not, what other options might exist to meet both advanced firms' and the state's objectives.*

10.2.1.7 Challenges to Increasing Electric Efficiency

The pace at which Vermont acquires all reasonably available cost-effective energy efficiency is limited by rate impacts, a responsible expansion pace of programs, and the cost-effective potential itself. Further, the state must be a responsible advocate for setting incentive and financing levels appropriately to encourage

[148] http://www.energy.gov/eere/amo/superior-energy-performance

investments in energy efficiency without overspending public resources to get the desired outcome. The state also should encourage innovation through the deployment of emerging technologies and continue to be an advocate for a portfolio that balances two important objectives, low-cost saved energy and long-lived measures. For example, in 2012 and 2013 Vermont led the region with the lowest levelized cost of saved energy at $0.035 per kWh and also led the region with the lowest lifetime cost of saved energy at $0.030 per kWh. Technologies with long measures lives persistently deliver benefits overtime, avoid the need for frequent replacement, and contribute to a longer weighted average measure life for the portfolio (Vermont's 2012-13 weighted average measure life of approximately 11.5 years was second longest in the region)[149].

Vermont will continue to explore new ways to integrate energy efficiency into supply-side resource assessments, including evaluating behavioral/conservation programs currently being tested by EEUs under the resource acquisition research and development EEU budget category which is intended to leverage the advanced meter infrastructure and digital meter data. Examples include EVT's residential "Home Energy Report" and commercial "Continuous Energy Improvement" test programs. Another is Burlington Electric Department's partnership with UVM, Burlington's Community Economic Development Office (CEDO) and the UVM Clean Energy Fund, to test whether advanced technologies and competition among peers can result in a higher degree of energy awareness and lower electric energy consumption.

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 recently collaborated with the EEUs to propose service quality reliability plans (SQRPs) and program implementation efficiency quantifiable performance indicators (QPIs) to the PSB. These indicators are intended to ensure continuous improvement of electric efficiency service delivery in Vermont – and efficient delivery of efficiency programs.

Recommendations

(1) *The DPS should encourage and facilitate innovative program designs and strategies to increase electric efficiency resource acquisition.*

(2) *The DPS should complete its planned process and impact evaluations of the behavior and conservation programs funded with EEU resource acquisition research and development budgets during the 2015-2017 performance period in order to inform the DRP that will set budgets and goals for the 2018-2020 performance period.*

[149] *http://neep-reed.org/Focus.aspx Northeast Energy Efficiency Partnership's Regional Energy Efficiency Database reported data for years 2011 through 2013.*

(3) *The DPS should work with the EEUs to continue to revisit, review, and strengthen the QPI and SQRP framework. Including weighting summer/winter peak savings goals for electric EEU's appropriately and work with EEUs to develop and weight a new QPI that reflects cumulative lifetime savings.*

10.2.2 Load Management

10.2.2.1 Advanced Meter Infrastructure (AMI)

The technology associated with the Advanced Meter Infrastructure (AMI) and digital meters has significant potential to increase system reliability and load management capabilities. "Smart Grid" generally refers to a class of technology that is being used to modernize utility electricity delivery systems. These systems are made possible by two-way communications technology and computer processing. This technology includes "smart meters," which are digital meters that play a key role in enabling the two-way communications that characterize a smarter grid. The potential benefits are that a smart grid would enable utilities and their customers to track and manage the flow of energy more effectively (including the cost of electricity at a given time), curb peak demand, lower energy bills, reduce blackouts, and integrate renewable energy sources and storage to the grid (including electric and plug-in hybrid vehicle batteries). The smart grid also has the potential to increase energy efficiency, thereby reducing environmental impacts of energy consumption, and empower consumers to manage their energy choices.

Many Vermont utilities have already begun the process of replacing old analog meters with new digital meters. As of the drafting of this CEP more than 80% of the state's electric meters are digital. The DOE, 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 DPS, EVT, and the Office of Economic Stimulus and Recovery, as well as Vermont's Congressional delegation. This grant has provided approximately half the cost of $138 million in infrastructure improvements that utilities have made across Vermont. The project has moved 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.

Recommendations

(1) *The DPS should monitor PSB docket 7307 and the pending Proposal for Decision for establishing uniform consumer privacy and cybersecurity expectations for utilities, and consumer choice policies.*

10.2.2.1.1 Automated Meter Infrastructure (AMI) – How it Works

Digital metering systems 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). Most of Vermont's digital meters 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 used in Vermont. VEC and WEC currently have a PLC system. 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. GMP, BED, and SED have 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. Some Vermonters have raised concerns regarding the health impacts of RF-based meter communications systems. The Vermont Department of Health performed a review of the issue in 2012 and the results are available on the Department's web site[150]. In addition, the DPS has supported customer opt-out policies to allow consumers to choose not to accept the new meter infrastructure.

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[150] *http://publicservice.vermont.gov/sites/DPS/files/Topics/Electric/Smart_Grid/smart_meters_facts%5B1%5D.pdf* *and the full report* *http://publicservice.vermont.gov/sites/DPS/files/Topics/Electric/Smart_Grid/radio_frequency_radiation_and_health_smart_meters%5B1%5D.pdf*

- **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 is be recorded from the meters each day. Internet *web presentment systems* 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.

10.2.2.2 Strategies for Load Management

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. Strategies for load management are either "in-front of" or "behind" the meter.

10.2.3 Demand Response

Energy efficiency refers to using less energy to provide the same or improved level of service to the energy consumer in an economically efficient way; it includes using less energy at any time, including during peak periods. In contrast, demand response entails customers changing their normal consumption patterns in response to changes in the price of energy over time or to incentive payments designed to induce lower electricity use when prices are high or system reliability is in jeopardy. Because most demand response programs in effect today are event driven, customers tend to assume that demand response events occur for limited periods that are called by the grid operator; but critical peak pricing (CPP) and real-time pricing (RTP) are growing in prevalence and impact. Many demand response programs are designed primarily to curtail or shift load for short periods of time; however, those programs that educate customers about energy use with time of use (TOU) rates, smart rates, and energy use feedback can also produce measurable reductions in customers' total energy use and cost.[151]

[151] http://www.epa.gov/cleanenergy/documents/suca/ee_and_dr.pdf *ES-1*

Further, the presence of generation, storage, and smart control technologies at customer premises offers the opportunity for customers to provide a number of valuable functions to the grid. These generally fall into a category termed "ancillary services"[152] and include voltage regulation, power factor control, frequency control, and spinning reserves.[153] Spinning reserves refer to the availability of additional generating resources, which can be called upon within a very short period of time.

In a system where utility operators or third-party aggregators have the ability to control end-use loads, it is typical for utilities to manage demand in a way that customers do not notice a change in the performance of the equipment. In this way, utility-controlled equipment has potential to become a form of spinning reserve when placed at the disposal of system operators and smart control technologies become an important resource for delivering demand response during high-cost periods or when the grid is at or near its operating capacity and may be at risk for system failures.

As technology evolves, it will be important for federal appliance standards to require installation of control technologies and two-way communication capability in new major appliances such as refrigerators, water heaters, furnaces, heat pumps, air conditioners, dishwashers, clothes washers, and clothes dryers, so that they can be a demand response resource for managing peak-time loads (in both the summer and winter) and also have the capability to automatically respond to changing smart rates.

Importantly, as the demand for space cooling increases due to increasingly hot summer temperatures, control technologies for cooling, combined with other spinning reserves, can help keep buildings and occupants cool while also mitigating peak time loads coincident with hot weather. To this end, control technologies for electric space heating and cooling, specifically heat pump technology, is a high priority. Of equal importance related to managing peak loads and keeping buildings cool are other building shell, weatherization, and ventilation strategies as well as design and passive cooling techniques like shade-promoting landscaping and siting considerations to improve shade and ventilation, cool roofs, and more reflective external walls.

Recommendations

(1) The DPS should encourage the adoption of equipment and appliances that can respond to utility signals, for example through DU and/or EEU incentives for customers and rate designs that allow participating

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[152] *One of a set of services offered in and demanded by system operators that generally address system reliability and operational requirements. Ancillary services include such items as voltage control and support, reactive power, harmonic control, frequency control, spinning reserves and standby power. The Federal Energy Regulatory Commission defines ancillary services as those services "necessary to support the transmission of electric power from seller to purchaser given the obligations of control areas and transmitting utilities within those control areas to maintain reliable operations of the interconnected transmission system."*

[153] *Smart Rate Design for a Smart Future, The Regulatory Assistance Project* *www.raponline.org/document/download/id/7680*

customers to save money. DUs and EEUs should coordinate activities as the market evolves to advance smart rates and controllable equipment as a demand response strategy.

10.2.4 Smart Rates

Smart rates are one way to balance supply and demand, reduce costs, and improve the environmental performance of Vermont's power supply.[154] Utilities that deploy smart rates vary the price of electricity to more accurately reflect their own costs in providing electricity to customers. Although there are different specific ways of designing smart rates, utilities typically charge lower rates during times of low demand, usually overnight, and higher rates during peak demand, usually afternoon and evening or on particularly hot or cold days. One key feature of smart rates is overall bill stability, meaning that for most customers, monthly bills will remain the same if their usage patterns do not change. Customers can choose to shift their consumption to lower-priced times to reduce their bills or can choose to pay a premium to have one consistent rate that does not vary over time.

What are "smart rates"?

"…rate designs that require the type of data collection that smart meters provide, and that are expected to produce significant peak load reductions, reduced and shifted energy consumption, improved system reliability, improved power quality, and reduced emissions. These include Time Of Use, Peak Time Rebate, Critical Peak Pricing, and Real Time Pricing."

(Lazar and Gonzales, 2015)

Traditional rates reflect highly averaged costs (e.g., across diverse customers in broad rate classes, and over many different hours of the year). Smart rates more accurately reflect the costs that individual customers are responsible for incurring to the system, ensuring a fair distribution of costs among customers. 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. Smart rates will not directly reduce consumer demand for electricity, nor will they increase energy efficiency; instead, they will shift the demand to lower-cost, off-peak times.

Smart rates are designed to take advantage of the data provided by AMI technology to more accurately assign costs among consumers based on where and when they use electricity. Smart rates reinforce long-standing principles of efficient rate design in that they reflect the utility's cost to serve a particular customer at a particular time. Efficiently designed rates reflect marginal costs, recover system costs on a volumetric basis, and send appropriate price signals to consumers who may adjust use accordingly.155

[154] *For a complete discussion of smart rates, see Lazar, J. and Gonzalez, W. (2015). Smart Rate Design for a Smart Future. Montpelier, VT: Regulatory Assistance Project. Available at: http://www.raponline.org/document/download/id/7680.*

[155] James Bonbright. *Principles of public utility rates. New York, Columbia University Press. (1961)*

Section 13 of Act 199 of 2014 required that DPS work with the Agency of Commerce and Community Development to investigate the competitiveness of Vermont's industrial or manufacturing businesses with regard to electricity costs. The DPS is currently exploring how best to incorporate into rate design proceedings the impact of electricity costs on business competitiveness and the identification of the costs of service incurred by businesses. The design and implementation of smart rates will take into account the results of that investigation, which will be available in December of 2015.

Although smart rates have been discussed and tested for at least 30 years, a new urgency for smart rates has been motivated by a strong perceived need to link wholesale and retail power markets that will enable customers to understand and influence consumption and the impact such consumption has on our planet.

New technologies are allowing customers and utilities to take advantage of smart rates. Smart rates are made possible by AMI because utilities need real-time data about customer usage to charge different rates depending on the time of day electricity is being used. Utilities that have not yet deployed AMI should continue to evaluate the costs and benefits of transitioning. Recent developments such as organized wholesale markets which produce transparent hourly market clearing prices, and consumer and regulatory interest in greater price-responsive demand, offer new opportunities to implement smart retail rates.

"Smart" appliances are coming on the market that can be turned on to take advantage of low-priced electricity or turned off when electricity is more expensive. For example, electric vehicles can be charged at night when prices are lower or the temperature in a in a home with air conditioning could be slightly raised when electricity costs are high. Homeowners could use a variety of software applications or services provided by their utility to automatically take advantage of smart rates. Distribution utilities may act as managers of these smart appliances, working behind the scenes to lower use during peak times to save money for both the customer and the utility. Customers would be compensated for their voluntary participation in any utility or third-party-directed load management programs.

Among the categories of smart rates are: 1) hourly pricing; 2) daily pricing including time-of-use, variable peak rate, critical peak pricing, and peak-day rebate; 3) fixed time-of use pricing, and 4) seasonal flat pricing. Other smart rates include vehicle charging rates, and rates related to distributed generation. The specific type and design of smart rates for utilities in Vermont will depend on their particular AMI infrastructure, load shapes, administrative capabilities, and resource management goals.

In addition to offering consumers the opportunity to save money by using electricity when rates are low, smart rates offer many benefits to the electric grid. By shifting consumption away from peak times, utilities will avoid wholesale capacity charges and lower Vermont's cost share of regional transmission projects. Smart rates can help lower capacity and energy charges in the long term as well as lower wholesale market prices in the short term.[156] Power supply savings, including both RNS and FCM savings, resulting from peak shifting should be passed through to ratepayers

There is some evidence that low-income consumers are less able to take advantage of smart rates because they have less flexibility in when they use electricity. Several studies have shown that low-income customers adjust their usage less in response to smart rates than average customers.[157] Even with this effect, low-income customers still benefited from smart rates because they tended to use electricity off-peak and overall system costs were lower. However, it is important to carefully consider the impact of specific smart rate plans on low-income customers. Utilities should take steps to ensure that low-income customers benefit from smart rates.

Recommendations

(1) Beginning in 2016, electric utilities with AMI capability should work in coordination with the DPS and PSB to create concrete plans to move to smart rates. Such plans would also be incorporated into utilities' integrated resource planning process.

(2) Utilities should plan to move all customer rate classes to simple, fairly priced smart rates as the standard option by 2018 for all rate classes. By 2018 all Vermonter's served by distribution utilities with AMI infrastructure should have access to smart rate options. Customers should retain the right to choose a flat rate, recognizing that they may pay a risk premium for guaranteed prices.

(3) Utilities should take intermediate steps to ensure that customers understand the new rates during a transition period before and after 2018. First, utilities should provide customers on legacy rates with shadow bills for a year that show what their monthly bills would be under new rate plans. Then, for the following year, they should offer customers who switch to smart rates bill guarantees so that these customers would pay either their legacy rate or the new smart rate, whichever is less expensive. Only utilities operating under an alternative regulation plan would be required to offer bill guarantees.

(4) Utilities and the DPS should mitigate any differential effect of smart rates on low-income Vermonters by prioritizing services such as provisioning and automation of smart appliances, lowering overall energy bills through efficiency and weatherization, and ensuring simplicity in smart rate design especially for residential customers.

[156] *The Impact of Dynamic Pricing on Low Income Customers. Ahmad Faruqui, Sanem Sergici, Jennifer Palmer. Institute for Electric Efficiency. Last retrieved on 9/8/2015 at http://www.edisonfoundation.net/IEE/Documents/IEE_LowIncomeDynamicPricing_0910.pdf.*

[157] *Id.*

10.2.5 Conservation Voltage Reduction and Volt-VAR Control

The distribution lines that deliver energy to homes and businesses typically lose some percent of the electricity they carry. ISO-NE assumes, on average, the system line losses are approximately eight percent. However, technology-based strategies exist whereby utilities can reduce line losses by operating the distribution system in the lower portion of the acceptable voltage range. By lowering voltage to the lowest level within industry standards, utilities can reduce line losses, peak loads, and save (or defer) energy use overall on some types of consumer loads.

Utilities can control distribution line voltage by changing settings on equipment at the substation serving the line or on equipment connected along the line. Voltage falls gradually as current flows further from the substation. Utilities must keep substation voltage at a level sufficient to ensure that voltage at the end of the line is within industry standards. Manual control of a system requires a margin above minimum voltage standards, however real-time data communications and remote control allow for margins to be smaller without affecting service to customers or damaging their equipment.

Utilities have used voltage reduction during periods of capacity shortages for many years without the assistance of Advanced Metering Infrastructure (AMI). For example, ISO-NE's operating procedures include Conservation Voltage Reduction (CVR) among the actions system operators may take to avoid involuntary load curtailments. The ISO estimates that a 5% voltage reduction saves 421 megawatts in a 28,000 megawatt system[158].

Historically, CVR was a substation bus-level strategy for implementation on traditional feeders where power flows in a single direction from the source to the load only and CVR typically utilized standalone substation voltage regulators or transformers with load tap changer (LTC) controls to adjust the voltage. While down-line feeder conditions were taken into account CVR was utilized primarily for gross adjustments. In Vermont, experience has shown that many circuits are not appropriate for this type of CVR implementation. For example, traditional CVR may not be a good strategy for very long circuits when voltage regulation occurs only at the substation bus and circuits with large commercial and industrial loads may not be capable of correct operation with reduced voltages. In addition, CVR may not be effective with circuits containing high concentrations of distributed generation (DG). Increasing penetration of DG, and in particular solar, has resulted in problems with voltage regulation, which in turn is complicated by CVR implementation. Some Vermont utilities have had to remove CVR on circuits to assure proper operation during daylight hours. DG will reduce the amount of current at the line drop compensation (LDC) controls of regulators or tap-changing transformers located in the substations. This current reduction then reduces the apparent voltage drop across the length of the feeder and results in low voltages delivered to customers at the ends of feeders. In some cases, CVR can also result in system problems where reverse power flow occurs.

[158] *See http://www.iso-ne.com/rules_proceds/operating/isone/op4/op4a_rto_final.pdf.*

Delivering power within appropriate voltage limits so that customers equipment operates properly while providing power at an optimal power factor to minimize line losses requires the consideration of a variety of factors throughout the distribution system, including but not limited to substation bus voltages; length of feeders; conductor size; the type, size and location of different loads; and the type size and location of distributed energy resources (renewable energy generation and storage resources). Balancing these considerations will be increasingly complex and important assuming more distributed energy resources will likely be added to the grid. With its limitations, simply lowering voltage via traditional CVR alone will likely not be an effective strategy. However, with the development of computing planforms, advanced algorithms, and high-performing communications and locational sensor technology associated with AMI, it is increasingly possible to coordinate and manage the distribution system better at the feeder, substation, or utilization level. Volt/VAR control, as a strategy, provides such an opportunity.

Voltage regulation and Volt-Ampere-Reactive (VAR) regulation are often referred to in the load management context together as Volt/VAR control (VVC). Power systems require a combination of real power and reactive power. Voltage optimization refers to the management of voltages on a feeder with varying load conditions whereby voltages must remain within ANSI standard limits. VAR optimization refers to supplying the right amount of reactive power at the right time (within a dynamic distribution system). Real power is supplied by a remote generator (watts) and reactive power can be supplied by a remote generator or a local supply (coil or capacitor)[159].

Future implementation of CVR should take advantage of utilities' maturing advanced metering infrastructure (AMI) programs and expanded supervisory control and data acquisition (SCADA) implementation[160]. Among the strategies available with AMI and SCADA is the integrated distributed model based Volt/VAR control (VVC) of distribution circuits. This is a control strategy in which distribution circuit information including voltage, load, and power factor are utilized to optimize circuit feeders. This can incorporate information of distribution circuit configurations from geographical information systems (GIS), detailed measurements from AMI and SCADA, and optimal power flow algorithms. This information would be used to integrate distributed resources (DR) including energy storage and load control with traditional distribution voltage control devices such as regulators and capacitors.

The DPS anticipates that implementation of these strategies will have a significant learning curve due to the technical challenges associated with the need for well-defined electric circuit models, defined control schemes, communication infrastructure, and monitoring requirements. Because of these challenges, the DPS believes that utilities should initially focus on having accurate GIS data and circuit models and an

[159] Understanding and controlling the VAR component of VVC is somewhat abstract and can be further explained in simple terms as follows. On any given distribution system, the voltage and current take the form of "sine-waves" within a power line and it is common for the voltage and current waveforms to not be perfectly synchronized due connected load characteristics. The asynchronous waveforms on an AC power line represent the VAR component of VVC. Correcting for the voltage and current asynchrony optimizes the system and saves energy.

[160]

ability to access the requisite AMI, SCADA, and DR information to integrate into circuit models. Without highly reliable information, it is unlikely that VVC implementation or other optimization strategies would be successful.

The DPS recognizes that control technology and software is rapidly evolving and expects that utilities should gain an understanding, and stay current with, these advancing control technologies. Once these challenges are understood, the utilities shift their focus to developing pilot programs to test the efficiency and cost-effectiveness of optimized circuit feeders. Given the potentially high cost in dollars and resources, and the integrated nature of smart grid technologies, it may be desirable to package VVC implementation with other smart grid opportunities, e.g., fault detection isolation and recovery (FDIR) and the optimization of DR.

Recommendations

(1) Distribution utilities should initially focus on having accurate GIS data and circuit models and an ability to access the requisite AMI, SCADA, and DR information to integrate into circuit models. Utilities should expand SCADA implementation, as necessary, to allow remote control of voltage control devices, data acquisition, and future flexibility.

(2) Distribution utilities should describe and report on their progress with VVC in their integrated resource plans.

(3) The DPS should coordinate with the DUs to have a third party evaluate the impacts of VVC initiatives and identify the appropriate feeders for long-term VVC.

(4) The DPS should explore performance-based incentives for distribution utilities that implement VVC with measurable and verifiable benefits.

10.2.6 Storage

Reducing and controlling load are two of the key tools for managing energy demand. The third – of increasing importance as our reliance on intermittent resources increases – is energy storage. The term "energy storage" covers both thermal and electric energy storage, and encompasses a wide variety of technologies, from pumped hydroelectric and fuel cells to compressed air and batteries. Energy storage can serve a wide variety of purposes, from shaving electricity demand peaks and supporting grid voltage to providing backup power and "firming" the output of intermittent renewables.

Energy storage may seem like a silver bullet to address many of the needs of a managed grid with a high penetration of distributed, renewable energy, but it has historically been too expensive to deploy at any meaningful scale. However, that tide is turning, much as it did for solar PV over the last decade, as the result of targeted commercialization efforts by the DOE, energy storage mandates at the state level, recognition of value by grid operators, and maturation of the market. A recent report[161] produced for the Australian Renewable Energy Agency predicts battery prices will fall 40-60% by 2020, which is good news, as the International Renewable Energy Agency is predicting[162] that the world will need to deploy 150 gigawatts (GW) of battery storage by 2030 along with 325 MW of pumped hydroelectric storage in order to integrate the 800 GW of solar and 550 GW of wind it will be necessary to deploy in order to restrict global temperature rise to 2°C by the end of the century.

Vermont has not yet adopted energy storage mandates like California's[163] or Oregon's[164], nor has it implemented a targeted incentive program for storage similar to New York's[165] or Massachusetts's[166]. Yet, Vermont is nonetheless leading the way on several energy storage fronts.

Residential Energy Storage

In May 2015, Green Mountain Power announced that it would be one of the first utilities to offer the new Tesla Powerwall to its customers, starting in October 2015. Tesla's announcement of the Powerwall, which comes in a modular 7 kWh "daily cycle" and a 10 kWh "backup" size, marked a seminal moment for the energy storage industry in terms of technology cost, scale, and demand, with units – priced at $250/kWh – sold out through 2016. The Powerwall has the ability to more closely align customer loads with periods of lower electric demand, store solar electricity for use in the evenings, and provide some amount and duration of backup power during outages. Individual customers have the potential for cost savings from both the load and renewables management features of storage, while the utility may have the opportunity to lower costs for all customers by aggregating and activating the load management features of multiple systems during periods of peak demand, such as hot summer days. In August 2015, GMP proposed to install two 10 kWh Powerwalls at Emerald Lake State Park in East Dorset, to take the park off the grid and provide for its electricity needs at a cost that is estimated to be 20% less than that of rebuilding the existing distribution line.

Commercial and Utility-Scale Energy Storage

Not only will Vermont customers be among the first to have access to the Powerwall, but a Vermont company – Dynapower of South Burlington – was announced as the supplier of inverters for the Powerwall's big brother, the 100 kWh Powerpack, designed for commercial and utility customers. At an

[161] http://arena.gov.au/files/2015/07/AECOM-Energy-Storage-Study.pdf

[162] http://www.irena.org/DocumentDownloads/Publications/IRENA_REmap_Electricity_Storage_2015.pdf

[163] http://www.cpuc.ca.gov/PUC/energy/storage.htm

[164] https://olis.leg.state.or.us/liz/2015R1/Downloads/MeasureDocument/HB2193

[165] http://www.nixonpeabody.com/NYSERDA_announces_performance_based_incentives, http://www.nyserda.ny.gov/About/Newsroom/2015-Announcements/2015-05-27-NYSERDA-Announces-Support-for-Seven-NY-Based-Energy-Storage-Projects

[166] http://www.mass.gov/eea/pr-2015/10-million-energy-storage-initiative-announced.html

estimated capital cost of $250 per kilowatt-hour, the Powerpack is priced well below what analysts predicted would be necessary for batteries to be cost competitive with new peaking plants for electricity[167], and even has the potential to supplant use of existing power plants.

While the potential of the Powerpack is impressive, it is still on the horizon, and Vermont has other near-term storage accomplishments from which it can glean real insights. In 2013, The DPS partnered with the DOE's Office of Electricity (DOE-OE) and Clean Energy States Alliance (CESA) to encourage a utility-scale energy storage demonstration project. The DPS's Clean Energy Development Fund issued a $50,000 solicitation, and the DOE-OE agreed to contribute $235,000 in funding to the selected project.

The Stafford Hill energy storage project was chosen to receive funding, and will be operational before the end of 2015. This 4 MW, 3.4 MWh electric energy storage system was installed in conjunction with a 2 MW solar photovoltaic project in Rutland, Vermont, by Green Mountain Power with controls supplied by Dynapower. The primary purpose of the system will be to facilitate and maximize renewable energy integration with the electric distribution grid. However, secondary applications will also be explored, including providing backup power to the local emergency shelter (and potentially an entire distribution circuit), improving power quality, promoting grid efficiency, offering ancillary services such as ramping into the regional wholesale market, and serving as an educational tool for students. Sandia National Laboratories is providing data analysis and other technical assistance to the project, and Green Mountain Power is working with VEIC to share best practices and lessons learned with regulators, other Vermont utilities, and stakeholders at the state, regional, and national level.

Green Mountain Power is also in the process of assessing the value of thermal storage at several test locations in Rutland. Thermal storage – in this case ice storage – is a way to manage the electric demands of cooling commercial buildings. Essentially, ice storage systems make ice when electricity supplies are cheap and abundant (at night), and use it to efficiently cool buildings during the day, when demand and prices are high.

<u>The Future of Energy Storage</u>

By the time the next CEP is adopted, Vermont will have learned a great deal about the deployment of energy storage at the residential, commercial, and utility scale. At the rate costs are decreasing – much faster than analysts predicted[168] – energy storage is set to become a disruptive force in the energy

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[167] *http://www.brattle.com/system/news/pdfs/000/000/749/original/The_Value_of_Distributed_Electricity_Storage_in_Texas.pdf*

[168] *http://www.nature.com/articles/nclimate2564.epdf?referrer_access_token=H9Rj7kdKUhrhz6Fb5ewzM9RgN0jAjWel9jnR3ZoTv0M00Vb3KgW1MD8qozWNCeynzkwpvLxVPLibQoJbfe-QKEu0ppqTXvcLlb8Vwz_nzK-yAn8RNMmZvOHZVqZQEn1U5XojC5FhPiQ23mWhSt0_N5L3eb1jQZedFMZw2y16duSxwzW7OVQ-V925n7gY-a1vMmlwPWTvamnQjRcKxGJMdFJW6rBZct3i6H7-3u7oczw%3D&tracking_referrer=thinkprogress.org*

marketplace. In fact, the Rocky Mountain Institute (RMI) recently estimated[169] that installing solar plus storage would become economic for millions of customers in the U.S. by 2030; after Tesla announced their battery prices, RMI revised that date a full seven years earlier, to 2022.

The adoption of electric vehicles will also play a major role in both the economics of storage as well as the management of the grid. As battery and vehicle manufacturing more closely coordinate, and align their products with the operation of the grid, products for consumers such as vehicles with algorithms integrating energy price signals, solar photovoltaic production, and backup storage functionality that also have some value in the aggregate for reducing peak loads and providing other grid services will emerge.

The fact that energy storage blurs line between load and supply, and offers other values to consumers, utilities, and grid operators, poses challenges that regulators, utilities, and industry will need to address sooner rather than later. These include the lack of industry standards, regulatory barriers to aggregation of behind-the-meter systems, protocols for charging and discharging of storage units (especially vehicle batteries) to prevent stress on the grid, and interconnection rules that properly account for the many use cases of storage. As the industry matures and states including Vermont learn from the pilot projects we are undertaking, solutions to these growing pains will emerge – but it's clearly time to get started.

Recommendations

(1) Study the performance of the Stafford Hill project after a period of operation to understand costs, benefits, and implications for grid-scale storage in Vermont.

(2) Explore opportunities for further collaboration with the DOE and Sandia National Laboratories with a focus on developing specific projects in Vermont.

(3) Work with GMP to assess the uptake, performance, and grid benefits of residential and commercial Tesla Powerwall deployments.

(4) Review the regulatory requirements for electric energy storage and capitalize on existing regulatory reform opportunities – such as the Rule 5.500 interconnection procedures – to address storage.

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[169] http://www.rmi.org/electricity_load_defection

11 Meeting Vermont's Electric Demand

Electric generation meets Vermonters' electricity needs by converting a variety of resources (renewable, fossil, and nuclear) into electricity and reliably delivering that power to our homes and businesses. The ongoing and rapid shift toward an integrated grid, with both central and distributed generation, and both dispatchable and variable generation matching an increasingly controllable load, opens new avenues for optimization of cost-effective utility portfolio construction when viewed as an integrated whole with other utility costs.

This chapter first describes the state's future electricity supply, in the context of Act 56's new requirements for electric portfolios. Electric generation in Vermont provides benefits, and also creates some local costs; the chapter describes both the state's approach to planning for and siting physical generation and grid infrastructure and strategies to promote responsible in-state renewable electricity generation. The regional transmission network delivers our power, and the markets and policies implemented there have a direct impact on how Vermont procures and pays for electric supply. Disruptions to the in-state and regional electric grids, or to energy resources both local and far-flung, can generate real risks to economic and human health, so we must also plan for energy assurance. 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.

The chapter concludes by building on Vermont's history of integrated resource planning to propose the need for comprehensive analysis of integrated planning in a context of distributed energy resources. The combination of distributed generation, energy storage, efficiency, and controllable electric loads has the potential to create substantial changes in how infrastructure and power supply decisions are made, along with their regulatory context.

11.1 Future Electric Supply from a Portfolio Perspective

Act 56 of 2015 established a multi-tiered renewable energy standard for Vermont's electric utilities. This set of obligations on each utility will have profound effects on how utilities make choices for their power supply portfolios. Increases in electric demand resulting from increased electricity use for both heating (efficient cold-climate heat pumps) and transportation (electric vehicles) will also require corresponding increases in power supply, especially as 2050 approaches.

Vermont utilities can continue to develop renewable sources of power for their customers, through direct 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 GHG 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, Vermont will be well-positioned to maintain a clean, regionally competitive power supply.

11.1.1 Act 56 Impact on Power Supply

Act 56 established a Renewable Energy Standard (RES) with two power supply renewable energy obligations for electric utilities[170]:

- Tier 1 is a total renewable energy requirement, requiring renewable energy totaling 55% of retail electric sales in 2017, climbing 4% every 3 years to 75% in 2032.

- Tier 2 is a carve-out of Tier 1 that requires new distributed generators (5 MW or less) connected to Vermont's electric grid totaling 1% of retail electric sales in 2017, rising 0.6% each year to 10% in 2032.

The RES also includes a Tier 3 requirement that electric utilities assist their customers to reduce fossil fuel use, by an amount equivalent to 2% of retail electric sales in 2017, rising to 12% by 2032. This invites electric utilities to participate, with partners where possible, in markets for fuel, appliances, and vehicles that have traditionally been unregulated. This embraces a broad sense of "energy services" that can be provided by electric utilities at least cost.

Compliance with the RES will be demonstrated through ownership of renewable energy attributes corresponding to energy from eligible generators. Such attributes might be acquired with the energy, or separately. Where possible, the New England attribute tracking system, called the NEPOOL GIS, will be used, although some imports (e.g. from HydroQuebec and the New York Power Authority) and some small in-state generators (e.g. net metered systems) may need to be accounted for separately, while ensuring no double-counting of attributes.

Because renewable energy certificates (RECs) may be separated from energy, utilities need not procure energy directly from the required amount of renewable energy resources. For example, a hydroelectric plant may sell its power into the New England wholesale energy markets without a long-term contract, and separately choose to sell its RECs to a Vermont utility. That utility in turn may purchase generic market power or energy from any other source to meet its customers' moment-to-moment energy needs, as long as it owns the required number of RECs at the time of compliance. This flexibility means that Vermont utilities are not required to procure energy directly from renewable generators in an amount corresponding to the RES requirements. That said, Vermont utilities already procure approximately 45% of retail electric sales from renewable sources and retain the RECs, so some level of continued correspondence between power supply and RECs is expected.

Because of the financial benefits of long-term contracts or ownership enabled by Vermont's regulatory structure, most eligible Tier 2 generators are likely to be owned by Vermont utilities, under long-term

[170] *This is a summary of the requirements; there are various other provisions adding additional flexibility.*

contract to them (including through the Standard Offer program), or net metered. As such, there is expected to be a much greater correspondence between energy supply and REC ownership for Tier 2 than Tier 1, accounting for sales of RECs between Vermont utilities. Tier 2 will make up approximately half of the increase in renewable energy for Tier 1 (10% is half of 75%-55%=20%). Net metering will reduce utility sales, but can also be thought of as a kind of power supply resource.

Tier 3 of the RES may have some indirect impacts on electric power supply requirements. One way is that Tier 2-eligible RECs may also be used for Tier 3 compliance. In addition, changes in electric demand resulting from strategic electrification (such as the adoption of cold-climate heat pumps or electric vehicles) may change both the amount and the load shape of required electric power. Load shapes will change on a daily basis (e.g. due to EV charging overnight) or on a seasonal basis (e.g. heat pumps driving increased winter electric needs). The extent of these effects depends on how utilities meet their Tier 3 obligations. DPS modeling conducted during the legislative process for Act 56 indicated an 8-10% impact on sales by 2032. Rate impacts from this increase in sales could be beneficial if peak demands are managed well, resulting in a flatter overall load shape.

11.1.2 Implement the Renewable Energy Standard

The PSB opened a proceeding on August 7, 2015 to define how Act 56 will be implemented. This section is therefore subject to change between the Public Review Draft and the final CEP, reflecting progress in that proceeding.

This CEP will be in force for the first six years of the RES, with the first utility obligations in 2017. It is likely that implementation of the RES by 2021 will have evolved significantly from its initial conception. However, some fundamental principles regarding intention and approach will guide implementation through the coming years.

Tiers 1 and 2 are fundamentally very similar to the renewable portfolio standards (RPS) adopted by other New England states. Our RES rule for these tiers is therefore likely to be very similar to those in our neighboring states. Renewable energy credits are tracked in a regional system call the NEPOOL Generator Information System (NEPOOL GIS). Vermont's use of this system will ensure that there is no double-counting of RECs between our utilities and those in other states. Our RES relies on, and provides credit for, imported resources (from NYPA and HydroQuebec), which are not currently reflected perfectly in the NEPOOL GIS. Addressing this will require either changes in that system or outside accounting of the renewability of these resources. Net metering RECs assigned to their host utilities cannot be transferred, so utility billing systems combined with tracking of REC assignment should be sufficient to verify utility RES claims.

Utility RES requirements under Tiers 1 and 2 are equivalent to a requirement for DG resources ramping from 1% in 2017 to 10% in 2032, and a separate, additional requirement for any renewable resource ramping from 54% to 65%. Utilities will be more assured of meeting the requirement, better insulated against policy changes in other states, and better able to make clear renewable energy claims if they acquire energy from renewable sources corresponding to these amounts, in addition to acquiring the RECs. The Act 56 structure acknowledges that renewable resources that came online before July 1, 2015, or are larger than 5 MW, may be treated as premium resources by other states. Such resources provide a backstop for Tier 1 compliance, but utilities are expected to maximize ratepayer value while meeting the RES.

When developing Tier 2 compliance portfolios, utilities should directly account for the in-state and grid-supporting nature of these resources. When choosing such resources, then, utilities should strive to deliver maximum ratepayer value, combining load shape (and related capacity value), location, and price to an optimal mix. Utilities must also plan for some level of uncertainty regarding which generators will provide Tier 2 RECs, given the role of independent power production through the Standard Offer and net metering. The integrated resource planning (IRP) process described later in this chapter should be a primary tool that utilities use to examine these portfolio and infrastructure choices.

Tier 3 energy transformation projects have the potential to change utility electric sales, and thus their supply portfolio needs. For example, a utility may support a transition of a building's heating system from an existing fuel oil boiler to a low-temperature heat pump. In that case, the electricity demand of the building will increase, thereby increasing the need for electricity supply coincident with the heat pump's use. More fundamentally, however, energy transformation engagement from distribution utilities opens the door to changes in the role of the utility. Underlying state policy guidance to pursue least-cost energy services, including economic and environmental costs, provides a baseline for guidance as utilities develop their compliance plans. Energy transformation projects, by definition, reduce customers' fossil fuel energy costs, and the environmental costs associated with that use. The shared nature of the grid infrastructure also opens the door for shared electric system benefits from Tier 3 projects.

As utilities develop energy transformation portfolios, they should consider the following guidance:

- Strive to maximize net ratepayer value from their project portfolio, including participant and non-participant value.

- Provide a diverse range of options to increase the likelihood that any customer can participate; particularly ensure that low-income customers benefit through participation and not only through shared system savings.

- Work to lower rates by maximizing Vermont's load factor – the ratio of average load to peak load – through careful management of any peak load impacts from Tier 3 projects.

- While consistency across multiple utility territories is important, so is trying new program offerings.

- Carefully consider the performance of programs, working to change them quickly to match market conditions.

- Recognize the resources beyond incentive payments that distribution utilities can provide to move markets and reduce fossil fuel use, including access to capital, ability to coordinate bulk purchase or community projects, continuity of service to rental properties, and use of the electric bill for marketing and repayment.

- Plan for the long term, including planning for increased and continuing Tier 3 obligations, to develop market transformation programs and strive for comprehensive energy service to each participating customer.

- Build on existing programmatic infrastructure and expertise developed by energy efficiency utilities, weatherization programs, and other energy service companies.

- Consider community-scale partnerships that can serve many customers in a single coordinated set of actions, as well as programs serving individual customers.

Looking beyond initial implementation, the three tiers of the RES combined are expected to meet only one quarter of the state's GHG reduction goals. Other policies should be designed with the RES in mind, and the RES should be flexibly implemented in order to work well with other policies or programs that achieve further renewable cost-effective adoption of efficiency, conservation, and renewables across the entire energy portfolio.

Recommendations

(1) Where cost-effective, utilities should consider acquiring energy from renewable resources in the amounts of Tier 1 and 3 RES requirements, rather than only RECs.

(2) When developing Tier 2 compliance portfolios, utilities should directly account for the in-state and grid-supporting nature of these resources to deliver maximum ratepayer value.

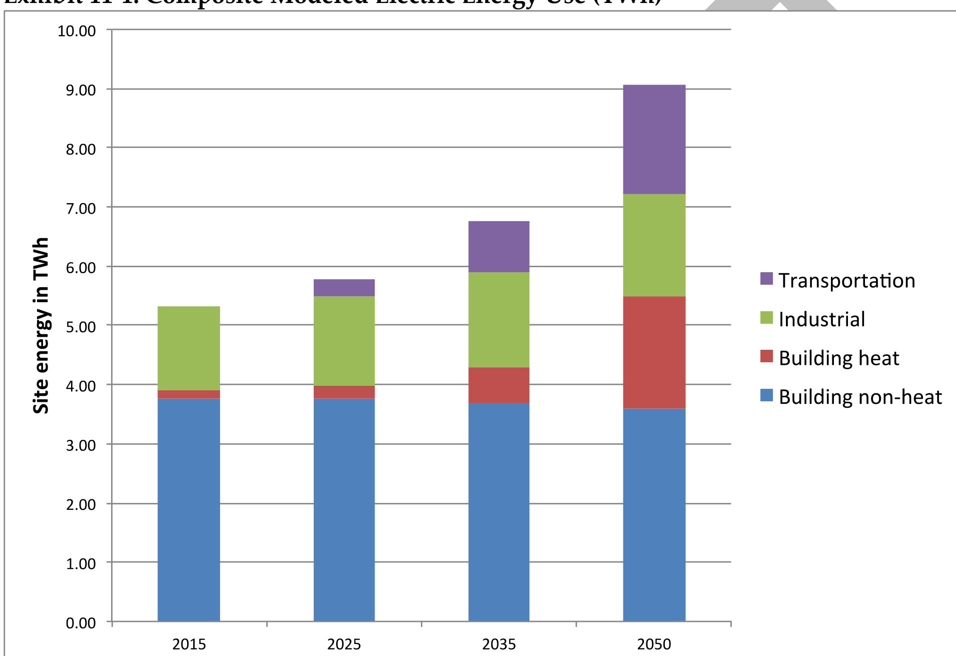
(3) Utilities should consider the guidance above when developing Energy Transformation portfolios.

11.1.3 Insights from the Total Energy Study

The 2014 Total Energy Study examined several future scenarios under which the state meets its 2050 GHG and renewable energy goals. These scenarios differ in how much electric energy is required, but collectively they provide a range of possible 2050 electric energy demand that can be used for the purpose of understanding portfolio and land use implications. The low end of the range (8 TWh/year) corresponds to a case with extensive use of liquid biofuels; the high end (approaching 10 TWh/year) to a case with limited use of such fuels. All of these cases incorporate extensive and aggressive electric energy efficiency. For comparison, current annual electric use is approximately 5.5 TWh; after accounting for losses generation, of approximately 6 TWh is required. In each case the electric supply must be virtually 100% renewable, because some other end uses have greater need than does electric generation to retain non-renewable fuels. This increasing electric use corresponds to a need for increases in supply, particularly in renewable supply, in Vermont's portfolio.

As an example only, one composite scenario at the higher end of the range of electric demand growth, shown in Exhibit 11-1, shows how different energy demand drivers contribute to this growth in energy demand. In Total Energy Study modeling, Vermont's population grows 3%, its GDP more than doubles, and the square footage of commercial buildings grows 13%. Nonetheless, this scenario shows electric demand for purposes other than heating, transportation, and industrial uses staying level, indicating both the extent of embedded energy efficiency and the changes driven by electrification of heat and transportation.

Exhibit 11-1. Composite Modeled Electric Energy Use (TWh)



In order to inform consideration of the cost and benefits of different electric portfolios, Exhibit 11-2 summarizes three electric portfolios, each of which generates approximately 9 TWh per year. Each of these three scenarios maximizes the amount of generation likely to be available from anaerobic digestion (methane), woody biomass electric generation, and in-state run-of-river small hydroelectric facilities. As such, they vary in their ratios of solar, wind, and large hydroelectric. It is reasonable to assume that solar PV serving Vermont will be overwhelmingly located here. To date, Vermont utilities have acquired about 55% of their wind power from facilities in Vermont, and the remainder from out of state. Large hydro would either be imported (e.g. from Maine, New York or Canada) or acquired from existing Connecticut River and Deerfield River hydroelectric facilities (which have lower capacity factors than assumed here, so would require more MW of capacity). Today, Vermont utilities get about half of their renewable energy from in-state sources, and half from out of state (prior to REC sales and purchases). These three scenarios would maintain at least half their generation in Vermont if each technology maintained its current in-state/out-of-state mix. Scenario A is 65% in-state; B is 58% in-state; C is 53%.

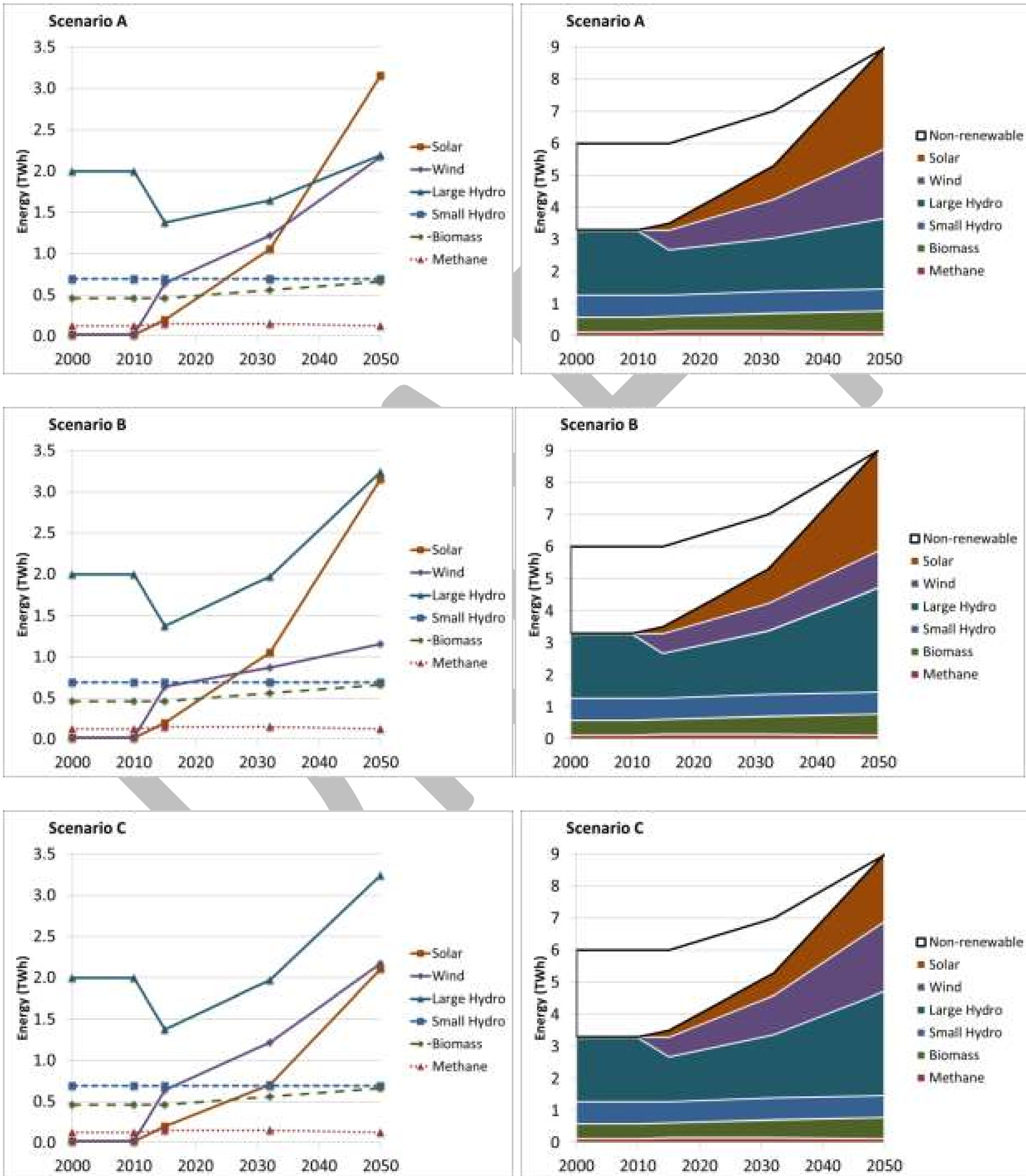
Exhibit 11-2. Three scenarios for 100% renewable electricity in 2050

Fuel	Scenarios: MW of Generation Capacity		
	A	B	C
Solar	2250	2250	1500
Wind	750	400	750
Methane	15	15	15
Biomass	100	100	100
Sm. Hydro	175	175	175
Lg. Hydro	250	370	370

Exhibit 11-3 shows the approximate energy derived from each of these resources under each scenario. 2000, 2010, and 2015 data in this exhibit is based on actual utility portfolios[171]. The three scenarios for 2032 achieve the RES requirements of 75% renewable and 10% new distributed generation, and the 2050 data correspond to the scenarios shown in Exhibit 11-2. It is critical to note that this figure represents portfolios before REC sales and purchases, and as such does not represent the power mix serving Vermont customers. Its intention is simply to explore a range of possible portfolios and their land use impacts.

[171] *The methane line includes landfill gas, which is expected to decay significantly by 2050 due to the diversion of organics under Act 148.*

Exhibit 11-3. Three scenario trajectories to 9 TWh of renewable electricity in 2050. Each scenario is shown with lines for each resource (left panel) and stacked areas totalling the full portfolio (right panel). Exhibit 11-2 contains the MW of capacity assumed in these scenarios. Each generates 75% renewable portfolios in 2032, assuming 7 TWh of energy needs, and 100% renewable in 2050 assuming 9 TWh. 2000, 2010, and 2015 are based on existing utility portfolios (before REC sales or purchases), including the transition to the new HydroQuebec contract.



These three scenarios have different land use impacts. The following summary of possible impacts is approximate, and uses current estimates and rules of thumb. It is in no way intended to describe a prediction of the actual impacts from these scenarios, nor to suggest that any of these scenarios is the exact future electric portfolio for Vermont utilities.

Assuming that all of the solar PV serving Vermont load is located here, all of these scenarios suggest significant increases from the current level of deployed solar. To date, there are approximately 120 MW of solar PV deployed (of which about 25 MW are residential rooftop-scale systems under 10 kW), and there are more than an additional 60 MW announced or in some stage of the permitting process. Scenario C involves 1,500 MW, assuming an average 16% capacity factor. If approximately ¼ of residential buildings have roofs suitable for solar PV and these roofs are all used, then between 300 and 500 MW of solar PV could likely be deployed on residential roofs. If 350 MW were deployed on residential roofs, the 1,150 remaining MW would require about 8,000 acres (assuming 7 acres per MW). To achieve 2,250 MW total in scenarios A and B, the 1,900 MW not on roofs would require about 13,000 acres. Disturbed lands, parking lots, and commercial rooftops would be possible sites for the non-residential generators. Rooftop deployment is more expensive than ground-mounted deployment, so the balance would have ratepayer cost implications as well as environmental and land use implications.

Under a grant from the DPS, a team of regional planning commissions has used geographic information systems (GIS) to estimate the number of acres in the state that are good for solar (e.g. reasonably flat) and also are **not**: FEMA floodways, river corridors, federal wilderness areas, rare and irreplaceable natural areas (RINAs), vernal pools, class 1, 2, and 3 wetlands, deer wintering areas, special flood hazard areas, conserved lands, hydric soils, habitat blocks > 2,000 acres, or local, prime or statewide-classified agricultural soils. There are more than 340,000 acres of such lands in Vermont. Many of these lands are likely not suitable due to un-accounted-for factors, such as current uses, aesthetic impacts, or other factors. However, it is also likely that there are many excellent sites for solar PV that are not counted in this total, including sites on disturbed land and in the built environment. Regardless, this data supports a conclusion that the estimated requirements for land area for even the higher solar deployment in scenarios A and B are very small compared with the statewide availability of suitable land.

If one assumes that 55% of the wind energy serving Vermont is located here, which is the current ratio, scenarios A and C would require approximately 410 MW of total capacity; scenario B would require approximately 220 MW (all assuming a 33% capacity factor). Currently deployed are 52 large wind generators, totaling 119 MW of capacity. This implies an average of 2.3 MW per turbine, but the three more recently constructed facilities average 2.75 MW per turbine. Scenario B would imply the equivalent of 36 additional 2.75 MW turbines; for scenarios A and B it implies an additional 106 such turbines. Improvements in wind technology to increase capacity factors, or the use of higher capacity turbines, could reduce the number of turbines needed to generate the assumed amount of energy.

Large hydroelectric generation under these three scenarios would either increase about 60% from current levels, or increase by a factor of 2.4. Scenario A would imply contracting or the equivalent of the nighttime hours on the Highgate interconnection with the Quebec electric system that we don't contract for now, plus another 20 MW of large hydro from some source. Scenarios B and C imply the equivalent of round-the-clock over the Highgate intertie and NYPA and an additional 140 MW, for a total energy of approximately 2.4 times what Vermont utilities current purchase from such generation.

With high levels of variable generation from wind and solar PV, all of these scenarios demand continued and substantial change in the operation and management of the electric grid over the coming decades. Concurrent deployment of electric vehicles and other electric energy storage, along with other kinds of controllable loads and supply, will increase operational flexibility. Vermont's electric system operates as part of a region, which may have a different overall electric mix, including imports from outside the region, offshore wind, and other renewable and low-carbon electric supply. Grid operations and the regional context are discussed later in this chapter.

11.2 New Electric Generation in Vermont

Electric generation in Vermont can be a boon to the state's economy. However, not every generation technology, scale, and location 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. The increased assessment of cumulative impacts associated with smaller projects will be critical as Vermont continues down the path of distributed generation.

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.

Direct jobs created include engineering, legal services, manufacturing, construction, and operation and maintenance associated with electric generators. Jobs related to wind and solar projects are concentrated during the construction phase (however, these jobs are short-term and may employ some out-of-state workers). Apart from jobs associated with specific projects, Vermont is home to a number of energy companies that employ Vermonters and export expertise and products.

Development of local renewable technologies such as biomass, wind, solar, and hydro will contribute to meeting the goals set by the 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 low-cost or no-cost fuels required to generate most forms of renewable electricity; energy security and stability; a diverse resource mix; and the expressed preferences of Vermonters for greater use of renewable resources, especially distributed and community-scale resources, these smaller-scale renewable projects offer great potential. Fostering small-scale and distributed renewable energy is an objective of the CEP. As the number of small-scale generators in the state grows, the DPS and electric utilities will continue to evaluate how to most cost-effectively and reliably integrate these generators into the electric system.

Small renewable electric projects have a number of incentive mechanisms already built into the policy framework in Vermont. Most notable is Tier 2 of the Renewable Energy Standard, which requires deployment of distributed renewables that are connected to Vermont's distribution grid or part of an approved plan to avoid transmission costs. The Standard Offer program provides one programmatic mechanism to ensure that all utilities get power from in-state DG resources using a diversity of fuels and technologies. 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 have contributed to the maturation of these technologies, helped to foster the renewable energy industry in Vermont, and generated public awareness and acceptance of these technologies. The distributed projects that these programs have facilitated account for 2.5% of Vermont's total electric supply, and that number is expected to rise to 12% or more by 2032 under the RES. Specific tools to further facilitate renewable energy supply in both centralized and distributed applications are further discussed below.

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 44% 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 long-term competitive advantage by being built in Vermont; in addition, siting choices would be limited by the gas transmission infrastructure. Such a plant is not recommended by the CEP.

11.2.1 Land Use and In-State Energy Resources

Renewable energy resources developed across Vermont to serve local energy demand will have some degree of impact on the landscape. The tradeoffs inherent in choosing to place a solar array, wind turbine, hydro dam, or other renewable generator on an open field, ridgetop, or river will alter that piece of the landscape for some period of time and may preclude many other uses of that same parcel. These tradeoffs are discussed in Chapter 5, as well as in the technology-specific sections of Chapter 13. Maximizing opportunities to utilize the built environment for co-location of renewables – including rooftops, parking lots, brownfields, grayfields, landfills, and so on will ease some, but not all, of the pressure on the state's greenfields.

Citizens, towns, renewable developers, the environmental community, and state leaders are clearly feeling the strain of a burgeoning in-state energy resource buildout, especially with the volume of projects entering the pipeline in the hopes of building before key federal incentives expire in 2016. The buildout of distributed energy across the state means that people are experiencing the paradigm shift of coming face-to-face with our energy sources. Regions, towns, and individuals are struggling to find resources to devote to understanding and participating in the energy permitting process, and many are starting to rethink the energy goals contained in their land use plans.

These growing pains are not unlike those that came with other substantial changes to Vermont's landscape, such as the advent of the state highway system and the proliferation of residential development that spurred the creation of Act 250. But, unlike Act 250, the regulatory pathway for most of the significant non-energy development in the State, Section 248 – the part of Vermont Law (Title 30) that governs the siting of electric generation projects – was not developed in response to a proliferation of energy projects. Rather, it predates the type and scale of distributed, renewable energy development we're seeing now, and has been continuously modified and adjusted as state policy has changed to both accommodate and manage the buildout of these resources. The resulting suite of policies, processes, orders, rules, and precedent and their attendant exceptions and caveats does its best to capture the intent of policymakers and best practices gleaned through experience, but does not offer a great deal of clarity and transparency for those without significant time to invest in parsing out the information.

In recognition of these issues, the Legislature and Administration have made – and continue to make – various attempts to reform the planning and siting processes for electric generation to reflect today's energy needs and generation resources.

<u>Energy Generation Siting Policy Commission</u>

On October 2, 2012, Governor Shumlin created the Energy Generation Siting Policy Commission (Siting Commission) through Executive Order No. 10-12. The charge of the Commission was to survey best practices for siting approval of electric generation projects (all facilities except for net- and group-net-metered facilities) and for public participation and representation in the siting process, and to report to the Governor and to the Vermont Legislature on their findings.

In April 2013, the Siting Commission released a report[172] containing their comprehensive package of 28 recommendations, which encompassed five broad themes:

[172] *http://sitingcommission.vermont.gov/publications*

- Increase emphasis on planning at state, regional, and municipal levels, such that siting decisions will be consistent with Regional Planning Commission plans.
- Adopt a simplified tiered approach to siting.
- Increase opportunities for public participation.
- Implement procedural changes to increase transparency, efficiency, and predictability in the siting process.
- Update environmental, health, and other protection guidelines (on a technology basis, where necessary).

A list of all the recommendations is provided in Exhibit 11-4, along with information on whether the recommendation requires statutory or rule change or has funding implications.

Exhibit 11-4

SITING COMMISSION RECOMMENDATIONS MATRIX

Recommendation Theme	Recommendation	Legislative Change	Rulemaking	Funding implications	Begin Implementation Now	Page(s) from SC Final
Planning	1. State Planning and Scenario Modeling			X	X (underway)	7, 8, 43
	2. RPC Planning (a), RPC Formal Party Status (b)	X (b)			X (a; underway)	7, 8, 45
	3. RPC Planning Costs (initial and ongoing)			X	X	7, 8, 46
	4. Municipal plans substantial consideration	X				7, 8, 47
Simplify Tiers	5. Simplified Tiers	X				7, 8, 48, 81
	6. Incentives within tiers	X				7, 8, 50
Public Participation	7. Establish a trigger point		X			7, 9, 50
	8. Earlier public notification	X				7, 9, 50
	9. Increase public engagement requirements	X				7, 9, 51
	10. RPC funding support during application period			X		7, 9, 52
Transparency, Efficiency, and Predictability	11. Hire Case Manager in PSB			X	X	79, 53
	12. Electronic Case Management/Online Docketing			X	X (underway)	7, 9, 54
	13. Develop checklists for each tier				X	7, 10, 54
	14. Concurrent timing of ANR permit filing and CPG		X			7, 10, 54
	15. PSB timelines for early stages of docket	X	X			7, 10, 54
	16. ANR response in keeping with performance standards				Underway	7, 10, 54, 85
	17. Overall CPG performance standards	X	X			7, 10, 55
	18. Rebuttable presumption for ANR permits	X	X			8, 10, 56
	19. Improve PSB website to create 'one-stop shop' for siting			X	X	7, 10, 56
	20. Update PSD website to provide pre-application information				X	7, 10, 57
Environmental, Health, and Other Protection	21. Update enviro, health and other standards and guidelines				X (underway)	8, 10, 58
	22. Modify Section 248 to give substantial consideration to Act 250 criteria	X				8, 11, 58
	23. Ag Agency become statutory party	X				
	24. DOH review and guidelines on health impacts				X	8, 11, 58
	25. ANR and PSD guidelines and tools for cumulative impact				X	8, 11, 59
	26. All parties agree on 3rd party monitoring experts and assign agency responsibility for oversight	X		X	X	7, 11, 59
Cross-Cutting	27. PSB 'pay attention' to list				X (underway)	11, 59
	28. Consider and assign funding sources	X			X (underway)	11, 60

Planning

Simplified Tiers

Technical Changes to Existing Statutory Language

While the comprehensive suite of recommendations has yet to be adopted by the Legislature, state agencies have made progress in discrete areas where possible. These include:

- *Electronic Case Management/Online Docketing System – Recommendation #12 (underway)*
  - The DPS and the PSB are in the process of implementing an integrated electronic filing web portal, case management, and document management system (PURE DOCS and ePSB), which will be searchable and which provide public access to all documents

designated by either agency as public. The first version of the system is expected to become available in early 2016.

- *Comprehensive Planning – Recommendations #1 and #2* (underway)
  - Total Energy Study: Following the publication of the 2011 Comprehensive Energy Plan, the Legislature asked the DPS to lead an inclusive process to evaluate and recommend policy options that could achieve the state's GHG reduction goals and the CEP's 90% renewable energy goal. This process culminated in the 2013 Total Energy Study.[173]
  - Regional Energy Planning: The DPS is funding three Regional Planning Commissions (RPCs) to ascertain their regions' renewable energy potential as well as comprehensively addressing their energy needs (electricity, heat, and transportation) through 2050. This initiative is discussed in greater detail later in this section.
- *Concurrent timing of ANR permit filing and CPG – Recommendation #14 (underway)*
  - Requiring full implementation of this recommendation will require a change in PSB rule, but ANR has begun to encourage petitioners to file collateral ANR permits, e.g. stormwater and state wetlands permits, simultaneously with their CPG filing. A recent example of this approach is VGS's Addison County Natural Gas Project Phase 1. While ANGP1 is an energy transmission – not a generation – project, it requires the same CPG and many of the same ANR permits as new generation. VGS filed their CPG, state wetlands, stormwater, and water quality certification applications all on the same day, allowing for the simultaneous update and review of complex resource data.
- *ANR response in keeping with performance standards – Recommendation #16 (underway)*
  - ANR's Department of Environmental Conservation (DEC) has established permit processing performance standards – or expected processing timelines – for a number of permits relevant to energy generation. ANR is actively working to streamline internal processes and re-allocate capacity to ensure these standards are met. While meeting performance standards is a goal for all DEC permitting, the high volume and tight timelines of many energy generation projects have made that sector a priority for the Department.
- *Update environmental, health, and other standards and guidelines – Rec. #21 (underway)*
  - Across all three ANR Departments, technical staff and scientists have begun to update policies and guidance documents related to energy generation. In some cases new technical guidance has been developed. By providing petitioners with technology-specific guidance and standards for solar, wind, biomass, and natural gas projects, CPG applications are typically more complete and better address natural resource considerations, resulting in a more efficient regulatory review process.

<u>Regional Energy Planning Pilot</u>

[173] *http://publicservice.vermont.gov/publications/total_energy_study*

In early 2015, the DPS funded three RPCs – Bennington County, Two Rivers-Ottauquechee, and Northwest – in a two-year pilot initiative to develop detailed energy components of each region's Regional Plan pursuant to their related statutory responsibilities as required by 24 V.S.A. Chapter 117, Subchapter 3. The energy plans are expected to advance the State's energy and climate goals while being consistent with local and regional needs and concerns, and to provide specificity to enable progress of each region toward those goals.

The work being performed by the RPCs covers three key areas: (1) identification of an overall statewide policy framework that will help guide the establishment of regionally appropriate targets for specific energy conservation, generation, and fuel-switching strategies; (2) development of comprehensive regional energy plans that include specific strategies for conservation, energy efficiency, and reduced use of fossil fuels, and (3) a geographic analysis that identifies energy resources and the most appropriate locations for new renewable (thermal and electric) energy generation projects, including an estimate of the theoretical potential generation from identified high-potential areas.

The RPCs are working with VEIC to develop regionally appropriate energy scenarios and strategies for each region using the Long-Range Energy Alternatives Planning (LEAP) model, including targets for conservation, renewable thermal and electric energy generation (local and/or imported), and fuel-switching targets. The RPCs will work iteratively with their towns to refine draft scenarios, resource maps, and strategies with the ultimate goal of producing draft regional energy plans for potential adoption into the overall regional plans.

As of early September 2015, each of the three RPCs had completed draft resource potential maps and LEAP modeling and were preparing to bring their results to local communities for feedback. As the project proceeds, the DPS and the RPCs will gain a better understanding of the value of the work, which may prove useful and replicable for the other eight RPCs in the state.

Solar Siting Task Force

The Solar Siting Task Force (Task Force) was created by the Vermont Legislature with the passage of Act 56, signed into law on June 11, 2015.[174] It directed the Commissioner of the DPS to call the first meeting of the Task Force on or before August 1, 2015. The duties of the Task Force are to study the design, siting, and regulatory review of solar electric generation facilities and to provide a report in the form of proposed legislation with the rationale for each proposal.

In addition to creating the Task Force, Act 56 – the primary function of which was to create a Renewable Energy Standards – contains some specific measures designed to address concerns legislators heard from constituents related primarily to the aesthetics of solar projects. These include:

- Giving automatic party status in 248 proceedings to host municipal legislative bodies and planning commissions
- Creating statewide setbacks for ground-mounted solar projects:

[174] http://legislature.vermont.gov/assets/Documents/2016/Docs/ACTS/ACT056/ACT056%20As%20Enacted.pdf

- Solar projects > 15 kW and ≤ 150 kW must be set back 40′ from the edge of a state or municipal highway and 25′ from adjoining property boundaries.
- Solar projects > 150 kW must be set back 100′ from the edge of a state or municipal highway and 50′ from adjoining property boundaries.

- Granting screening authority to towns:
  - Allows municipalities to adopt a freestanding solar screening bylaw and make recommendations to the PSB applying the bylaw to a ground-mounted solar facility.
  - Requires ground-mounted solar facilities to comply with screening bylaws or ordinances unless the Board finds that compliance would prohibit or have the effect of prohibiting the installation or functional use of the facility.

The Task Force will review the siting of solar projects in the context of these new requirements, and is also directed by the Legislature to review a forthcoming report from the Agency of Natural Resources on the environmental and land use impacts of renewable electric generation in Vermont. To date, they have reviewed the findings of the Siting Commission as well as a number of background documents available on the Task Force website,[175] as well as begun the ongoing process of listening to towns, neighbors, and members of the public to understand ongoing and evolving concerns with solar siting.

Net Metering and Renewable Energy Standard Design

Two renewable energy rule design processes are currently underway that provide opportunities to recommend improvements to the siting and review aspects of these types of projects.

Act 99 of the 2013-2014 legislative session amended the state's net metering law and created a process to revise the rules under which net metering projects are reviewed by the PSB.[176] In its initial comments to the Board, the DPS proposed as part of its rate structure construct that rooftop projects and those sited on parcels with reduced economic or environmental potential receive additional credit, in order to level the playing field between these typically more challenging sites and those that are easier to develop, such as greenfields.[177]

Act 56 of the 2014-2015 legislative session created a Renewable Energy Standard (RES) for the State, which is discussed at length elsewhere in this chapter. The PSB opened Docket 8550 in August of 2015 to address issues related to implementation of the RES.[178] The process to develop rules to implement the RES may offer opportunities to address siting aspects of renewable energy generators above and beyond

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175 http://solartaskforce.vermont.gov/

176 http://psb.vermont.gov/statutesrulesandguidelines/proposedrules/rule5100

177 http://psb.vermont.gov/sites/psb/files/20150612%20Act%2099%20Workshop%20Comments%20of%20the%20Department%20of%20Public%20Service.pdf

178 http://psb.vermont.gov/docketsandprojects/electric/8550

the characteristics prescribed in the underlying legislation. Understanding how siting is addressed in the RES equivalents in other states will be especially helpful as the Docket 8550 process unfolds.

<u>General Regulatory Improvements</u>

Many state agencies have played an active role in each of the siting initiatives discussed above, and have or are making specific recommendations in those particular contexts. As statutory parties to the 248 process, and in their day-to-day interactions with towns and neighbors of renewable energy projects, the DPS and ANR also have a more expansive perspective on the benefits and drawbacks to the existing systems for siting and review of all sizes and types of renewable energy projects.

Some of the elements of the 248 process that may benefit from revision in the near term include:

- Consideration given to agency permits in the 248 process: This includes ANR's permits related to natural resource considerations that are reviewed separately (and potentially redundantly) in Section 248, as well as pre-existing conditions in Act 250 permits that run with a piece of land on which an energy project is proposed, but which are not necessarily incorporated (or may in fact bebcontravened) in a Section 248 review and approval.

- Section 248 rules and requirements for different sizes and types of renewable energy projects: The current system is disjointed and lacks clarity in terms of applicable statutory criteria, requirements for application completeness, information required to demonstrate compliance with the statutory criteria, and the process and requirements for submitting comments, requests for intervention, and hearings.

- Roles and responsibilities of the DPS and other state agencies: Particularly in net metering proceedings, the roles of statutory parties and state agencies who have expertise and authority to provide information on relevant statutory criteria (including but not limited to the State Division of Historic Preservation, the Agency of Transportation, and the Department of Health) are not entirely clear in terms of requirements for hearing requests, imposition of particular conditions, and raising concerns about the extent and nature of the impacts a project may have on the 248 criteria.

- Timelines: Towns, neighbors, and parties require sufficient opportunity and time to comment effectively on CPG petitions and applications. At the same time, the process would benefit from timelines for issuance of decisions by the Board for applications and petitions where no issues have been raised.

Recommendations

(1) The state should evaluate the impact of the solar siting reforms contained in Act 56 of 2015 and consider the recommendations to be made by the Solar Siting Task Force.

(2) *The PSB should implement the ePSB electronic filing system as soon as possible.*

(3) *The DPS should continue to advocate for financial incentives and regulatory and other tools to encourage siting of renewables as appropriate on the built environment, other disturbed lands such as brownfields, and in places that offer the opportunity for optimizing multiple uses, such as grazing and recreation or parking in conjunction with solar arrays.*

(4) *The state should review the preliminary outcomes of the Regional Planning Commission energy planning pilot and, if positive, seek funding for the remaining eight RPCs as soon as possible, as well as continuing to work closely with RPCs as they assess their regions' energy needs, opportunities, and challenges.*

(5) *State agencies should continue to work with municipal legislative bodies, planning commissions, and energy committees as well as partners such as the Vermont League of Cities and Towns, Vermont Planners Association, and the Vermont Energy and Climate Action Network to provide tools and training to enhance local and regional energy planning, community-led project development, and regulatory process participation.*

Electric Equivalents for Renewable Generators

Electric generators are often compared on the basis of their generation capacity, expressed in megawatts (MW) or kilowatts (kW). However, different kinds of generators operate differently, and produce different amounts of energy per unit of capacity. A generator that runs at its maximum all the time is said to have a capacity factor of 1. A generator with the same capacity, but which outputs only 20% as much energy over the course of the year, has a capacity factor of 0.2. The table shows illustrative capacity factors for different kinds of renewable electric generators.

Illustrative Capacity Factors for Renewable Electric Generators

Fuel	Capacity Factor
Solar	0.16
Wind	0.33
Methane	0.95
Biomass	0.75
Sm. Hydro	0.45

Using these capacity factors, one can determine the electric energy equivalence of different generators. For example, each of the follow generators might be expected to generate approximately the same amount of annual electric energy (about 60 GWh, or 1% of Vermont's annual electricity use):

- A 20 MW wind project, consisting of eight 2.5 MW turbines, or half the size of the Sheffield wind project.
- 44 MW of solar PV, using a land area of approximately 300 acres if ground-mounted, or roughly equivalent to the cumulative capacity of all the solar PV deployed to date under the Standard Offer program.
- 15 MW of run-of-river hydroelectric generation, or approximately three times the size of GMP's Waterbury Dam hydroelectric generator.
- 9 MW of woody biomass electric generation, or slightly less than 1/5 the size of the McNeill generating station in Burlington.
- 7 MW of anaerobic digestion, or somewhat more than all of the currently operating anaerobic digesters in Vermont.

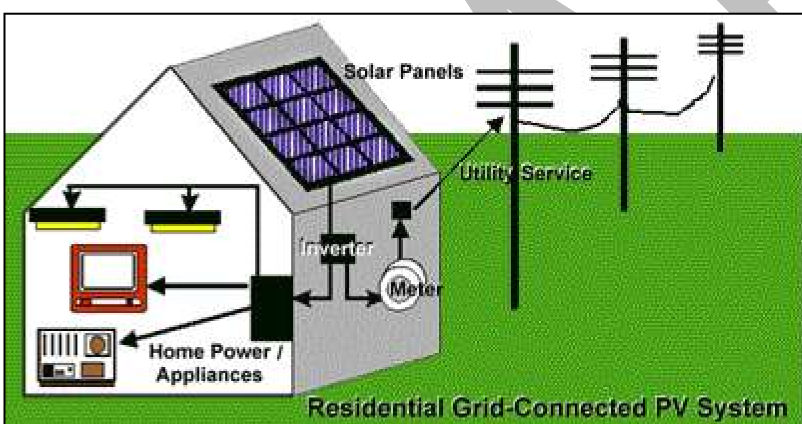
11.2.2 Strategies to Shape In-State Renewable Energy Development

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.[179]

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.

11.2.2.1 Sustain 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 net metering law was amended in 1999, 2002, 2008, 2010, 2011, 2013, and 2014. Over time, these changes established a mature program that:

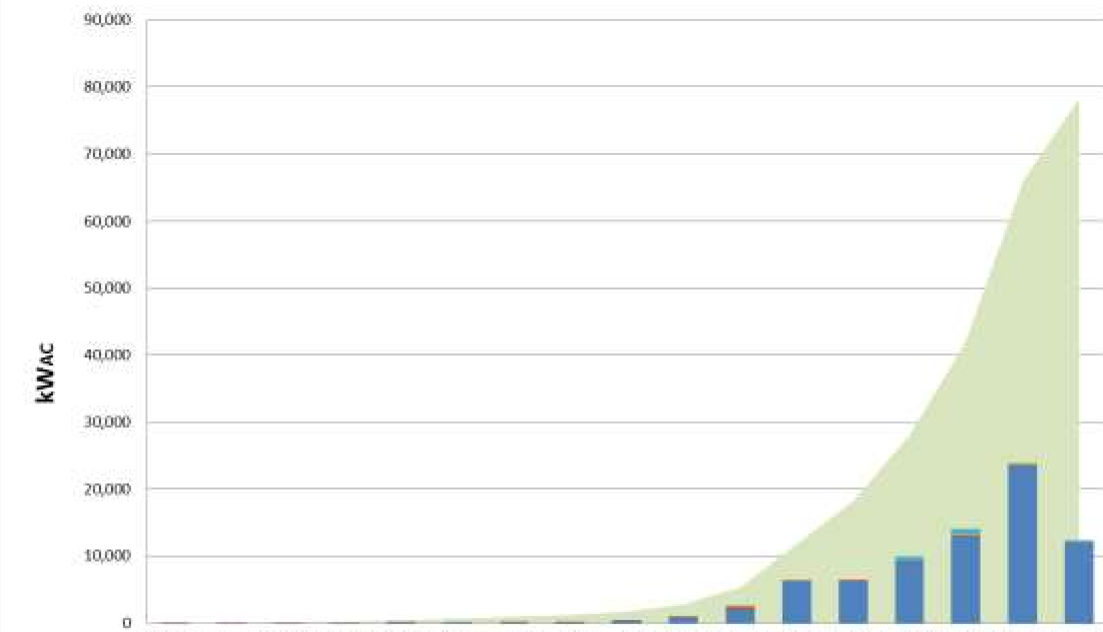
[179] *Electric efficiency, the most cost-effective supply resource, is discussed in Section 4.*

- has a cap per utility of 15% of 1996 utility system peak[180] or previous year's peak (whichever is higher),
- allows systems up to 500 kW, with additional limited opportunity for systems up to 5 MW for economic development or on closed landfills,
- opens group net metering for all customers,
- has a registration permitting and interconnection process for solar PV systems under 15 kW,
- adds a solar credit that has the effect of increasing the customer value of net metering to 20 cents per kWh for systems under 15 kW and 19 cents per kWh for larger systems, and
- allows Vermont's electric cooperatives to pilot alternate net metering structures.

Exhibit 11-5 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 1.2 MW. By the beginning of 2011, the numbers had climbed to 1,319 installed systems with an installed capacity of just under 11 MW. By August of 2015, there are more than 5,800 systems that have received permits, whose capacity exceeds 78 MW. An additional 34 MW of projects are awaiting permits. Solar PV dominates net metering, with 97% of all systems, over 95% of capacity, and 88% of energy generation using this technology.

[180] *"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 DPS for the year.*

Exhibit 11-5. Net Metered Permitted Capacity by Year and Type



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cumulatve Capacity	49.82	98.55	175.51	228.45	441.05	674.62	985.71	1261.19	1756.62	2807.21	5322.89	11779.8	18184.7	28047.6	42056.5	65935.0	78283.5
Hydro	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.25	0.00	0.00	716.15	664.25	0.00	360.00
Methane	0.00	0.00	0.00	0.00	0.00	65.00	0.00	0.00	0.00	19.00	39.00	126.75	0.00	0.00	248.00	292.50	0.00
Wind	31.91	9.50	27.95	30.95	98.50	71.94	124.15	101.51	148.03	157.94	482.41	153.99	238.70	65.53	124.88	98.00	99.00
Solar	17.91	39.24	49.00	21.99	114.10	96.64	186.94	173.97	347.41	873.65	1976.02	6176.24	6166.15	9081.26	12971.7	23488.0	11889.4

Source: DPS

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 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.

As net metering has met a rapidly increasing portion of Vermonters' electric energy needs, the question of appropriate and fair monetary compensation for net metered generation has risen in prominence. The DPS published analysis in both 2013 and 2014 showing that on a statewide basis, solar PV net metering under the state's current net metering structure produces minimal net subsidy between net metered and other customers, when viewed over the 20-year life of the generator, accounting for energy, capacity, renewability, and infrastructure benefits. 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. However, there is significant variability between utilities, due to different infrastructure designs (distribution systems designed to meet winter vs. summer peaks) and different retail rates.

Act 99 of 2014 transitions net metering from a structure in which many details are established in statute, to one in which the PSB designs the details of the program within a broad statutory framework. The PSB has been charged to design a program that[181]

(A) advances the goals and total renewables targets of 30 V.S.A § 8001, 8004, and 8005 and the goals of 10 V.S.A. § 578 (GHG reduction) and is consistent with the criteria of 30 V.S.A § 248(b);

(B) achieves a level of deployment that is consistent with the recommendations of the Electrical Energy and Comprehensive Energy Plans under sections 202 and 202b of Title 30, unless the Board determines that this level is inconsistent with the goals and targets identified in item (A) above. Under this item (B), the Board shall consider the Plans most recently issued at the time the Board adopts or amends the rules;

(C) to the extent feasible, ensures that net metering does not shift costs included in each retail electricity provider's revenue requirement between net metering customers and other customers;

(D) accounts for all costs and benefits of net metering, including the potential for net metering to contribute toward relieving supply constraints in the transmission and distribution systems and to reduce consumption of fossil fuels for heating and transportation;

(E) ensures that all customers who want to participate in net metering have the opportunity to do so;

(F) balances, over time, the pace of deployment and cost of the program with the program's impact on rates;

(G) accounts for changes over time in the cost of technology; and

(H) allows a customer to retain ownership of the environmental attributes of energy generated by the customer's net metering system and of any associated tradeable renewable energy credits or to transfer those attributes and credits to the interconnecting retail provider, and:

(i) if the customer retains the attributes, reduces the value of the credit provided under this section for electricity generated by the customer's net metering system by an appropriate amount; and

(ii) if the customer transfers the attributes to the interconnecting provider, requires the provider to retain them for application toward compliance with the Renewable Energy Standard.

[181] *The text that follows is from 30 V.S.A. §8010, adapted to this CEP context.*

As this Public Review Draft of the CEP is being prepared, the PSB has concluded an initial working group phase for its development of rules that fulfill these requirements. The final CEP will reflect those draft rules and make any resulting appropriate recommendations.

Net metering has great potential to be a primary method for the development of small-scale renewable electric generators in Vermont over the coming years. Tier 2 of the Renewable Energy Standard requires development of new distributed generation at a sustained pace, likely to exceed 20 MW per year for the next 15 years. Net metering provides an appropriate tool to develop a significant portion of this generation. As such, it is critical that the state implement a program that is financially sustainable over the long term and avoids boom-and-bust cycles. This requires a program that allows participation from a wide range of possible customers, in each utility service territory, while being financially sustainable for both participating and non-participating customers, as well as the firms that develop and install generators.

In the stakeholder process, the DPS has advocated for a net metering program that explicitly reflects the value provided by generators, while providing stable and predictable bill credits to participating customers, allowing customers to access low-cost capital. Value can take the form of explicit ratepayer value (such as energy, capacity, and transmission and distribution infrastructure costs) and environmental value (such as Renewable Energy Creditss that can meet the requirements of Act 56). Of particular note is the DPS's proposal to value avoided land use impacts from net metered generators located on buildings, brownfields, closed landfills, and other disturbed lands. Recognizing such siting-related value will increase the long-term sustainability of the program by reducing land-use impacts.

Recommendations for Net Metering

(1) The PSB and DPS should continue to work with stakeholders to design and implement a financially sustainable net metering program meeting the requirements of Acts 99 and 56.

(2) The PSB should implement, as soon as feasible, an online process for submission of net metering application and registration forms.

11.2.2.2 Study the Standard Offer Program

The Standard Offer program was established in 2009 as a 50 MW feed-in-tariff program, providing to developers of small qualifying renewable generation projects a fixed price for power under long-term standard contracts. The program was directed at certain renewable technologies and at projects of 2.2 MW in size or smaller. Power from each generator is allocated among Vermont's utilities on a pro-rata basis[182].

[182] *Washington Electric Cooperative has been exempt from this program due to the composition of its power portfolio.*

In order to ensure rapid development of the qualifying renewable technologies, the Legislature mandated that the rates paid reflect the actual costs of the various renewable technologies. The rates proved attractive, and the initial 50 MW allocation was quickly fully subscribed. Nearly all generators awarded a contract from this original tranche are now operating. The 2011 CEP proposed expanding the program, using market forces to set the prices, rather than an administrative process. Act 170 of 2012 added 77.5 MW of additional capacity to the program, to be added in annual increments of 5 MW for each of three years, then 7.5 MW for each of three years, followed by 10 MW for each of four years. By 2022, contracts totaling 127.5 MW will be awarded. Many of these generators will be among the primary generators that utilities use to meet the Tier 2 distributed generation requirements of Act 56. Each year's allocation allows for both independent providers and utility-owned projects.

To date, contracts have been awarded to 68 generators with a total capacity of 71.8 MW. This includes 38 solar PV systems totaling 59 MW, six small wind projects totaling 520 kW, six hydroelectric projects totaling 4.9 MW, two woody biomass CHP projects totaling 1.2 MW, one landfill methane project of 560 kW, and 15 farm methane projects totaling 5.4 MW. 51 projects totaling 52.6 MW are operating.

The Standard Offer program has also been expanded to house non-net-metered farm methane generators that had previously been fostered by a separate "cow power" program. These generators do not count toward the programmatic cap. Generators that provide "sufficient benefit" to the operation of the electric grid may also be awarded contracts outside of the cap.

The market based pricing structure established by Act 170 has been very successful at reducing the cost of the Standard Offer program. For each technology, the PSB establishes a cap, based on the expected cost to develop that technology, and projects compete for limited capacity by offering prices at or below that cap. Where the legislative and PSB processes that established prices for solar PV in the initial phase of the program has established prices between $0.24 and $0.30 per kWh, the most recent request for projects resulted in contracts offered at $0.1096/kWh and $0.1097/kWh.

The Standard Offer program should be diverse among different types of generation. The most recent solicitation, for example, established separate tranches for solar PV and for other types of generation, such as small wind, hydroelectric, and non-farm methane. Given its limited capacity each year, along with technology-based price caps, the Standard Offer program is well suited to fostering new renewable generation technologies which may not be able to otherwise attract power purchase agreements or net metering customers, while limiting ratepayer exposure to higher costs through its annual cap and competitive process. Allocation of annual capacity to a diverse range of technologies diversifies utility portfolios and fosters technologies and firms which may later be able to compete on price and performance alone.

The market-based Standard Offer program is set to continue throughout the period of this CEP. It has proven to be relatively flexible (e.g. the tranche system that attracted wind, hydroelectric, and methane projects in 2015) while remaining cost-effective. As implementation begins for the Renewable Energy Standard, which requires utilities to acquire RECs from projects very similar to Standard Offer projects, the continued need for a program of this sort after 2022 is uncertain.

Recommendations for Standard Offer Program

(1) Before 2022, the DPS should evaluate the existing Standard Offer program in the context of the RES to determine whether the program should be extended or if a successor program of a different sort is warranted.

(2) The PSB should continue to use its authority to foster deployment of diverse resources through the Standard Offer program.

11.2.2.3 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 Legislature has responded to the concern by requiring the PSB to establish simplified interconnection rules for small systems (<150 kW), an even simpler system for the smallest solar PV systems (<15 kW), and clear standards and a timeframe for responding to interconnection requests of larger systems.

These rules created by the PSB for small systems below 150 kW and very small solar PV systems below 15 kW have worked well to ensure safe and timely interconnections of more than 6,000 net metered systems. The interconnection rule developed for larger systems (>150 kW, Rule 5.500) is 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.

Through the processing of thousands of interconnection requests in the last several years, Vermont's utilities have gained a great deal of experience identifying common issues with interconnection requests and addressing them in a way that supports the reliability of the electric grid while quickly and fairly addressing each request. Utilities have also identified the need for additional flexibility in the Rule 5.500 interconnection process applicable to larger systems, allowing simple changes to the configuration of the grid necessary to accommodate a generator to be identified without a long and expensive study process. In the future, some projects below 150 kW may require a more robust analysis than the current system allows, due to clustering or cumulative effects with other generators on a circuit.

The DPS is coordinating a working group process during the summer of 2015 to develop a suggested modification to Rule 5.500 to address these concerns. The group's draft rule will also explicitly allow for and define processes for interconnection of electric energy storage; clarify the applicability of various electric codes; allow for and encourage the deployment of smart inverters that can allow generators to provide grid support (rather than tripping offline at the first sign of trouble, potentially exacerbating an issue); and require the PSB to host a centralized online interconnection application system. When the working group has fully addressed these issues, the DPS will petition the PSB to begin a rulemaking and adopt the new rule. The DPS obtained DOE grant support for this project through a competitive State Energy Program solicitation. In parallel with the rule update, the DOE grant is also supporting Green Mountain Power to develop a "Solar Map" which will make grid information of the sort necessary to evaluate a potential location for interconnection freely available through an online map application. Such a Solar Map will allow project developers to identify sites where projects will be most easily able to interconnect, and where generators could provide particular value to the operation of the grid.

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 PSB should promptly act on the Interconnection Rule Working Group's recommended changes to Rule 5.500, including development of an online interconnection application.

(3) Vermont utilities should learn from Green Mountain Power's experience developing the Solar Map to make timely interconnection-relevant information freely available statewide.

11.2.2.4 Maintain Existing Renewable Generation

Meeting long-term renewable electricity and energy goals requires maintaining existing renewable electric generation in Vermont, in addition to the development of new resources. Existing generators have the potential to be cost-effectively maintained and operated at costs at or below the cost of new generation, due to the fact that many of these generators have been fully depreciated or have paid off loans related to their construction. Many older facilities are hydroelectric generators, and occupy a large fraction of all of the potential dam sites for hydroelectric generation. The loss of such systems could result in an irreversible loss in in-state hydroelectric generating capacity. Hydroelectric generation is variable with water flow, but varies differently over time than do other variable generators such as solar PV and wind, providing valuable diversity in in-state generation.

Recommendations

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

(2) Vermont utilities should explore opportunities to purchase independently owned renewable electric generators 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.

(3) Vermont utilities that own renewable electric generators should actively maintain and, where cost-effective, enhance them to enable long operating lifetimes and low-cost electricity.

11.3 Regional and National Context

The first electric systems were largely small, disconnected generation resources serving local load, such as a small hydroelectric facility that would provide electricity for homes and businesses located in the immediate area. As efforts to provide electricity to all Vermonters grew, these systems were connected and generation in one town began to serve generation in other areas. As these interconnections grew, so did the size of the generation sources providing energy – from kW-scale hydroelectric facilities in the late 1800s to GW-scale nuclear facilities in the 1970s. The creation of larger generating facilities increased the need for transmission to allow significant amounts of electricity to flow from one area to another. In order to formalize the process for coordinating generation and transmission planning, the New England electric utilities created a structure called the New England Power Pool (NEPOOL) in 1971.

These interconnections between electric utilities are regulated by the federal government. The Federal Power Act grants to the Federal Energy Regulatory Commission (FERC) authority over "transmission of electric energy in interstate commerce" and to the "sale of electric energy at wholesale in interstate commerce."[183] The term "interstate commerce" does not limit federal jurisdiction to transactions that happen outside Vermont borders. Any transmission of energy from one utility to another and any sale of energy that does not involve the ultimate end user of energy constitutes interstate commerce. FERC reviews these transactions to ensure that they result in just and reasonable and non-discriminatory rates.

In 1999, in response to FERC directives to transmission companies regarding open access principles, NEPOOL formed ISO-NE. This entity was designed to operate the New England electric system, and over time, the responsibilities increased to include comprehensive planning of the transmission system and designing and administering the wholesale electricity markets. Under the Federal Power Act, ISO-NE has the authority to file proposed changes to wholesale markets and transmission tariffs, with FERC required to find that market rules and transmission tariffs are just and reasonable and not unduly discriminatory.

NEPOOL has evolved over the years but continues to have a role in the design of the wholesale electricity market and transmission planning efforts. NEPOOL now constitutes the formal stakeholder in ISO-NE's review of wholesale market rules and transmission planning and is comprised of six sectors: Transmission Owners (entities such as VELCO that own transmission infrastructure), Public Power (cooperatively and municipally owned utilities, including the Vermont municipal and cooperatively owned utilities), Alternative Resources (including efficiency and demand response providers such as EVT), generators (entities that produce power), End User (entities that represent consumers, such as state public advocates and environmental groups), and Supplier (entities that provide power for customers in restructured states, which does not include Vermont). ISO-NE is required to present proposals to NEPOOL, which then provides an advisory vote on the proposals. ISO-NE may file proposals even with zero support from NEPOOL; however, in theory, FERC takes into consideration NEPOOL's support for ISO-NE's proposal. There are also two state entities that participate in these processes. The New England States Committee on Electricity (NESCOE), which is funded by ratepayers and managed collectively by

[183] *Federal Power Act § 201(b)(1).*

the New England states, with the governor's office of each state appointing one or more managers. In addition, the New England Coalition of Public Utility Commissioners (NECPUC), which consists of the public utility commissions, helps provide oversight of the ISO-NE budget and works with NEPOOL and NESCOE.

11.3.1 Wholesale Electricity Markets

The wholesale price of electricity in New England is set through competitive wholesale markets, in which resources (primarily generation, energy efficiency, and demand response) bid to be able to provide power or other services. An individual resource may be able to provide multiple benefits to the electric system:

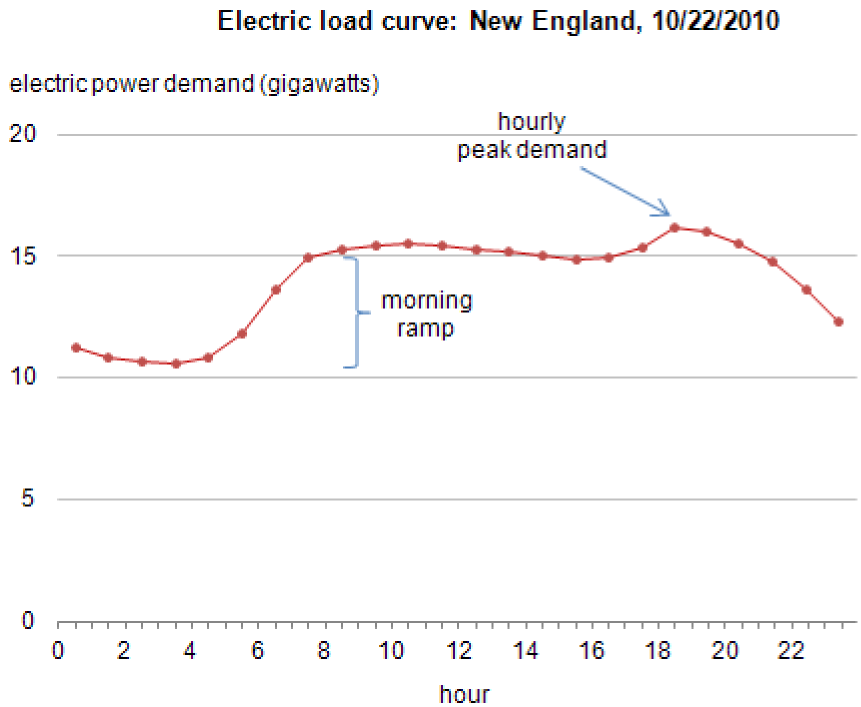
- Energy, measured in MWh, is the actual electrons that flow across the line;
- Capacity, measured in New England as kW-month, is the ability of a resource to be able to provide energy when called upon; and
- Ancillary services describes the ability to operate the resource in such a way as to ensure that system stability is maintained

In order to determine the appropriate price paid for each of the attributes listed above, ISO-NE administers competitive wholesale markets, as described below.

Energy Market

The energy market is comprised of two markets – one day-ahead market which is used for planning purposes and creates financially binding obligations by generators to provide power, and a real-time market which recognizes that fluctuations in consumer demand will occur, either as a result of an incorrect weather forecast (a day that was forecast to be mild turns out to be hot and muggy, causing people to turn on air conditioners) or as a result of an outage at a generator or a transmission line that prevents a resource from providing energy into the grid. In the day-ahead market load submits demand bids – statements that the utility needs a certain number of MWh at any given instance, over five-minute periods throughout the day. Generators submit supply bids, stating that they will provide a certain number of MWh in five-minute increments at a certain price. ISO-NE selects the least expensive resources to supply the total number of MWh needed. The last unit selected, the one at the margin, is called the marginal unit and the price that it bid is called the marginal price. All generators that produce energy are paid this marginal price for every MWh bid.

The amount of power needed shifts throughout the day and is commonly referred to as a load curve. Typically there is limited power needed during the early morning hours, with a steep curve upward from 5 a.m. to 8 a.m., as people are getting ready for work (often referred to as the morning ramp) and then relatively steady load until peak demand is hit around 6 p.m., as people arrive home, with load dropping off again as people begin to go to bed around 10 p.m.



The cost of power during the day typically corresponds to the need for MWh. In the early morning hours, there is limited need for power and therefore only the least expensive units are typically online. During the morning ramp, ISO-NE will need to call upon (dispatch) an increasing number of units, climbing up the cost curve for resources, with these units maintained during the day. ISO-NE will then need to dispatch even higher priced units for the peak hour of the day.

Any generator that is smaller than 5 MW may act to reduce the load within the interconnection utility rather than participate in the energy market. For example, a 4 MW solar facility located within Vermont may have a contract with the Vermont utility that it is interconnected with. The generator is paid directly by the utility – in this scenario, ISO-NE does not account for the generation in its dispatch, but instead sees a reduction in the utility's load, and the utility does not need to buy the number of MWh produced by the solar facility when it is producing power. The value of these resources corresponds to the value of the time when it is producing power and reducing the interconnecting utility's load. For example, a solar facility that reduces load during peak hours, when the wholesale market prices are highest, reduce higher costs compared to a resource that produces mainly in early morning hours when prices are often low.

<u>Capacity Market</u>

The New England electric system is designed to provide power whenever called upon. In order to do so, ISO-NE must plan for all load levels, including very hot days when everyone wants to run their air conditioning. Depending on the season, the peak demand can range from 15,000 MW in the spring or fall, to 20,000 MW during the winter and 28,000 MW during the summer. The particular hour of the particular day with the highest load level is called peak demand, and ISO-NE ensures that the system can meet that need.

ISO-NE predicts the peak demand three years into the future and adds a reserve margin; this amount is called the Installed Capacity Requirement, in other words, how many resources are needed to meet this peak requirement. Unlike the energy market, which is responding to specific needs for electricity at any given period in time, capacity requirements can be met by several types of resources – generation can provide power when called upon (although many generators can take hours to ramp up to full production), energy efficiency is a resource that is always considered to be "on" during certain hours, and demand response is the reduction of load, typically in response to high energy prices.

After determining the Installed Capacity Requirement, ISO-NE conducts a Forward Capacity Auction to purchase the amount of capacity required. ISO-NE selects resources based on the lowest price first and then goes up the supply stack until the requirement is met. Those resources that clear in the auction receive a Capacity Supply Obligation, in which the resource agrees to provide power (or reduce load) when called upon. To the extent that a resource does not meet its Capacity Supply Obligation it will incur financial penalties.

Ancillary Services Markets

In order to account for potential contingencies such as a generator or transmission outage, ISO-NE maintains reserve resources. There are three types of reserves:

- Ten-minute spinning reserves are generators that are already operating but are not producing at full power. These resources can ramp up power production within ten minutes to provide power as needed.
- Ten-minute non-spinning reserves are generators that are not online but have demonstrated that they are able to start and be able to produce a certain amount of power within ten minutes.
- Thirty minute non-spinning reserves are generators that are not online but have demonstrated that they are able to start and be able to produce a certain amount of power within thirty minutes.

ISO-NE requires that, at all times, there are sufficient ten-minute reserves to meet the largest single contingency (for example an outage by the largest generator operating within New England), and that between a quarter and half of the ten-minute reserves consist of spinning reserves. The rationale for having spinning reserves is that the single largest occurrence of generator failure is during start-up; since these generators are already producing power they are much more likely to be able to increase production within ten minutes and provide the necessary reserves. The amount of thirty minute reserves must be equal to the amount needed to meet one-half of the second largest contingency.

In addition to the reserves markets, ISO-NE manages a regulation market, with regulation in this context meaning the ability of generators to increase or decrease output every four seconds to respond to small changes in the electric system.

Participation in the Wholesale Markets

Each of Vermont's distribution utilities are required under the ISO-NE tariffs and market rules to participate in the wholesale markets described above. In order to protect against market volatility, utilities can enter into bilateral contracts with resources for energy and capacity needs. These resources are still entered into the markets; however, the utility will pay only the contract price to the resource, rather than the market price. For example, if a utility has a long-term contract for energy from a generator for $60/MWh, the price the generator is paid through the wholesale market will vary according to hourly market prices and will often be above or below that price. Regardless of the wholesale price, the generator receives $60/MWh from the utility, providing the generator revenue stability and the utility rate stability. Although the utility will likely be paying higher than market prices at some times during the year it will have estimated the long-range market price of energy and determined that the contract price is an appropriate hedge against market volatility. Vermont utilities are typically more heavily hedged against market price volatility through bilateral contracts than utilities in other states.

The Vermont regulatory role in the wholesale market process is typically after-the-fact review of a utility's long-term contracts during a rate case, or, for larger contracts, before-the-fact review in a proceeding under 30 V.S.A. § 248. During these reviews, the PSB can examine whether the utility was prudent in entering into the contract – which would involve testing the reasonableness of the utility's estimates of future wholesale prices and the efforts the utility undertook in pursuing alternative resource options.

11.3.2 Transmission Planning

ISO-NE produces an annual Regional System Plan that sets forth a forecast of expected peak demand, load, and transmission needs over a ten-year period. Transmission needs are driven by the amount of demand and generation within geographical areas; consequently, retirement of large generators or significant increases in demand can impact the need for transmission. Additionally, ISO-NE must comply with reliability planning criteria established by national and regional bodies such as the North American Electric Reliability Corporation and the Northeast Power Planning Committee. To the extent that these entities establish more conservative standards, it increases the need for additional transmission.

From 2002 to 2015, ISO-NE has put into service $7.2 billion of transmission infrastructure and expects to spend an additional $4.8 billion on transmission infrastructure for reliability purposes from 2015 to 2025. The costs of reliability projects are socialized across the region, with each state paying based upon its proportion of peak demand. Vermont represents approximately 4% of the regional peak demand.

Ensuring a reliable transmission system is dependent on the location of both load and generation. For example, an area with light load and significant amounts of generation would need sufficiently robust transmission in order to move the energy generated and not consumed in the area to an area of the grid that required the energy. Absent sufficient transmission, ISO-NE must minimize the amount of generation produced in the area, referred to as curtailment, in order to maintain system stability and reliability. In the northern portion of Vermont there is a significant amount of generation, from existing in-state hydroelectric and wind resources as well as the interconnections to Hydro Quebec, with low load and a relatively weak transmission system. As a result, ISO-NE has periodically curtailed generation in the area. Adding new generation in the area without upgrading the transmission could result in increased curtailment of existing resources.

In addition to the transmission required to meet reliability standards, in 2016-2017, ISO-NE will be implementing FERC Order 1000, a mandate for regional entities to plan for transmission projects necessitated by public policy, and also implement competition in the transmission reliability arena. With respect to public policy projects, ISO-NE and stakeholders will be identifying and reviewing state and local public policies to determine whether transmission can most cost effectively achieve these policies. To the extent that a project is selected under the Order 1000 process, the costs of this public policy project will be socialized among the region, although through a different formula than that used for reliability projects. Those states with public policies necessitating the transmission project will pay 30% of the project costs, with the remaining costs socialized among the region based on each state's share of regional peak demand.

Prior to Order 1000, the transmission owner that had a reliability need within its service territory was expected to provide a solution to the issue. Order 1000 mandates that the transmission reliability planning process be open to any transmission provider and allows transmission owners to compete to address reliability concerns. With the advent of competing transmission proposals, ISO-NE and stakeholders will need to address cost containment issues. Currently, reasonably incurred transmission costs can be recovered from ratepayers regardless of the transmission owner's original cost estimate; in other words, if the transmission owner estimated the cost of the transmission project at $250 million and the final costs were $400 million, that full amount would be allowed to be recovered in rates provided that the expenditures were prudent. To the extent that developers are competing to build transmission projects there must be greater certainty with the cost estimates.

The issue of more accurate cost estimating will be helpful in advocating for greater use of non-transmission alternatives (NTAs). Non-transmission alternatives are reliability solutions that do not rely entirely on transmission lines. For example, if peak demand can be reduced in an area through targeted energy efficiency, demand response or small scale generation, these efforts could be able to obviate the transmission constraints. ISO-NE has begun to do planning studies that examine the possibility of generation resources and energy efficiency addressing transmission constraints. However, NTAs are at a disadvantage as the costs of a transmission solution will be automatically paid for by ratepayers, and the costs will be socialized among the region.

11.3.3 Regional Initiatives

A significant issue facing the region is the increasing reliance on natural gas for energy production. Typically natural gas pipelines are built based upon long-term (around 20-year) contracts with gas distribution companies estimating the need for gas based upon the expected increase in natural gas heating and industrial customers. Generators purchase natural gas from the pipelines based upon what it needs to produce power. Because the energy markets operate on a day-to-day basis, gas-fired generators are not always certain that they will be called upon to run or if called upon, how much power it will be asked to produce. If the generator enters into a long-term contract for natural gas there is the possibility that it will not be called upon to run and must resell the gas, probably at a loss.

As a result of this disincentive for generators to enter into long-term contracts for gas capacity, the natural gas infrastructure in New England has been constructed to meet the needs of heating and industrial customers, and not the electric generators. Consequently, during times of peak demand for heating, there is insufficient pipeline capacity to meet the needs of the electric system. Instead of gas-fired generation, ISO-NE is required to dispatch oil-fired and coal-fired generation, increasing air emissions and typically increasing costs (as oil tends to be a more expensive fuel than gas). Many of the oil-fired units are 50+ years old and most of the coal-fired units in New England either have already or are scheduled to retire within the next few years.

Several of the New England states have seen significant price spikes as a result of the gas pipeline constraints and are examining the possibility of establishing a structure whereby electric customers pay for new natural gas infrastructure related to the needs of the electric system. There are currently no generators in Vermont that rely primarily on natural gas as a fuel source and the natural gas pipelines within Vermont are not connected to the rest of the New England system.

Recommendations

It is critical that Vermont:

(1) *Continue to work with stakeholders in the region to address natural gas pipeline constraints during periods of cold weather in a manner that minimizes costs to Vermont consumers, addresses emissions from oil- and coal-fired resources, and ensures reliable electric service.*

(2) *Work with stakeholders to examine reliability planning standards to ensure that the standards are reasonable and appropriately account for the cost to ratepayers of transmission upgrades.*

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

(4) *Focus on electric efficiency and peak load reduction, as Vermont's peak demand is used to calculate its share of regional transmission reliability and public policy projects.*

(5) *Consider the location of proposed large generation resources with respect to the impact on the transmission system and existing resources.*

(6) *Continue focus on Vermont's regional participation and advocacy at ISO-NE, FERC, and regional organizations such as the New England States Committee on Electricity.*

11.3.4 The Regional GHG Initiative and the Federal Clean Power Plan

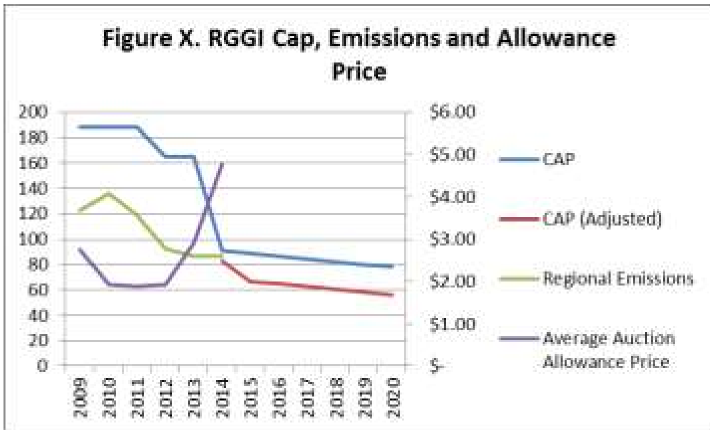
The Regional GHG Initiative (RGGI) is a cooperative effort by northeastern and mid-Atlantic states to establish a multi-state cap-and-trade program, with a market-based emissions trading system, to reduce carbon dioxide (CO2) emissions from the region's electricity generating utilities. Currently, there are nine states participating in RGGI: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island and Vermont. Each of the none states that participate in RGGI is represented by energy and environmental regulators; in the case of Vermont, these representatives are the chair of the PSB and the secretary of the Agency of Natural Resources (or their designees).

The RGGI states have established a regional cap on CO_2 emissions from the electric power sector, and require certain fossil-fuel fired power plants (25 MW or greater), in participating states, to possess a tradable CO_2 allowance for each ton of CO_2 they emit.. The RGGI states have implemented statutes or rules that limit emissions of CO_2 from electric power plants, create CO_2 allowances, and establish participation in CO_2 allowance auctions. Under RGGI, each of the participating states is allocated a certain number of allowances during a three-year compliance period. The states collectively auction the allowances on a quarterly basis, and any qualified 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.

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).

The initial RGGI cap of 188 million tons for the years 2009-2011, established during the initial program design period, proved to be overly conservative. The allowance price remained at or near the program floor or reserve price from 2010 through 2012.

Exhibit 11-6. Changes in the RGGI Emission Cap, Covered Regional Emissions, and the Average Allowance Auction Price



During the scheduled program review of 2012, the RGGI states agreed to two measures to bring the cap and amount of allowances in circulation into line with actual regional emissions. First, starting in 2014 the annual base cap was reduced 55% to 91 million tons, just below actual 2012 emissions, and an annual reduction of 2.5% was established. Second, the states agreed to annual adjustments to the base cap to account for the number of allowances still in circulation from the program's earlier years. The RGGI states are planning the next scheduled review of the program in 2016.

Earlier this year (2015), the Analysis Group released a report on the economic benefits of RGGI for the years 2012-2014 (reference: The Analysis Group, "The Economic Impacts of the Regional GHG Initiative on Nine Northeast and Mid-Atlantic States" July 14, 2015 http://www.analysisgroup.com/uploadedfiles/content/insights/publishing/analysis_group_rggi_report_july_2015.pdf). The report found that, across the region, the initial $0.98 billion in CO_2 allowance auction proceeds received by the states resulted in $1.3 billion in net economic value. The most cost-effective measure was state investment in energy efficiency programs, with additional contributions realized through measures such as consumer rebates that help recirculate money through the regional economy.

The U.S. Environmental Protection Agency announced the Clean Power Plan (CPP) final rule on August 3, 2015. The CPP regulates carbon dioxide emissions from power plants under section 111(d) of the Clean Air Act, and establishes levels of carbon dioxide emissions from power plants for each state. Vermont has no electricity generating units that meet the definition of a regulated entity under the CPP and therefore has no compliance obligation under this federal rule. However, each of our RGGI state partners does have a compliance obligation, and the CPP has the flexibility (e.g. by allowing multi-state compliance) to allow RGGI to be the primary compliance path for these states. The state will continue to work with our RGGI partners during this program review to maintain and potentially expand opportunities to reduce CO2 emissions from the electricity generating sector within the region and beyond. This is appropriate, given that Vermont utilities continue to purchase power from, and share a transmission grid operator in ISO-NE with, states that have CPP obligations. It is important to remain a full and equal participate in RGGI, and reflect our commitment to constructive action along with regional partners.

Recommendations

(1) *Continue to participate with RGGI to reduce carbon dioxide emissions from fossil-fuel fired electricity generation.*

(2) *Explore with neighboring states expanding RGGI to other fuels and sectors and/or allowing linkage between RGGI and other carbon markets.*

11.4 Energy Assurance: Safety, Security, and Resilience

As many recent significant storm events, including Tropical Storm Irene and recent ice storms, have reminded us, the state must be prepared for and plan for electric power supply emergencies. Under the State Emergency Operations Plan, the DPS 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 DPS 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. Vermont adopted its first Energy Assurance Plan (EAP) in August 2013, on the 10th anniversary of the Northeast blackout of 2003, which affected more than 50 million people (although Vermont was not among them). The DPS will update the EAP during the fall of 2015.

Energy Assurance is defined as: "The ability to obtain, on an acceptably reliable basis, in an economically viable manner, without significant impacts due to Energy Supply Disruption Event(s), or the potential for such events, sufficient supplies of the energy inputs necessary to satisfy Residential, Commercial, Governmental, and non-governmental requirements for Transportation, Heating (space and process heat), and Electrical Generation."

Energy Assurance involves an array of activities that fall into three main categories:

- Planning and preparation involve identifying key assets and personnel, designing resiliency into critical infrastructure, and creating and updating energy emergency response plans.

- Training & education entails the training of Government and Energy Assurance Stakeholders' personnel, as well as conducting exercises that test the effectiveness of the energy assurance response plan(s).

- Response activities include monitoring events that may affect energy supplies, assessing the severity of disruptions, providing situational awareness, coordinating restoration efforts, and tracking recoveries.

Energy Assurance includes the consideration of all hazards in the development and implementation of programs and initiatives that address education, training, planning, and execution over short, medium, & long term time horizons, for all relevant energy supplies, and interdependent systems such as transportation and telecommunications.

The EAP addresses natural gas and unregulated heating and transportation fuels as well as electricity. It directly addresses interdependencies among fuels, and among systems (e.g. the energy sector's reliance on telecommunications). The EAP is designed a reference and also as an actionable document for use in preparing for and responding to an emergency that impacts energy availability.

Apart from emergency preparedness, utility planning such as Integrated Resource Plans must take energy assurance into account. This includes preparatory actions that help the power stay on, such as careful vegetation management to clear trees away from power lines, and the strategic location of utility infrastructure so as to avoid risks in the first place (siting substations and generators outside of floodplains and river corridors, for example) or make restoration of power easier (such as by siting power lines along roadways).

Vermont Electric Cooperative's and Green Mountain Power's combined storm costs for 2013 alone were $22 million. These costs emphasize the potential savings from increased effectiveness and lower-cost weather event assessment, preparation, response and customer service restoration from increasingly severe and frequent weather events. The Vermont Weather Analytics Center Project (VTWAC) is a two-year, highly collaborative $16.6 million undertaking by VELCO (Vermont Electric Power Company) and IBM Research. It builds on previous smart grid investments by utilizing coupled models and leading-edge analytics to optimize integration of renewable generation resources, increase grid reliability and lower weather event-related operational costs. The VTWAC project's four components comprise four models: (1) a Vermont-specific version of IBM's Deep Thunder predictive weather model to produce high-resolution, accurate forecasts up to 48 hours in advance down to 1 km^2 to lower weather event-related costs and increase grid reliability; (2) an advanced electric demand forecast utilizing smart meters, Deep Thunder and other data sources in order to better plan for future system reliability needs; (3) generation forecasts for solar, wind and separately correlated hydro to improve power supply planning efficiency; and (4) a coupled model with a probabilistic framework that synthesizes the other models' output to produce actionable information enabling optimal balancing of renewable generation, efficiency, demand response and transmission resources. The initial application of the VTWAC focuses on mitigating transmission constraints to minimize curtailment of renewable energy. The near-, mid- and long-term benefits of the project focus on improved transmission and distribution grid reliability through earlier, much more accurate weather event information, and improved balancing of energy supply and demand through increased information on Vermont's intermittent (renewable) generation resources.

When outages happen, Vermont electric utilities can update a central website: http://wwwvtoutages.com. Some utilities have electronic feeds to automatically update this website every 15 minutes via their outage management system, while the remaining utilities must log in and manually update the outage numbers. The Department is working with the latter group of utilities to increase the number of utilities with an automatic feed to the site. All Vermont electric utilities have log-in access to this web site, and are expected to keep it updated to the extent possible. This public web site indicates outages in several formats: 1) a map of the state showing counties color coded according to the current number of outages per county, 2) a list of current outages by utility (and the last time the site was updated by each utility), 3) a matrix showing current outages by utility and county with totals for utilities, counties, and statewide, and 4) a line graph indicating historical statewide outages. This site is used by the utilities, state officials, the media, and the general public to monitor electric outages, especially during emergencies. Some utilities have individual outage web pages on their web sites, and these are linked from www.vtoutages.com.

When provided with appropriate generation and/or storage, portions of the electric grid can be configured to operate independently. These portions of the grid are called microgrids. As electric circuits around Vermont begin to host more distributed generation, it is becoming increasingly possible to configure storage and enable renewably-powered microgrids. There are many other flavors of microgrids, which vary based on how they are powered, how every is stored, how loads are controlled or curtailed when in the microgrid state, and whether they generally operate connected to or separate from the statewide grid. In some respects, a homeowner with a backup generator is operating a kind of microgrid. The increasing availability of home electric energy storage, coupled with residential solar PV, could enable individual renewable microgrids. Green Mountain Power has installed the state's first fully renewable microgrid in Rutland. The Stafford Hill solar PV generator is coupled with 4 MW of battery storage. In case of a grid failure, the circuit where Stafford Hill is connected can separate from the rest of eth grid. This circuit is also home to Rutland High School, which serves as an emergency shelter. In the case of an extended emergency, the solar PV generator could power the shelter indefinitely, without requiring any delivery of fuel except by sunlight.

Recommendations

(1) *The DPS should complete its update of the Energy Assurance Plan, working with and informing stakeholders to ensure that the state is prepared for the energy components of disasters or other emergency situations.*

(2) *Vermont utilities should harness the capacity of the Weather Analytics Center to increase energy assurance, reliability, and resilience, while more cost-effectively integrating variable renewables.*

(3) *As soon as it is technologically and economically feasible for each utility to do so, it should provide an automatic feed to vtoutages.com.*

(4) *The DPS and utilities should learn from the experience and performance of the Stafford Hill microgrid, and monitor progress in microgrid technology. Where appropriate based on this experience, utilities should facilitate development of microgrids, particularly those which support critical infrastructure.*

11.5 Utility Innovation and Market Participation

The pace of innovation in the electric sector is increasing, especially for distributed energy resources. For instance, solar PV prices have fallen by nearly 60% in the last four years, while the number of electric vehicles in Vermont has increased by more than a factor of ten and cold-climate air-source heat pumps are rapidly expanding in availability. Vermont utilities have completed deployment of a statewide smart grid in the last five years, opening the door for modern information technology tools to manage the electric system. Changes wrought by evolving technology will challenge long-held paradigms that underpin utility business models, while also providing opportunities for utilities to increase their own fostering of innovation. Vermont must harness this innovation for ratepayers' benefit and use it to help meet our energy goals, thereby advancing economic, environmental, and health priorities.

Vermont's regulated, vertically integrated electric utilities should become engines of innovation in their service territories. This CEP firmly establishes Vermont as a place where new ideas, technologies, and approaches are welcome. The regulatory environment must also support new ideas. The Energy Transformation (Tier 3) obligation in the Renewable Energy Standard explicitly opens the door for electric utilities to expand their service offerings to the benefit of their customers.

Critically, the RES also establishes an expectation that utilities will meet their Tier 3 obligations in partnership with others, unless the utility is unique situation to provide the service in question (e.g. using its bill as part of a financing offering). This partnership expectation is critical to ensure that utilities use their role to foster new markets and firms, rather than collect inappropriate additional market power. Partnerships with entrepreneurs, especially, are appropriate.

Utility engagement outside of their natural monopoly (electric energy service) means engagement in competitive markets. One option is for utilities to form unregulated subsidiaries, which can take the risk of market engagement, while keeping all of the reward. However, the policy driver for such market engagement is to bring aspects of the regulated utility to bear (e.g. its existing customer relationships, its billing system, and its access to capital, etc.). Municipal and cooperative utilities also do not have the same opportunity for unregulated activities, so focusing on that structure for implementation could lead to 20% of the state being underserved.

If the regulated utility is going to engage, then, regulators should maintain institutional skepticism, while also seeing the policy need. It is therefore appropriate to consider shaping how utilities engage in these markets to meet otherwise unmet needs, rather than introduce additional competition. The utility's role should be to drive creation of new markets and transform existing markets. This means only engaging in other markets to the extent it is adding value beyond what existing market participants are already doing. It also means exiting markets as they mature.

Where a utility offers a service that could be provided by another business, they and their regulators should take care to maintain a fair playing field as much as possible. For example, if a utility is offering leasing or tariffed hardware with payment on the electric bill, then it should also offer access to their bill for repayment to other participants in that same market, at a fair cost.

The structure of shareholder incentives for for-profit utilities, like Green Mountain Power, such as those embedded in an alternative regulation plan, shapes their market behavior. Continued evolution in these structures should establish shared risk and reward for innovative activities. Under such a structure, shareholders and ratepayers each take some of the financial risk, and each sees rewards when innovative ideas pan out. While separating activities and their downstream effects into different classes can be a challenge, the regulatory structure should have enough separation between traditional services and innovative services that the risk and reward from innovation is not swamped by other risks or rewards from the (much larger) traditional services.

11.6 Integrated 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 other 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.

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, transmission and distribution improvements, and an associated financial plan 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 covering all of the utility's operational and financial resources.

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 DPS. 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 electric 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. An appendix to this CEP[184] provides detailed guidance to distribution utilities for the development of their IRPs. This includes identification of particular content expected in each IRP (e.g. details regarding load forecasts, portfolio considerations, expected transmission and distribution upgrades, and associated financial plans).

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.*

(3) *Utilities should use the IRP framework to plan for high DER penetration futures, and develop better understandings of the costs and benefits of different combinations of DER deployment.*

11.7 Power Sector Transformation

Power sector transformation refers to a strategy by which states, utilities, and other partners seek to capture the value of distributed energy resources (DER) for the benefit of consumers through lower costs, cleaner generation, and better system reliability. This transformation, sometimes also called reform, not only affects the electric distribution utilities (DUs) but leverages them to facilitate change in ways that encourage greater customer participation and entry of new market players (into the business of supplying electricity). Regulatory interventions and oversight become the main instrument for achieving these changes. Power sector transformation charts a course that fundamentally alters the way utilities seek to reduce costs and improve system performance[185]. The goal is to capture system, societal if that is the preference in a jurisdiction, and customer value from small distributed local resources and complementary changes to regulation and the role of the DU.

At a high level, global trends in the enabling communications technology and distributed energy resources create opportunities for improvements in costs, reliability, and environmental performance of the electric utility sector. In order to facilitate the change, complementary policy, regulation, and utility efforts will be needed sooner rather than later. Distributed energy resources and communications

[184] *This draft of this appendix will be released separately from the draft CEP, and will be subject to public comment and feedback prior to finalizing.*

[185] *That is to say, through industry consolidation and economies of scale.*

capabilities are still evolving, but the path is relatively clear. Distributed energy resources such as solar and wind, combined with distributed storage, flexible loads (such as electric vehicles and controllable devices), and a centrally managed platform, offer great potential for improving the performance of the grid. The central question is: How do regulators, system operators, and electric distribution utilities need to evolve the system to remove barriers, enable the distributed grid to emerge, and motivate the DUs to function as a cooperating partner in facilitating these changes?

Several U.S. states have taken the lead in this transformation, and have begun to take steps toward it by launching regulatory processes. Vermont has not taken explicit and separate steps but is in many ways well along its own path. The RES in Act 56 sets an explicit structure for distributed generation resources to support the grid and explicitly invites electric utilities to partner outside of their traditional regulated role to reduce their customers' use of fossil fuels while managing DERs to enhance overall cost-effectiveness. Vermont's earlier actions to establish Energy Efficiency Utilities is another example of its steps along the path, Vermont is at a stage at which it can continue to chart that path while being cognizant of progress made in neighboring states and other regions of the US. Summarized in Appendix A are some of the relevant features of select state efforts, beginning with New York's Reforming the Energy Vision (REV) process and then outlining the work of other active states that will be informative to Vermont.

Other states have either opened formal regulatory proceedings or have informal efforts underway with some measure of support or acknowledgement from the executive branch of government. States like Hawaii are experiencing the pressure for policy and regulatory reforms in real time as the combination of high costs and a wealth of solar resource potential results in high penetration of distributed resources.[186] Other states that have either formal processes or some other type of effort underway or in development relating to sector transformation include New York (the REV process mentioned above), California, Minnesota, Michigan, Massachusetts, District of Columbia, and Rhode Island. The mix of states that are active include a mix of both retail choice states and states like California that are under more traditional integrated utility systems. Illinois, Connecticut, Maryland, and New Jersey are in the process of planning next steps.

The list of topics that are included in these efforts are many, but center around the issue of identifying both the value and challenges of DER interventions in the distribution system, and to identify and to use a transparent system of valuing all system resources, whether utility or customer investments. Key topics around efforts to engage in power sector transformation include those related to redefining the role of the regulated company, the utility business model (or alternative regulation), distributed resource planning, distributed resource access, integrating wholesale with retail markets, and rate design. Serial efforts to address these areas are common due to resource constraints. Demonstration projects appear to be an important component of the transformation process.

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[186] *In April of 2014, the Hawaii PUC reported that approximately 10% of residential customers have rooftop PV. White Paper, April 2014 at 11.* http://puc.hawaii.gov/wp-content/uploads/2014/04/Commissions-Inclinations.pdf

11.7.1 Context for Vermont's Transformation

Vermont's current regulatory and policy framework is, in many ways, designed to promote development of distributed energy resources, and the planning process is likewise designed to capture value from DER. Vermont utilities are on a three-year planning cycle to develop least cost IRPs that are intended to identify least cost resources, whether central station or distributed energy resources. Vermont's planning framework for bulk transmission and subtransmission exists through a collaboration of VELCO and the Vermont System Planning Committee and includes consideration of DER-like non-transmission alternatives (NTAs).[187] This process also includes a fairly unique effort to integrate baseline forecasts of energy demand with energy efficiency planning efforts in developing integrated statewide and localized forecasts of energy demand.

The process of grid modernization is well underway, with advanced metering infrastructure in place in most households and businesses. More than 90% of the state is served by utilities that were relatively early adopters of AMI (including BED, GMP, WEC, Stowe, and VEC). This creates a number of opportunities for innovative rate design and controlled charging of flexible loads, including electric vehicles.[188] Retail rate design offers considerable potential to encourage customers or entities controlling loads to capture locational value for the benefit of customers. Rate design is discussed further in chapter 10.

The planning structures in Vermont could be leveraged or extended to better address distribution system planning efforts around DER, either on a utility-by-utility basis, or by focusing it first on the larger systems. Other jurisdictions are looking at ways to redesign their systems to allow for bidirectional flows. This need is now well-recognized for distribution systems in most jurisdictions, including Vermont. Given long lived nature of any investments this is an issue for Vermont's electric distribution system planners to get ahead of.

While Vermont does not have competitive retail markets, this does not appear to limit its ability to rely on market forces to deliver on DER potential. In Vermont, at least one utility, GMP, has helped to guide innovation in the state, in cooperation with partners like NRG.[189] States can clearly make significant progress toward capturing value from DER in the absence of retail choice. Indeed, utilities in California have made spurring the development of markets for DER services a foundational principle.[190] Many

[187] *Vermont System Planning Committee, available at http://www.vermontspc.com/*

[188] *Controlled charging of household loads dates back decades in Vermont (used by utilities for rental electric hot water heaters in the 1980s), but the opportunities to apply increasingly to electric vehicle loads, and most thermal household and commercial loads.*

[189] *GMP has partnered with NRG and provides innovative storage services using Tesla batteries. GMP has also worked to develop innovative pilots through its Energy Homes of the Future and Energy City of the Future in Rutland. Some of the innovative solutions offered by GMP and NRG are presented on GMP's web site at http://www.greenmountainpower.com/innovative/gmp-nrg-making-vermont-a-national-leader/*

[190] *See, for example, the DRP of Southern California Edison. Principle #5 states that "Competitive Processes Should Be Utilized to the Greatest Extent Possible" asserting that this is " asserting that this is in turn a foundation of Commission policy for creating customer value. Southern California Edison, Application of Southern California*

elements of the value proposition are connected to centralized planning efforts that can be adopted either context, system portions of the system, grid services, remain fundamentally part of the distribution system platform monopoly. Market-based reforms, including retail choice, offer additional promise of capturing dynamic efficiency that results from a competitive process with many players. Vermont is unlikely to embrace retail reforms in the near future, but could take measured steps to encourage some dynamic efficiencies to the participation of third-party DER providers and aggregators, consistent with the principles discussed in section 11.5 above.

11.7.2 Opportunities Looking Forward

A comprehensive approach to efforts around power sector transformation would include efforts to revisit grid system planning and grid modernization, especially distribution planning; the business model (or alternative regulation that applies to Vermont distribution companies); options for rate design, including those enabled by AMI; and issues around access to the grid, including the state's existing interconnection regime. A serial approach would prioritize these several opportunities for improvement with an overall direction in mind.

Vermont has already reformed grid planning in ways that allow for some consideration of DER at the level of transmission and subtransmission[191]. The state has also made substantial progress with the utility business models for its largest electric utility in ways that largely decouples sales from profits.[192] Vermont has created a successful framework for implementing electricity energy efficiency that integrates with grid planning. Metering infrastructure has been installed to enable advanced forms of retail pricing[193], recommendations for which are described in Chapter 10, and Vermont has pursued a steady path toward the development of renewables through net metering and standard contracts and toward the adoption of electric vehicles.[194]

Vermont has options going forward. Vermont can mirror the efforts of states like New York and California, which have undertaken a fairly comprehensive review of the entire system. However, many of the issues around the reforms are technical in nature, and Vermont would be challenged to assemble the

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Edison Company (U 338-E) for Approval of its Distribution Resource Plan, July 1, 2015 at 9, available at http://www.cpuc.ca.gov/NR/rdonlyres/0165F5EC-8FD4-44C6-9818-A04452961CEC/0/A1507XXX_DRP_Application_SCE_Application_and_Distribution_Resources_Plan_and_Appendices_AJ1.pdf

[191] *Vermont Public Service Board Docket 7081, Order Approving Memorandum of Understanding, available at http://psb.vermont.gov/sites/psb/files/orders/2007/7081finalorder.pdf*

[192] *Public Service Board, Alternative Regulation Page, available at http://psb.vermont.gov/utilityindustries/electric/backgroundinfo/altreg*

[193] *Vermont DPS, Advanced Metering Infrastructure Deployment Plans, available at http://publicservice.vermont.gov/topics/electric/smart_grid/amiplans*

[194] *VEIC, Substantial Growth in Number of Electric Vehicles in Vermont over the Past Year, November 2014, available at https://www.veic.org/media-room/news/2014/11/03/substantial-growth-in-number-of-electric-vehicles-in-vermont-over-the-past-year*

critical mass of engagement from business and advocates that larger states such as New York and California can bring to bear. Vermont can, however, benefit from lessons learned in other states. At the other extreme, Vermont can maintain an observer role in monitoring the efforts of states that are most active in formal power sector transformation processes, such as New York, California, and Massachusetts. As an observer Vermont can still capture the lessons learned from these early leaders and build on proposed reforms or the success with the implementation of those reforms. The Distribution Resource Planning (DRP) proposals and progress of New York and California on a wide range of issues offer great potential for accelerating progress around capturing greater value from DERs.

Another choice that seems advisable, however, allows the state to address the impending challenges and opportunities in a way that preserves focus and control through measured steps forward. Under such a path, Vermont would identify priorities and build on earlier successes and its own circumstances. Utilities would be asked to provide a couple important deliverables that were designed to meet parameters set in a PSB proceeding. Such a process could then allow space for transparency and public participation.

Vermont utilities can play an active role in helping to shape the future for DER by crafting demonstration projects that meet certain well defined objectives. This is analogous to the seven demonstration projects that are already approved and being pursued for New York, and those that have been proposed by California utilities in their distribution resource plans filed on July 1, 2015. Some of these pilots were created with local governments, universities and local groups cooperating with the utilities. The scope of these demonstration plans could be the subject addressed in PSBproceedings. Here companies such as GMP could work with its partners to develop and demonstrate a DER platform, or pilot project initiatives, consistent with goals for efficiency, clean energy, and improvements in reliability.

11.7.3 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, load management, 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. The benefits obtained from DUP can include reducing the load on T&D systems, deferring the costs of upgrading T&D infrastructure, 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 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 DPS views DUP as consistent with Vermont statutes and PSB 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.

12 Energy Supply Resources Summary

The following two chapters of the CEP address energy supply resources which can be used to meet the energy service needs (heat, mobility and power) identified and described in the preceding chapters. As identified in the preceding chapters, end-use energy efficiency is a key resource that can meet energy service demands without use of any of the supply resources discussed in the following chapters – often at lower cost and with fewer environmental and health impacts. As such, it is and should remain the first option for meeting energy service demands. Energy efficiency cannot meet all energy needs, however, so supply resources are required.

Chapter 13 addresses renewable energy sources, and chapter 14 non-renewable sources.

The renewable resources examined are:

- Solar
- Wind
- Wood and other solid biomass
- Liquid biofuels
- Methane from on-farm and non-farm digesters as well as landfills
- Hydropower

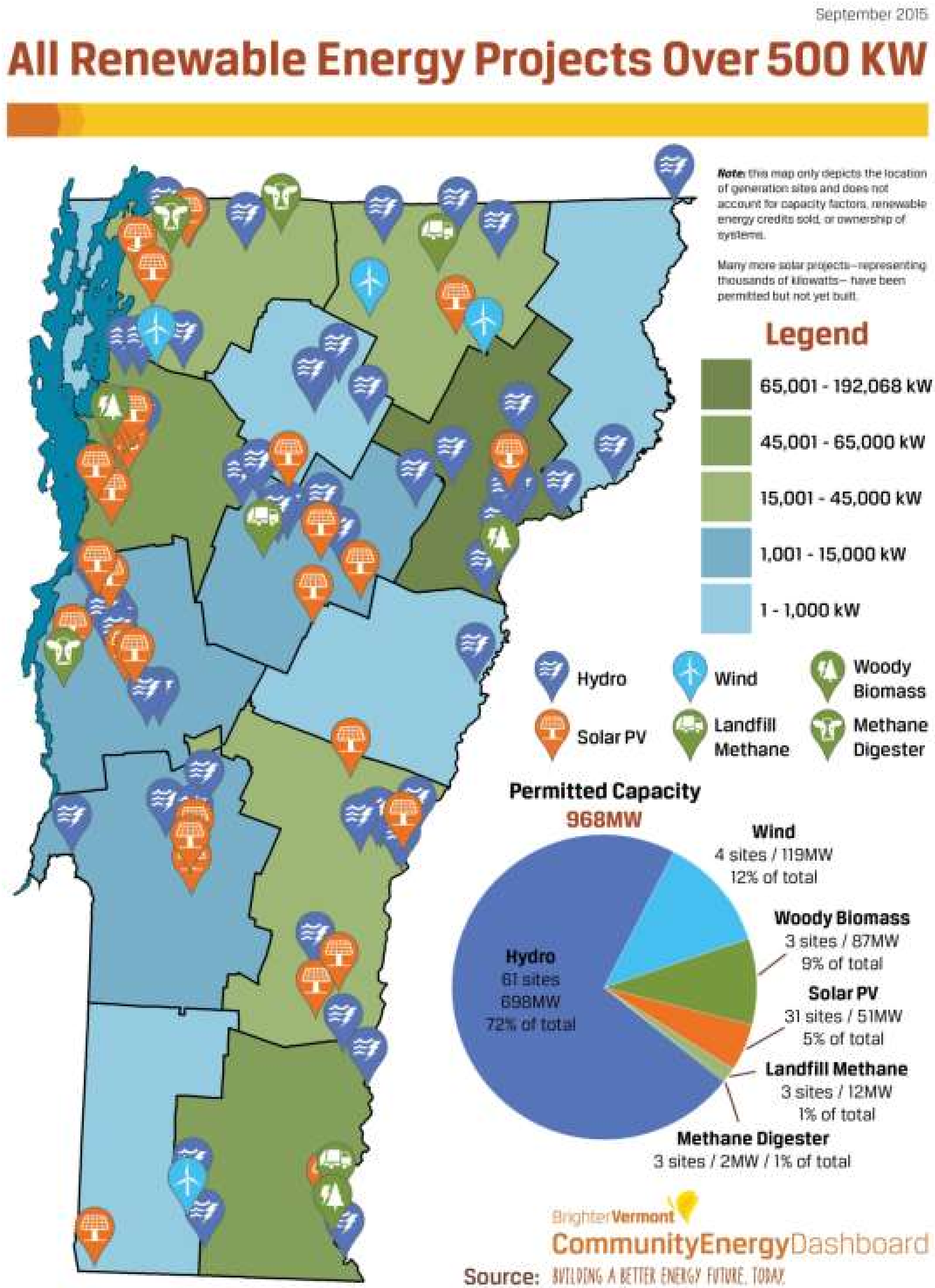
The non-renewable resources examined are:

- Petroleum
- Natural Gas
- Coal
- Nuclear

Each of these sources can be used to generate electricity, and many of them are also used to power vehicles or provide heat in buildings or industry. Earlier chapters discuss the fuel choice decision; these chapters address issues and opportunities, and make recommendations related to the extraction of energy from the resources.

13 Renewables

Exhibit 13-1. Renewable Energy Projects in Vermont > 500 kW



13.1 Solar Energy

Solar energy is the capture of sunlight to generate power or heat. Solar power production for Vermont, and locations with similar solar irradiation levels, is accomplished primarily with solar PV systems, even though there are other technologies used to generate solar power. Given that solar PV is the primary technology used in Vermont, this chapter will only cover solar PV in relation to power generation. For solar heating, the chapter will focus on solar thermal collectors used to heat domestic hot water but will also briefly cover solar space heating as well as solar lighting.

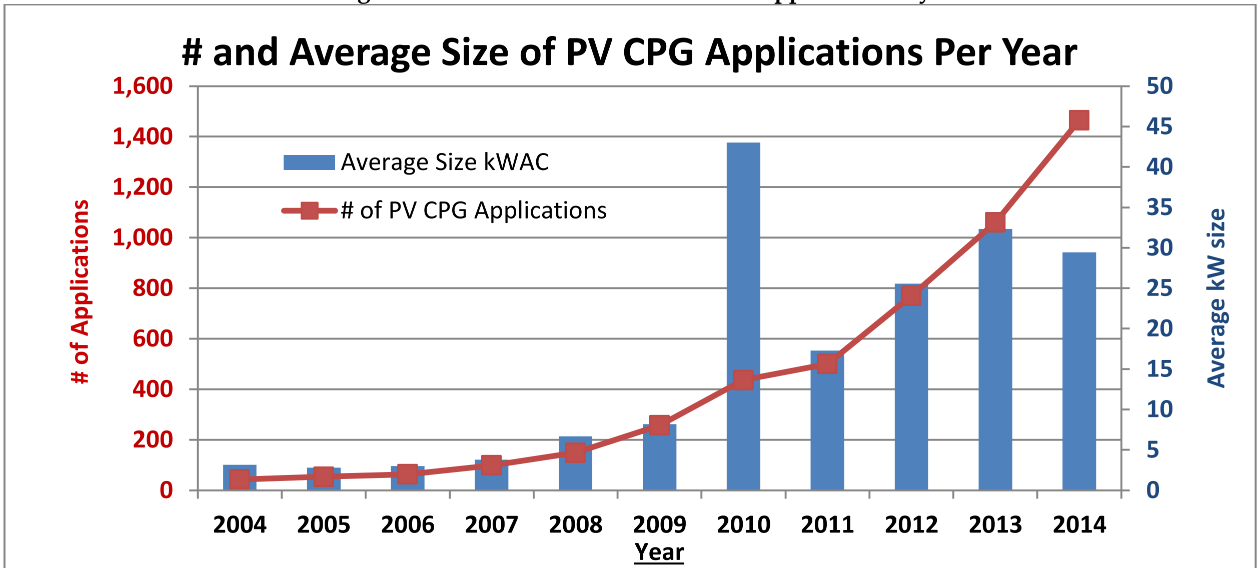
13.1.1 Solar Photovoltaics (Solar PV)

United Church of Thetford, 15 kW solar PV system.

13.1.1.1 State of the Market

Vermont has experienced tremendous growth in the amount of solar PV deployed across the state over the last five years. By all measures, the use of solar PV to create power in Vermont is on the rise: the number of systems (residential, commercial, and utility scale), the average size of systems, and the total capacity of systems installed, have all steeply increased over the last five years, as can be seen in Exhibits 13-2 and 13-3.

Exhibit 13-2. Number and Average Size of Solar Photovoltaic Permit Applications By Year



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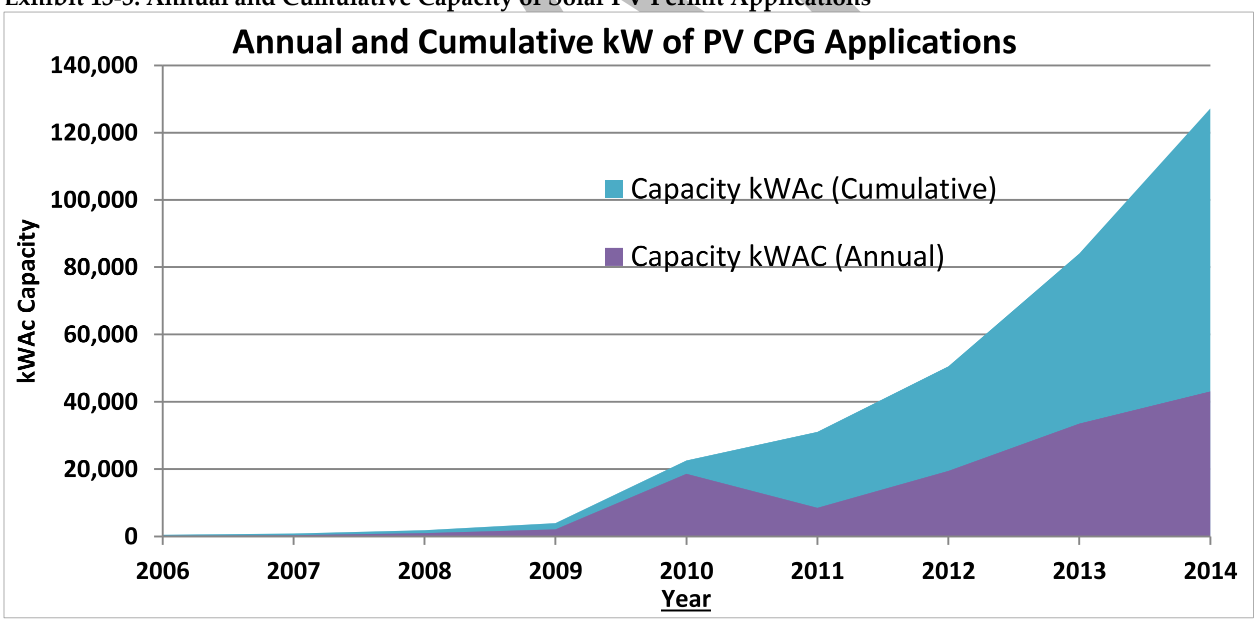
Preliminary DPS data for the first half of 2015 shows the fast growth of solar PV continuing into 2015, and it is projected to stay strong through 2016.

Exhibit 13-3. Annual and Cumulative Capacity of Solar PV Permit Applications



This growth has resulted in approximately 180 MW of solar PV either installed or in the permitting process in Vermont[196].

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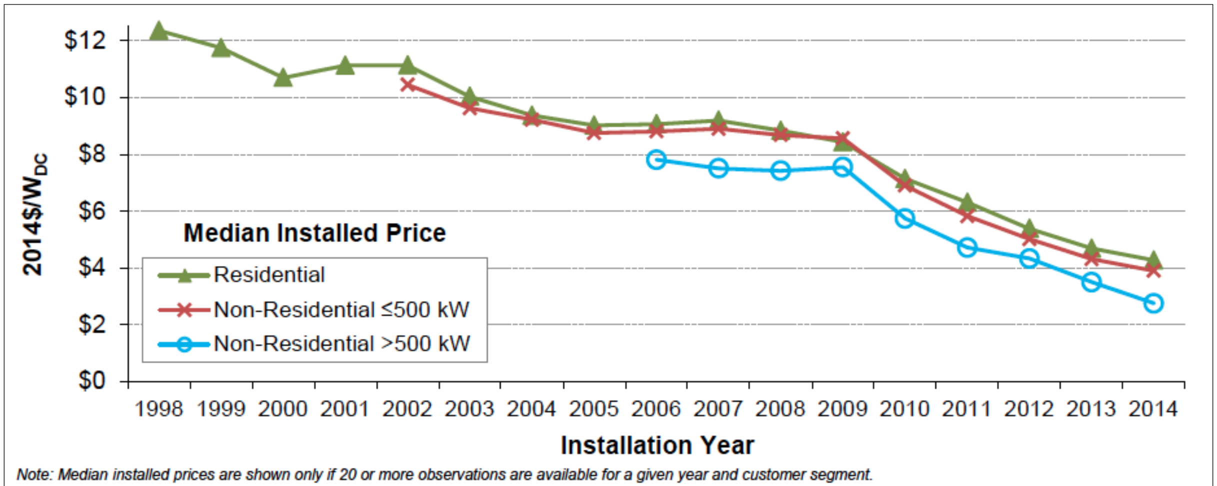
[195] *DPS Generator database 8-20-15*

[196] *This does not include the 100 MW of large (20 MW) systems that have applied for interconnection in VT.*

The efficiency of solar PV panels also increasing, allowing solar PV to produce more power per square foot than ever before. In the last 10 years, the efficiency of the most common type of solar PV used in Vermont increased from about 12% to 16%. In laboratory tests, the type of solar PV modules most commonly used in Vermont reach efficiencies of about 23%[197]. Such laboratory results demonstrate the potential for further increases in solar PV efficiency for that will be installed in the near future which, in turn, will help to reduce the cost of solar PV power.

Exhibit 13-4. U.S. National Installed Cost of Solar PV Systems[198]



The only aspect of solar PV power that is waning is the cost to install it. National price data is shown in Exhibit 13-4 and demonstrates the declining installed price per watt of solar PV from over $12/watt in 1998 to just over $4/watt in 2014 for residential systems. Due to economies of scale, larger commercial systems have installed costs that are even lower.

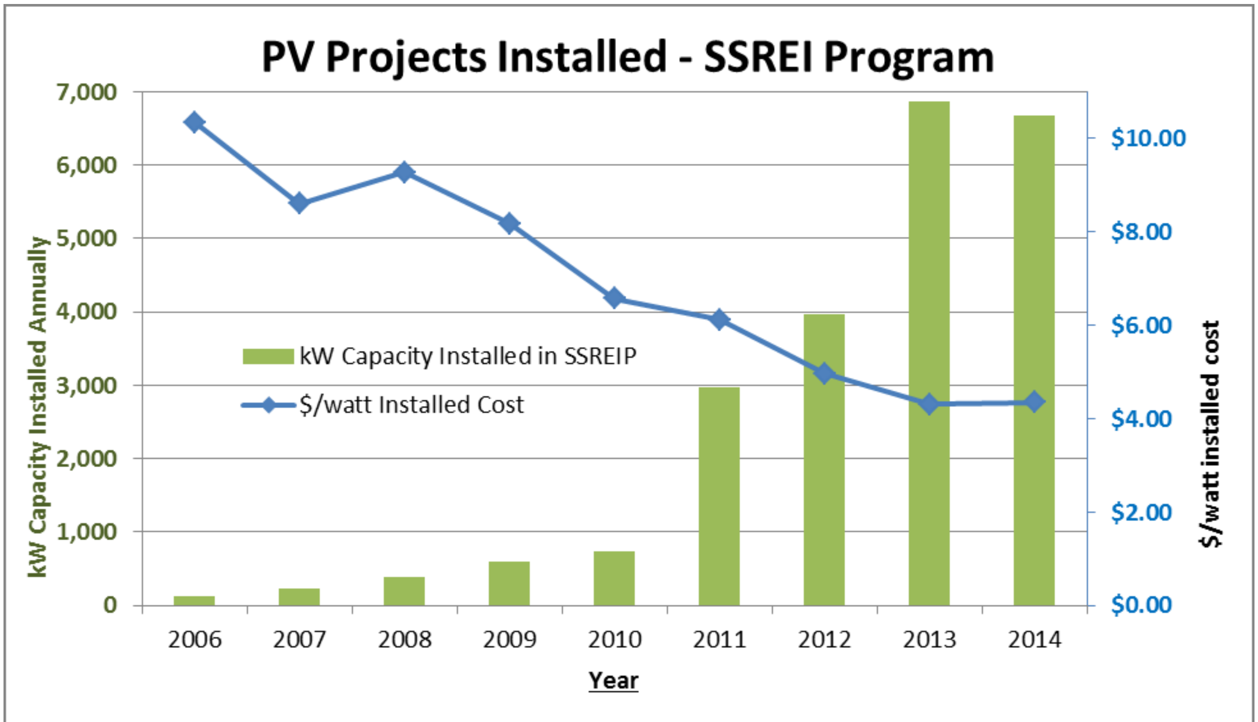
The installation costs for residential solar PV systems in Vermont have mirrored the dramatic drop seen nationally. Over the past 10 years, most residential installations in Vermont were supported by financial incentives paid through the Clean Energy Development Fund's Small Scale Renewable Energy Incentive (SSREI) Program. The SSREI Program has collected the installed cost data from the almost 4,000 systems that have participated in the program. As you can see in Exhibit 13-5, the cost to install solar PV in Vermont dropped approximately 58% in the last 8 years[199].

[197] Photovoltaics Report. *Dr. Simon Philipps (Fraunhofer ISE) and Werner Warmuth (PSE AG). Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, 26 August 2015*

[198] *US solar PV prices 1998-2014 graph via LBNL/SunShot*

[199] *Vermont Small-Scale Renewable Energy Incentive Program data, 2006–2014.*

Exhibit 13-5. Cost ($ per kW) and Capacity of Solar Photovoltaic Systems Installed through the SSREI Program, 2004–14



Because of this dramatic drop in price and increased market penetration of solar PV, the CEDF ended the incentive payment for solar PV systems at the end of 2014. This incentive had been in place since 2004, before the CEDF was even created, and was a critical component of the solar PV market over those 10 years. The discontinuation of the incentive was consistent with CEDF's plan to decrease incentives as the solar PV market matured.

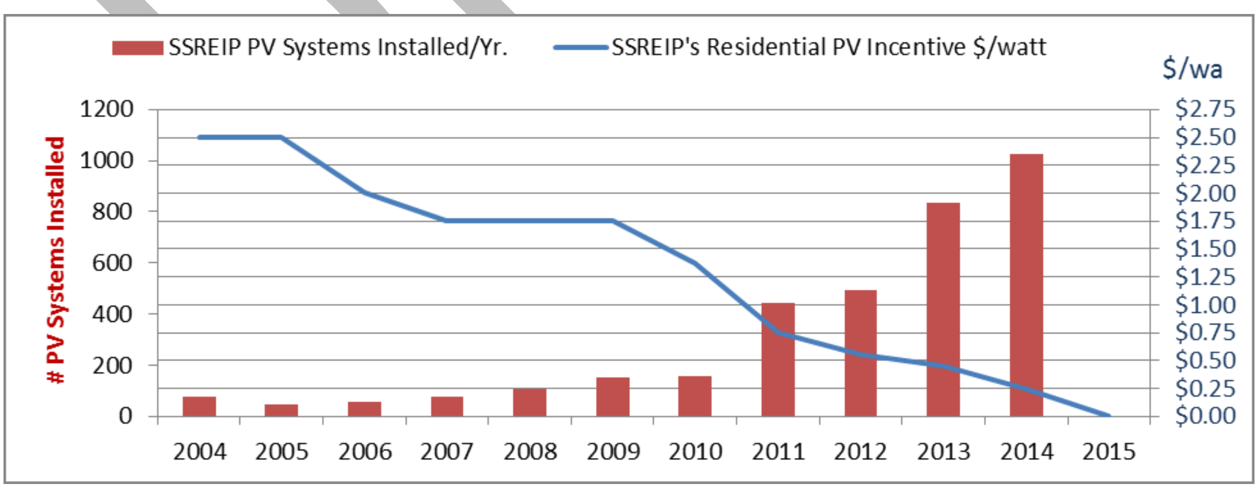
Many of the solar PV projects have been installed on farms and other businesses involved in Vermont's vibrant farm and food sector. The Farm-to-Plate Network has tracked solar PV installations on farm and food organizations' buildings and land. This is shown in Exhibit 13-6.

Exhibit 13-6. Solar PV in Vermont's Food and Farm Sector[200]

ORGANIZATION TYPE	# OF SITES	SOLAR TYPE	INSTALLED CAPACITY (KW)	% OF TOTAL
Farm	44	Roof	792.9	5.7%
	46	Ground	7,926.4	56.9%
Processing	3	Roof	266.8	1.9%
	4	Ground	590.7	4.2%
Distributor	1	Roof and ground	382.8	2.7%
Retail	12	Roof	323.9	2.3%
	2	Ground	208.4	1.5%
Nutrient Management	1	Ground	2,200	15.8%
Food shelf	1	Roof	14.3	0.1%
Educational Institution	8	Roof	69.2	0.5%
	7	Ground	516.7	3.7%
Support Organization	6	Roof	217.1	1.5%
	1	Ground	399.4	2.9%
		TOTAL	**13,908.5**	**100%**

As the Exhibit 13-7 shows, the amount of solar PV systems incentivized through the SSREI Program steadily increased even as incentive payments decreased. By 2014, the value of the incentive had dropped by a factor of 10, from $2.50/watt in 2004 to $0.25/watt in 2014. The number of CPG applications for projects under 15 kW in the first half of 2015 indicates that there will not be a drop in the number of residential solar PV systems installed in 2015 compared to 2014, despite the lack of a $/watt incentive.

Exhibit 13-7. SSREI Program Incentive Levels and Number of Solar Photovoltaic systems installed



[200] *Data from Renewable Energy Atlas of Vermont; in the Energy Plan of the Farm-to-Plate Network plan (to be released) see http://www.vtfarmtoplate.com/plan/chapter/4-6-food-system-energy-issues*

In addition to the SSREI Program, Vermont has supplied incentives to solar PV projects through the CEDF and loan programs as well as through supportive net metering policies and a business solar tax credit. Solar PV projects also receive federal support from a 30% tax credit and, for commercial systems, an accelerated depreciation schedule.

With the increase in the number of solar PV systems being installed, the local solar PV industry in Vermont has also grown. For the past two years, the CEDF has commissioned an industry survey and report on Vermont's Clean Energy Sector. The results of the 2015 study demonstrate that job growth in the solar PV sector has increased 21.8% since 2013 with a total of 1,889 solar PV jobs reported[201]. Solar PV has the largest number of jobs in the Clean Energy Sector and provides opportunities ranging from manufacturing to sales, design, and installations and is the fastest growing of all the renewable energy technologies.

The continued growth of the solar PV sector over the last 10 years has helped Vermont achieve top rankings in many national metrics regarding solar PV and led to Vermont's reputation as a leader in the country on policies in support of solar PV development[202].

Vermont's strong support for solar PV though policies such as renewable energy goals and requirements and state financial incentives, combined with national tax incentives, falling solar PV costs, and a greater understanding of the value of solar PV power, have created a fertile market for aggressive solar PV growth in the state.

Even though there has been a tremendous growth in smaller, residential solar PV systems, the increase in statewide installed kW capacity is being driven by the larger commercial systems. Five years ago, Vermont had only one commercial system installed that was over 200 kW in size. Today there are over 100 solar PV systems over 200 kW either installed or in permitting.

Vermont's Standard Offer Program, which commenced in 2010 and provides fixed long-term contracts for solar PV power, was the initial driving force behind the first larger-sized projects in Vermont (the program has a 2.2 MW facility size limitation). The Standard Offer program has a total cap of 127.5 MW and must contract with a mix of all renewable energy technologies, not just solar PV. In addition, the Federal Solar Tax Credit as well as the Vermont investment tax credit made the economics for all these projects favorable enough for the developers to take on the capital risks in bringing these projects online.

In addition to the commercial projects being built through the Standard Offer and Net Metering programs, Vermont has seen an increase in utility-owned large solar PV systems with GMP, VEC, and BED all investing in large arrays to serve as part of their own power resource portfolios. In addition, GMP has contracted with commercial solar PV projects to purchase the power output to serve their customers.

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[201] *2015 Vermont Clean Energy Industry Report. Prepared by BW Research Partnership for the DPS.*

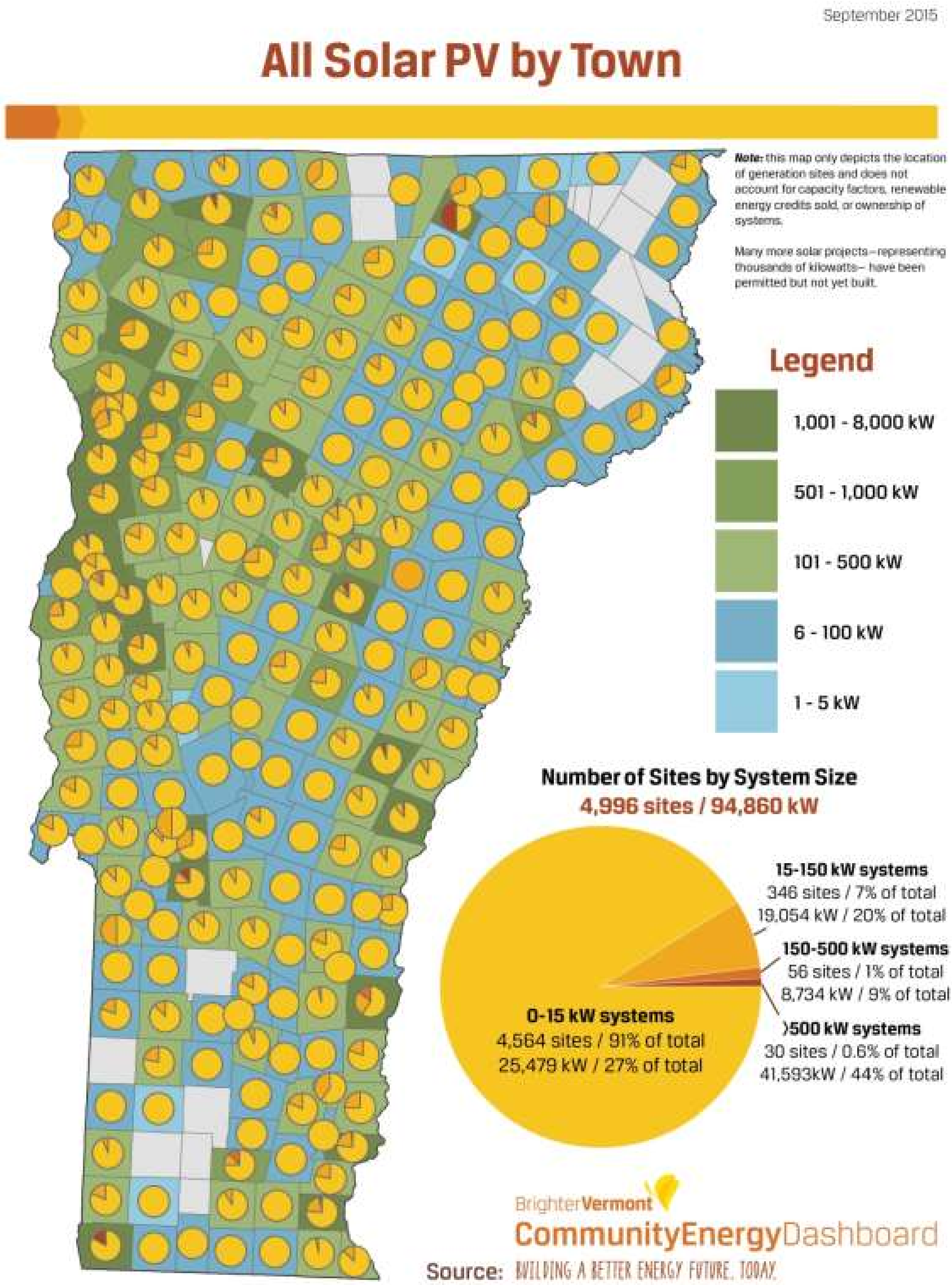
[202] *SEIA 2014 report on Top 10 Solar States http://www.seia.org/research-resources/2014-top-10-solar-states & the 2015 U.S. Clean Tech Leadership Index both rank Vermont among the top ten of the fifty states*

While the growth of solar PV has been astounding and solar PV systems are becoming a common sight across the state, solar PV supplies only a small amount of the state's total electric consumption, accounting for less than 2% of Vermont's total electric usage in 2014[203]. However, it provides a disproportionately large benefit to the state's electric utilities due to solar PV's power characteristics, in that solar PV often provides power locally during summer peak times when the demand and price for electricity is very high. Conversely, PV requires a large amount of land per unit of energy produced, and therefore siting of solar PV facilities has raised some aesthetic and orderly development concerns for adjoining landowners and municipalities. These issues are discussed below in the Challenges and Benefits sections, respectively.

The Solar PV by Town map (Exhibit 13-8*)* shows the wide distribution of solar PV across Vermont as well as the relative saturation of solar capacity by town.

[203] *DPS data*

Exhibit 13-8. Solar Photovoltaic Installations by Town and Size



<u>Future Solar PV Market</u>

Planning for future solar PV market development in Vermont is difficult. It is not possible to simply estimate future solar PV growth by projecting the growth of the last five years forward 5 or 20 years. This plan does assume continued growth in the solar PV market over the next five years and projects that it could account for as much as 20% of the state's total energy needs by 2050. The ISO-NE Solar PV Forecast working group has determined that trends indicate an estimated 235 MW of solar PV in Vermont by 2024. That would mean an increase of less than 100 MW from what is now installed and about 55 MW more than has entered the CPG permitting process. This energy plan assumes that level of growth to be a low-growth scenario for solar PV development over the next 10 years.

The future of the Vermont solar PV market will likely be affected the most by the reductions in the federal solar Investment Tax Credits (ITCs). The commercial credit is scheduled to be lowered from 30% to 10% and the residential credit from 30% to 0% on December 31, 2016. For the very short term (end of 2015 and 2016), the expiration of the ITC will likely put more upward pressure on the amount of solar PV installed as homeowners and developers try and get projects approved and installed before the credits expire.

For the purposes of this CEP, it is assumed the tax credits for solar PV (and solar thermal) will not be extended. In addition, as more solar PV projects come online, viable locations may become more costly and there may also be additional interconnection costs required to ensure that the particular electric distribution circuits will be able to handle increased levels of solar PV power reliably. There will likely be further reductions in the cost of the solar PV equipment, but these are not predicted to be sufficient to fully compensate for the decreased tax credits and increased interconnection and siting costs.

With economies of scale, large systems are the most cost-effective way to install solar PV. However, such systems require large open spaces close to electric distribution lines that can handle the greater loads. Thus, concerns about land use and aesthetic impacts of such large systems will need to be addressed as one of the challenges the solar PV market will face.

13.1.1.2 Resources

Sunlight is Vermont's most abundant energy resource. On average, over 100 million MWh worth of solar energy hits Vermont every day[204]. If it were possible to convert even a tiny fraction of this solar energy into solar PV power, Vermont could theoretically meet its 90% renewable energy goal with solar power alone.

Thus, the limiting resource for solar PV is not the fuel but the efficiency of the technology and, primarily, space. Given the efficiency of current solar PV technology, each MW of solar PV needs approximately seven acres of sun-exposed space to produce roughly 1,200 MWh over a year's time[205]. The factors that may limit the locations where solar PV can be sited (solar access, aesthetics, environmental concerns,

[204] *NREL National Solar Radiation Database (TMY2) data sets for Burlington, VT*

[205] *Assuming a 14% capacity factor*

electric system stability) and the amount of land that needs to be found for solar PV to meet the CEP's 90% goal are discussed in the Challenges section below.

13.1.1.3 Siting & Permitting

In 2015 the Legislature created a Solar Siting Task Force to investigate the siting and permitting of solar PV and is obliged to have draft legislation for the 2016 legislative session. The recommendations of the Task Force will influence the final draft of this chapter and its recommendations.

The dramatic increase in solar PV development has led some Vermonters to question how much control local communities should have over the permitting of solar PV and whether the current permitting regimen in place is adequate to preserve communities and protect adjoining landowners while ensuring appropriate treatment of ecologically sensitive areas and the conservation of agriculturally productive land. Permitting for all solar PV systems resides with PSB with input and requirements (depending on the details a proposed project) from the Agency of Natural Resources, Agency of Agriculture, Division of Historic Preservation, and the DPS. In addition, municipalities, abutters and others can participate in the PSB permitting process. Some communities and Vermonters have not found the PSB permitting process adequate to address their interests and have called for increased local control of solar siting. In the 2015 legislative session, Act 56 gave communities more leverage in the siting process by giving host municipalities the right to appear as parties in the 248 process, establishing statewide minimum setbacks for solar PV systems over 15 kW, and allowing municipalities to enact and apply screening ordinances to solar facilities in the context of a 248 proceeding.

Solar PV is not as dense power-wise as other energy sources and thus requires a larger amount of space, relatively, to produce an equal amount of power. Furthermore, solar PV has specific siting needs with respect to solar access and interconnection with the power grid. Residential and smaller commercial systems can be installed on roofs of existing structures with good solar access and no special consideration of the distribution interconnection is normally required. By contrast, larger commercial and utility-scale systems need to be located in areas of the distribution system served by three-phase lines, and engineering analysis is often required to ensure the solar PV system can supply power without compromising the reliability of the electric grid.

The local distribution utility addresses interconnection issues in response to an interconnection application filed by the project developer. The interconnection agreement reached between the utility and the developer is incorporated into the Certificate of Public Good, if one is granted to the project.

Pursuant to Vermont's statutory net metering system size limit of 500 kW, commercial systems seeking to take advantage of this program are often designed for a capacity of just under 500 kW. There are also many commercial projects installed with just under 150 kW of capacity to take advantage of the streamlined approval process available to projects under that size.

The PSB, through its Rule 5.100, has established expedited permitting pathways for solar PV systems under 150 kW and systems under 500 kW. These variations of the Section 248 review process conditionally waive certain statutory criteria and provide a very narrow window – between 10 and 30 days once a petition or application is filed with the PSB – for the submission of comments to the PSB on concerns and issues raised by the project, or to request a hearing. Some citizens and municipalities have found it difficult to engage effectively in the review of solar PV projects, given the expedited timelines and the court-like permitting process.

Act 99 of 2014 directed the PSB to convene a process to create new net metering and interconnection rules. The early results of this process will influence the final draft of this chapter and recommendations regarding solar PV development and permitting.

13.1.1.4 Benefits

Solar PV power has several advantages that make it a power source that the state should continue to support.

As a non-emitting power generator, solar PV has similar benefits to other renewable energy generation in that it can supplant power generated by polluting power sources, such as those that use fossil fuels. Thus, an increase in solar PV generation can lower GHG emissions attributed to Vermont's electric power consumption. Solar PV carries the benefit of being able to be located in close proximity to humans without concerns of pollutants that are hazardous to human health, such as particulate matter, nitrous and sulfur oxides, ground-level ozone, and carbon monoxide,

Solar PV also has electric system benefits due to the time and location of its power production. Solar PV is largely a peak electric load–following resource, meaning that during peak summer loads, solar PV systems are at near their highest production, resulting in costs savings to the utility and providing grid reliability benefits.

Solar PV is also extremely distributed, meaning it can produce power throughout the electric distribution system close to the houses and businesses where the electricity is used. This distributed nature of solar PV lowers line losses for the utility as less power needs to be transported through its lines, adding another element of cost savings.

In addition, solar PV power is generated without a significant amount of noise and requires only low levels of maintenance.

Solar PV provides the utilities with increased diversity and grid resiliency. A fleet of small solar PV generators limits the financial and technical risks of relying too heavily on any one power technology or facility.

While solar PV's power generation curve pairs well with the majority of the state's power demand curve, this is not the case for all Vermont's utilities – some have peak power demands after dark, for example – and this one benefit could become a challenge.

13.1.1.5 Challenges

Changing Time of Peak Demand

As more solar PV power is installed in Vermont, and regionally, the increased solar PV power production will shift the daytime peak further toward sundown, thereby diminishing the peak cost advantage of solar PV. One response will be to encourage more west-facing panels (instead of south-facing panels) to maximize late afternoon production when electricity prices are highest. Under existing net metering rules, all kWh produced are valued the same, regardless of when they occur, and a south-facing array produces the greatest number of kWh. New net metering rules currently being crafted by the PSB could value energy from solar PV systems differently, depending on time of day.

Solar PV is not likely to be able to contribute to reducing energy demand during winter peaking periods. While the demand during winter peaks across New England is not as large as summer peak demands, limited natural gas during cold temperatures can create energy demand peaks resulting in very high peak prices for Vermont utilities at times when solar PV production is low or non-existent.

Tax Credits

Economically, the biggest challenge facing solar PV is the reduction of the federal (and state) investment tax credits at the end of 2016. There is a level of market uncertainty for solar PV companies as after this date, the tax credit for commercial systems will drop to 10 percent and the credit for residential systems will drop to zero. The new net metering program rules that take place in 2017 will be critical in providing market certainty for the value of solar PV net metered projects in Vermont.

Land Use

Solar PV requires adequate access to both sunlight and electric distribution lines to take the power produced. These requirements often lead solar PV project developers to select sites that end up being quite visible, such as in open fields next to roads where the larger distribution lines are accessible. Individuals, adjoining landowners, and communities have raised concerns about the aesthetic and farmland impact of selecting such sites, especially in areas where several commercial and utility-scale solar PV systems are located in close proximity. Siting solar PV on agricultural land, near roads and other highly visible locations, and in the midst of residential communities will likely become more of a challenge as more of these types of solar PV projects are built.

For Vermont to get a significant amount of its power from solar PV, while avoiding the most contentious land-use debates, the state will have to maximize the installation of solar PV on existing roofs, and on land with without significant natural resources, or that has already been removed from the working landscape; for example parking lots, reclaimed gravel pits, and capped landfills.

If Vermont did maximize the use of the residential roofs for the increased deployment of solar PV, approximately 375 MW could be sited on residential roofs[206]. That would be 75,000 homes with an average of 5 kW on each roof – which is challenging due to the increased costs and lower power

[206] *Assuming 25% of all residential roofs were viable for a 5 kW PV array.*

production of many small roof-mounted systems compared to larger ground-mounted systems. To contribute significantly to the overall goal of reaching 90% renewable energy usage in Vermont by 2050, an additional 1,000 to 2,500 MW of solar PV would need to be installed in Vermont. Thus, at least an additional 625 MW, above the 375 MW that could be installed on residential roofs, would have to be installed by 2050.

To maximize the use of roofs and other already developed areas for solar PV development, Vermont would have to provide incentives and establish other programs that accomplish that goal at lowest possible cost to the ratepayers. This could be done by providing a higher net metering tariff for roof-mounted solar PV and solar PV in areas such as parking lots, for example.

Under current net metering rules, a net metering customer can reduce their annual bill to zero, but if the customer generates more power than they use in a year, they receive no payment for this net excess generation. Customers therefore install solar PV systems on their roofs based on their power consumption and not on the size of their roofs, leaving part of the roof empty. Net metering tariffs could allow customers to monetize any net excess power produced as an incentive for solar PV systems to be designed based on the size of the roof.

Group net metering is one way to maximize the good solar roofs under the current net metering rules, but it is complicated and burdensome for the average residential customer to initiate. Allowing customers to lease their roof space to their host utility and/or to get paid for excess power would make it simpler for many customers who have good solar roofs but who do not want to invest in a solar system. Utility- or third-party ownership and payment will provide them with an incentive to support increased solar PV generation.

While the state should be careful to not strengthen the utilities' monopoly to the detriment of Vermont's vibrant solar energy business sector, there is a value in having the utility involved in residential rooftop systems as a way to maximize use of such sites. Even without the utility owning rooftop solar PV, such systems could be part of a rooftop solar PV tariff that requires the power be purchased by the utility in situations where group net metering is not desirable.

Utility owned rooftop solar PV could also provide more publically available data – serving as a type of research and development program that customers wouldn't want to fund on their own, but would be willing to host if compensated.

The amount of solar PV that could be installed on large commercial rooftops, multifamily housing rooftops, parking lots, and closed landfills has not been calculated. The state should estimate the technical potential for solar PV on these sites as well as the costs and benefits of installing solar PV at such sites. Such analysis would help inform policy decisions on how to encourage such sites. In addition, the state could explore mechanisms to require that, where practical, all new commercial, multifamily housing, and parking lot construction be equipped with solar PV.

The CEP lays out a course designed to result in Vermont obtaining 90% of its total energy needs from renewable energy. As is discussed in Chapter 11, the amount of energy Vermont will need to get from each renewable technology to reach the 90% goal varies depending on what is installed over the next 35 years. Vermont currently has approximately 180 MW[207] of solar PV installed or in the permitting process.

In Chapter 11 the CEP lays out different scenarios for the amount of solar PV Vermont might have in 2050. This amount ranges between 1,500 and 2,250 MW of solar PV. That is roughly 8 to 12 times the current amount of solar PV installed or in permitting. To reach the 1,500 MW level, Vermont will need to install an average of roughly 38 MW of solar PV each year for the next 35 years. It is reasonable to assume that the solar PV needed will be overwhelmingly located within the state's boundaries.

The land use and grid reliability challenges become more pronounced as the amount of solar PV installed grows. Finding sites that have good solar access and that can meet the aesthetic, environmental, and grid stability challenges for all this new generation will be a challenge. To the extent that land can be used for solar PV installations and additional purposes, including recreation, agriculture, and parking, it diminishes the conflict between single use choices.

While efficiency of solar PV is going up (requiring less space per/kWh generated), the solar arrays being installed will degrade over time (kWh output will decrease about one% a year), creating a need to either re-power existing plants or to find locations for new solar PV just to keep solar generation constant. For each 100 MW of solar PV installed, 1 MW of new solar PV must be installed annually, or re-powered at existing sites, to keep the power produced from solar PV constant.

In addition, while most solar PV projects assume a 20-30 year operating life for the purposes of permitting, it will likely be necessary to re-power existing facilities after 30 years and continue energy generation in those locations if the state is to maintain the levels of in-state renewable generation necessary to achieve the 90% by 2050 goal.

The land-use challenges as well as the intermittent nature of solar PV are issues that are, and have been, faced by other states and countries. For example, Germany has largely overcome these challenges to the point where, in 2014, seven percent of its electricity is provided by solar PV; a total of 38,000 MW spread over 1.5 million solar PV systems[208]. An equivalent amount of solar PV per square mile in Vermont would be approximately 2,600 MW[209]. That is 350 MW more than the high solar PV scenario in Chapter 11 for Vermont's 2050 energy portfolio. To match Germany's seven percent from solar PV, Vermont would need about 343 MW of solar PV.

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[207] *About 120 MW installed and an additional 60 MW in permitting. This does not include the ~100MW of large (>20MW) projects that have requested interconnection studies in the summer of 2015*

[208] Photovoltaics Report. *Dr. Simon Philipps (Fraunhofer ISE) and Werner Warmuth (PSE AG).*

Fraunhofer Institute for Solar Energy Systems ISE, Freiburg, 26 August 2015

[209] *Vermont has only about 7% the amount of square miles as Germany*

To clarify the eligibility of solar PV projects in Vermont's Current Use program, the Vermont Tax Department created a technical bulletin.[210] The bulletin explains the criteria and their statutory basis. One notable criterion: a facility may be part of a farming operation (and thus eligible for the program) if half or more of the electricity is used by farm buildings that are enrolled in the program.

<u>Price</u>

The price of solar PV as compared to fossil fuel and nuclear market power has long been a challenge for solar PV. Solar PV prices remain above current market power that is at historic lows due to low natural gas prices; gas is the fuel largely responsible for setting power prices in the New England power region. Solar PV's price, once seen as its primary problem, is becoming less of a concern every year as solar PV prices decrease and as solar PV power is valued compared to the power that it is displacing during the day and as its ancillary benefits (long-term stable price, forward capacity credits, peak shaving) and environmental benefits are fully valued.

<u>Fire Fighting</u>

Roofs covered with solar PV systems present a new challenge for Vermont fire fighters. Fire fighters often need to cut holes in roofs of structures with an active fire. How best to access a roof with a solar PV system and to remove the solar PV panels or parts of the electric system while fighting the fire and preventing accidental electric shock to the fire-fighters requires new training and awareness. In addition solar installers should be aware of the latest fire safety codes related to solar PV and structures.

<u>Grid Disconnection</u>

If the price of solar PV and power storage continue to decline, customers currently interconnected by the electric grid could decide to disconnect from the grid. There is a danger in policies or trends that would cause or encourage customers to disconnect from the grid or act in other ways that do not support a modern electric grid that is over 90% renewable and highly reliable. Many of the benefits of solar PV rely on it being connected to the grid. The state should work to avoid policies that result in customers with the most means disconnecting from the grid and leaving those with the least means (or insufficient means means) to disconnect to pay for the maintenance and renewable energy improvements to the electric portfolio.

The state and the electric utilities should establish programs that encourage customers to think of themselves as part of an interconnected energy system made up of their neighbors and fellow Vermonters and to act in ways that are beneficial for the whole system, and not just themselves, if the CEP goals are to be met.

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[210] *Solar Generating Facilities Constructed on Land Enrolled in the Current Use Program. Technical Bulletin 69, issued July 13, 2015.* *http://www.state.vt.us/tax/pdf.word.excel/legal/tb/TB69.pdf*

Strategies and Recommendations

Strategy 1: Encourage utility and commercial solar PV projects without allowing such projects to limit residential solar PV installations

Recommendations

(1) Establish new 2017 net metering rules that provide interconnection, application, and generation credit forsystems that preserve viable residential access to solar PV installations.

(2) Maximize electric grid information, including circuit-level data of the distribution grid, to facilitate siting of projects that will maximize the benefits of solar PV as well as to deter projects that will not be able to interconnect cost effectively.

Strategy 2: Increase and maximize the number of solar PV systems sited on the built environment

Recommendations

(1) Structure utility regulations and net metering rules, policies, and incentive programs to promote installation of solar PV projects where there is electric demand and on locations where the land has already been built impacted (e.g. roofs, parking lots, landfills).

(2) Facilitate the statewide collection of aerial photographs or LiDAR images of high population areas and make them publicly available to allow for better remote site assessments of the amount of solar PV that could be built on existing roofs, parking lots, and other such spaces.

(3) Establish tariffs and/or net metering rules that allow utilities and/or commercial third parties to install solar PV on their customers' roofs, or pay for excess power produced, as a way to maximize the use of well-sited roofs for solar PV.

(4) Continue to support updates to building standards and energy codes that promote solar PV for new construction and major renovations.

Strategy 3: Increase the amount of solar PV generation in Vermont's power portfolio.

Recommendations

(1) Encourage the development of locally controlled solar PV projects as a way to strengthen community support for otherwise challenging siting projects.

(2) Encourage utilities to offer customers the option of making solar PV loan payments on their utility bills.

(3) Complete the revisions to the PSB's interconnection rules (Rules 5.100 and 5.500) with an effort to make the interconnection application process as predictable and timely as possible for solar PV systems. The

interconnection process should be designed in a way to allow it to evolve and allow for flexibility as solar PV and inverter technologies change and solar PV penetration reaches critical levels.

(4) *The state should continue to install solar PV systems on state buildings, and should use solar PV systems for remote power needs where appropriate.*

(5) *Create, partnering with the UVM-Extension and farmers, basic guidance for grazing sheep within and around conventionally installed, ground-mounted solar arrays, and guidance for other agricultural uses or ecological system services that can occur within a conventionally installed, ground-mounted solar array.*

***Strategy 3: Increase the safety of PV systems*.**

Recommendations

(1) *Provide fire fighters with basic training in fighting fires on structures that have solar PV installed.*

(2) *Provide training to Vermont solar PV installers on the latest fire and electric safety codes to increase safety and help to secure solar PV generation.*

***Strategy 4: Improve the solar PV permitting process*.**

Recommendations

(1) *The state should evaluate the impact of the solar siting reforms contained in Act 56 of 2015 and consider the recommendations to be made by the Solar Siting Task Force.*

(2) *Protect, through the Section 248 process, farmland and especially primary agricultural (NRCS-rated) soils, by requiring that no soil be removed from any site, and that decommissioning plans be required for all ground-mounted solar projects of 500 kW or more.*

(3) *Establish construction practices for roads and other practices that facilitate low-cost decommissioning and effective soil reclamation.*

(4) *Ensure, through PSB rule, that towns, neighbors, and parties have sufficient opportunity and time to comment effectively on solar PV CPG petitions and the larger net metering applications.*

13.1.2 Solar Thermal

Although Vermont's weather limits the amount of solar energy available in comparison with sunnier locations, there is enough sunlight to warrant support for solar 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.

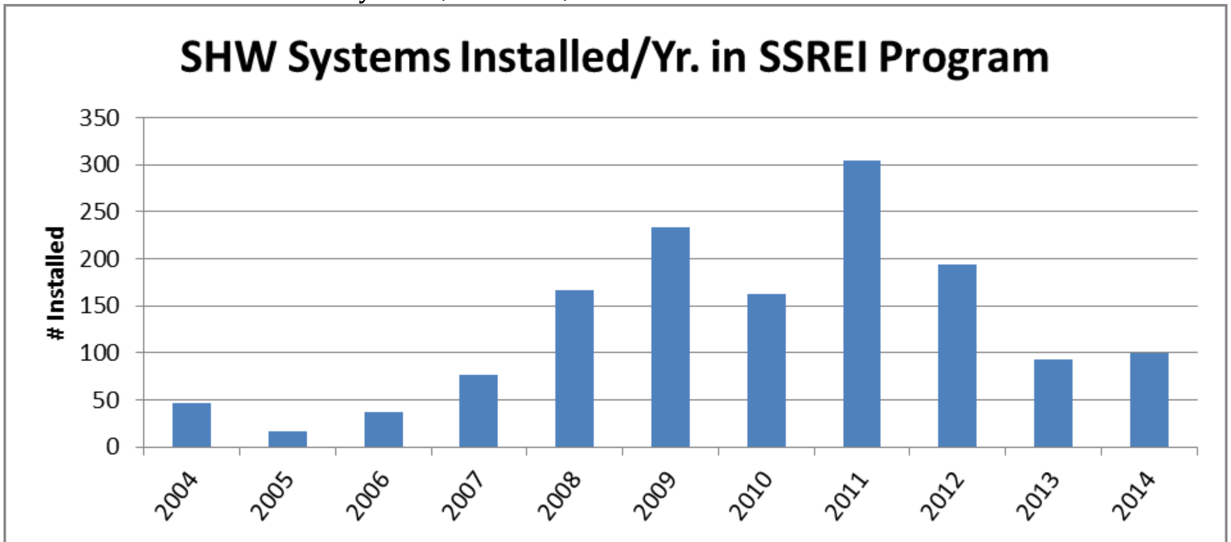
At Vermont's northern latitude, most of its annual sunlight is available in the summer, when space heating is not required but heat for water is still needed. Thus, solar energy generation in Vermont is best suited for heating domestic hot water with an active solar hot water system. A properly sited and designed solar hot water system in Vermont can supply 60% to 70% of the annual thermal energy needed for domestic hot water usage. Such a system can provide a reasonable rate of return[211] 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 can be manufactured or assembled in Vermont. Unfortunately, the one company that was assembling solar hot water systems in Vermont went out of business in 2014.

The Vermont SSREI Program has provided incentives for solar hot water (SHW) systems since 2004. As the Exhibit 13-9 below shows, there has been a significant decrease in the installation of solar hot water systems in the state. This is likely attributed to several factors:

1. Price: SHW system costs have not come down. The installed cost of SHW systems has remained constant and even has increased slightly since 2009. The price difference between solar PV and SHW used to be an advantage for SHW, but as solar PV prices have fallen dramatically and SHW prices have remained constant the advantage has started to shift to solar PV. This has led Vermonters to choose solar PV over SHW systems as the price of solar PV has come down.
2. Complexity: SHW systems can involve complex plumbing that require regular maintenance.
3. Competition: Solar PV installers are marketing solar PV-powered high-efficiency heat pump electric water heaters and are offering leasing and financing products that make a solar PV-powered hot water heater an easier purchase.

[211] *John Richter, "Financial Analysis of Residential PV and Solar Water Heating Systems," 2009.*

Exhibit 13-9. Solar Thermal Systems, Vermont, 2004–2014



Source: Vermont Small Scale Renewable Energy Program

<u>Solar Space Heating</u>

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) *Create a financing system that could include the electric utilities and Vermont Gas, to offer on-bill financing of SHW systems.*

(2) *Ensure that solar thermal applications are eligible for and included in the energy innovation tier of the Renewable Energy Standard.*

(3) *Lead by example by having the state install solar thermal systems on buildings where practical.*

(4) *Consider building code requirements that passive solar design and siting principles be incorporated into new buildings that have a large hot water load (i.e. laundromats, hotels).*

(5) *Evaluate Vermont's solar thermal installations and recommend specific and targeted, high-value uses of active, solar thermal energy systems.*

13.1.2.1 Solar Lighting

The use of sunlight to brighten our homes and buildings is called daylighting. Proper use of daylighting can reduce electricity used during the day for lighting as well as provide what most consider a more pleasant space in which to live and work. For these reasons daylighting should be encouraged.

However, there are energy trade-offs to daylighting that should be considered. Where there is a window or skylight letting in daylight there is more heat leaving the building, compared to the wall or celling without the window, resulting in increased energy use. In addition, improperly designed homes and businesses can have problems with too much sunlight entering the building causing an increased use of energy as the occupants turn to air conditioning and/or fans to cool the building.

As lighting has become more efficient the energy savings form daylighting has decreased. At the same time the understanding of thermal envelopes and the loss of energy from daylighting techniques (skylights and windows) has increased. This has led to less interest in daylighting as an energy saving measure and more of a quality of life issue due to the benefits of living and working in spaces with natural daylighting.

13.2 Wind Energy

13.2.1 Overview

Wind energy provided 4.4% of the nation's electricity during 2014 and delivered 28% of all new capacity installed over the past five years. [212] The U.S. ranks third in the world in annual wind power capacity additions in 2014, and second in cumulative capacity installed through the end of 2014, at 65,877 MW (see Exhibit 13-10).[213] However, we lag behind over a dozen other countries (most in Europe) in terms of wind capacity as a percentage of total electricity generated.[214]

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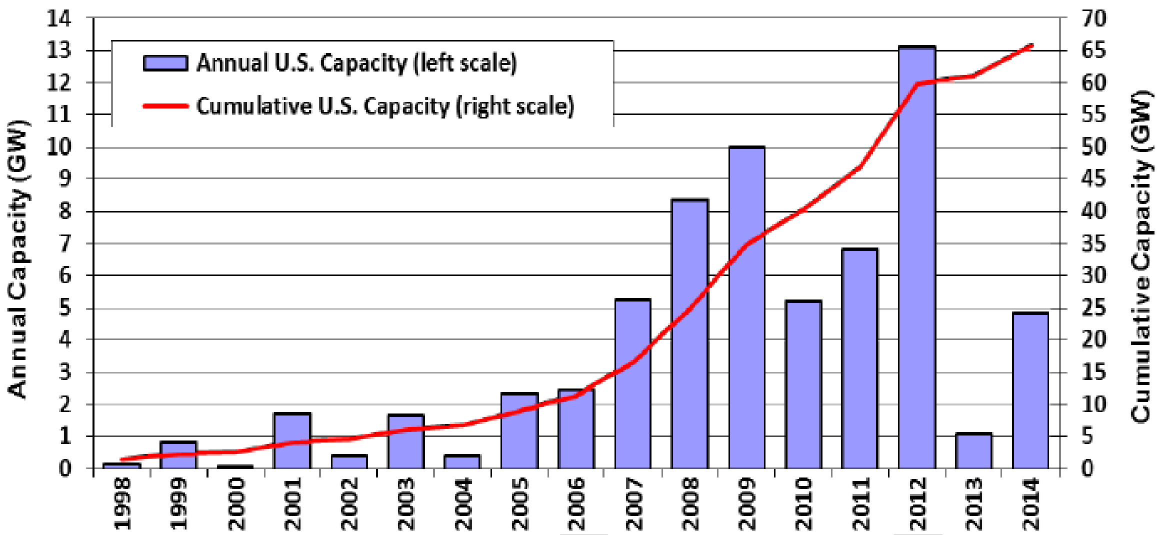
[212] *AWEA U.S. Wind Industry Annual Market Report Year Ending 2014*

[213] *http://emp.lbl.gov/sites/all/files/lbnl-188167.pdf*

[214] *Ibid*

Exhibit 13-10. U.S. Wind Power Installed Capacity[215]



In Vermont, about 6% of our electric power is currently sourced from wind energy generated in-state, primarily from the large wind facilities in Searsburg, Sheffield, Lowell, and Georgia/Milton, which together account for 119 MW of installed capacity and over 300 GWh[216] of annual production. Vermont imports an additional 200 GWh of wind energy from facilities in Maine and New Hampshire, bringing the total contribution of wind energy in our electric portfolio to approximately 9.5%.

13.2.2 State of the Market

Wind power production is considered a complement to solar output in a renewable portfolio, on both a daily and a seasonal basis. For example, during Vermont's winter, when solar insolation is at its weakest, 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. In the last decade, wind resource forecasting has emerged as a primary mechanism for effectively managing wind resource variability, and is in use by plant operators in addition to utilities and the regional grid operator, ISO-NE, which in 2013 incorporated wind forecasting into its daily system operations.[217]

Vermont can add additional wind power to its portfolio in several ways: purchases from out-of-state wind projects (including offshore wind), purchases from in-state wind projects (through the Standard Offer program in addition to power purchase agreements by utilities), and interconnection of additional

[215] http://emp.lbl.gov/publications/2014-wind-technologies-ma

[216] EIA and DPS data.

[217] http://isonewswire.com/updates/2014/4/1/new-wind-power-forecast-integrated-into-iso-ne-processes-and.html

small-scale, net metered installations that serve homes, businesses, and communities.[218] In aggregate, net-metered wind projects in Vermont amount to just shy of 2 MW, while wind projects just recently approved under Vermont's Standard Offer Program amount to about 700 kW. When added to the 119 MW of capacity at Vermont's four large-scale wind farms, the total installed capacity of wind permitted in the state equals approximately 122 MW (see Exhibit 13-11).

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 13-11. Wind Projects in Vermont's Electric Portfolio

Scale	Project	Developer/Owner	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	4	2.5 MW	10 MW	Operating
	Kingdom Community Wind	Green Mountain Power	Lowell	21	3.0 MW	63 MW	Operating
	First Wind Sheffield	SunEdison	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			82 MW	Operating
	Saddleback Wind	Patriot Renewables	Carthage, ME			7 MW	Operating
	Hancock Wind	SunEdison	Hancock County, ME			13.5 MW	Under Construction
Small Community				**# Sites**	**Avg kW**		
	Net-Metered[219]	Various	Various	188	10 kW	1.9 MW	Permitted
	Standard Offer	Various	Various	8	81.5 kW	652 kW	Approved contracts

[218] 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.

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

13.2.3 In-State Resources

Vermont's higher elevations 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 constraints, 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 DPS participated in a U.S. Department of Energy study[220] that estimated Vermont's theoretical wind power potential to be approximately 6,000 MW. The study considered the strength 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.[221] In 2006, the Green Mountain National Forest updated its Forest Plan.[222] 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 2003, following a study of the potential wind resources on state – owned land,[223] Vermont's Agency of Natural Resources concluded that large-scale wind project development on state lands is incompatible with the Agency of Natural Resource's mission of land stewardship. The resulting policy, *Wind Energy and Other Renewable Development on ANR Lands*,[224] encourages the development of small-scale projects that help the Agency or its lessees meet on-site energy needs and that provide clear environmental and economic benefits. In 2011, the Agency did approve the installation of a 100 kW turbine on state forest land leased to the Burke ski area, which generates roughly 15% of the mountain's electricity use.[225]

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.

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[220] *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.

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

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

[223] http://publicservice.vermont.gov/sites/DPS/files/Topics/Renewable_Energy/Resources/Wind/Final%20Public%20Lands%20report.pdf

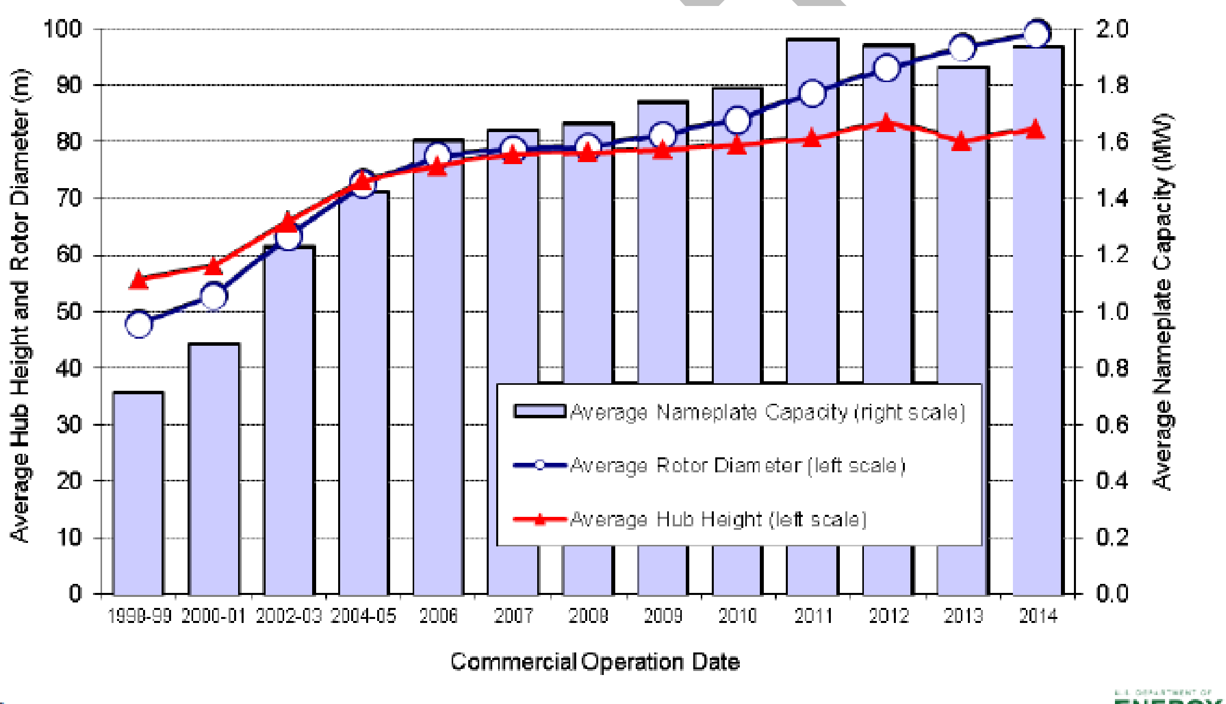
[224] http://fpr.vcms.vt.prod.cdc.nicusa.com/sites/fpr/files/About_the_Department/Rules_and_Regulations/Library/windpower.pdf

[225] *National Renewable Energy Laboratory Case Study: Burke Mountain Wind Turbine, March 11, 2013*

Ten-plus years of wind measurements indicate the average wind speeds along the ridge are 15 to 17 mph. Annually, the 11 Searsburg 550 kW turbines together produce about 12,000 MWh; this is enough to power about 1,700 homes.

Since Searsburg's development, wind turbines deployed for utility-scale projects have tended to be taller, with larger rotor diameters, two factors that have led to higher rated capacity and greater production per turbine (see Exhibit 13-12). These technological developments have allowed for the deployment of fewer turbines for a given size of wind farm, and for the siting of turbines in locations that previously were considered to have marginal wind resources.[226] This means that wind farms in Vermont are no longer restricted to ridgelines, though high elevations continue to offer higher-speed and more reliable winds.

Exhibit 13-12. Trends in Turbine Size[227]



Some of these developments are reflected in the wind projects that have been built since Searsburg, as shown in Exhibit 13-12, above. The First Wind project in Sheffield came online in October 2011, with a rated capacity of 40 MW. Green Mountain Power's 63 MW Kingdom Community Wind project in Lowell came online in 2012. The 10 MW Georgia Mountain Community Wind project on the Georgia-Milton line also came online in 2012. These three projects all use turbines between 2.5 and 3 MW in rated capacity, are located at elevations ranging from 1,400' to 2,900', and had capacity factors in 2014 of 27-37%. The highest capacity factors (37% and 35%) came from Georgia Mountain and Lowell, at 1,400' and 2,600', respectively – demonstrating that capacity factor in Vermont is not related to elevation alone. Future

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[226] http://emp.lbl.gov/sites/all/files/lbnl-188167.pdf

[227] http://emp.lbl.gov/publications/2014-wind-technologies-ma

wind projects may benefit from modern wind resource prospecting tools to locate sites that have less aesthetic impact, by virtue of lower elevations, yet benefit from high wind speeds due to other geographical features, and capture those winds with modern turbines designed to operate in lower wind speed environments, in order to optimize production and minimize their footprint on the landscape.

Sheffield 40 MW wind project as seen from Crystal Lake State Park

At the other end of the spectrum, small-scale wind facilities – most often represented by a single turbine, which can range from less than 1 kW to 100 kW for a small commercial turbine – also benefit from careful siting. These turbines, which are usually located at the site where their energy is used, must be positioned so they extend as high as possible above obstacles; they are less cost-effective than large turbines, thus the economics are very sensitive to production. Technical expertise and warranty protection to maintain the system are also essential to securing years of optimum performance. Many small- and mid-scale wind turbine manufacturers have gone out of business in the last several decades, leading to industry initiatives such as the Small Wind Certification Council[228], American Wind Energy Association small wind industry standards[229], and Interstate Turbine Advisory Council[230]. Vermont does have a domestic wind turbine manufacturer, Northern Power Systems, whose 100 kW turbines are deployed across the state including at Burke and Bolton Valley ski areas, the Rock of Ages quarry in Graniteville, Dynapower headquarters in South Burlington, Northland Job Corps in Vergennes, Blue Spruce Farm in Bridport,

[228] http://www.smallwindcertification.org/

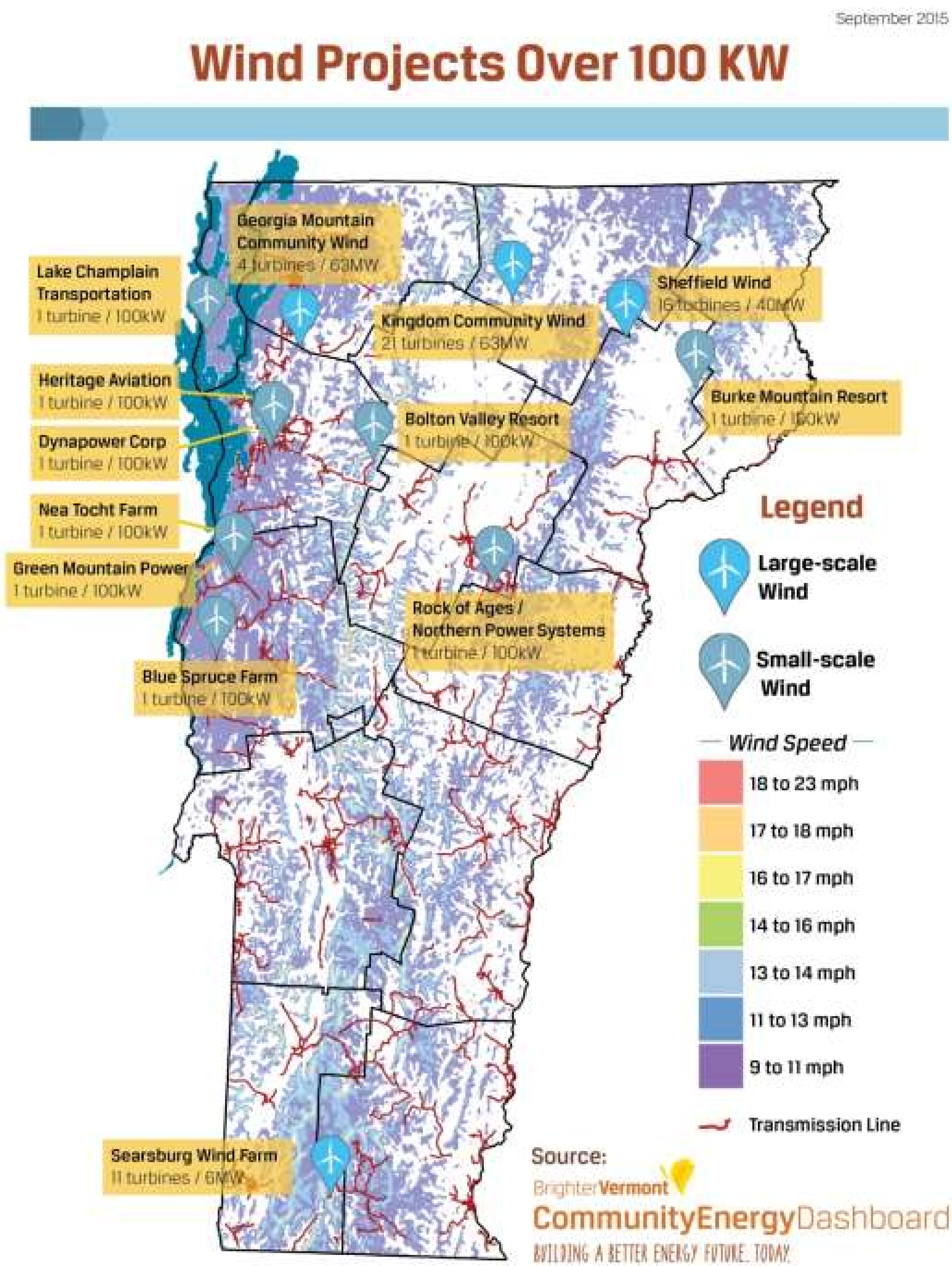
[229] http://www.awea.org/Issues/Content.aspx?ItemNumber=4651

[230] http://www.cesa.org/projects/ITAC/

Nea-Tocht Farm in Ferrisburgh, and Heritage Aviation at Burlington International Airport. Exhibit 13-13 is a map of all the wind projects in Vermont larger than 100 kW.

Northwind 100 at Blue Spruce Farm in Bridport

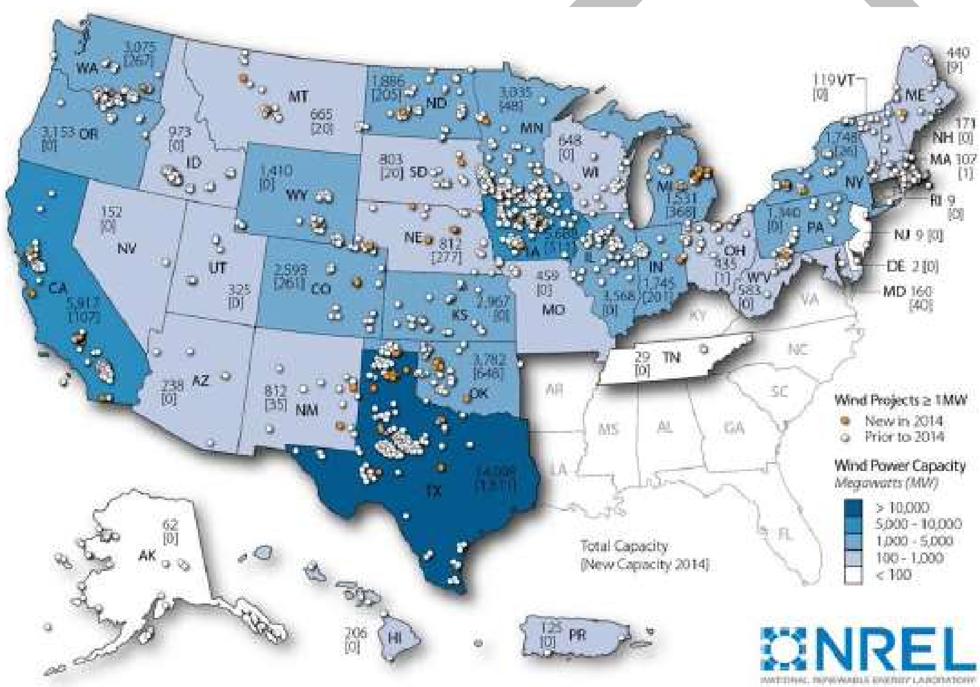
Exhibit 13-13. Wind Installations by Town and Size



13.2.4 Out-of-State Resources

Wind generation projects continue to come online across the Northeast and in bordering provinces in Canada, including the first offshore wind project to "break water" off the coast of New England, Deepwater's Wind's 30 MW Pioneer Wind Farm off the coast of Block Island. Vermont utilities currently purchase some out-of-state wind power and are likely to continue to do so into the future, especially if offshore wind becomes cost-competitive with market power. In November 2010, ISO-NE completed the New England Wind Integration Study[231] 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 GHG Initiative.

Exhibit 13-14. Installed Wind Capacity by State[232]



Note: Numbers within states represent cumulative installed wind capacity and, in brackets, annual additions in 2014

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

- New Hampshire's 2014 *10-Year State Energy Strategy*[233] identifies 171 MW of operating utility-scale wind capacity, with an additional 2,100 MW of technical potential for land-based wind

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

[232] http://emp.lbl.gov/publications/2014-wind-technologies-ma

[233] https://www.nh.gov/oep/energy/programs/documents/energy-strategy.pdf

and 3,500 MW of technical potential for offshore wind. In Coos County, NH, the Granite Reliable Wind project has been operating since late 2011. The facility's owner, Nobel Environmental Power, has contracted with GMP to purchase 82 MW of the 99 MW project, for a period of 20 years starting April 1, 2012.[234] Two other wind projects are operational in the state: the 24 MW Lempster project and the 48 MW Groton wind project. A number of other facilities have been proposed by various developers in recent years.

- According to Maine's 2015 *Comprehensive Energy Plan Update*,[235] 444 MW of wind have been built in the state, with "significant additional projects proposed." and nearly 3,000 MW of on-shore and offshore wind by 2020. In addition, the Maine Legislature passed two major initiatives to encourage both on- and offshore wind development: "An Act to Implement Recommendations of the Governor's Task Force on Wind Power Development" (PL 661) and "An Act to Implement the Recommendations of the Governor's Ocean Energy Task Force" (PL 615).

- The *Massachusetts Clean Energy and Climate Plan for 2020*[236] includes a goal of 2,000 MW installed wind power in state by 2020, much of which is to be supplied from offshore facilities. As of October 2014, wind energy capacity totals over 100 MW, with over half the installed capacity in community wind projects.[237]

- As of spring 2014, twenty wind energy projects are operating in New York with a rated capacity of a little more than 1,812 MW, enough to power more than 500,000 homes.[238] The 2015 State Energy Plan anticipates that the state's Renewable Portfolio Standard will lead to the promotion of additional wind onshore wind development, but places greater emphasis on the potential for offshore wind development as a means of meeting domestic energy needs.[239]

- Hydro-Quebec's (HQ) on-line wind generation capacity is currently 2,669 MW, with 523 MW under construction and 542 MW planned to be installed by the end of 2017.[240]

234 http://www.greenmountainpower.com/upload/photos/4773._2014_GMP_IRP_The_Supply_of_Electricity_Chapter_112514_Clean_and_Final.pdf

235 http://www.maine.gov/energy/pdf/2015%20Energy%20Plan%20Update%20Final.pdf

236 http://www.mass.gov/eea/docs/eea/energy/2020-clean-energy-plan.pdf

237 http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/wind/wind-energy-projects.html

238 http://www.dec.ny.gov/energy/40966.html

239 http://energyplan.ny.gov/Plans/2015

240 www.hydroquebec.com/distribution/en/marchequebecois/parc_eoliens.html

It is clear that, regardless of Vermont's own utility-scale wind production, utility-scale wind – especially from offshore projects – will be a growing resource in the regional market (see Exhibit 13-14 for a map of installed capacity by state).

13.2.5 Siting and Permitting

In Vermont, the primary permit for all electric generation projects is a CPG issued by the Vermont PSB (PSB) under 30 V.S.A.§ 248 (Section 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.[241]

Among the criteria, the PSB considers orderly development of the region, demand for service, system stability and reliability, economic benefit to the state and residents, and whether there is an undue adverse effect on aesthetics, historic sites, air and water purity, the natural environment, and public health and safety. The orderly development criterion requires that the PSB find a project will not unduly interfere with the region's orderly development by giving due consideration to the recommendations of the municipal and regional planning commissions, the recommendations of the municipal legislative body, and the land conservation measures contained in the town plan.

Statutory parties to the Section 248 process include the DPS, which represents the public interest before the PSB, and the Agency of Natural Resources (ANR), which manages the state's natural resources and oversees the state's environmental regulations. The Vermont Division for Historic Preservation, which reviews many projects for conformance with state and federal historic preservation laws, 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.[242] These agencies, as well as the Agency of Agriculture, Food & Markets, encourage project developers to reach out to them and to landowners and host communities prior for filing a Section 248 permit to resolve issues and concerns. Some agencies, such as ANR, also have ancillary permits that projects will be required to obtain in addition to the Section 248 CPG.

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.

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241 *http://psb.vermont.gov/sites/psb/files/publications/Citizens%27%20Guide%20to%20248%20February%2014%202012.pdf*

242 *http://accd.vermont.gov/strong_communities/preservation/review_compliance/telecom_criteria*

Many interveners in wind project matters have voiced concern that the PSB process makes it too complex and 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, requirements, and permitting times in Vermont, which often exceed those of neighboring states.

In 2004, the Vermont Commission on Wind Energy and Regulatory Policy provided recommendations[243] on whether 30 V.S.A. § 248 provided appropriate review of "commercial"[244] 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; many of these recommendations have been subsequently implemented by the PSB.

In 2013, the Governor's Energy Generation Siting Policy Commission produced a report[245] containing a comprehensive package of reforms to address concerns with siting and permitting of larger-scale (> 500 kW) energy generation projects. Like the 2004 Wind Commission, the Siting Commission's recommendations included a focus on increasing opportunities for public participation and implementation of procedural changes in the siting process, including greater pre-filing consultation with communities, as well as increased planning, adoption of a simplified, tiered approach to siting, and provision of siting and technology guidance and guidelines. Many of these recommendations required statutory change, but some that did not, such as efforts to enhance regional energy planning, are now underway.

13.2.6 Benefits

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

Relative Cost and Price Stability

New wind generation is the least expensive form of new renewable energy electric generation to build in Vermont today. A 2013 study in the Journal of Environmental Studies and Sciences found that wind (and solar) are less expensive than electricity from coal when climate change and health impacts are factored in,[246] and a 2015 analysis by the U.S. Department of Energy concluded that wind power will be cheaper than power produced from natural gas within the decade, even without subsidies.[247] That said, high

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

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

245 http://sitingcommission.vermont.gov/sites/cep/files/Siting_Commission/Publications/FinalReport/Final%20Report%20-%20Energy%20Generation%20Siting%20Policy%20Commission%2004-30-13.pdf

246 http://www.springer.com/about+springer/media/springer+select?SGWID=0-11001-6-1436444-0

247 http://www.energy.gov/eere/wind/maps/wind-vision

permitting and construction costs can 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, since the wind resource is free. This leads to stable pricing over the projected 20-year life of a typical installation. Given the recent advances in turbine technology that increase operational efficiencies, prices of long-term contracts for wind have reached an all-time low, even in more challenging places to build such as Vermont, at 5-6 cents/kWh. This is on par with average wholesale power prices and competitive with the expected future cost of burning fuel in natural gas plants.[248]

Reduced Emissions

The generation of wind power itself produces no emissions; wind generation in New England power markets is "must run" and directly displaces generation at facilities with higher operating costs that are dispatchable (coal, oil, and natural gas). The emissions of these facilities, estimated to be displaced by wind, is 914 lb of CO_2 per MWh generated.[249] Thus, all wind projects now installed in Vermont reduce approximately 275 million pounds of CO_2 emissions from the New England grid annually.

Nationally in 2014, the 181.8 million megawatt-hours (MWh) generated by wind energy avoided an estimated 125 million metric tons of carbon dioxide (CO2) – the equivalent of reducing power-sector CO_2 emissions by 5.7%, or 26.4 million cars' worth of carbon emissions. Moreover, in 2014, wind energy generation reduced water consumption at existing power plants by approximately 68 billion gallons of water – the equivalent of roughly 215 gallons per person in the U.S. or conserving the equivalent of 517 billion bottles of water.[250]

Economic Impact

As of the end of 2014, the U.S. wind energy industry supported 73,000 full-time equivalent (FTE) jobs directly associated with wind energy project planning, siting, development, construction, manufacturing and supply chain, and operations.[36] Vermont firms currently employ 304 workers in the wind energy field.[251] Vermont's wind projects also pay municipal property taxes, in addition to contributing to the state education fund, and may negotiate additional payments to host and neighboring towns. Annual

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[248] http://emp.lbl.gov/sites/all/files/lbnl-188167.pdf

[249] http://www.iso-ne.com/static-assets/documents/2014/12/2013_emissions_report_final.pdf

[250] *AWEA U.S. Wind Industry Annual Market Report Year Ending 2014*

[251] http://publicservice.vermont.gov/sites/DPS/files/Announcements/Vermont%20Clean%20Energy%20Industry%20Report%20FINAL.pdf

payments to towns have prompted residents of Lowell to vote to eliminate municipal taxes and residents of Sheffield to vote to cut their tax rate in half.[252]

13.2.7 Challenges

Aesthetics

The aesthetic impact of wind projects is often a primary consideration for project neighbors and host and viewshed towns. In its review of a project under Section 248, the PSB assesses whether a project will have an undue adverse effect on aesthetics using the so-called Quechee analysis, adopted from Act 250.[253]. The DPS usually engages aesthetic experts for the permitting process to provide testimony to the PSB on the aesthetic impact of proposed wind power projects. The PSB's review of aesthetic impacts is also significantly informed by the overall societal benefits of the project.

As long as wind turbines are visible, and it is necessary to site them at higher elevations, aesthetics will continue to play a major role in the public discourse about wind energy. The DPS has compiled reports, recommendations, and other resources related to aesthetic review of wind projects – such as those produced by the 2004 Vermont Commission on Wind Energy Regulatory Policy and the 2002 Wind Siting Consensus Building Project – on its wind resources webpage.[254]

Aesthetic impressions also contribute to concern over the impacts of wind on property values, which are not explicitly considered in the Section 248 process. In 2013, a Lawrence Berkeley National Laboratory (LBNL) researcher analyzed sales of 51,000 homes near wind turbines in 27 counties in 9 states and found no statistical evidence that home prices near wind turbines were affected.[255] A follow-on study conducted by LBNL and the University of Connecticut looked specifically at property values for homes near wind turbines in Massachusetts and again found no measurable impact on property values.[256] Nevertheless, towns in several Vermont communities have lowered home assessments in response to wind projects.

Environment

Like any other source of energy production, wind power is not free of impact to the environment, and these impacts are reviewed by the PSB in a Section 248 proceeding. Utility-scale projects in the U.S. use

[252] http://caledonianrecord.com/main.asp?SectionID=180&SubSectionID=778&ArticleID=91442, http://caledonianrecord.com/main.asp?SectionID=180&SubSectionID=778&ArticleID=108107, http://www.miltonindependent.com/georgia-wind-towns-sign-tax-agreement/

[253] http://psb.vermont.gov/sites/psb/files/248_Guide_March_29.doc

[254] http://publicservice.vermont.gov/topics/renewable_energy/resources#wind

[255] http://emp.lbl.gov/publications/spatial-hedonic-analysis-effects-wind-energy-facilities-surrounding-property-values-uni

[256] http://emp.lbl.gov/publications/relationship-between-wind-turbines-and-residential-property-values-massachusetts

available land on the order of 30-141 acres per MW, but with less than one acre per MW of permanent disturbance.[257] The construction of roads for construction and ongoing maintenance can fragment large blocks of habitat, and without proper design and construction, those roads have the potential to degrade headwater streams. High elevations provide essential habitat to species such as the Bicknell's thrush, which is also threatened by the effects of climate change.[258] And the turbines themselves can be hazardous to flying animals such as birds and bats, due to direct physical impacts or internal damage caused by changes in air pressure from spinning blades.

Advances in turbine technology, lessons from operational projects, and research efforts have led to best practices that are essential to avoid or mitigate impacts to the environment from wind projects. These include careful siting to avoid or minimize disrupting or degrading habitat, operational and technological solutions such as halting turbines during times of high bat activity, and methodical pre- and post-construction monitoring of indicators such as stream health to detect and address issues that may arise. Organizations such as the U.S. Fish and Wildlife Service and National Wind Coordinating Collaborative are actively engaged in better understanding impacts from wind facilities and offering siting, design, operational, and management recommendations to the wind industry and other stakeholders.[259] The Agency of Natural Resources also actively engages with developers early in the design stages of projects in order to work proactively to avoid and mitigate environmental impacts, and has developed web-based map tools to help identify important natural resource areas.[260]

Health

Potential impacts to human health from wind turbines can also be of concern to communities and project neighbors. In 2012, the Government of Canada undertook the most comprehensive study to date on the effects of wind turbines on public health.[261] The only self-reported effect they found to be statistically associated with increasing levels of wind turbine noise was annoyance toward wind turbine features such as noise, shadow flicker, blinking lights, vibrations, and visual impacts. Objectively measured results were consistent with the self-reporting findings. Wind turbine noise was not found to be related to measures of sleep quality or physiological indicators of stress such as hair cortisol concentrations, blood pressure, or resting heart rate. These results are considered preliminary, since Health Canada has not yet published their findings in peer-reviewed scientific journals. The Health Canada findings appear to be consistent with the results of earlier studies described in literature reviews.[262]

[257] http://www.nrel.gov/docs/fy09osti/45834.pdf

[258] http://vtecostudies.org/projects/mountains/mountain-songbird-research/breeding-bird-studies/

[259] http://www.fws.gov/habitatconservation/windpower/Wind_Turbine_Guidelines_Advisory_Committee_Recommendations_Secretary.pdf, https://nationalwind.org/

[260] http://www.anr.state.vt.us/site/html/maps.htm

[261] http://www.hc-sc.gc.ca/ewh-semt/noise-bruit/turbine-eoliennes/summary-resume-eng.php

[262] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4256253/, http://www.ncbi.nlm.nih.gov/pubmed/21914211

There is a larger body of literature available on the public health implications of annoyance from other sources of community noise, including roads, airports, and industry. The World Health Organization developed guidelines to address community noise,[263] which form the basis of the current sound limits for wind facilities in Vermont.[264] In 2014, the PSB opened a docket on the potential of establishing sound standards for generation facilities, including wind.[265] They held three workshops, in addition to soliciting written comments on best practices, but no further orders have yet been issued.

In 2010, the Vermont Department of Health issued a report on *Potential Impact on the Public's Health from Sound Associated with Wind Turbine Facilities*.[266] They concluded that while there is no direct health effect from wind turbine sound, there is sufficient evidence of a secondary health effect from sleep disturbance due to excessive sound at night, and therefore recommend nighttime sound levels from wind turbines be limited to 40 decibels or less, measured at the exterior façade of a dwelling and averaged over 12 months.

In addition to complying with sound limits, there are many actions developers can take to avoid or mitigate annoyance from a wind facility. These include reaching out early to engage project neighbors and communities in the planning stages of a wind facility, incorporating their suggestions into the design and siting of the facility, and offering opportunities to directly share in the ownership, control, or benefits of the project. Developers should also establish a Good Neighbor Policy, have a plan in place to address noise complaints, consider entering into noise easements with abutters, and possibly plan for the purchase of nearby properties whose owners are especially sensitive to the visual or acoustic properties of wind facilities.

Measured Production Capacity

The electric 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. Exhibit 13-15 provides insight into the capacity factors achieved by the large-scale Vermont-based wind projects.

Exhibit 13-15. Vermont Wind Project Capacity Factors[267]

Project	Estimated CF	Actual CF in 2014	Lifetime Average CF	Best Achieved CF
Searsburg	27	27	24	31

263 http://www.who.int/docstore/peh/noise/guidelines2.html

264 http://psb.vermont.gov/forconsumersandthepublic

265 http://psb.vermont.gov/docketsandprojects/electric/8167

266 http://healthvermont.gov/pubs/ph_assessments/wind_turbine_sound_10152010.pdf

267 *Compiled from production data reported to the DPS, Certificate of Public Good filings, compliance filings, and communication with utilities. Figures are rounded to the nearest whole number.*

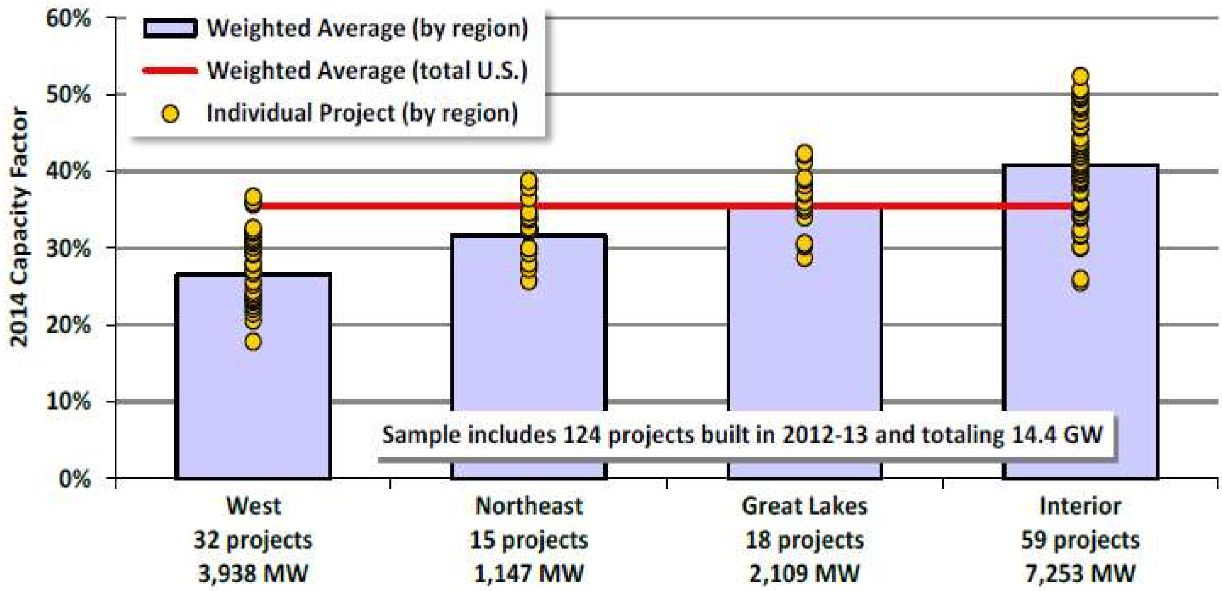
Sheffield	32	25	24	25
Georgia/Milton	28-34	37	N/A	38 (2015 YTD)
Lowell	36	35	N/A	39 (2015 YTD)

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. Utility-scale wind projects in the Northeast in 2014 generally saw capacity factors ranging from 25-40%, with averages in the mid-30s, due to factors including wind resource, turbine technology, and transmission curtailment (see Exhibit 13-16).[268] Curtailment – or reduction in output ordered by the regional transmission operator – was estimated to be 3.3% in New England in 2014 and is likely to become an increasingly important factor in the feasibility of building new wind projects, especially in transmission-constrained areas of the state and region (see Exhibit 13-17).[54,269]

268 http://emp.lbl.gov/sites/all/files/lbnl-188167.pdf.

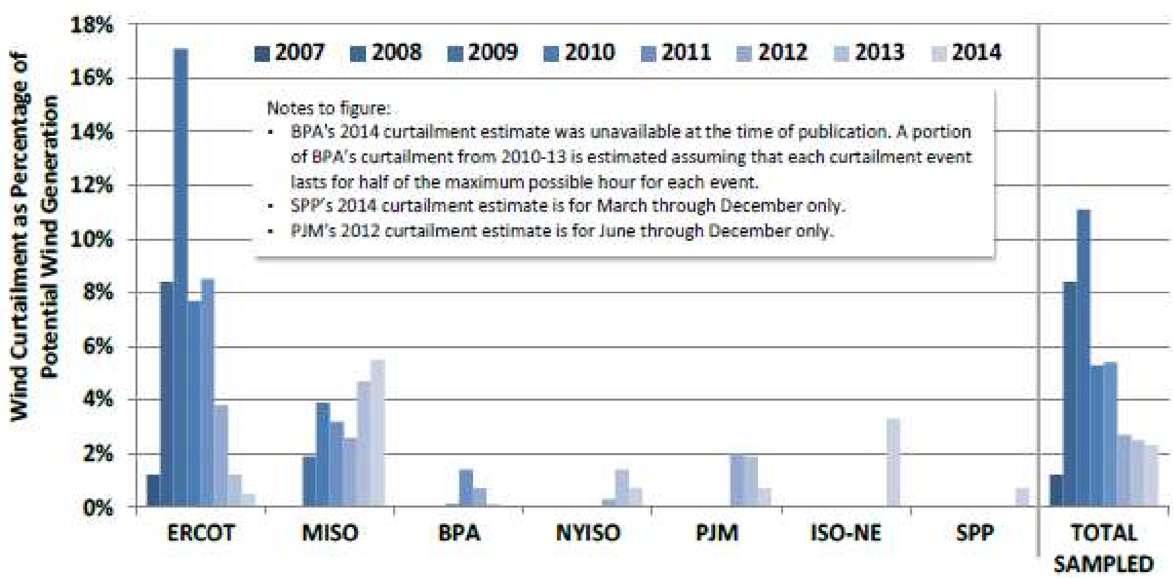
269 http://publicservice.vermont.gov/sites/DPS/files/Pubs_Plans_Reports/Legislative_Reports/Recommendations%20Related%20to%20Curtailment%20of%20In-State%20Electric%20Generation%20Plants.pdf

Exhibit 13-16. Regional Wind Capacity Factors[270]



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

Exhibit 13-17. Region-Specific Wind Curtailments[270]



270 http://emp.lbl.gov/publications/2014-wind-technologies-ma

project's CPG. Cumulative data on the actual power production of wind turbines in Vermont can be used to evaluate the estimated production presented by any new proposed projects.

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. In 2010, ISO New England commissioned a study that found wind could meet up to 24% of the region's electricity needs in 2020, and that current generation resources are adequate to compensate for wind variability even at 20% penetration (see Exibit 13-18 for a comparison of wind penetration in states). However, the study emphasized – and ISO continues to emphasize – the need for flexible resources to compensate for times when the wind doesn't blow, especially within the course of a day.

Exhibit 13-18. Installed Capacity By State and as a Percentage of In-State Generation[271]

Installed Capacity (MW)				Percentage of In-State Generation	
Annual (2014)		Cumulative (end of 2014)		Actual (2014)*	
Texas	1,811	Texas	14,098	Iowa	28.5%
Oklahoma	648	California	5,917	South Dakota	25.3%
Iowa	511	Iowa	5,688	Kansas	21.7%
Michigan	368	Oklahoma	3,782	Idaho	18.3%
Nebraska	277	Illinois	3,568	North Dakota	17.6%
Washington	267	Oregon	3,153	Oklahoma	16.9%
Colorado	261	Washington	3,075	Minnesota	15.9%
North Dakota	205	Minnesota	3,035	Colorado	13.6%
Indiana	201	Kansas	2,967	Oregon	12.7%
California	107	Colorado	2,593	Texas	9.0%
Minnesota	48	North Dakota	1,886	Wyoming	8.9%
Maryland	40	New York	1,748	Maine	8.3%
New Mexico	35	Indiana	1,745	New Mexico	7.0%
New York	26	Michigan	1,531	California	7.0%
Montana	20	Wyoming	1,410	Nebraska	6.9%
South Dakota	20	Pennsylvania	1,340	Montana	6.5%
Maine	9	Idaho	973	Washington	6.3%
Ohio	0.9	New Mexico	812	Hawaii	5.9%
Massachusetts	0.6	Nebraska	812	Illinois	5.0%
		South Dakota	803	Vermont	4.4%
Rest of U.S.	0	*Rest of U.S.*	4,941	*Rest of U.S.*	0.9%
TOTAL	**4,854**	**TOTAL**	**65,877**	**TOTAL**	**4.4%**

* Based on 2014 wind and total generation by state from EIA's *Electric Power Monthly*.

Currently wind power is less than 2% of the ISO-NE grid,[272] but there is a focus among system planners to optimize resources in light of growing energy production from intermittent renewables. At present, 42% of the proposed projects in the ISO's Generator Interconnection Queue are wind-powered.[273]

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[271] http://emp.lbl.gov/publications/2014-wind-technologies-ma

[272] http://www.iso-ne.com/about/what-we-do/key-stats/resource-mix

The issues of optimization need to be considered in the context of the entire ISO-NE power pool, the renewable energy policies of members states, and increasing penetration of distributed renewable energy other than wind. ISO anticipates needing to adopt more sophisticated forecasting tools, attract and retain more fast-responding capacity in reserve, and regional investments in transmission resources to connect remotely located wind projects to demand centers.[274]

Strategies and 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:

Strategy 1: Continue to facilitate development of in-state wind projects in order to achieve the state's renewable energy goals, with a particular focus on small- and medium-scale and community-directed projects and projects that offer a significant benefit for ratepayers.

Recommendations

(1) Facilitate the development of projects that are community-led or that have engaged communities in the planning, design, and benefits of the proposed project.

(2) For large-scale projects, development should be permitted if there are environmental, economic and societal benefits to Vermonters, and all other Section 248 criteria are fulfilled.

Strategy 2: Learn from existing wind in-state wind projects to improve the siting and review requirements and processes for future wind development.

(1) The DPS, ANR, and DOH should continue to learn from the operation of existing wind projects to inform any future recommendations for sound, aesthetic, health, environmental, and public engagement guidelines or standards;

(2) The State should consider formulating requirements for health impact assessments and pre-development public engagement and mediation processes for projects that fail to meet recommended guidelines or standards.

[273] http://www.iso-ne.com/static-assets/documents/2015/02/2015-powergridprofile-final.pdf

[274] http://www.iso-ne.com/aboutiso/fin/annl_reports/2000/2014_reo.pdf

13.3 Solid Biomass

13.3.1 Overview

Bioenergy is a broad category that includes different types and sources of fuel, with a variety of technologies in use and in development. As described in this report, bioenergy consists of woody and non-woody solid biomass, liquid biofuels, and methane biogas. This chapter entails solid biomass only. This section of the CEP focuses on solid biomass, primarily wood, used to provide electric and thermal energy. Agricultural biomass (e.g. straw pellets) and short-rotation woody biomass (e.g. willow plantations) are currently a minor source of feedstock for energy, but are also included in this section. Not included here are liquid biofuels and methane biogas discussions included later in this chapter.

All forms of bioenergy, like the other forms of energy production, have benefits and drawbacks that must be weighed carefully. This update to the CEP discusses some of the ways that Vermont is expanding the use of bioenergy resources while making decisions that are economically, environmentally, and socially responsible. This section concludes with strategies and recommendations that appropriately and sustainably expand wood supply and demand, primarily for clean, efficient, advanced wood heat.

Wood plays a major role in Vermont energy mix. An estimated 32% of Vermont households heat with firewood or wood pellets. More than 200 commercial facilities use wood chips or pellets for heating, and this number is rapidly growing. Vermont is a leader in heating schools and institutional facilities with wood chips (more than one-third of all Vermont children attend schools heated by wood). Wood chips fuel two large wood-fired electric power plants, as well as a number of smaller commercial and public facilities that use wood to create heat and/or electricity.

Other forms of solid biomass are in various stages of research and development, commercialization, and market readiness in the state. As was the case in 2011, there is the potential for use of alternative biomass material other than forested wood for energy production. For example, grass, crops such as corn, and fast-growing trees such as willows are being investigated for feasibility as part of Vermont energy mix.

Vermont's forest economy is an integral part of a regional and international market where product price fluctuates with supply and demand beyond our borders. Fifty-nine percent of the wood harvested in Vermont is processed within the state. This value-added local rural economy is essential for many communities and landowners. However, Vermont is also part of a larger regional economy where wood flows freely. Northern hardwood – maple, beech, yellow birch – are prized and sought after throughout the world. Although exports of raw materials exceed imports, the ratio remains almost equal: 1.2 to 1.

It is estimated that the forest products economy employs 10,555 people and has $1.4 billion in economic output annually. Vermont's gross state product, the state-level equivalent of the national gross domestic product, for all forest product manufacturing is $266 million, and represents 8% of the state's manufacturing value.

Primary products include solid wood products from sawmills and veneer mills. These primary manufacturers employ 2,327 workers. Payroll in the wood products sector is about $67 million annually. Today annual economic output, in terms of annual sales or value of shipments, stands at $239 million.

Secondary manufacturers transform lumber and other primary solid products into finished consumer products or components for finished products. The making of furniture, moldings, turnings, and similar products employs nearly 1,600 Vermont workers. The payroll in this sector is about $49 million annually. Annual economic output, in the form of sales or value of shipments for the secondary wood products sector, is about $143 million in Vermont.[275]

13.3.2 Principles

Recognizing and strengthening Vermont's current forest-based businesses will have many co-benefits. A strong forest economy keeps forest landowners able to maintain intact forests, supports forest operations that improve wood quality, and in turn improves opportunities to be good land stewards. The interconnection between forest economy, social benefits, and a healthy forest ecosystem will remain foremost when evaluating recommendations for expanding wood energy as part of this CEP. The following principles will be considered when developing solid biomass energy policies:

(1) Maintain forest health as a prerequisite to a sustainable wood energy fuel supply, while ensuring continuation of other forest-derived products, values and benefits.
(2) Improve the economic stability of forestland by expanding opportunities to market low-grade wood as an energy fuel source, while supporting existing forest products and expanding opportunities for secondary forest product development.
(3) Increase the use of clean wood energy technology especially in areas of at-risk populations.
(4) Maintain in-forest carbon storage and uptake, and support efficient advanced wood energy technology to improve energy use per carbon emitted from wood energy.
(5) Expand energy production from this renewable (but finite) source by using efficient wood energy technology recognizing that without advanced electric energy technology, thermal energy production currently is more efficient and therefore the best energy choice for wood.
(6) Use newer, cleaner-burning wood heating systems in order to reduce the overall emissions of particulate matter and other air pollutants that may directly affect public health, such that expansion of wood energy usage does not adversely affect air quality.
(7) Improve local infrastructure and technology to support expansion of clean and efficient advanced wood energy in Vermont.
(8) Capture the unique and diverse ecosystem services that grass and willow offer.

[275] *The Economic Importance of Vermont's Forest-Based Economy 2013, Northeast State Foresters Association (NEFA 2013),* *http://www.nefainfo.org/uploads/2/7/4/5/27453461/nefa13_econ_importance_vt_final_web_jan29.pdf*

13.3.3 Policy and Regulatory Framework

Total Energy Study (TES) – The DPS completed a TES in December 2014 fulfilling requirements in Act 170 of 2013 and Act 89 of 2013. The approach addressed both the targeted goals set for GHG reductions and an increased use of renewable energy. An additional goal was to increase use of locally derived fuels in energy production. Wood energy was identified as playing a significant role in achieving these goals. Four scenarios were tested: business as usual, a carbon tax, total renewable energy and efficiency standard (TREES), and total renewable energy and efficiency standard with a local energy requirement (TREES local).

The report emphasized that the increase wood energy needs to be compatible with goals for air quality, forest health, and efficient use of renewable resources. This could be accomplished using advanced wood heating systems installed in weatherized buildings such that more buildings could be heated, more efficiently, while also resulting in better air quality due to the use of improved combustion technology.

This modeling study showed significant increases in jobs and sales in the forestry sector, possibly doubling baseline sales and employment, or at least 40-60% increase above baseline values.

25 X '25 – Federal legislation is pending that would extend tax benefits for renewable energy technologies through the production tax credit (PTC). This would be a two-year extension (through 2016) of a PTC that can be claimed as a 2.3 cent per kilowatt hour – or an alternative 30% investment tax credit - for new projects that generate renewable electricity from by sources including biomass energy projects.

PSB CPG/Section 248 – Under Title 30 V.S.A. §248, the PSB is tasked with ensuring that new infrastructure for electric energy generation and transmission meets the ten statutory criteria in the best interest of the public, before granting a CPG approving the new project.

Air Emissions – 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 created significant amounts of smoke, whereas modern models emitted 70% to 90% less pollution. Most older units were retired by January 2013 and replaced with newer, more efficient boilers that comply with air quality standards.[276] On February 3, 2015, EPA strengthened its New Source Performance Standards (NSPS) for residential wood heaters. Previous standards were enacted in 1988, and amended in 1996. The standards are in two steps, the first taking effect 60 days after the enactment of the standard, the second five years after. Under Step 1, wood and pellet stoves have a particulate matter limit of 4.5 grams emitted per hour of operation, and under Step 2 (in 2020) this will be reduced to 2.0 grams emitted per hour of operation.

Forest Regulations and Best Management Practices

[276] *Vermont Outdoor Wood Boiler Change-Out Program, www.anr.state.vt.us/air/htm/OWBChangeOutProgram.htm*

- **Forest Action Plan –** The Food, Conservation and Energy Act of 2008, commonly referred to as the Farm Bill, included a provision requiring states to complete a statewide forest resource assessment. The Vermont 2010 "Forest Resources Plan and State Assessment and Resource Strategies" set direction through 2015, at which time a new forest action plan will be instituted. The vision for Vermont forests outlined in the 2015 action plan emphasizes healthy forests: "The forests of Vermont will consist of healthy and sustainable ecosystems valued for their significant environmental, societal, and economic benefits. Citizens, landowners, businesses, and government understand their civic responsibility for and participate in the stewardship of trees and forests for this and future generations." Strategies for accomplishing this vision cover topics of biological diversity, forest health and the productive capacity of forest ecosystems, forest products, conservation of soil and water resources, and maintenance of forest contribution to global climate cycles (carbon sequestration).
- **Acceptable Management Practices –** The Acceptable Management Practices (AMPs) for Maintaining Water Quality on Logging Jobs in Vermont are preventative measures that help control soil erosion and protect water quality. They are designed to minimize the effects of logging on natural hydrologic functions of forests. The 1986 Vermont Legislature passed amendments to Vermont's water quality statutes Under Title 10 V.S.A. Chapter 47: Water Pollution Control to further protect water quality, the AMPs were developed and adopted as rules for Vermont's water quality statutes and became effective August 15, 1987. Vermont AMPs are currently being revised to clarify requirements, improve educational components, and strengthen implementation.
- **Heavy Cut Law –** Title 10 V.S.A. Chapter 83: Regulation of heavy cutting was established in 1997 (amended in 2003 and 2005) to prevent large areas of clear cutting conducted without a forest management plan identifying this as a viable regeneration strategy. Foresters planning to conduct a heavy cut (reduce trees/acre below a silvicultural standard C-line, would need to notify the state and submit a forest management plan in advance of the harvest for state approval.
- **Wetland Rules –** Title 10 V.S.A. §6025(d)(5) Vermont Wetland Rules were adopted in 2010 to protect significant wetlands of the state. Silvicultural activities are allowed with some restrictions as outlined in 6.01-6.05.
- **Threatened and Endangered Species –** Under Title 10 V.S.A. Chapter 123: Vermont threatened and endangered species: activities that could affect a state-threatened or -endangered animal or plant species require a permit from the Department of Fish and Wildlife.
- **Shoreland Protection Act –** In 2015 a new law was enacted that limits activities near ponds and lakes. Harvesting exemptions require an approved plan prior to harvest activities.
- **2012 Biomass Energy Development Working Group of the Legislature**

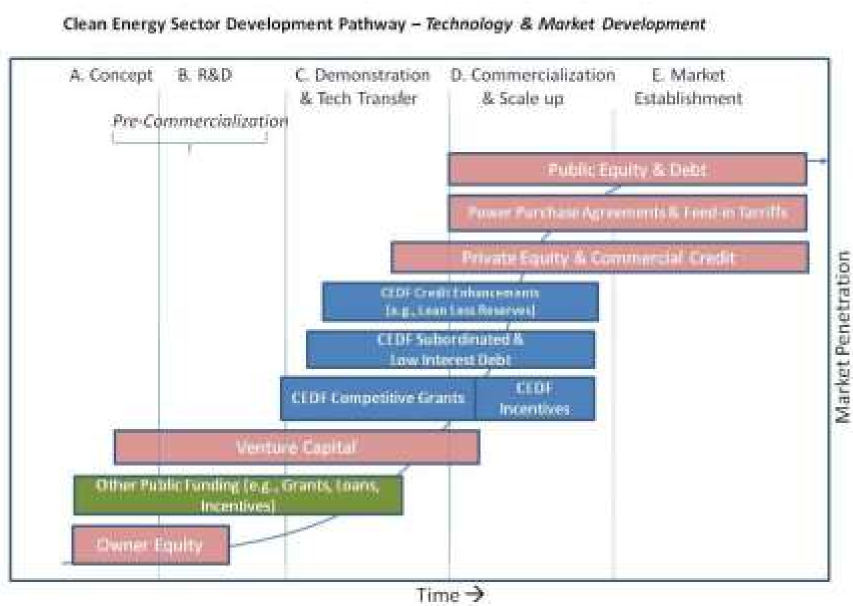
<u>Status of Recommendations to Enhance and Further Develop Wood for Energy</u>

To maximize the benefits while minimizing negative impacts of the wood energy economy, FPR has developed Voluntary Harvesting Guidelines that will improve resource sustainability.

To assign priority to home heating with wood through incentives and policies, and improve thermal energy efficiency:

- ANR offered a wood stove change out program for outdoor furnaces to improve air quality and efficiency.
- ANR is currently developing an inefficient furnace change out program directed at replacing oil furnaces with efficient wood furnaces, supporting local forest economy rather than payment for out-of-state fossil fuels.
- ANR is also developing a woodstove change out program directed at replacing aging, inefficient wood stoves with clean, efficient wood stoves, supporting emission reduction, human health, and reducing GHG emissions by using less wood per unit of thermal energy.
- FPR produced a forest fragmentation report to the Legislature with recommendations to strengthen working forest lands, including the need for modifications of Act 240 under criterion 8, and the need for flexibility in establishing thermal energy facilities in growth centers.
- The Working Lands Initiative was created in 2012 to support working forests and farms, offering grants through the Working Lands Enterprise Fund (WLEF). Economic development of forest businesses has been in support of secondary wood products and markets.
- A company was contracted to analyze Vermont wood markets, supply chain, and other forest economy characteristics to support marketing efforts and policy development.
- The Vermont Clean Energy Development Fund has supported wood energy projects.
- The current strategic plan for the CEDF is focused on clean, efficient, and cost effective energy projects that are beyond pre-commercial stages of development (Exhibit 13-19). Their goal for combined heat and power projects is at least 65% efficiency.

Exhibit 13-19. Clean Energy Development Fund (blue) niche showing the select tools to help foster greater investment in clean energy projects



- The Agency of Commerce and Community Development has on staff a person to facilitate natural resource commerce projects.
- School construction of wood-energy facilities is once again eligible for state aid.

Status of Recommendations to Protect Forest Health

- The voluntary harvesting guidelines recommended in the BioE report were used to inform the new FPR "Voluntary Harvesting Guidelines."
- The State FPR conducted an "Assessment of Timber Harvesting and Forest Resource Management in Vermont: 2012" as a re-assessment of a 1990 study, "The Impact Assessment of Timber Harvesting Activity in Vermont". The assessment involved the post-harvest evaluation of eighty-one timber harvesting operations for compliance with the "Acceptable Management Practices (AMPs) for Maintaining Water Quality on Logging Jobs in Vermont" and potential impacts on a number of other forest attributes which contribute to forest health. Middlebury College is conducting a feasibility study for use of short-rotation willow plantations as fuel for their wood energy facility.
- ANR has developed online spatial data layers, ATLAS, in support of natural resource planning to help foresters, landowners, and loggers to locate and protect species and natural communities at risk.
- Educational training for loggers is offered annually through the Logger Education to Advance Professionalism Program (LEAP).
- FPR continues to monitor rates of forestland gain or loss, harvest and growth of timber, in collaboration with the USDA Forest Service.
- The Department of Fish & Wildlife published a Wildlife Habitat Landowners Guide including methods for monitoring residual wood biomass and wildlife tree retention that can be used for post-harvest monitoring as part of the Use Value Appraisal program.
- The State AQ has posted online public information on home use of firewood, including improved efficiency and air quality gained from using dry wood.

Voluntary Harvest Guidelines – In Title 10 V.S.A. §2750, Act 24 the Commissioner of FPR was required to develop voluntary harvesting guidelines for use by private landowners to help ensure long-term forest health and sustainability by January 2015. Furthermore, harvests conducted on state lands and wood purchased by the State will be consistent with these guidelines with the objective being long-term forest health and sustainability in addition to other management objectives.

Act 56 (H. 40) Biomass and Renewable Energy Credits – On June 11, 2015, Governor Shumlin signed into law H. 40, An Act Relating to Establishing a Renewable Energy Standard (the "RES"). This significant renewable energy law establishes a mandatory renewable energy standard for Vermont utilities. H. 40 repeals Vermont's Sustainably Priced Energy Development ("SPEED") Program, except for the Standard Offer program. The RES requires that retail electricity providers (1) have a minimum amount of renewable electricity in their supply portfolios; (2) support relatively small (≤ 5 MW) renewable energy projects connected to the Vermont grid (known as "distributed renewable generation projects"); and (3) invest in projects to reduce fossil fuel use for heating and transportation (known as "energy transformation projects"). The RES is comprised of three interrelated tiers:

(1) **Total renewable energy** requirement, which is essentially an RPS (Tier 1);
(2) **Distributed renewable generation** ("DRG") requirement (Tier 2); and
(3) **Energy transformation requirement** that can be satisfied through either additional distributed generation and/or cost-effective projects that reduce Vermont's fossil fuel consumption and related GHG emissions (Tier 3).

To qualify, a biomass plant must (1) generate both electricity and thermal energy from same fuel, with the majority of the energy recovered being thermal; and (2) biomass energy production must comply with "renewability standards" to be adopted by the Commissioner of Forests, Parks and Recreation. Biomass that does not qualify for Distribute Renewable Generation (DRG) or Energy Transformation still qualifies under the Total Renewable Energy tier. This act takes effect on July 1, 2015. ANR is directed to report on environmental and land use impacts of renewable electric generation in Vermont, methods for mitigating impacts, and recommendations for appropriate siting and design.

13.3.4 Environmental Considerations

Environmental Protection Agency Carbon Policy

The carbon emission impacts of switching from fossil fuels to wood fuel is very complicated, due in part to the complexity and variability of forests, and is intertwined with the natural carbon cycles of forests.

Forests pull carbon from the atmosphere and store vast quantities in soil, trees and other vegetation. This process of carbon uptake reduces atmospheric carbon, moderating the rate of climate change and its associated impacts. The cumulative effect of many trees removing and storing carbon from the atmosphere across large areas is significant. Factors include measuring the amount of stored carbon and the process of uptake by forests as they change, are exposed to various stress factors, are harvested and wood processed. Then harvested wood factors as they are processed into durable wood products, used for other products, or burned for heat and power. But in developing general policies to employ when assessing positive or negative GHG benefits in the abstract, the results are unreliable.

Burning wood can emit higher gross amount of carbon dioxide per unit of energy than burning oil. However, burning wood for heat emits biogenic carbon that has been constantly cycled between forests and the atmosphere over time as part of the natural carbon cycle. Burning oil emits geologic sources of carbon, taking this fossil carbon stored beneath the surface of the earth for millions of years and creating a one way path to the atmosphere. Burning wood emits carbon that was previously in the atmosphere 20-100 years ago, whereas burning oil emits carbon that was in the atmosphere 20-100 million years ago.

For many years the EPA has been working to develop an accurate, scientifically worthy, economically feasible method for accounting for forest carbon changes, biogenic accounting, for use in evaluating bioenergy emissions. The current draft version of their methods relies on two factors important to this

CEP: 1) Whether the wood is "waste" wood resulting from harvesting sawlogs or the wood is harvested solely as energy wood; and 2) harvesting is conducting in a manner that maintains forest health.

<u>Forest Sustainability Standards</u>

Private forest landowners have flexibility in forest management objectives and methods. There are many voluntary guidelines for managing forests sustainably, and a few organizations have established specific standards to be followed to garner a sustainability certificate.

The American Tree Farm System (ATFS) has a forest sustainability measurement system that is required by participants. There are 493 tree farms in the Vermont ATFS program for a total of 172,209 acres.

The Forest Stewardship Council (FSC) has a set of standards used to evaluate responsible forest management. While FSC is a voluntary program, it uses the power of the marketplace to protect forests for future generations. In Vermont there were 74,175 acres of forestland certified by FSC in 2013.

The Sustainable Forestry Initiative (SFI) is a forest certification system that requires independent, third-party audits that are performed by internationally accredited bodies. The standards cover key values such as protection of biodiversity, species at risk and wildlife habitat, sustainable harvest levels, protection of water quality, and prompt regeneration. The SFI updated its standards in 2015.

13.3.5 Health Considerations

Expanding wood energy usage in Vermont comes with factors to consider related to human health. The primary pollutant of concern from wood boilers is particulate matter (PM); however combustion of wood and other biological materials emits similar amounts of nitrogen oxides (NOX), volatile organic carbons (VOCs), and carbon monoxide (CO) as other solid fuels, and dramatically more of certain pollutants than oil and gas. While recent state and federal regulations impose stricter limits on particulate matter (PM) emissions from wood boilers, it is important to consider the health effects of PM and other pollutants so that proper steps can be taken in promoting best practices to reduce the emissions of pollutants and minimize adverse health effects.

Particulate matter (PM) emitted in combustion can include many different constituents, and particulate matter inhalation has been associated with adverse respiratory and cardiovascular health outcomes. Advanced wood heat technology can significantly reduce PM emissions with subsequent health risks.

Carbon monoxide (CO) is a product of incomplete combustion, which is typically emitted by all combusting fuel sources, albeit in different concentrations. CO can accumulate in poorly ventilated spaces, and pose a significant acute and chronic health hazard. Typically, CO emissions from wood burning increases with fuel moisture, and best practices for efficiency, such as using dried/seasoned fuel, are good controls for excessive CO emissions. Additionally, educational steps on best practices for ventilation and safe distances from households for residential boilers should be used.

13.3.6 Resources

13.3.6.1 In-state Wood Energy Production

Space heating represents one-third of Vermont's total energy demand and 80% of that is met by fossil fuels (one-half of that is oil). Despite a long and continuing tradition of heating with wood, only 15% of Vermont's heating demand is currently met with wood. This represents an enormous opportunity to expand use of efficient, clean-burning wood technologies, while creating markets for low-quality wood, providing an economic incentive for improving timber quality and value-added prospects for durable wood products, and supporting forest landowners so they can keep forestland intact.

Current Solid Biomass Use for Thermal Energy

Wood is a relatively low-cost, local source of thermal energy in Vermont. Wood systems are used in nearly 300 systems throughout the state (Exhibit 13-20 and 13-21). 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.

Exhibit 13-20. Current Vermont Wood Boiler Use

Building Type	Number of Installations
Campus systems and complexes	3
Businesses	15
College campuses	5
Low-income multi-family complexes	15
State buildings	11
Schools	50
Bulk pellet residential boilers	200 +/-
Total	**299 +/-**

Exhibit 13-21. Wood Boiler Technologies and Fuels

Technology	Cordwood boilers	Pellet boilers	Single facility woodchip heating	District heating with woodchip boilers	Industrial combined heat and power
Typical heat output capacity	20kW-100kW	20kW-1MW	500kW-9MW	1.5MW-15MW	8MW-150MW
Application	Home heating and farm buildings	Home heating and small commercial buildings	Schools, hospitals, office buildings, etc.	College campuses and downtown communities	Merchant power plants
Fuel type	Cordwood	Pellets	Woodchips	Woodchips	Woodchips

Annual fuel use	2-15 cords	2-20 tons	100-10,000 tons	500-50,000 tons	1,000-500,000 tons
Fuel sourcing	Locally harvested firewood	Premium pellets	Paper grade and screened bole chips	Bole chips and whole-tree chips	Whole-tree chips and hog fuel
Average efficiency	70%	80%	75%	75%	28-40%

<u>Residential and Commercial Use</u>

Wood is widely used in residential heating in Vermont. An estimated 15% of homes use wood as a primary or secondary heat source. Wood heat has increased in popularity in schools as a replacement for fossil oil fuel, and pellet use has jumped as small commercial buildings convert to pellet boilers. Local wood use is estimated at $43.6 million staying in the local economy, replacing heating oil that would have cost $149.1 million (2012, BERC).

Replacing home heating of natural gas systems with wood systems would improve our renewable energy portfolio, but cost and emissions would not be improved (given current prices and heating equipment efficiency). But there remain about half of Vermont homes that still heat with oil. This amounts to about 89,000,000 gallons of heating oil annually, or 142 gallons per person each year. Substituting wood for oil in an advanced wood heating system would save homeowner's money, invest in local wood markets, reduce fossil fuel use, and improve net GHG emissions.

NOTE: The data in this section will be revised upon completion of a new fuel survey undertaken during the summer of 2015. 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.[277] Combining cordwood with the 40,000 green tons needed to make pellets for residential heating required about 825,000 tons of wood. All in-state uses of wood for fuel in 2013 totaled 1.7 million tons.[278] According to the Energy Information Administration (EIA), residential wood consumption gradually declined after 1979 but picked up again in 2005 and surged as fuel prices shot up after the Great

[277] *Vermont Residential Fuel Assessment for the 2007-2008 Heating Season (hereafter, VRFA), Paul Frederick, Vermont Department of Forests, Parks, and Recreation, August 2011, Pg. 2;* ***NOTE: The data in this section will be updated for the final report with the results of a new survey conducted in the summer of 2015.***

[278] *Agency of Natural Resources (Frederick)*

Recession in 2009.[279] (Exhibit 13-22.) 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.

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.[280] Wood pellet stoves are increasingly popular because of their cleaner emissions, higher efficiencies, and greater ease of operation – including the advantage of operating on thermostats, much like oil, gas, and propane systems.[281] Sales of pellet-burning appliances nationwide grew from 18,360 in 1999 to 141,208 in 2008. Sales in 2011 stood at 62,451.[282] 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.[283] 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.

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[279] *EIA State Energy Data System, 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.*

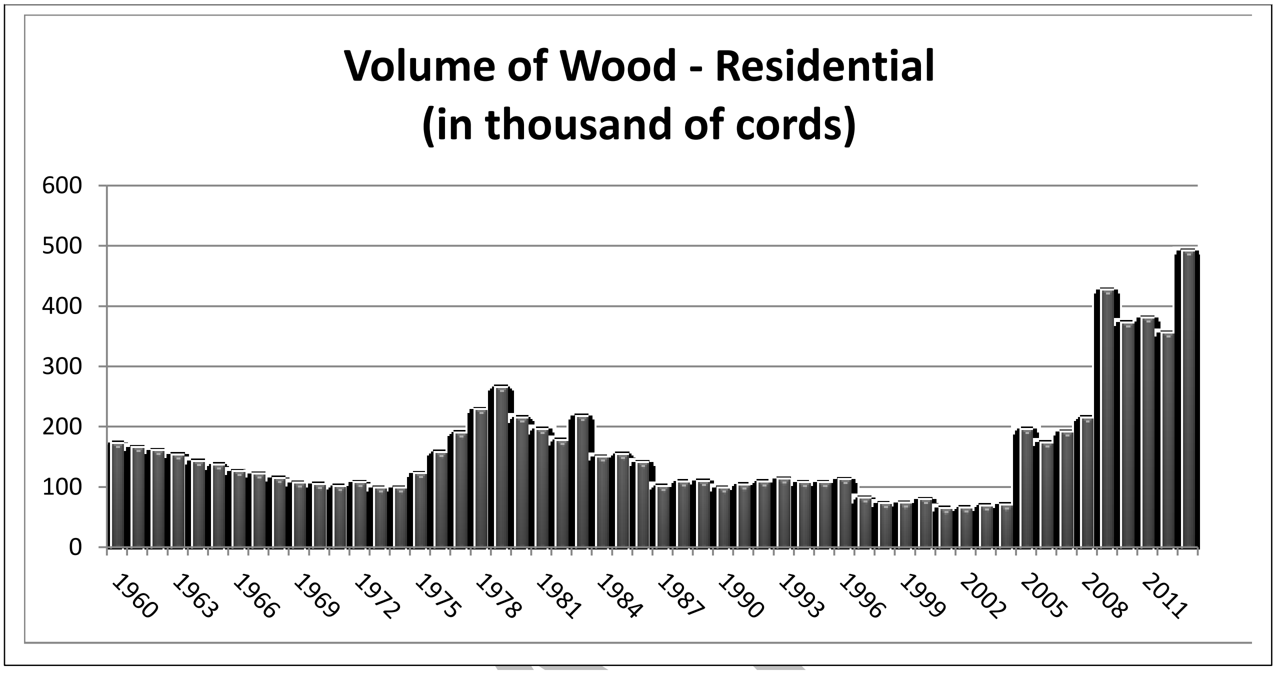
[280] *VRFA, p. 2*

[281] *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.*

[282] *Hearth Industry Unit Shipments 1998-2011, Pellet Fuels Institute, http://www.pelletheat.org/assets/docs/industry-data/2011-us-hearth-shipments.pdf; Accessed August 24, 2015*

[283] *VRFA, p. 10.*

Exhibit 13-22. Residential Wood Energy Consumption, Vermont, 1960-2013, by Volume of Wood



Source: EIA

At $294 per ton of wood pellets, the cost to heat with a pellet stove in July 2015 was $22.41 per MMBtu (million British thermal units) less than that of every other fuel except cordwood and natural gas. Cordwood cost $17.21/MMBtu, while fuel oil cost $23.82/MMBtu and natural gas, $17.91/MMBtu.284 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.

<u>District Heating</u>

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 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.

District Heat Montpelier is a joint project of the City of Montpelier and the State of Vermont to provide local renewable energy to downtown Montpelier. With the rebuilding of the state's existing central heating plant in 2013 and 2014, modern wood-fired boilers heat the Capitol Complex and 21 buildings in downtown Montpelier including City and School buildings as well as private customers. The benefits of District Heat include:

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[284] *Vermont Fuel Price Report, July 2015;* *http://publicservice.vermont.gov/sites/DPS/files/July%202015%20Fuel%20Price%20Report.pdf;*

- Reduced health threatening air emissions from fuel combustion in downtown Montpelier by as much as 11 tons per year.
- Displacement of approximately 300,000 gallons of oil per year between the state and downtown buildings as a prime fuel source with locally/regionally produced wood chips keeping that economic activity in the northeast.
- Fuel cost stabilization for city government and the school department allowing tax dollars to potentially be redirected toward services or infrastructure rather than to pay rising oil prices.
- An economic development opportunity in downtown Montpelier by providing a cleaner and potentially cheaper source of heat for private building owners.
- The removal of many private oil furnaces and underground fuel oil storage tanks to be removed from potential flood areas.
- The two schools alone had consumed about 80,000 gallons of fuel each year, for an average cost of $212,388 per year.

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 cordwood, wood chips, and 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 below. 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 EVT be authorized to offer incentives for installation of woody biomass heating systems in a manner that promotes deployment of such systems. These incentives as well as additional incentives from the Vermont Small Scale Renewable Energy Program for biomass equipment are helping to drive increased use of biomass 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.

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.

<u>Electric</u>

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.[285] The plant burned nearly 500,000 tons of wood fuel in 2013.[286] 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. In April 2014, a second feasibility study was completed by Ever-Green Energy of St. Paul, MN, focused specifically on using the heat bi-product from McNeil to meet the thermal energy needs of the collaborators at the Fletcher Allen Hospital (now University Medical Center), and buildings on the University of Vermont campus.[287]

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. In 2011, 193,000 green tons of biomass chips were exported to surrounding states while 479,000 green tons were reported to have been imported into the state.[288] 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 44,000 tons of wood per year.[289]

Wood fuel has evolved from being essentially a waste product to being a commodity whose price is reflective of its economic value. For most of the period from 1984-present, the wood-fueled power plants relied on a blend of wood processing residues, wood from forest harvesting, and wood residues from

[285] *BED 2008 Integrated Resource Plan*

[286] *Vermont Department of Environmental Conservation, Air Quality Division*

[287] *See Ever-Green Energy: http://www.ever-greenenergy.com/projects/burlington-vt/ and https://ever-greenenergy.sharefile.com/d/s23dfa3b4a06425b8*

[288] *Economic Importance of Vermont's Forest Based Economy 2013 NEFA*

[289] *Estimated Wood Fuel Usage in State of Vermont, Agency of Natural Resources, 2013*

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 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, when compared to other uses, is low. 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.

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, NH, are operating in the region, meaning that the practical outcome will be increased competition for fuel grade wood in our region.[290] Region facilities using low-grade wood are within driving distance for Vermont wood sourcing, especially the New Hampshire facilities. Exhibit 13-23 shows the wood-fired power plants (blue) and pellet facilities (yellow) adjacent to Vermont.

Exhibit 13-23. Wood Production and Power Facilities in New England

Source: Dept. of Forests Parks and Recreation

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 in 2011, two proposed woody biomass electric production facilities in Vermont that would each yield approximately 30 MW of electricity and use a portion of the thermal energy generated for other purposes were under consideration. Neither the North Springfield nor the Fairhaven project received a permit, although the latter remains on hold and has not been cancelled.

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

Details of the PSB Order on the North Springfield project illustrate concerns regarding the evaluation of potential impacts on forest health:

> *Absent a harvesting plan that is sufficient to protect long-term forest health and sustainability, the Project would have an undue adverse impact on Vermont's forest resources.*
>
> *Impacted forest components will vary from harvest site to harvest site. Therefore, the best approach for avoiding undue adverse effects from harvesting is to identify critical natural resource concerns and the harvesting standards needed to safeguard them based on the current understanding of forest science.*
>
> *To support this approach, the following forest components should be accounted for in harvesting operations:*
>
> - *Protection of species and areas of special concern, including necessary wildlife habitat, including deer yards, wetlands, vernal pools, bear mast areas, Rare, Threatened and Endangered species ("RTE"), and S1, S2 and S3 natural communities.*
> - *Support for wildlife habitat and biodiversity through retention of snags, and down woody material.*
> - *Renewal of soil health through retention of down woody material and limited soil disturbance.*
> - *Adherence to laws and rules including Acceptable Management Practices and Heavy Cut.*
> - *Management for non-native invasive plants to prevent transport and spread.*
> - *Adherence to forest insect and disease quarantines and policies.*
> - *Promotion of adequate regeneration and healthy residual stands.*
> - *Preparation of forests for climate change adaptation (build resilience).*
>
> *All harvesting should follow written silvicultural prescriptions based upon accepted silvicultural practices reflecting stand conditions, landowner objectives, and referencing appropriate silvicultural literature and guides."*[291]

Furthermore, the concluding finding from the PSB in rejecting the permit for the North Springfield facility stated "that the Project would not promote the general good of the State of Vermont, with consideration given to the Project's expected annual GHG emissions and the low level of thermal efficiency at which the Project would operate".

Combined Heat and Power (CHP)

One of the challenges facing all biomass power is facility siting. Siting challenges include the limited number of properties suitable for industrial development, coupled with infrastructure limitations related to transportation, public systems (e.g. water, sewer), and combined heat and power distribution.

[291] *Public Service Board Order for Docket 7833, entered: 2/11/2014, http://psb.vermont.gov/sites/psb/files/orders/2014/2014-02/7833%20Final%20Order.pdf*

Locating a host facility that has the ability to use the magnitude of excess heat produced on a continuous basis is a major challenge. People generally do not want power plant-sized facilities located in or near population centers, but this is exactly where such facilities must locate to use the thermal load, unless industrial processes make use of it. Retrofitting the existing electric power plants, McNeil and Ryegate, has additional difficulties. The McNeil plant has the potential to add a heating loop because of its proximity to the University of Vermont campus. Ryegate, on the other hand, has no such potential host within a feasible distance, although it has the capability to heat about 1,300 homes.

Particulate matter from biomass combustion usually 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. However, these control technologies must be considered because of the need to site CHP facilities near population centers. Without such emissions control measures, particulate matter emissions may lead to an increase in respiratory and cardiovascular conditions in areas near facilities.

The Standard Offer Program currently requires biomass plants to meet an efficiency level of 50% to be eligible. With an electric-only plant's efficiency less than 30%, the only way to meet the requirement is with a CHP plant, which was the intent of the eligibility requirement. The efficiency requirement needs to include a mechanism to incentivize CHP plants that might initially be less than 50% efficient, but that will increase their efficiency over time.

Given Vermont's limited state incentives and financial resources, they should flow first to the most efficient projects that displace the most fossil fuel for the investment: thermal-led energy facilities including district heating, and CHP projects. It should be noted that financial 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.

13.3.6.2 Other Biomass Energy Production

Solid biomass also includes rapid growing plants such as willow and densified grass products, both of which are burned for thermal energy. Middlebury College investigated the use of short-rotation willow plantations as fuel for their wood energy facility. The first harvest was poorly stored, and too wet to burn properly, with insufficient volume to obtain correct combustion settings on the boiler. The test plots continue to yield good data. Middlebury has harvested its seven-acre plot a second time, and is using some of the willow as a product (ski gates for the slalom course) and as planting stock for stream-bank restoration.[292] Meach Cove Farm has been burning switchgrass pucks in a boiler designed for high-ash fuels for most of the 2014-2015 heating season, and results show normal efficiencies and combustion characteristics.

<u>Market Development Status and Strategies for Grass and Willow Energy</u>

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[292] *Middlebury Willow Site Yields More than Research Data, Middlebury College, http://www.middlebury.edu/sustainability/news-events/news/2014/node/475222; Accessed August 25, 2015*

Yields of Grass in Field Trials – As a result of the efforts of the University of Vermont Extension's field trials, in collaboration with Vermont Sustainable Jobs Funds' Bioenergy Initiative, yields of switchgrass (Panicum virgatum) and several other grasses are well-established, at between three and five tons per acre. For example, in trials at three sites, using five varieties of switchgrass, yields after three years ranged from 2.5 to 6.5 tons per acre with an average of 4.4 tons per acre.[293] These yields are aligned with yields in places with similar climate and soil conditions, such as the states of New York and Pennsylvania, and the Province of Ontario.

A blend of grasses (a "polyculture") yielded more than four tons per acre at all sites, and would be resilient in the face of changing rainfall and other weather conditions. Yields of miscanthus (Miscanthus gigantean), a non-invasive, infertile clone, can be seven tons per acre, and it seems to do well in some of Vermont's wetter, heavier soils.

Yields of Willow in Field Trials – Trials at Middlebury College over the six years since planting with two harvests have shown a yield of four tons per acre per year.[294] The trial encompasses seven acres.

Utilization of Grass – A niche in how to handle grass has emerged for its use in boilers from 100,000 – 500,000 Btu per hour, namely to compress the grass into rounds, having 2.5-inch diameter. Using grass in this scale of boiler, now manufactured in the US, makes sense because the boiler is large enough to justify incorporating advanced combustion to burn a low-cost, high-ash fuel, and too small to justify the cost of a wood-chip system with traveling auger to handle the chips.

Utilization of Willow – Ideally, willow plantations are coppiced every three years, and harvested with equipment similar to forage harvesting equipment. Work over the last five years at the State University of New York, College of Environmental Science and Forestry with the farm implement manufacturer Case New Holland has yielded a viable harvester. It is based on existing technology for an animal-forage harvester, and can harvest approximately 75 tons per hour. Starting with stems as thick as 4.75", it yields chips 0.4" to 1.75" long, harvesting approximately five acres per hour.[295]

Regardless of the method to harvest chips, they will burn properly only if kept somewhat dry and not mixed with snow and ice during the harvesting process.

The CEP recognizes the potential for the greater use of biomass material other than solid wood. These sources have begun to prove themselves in terms of expected agronomic yields in Vermont conditions, and the pathways to utilization have become clearer, as well. As a way to diversify fuel supply and stabilize farm income, both grass and willow could contribute to thermal production in Vermont in the

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[293] *Evaluation of Warm Season Grasses for Biomass Potential in Vermont, 2009 – 2012, UVM Extension (2013); http://pss.uvm.edu/vtcrops/articles/EnergyCrops/Vermont_WSG_Biomass_Report4.2013revised.pdf*

[294] *Yield of 30 Shrub Willow Cultivars Over Two Rotations In a Yield Trial At Middlebury Vermont, Shun Shi et. al., (2014)*

[295] *Evaluation of a single-pass, cut-and-chip harvest system on commercial-scale short-rotation shrub willow plantations, Eisenbeis, et. al., BioEnergy Research, Volume 7 Issue 4. December, 2014.*

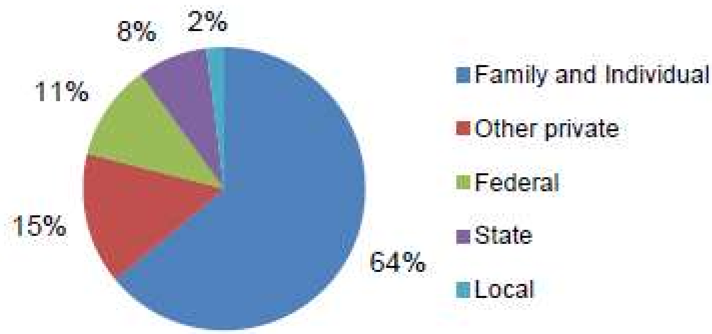
next five to seven years. Some technical hurdles remain, and continue to be addressed. As with wood fuel, utilization rates depend on the strength of the relevant economic sector (agriculture rather than forestry, in this case) and on the price of fossil fuels. Unlike wood fuels, which are already available, switchgrass and willow plantings take three years to mature (although often a harvest in the second year is worthwhile). The state will coordinate its overall strategy to include these sources and associated technologies, and will evaluate their potential for Vermont as they develop.

13.3.6.3 Forest Resource Characterization

We depend on forests for their material and economic contributions of timber, veneer, pulpwood, firewood, chips and pellets, (for both space heating and electric generation), and maple syrup, as well as the values and services forests provide, such as water supply and water quality protection, flood control and protection, wildlife habitat and biodiversity, clean air and carbon sequestration, outdoor recreation and scenic beauty. It is in this context that we consider expanding forest use as a renewable energy source.

Forests dominate Vermont's landscape. Currently 75% of Vermont is forested by a mix of species, ages, and forest types. The majority of Vermont's forestland is held by private landowners (80%). Approximately 2.9 million acres, 62%, of forestland is owned by families and individuals (Butler et al 2015). Corporate-owned forests encompass 681,000 acres, and other private forests encompass only 133,000 acres. Unlike other northeastern states with large corporate ownerships, a relatively small percentage of Vermont's forest is owned by businesses, including timberland investment management organizations (TIMOs) and Real Estate Investment Trusts (REITs). A relatively small proportion of Vermont's forest is public land (21%). The Federal Government holds 491,000 acres (11%) of forestland, most of which is administered by the Green Mountain National Forest (446,400 acres). The State of Vermont holds 368,000 acres of forestland (8%) in various state agencies including state parks and forests, and local governments hold another 73,000 acres of forestland (2%) (Exhibit 13-24).

Exhibit 13-24. Ownership of Forests in Vermont[296]



Forest health is of utmost importance in any discussion of forest use. Healthy forests are highly resilient and capable of self-renewal. They maintain forest processes and are structurally complex, ecologically productive, and composed of diverse native plants and animals. Although it is unrealistic to revert to pre-settlement forest conditions, striving toward healthy forests can be compared to creating and maintaining the characteristics of relatively undisturbed forests of the region. Healthy forests support and maintain biological communities (species assemblages), support physical elements of the ecosystem (soils, air, water), and support ecological processes (nutrient cycling).

Vermont's forests provide crucial habitat for healthy and sustainable populations of native plants and animals. In Vermont we have between 24,000 and 43,000 species (of which 653 are rare), and nearly 100 natural community types. A large proportion of these species and communities are associated with forested conditions.

Healthy forests play a vital role in absorbing water and moderating its movement across the landscape. Although forests cannot prevent large floods outright, they do temper their frequency, intensity, and extent, which in turn significantly reduce loss of life and property damage stemming from serious flooding. Forests intercept rain, meltwater and runoff and prevent impurities from entering our streams, lakes and ground water. Forests are able to have this effect on water in part by: slowing it down, spreading it out, and allowing it to sink into the soil. As forests slow the water down and spread it out, forests limit erosion and the ability of water to transport sediment, nutrients and pollutants that can cause problems for water treatment plants, recreation or functional wildlife habitat. Absorbed water permeates soil and is filtered before reaching surface waters. Tree canopies shade streams maintaining cool temperatures necessary for many aquatic species and for keeping algae in check.

Tree leaves serve as sponges for many air pollutants removing them from circulation where they do harm to humans. Forests provide Vermonters with enormous benefits and a range of critical services. A

[296] *Forests of Vermont and New Hampshire 2012, Morin, R.S. et al, Resource Bulletin NRS-95, USDA Forest Service, Northern Research Station, July 2015, www.fs.fed.us/nrs/pubs/rb/rb_nrs95.pdf*

thriving forest economy, functioning natural systems, and Vermont's quality of life rely on maintaining blocks of contiguous forests across Vermont's landscape. There is much at stake in maintaining healthy forests, but careful planning can allow for harvesting that is compatible with forest health goals.

Prices

Forests are a significant part of Vermont's economy. The harvest and manufacturing of forest products contributes $1.4 billion in annual economic output to Vermont's economy[297]. Pellet fuels and cordwood continue to be a substantial part of this overall output. Over the past decade, markets have experienced significant volatility in fuel prices (Exhibit 13-25). Concerns regarding $100 per barrel have faded as oil has traded under $40 recently. Prices for cord wood remain less expensive for consumers when comparing cost per unit energy but recent decreases in fuel oil have reduced the price advantage for pellets (Exhibit 13-26).

Exhibit 13-25. Fuel Price Volatility (2008-2015)

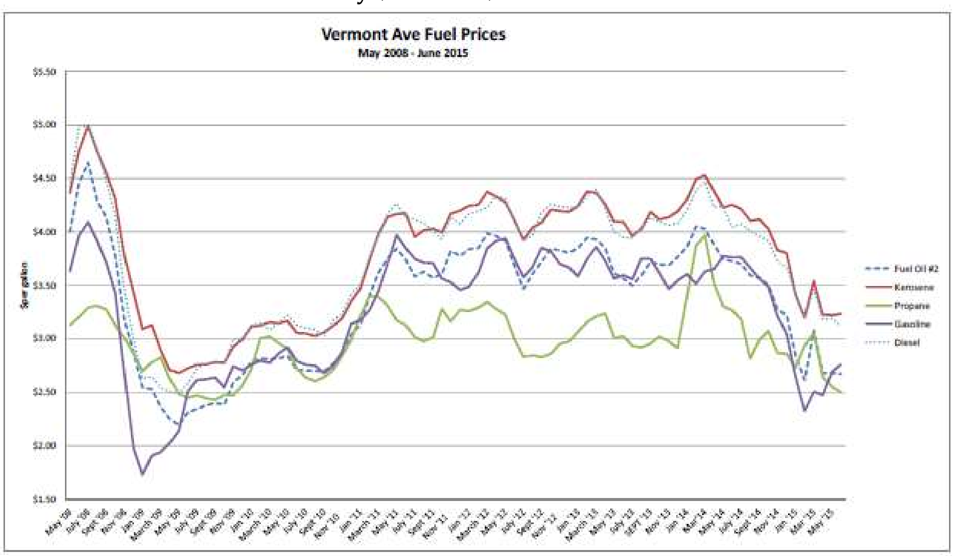


Exhibit 13-26. Fuel Price Comparison (August 2015)

Comparing the Cost of Heating Fuels

Type of Energy	BTU/unit	Typ Effic	$/unit	$/MMBtu	High Efficiency	$/MMBtu
Fuel Oil, gallon	138,200	80%	$2.45	$22.12	95%	$18.63
Kerosene, gallon	136,600	80%	$3.01	$27.55		
Propane, gallon	91,600	80%	$2.30	$31.42	93%	$27.03
Natural Gas, therm	100,000	80%	$1.43	$17.91 *	95%	$15.08
Electricity, kWh (resistive heat)	3,412	100%	$0.15	$43.46		
Electricity, kWh (cold climate heat pump)	3,412		$0.15		240%	$18.32
Wood, cord (green)	22,000,000	60%	$ 227.14	$17.21 *		
Pellets, ton	16,400,000	80%	$294.00	$22.41 *		

* The natural gas price is based on the rate effective 5/6/15. *Wood green and Pellets updated 9/19/14.

Projections for Wood Supply

Wood availability as a fuel source for thermal and electric energy hinges on continued forest growth, regeneration success as a foundation for future forests, and competitive market price that can support landowners maintaining working forest land.

One measure of wood supply is the estimate of forest growth compared with harvest. In an unregulated market the supply can be variable, but currently net annual growth exceeds harvest on a statewide basis by nearly a 2:1 ratio. Local availability of wood does vary around the state depending on acres of forest land, tree species, forest age and maturity, local wood markets, and other factors.

Current inventories show that Vermont's forests add 2.4 million cords of timber growth per year whereas about 1.4 million cords is harvested. For context, Vermont's standing forest holds 80 million cords of timber (including trees 5 inches or greater in diameter). While the supply is substantial, not all this wood is available for use as energy wood.

Landowner Economics

The annual carrying cost of land is a significant factor in whether private forestland can be owned, managed, and maintained in large blocks into the future. Unlike the annual return from an agricultural operation, working forest land is typically managed on longer rotations where income generating harvests are spread out over years and often decades. If economic pressures befall forest landowners, they may have limited options to generate income and may turn to subdivision and parcelization of portions of their land.

One key economic variable for land owners is property tax. Vermont's Use Value Appraisal ("Current Use") program is intended to stabilize property tax rates and assess working lands at their value for either agricultural or forestry use. This program has been instrumental in keeping annual property taxes affordable and allowing forestland owners to hold and steward parcels of 25 acres or larger. Maintaining and strengthening the Current Use program is a key strategy to support forest integrity.

13.3.6.4 Pressures on Wood Supply

Fragmentation – The most recent FIA figures from 2013 show a continuing, though gradual, loss of about 75,000 acres of forestland since 2007. It is clear from the FIA data that our forestland is no longer expanding and in the long term is vulnerable to land-use conversion and fragmentation as slow but steady development growth resumes.

As forest fragments become ever smaller, practicing forestry in them becomes operationally impractical, economically nonviable, and culturally unacceptable. In turn, we lose the corresponding and important contributions that forestry makes to our economy and culture. The result is a rapid acceleration of further fragmentation and then permanent loss.

Forest health, sustainability, management opportunities, and the ability of forestland to provide needed products and ecosystem services and suitable habitat are affected to varying degrees, and in different ways, by changes in the fragmentation of forests and urbanization.

Climate Change – Despite the wealth of this state's forest resources, there are indications of a future that may look quite different from today. Climate change presents a major challenge to the ecological and economic viability of forests. Although there is uncertainty about the timing and magnitude of forest impacts, it is certain that forest changes have been occurring and will continue. The capacity of Vermont's forest species to adapt to change will depend, in part, on how carefully they are managed and conserved today[298].

Non-Native Forest Pests – Non-native forest pests have affected forests as humans have moved plant material from one region to another. Currently there are three known insect pests that could significantly affect forest health in the near-term: emerald ash borer, hemlock woolly adelgid, and Asian longhorned beetle. Wood movement has been largely responsible for pest movement between states, and several quarantines are now in place to slow the spread of these insects. In 2015 the Legislature passed a law to ban firewood movement across Vermont borders. This law will be implemented by July 2016.

Overseas Market Demand – European demand for wood pellets has emerged as a significant factor in eastern pellet markets. The European Commission's 2009 Renewable Energy Directive mandated that by 2020 the European Union (EU) fulfill at least 20% of its energy needs from renewable sources. In FY2014, the United States exported 3.8 million metric tons of wood pellets, 97% of which went to the EU. That year, the U.S. claimed a 60% share of the EU wood pellet market, up from 44% in 2013.[299] Much of this demand is coming from electric utilities that are switching from coal to meet their EU targets. There have been efforts to site a pellet facility near a deep water port for export to the EU in Maine, but no facilities are operating currently. However, given the demand from the EU nations to meet their energy targets, the Northeast is likely to see additional efforts to supply wood energy products to Europe in the future, which may in turn impact the price and availability of woody biomass products in Vermont, and the long-term health of the region's forests.

13.3.6.5 Benefits and Challenges for Increased Use of Woody Biomass

Among the reasons to increase the usage of woody biomass in the state, the following stand out:

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[298] *Creating and Maintaining Resilient Forests in Vermont: Adapting Forests to Climate Change, VT Dept. of Forests, Parks and Recreation, May 2015,* *http://fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/The_Forest_Ecosystem/Library/Climate%20change%20report_final_v6-18-15a.pdf*

[299] *Money Does Grow on Trees as U.S. Forest Product Exports Set Record, USDA Foreign Agricultural Service, April 16, 2015, http://www.fas.usda.gov/data/money-does-grow-trees-us-forest-product-exports-set-record; Accessed August 25, 2015*

- Replacing heating systems fueled with fossil fuels with advanced wood heating systems will benefit local businesses, local forest product economy, and Vermont forest landowners by keeping funds local rather than supporting overseas economies
- Increasing the use of advanced wood heating systems will generate more energy output per wood input so less wood will be required to support current or future use.
- Replacement of older wood heat technology with advanced wood heat technology will improve air quality.

Including thermal wood energy as part of the total energy mix will help the state to meet its goals for increasing local, renewable energy, and reducing the state's GHG emissions.

Expanding the use of woody biomass must overcome a variety of obstacles. Many advances have been made to improve the efficiency and reduce the emissions of residential stoves and furnaces. However, there are approximately 12 million wood stoves in homes today, and three quarters of those are older, non EPA-certified stoves that are 50% less efficient than newer stoves.[300]

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. There is a large range in emissions such as fine particulates and other air pollutants that vary considerably depending on stove age, type and operation. Wood smoke affects indoor and outdoor air quality, and is linked with health impacts such as asthma.[301] 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 propane.[302] 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.[303]

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.

Inexperience coupled with modern technology has resulted in some portion of the population that is not heating with wood using the best techniques. An educated citizenry could significantly increase the

[300] *Consumers - Energy Efficiency and Wood-Burning Stoves and Fireplaces, U.S. Environmental Protection Agency, www.epa.gov/burnwise/energyefficiency.html; Accessed August 25, 2015*

[301] *EPA, http://www.epa.gov/asthma/woodsmoke.html*

[302] *EPA, www.epa.gov/burnwise/energyefficiency.html*

[303] *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*

energy produced using the same amount of fuel wood. Statewide education activities can help improve performance of heating systems. Potential topics include: wood stove performance and the quality of the fuel wood used, planning ahead to purchase and dry wood, and use of advanced wood stove and furnace systems that further improve performance of wood.

Optimizing our renewable resources by using them appropriately and efficiently will stretch our money and our resource to reach more of our energy demands without additional fuelwood. Future decisions should optimize our resources.

Strategies and Recommendations

Strategies

(1) Encourage, promote, and incentivize converting fossil fuel heating systems to advanced wood heating systems by: encouraging local manufacturing of advanced wood heat technology, supporting development of wood delivery infrastructure, supporting development of sustainable forestry and procurement services, expanding processing facilities, encouraging bulk delivery systems, advancing installation technology, and providing training and education on the benefits of heating with efficient, clean wood energy systems.

(2) Support programs that strengthen Vermont forest product economy, keeping forest land economically viable and maintaining working forest land (e.g. UVA).

(3) Retain the two Vermont power plants fueled with wood as a valuable part of the forest products economy and our state energy mix, and work to upgrade efficiency as technology becomes available.

(4) Diversify solid biomass options by continuing to support agriculture-based biomass (e.g., native and perennial grasses and short-rotation willow). Assess potential for grass and willow cultivation in coordination with regional planning agencies, conservation advocates, and farmers.

Short-Term Recommendations

(1) Conduct an intensive, statewide education campaign to provide best practices on wood burning to promote the most efficient, clean, and cost-effective use of technology.

(2) Maintain forest health as a prerequisite to a sustainable wood energy fuel supply, while ensuring continuation of other forest-derived products, values and benefits. Actions include:

- *Update the Vermont wood supply analysis, and support development of a predictive model for forest growth and yield that more accurately assesses future wood supply.*
- *Maintain monitoring efforts by ANR that include trends in forest growth and regeneration, forest harvest levels, tree health (including abiotic and biotic threats to tree health), water quality, forest carbon stocks, wildlife habitat quality and other ecosystem measures that are essential to understand*

trends and provide assistance to forest landowners in maintaining forest health and a sustainable wood supply.

- *Promote the use of the 2015 Voluntary Harvesting Guidelines to inform best management practices.*
- *Implement education programs for natural resource professionals and develop strategies that promote high-quality forestry practices, such as the proposed forester licensing, to further protect forest health.*
- *Implement new out-of-state firewood movement law to discourage transport of untreated firewood into Vermont that may inadvertently transport destructive forest pests. Wood chips will still be accepted from adjacent states when accompanied by compliance agreement.*

(3) Promote the expanded use of advanced wood heating using equipment that has high efficiency and low emissions. This includes offering wood stove change out programs, such as that offered by the ANR Air Quality and Climate Division. This also includes offering change out programs to substitute fossil fueled heating equipment with advanced wood heating equipment to reduce net carbon emissions, promote local wood fuel sources, and expand use of this renewable resource.

(4) New electric generation from wood should include combined heat and power technology to maximize efficiency. A priority should be placed on the expansion of wood in the thermal energy market, where efficiency can be as high as 80-90%.

(5) Harvest and continue to gather data on Vermont's existing field trials of grasses and willow.

(6) Support combustion trials of grasses in boilers in the 100,000-500,000 Btu/hr range.

<u>Long-Term Recommendation</u>

(1) In order to double wood's share of building heating by 2035, improve local infrastructure and technology to support continued expansion of clean and efficient advanced wood energy systems in Vermont:

a. Develop a comprehensive action plan over the next few years to serve as a roadmap for expanding the use of advanced wood heat in Vermont, including strategies to increase the number of buildings heating with wood fuels, promotion of locally sourced wood, expansion of "best in class" advanced wood heating equipment that is clean, efficient, and cost effective, expanding weatherization of buildings to keep heat in, replacement of fossil heating fuels, ensuring continuation of other forest-derived products, and strategies to maintain forest health and forest values and benefits beyond wood use for thermal energy.

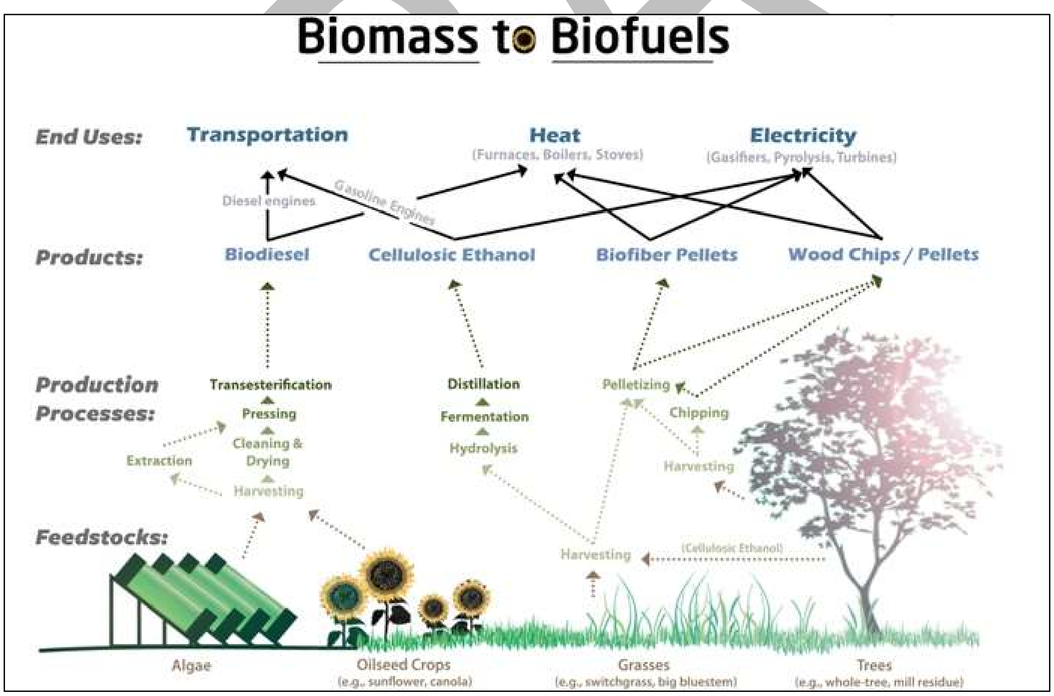
13.4 Liquid Biofuels

13.4.1 Overview

Biofuel is fuel produced directly or indirectly from organic material. Often referred to as secondary biofuels because they must be processed before use, liquid biofuels include starch and cellulosic ethanol, and biodiesel. Liquid biofuels are particularly useful because, unlike woody biomass, they can be used in transportation applications and in existing heating infrastructure. If sustainably produced, biofuels can displace fossil fuels, support local economies and job growth, lead to lower GHG emissions and better air quality. In addition to reducing our dependence on foreign oil, greater utilization of liquid biofuels can help Vermonters reduce air and groundwater pollution by lowering the amount of petroleum pollution released into the environment. Vermont has potential for producing biofuels, especially biodiesel which can support the economy and keep energy spending in-state.

There are many types of liquid biofuels created from varying feedstocks. The characteristics of these fuels vary greatly – from how sustainable they are, to the commercially available supply, to the price and appropriate applications. Recommendations for each type of liquid biofuel will vary depending on these characteristics. In general, Vermont should strive to convert from fossil fuels to biofuels while concurrently working to make biofuels more sustainable and affordable. Vermont should also work to stimulate a local, sustainable biofuel production economy.

Exhibit 13-27. Biomass and Biofuels Usage



Source: Vermont Sustainable Jobs Fund

Biodiesel is an oil-based diesel substitute derived from oilseed crops, waste oil, or algae. Biodiesel is easy to use, biodegradable, nontoxic, and sulfur free. Biodiesel in the U.S. is produced primarily from soybean oil although corn oil, canola oil, palm oil, and animal fats are also used.

Biodiesel can be blended with diesel up to 5% to form B5 and safely used "on-road" in diesel engines. Diesel is used in some light-duty vehicles, but primarily it is used in heavy-duty and medium-duty applications. Blends greater than B5 void some equipment and vehicle warranties. Few renewable fuels exist that are suitable for medium and heavy-duty transportation applications, so commercially available biodiesel blends represents progress in this area. In "off-road" applications, many Vermonters use pure biodiesel, B100, to power farm equipment or other small diesel engines.

Biodiesel can also be blended with no. 2 home heating oil up to 20% to form B20, and safely burned in existing furnaces and boilers. Blends of biodiesel and home heating oil are sometimes referred to as Bioheat, an industry trademarked term that usually applies to blends of 2-5% biodiesel, 98-95% petroleum-based home heating oil. Higher blends are available and blends of up to B20 (20% biodiesel, 80% petroleum-based home heating oil) are approved for use in existing equipment.

Ethanol is ethyl alcohol which can be blended with gasoline and used in internal combustion engines. It is derived from the fermentation of agricultural products including corn, sugar, or grains to form starch ethanol or from the fermentation of agricultural wastes, grasses, or wood to produce cellulosic ethanol. Ethanol can be blended up to 10% with gasoline to form E10 and used in any engine that takes regular gasoline. In blends greater than 10%, specialized adaptations (or flex fuel vehicles) are necessary because ethanol corrodes rubber fuel system parts. Ethanol is suitable for use in light-duty transportation applications. Ethanol also reduces the ozone-forming emissions of internal combustion engines, so E10 is required in many urban areas that do not meet federal air emissions guidelines. Vermont is in compliance with federal law, so oxygenated fuel is not required here although most gasoline sold in the state is E10.

Both biodiesel and ethanol emit fewer GHGs than gasoline, fossil diesel, or home heating oil and all have a positive energy return on energy invested, even if by only a slim margin. The feedstocks and fuels perform differently across a variety of environmental metrics such as land use, impacts to water quality, or land conversion. The Federal Renewable Fuel Standard classifies both ethanol and biodiesel as "renewable," so for the purposes of the CEP goal of meeting 90% of Vermont's energy needs with renewable sources by 2050, liquid biofuels are considered renewable.

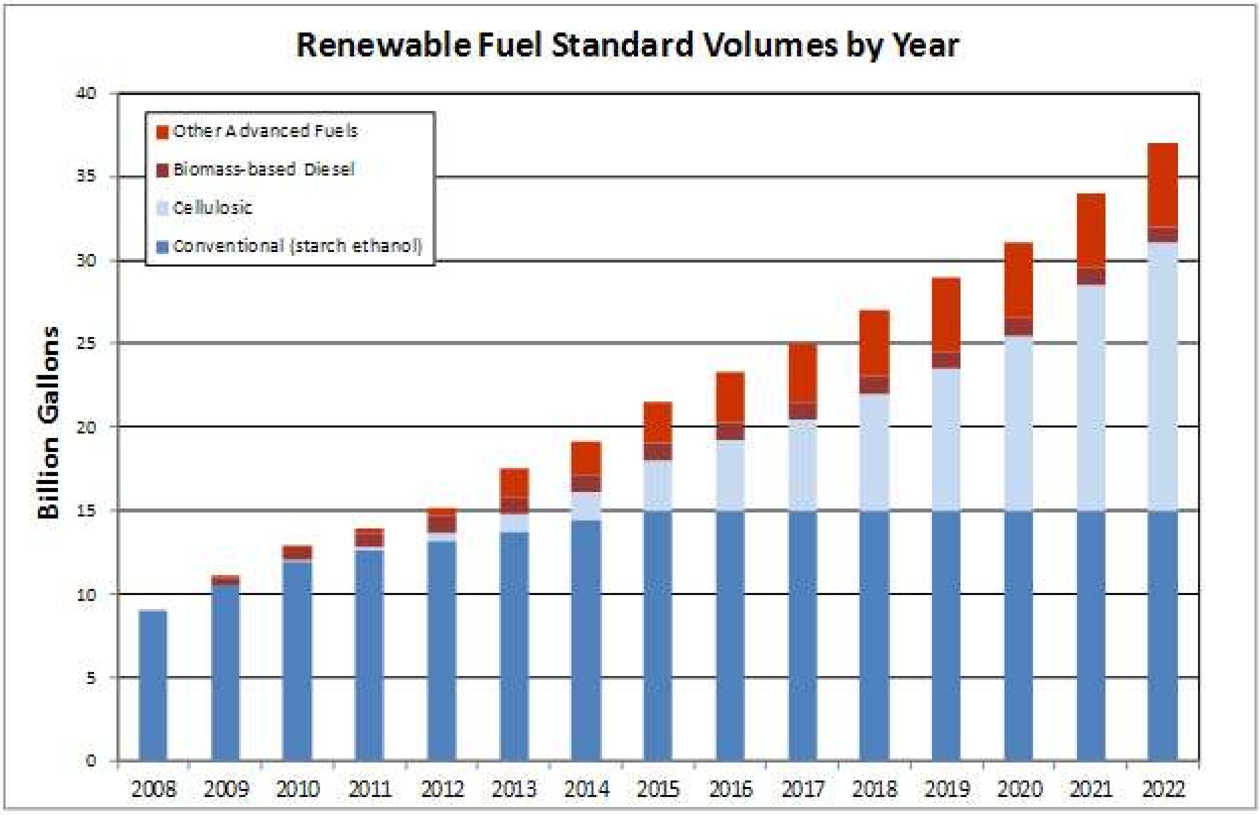
13.4.2 State of the Market

13.4.2.1 National production

Since the 2011 Comprehensive Energy Plan, the market for biofuels has transformed from a local, boutique small-scale market to a national commodity market. Driving this shift was the federal Renewable Fuel Standard. The original standard, passed in 2005, required that 7.5 billion gallons of ethanol be blended into transportation fuels by 2012. In 2007 the law was amended to include biodiesel, add different categories of biofuel, require that renewable fuels emit less GHGs than fossil fuels, and require that 36 billion gallons of renewable fuels be blended into transportation fuels in the US by 2022. The law requires refineries, blenders, and importers to either blend renewable fuels into the fuel they sell or to buy Renewable Identification Numbers (RINs) from suppliers who are producing and selling biofuels themselves. A federal $1 tax credit for biodiesel blending also provides a strong incentive for biodiesel production. A 2015 amendment to the credit proposed in the U.S. Senate Finance Committee would change the blenders credit to a producers credit and extend the credit for an additional two years. This change may affect Vermont blenders. This tax credit has been a source of uncertainty for biodiesel producers, going through frequent rounds of expiration and renewal. A stable, long-term federal tax credit would provide greater certainty to producers and be more effective at drawing producers into the market.

The national, annually increasing requirements in the Renewable Fuel Standard have stimulated investment in supply and delivery infrastructure for biofuels including ethanol, usually derived from corn, and biodiesel, usually derived from oilseed crops. In the US 95% of gasoline is already an E10 blend, meaning the US is reaching what is called the “blend wall” or the maximum amount of ethanol that can be added to gasoline without significant changes to the light-duty fleet. Future growth in the Renewable Fuel Standard targets cellulosic ethanol, biodiesel, and other advanced fuels including fuel derived from algae. If the Renewable Fuel Standard remains in effect, a robust national market will develop for biodiesel and cellulosic ethanol by 2022. Vermont is well positioned to benefit from this market as the state has been actively incubating biodiesel production for over a decade. Biodiesel can now be easily obtained from most petroleum distribution hubs around the U.S. including hubs at Albany, NY, Portsmouth, NH, and Montreal, Quebec, used by Vermont wholesale and retail suppliers of petroleum products.

Exhibit 13-28. Federally Mandated Production of Renewable Fuels



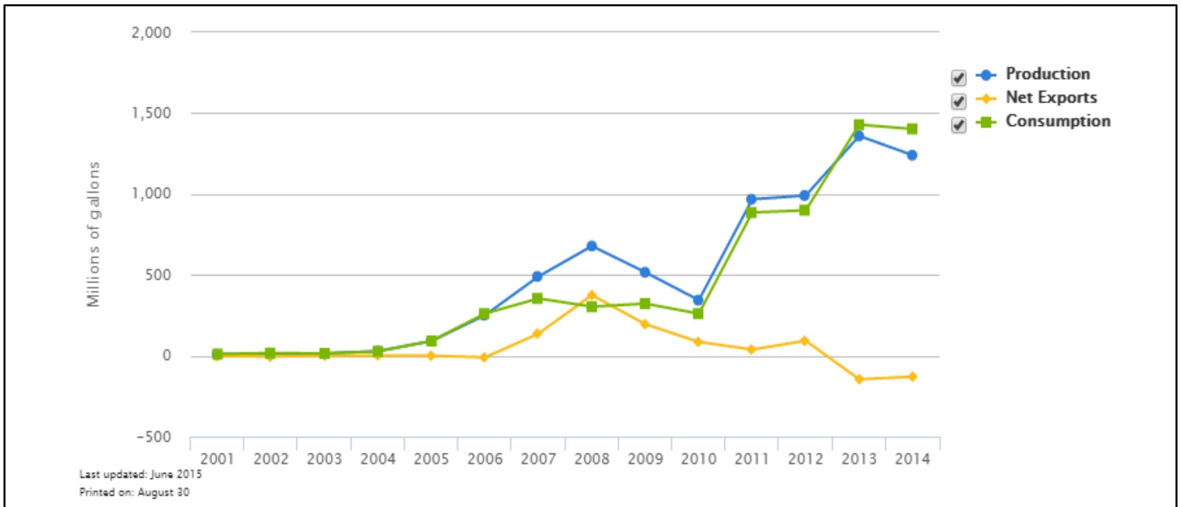
Source: EPA Alternative Fuels Data Center.[304]

Commercial sales of biodiesel greatly increased in 2005, when about 100 million gallons were produced in the United States. Production increased until 2008, when it fell slightly in response to the recession, then rebounded and rose to nearly 1.5 billion gallons in 2014. 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.[305] The Renewable Fuel Standard and the new research initiative have created a strong market for biodiesel in the US more broadly.

[304] *Last retrieved on 8/30/2015 at http://www.afdc.energy.gov/laws/RFS.*

[305] *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 13-29. U.S. Biodiesel Production, Exports, and Consumption



Source: Alternative Fuels Data Center.[306]

13.4.2.2 Production in Vermont

The economics of liquid biofuel production in Vermont have been deeply influenced by the recent price drop for petroleum products. The cost of diesel fuel dropped from roughly $4 per gallon in 2011 to $2.66 as of this writing. Some farmers who were previously producing biofuels have ceased production. Others continue motivated by the opportunity for fuel independence and the co-products of biofuel production. At the same time that biodiesel production has become less attractive for economic reasons, funding for inter-sectoral coordination efforts has concluded. A grant from the DOE that funded the Vermont Bioenergy Initiative concluded, so coordination efforts have moved from that initiative to the Farm To Plate Energy Cross Cutting Team.[307]

The Vermont Bioenergy Initiative resulted in significant research and capacity building among farmers in the state. There are extensive technical resources available for farmers and others interested in biofuel production at the Vermont Bioenergy Initiative website.[308] There are ongoing research and educational efforts at the University of Vermont especially in oilseed and algae to biodiesel research.[309]

[306] *Source data from the EIA Monthly Energy Review, Table 10.4. Last retrieved on 8/30/2015 from http://www.afdc.energy.gov/data/10325.*

[307] *The website for that team is http://www.vtfarmtoplate.com/network/energy*

[308] *Vermont Bioenergy Initiative. http://vermontbioenergy.com/*

[309] *Professors Darby and Dahiya at the University of Vermont both run excellent research and education programs in bioenergy. Their websites are http://www.uvm.edu/extension/cropsoil/oilseeds and http://www.uvm.edu/~adahiya/*

Although the economics of biodiesel production in Vermont are less attractive due to the recent price dips in petroleum, Vermont still has the opportunity to expand the production and use of agriculturally derived biofuel products to heat homes, offices, and commercial spaces and for use in transportation and on farms. During the past 15 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. Many of these projects remain active because farmers are interested in energy independence, building capacity for a time when diesel prices may rise, or environmental sustainability.[310]

Several farms now produce their own fuel in Shaftsbury, Alburgh, Orwell, and Newbury. The sustainable production of bioenergy feedstocks and fuels is part of an integrated perspective of farm-based productivity that yields a variety of food, fiber, and fuel products for local use. Such strategies are consistent with the state's overall focus on retaining the working landscape and its commitment to small farmers.

13.4.3 Resources

According to estimates, Vermont has the potential to produce about 4 million gallons of B100 per year from in-state agriculture lands, representing an eightfold increase from the state's peak production in 2008.[311] If that number is realized, much of this fuel is likely to be used for off-road vehicles including farm and construction equipment. In order to sell biodiesel for on-road use, Vermont producers would require significant additional technical capacity to register with the EPA as a biodiesel producer meeting ASTM requirements.[312]

Vermont has a long history as an agricultural state and has the opportunity to support farms that add bioenergy crops to their rotations. Vermont's land area consists of 5.9 million acres, of which approximately 1.25 million (21%) are classified as farmland. Of the 1.25 million acres, approximately 536,052 acres of that land is in cropland of which 446,020 acres are harvested.[313] This leaves approximately 90,032 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

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[310] *Recent data about the economics of biodiesel production on farms is available in the Vermont On-Farm Oilseed Enterprises: Production Capacity and Breakeven Economics report available at http://vermontbioenergy.com/wp-content/uploads/2013/03/VT-Oilseed-Enterprises_July_2013.pdf*

[311] *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.*

[312] *On-farm Biodiesel Production in Vermont: Legal and Regulatory Overview. Institute for Energy and the Environment. Vermont Law School. 2015. Last retrieved on 9/14/2015 at http://vermontbioenergy.com/wp-content/uploads/2014/07/Legal-Regulatory-Review-of-On-farm-Biodiesel-Production_IEE_VSJF_2015.pdf*

[313] *USDA Census of Agriculture—2012 Census Publications: Vermont, http://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_State_Level/Vermont/st50_1_009_010.pdf.*

feed stocks in Vermont is possible.[314] 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.

Exhibit 13-30. 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

Source: VSJF, updated Vermont 25 x '25 Initiative data

At a hypothetical farm producing 100,000 gallons of biodiesel per year, researchers at the Bioenergy Initiative estimated that the cost of production for biodiesel in Vermont was $2.13 per gallon.[315] With diesel selling at a record low of $2.66, there is currently a slim profit margin for oilseed biodiesel production.[316] If Vermont farmers could participate in the Federal Renewable Fuels market where they could sell Renewable Identification Numbers and take advantage of a $1 per gallon blending tax credit, the economics of biodiesel production would become more attractive. Enrolling in these programs takes significant up-front investment and administrative capacity, so it may not make sense for relatively small-scale facilities. Ramping up production to meet more aggressive in-state production goals would entail bringing more acres into production, although economic incentives for farmers to do so do not currently align.

Selling oil for consumption as food produces almost three times the profit as processing it into biodiesel. There is little financial incentive for farmers to use oilseed crops to produce biodiesel for sale in the market, although many continue to produce biodiesel for on-farm use.[317]

Developing the potential of algae-based biodiesel production is another promising area for in-state production. Burlington-based GSR Solutions is researching ways to use waste water to grow oleaginous

[314] *This calculation uses Vermont 25 x '25 Initiative 2008 baseline assumptions updated with current data from the 2007 Agriculture Census and VSJF.*

[315] *Vermont On-Farm Oilseed Enterprises: Production Capacity and Breakeven Economics. Vermont Bioenergy Initiative. Netaka White and Chris Callahan. 2012. Last retrieved on 9/11/2015 at http://vermontbioenergy.com/wp-content/uploads/2013/03/VT-Oilseed-Enterprises_July_2013.pdf.*

[316] *Diesel prices from the EIA Weekly Retail Gasoline and Diesel Prices. PADD 1A. Last retrieved on 9/14/2015 at http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_r1x_w.htm.*

[317] *Vermont On-Farm Oilseed Enterprises: Production Capacity and Breakeven Economics. Vermont Bioenergy Initiative. Netaka White and Chris Callahan. 2012. Last retrieved on 9/11/2015 at http://vermontbioenergy.com/wp-content/uploads/2013/03/VT-Oilseed-Enterprises_July_2013.pdf.*

algae to produce biodiesel.[318] Algae production remains in the research stage with full commercial production a number of years away. As diesel prices have dropped, the economic incentive to continue research and production has diminished. However, it is important to continue support for research and development efforts, especially during times of low petroleum prices, because once the technology becomes scalable and economics align, algae could become an important source of renewable fuel in the future.

13.4.3.1 Potential Expanded and New Sources of Biodiesel for Thermal Uses

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. One dealer in Morrisville has installed state-of-the-art biodiesel blending equipment to offer customers a range of biodiesel and blends, with their biodiesel product coming from White Mountain Biodiesel in New Hampshire.

As demand and production increase, local fuel marketers have the capacity to expand the volume of biodiesel blends offered to Vermont customers. 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.[319] 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.[320] 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. As of this writing, these other states have not adopted similar requirements, so the law has not gone into effect in Vermont.

Bioheat is preferred to pure fossil fuel heating oil, but because it is a blend of renewable and fossil sources, it is not a wholly renewable alternative to heating oil. It should be used to supplement wood and heat pumps. Bioheat in home heating is expected to serve as a bridge fuel for individual systems until they can be replaced by clean-burning wood and electric heat pumps.

13.4.4 Benefits

Liquid biofuels, especially biodiesel, whether acquired in national commodity markets or procured from local sources, can offer a variety of benefits to Vermonters including improved environmental performance, cost savings, and renewability.

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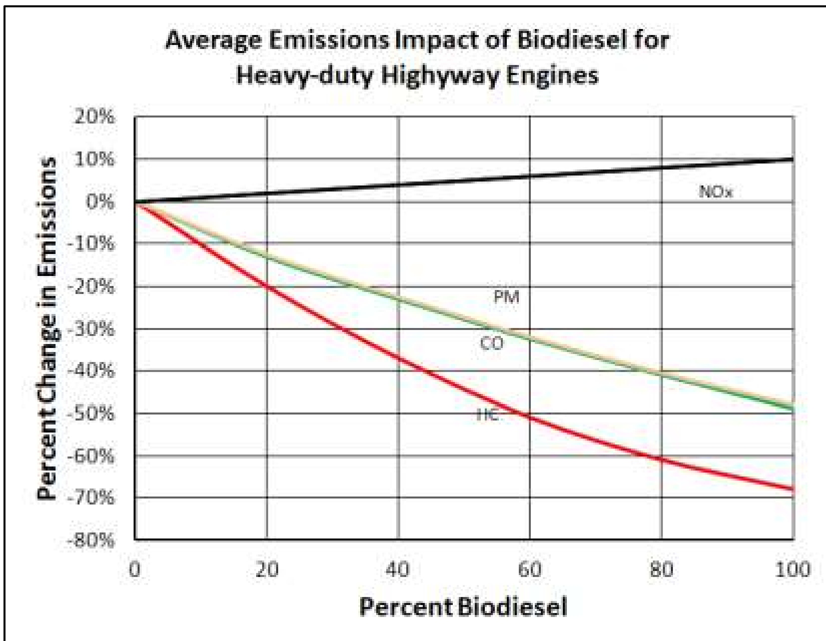
[318] *More information about biodiesel produced from algae is available at http://vermontbioenergy.com/algae/*

[319] *10 V.S.A. § 585.*

[320] *10 V.S.A. § 585.*

The reduced pollution and GHG 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 GHG emissions at the point of combustion and on a full life-cycle basis.

Exhibit 13-31. Average Emissions Impact of Biodiesel for Heavy-duty Highway Engines.

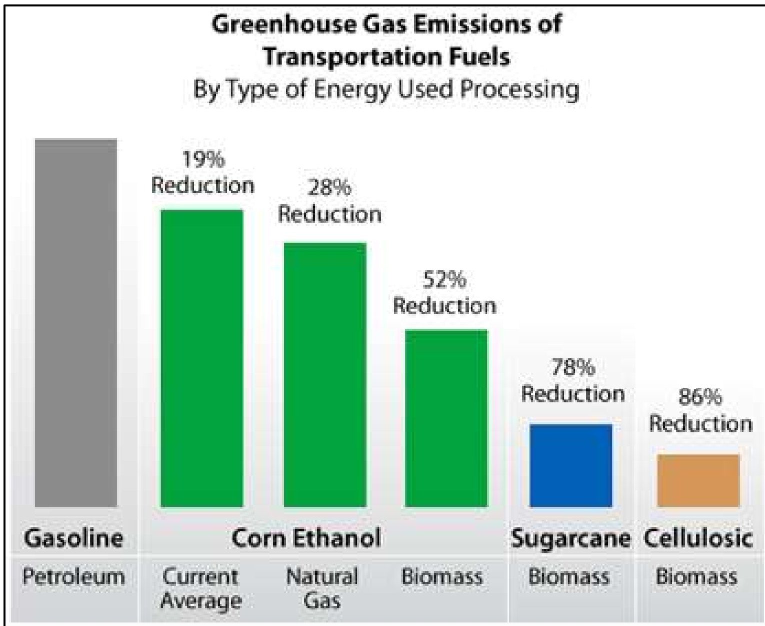


Source: US Department of Energy Alternative Fuel Data Center[321]

Ethanol, which is not generally produced in Vermont, but is sold in the state through national commodity markets, offers substantial air quality benefits, and it is a renewable fuel. It performs less well than biodiesel in other environmental metrics such as energy return on energy invested and land use/land conversion. (See exhibit 13-32 below).

[321] *Biodiesel Vehicle Emissions. U.S. Department of Energy Alternative Fuel Data Center. Last retrieved on 9/14/2015 at http://www.afdc.energy.gov/vehicles/diesels_emissions.html*

Exhibit 13-32. GHG Emissions of Ethanol Compared to Gasoline



Source: US Department of Energy Alternative Fuel Data Center.

13.4.5 Challenges

13.4.5.1 Environmental performance

Environmental performance across a variety of metrics differs for different types of biofuels. As the industry has grown, so too has criticism of broader environmental impact of the production of biofuels, especially ethanol. Life cycle analyses have shown that corn ethanol requires a large input of fossil fuel in the form of fertilizer, fuel for farm equipment, transport, and processing.

Studies show that ethanol yields between .84 and 1.65 units of energy for each unit of energy used to create it (energy return on energy invested or EROEI). That means in some cases, it takes more energy to make ethanol than the ethanol itself yields. Cellulosic ethanol performs much better on this metric with yields as high as 6.61 units of energy delivered for each unit of energy used to create it.[322] Biodiesel also performs better than corn ethanol on EROEI. Biodiesel in Vermont yields between 2.6 and 5.9 units of energy for each unit required to produce it.[323]

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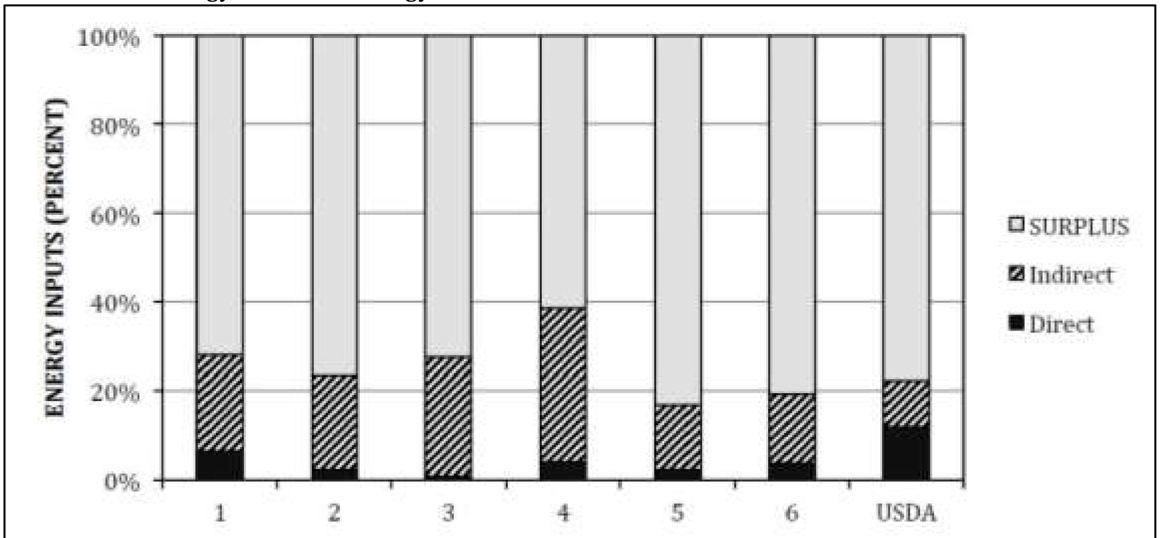
[322] *Ethanol's Energy Return on Investment: A Survey of the Literature 1990-Present. Environmental Science and Technology. 2006, 40, 1744-1750. Roel Hammerschlag.*

[323] *The Energy Return on Invested of Biodiesel in Vermont. Eric Garza. Rubenstein School of Environment and Natural Resources. 2011. Last retrieved on 8/31/2015 at* http://www.vsjf.org/assets/files/VBI/Oilseeds/VSJF_EROI_Report_Final.pdf.

Exhibit 13-33. Energy Return on Energy Invested for Six Biodiesel Facilities in Vermont



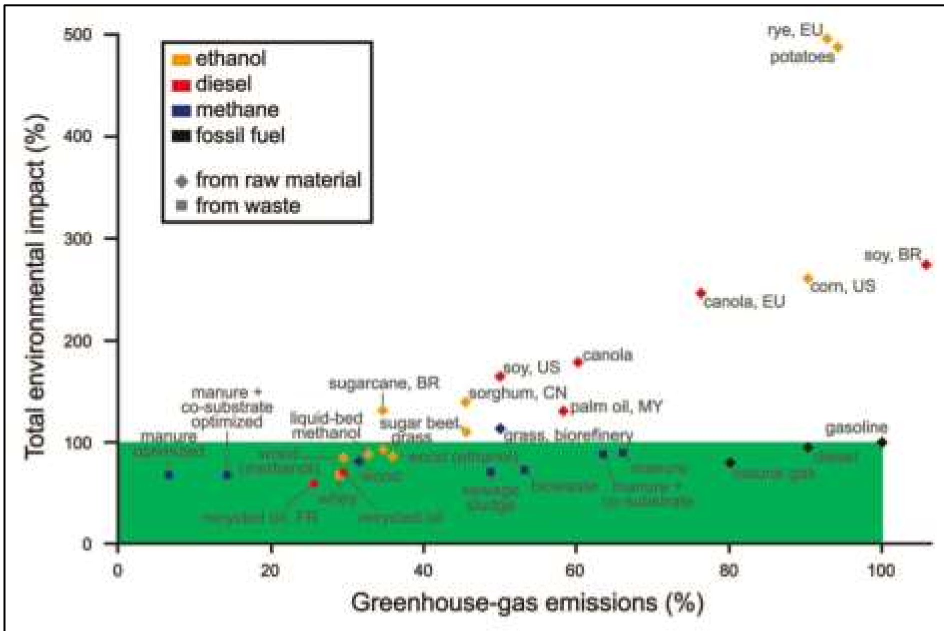
Source: The Energy Return on Invested of Biodiesel in Vermont.

Part of the public perception challenge facing biofuels, biodiesel in particular, stems from the confusion regarding the differences between ethanol production and 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. To continue to advance, biodiesel must overcome this perception.

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, 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.

Starch ethanol is also land-intensive and may displace the production of food crops or cause land conversion from wilderness areas to farmland. A study of the environmental impacts of various biofuels created a single combined metric to measure impact to ecosystems, soils, human health, and land conversion and compared that metric with the GHG emissions savings over gasoline and diesel. Results showed that many biofuels, especially advanced biofuels created from waste products, outperformed gasoline and diesel on GHG emissions as well as the other environmental indicators. Unfortunately corn ethanol, the most commonly consumed biofuel in the state of Vermont, provided only marginal GHG savings and had a significant environmental impact in other areas.[324]

Exhibit 13-34. Environmental Impact of Biofuels Compared to Gasoline and Diesel



Source: Zah et. al.

All energy choices have environmental impacts, but the impacts of biofuels can be reduced by choosing better feedstocks, growing them on marginal farmland, and sourcing locally. Vermont can work at the national and local levels to improve the sustainability of these fuels. *Sustainability* here refers to best management practices that do not exceed the long-term productive capacity of the land base, as well as protect and enhance biodiversity, soil, air, and water quality.

13.4.5.2 Availability and Clear Labeling

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 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

[324] *Ökobilanz von Energieprodukten: Ökologische Bewertung von Biotreibstoffen (Empa, St. Gallen, Switzerland, 2007). R. Zah et al. Last retrieved on 8/30/2015 at http://www.news.admin.ch/NSBSubscriber/message/attachments/8514.pdf. Please note that this study is presented in German as well as in English.*

addressed; reliable supply including "automatic" delivery; and improved on-site fuel storage and refueling infrastructure in the state.[325]

Under the Renewable Fuel Standard and the current specifications in the ASTM, wholesale dealers of diesel fuel are not required to report the blend of biodiesel they are using to retail purchasers if that blend is B5 or below.[326] Wholesalers of no. 2 heating oil are not required to report the biodiesel content of the fuel they sell as long as it is B20 or below. As a result, it is very likely that much of the diesel and heating oil sold in Vermont contains some percentage of biodiesel, but neither fuel dealers nor the state can track this data.

Equipment manufacturers, fuel dealers, and users would all benefit from knowing the exact biodiesel blend they are receiving. The problem has been discussed nationally for several years, but remains unresolved. There may be some inexpensive and feasible research methods for discovering how much biodiesel is being sold in Vermont using a combination of market pricing data and hand-held fuel analyzers. It may be worth undertaking a study to determine how much biodiesel is being sold in the state, although this would not help retailers disclose to individual customers the blend they are receiving.

13.4.5.3 Challenges to fostering local production

Small-scale biodiesel production methods are well established in Vermont, and there are many successful producers in the state although there are no commercial-scale production facilities. Because diesel prices are low, the economic incentive to produce and use biodiesel on the farm is relatively low. Some farmers produce and use their own biodiesel for other reasons including economic independence and environmental sustainability as well as an integrated agricultural approach where oilseeds are used for both biodiesel production and for seed meal which can be used to feed livestock or as fertilizer.

For local producers to ramp up production to a scale that could significantly impact Vermont's GHG emissions and market biodiesel for on-road use, they would be required to meet ASTM specification which poses a significant barrier. Registering for participation in the Renewable Fuel Standards program to receive RINs and registering as a blender to receive the $1 per gallon tax credit would improve the economics of local biodiesel production, but would require a substantial investment of time and energy that may not be feasible or desirable for many farmers.

Part of the challenge facing Vermont bioenergy developers is that the model employed in the state differs from traditional commodity-scaled systems funded elsewhere. Even when biodiesel itself is uneconomical to produce, there may be interest on the part of farmers because oilseed biodiesel production is part of a larger, integrated farm plan that includes oilseeds providing fuel, feed, food, and revenue.

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[325] *Vermont Biodiesel Supply Chain Survey, p. 7.*

[326] *Testimony from congressional hearing on biodiesel RIN fraud. Biodiesel Magazine, July 11, 2012. Last retrieved on 8/30/2015 at http://www.biodieselmagazine.com/blog/article/2012/07/testimony-from-congressional-hearing-on-biodiesel-rin-fraud.*

13.4.6 Strategies and Recommendations

Strategy 1: Improve the environmental and economic performance of liquid biofuels

Recommendations

(1) The state should work with federal partners to support federal policy changes that increase the sustainability of biofuels by increasing the volume of advanced biofuels, especially cellulosic ethanol and algal biodiesel, and instituting national sustainability standards for corn ethanol.

(2) Public and private stakeholders should continue to develop a sustainable biofuels industry in Vermont to enable the production and use of biofuels for transportation, agricultural, and thermal applications.

Strategy 2: Increase the use of biodiesel in transportation and heating

Recommendations

1) *The DPS should investigate methods for determining the biodiesel content of home heating oil and diesel in the state. If low-cost, feasible methods exist, the DPS should determine how much biodiesel is being used and report this information to the public and help facilitate reporting for heating fuel and transportation retailers who wish to market their products as partially renewable.*

2) *The DPS should study the biodiesel market to consider whether there is sufficient supply, price impacts to consumers, and the potential blending regulations to mitigate the negative effects of biodiesel on equipment in a cold climate. Once this study is complete, the DPS should use the results to determine whether it is feasible and cost-effective for the state to require a 20% biodiesel blend in home heating oil and a 5% biodiesel blend in diesel transportation fuel.*

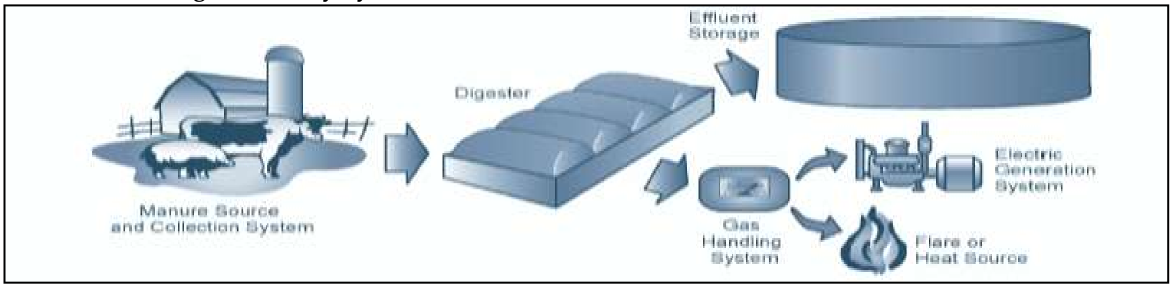
13.5 Biogas: Farm and Landfill Methane

13.5.1 Farm Waste Digesters

Manure has traditionally been stored in storage lagoons, where it produces odors and methane that escapes into the air; biogas systems capture and harness the methane.

Farm waste digesters are systems that use an anaerobic digestion to produce methane which is used to run combustion engines for the production of heat and power. In a typical Vermont system, manure and other farm waste, are kept warm in a closed tank for three weeks. Exhibit 13-35 shows a simplified diagram of the process.

Exhibit 13-35. Biogas Recovery Systems



Source: EPA

13.5.1.1 State of the Market

The private and public benefits are why the DPS, the Vermont Agency of Agriculture, Food & Markets (VAAFM), with assistance from federal agencies such as 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.

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 income. Incentives for farm biogas production facilities have been available in Vermont through programs like GMP's Cow Power, the state's Clean Energy Development Fund, and the USDA.

In 2009, the advent of the Standard Offer Program created more opportunities for farm methane producers to generate sufficient revenues to become viable. By the end of 2013, farm methane projects were producing more electricity than the solar projects in the Standard Offer Program.

Over the last five years, digester-design companies have created designs for smaller systems. In April, 2015, after considering Vermont's existing digesters and their costs, and calculations based on costs of proposed projects, the PSB established a higher rate for smaller projects.[327] The new rate of 19.9 cents per kWh for projects less than or equal to 150 kW could lead to farms with 500 or fewer cows installing a digester. Standard Offer prices are periodically adjusted and the most recent prices offered for farm methane projects are $0.145 per kWh fixed over the 20-year contract for projects with a nameplate capacity greater than 150 kW.

In 2010 the Legislature allowed existing farm methane projects into the Standard Offer program and released all farm methane projects from the Standard Offer's Capacity Cap allowing existing farm methane generators to obtain Standard Offer price contracts without having to go through the auction process.

[327] *PSB ORDER RE 2015 STANDARD-OFFER PRICES FOR FARM METHANE PROJECTS, in dockets 7873 and 7874. April 2, 2015.*

Most of the farmers who operate digesters in Vermont add some “food-processing residuals,” such as whey from cheese making, to increase the energy output of their system. All of them use separated solids for bedding, and studies have shown that the material is safe to use for animal bedding. 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.

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 agricultural waste products. The biogas yields per ton of crops or food wastes are much higher than those of cow manure. If these wastes were readily available, and the output of the digester were shown to be safe, Vermont’s potential electric capacity from farm-based digesters could be doubled from 15 MW to 30 MW.

Mixed-substrate digesters exist in the U.S. and have a strong track record in Europe. However, none of the projects align strongly with Vermont’s market conditions, rural character, and permitting structure.

Two farms, on a trial basis, will be taking food scraps (considered solid waste) and testing the resulting, digested manure for suitability as bedding. The food scraps will be ground into slurry away from the farm, and injected into the digester using the same reception pit as the farms use to receive food-processing residuals such as whey from a creamery.

Vermont has one trial project to grow algae using the outflow of the digester. The algae can then be harvested for oil or other uses.

13.5.1.2 Resources

Thanks to the combined efforts of farmers and their partners, Vermont farms have emerged as leaders in the field of farm methane digester development. As of July 2015, there were 17 systems operating in Vermont, with an installed capacity of about 3 MW. The list of operating systems is shown in Exhibit 13-36, below. Of the 19 states with a significant cow population, on a per-cow basis Vermont has double the number of digesters than the next leading dairy state, Pennsylvania. On a per-capita basis, Vermont has quadruple the number of manure digesters than the next leading dairy state, Wisconsin.[328]

With a history of early attempts going back to 1982, and the introduction of the Cow Power program, a green pricing program created by Central Vermont Public Service in 2005, and the consistent support of

[328] Here, “significant cow population,” also known as “dairy state,” is a state with more than 100,000 milk cows. By this definition, of the 48 states with cows in USDA’s census, 19 are dairy states. Total US cows are 9.25 million. Dairy states account for 88% of all those cows. The median number of cows in the 48 states is 85,000 and the average is 192,700 cows. Sources: USDA 2012 census for milk-cow numbers by state, and the EPA AgSTAR database of digester projects.

Green Mountain Power's Renewable Development Fund and the Clean Energy Development Fund, dairy farmers have built sixteen systems that are now generating electricity.

Two methane projects that are owned by non-farmers and located on farms are proceeding to formal permitting. The two projects differ in key respects, and would be the first such projects in Vermont.

Green Mountain Power is proposing to build a three-farm digester in the Town of St. Albans, two-and-a-half miles from St. Albans Bay. The project would produce electricity, with a capacity of 450 kW, using manure from three farms, totaling approximately 2,000 cows. Two of the farms adjoin the site and would deliver manure by pipe, and receive liquid from the digester also by pipe. The other farm would use trucks.

In Salisbury, Lincoln Renewable Natural Gas, LLC proposes to build a three-tank, 1.3-million-gallon digester that includes equipment to purify the biogas for use in a pipeline, and has a long-term agreement to sell the gas to Middlebury College. The project incorporates manure from three farms, totaling 2,400 cows. On average, the digester and the gas-upgrading equipment will deliver 130 scfm of renewable gas to the pipeline.

Since the last edition of this report, Vermont's fleet of farm methane systems has more than doubled, and estimated electricity produced has almost doubled, to approximately 22 million kWh.[329] Exhibit 13-36 shows the kW capacity of the 17 operating systems.

Exhibit 13-36. Operating Farm Methane Generators in Vermont

Farm	Size (kW)
Blue Spruce Farm	680
Chaput Family Farms	300
Dubois Farm	450
Four Hills Farm	450
Gebbie's Maplehurst Farm	150
Gervais Family Farm	400
Green Mountain Dairy	600
Joneslan Farm	65
Kane's Scenic River Farms	225
Keewaydin Farm	20
Maxwell's Neighborhood Farm	225
Monument Farms	150

[329] *From Green Mountain Power's internal accounting, as presented to the Renewable Development Fund.*

Farm	Size (kW)
Nelson Boys Dairy	300
Pleasant Valley Farms	600
Riverview Farm	180
Vermont Technical College	375
Westminster Farms	450
Total	***5,620***

As of 2015, Vermont has about 870 dairy farms milking a total of about 134,000 cows.[330] These cows are housed in a variety of barn types and are managed in a wide variety of ways. Some farmers pasture their cattle while others house them, or at least the cows and calves, year-round.

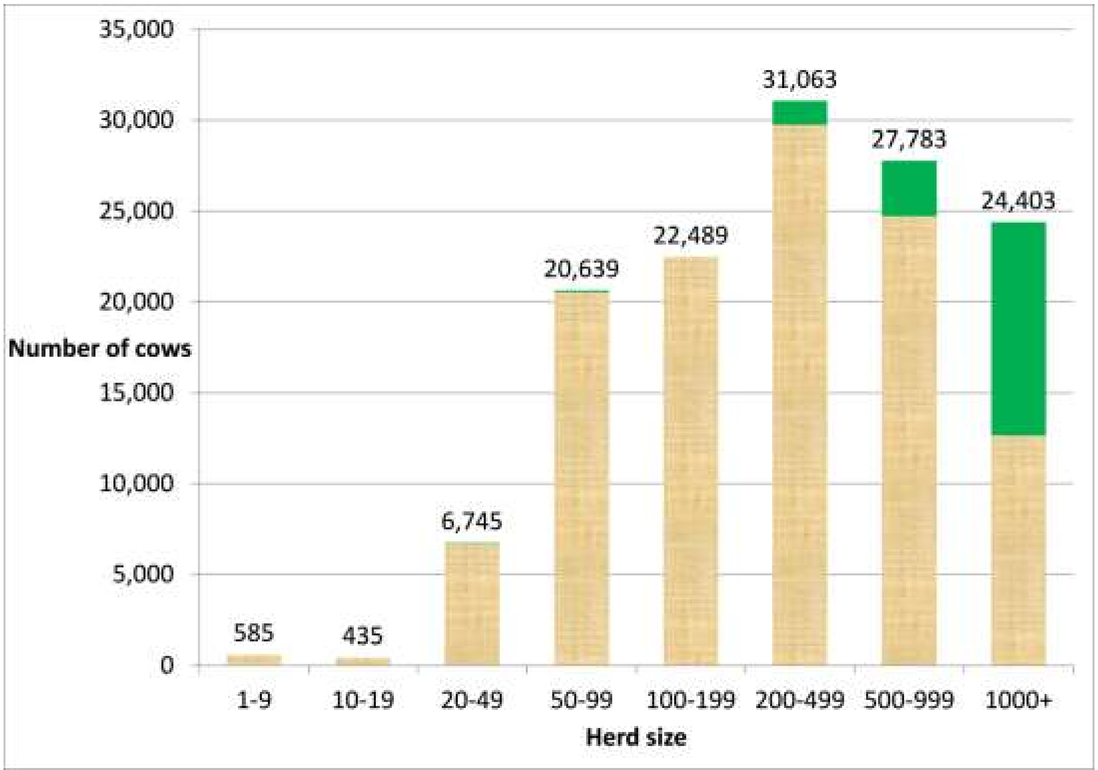
For the 2009 Vermont 25 x ’25 Initiative report, the VAAFM estimated that about one-half of the manure in the state would be available for digestion. VAAFM estimates that this would give a total installed electric generation capacity from manure of 15 MW, producing about 90 million kWh of electricity annually.

Most of Vermont’s dairy farm manure is generated on farms with fewer than 500 cows. Only about 10% of the dairy farm manure from the roughly 134,000 dairy cows is going through a digester as is shown in Exhibit 13-37, below.

[330] *Per “Milk Matters: The Role of Dairy in Vermont” Vermont Dairy Promotion Council, produced in collaboration with ACCD and VAAFM.*

Exhibit 13-37. Vermont Dairy Herd Sizes

Note: Green corresponds to cows in those herd sizes whose manure is being digested. Note that herd size doubles from each category to the next.



Sources: EPA AgSTAR database (June 2015) and USDA Census (2012)

13.5.1.3 Siting and Permitting

Farm methane projects that produce power to the electric grid are required to obtain a CPG from the PSB. In Act 88 of 2014, the PSB's jurisdiction over farm methane projects was explicitly narrowed to the electric-generation aspects of the project, while permitting for food-processing residuals continues to be permitted through ANR's Solid Waste Division. Air pollution emissions from digesters and gas-fired generators are subject to permit/approval, and annual emissions reporting through ANR's Air Quality and Climate Division. The VAAFM retains jurisdiction on manure management.

13.5.1.4 Benefits

The anaerobic digestion process destroys pathogens, reduces odors, changes the form of agronomic nutrients, and yields a gas mixture of methane and carbon dioxide. The volume of manure remains essentially constant. In addition, the nutrients from the manure remain in the material that is extracted from the digester, making these nutrients more readily available to plants, and more precisely applied for improved crop production.

Biogas from top of the digester tank consists of 45% carbon dioxide and 55% methane, along with small amounts of other gases. The GHG value of methane in the atmosphere, over a 100-year time horizon, is 21 times that of carbon dioxide, so any system that captures methane from manure and burns it, converting it to carbon dioxide, significantly reduces GHG emissions. In addition, the power produced offsets power produced from sources higher in GHG emissions.

In addition to the GHG benefits, 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 additional renewable baseload power to the grid, and a range of environmental benefits, from odor amelioration to GHG reduction.

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.

Whether a digester is owned by a farmer or not, the owner can take advantage of products other than electricity to generate income or save money in new ways, such as operating a greenhouse using extra heat from the engine331, composting extra solids from the digester for sale, or applying liquids from the digester using a dragline system.

13.5.1.5 Challenges

Faced with a large untapped potential, and all the benefits of farm methane projects, nonetheless project development has stalled. As of late 2015 no farmer is building a digester, nor have any farms committed to building a digester.

Vermont draws social and economic benefits from its working agricultural sector. While dairy farming and dairy processing provide 70% of Vermont's agricultural sales, milk prices are volatile and cash flow can be very uncertain.332 Investing in a digester dwarfs competing farm investments such as land, cows, barns, and equipment.

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

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[331] *See, for example, the case study on Maxwell's Neighborhood Farm: http://www.vtfarmtoplate.com/assets/resources/files/6_Digester%20on%20a%20Dairy%20Farm_Maxwells%20Neighborhood%20Farm_Final.pdf*

[332] *Dairy farmers endured an average milk price of $13.82 per hundred pounds of milk for 2009, followed by four years of prices at or near $20. Finally, 2014 brought an average price of over $25 per hundred pounds (http://future.aae.wisc.edu/data/annual_values/by_area/10?area=VERMONT). By August of 2015, prices plunged far enough that farmers diverted milk to the manure pit rather than lose money by shipping it (http://vtdigger.org/2015/07/09/glut-of-milk-leads-vermont-farms-co-ops-to-dump-product/). Prices for 2016 are projected as $16.40 per hundred pounds (http://www.ers.usda.gov/publications/ldpm-livestock,-dairy,-and-poultry-outlook/ldpm-254.aspx; http://www.ers.usda.gov/media/1885180/dairy-forecasts-august-2015.xlsx).*

sufficient revenues (or generating enough savings, in the case of net metering) from the electricity, and accessing capital all remain difficult barriers, despite Vermont's track record and improvements in each area since 2012.

Despite the GHG benefits outlined in the previous section, farm methane and other biogas digesters with electric generators emit substantial quantities of criteria air pollutants and air toxics including sulfur dioxide, carbon monoxide, hydrogen sulfide, formaldehyde, etc.

Given the substantial initial capital expenditure, and the extended development period of up to four years, access to grant funding has proven essential to covering costs for such expenses as planning, engineering, and connecting to three-phase power. However, there are now fewer grant opportunities as there were when most of Vermont's existing farm digesters were built. This has been a challenge for new projects to move forward.

Similarly, access to low-cost credit from organizations such as CEDF and VEDA's Agricultural Credit Corporation has been instrumental to the success of farm digesters. Farms generally have to mortgage their farm to develop a digester because lenders often will not take the digester as collateral.

Finally, a range of specific challenges for the farmers/operators of the systems have emerged:

- Equipment failures in some cases, due to flawed design, accompanied in some instances by weak customer support from undercapitalized and immature equipment providers.
- Persistent issues at most projects from corrosion and/or fouling caused by hydrogen sulfide gas.
- Additional labor demands on farmers, especially if they want to fully utilize co-products, such as running a greenhouse to use the heat, or setting up a compost operation to increase the value of the solids.
- Environmental permitting for inputs spans several divisions of the ANR, and types of permits, depending on the material.
- Unexpected fee for air emission permit.

Recommendations for Farm Methane

(1) *Develop support from Vermont state agencies, departments, and electric utilities for the development of farm biogas recovery systems through incentives, education, and outreach programs.*

(2) *Work with federal partners for continuation of NRCS and USDA REAP grants for on-farm bio-digesters.*

(3) *Revise ANR's solid waste rule to include existing and new farm digesters as a safe and cost-effective pathway for the approximately 30,000 near-term tons of food waste per year that will be diverted from landfills.*

(4) *Coordinate, via regularly scheduled meetings between ANR, DPS, and VAAFM staff, to better cooperate and align state activities related to anaerobic digestion and to facilitate the sharing of information across all AD sectors: farms, food-processing industry, and wastewater treatment.*

(5) *Convene the relevant state agencies and VGS personnel to review progress on increasing the fraction of renewable natural gas in VGS system.*

13.5.2 Non-Farm Anaerobic Digesters

The anaerobic digestion of organic waste can also be used in non-farm applications using either non-farm organic waste material or combining farm waste material with non-farm material.

13.5.2.1 State of the Market

Non-farm digesters are most commonly found at food-processing facilities and municipal waste facilities where they have large quantiles of organic waste material and a need for the heat and electric produced. In 2010, Purpose Energy installed an anaerobic digester at the Magic Hat Brewery in South Burlington to provide heat for brewing, to power the facility, and to reduce the biological oxygen demand (BOD) of Magic Hat's liquid waste stream.

Brattleboro, Montpelier, Essex Junction, and other municipalities have anaerobic digesters as part of their municipal waste systems that provide heat and power to the facilities. These systems destroy methane, a powerful GHG, and reduce BOD while producing energy, whereas waste water treatment plant commonly use large amounts of energy.

Vermont has approximately 90 municipally operated wastewater treatment facilities. Thirty are above the permitting threshold of one million gallons per day or serving a population of 10,000. In addition, there are approximately 60 private or institutionally operated systems. A back-of-the-envelope calculation indicates that facilities serving 10,000 or more people have the potential to reduce their electricity usage by about one quarter.

Act 148 institutes a ban on disposal of food residuals for all waste generators, including residential generators, to be enforced by 2020 and mandates that solid waste processers offer services for processing food residuals by 2017 and that haulers must offer curbside collection of food residuals by 2017. Food waste could be processed along with sewage, among the many pathways.

ANR's Wastewater Program, in the Watershed Management Division of the Department of Conservation surveyed ten facilities. The responses indicated that, among the 23 digesters at these ten facilities, only a minority of the digesters is sending the biogas to be burned for energy.

13.5.2.2 Siting and Permitting

Section 248 applies to anaerobic-digester projects at any municipal (or other) wastewater treatment facility that would involve electricity generation. No additional permits are necessary specifically from the Wastewater Program. Nor does the Program require permits for the heat-recovery aspects of operating a digester. However, as with any stationery source of air emissions, any boiler or engine-generator may be subject to air emissions fees, depending on the amount of emissions.

13.5.2.3 Benefits

Wastewater treatment plants use a lot of electricity. Using EPA generalizations of 1,200 kWh to process one million gallons of wastewater per day, and a city of 10,000 requiring this size of facility, a city the size of Milton would use more than 400,000 kWh per year, at a cost of more than $50,000, to treat its wastewater.[333] Based on the experience at Essex Junction's wastewater treatment facility, a city the size of Milton could save $10,000 in electricity, and perhaps a similar amount in heat, if it installed a system that generated electricity and captured some of the heat from the engine coolant and from the exhaust gases.

13.5.2.4 Challenges

Using the methane, or the exact anaerobic process used to generate it, would not have any impact on biosolids management, as the anaerobic process generally would not have any impact on the biosolids.

As at a dairy farm, waste management and processing at a wastewater treatment facility is complex and entails multiple control points and points of potential failure. Good operators, whether they operate a dairy farm or a wastewater treatment facility, are justifiably wary of putting a known and good outcome at risk by adding complexity to their operation. Although the probability of a failure may be low, the consequence(s) can be dire – fish kills, public health problems, and fines. "Risk" entails accounting for both probability and consequence.

Unless there is a compelling case, financially or operationally or both, to advance a biogas-utilization project at a wastewater treatment facility, avoiding risk and sticking with the status quo will win.

Recommendations for Non-Farm Anaerobic Digesters

(1) *Support and encourage municipalities that are remodeling their waste treatment facilities to include anaerobic digestion with methane capture as part of their treatment systems.*

(2) *Investigate the solid waste permitting process and how it relates to farm digesters and recommend changes to the permitting process especially for the hauling and handling of material headed to and coming out of anaerobic digesters.*

(3) *Convene staff from ANR, DPS, and VAAFM to coordinate, cooperate and align state activities related to anaerobic digestion and to facilitate the sharing of information across all AD sectors: farms, food-processing industry, and wastewater treatment.*

13.5.3 Landfill Methane

As refuse decomposes in landfills, methane gas is released, eventually rising to the atmosphere. Landfills

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[333] *Clean Energy Opportunities in Water & Wastewater Treatment Facilities: Background and Resources (2009), http://www.epa.gov/statelocalclimate/documents/pdf/background_paper_wastewater_1-15-2009.pdf*

control this flammable gas by collecting it via pipelines buried in the landfill and use it as a fuel in combustion engines to create energy.

13.5.3.1 Resource & State of the Market

Vermont currently has a small number of landfill biogas generation facilities, with operations in Coventry (8 MW), Moretown (3.2 MW), Burlington's Intervale (Rated at 350 kW but producing at an estimated 60kW), Williston Gas Watt Energy (90 kW).

The Brattleboro landfill also has a project (~300 kW of capacity but generating less) that was re-started in 2010 and although has not been producing power continuously, the project was recently purchased by a Brattleboro Organic Energy LLC who is looking to keep the landfill gas generator operational as well as to co-locate a food-waste digester at the site.

Landfill methane projects can qualify for Standard Offer contracts at a 20 year levelized price of $0.09/kWh or they can net meter – which is what the Burlington Intervale system is doing.

With only one landfill in the state (Coventry) still receiving material and other landfills being either already developed or not viable for gas to energy projects the outlook for landfill gas to energy in Vermont is that any new capacity will be offset over time with a decrease in methane from the closed landfills.

13.5.3.2 Siting and Permitting

Increased awareness of the environmental problems caused by landfills has made permitting for landfills much more stringent resulting in all but one landfill in Vermont still being able to accept new material. Any closed landfills that are viable for the collection of the methane and have access to necessary electric distribution lines should not have difficulty obtaining a CPG for a gas to energy project.

13.5.3.3 Benefits

In addition to the renewable energy generated, the destruction of the methane has great GHG reduction benefits as methane is a potent contributor to the climate change problem. The projects also can provide revenue to a landfill owner that can help to cover long-term environmental maintenance costs of the landfill.

13.5.3.4 Challenges

Act 148 institutes a ban on disposal of food residuals for all waste generators, including residential generators, to be enforced by 2020 and mandates that solid waste processers offer services for processing food residuals by 2017 and that trash haulers must offer curbside collection of food residuals by 2017.

This will result in less food waste being deposited in Vermont's remaining landfill and therefore there will be less methane produced from which to generate power.

13.5.4 Other Biogas

In addition to anaerobic digesters and landfill methane, other sources of biogas may emerge in the future. For example, projects in other states have attempted to commercialize gasification or pyrolysis of solid waste. Should such a technology prove effective, environmentally sound, and otherwise viable for Vermont's organic waste, Vermont should revisit the use of such waste as a fuel for renewable biogas.

13.6 Hydropower

13.6.1 Overview

Prior to the 1920s, Vermont relied on hydro resources almost exclusively for its electricity needs.[334] 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, while out-of-state hydro is a major component of our supply. Hydropower has many benefits. It is renewable, has low emissions of GHGs, 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 support environmentally sound hydropower development in the state.

13.6.2 State of the Market

Vermont today has 71 FERC-licensed hydropower generation facilities, with an estimated installed capacity of more than 750 MW. Subtracting the Connecticut and Deerfield River facilities – which serve customers outside of the state – and adding in the unlicensed facilities in the state, the installed in-state capacity is closer to 200 MW. The generation from these facilities powers nearly 10% of Vermont's electric load.

Exhibit 13-38. Vermont Hydroelectric Projects

Plant Owner	Capacity (MW)
GMP[335]	99

[334] https://www.burlingtonvt.gov/sites/default/files/PZ/Historic/National-Register-PDFs/Hydroelectric%20Generating%20Facilities%20in%20VT.pdf

[335] http://www.greenmountainpower.com/upload/photos/4773._2014_GMP_IRP_The_Supply_of_Electricity_Chapter_112514_Clean_and_Final.pdf

Plant Owner	Capacity (MW)
Independent Power Producers[336]	41
Standard Offer[337]	2
Municipal Utilities[338]	30
All Other	28
Total	*200*

A portion of current capacity was added in the 1980s under the Public Utility Regulatory Policies Act (PURPA) of 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, though at a higher price relative to the wholesale power market.

The pace of hydro development dropped off significantly after the early 1990s, due to a number of factors including the loss of economic incentives, stricter permitting requirements, and the elimination of "low-hanging fruit." Advocacy efforts by the hydropower community led to several studies to analyze the potential for new hydropower resources in Vermont, and several projects that have recently or will imminently come online provide insights into what it might require to add more in-state hydropower to the mix – and to keep what we currently have.

Current state policy continues to support the development of environmentally sound in-state hydroelectric projects. This policy achieves the objectives of helping Vermonters meet their long-term energy needs with low-costs renewable resources – hydro projects represent the least expensive power currently being generated by Vermont utilities – while also protecting the health of Vermont's waters.

13.6.3 In-State Resources

Obtaining an accurate estimate of how much undeveloped hydro capacity exists in Vermont that can be developed in a cost-effective and environmentally benign way is challenging. Estimates range from 25 MW at 44 sites (estimated by the ANR in 2008[339]) to 434 MW at 1,291 sites (estimated in a DOE desktop

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[336] *http://static1.1.sqspcdn.com/static/f/435218/25863851/1421442956143/Schedule+B+-+2014-2015-FY15.pdf?token=TvpupnR2Vg1aInvc0JUzhk%2FY2Ic%3D*

[337] *http://vermontspeed.com/projects-online/*

[338] *DPS data*

[339] *http://www.vtwaterquality.org/rivers/docs/rv_smallhydroreport.pdf*

study in 2006).[340] A 2007 study for the DPS identified more than 90 MW developable at 300 of the existing 1,200 dams.[341]

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. However, the permitting requirements for hydropower do not necessarily scale with size, thus the economics are skewed in favor of larger sites in the absence of incentives that would make the smaller sites capable of supporting up-front environmental and engineering studies as well as the extensive and lengthy permit process hydropower is required to undertake at the federal level.[342]

One generally cost-effective way to increase the contribution of hydropower to Vermont's electricity mix without developing non-powered dams is to upgrade existing hydroelectric facilities by installing small turbines at the dams that utilize conservation bypass flows, or installing new turbines that can operate efficiently and 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 some cases, these upgrades can even reduce environmental impacts; Green Mountain Power has taken advantage of relicensing of its dams to change operations in ways that meet modern water quality standards while increasing output at its existing facilities. [343]

In addition, existing municipal water supply and wastewater treatment pipelines can be retrofitted with turbines to capture excess pressure in these systems without otherwise altering the regular operation of the system. Such in-pipe hydroelectric systems have minimal environmental impact, though they also produce only a small amount of electricity. The town of Bennington has developed such a project,[344] as has the city of Barre,[345] following a 2013 change in federal permitting law that expedited the processing and review of conduit systems.[346]

13.6.4 Out-of-State Hydro Resources

<u>Canadian Hydropower</u>

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[340] http://www1.eere.energy.gov/water/pdfs/npd_report.pdf

[341] http://publicservice.vermont.gov/sites/DPS/files/Topics/Renewable_Energy/Resources/Hydro/DPS-Undeveloped-Hydro-Potential-FINAL-VERSION.pdf

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

[343] http://news.greenmountainpower.com/manual-releases/GMP-Upgrades---Doubles-Hydro-Generation-at-Otter-C?feed=d51ec270-a483-4f6c-a55e-8e5fbe2238c2

[344] http://www.vtenergyatlas-info.com/wp-content/uploads/2010/02/Bennington-hydro-final-rpt.pdf

[345] http://www.vecan.net/wp-content/uploads/jeff-McDonald_VECAN_Barre-Micro-Hydro-Project.pdf

[346] http://www.ferc.gov/industries/hydropower/indus-act/efficiency-act.asp

Vermont currently receives about a third of its electricity from out-of-state hydro, principally from Hydro-Quebec (HQ). In 2010, the Legislature officially recognized this resource as renewable.[347,348] HQ power offers greater price stability than the market, is priced competitively with or favorably compared to the market, and does not contribute to the air quality problems of our region. 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.[349]

The original, 30-year, 310 MW contract between Vermont utilities and HQ is in a phaseout period. A new, 26-year, 225 MW contract took effect in late 2012. The electricity is priced at $58.07 per MWh to start and will be adjusted annually with a formula designed to keep the contract aligned with the power markets but buffered from volatility and sustained high-price periods. 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. The utilities are allowed to resell these attributes, provided they split the proceeds with HQ. However, these environmental attributes are not currently valued in renewable energy markets outside of Vermont.

Under the HQ 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 HQ contract does not require delivery of power at Highgate.

HQ currently has 36,643 MW of generating capacity, capable of producing 173,000 GWh annually.[350] HQ has a surplus of approximately 30,000 GWh, resulting from decreased exports to the U.S. following the advent of abundant natural gas supplies in this country, as well as new projects (including a number of wind projects) coming online in Canada.[351] It is not surprising, then, that there are at least three active proposals for transmission lines that would bring HQ power to the New England region, especially given the renewable power needs of southern New England states.[352]

In addition to HQ, other Canadian hydro resources may become available to Vermont and the region in the future. Newfoundland and Labrador have started a new major hydro project, the Lower Churchill Development. This project will be built in phases, with the first complete by 2017. When completed, this

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[347] http://www.vermont.gov/portal/government/article.php?news=1829

[348] *All power purchased from HQ is system power and not tied to any single unit. Of the HQ power in 2010, 99% is from hydro. Hydro-Qu*ebec, Sustainability Report 2014, www.hydroquebec.com/publications/en/enviro_performance/pdf/rdd_2010_en.pdf

[349] https://www.vermontelectric.coop/content/hydro_quebec_final_psb_order.pdf

[350] http://www.hydroquebec.com/sustainable-development/energy-environment/power-generation-purchases-exports.html

[351] http://www.energy.ca/sites/energy.ca/files/energy_council_of_canada_-_economics.pdf

[352] http://vtdigger.org/2014/06/08/special-report-vermont-smack-middle-crucial-electricity-supply-demand/

facility should add another 3,000 MW to the electric grid; whether it is sold to New England or to other parts of Canada, such as Ontario, is still undetermined.

New York Hydropower

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. Vermont's current NYPA entitlement – which all goes to our municipal utilities – is 15 MW, which is guaranteed until 2025. Even at the reduced level, the price continues to make this energy attractive to the Vermont municipal utilities who receive it.

Maine Hydropower

Stowe Electric Department has been purchasing power from the Worumbo hydroelectric project in Lisbon Falls and Durham, Maine, since 2010. The current contract for 2.613% of the output of the production of this 19 MW facility is set to terminate on May 31, 2016.

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.

13.6.5 Siting and Permitting

Hydroelectric projects – unlike solar, wind, biomass, and other grid-connected renewable electricity projects – are required to obtain a federal authorization (from the Federal Electric Regulatory Commission, or FERC). FERC authorization is required whether the project is large or small (the largest FERC-authorized project in Vermont is 320 MW, and the smallest is 5 kilowatts). The FERC process can be time- and resource-intensive, especially for projects that have greater potential for impacts to natural and cultural resources. 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 and the National Historic Preservation Act.

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 – called "exemptions" – has no expiration date; those projects may operate indefinitely without further review, as long as they are in compliance with the terms of their permit.

Some European countries have regulatory regimes that seem to facilitate hydro development, and some states have worked to streamline their permitting process. However, hydropower developers both in and outside of Vermont continue to be challenged by the length and expense of permitting, something state legislatures and the U.S. Congress periodically attempt to address.

In 2012, the Vermont legislature passed Act 165, which directed the Commissioner of the DPS, in consultation with the Secretary of ANR, to "seek to enter into a memorandum of understanding [MOU] with the Federal Energy Regulatory Commission (FERC) for a program to expedite the procedures for FERC's granting approval for projects in Vermont that constitute small conduit hydroelectric facilities and small hydroelectric power projects."

After consulting with FERC and many stakeholders, the agencies tasked with implementing Act 165 concluded that it was infeasible to enter into such an MOU, and that the next best way to expedite the development of small hydropower projects in Vermont was to provide greater assistance to developers early on in a project, to better coordinate communications to developers and to FERC, and to identify projects that could gain support from the state resource agencies and communicate such support to FERC in order to expedite the permitting process. Therefore, the Team created an interagency MOU, which was fully executed by the DPS, ANR, and ACCD as of July 3, 2013. The MOU provides for such enhanced coordination, identifying and assisting developers of low-impact projects of high public value (such as those owned by public entities and those utilizing existing infrastructure), and other assistance as resources allow.

Following the execution of the MOU, the agencies developed a two-step screening process to identify and assist low-impact projects: The Vermont Small Hydropower Assistance Program, which debuted in the summer of 2015. The first step involves a desktop review of project proposal characteristics, while the second step is based on a site visit (and predicated on successful screening through the first step). The agencies will provide enhanced assistance to projects that screen as low impact, as appropriate (for instance, waiving scoping periods in the FERC process and/or representing to FERC that agency concerns have been satisfied).[353]

13.6.6 Benefits

Hydroelectricity is produced from our rivers, and operates without generating carbon emissions or pollutants. Other than low-flow periods in the summer, the hydropower resource is generally consistent and abundant, and the infrastructure long-lived, leading to low-cost, steady power that can be used to

[353] http://publicservice.vermont.gov/topics/renewable_energy/resources#hydro

help integrate the more intermittent renewable resources such as wind and solar. Many of Vermont's utilities own hydroelectric resources, which comprise a significant and low-cost portion of their electric power portfolios. Some of Vermont's municipal utilities were formed in main part due to the development of local hydropower resources, which continue to play a major role in their ability to keep rates competitive for their customers.

Hydroelectric resources also employ local engineers and operational staff, and have led to local entrepreneurial efforts to develop new, low-impact technologies.[354] According to the Vermont Clean Energy Industry Report, hydropower employs 229 people in the state.[355] Vermont-based hydropower resources also pay property taxes, provide recreational opportunities such as boating and fishing, and are important aesthetic and historic resources to a number of towns.

13.6.7 Challenges

Despite the many benefits that hydropower provides, 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, loss and degradation 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.

Existing dams retrofitted for hydropower, as well as those undergoing relicensing, are also required to meet Water Quality Standards, which were adopted and have evolved in the time since many Vermont dams were first licensed. Projects going through relicensing will likely need to change operations in order to provide adequate flows in the bypass reach, and to operate more closely to run-of-river mode. In relicensing, projects that had previously stored water in impoundments for use during peak demand may no longer be able to do so to the same extent, and projects that had used flows to the detriment of aquatic life may need to sacrifice some production. The losses in peak power and production potential can be mitigated to some extent by the implementation of modern controls and more efficient equipment, but this needs to be considered by hydro plant operators, especially utilities, as they plan for their future electricity portfolios.

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. The Vermont Small Hydropower Assistance Program contains the following screening criteria; a project that meets them is likely to meet a low-impact standard:

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[354] http://www.littlegreenhydro.com/

[355] http://publicservice.vermont.gov/sites/DPS/files/Announcements/Vermont%20Clean%20Energy%20Industry%20Report%20FINAL.pdf

- Will not be located on Class A waters, Outstanding Resource Waters, or federally or state-protected river reaches.[356]
- Will be located at an existing dam, **or** project will not require a dam or other impoundment.
- Will be located on lands controlled by applicant or otherwise demonstrate support from adjoining landowners.
- Will not increase the impoundment elevation.
- Will be operated as true run of river.[357]
- Has proposed bypass flows that will meet hydrologic standards as defined by the ANR Flow Procedure:[358]

Season	Period	Median Flow Standard[359]	Default (cfs/mi^2)
Fall/winter	Oct 1 – Mar 31	February	1.0
Spring	Apr 1 – May 31	April/May	4.0
Summer	June 1 – Sep 30	August	0.5

<u>OR</u>

Where there is virtually no bypass (tailrace discharges at the dam or into plunge pool close to the dam such that adequate circulation is maintained) and will have a spillage proposal of at least 7Q10 drought flow.[360]

Because of the stringent and lengthy permitting process hydropower is required to undertake – at least in comparison with other renewable sources of electricity – incentives continue to play an important role for the development of desired resources in Vermont. Net metering at the retail rate has proven sufficient for some projects, such as many whose PURPA contracts are expiring. Those projects are likely to have paid off their debts and may have FERC exemptions, meaning their licenses do not expire and they are not subject to definite review under modern Water Quality Standards.[361] It is clear that new hydroelectric

[356] *Lists of Class A and Outstanding Resource Waters are available on ANR's Natural Resources Atlas: http://anrmaps.vermont.gov/websites/anra/; federally protected waters can be identified via http://www.ferc.gov/industries/hydropower/gen-info/licensing/small-low-impact/get-started/sites.asp.*

[357] *A true run-of-river project is one which does not operate out of storage and, therefore, does not artificially regulate streamflows below the project's tailrace. Outflow from the project is equal to inflow to the project's impoundment on an instantaneous basis.*

[358] *Reference for further detail: http://www.anr.state.vt.us/dec/waterq/rivers/docs/rv_flowprocedure.pdf*

and www.fws.gov/newengland/pdfs/Flowpolicy.pdf.

[359] *Application of the fall/winter and spring period flows for spawning and incubation will be determined by the VT Dept. of Fish & Wildlife site-specifically. If not required, the August median flow will be applied year-round.*

[360] *The 7Q10 refers to the lowest average streamflow expected to occur for seven consecutive days with an average frequency of once in ten years. If it's a gaged stream, ANR can supply this statistic. If not, use 0.1 csm, the statewide value.*

[361] *ANR does have regulatory tools to bring unlicensed facilities that violate Water Quality Standards into compliance over time.*

projects (especially those above the net metering threshold of 500 kW) and perhaps capacity upgrades at existing facilities will need incentives to develop in any meaningful numbers. The Standard Offer program, which awarded above-market contracts to two of the four hydro projects that have been developed since the last CEP, may be an appropriate venue in which to further explore incentives for low-impact hydro development in the state.

Strategies and Recommendations

Strategy 1: Maintain production levels from existing Vermont-based hydro projects to the extent they comply with Water Quality Standards

Recommendations

(1) Identify opportunities to increase production at existing facilities through implementation of advanced operational controls, more efficient equipment, and/or conservation flow turbines at the dam.

(2) Develop incentives through the Standard Offer and/or Clean Energy Development Fund to increase production from existing facilities.

(3) Implement a multi-agency hydropower project tour to review operations and provide recommendations for operational controls and equipment upgrades necessary to meet Water Quality Standards well in advance of relicensing.

Strategy 2: Develop new Vermont-based hydro projects to the extent they comply with Water Quality Standards

(1) Commission a study of the economically developable hydro sites in Vermont, as an update and refinement of previous studies. Use this as a basis for Standard Offer, Clean Energy Development Fund, and other incentive development, and, possibly, for coordinated interagency support.

(2) Provide financial support to projects that meet the Vermont Small Hydropower Assistance Program low-impact criteria in order to conduct engineering and environmental studies necessary to proceed through permitting.

(3) Work with ANR to assess watershed-wide opportunities to increase hydropower (at existing dams or operations) while also decreasing the overall environmental impact of dams (through targeted removals of existing dams that have been determined as inappropriate for hydropower after a review of their hydroelectric potential and environmental circumstances.)[362]

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

Strategy 3: Secure additional stable long-term hydropower supply potentially available from Canadian provinces and other states in the Northeast.

(1) *Assess the optimal amount of out-of-state hydropower desirable in a Vermont energy portfolio and evaluate opportunities to secure favorably priced, long-term contracts for that power.*

(2) *Evaluate opportunities to benefit from planned transmission projects that will bring hydropower to or through Vermont from out-of-state.*

Chapter 14 – Non-renewables

Most of the energy used in Vermont comes from non-renewable sources. Natural gas and petroleum products account for 62% of Vermont's total energy usage and 100% of Vermont's energy-related in-state GHG emissions.[363] Vermont consumed 15.3 million barrels of petroleum and 9.6 billion cubic feet of natural gas in 2013, the most recent year for which data are available.[364]

Although they are the biggest drivers of climate change and air pollution in the state, fossil fuels continue to constitute the majority share of energy consumption because of their relatively low price, well established distribution system, compatibility with existing infrastructure and equipment, and on-demand characteristics.

Whereas electricity and natural gas are regulated monopoly industries with rate setting, infrastructure siting, and planning overseen by the PSB, petroleum products and coal are distributed without rate and infrastructure regulations by the state. Extraction and distribution of these fuels are regulated by environmental and safety standards nationally, but the state holds little regulatory authority over prices or distribution for these fuels.

As a result there are fewer policy and regulatory levers in this sector available to influence the market. As the state seeks to drive energy consumption away from these polluting fuels, the most effective tools lie in encouraging efficiency and clean and affordable alternatives in space heating, transportation, and electricity. Recommendations in those chapters of the CEP are designed to lower consumption of fossil fuels. For applications where electrification, biomass, or other renewable fuels are unavailable, the negative impacts of fossil fuel use can be somewhat mitigated by choosing cleaner fuels such as natural gas and reduced sulfur heating oil and encouraging the most efficient and clean-burning technologies available. Blending renewable biodiesel and biogas into existing fossil fuel delivery systems would reduce the environmental and health impacts of using those fuels.

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[363] *Energy Information Administration. Table 2 of the 2011 state energy-related carbon dioxide emissions by fuel. Last accessed on 8/12/2015 at http://www.eia.gov/environment/emissions/state/analysis/.*

[364] *Energy Information Administration. Vermont State Profile and Energy Estimates. http://www.eia.gov/state/data.cfm?sid=VT*

14.1 Petroleum

14.1.1 Overview

Petroleum products provide 49.6% of Vermont's energy and account for 92% of the state's GHG emissions from energy use.[365] Petroleum is processed into a wide array of energy products including jet fuel, and residual fuel oil, but just three products comprise the bulk of Vermont's use: gasoline, distillate fuel oil (which is used as both diesel gasoline and home heating oil), and propane. Transportation, space heating, and water heating are the primary drivers of petroleum consumption in the state.

Gasoline is the largest single contributor to both energy and GHG emissions in the state. Gasoline accounts for 28.9% of total energy use. The transportation sector accounted for 44.6% of the GHG emissions in Vermont in 2012 with the majority of those emissions coming from gasoline and diesel. Up to 10% ethanol is blended into gasoline, so there is a small "renewable" component to gasoline consumption. For a more detailed discussion of ethanol, see the Biofuels section of Chapter 13.

Distillate fuel oil, which is both No. 2 home heating oil and diesel fuel, makes up 18.3% of Vermont's energy usage and is used in medium and heavy-duty transportation and for space and water heating. Approximately 68 million gallons of heating oil is sold annually for residential consumption. Approximately 71 million gallons are used as diesel fuel in transportation. Propane, also referred to as liquefied petroleum gas (LPG), used in space heating, water heating, and cooking is expected to continue its strong growth. Approximately 67 million gallons of propane is sold annually for residential consumption.

Commercial enterprises sometimes use heating oil and propane 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 24 million gallons of heating oil and 43 million gallons of propane.

Industrial enterprises typically use heating oil and propane 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 21 million gallons of heating oil and 4 million gallons of propane.[366]

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.

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[365] *Energy Information Administration. Table 2 of the 2011 State energy-related carbon dioxide emissions by fuel. Last accessed on 8/12/2015 at http://www.eia.gov/environment/emissions/state/analysis/.*

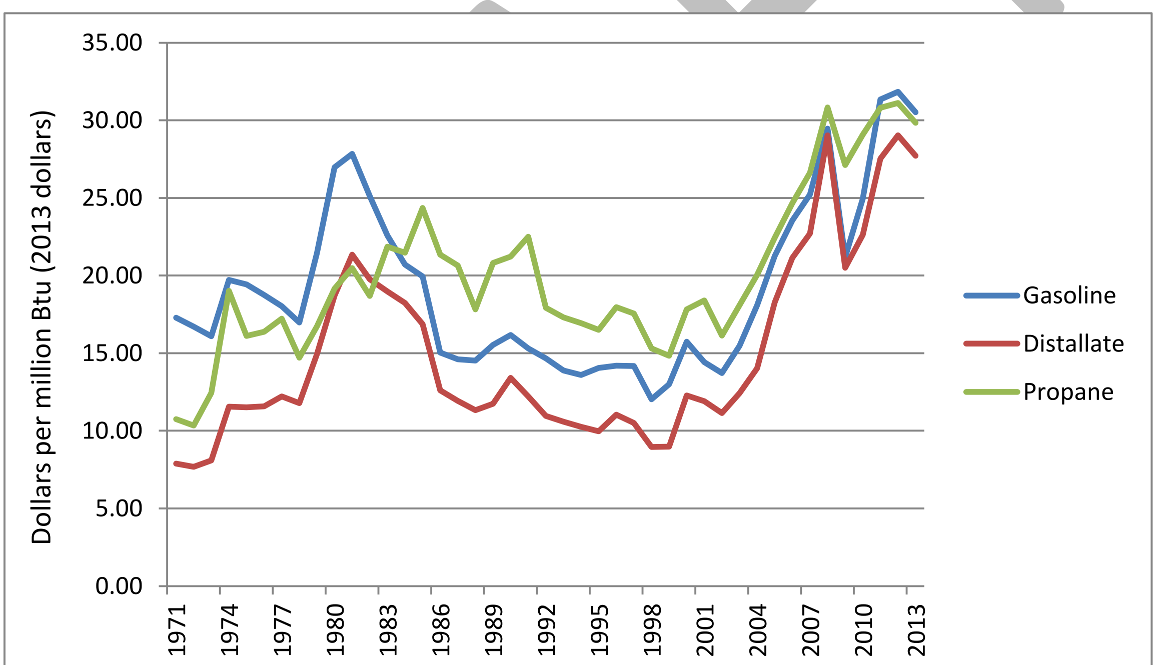
[366] *All petroleum consumption data in this section comes from the Energy Information Administration's. State Energy Data System (SEDS). Consumption data. The data are current as of 2013, the most recent available dataset. Last retrieved on 8/13/2015 at http://www.eia.gov/state/seds/.*

14.1.2 State of the Market

14.1.2.1 Prices

Prices for gasoline, fuel oil, and propane have declined precipitously over the past 12 months. Domestic petroleum production has experienced rapid growth in the U.S. since 2009, production has also accelerated in Russia, Nigeria, Iraq, and Saudi Arabia giving lift to global supplies. Meanwhile demand in Europe has dropped slightly and growth in demand in Asia is moderating due to economic slowdown and increasing vehicle efficiency. This confluence of market forces has led to the recent decline in prices. However the long-term trend in petroleum prices is upward with a high degree of volatility. Global market forces shaping oil prices are unpredictable. However the long-term trend in petroleum prices is upward with a high degree of volatility. Short-term price spikes, as well as longer-term upward trends create an economic drag on consumers as well as commercial and industrial enterprises in the state. Because nearly half of all households rely on home heating oil, and nearly all households rely on gasoline or diesel for transportation, price uncertainty and price spikes have a significant effect on Vermonters.

Exhibit 14-1. Prices for Petroleum Products in Vermont, 1970-2013 (2013 Dollars)



Source: EIA[367]

The recent downward trend in prices has led to a slight uptick in consumption although total consumption has not yet rebounded to pre-recession levels. Efficient vehicles and a drop in the vehicle miles traveled (VMT) are likely holding down demand in response to lower prices although if prices

[367] *EIA SEDS database. Motor Gasoline, Distillate Fuel Oil, and Liquefied Propane Gas Price data for Vermont. Last retrieved on 8/21/2015 at http://www.eia.gov/state/seds/.*

continue to stay low there may be increased demand. Prolonged depressed prices for petroleum products make efficiency investments and renewable, low-carbon alternatives less competitive. Consumers may be less likely to invest in electric vehicles, weatherization, or wood heating infrastructure. Low prices may motivate investment in petroleum-reliant infrastructure like new boilers or less efficient vehicles. These effects have not been observed yet, but may occur if prices remain low for a prolonged period.

The lower price of oil has made petroleum products more attractive in the regional electricity market, so during winter price peaking of natural gas, some electric generators have been switching to oil which is more polluting.[368]

14.1.2.2 Industry Consolidation

There has been consolidation among retail dealers of heating oil and propane in recent years. Demand for home heating oil has been steadily dropping. As fewer gallons are sold, fewer dealers can economically compete for business. Traditionally most heating fuel dealers were small second- or third-generation family-owned businesses.[369] Although there are still many small businesses, consolidation has resulted in an overall decline in the number of retail sales operations. Because petroleum products are "unregulated" at the state level (meaning prices and supply are driven by market forces rather than being set by the state), a functioning competitive market is crucial for fair and efficient pricing. As consolidation continues, it is important to monitor market power to ensure competitive pricing. Maintaining market competitiveness is also important in the retail gasoline market.

14.1.3 Resources

All petroleum products consumed in Vermont are imported. There are no known petroleum reserves in the state. The state spends nearly $2.3 billion annually on petroleum products which are extracted and refined elsewhere. That's about 8% of the state's GDP. This represents a significant flow of financial resources away from the state's economy. Some small percentage of those expenditures remains in the state with retailers which are often small business franchise owners.

Petroleum products are imported to Vermont via a variety of mechanisms, although Vermont is relatively isolated from major supply lines and pipelines. Albany, NY, Montreal, Quebec, Portsmouth, NH, and Portland, ME are all major hubs for petroleum products in the Northeastern region, providing heating oil, gasoline and other refined products to Vermont via rail and tanker truck. Most of the products consumed in Vermont are refined at major east coast refineries in New York and New Jersey or at refineries in St. John, New Brunswick, Canada. Some refined products are stored and distributed from facilities on the Burlington waterfront. These products are imported via rail from Albany and Montreal. Major supply disruptions can occur if rail or truck traffic is interrupted between these cities and Vermont or if refineries

[368] ISO New England 2015 Regional Energy Outlook. January, 2015. Last retrieved on 8/13/2015 at http://www.iso-ne.com/static-assets/documents/2015/02/2015_reo.pdf.

[369] Matt Cota, Vermont Fuel Dealers Association, 2011 VFDA Heating Fuel Fact Sheet.

on the east coast go offline. Because a majority of Vermont homes and businesses rely on petroleum products for heating, transportation, and production, disruption of supply can cause serious effects especially during winter.

Exhibit 14-2. Petroleum Delivery Infrastructure in the Northeast

Source: EIA[370]

Heating oil supply disruptions are slightly buffered by the Northeast Home Heating Oil Reserve, maintained by the federal government which stores heating oil in Groton, CT and Revere, MA and sells it to private suppliers in the event of major supply disruptions or price spikes. The federal government also maintains the Northeast Gasoline Reserve established in response to disruptions occurring during Hurricane Sandy in 2013. The gasoline reserve holds one million gallons in three locations. The heating oil and gasoline storage locations are further away from Vermont than Albany and Montreal, where current supplies are usually procured. In the event that these reserve supplies are needed, prices would likely rise in the state, and fuel dealers would be forced to travel further to obtain supplies. There are no nationally maintained propane reserves in the northeast.

14.1.4 Benefits

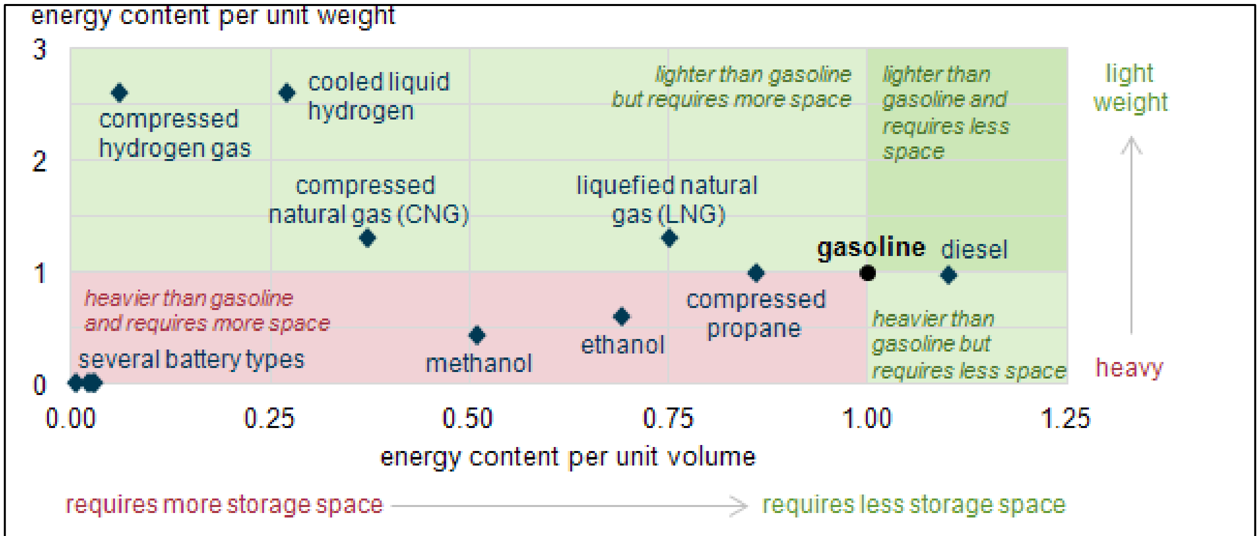
Petroleum products offer many benefits that make them an attractive option for transportation, heating, and industrial processes. They are energy-dense, easy to transport, supported by existing infrastructure, and they require very little labor on the part of the end user.

Petroleum products are the among the most energy dense fuel sources available, which means they have a high energy content per unit of weight or volume. For transportation applications this especially attractive because vehicles must accommodate storage capacity for their own fuel. Electric batteries are heavy, and natural gas, even in a compressed or liquid form, takes up more space per unit of energy than

[370] *EIA. US Energy Mapping System. Last retrieved on 8/21/2015 at http://www.eia.gov/state/maps.cfm.*

gasoline or diesel. Gasoline and diesel remain the most energy-dense options by volume for transportation.

Exhibit 14-3. Energy Density of Transportation Fuels Indexed to Gasoline (Gasoline = 1)



Source: EIA[371]

Petroleum products are liquid which means they can be easily transported via tanker truck, tanker ship, pipeline, and rail car. Unlike many renewable energy options, petroleum products can be stored and burned on demand to produce energy.[372]

In 2014, low-sulfur heating oil rules went into effect in Vermont. The rules reduced the amount of sulfur to under 500 ppm in 2014, and will reduce sulfur to under 15 ppm by 2018. Removing sulfur from heating oil will improve the efficiency of existing equipment and allow for installation of high-efficiency condensing oil heat boilers. The removal of sulfur reduces SO_2 emissions as well as PM10 and PM2.5. These emissions contribute to respiratory illness in the state, so ultra-low sulfur heating oil will reduce the negative health impacts of petroleum.

Existing infrastructure supports the use of petroleum. Refined petroleum products have been widely available since the early 1900s, and by the 1950s oil surpassed coal as the most important energy source in the US. For decades infrastructure investment has been driven by low prices for petroleum products. From funding highways over railways to zoning low-density suburbs, public policy at the local, state, and national levels has assumed continued, affordable access to petroleum products.

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[371] *EIA, Today in Energy, Feb. 14, 2013. Few Transportation Fuels Surpass the Energy Density of Gasoline and Diesel. Last retrieved on 8/25/2015 at http://www.eia.gov/todayinenergy/detail.cfm?id=9991.*

[372] *Wood, biodiesel, ethanol, some hydro facilities, and battery storage are renewable options that also can function "on demand" although those sources are not practical for all applications for other reasons.*

As a result, billions of dollars have been invested in public infrastructure and privately owned equipment that supports or relies on petroleum. For example, in Vermont about half of residences heat with oil which means they have a significant investment in an oil furnace.[373] Those homes are unlikely to switch to wood even if wood is more affordable because they likely do not own an adequately-sized wood stove. About 72% of Vermont homes have either a wood-stove or a fireplace as a back-up source of heat. The same is true in transportation because many homes and businesses already own gasoline-powered vehicles. Petroleum can be easily used throughout this system without any adaptation or additional capital costs.

14.1.5 Challenges

Even with its many advantages, petroleum presents a litany of challenges for the state. GHG emissions and other air pollutants from petroleum are high when compared with natural gas and renewables. The supply of petroleum is vulnerable to disruption from natural disasters and unexpected events along key supply lines. The price of petroleum is extremely volatile in the short term, and upward-trending in the long-term. Any policies the state adopts to address these concerns will have wide-ranging ramifications for every sector.

Petroleum fuels are among the most heavily polluting fuels in Vermont's portfolio. Petroleum products used for transportation and in other equipment, such as construction and garden equipment, are Vermont's largest source of these pollutants: GHG emissions; air toxics; volatile organic compounds; nitrogen oxides; fine particulate matter (PM); carbon monoxide; and carcinogenic compounds such as benzene, aldehydes, and butadiene. These pollutants are known to cause cancer, aggravate respiratory diseases such as bronchitis and asthma, and put young children, developing fetuses, and older adults at an increased risk of pulmonary diseases.[374] Second only to coal, gasoline and distillate emit the most carbon dioxide per unit of energy emitted of any fossil fuel source (around 160 lbs. per million BTU). Propane performs only slightly better at (139 lbs. per million BTU). Efficient equipment, blending biofuel, and emissions control devices can reduce these emissions.

The supply of petroleum products in the state is vulnerable to disruption which can increase price and make fuel inaccessible to many. Inclement weather, international and domestic production or refining disruptions, or supply line disruptions can all cause supply in the state to drop. Global economic forces affect the price and availability of fuel. Smaller-scale events, such as a downed train line into Albany, NY, a major supply hub for Vermont, could affect the supply of gasoline, propane, and heating oil. Because petroleum constitutes such a large portion of Vermont's energy use, understanding and responding to disruptions in supply is critical to ensure energy security for Vermonters.

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[373] *Vermont Single-family existing homes Onsite Report. NMR Group Inc. for the Vermont DPS. 02/15/2013. Last retrieved on 8/25/15 at http://publicservice.vermont.gov/sites/DPS/files/Topics/Energy_Efficiency/EVT_Performance_Eval/VT%20SF%20Existing%20Homes%20Onsite%20Report%20-%20final%20021513.pdf.*

[374] *Vermont Department of environmental conservation Air Quality and Climate Division. "Mobile Sources Section." Last accessed on Aug. 6, 2015 at http://www.anr.state.vt.us/air/MobileSources/index.htm.*

Prices for petroleum products are set by market forces. Since 2000 prices have been trending upward, with an interruption in that trend during the great recession and again during the recent price drop due to changing supply and demand conditions. Since 2005, when natural gas and petroleum prices were decoupled by advances in extraction technology for gas, prices for petroleum products have consistently been higher than prices for natural gas which has led to a regional shift to natural gas for some energy applications, namely electricity generation and home heating where the natural gas supply infrastructure exists. Wood has provided an economic alternative for home owners for decades with greater incentive during the periods when petroleum prices spike. The unpredictability of oil prices makes planning difficult for businesses and residents in the state and can affect fuel access for some economically vulnerable residents when prices spike.

As discussed earlier, historical decisions about infrastructure have been supported by relatively inexpensive prices for petroleum products. Capital investments in petroleum-dependent equipment and infrastructure represent a significant sunk-cost in Vermont. These investments "lock-in" users to a specific fuel source. As systems reach the end of their useful life, it is important to consider replacing them with systems that can use renewable fuel types such as electricity, wood, or higher blends of biofuels. In the meantime, adding renewable fuels, such as biodiesel, to petroleum supplies can reduce the negative impacts of transportation and heating on the environment.

Strategies and Recommendations

Moving to Renewable Alternatives

In many applications where efficiency and renewable alternatives can replace petroleum, the state is implementing policies to move away from petroleum use. Because petroleum is sold in unregulated markets, there is little the state can do directly in the petroleum markets to encourage efficiency and alternatives. Strategies for moving away from petroleum, including weatherization, transportation alternatives, electrification, and others can be found throughout this plan. Because the primary applications of petroleum in the state are home heating, water heating, and transportation, it is critical to create viable alternatives in those areas. For detailed recommendations about space heating, see Chapter 7. Developing alternatives in transportation remains one of the most challenging areas for reducing petroleum use. Encouraging a market for liquid biofuels that can directly replace petroleum is one important strategy. For specific recommendations see the Liquid Biofuels section of chapter 13. For details and recommendations about transportation more generally, Chapter 8.

Maintaining Emergency Preparedness

New England states and fuel dealers participate in regularly scheduled conference calls to discuss any issues related to petroleum 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 used to discuss the status of the fuel supplies, and strategies to restore supplies.

The statewide Energy Assurance Plan, originally drafted in 2013, will be updated during the fall of 2015. The purpose is to plan for emergency disruptions in energy supply across all resources, including liquid petroleum fuels. The plan includes an energy supply disruption tracking process, which is used to collect data on supply disruption events in an effort to learn from these events and minimize the disruption of future events. The DPS is the lead agency for State Support Function 12 (Energy), which includes thermal energy, energy for transportation, and energy to power communications. SSF12 is responsible for providing information to Vermont Emergency Management on the status of fuel supplies during an emergency.

1) *All state agencies should take into account market dynamics and petroleum prices when designing programs to support low-carbon heating and transportation alternatives, especially during time of low petroleum prices when alternatives are less competitive.*

2) *DPS, in conjunction with Vermont Emergency Management, should continue long-term energy assurance planning to monitor liquid fuel supplies and respond to emergency shortages.*

14.2 Natural Gas

14.2.1 Overview

Natural gas is an odorless, colorless gas that consists mostly of methane, but also contains ethane, propane, butane, and pentane. Most natural gas contains added sulfur to give it a characteristic smell that allows for the easy detection of leaks.

Natural gas accounts for a small part of Vermont's total energy use. Use is relatively low in Vermont because natural gas distribution is limited to the northwestern corner of the state and the population is highly dispersed. In the New England region, which shares an electric grid, natural gas is a major fuel source. Vermont relies on natural gas at the regional level to provide electric power especially when renewable intermittent sources are not generating, and it is also used extensively and increasingly for heating and industrial processing.

Major applications for natural gas in Vermont include residential and commercial space heating, water heating and cooking, and industrial processes. Efficient new technologies such as natural gas–powered cooling systems and heat pumps are beginning to compete with electricity in other end uses. Compressed natural gas is being introduced as a fuel for commercial and industrial facilities and there has been a small increase in its use for transportation, especially for fleet vehicles.

Natural gas is not as environmentally friendly as renewable energy, but it is currently less expensive. It is also cleaner than other fossil fuels, when properly extracted and distributed. However, exposure to supply disruptions, price volatility, the region's heavy dependence on natural gas for electric generation, and greenhouse gas emissions associated with the fuel are all reasons for caution. Adding "biogas" to the natural gas distribution system makes natural gas a more attractive option. Biogas is renewable methane produced by decomposing organic matter such as cow manure or material in landfills, which is then captured and burned to generate electricity or for other applications.

14.2.2 State of the Market

In 2013, the most recent year for which data are available, Vermonters consumed 9,512 MMcf of natural gas, accounting for about 6% of the state's total delivered energy use. The residential sector consumed about 36% of the state's total natural gas, the industrial sector consumed 14%, and the commercial sector consumed 50%. The electric power and transportation sectors accounted for less than 1% of statewide natural gas use. The residential sector uses natural gas primarily for space and water heating. An estimated one in six households use natural gas as their primary space-heating source.[375]

The commercial sector is the fastest-growing area for natural gas use because compressed natural can be trucked to areas where pipeline infrastructure is lacking. Overall usage in the state is going up as

[375] *EIA, Vermont Profile Analysis. Last accessed on 8/14/2015 at http://www.eia.gov/state/analysis.cfm?sid=VT.*

compressed natural gas becomes available for commercial and industrial applications and pipeline infrastructure expands.

Vermont Gas Systems is the only regulated natural gas distribution utility in the state. It serves over 40,000 customers. Natural gas delivered via pipeline is currently available only in the northwest corner of the state, in portions of Franklin and Chittenden Counties. An expansion of the pipeline system is underway to provide natural gas to densely populated portions of Addison county.

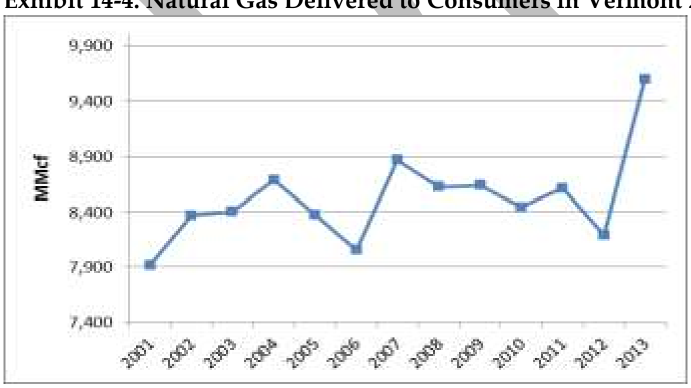
Vermont Gas Systems obtains its natural gas from Canadian supplies in Alberta, and Ontario and it is transported to Vermont via a TransCanada pipeline. Vermont Gas Systems also maintains a liquefied petroleum gas supply (propane). Propane is mixed with natural gas during the peak periods when demand is greater than what the pipeline can supply. This allows VGS to supply its customers without costly firm contracts.

Another natural gas company, NG Advantage, serves customers in Vermont and neighboring states by compressing natural gas at its station in Milton, VT, and delivering it via tanker truck to large commercial and industrial users. The use of compressed natural gas is increasing because natural gas is competitively priced, and compressed natural gas can be delivered to customers who do not have access to pipeline infrastructure.

Although the PSB has authority to regulate compressed natural gas companies under 30 V.S.A. § 203(1), it has exercised its discretion not to require them to obtain a CPG pursuant to 30 V.S.A. § 231, instead relying on competitive market forces to control rates, service quality, and reliability.[376] Supply of compressed natural gas is not guaranteed by state reliability requirements.

Overall increases in natural gas consumption in the state since 2011 are being driven by a rise in consumption of compressed natural gas in industry and transportation, an expansion of the distribution system by VGS, and colder winter weather.

Exhibit 14-4. Natural Gas Delivered to Consumers in Vermont 2001-2013 (MMcf)



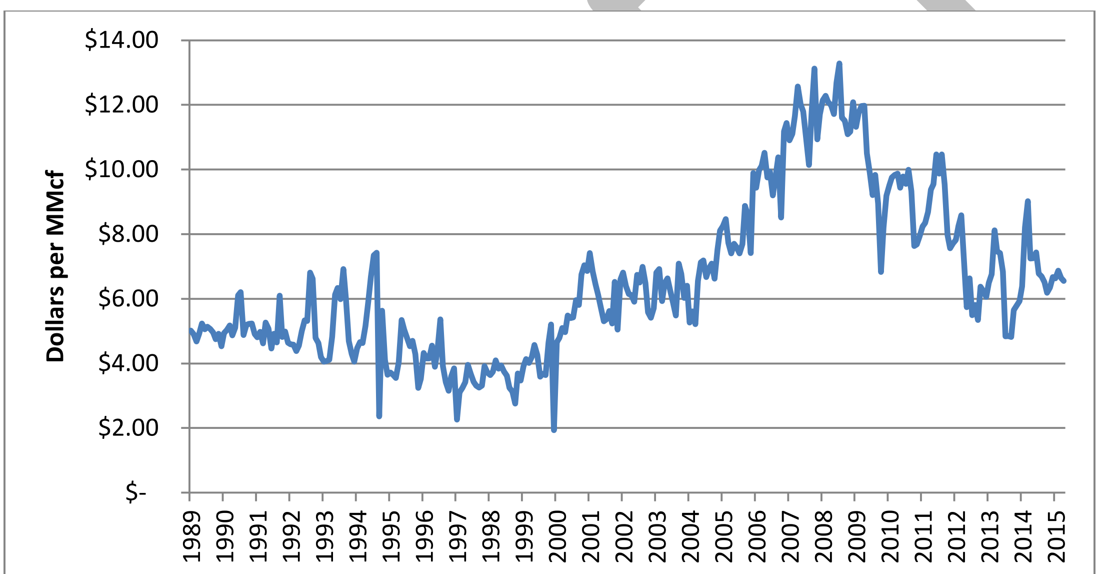
[376] *Vermont Public Service Board Docket Number 7866, Declaratory Ruling Re: Regulatory Status of NG Advantage LLC. Entered 10/10/2012. Last retrieved on 9/10/2015 at* *http://psb.vermont.gov/sites/psb/files/orders/2012/2012-10/7866%20Final.pdf*

Source: EIA[377]

Shale gas discovery and extraction has driven recent natural gas prices lower. 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. 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 costs for natural gas and gas-fired electric energy.[378]

Vermont, along with other New England states, participated in an Avoided Energy Supply Costs study to develop reasonable cost estimates of energy consumption. The study forecast shows that New England natural gas prices are expected to increase moderately, but remain relatively low because of high levels of supply.[379]

Exhibit 14.5. The Wholesale Price of Natural Gas in Vermont 1989-2015 (2015 dollars)



Source: EIA.

Although prices are projected to remain relatively low on average, volatility in price has increased dramatically in recent years. Winter price spikes for natural gas during the 2011-2012, 2012-2013, and 2014-2015 heating seasons caused concurrent price spikes in the regional electricity markets because

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[377] *Energy Information Administration, State Energy Data System, Natural Gas Consumption for Vermont.*

[378] *Avoided Energy Supply Costs in New England: 2015 Report. Synapse Energy. Last Accessed on 8/21/2015 at* *http://publicservice.vermont.gov/sites/DPS/files/Avoided%20Energy%20Supply%20Costs%20in%20New%20England%202015%20Final.pdf*

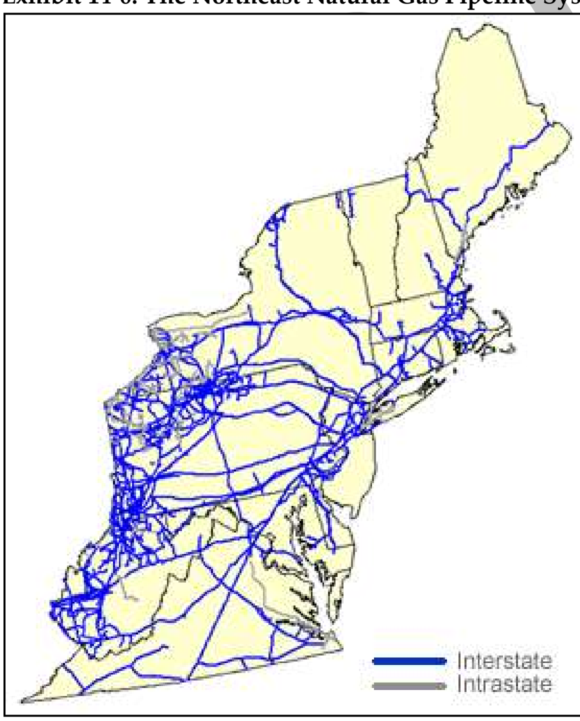
[379] *"Avoided Energy Supply Costs in New England: 2015 Report" Synapse Energy. Last Accessed on 8/21/2015 at* *http://publicservice.vermont.gov/sites/DPS/files/Avoided%20Energy%20Supply%20Costs%20in%20New%20England%202015%20Final.pdf*

marginal units in New England generally use natural gas acquired under interruptible contracts. Residential consumers in Vermont are insulated from these price spikes because, as a regulated utility, VGS maintains a supply of propane which can be added to the system in the event of supply disruptions. Although market prices can be volatile, VGS engages in a comprehensive hedging program, which limits customers' exposure to short-term price volatility. Inter-seasonal price volatility in the natural gas market is likely to increase as more natural gas electric generating units come online in the New England market to replace retiring coal stations, unless and until natural gas infrastructure in New England provides adequate capacity for these generating units when they are needed.

14.2.3 Resources

Vermont does not contain any known gas reserves. Gas is imported to the state via a pipeline from Canada. Vermont Gas Systems imports natural gas from the gas fields of Alberta and Ontario, Canada via a TransCanada pipeline at Highgate. From there the gas is distributed to over 40,000 customers via 650 miles of underground lines. The state is not connected to the regional New England pipeline system. Recently proposed expansions in the pipeline system in New England, such as the proposed Northeast Energy Direct pipeline in Massachusetts, will not affect prices for wholesale gas in Vermont. Expansions will likely lower the wholesale price for electricity that Vermont electric utilities pay during winter peaking events.

Exhibit 14-6. The Northeast Natural Gas Pipeline System



Source: EIA's Natural Gas Pipelines in the Northeastern Region.

14.2.4 Natural Gas for Electricity Generation

Natural gas is a secondary fuel source for the wood-fired McNeil generator in Burlington; however, there are currently no electric facilities that burn natural gas as a primary fuel in Vermont. Due to Vermont's participation in the regional wholesale electricity market and the increasing importance of gas-fired generators in the system's resource mix, New England's gas pipelines are a crucial resource to ensure reliable electric service in Vermont.

Approximately 44% of net electric energy in the region currently comes from natural gas generators.[380] There is an inadequate supply of natural gas at the regional level during cold periods to maintain low and predictable prices for electricity. There are several factors underlying this shortage. Pipeline infrastructure in the region is functioning at full capacity during many of the winter hours with no room to ramp up supply during peak demand. The vast majority of natural gas generators do not have firm contracts with gas pipelines for delivery of fuel, and consequently these generators are not able to receive natural gas during periods of very cold weather when gas is being used for heating needs. Some generators can use oil or propane as an alternative, but these fuels are often much more expensive than natural gas and more polluting. Finally there is very little natural gas storage capacity in the region, so generators cannot stock up when natural gas is abundant.

Although Vermont's electric portfolio currently has only a moderate exposure to natural gas price volatility, increasing Vermont's dependence on market purchases would expose Vermont's electric distribution utilities to additional electric price volatility, and in the long run could raise prices for consumers.

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 specific quantity of electricity at a designated time, and natural gas plants are currently meeting this need regionally. 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.

14.2.5 Siting and Permitting

Siting and permitting of energy infrastructure is governed by 30 V.S.A. § 248 which outlines criteria to ensure that development will promote the general good of the state. Permitting is a broadly focused process that takes into account economic benefits, environmental benefits and impacts, orderly development and many other concerns. Siting concerns pertain to the proposed location of infrastructure and the potential impacts associated with the construction and operation of the pipeline. Natural gas pipelines and their associated infrastructure can at times invoke conflicts and competing priorities.

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[380] *ISO New England, Resource Mix. Last accessed on 8/21/15 at http://www.iso-ne.com/about/what-we-do/key-stats/resource-mix.*

Developers of new pipeline projects within the state must apply for a CPG from the PSB. Applications are evaluated by the PSB using standards outlined in Vermont statute, Title 30 § 248. Pipelines crossing state borders are regulated by the Federal Energy Regulatory Commission, so any proposed pipelines connecting Vermont to neighboring states or to the regional pipeline system would fall under federal jurisdiction. Eminent domain may be applied to site pipelines which receive a CPG, and easements granted to pipelines include the right to conduct monitoring and maintenance. As with other sources of energy, siting of natural gas infrastructure should be undertaken with a thoughtful consideration of competing uses and energy needs.

Pipelines are buried underground, so visual and noise impacts are minimal. However, construction requires that a right of way be cleared and maintained and that pipeline be laid. A portion of the right of way continues to be mowed and maintained for the life of pipeline, in order to prevent roots from woody vegetation from impacting the underground infrastructure. In previous siting cases parties have raised concerns about impact to agricultural soils, vegetative management on farms in pipeline corridors, and impacts to endangered or threatened species, significant natural communities, wetlands, and archeological sites.

These concerns can be avoided or minimized by choosing pipeline routes that follow corridors already impacted by transportation or electric infrastructure and through specific mitigation measures such as burying pipeline deep below agricultural soils, replacing topsoil after construction, routing around sensitive natural and historical areas, and drilling deep beneath wetlands and streams rather than trenching from the surface.

Parties have also raised concerns regarding the GHG impacts associated with the expansion and operation of natural gas pipelines in Vermont. An expansion of the pipeline and use of more gas will raise consumption of fossil natural gas in the short-term; however, the gas mix might include a rising percentage of renewable natural gas from digesters, landfills, and other renewable sources over the long-term. Capturing methane released by decomposing waste or manure and adding it to the pipeline system to be used in homes and businesses has substantial climate benefits because methane is a GHG 20 times more powerful than carbon dioxide.

Renewable gas can be produced locally, keeping energy spending in-state. Building on the experience of using methane digesters to produce gas that is burned to generate electricity, entrepreneurs are developing methods to produce renewable gas and deliver it large institutional users or directly into the pipeline system. One such project in Salisbury, VT, recently applied for a CPG.

An expansion of Vermont's pipeline system to connect to the U.S. pipeline system will improve reliability in the event of pipeline disruptions in Canada and provide access to a wider market which may provide more affordable gas. Connection to the U.S. pipeline system may also facilitate the purchase of renewable natural gas from areas outside Vermont. Although such large-scale projects are still years away, pipeline infrastructure lasts for decades and could be used when renewable gas becomes more widely available. Renewable gas is chemically identical to fossil gas, and therefore compatible with pipeline and end-use equipment.

Compressor stations are required to maintain adequate pressure in the pipeline. Compressor stations are sited above ground and can have impacts on the surrounding area including visual and noise impacts. Impacts may be remediated with screening and setbacks.

In 1994 VGS began a multi-year project to expand the capacity of its natural gas transmission system. The company added a loop from the U.S.-Canada border to Swanton, then on to St. Albans. In the summer of 2007, the company expanded its distribution system to make natural gas available to 650 homes and a number of businesses in Jericho village. The company subsequently expanded to Hinesburg and Underhill.

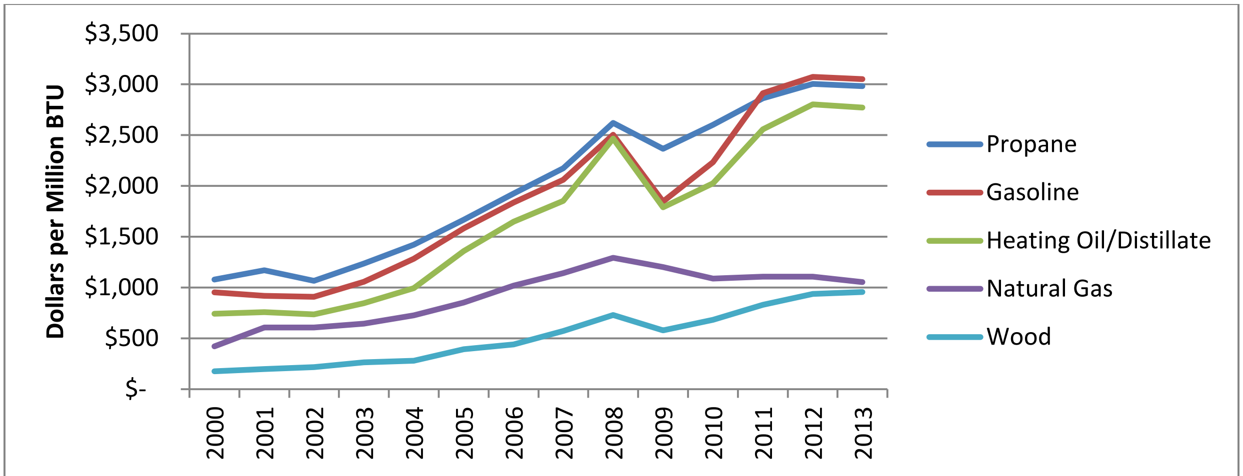
In 2012, VGS applied for a CPG to construct an extension of its pipeline network to bring service to Addison County. The expansion was approved by the PSB in late 2013, and construction is underway. Any future in-state expansion of the natural gas transmission pipeline network by VGS or other companies would undergo a rigorous process of review by the PSB.

14.2.6 Benefits

Natural gas is relatively clean and inexpensive when compared to other fossil fuels and can be used in many applications where renewable sources cannot. Natural gas prices are expected to remain low because of ongoing development of shale gas. Because natural gas is inexpensive and stably priced relative to other fossil fuels, it offers a substantial economic development opportunity for communities with access to pipeline infrastructure or for large institutions using compressed natural gas delivered by tanker trucks.

Many industrial processes require large amounts of energy delivered on demand, which is currently unrealistic for intermittent renewable energy sources. Fossil natural gas has a significant role to play in ensuring an affordable and stable cost of living and doing business in Vermont. The state should foster opportunities to substitute natural gas for other fossil fuels in strategic areas where renewable energy is not feasible. Over time efficiency, expansion of biomethane production, and power to gas technologies that use excess renewable generation to create synthetic methane, may replace fossil natural gas with renewable gas. Renewable gas can be used in infrastructure developed to distribute and use fossil natural gas without any modifications to equipment.

Exhibit 14.7. Energy Price by Fuel Type, 200-2013 (2013 Dollars)



Source: EIA[381]

Because gas can be burned when it is needed, it can provide energy on demand. In applications where renewable energy or efficiency cannot provide appropriate energy services, it is more desirable to use natural gas than to use other fossil fuels. These applications include providing reliable electric power when renewable sources are not generating, medium and heavy-duty transportation, space heating where wood is impractical such as at large institutions, and many industrial processes that require large amounts of heat.

Natural gas is generally delivered through pipelines (instead of delivery trucks which are themselves polluting). Compressed natural gas delivered via tanker truck is more polluting than pipeline gas because of the transportation involved, but still less polluting than other fossil fuels because other fossil fuels are also delivered by tanker truck. There are already several large customers in Vermont receiving compressed natural gas including those at the Middlebury "gas island" being served by NG Advantage. In areas where pipeline infrastructure is not available or planned, and manufacturing processes require large amounts of energy, use of compressed natural gas may be preferable to use of other fossil fuels,

Currently, the energy efficiency utilities in Vermont offer customized incentives for switching to gas to customers using electric space and water heating in the natural gas service territory. As a designated EEU, VGS offers incentives for higher-efficiency furnaces, boilers, and water heating systems.

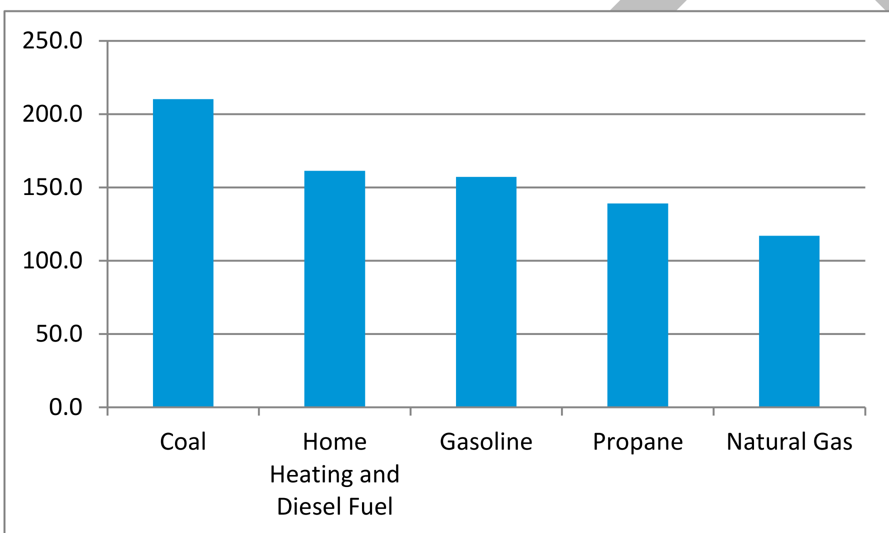
[381] EIA http://www.eia.gov/state/seds/sep_prices/notes/pr_print2009.pdf

14.2.7 Challenges

Natural gas suffers from the same environmental and economic concerns applicable to other fossil fuels, including concerns 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).

Among fossil fuels, natural gas generally emits the lowest levels of almost all pollutants per unit of energy.[382] Nitrogen oxide emissions from natural gas are lower 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 are significant; however, CO_2 emissions are lower than other fossil fuels.

Exhibit 14.8. CO_2 Emissions (lb/MMBtu)



Source: Enery Information Administration's "Carbon Dioxide Emissions Coefficient" last retrived on 8/15/2015 from http://www.eia.gov/environment/emissions/co2_vol_mass.cfm.

Leakage from natural gas distribution systems can have serious environmental consequences because methane, the primary component of natural gas, is a GHG 20 times more potent than carbon dioxide. However, the leakage rate from natural gas pipelines is estimated to be very small, and VGS's pipeline network is a relatively new system. The company has replaced all cast-iron and bare steel mains, elements that are a significant source of leaks in other states. Going forward, care should be taken to

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[382] *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*

continue to avoid methane leakage in any future distribution or transmission pipeline construction and maintenance of the existing pipeline system.

Hydraulic fracturing is a technique used to extract natural gas from shale and tight sands by injecting water, sand, and chemicals under high pressure to release gas. Hydraulic fracturing has resulted in extensive new supplies of natural gas coming onto the market, a drop in price, and the decoupling of natural gas and oil prices. Low prices for natural gas as well as a moderation in growth of electricity prices on the New England market are a result of the increase in supply of natural gas related to hydraulic fracturing. Vermont Gas Systems obtains supplies from a variety of suppliers in Alberta and Ontario, Canada. It is currently not possible to track whether gas used in Vermont is extracted using hydraulic fracturing because gas from several sources is mixed at purchasing hubs where VGS obtains much of its gas.

This extraction technique, when used without appropriate environmental controls, can impact water quality, air quality, and result in significant fugitive methane emissions. There are many best practices and technical solutions to limit the impact of hydraulic fracturing to climate, air, land, and water. Natural gas companies in Vermont should pressure its suppliers to obtain natural gas from sources that implement best practices to limit environmental impacts. The state should also work at the national level to improve environmental regulations pertaining to natural gas extraction.

Regulation of extracting shale gas may lead to reduced exploration and extraction in the future, adding costs and calling into question projected low prices. Additional state or national regulations may emerge to mitigate the environmental impacts of shale gas extraction on groundwater, surface water, and air emissions. Recently released EPA regulations of methane emissions in the extraction process will improve the overall environmental performance of natural gas.[383]

Strategies and Recommendations

Efficient and appropriate use of natural gas

Some fossil fuels are currently needed to provide reliable energy services on demand, and natural gas is the least expensive and least polluting fossil fuel option for many applications. Vermont can reduce the impact and extend the benefits of natural gas use by increasing natural gas efficiency and adding renewable biomethane, also known as renewable natural gas or RNG, to the natural gas mix.

1) *Vermont Gas Systems and regulators should consider the pace and availability of efficiency, efficiency that VGS has conducted in the past, and the pace of adoption of biomethane when considering expansion of natural gas service via pipeline or truck.*

[383] *EPA announced new regulatory actions pertaining to oil and natural gas extraction and processing on August 18, 2015. More information about these regulations are available at http://www.epa.gov/airquality/oilandgas/actions.html.*

2) *In applications where wood or sustainable biofuels are not appropriate, natural gas is being used to move away from petroleum products, and pipeline gas is not available or planned, there is role for the strategic and efficient use of compressed natural gas transported via tanker truck, to play in advancing the economic and environmental goals of the state.*

3) *DPS should continue to track trends in the use of compressed natural gas in both transportation and in natural gas "islands" or individual customers that are supplied by tanker truck.*

4) *The state should encourage the development of the biomethane sector by supporting proposals for appropriately sited, cost-effective biomethane production facilities and related infrastructure and approving the procurement of biomethane to add to the natural gas supply.*

14.3 Coal

14.3.1 Overview

Vermont does not consume any coal directly as a fuel source. There are several coal electric generating stations in New England, and because Vermont utilities purchase about 49% of their power from regional markets (after the sale of RECs is accounted for), coal is a source of electricity in Vermont. Vermont obtained 2.4% if its electricity from coal sources in 2013.[384] This number is likely to decline in the future.

Coal is one of the most polluting fuels available. It releases CO_2, CH4, and $N_2$0 which are GHGs contributing to climate change. Burning coal also emits NO_x, SO_x, CO, lead, mercury, and particulate matter. These pollutants are known to cause severe health effects including asthma, heart attacks, and other cardiovascular ailments.[385]

Coal to supply the New England grid is sourced from Virginia, West Virginia, Pennsylvania and as far away as Colombia, Venezuela, and Indonesia.[386] Because many of the largest coal generating stations are located on the coast, they receive shipments by barge from all over the world on an open, unregulated market.

Historically coal has constituted a significant percentage of New England's generating capacity, though now for a variety of reasons use of coal is declining. In 2014, coal delivered 5% of the electricity consumed in New England, a sharp decline from 18% just nine years before in 2005. Coal cannot compete against other resources in an era of low natural gas prices, stricter federal environmental requirements for mercury and hazardous air pollution, slowing load growth, and ageing plants. Two large plants are scheduled to go offline in 2017, Brayton Point and Salem harbor in Massachusetts. Plants still in operation are running at greatly reduced capacity because natural gas is cost competitive.

The federal Clean Power Plan, announced in August, 2015, sets reduced emissions targets for coal and natural gas plants. States have some flexibility in meeting EPA goals, but the new rule could result in the closure of additional coal plants in New England. All the New England states except Vermont must comply with the Clean Power Plan. Vermont does not have any coal or natural gas fired stations, so has no obligations under the rule.

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[384] *This is the most recent year for which data are available. For a more thorough discussion of how the sale of Renewable Energy Credits affects the mix of electricity purchased in Vermont, please see the Total Energy Study. Last retrieved on 8/24/2015 at http://publicservice.vermont.gov/publications/total_energy_study*

[385] *The EPA is charged with regulating these pollutants under the Clean Air Act. More information about the health effects of these pollutants was last retrieved on 8/24/2015 at http://www.epa.gov/airquality/urbanair/.*

[386] *New England Power Plants that Use Coal and Where the Coal Comes From. Appalachian Voices. Last retrieved 8/26/2015 from http://appvoices.org/resources/maine-legislation/Data-on-New-England-Power-Plants-Coal-Use-2008.pdf.*

14.4 Nuclear

14.4.1 Overview

Nuclear power continues to be an important source of electric energy for Vermont. Nuclear provides affordable, reliable baseload power. Utilities here either own or contract with nuclear facilities in the region. Several Vermont utilities have entered into long-term power purchase agreements with Seabrook Nuclear Station in New Hampshire to procure both capacity as well as energy. Green Mountain Power owns a 1.7% share of the Millstone 3 nuclear generating unit in Connecticut. Although no new nuclear facilities are expected, nuclear continues to be a key resource, providing power to the New England grid as well as to Vermont utilities. Vermont's only nuclear facility, Vermont Yankee, disconnected from the grid and was manually shut down in December 2014.

14.4.2 Resources

Currently, four nuclear power plants operate within the New England grid, with a total capacity 4,026 MW, supplying roughly 34% of the energy used by the region in 2014, the most recent year for which data are available. These units are operating nearly round the clock, with a 90% capacity factor. Nuclear energy will constitute slightly less of New England's use in 2015 when the retirement of Vermont Yankee will be reflected in the data. Vermont Yankee provided about 4% of the region's power in 2014. The plant closed for economic reasons. Low natural gas prices in the region have led to cost-competitive gas-fired plants taking over an increasing market share from traditional baseload sources.

Green Mountain Power also owns 1.7% of the Millstone 3 nuclear 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 GMP's supply requirements.

Green Mountain Power and the Vermont Electric Cooperative both have long-term power purchase agreements with the Seabrook Nuclear Station. Green Mountain Power expects to obtain about 500,000 MWh annually. In 2015, both utilities have also contracted for capacity from Seabrook to offset their obligation in the regional forward capacity markets. In total, GMP plans to receive about 10% of their power from nuclear in the near term. Vermont Electric Cooperative has entered into a contract with Seabrook Nuclear Station to purchase about 80,000 MWh annually.

14.4.3 Benefits

Nuclear power provides low-carbon, stably priced energy and capacity to Vermont utilities. Unlike intermittent renewable sources, nuclear power stations provide low-carbon electricity nearly 24 hours per day. Outages for maintenance and refueling are known well in advance, so grid operators can plan for them. In an era when capacity prices on the New England market are rising, nuclear can offer stably-priced capacity to meet utility obligations.

14.4.4 Challenges

There is no national solution for the permanent storage of radioactive spent nuclear fuel. Spent fuel is stored in pools constructed of concrete and lined with steel for a minimum of three years where it continues to cool in water. Following the pool-storage period, fuel is moved into dry casks at individual nuclear stations. Both storage pools and dry cask systems are regulated by the Nuclear Regulatory Commission.

The possibility of a nuclear disaster, however remote, is a lingering specter for the nuclear industry and for communities surrounding nuclear facilities. Following the a severe nuclear accident at the Fukishima Daiichi facility in northeastern Japan in 2011, emergency preparedness was called into question at nuclear plants in the US. In 2013, the Nuclear Regulatory Commission released a series of new rules to enhance safety at nuclear facilities including additional measures pertaining to individual and multi-reactors, spent fuel pools, flooding, and seismic protection. Public safety remains a high priority at nuclear facilities including a the Vermont Yankee facility where spent fuel currently remains in pool and dry cask storage even though the plant is offline.

Entergy Nuclear has requested an exemption from federal requirements to conduct emergency planning within a ten mile radius of the Vermont Yankee plant beginning in 2016. The state opposed the exemption, and litigation before the Nuclear Regulatory Commission is ongoing.

14.4.5 Site Decommissioning and Restoration

The Vermont Yankee facility is located in Vernon and is currently owned by Entergy Nuclear Vermont Yankee LLC, a subsidiary of Entergy Nuclear Operations, Inc. A decommissioning fund established and during its operation will cover the financial expenses of dismantling the plant and decontaminating the property. The Nuclear Regulatory Commission regulates the decommissioning process. As of this writing, Entergy Vermont Yankee plans to employ a "deferred dismantling" plan whereby structures are left in place and the plant in maintained until radioactivity decays. Then the plant will be disassembled and the site decontaminated.

In a resolution of longstanding litigation, the state and Entergy Vermont Yankee reached a settlement in December 2013. In the terms of the settlement, Entergy agreed to restore the site to support use of the property "without limitation" following radiological decommissioning.[387] A separate fund was established for this purpose. The Vermont Yankee site continues to be an active storage location for spent

[387] *The complete text of the Memorandum of Understanding between the DPS and Entergy Vermont Yankee is available at http://psb.vermont.gov/sites/psb/files/docket/7862Relicensing6/Docket_7862_MOU.pdf.*

nuclear fuel, and around 250 staff members will continue on at the site until 2020 when Entergy hopes to move spent fuel to dry cask storage. The dry cask storage units will remain in place until a national solution to the storage of spent nuclear fuel is settled. The dry cask storage areas are exempt from the restoration requirement of the settlement.

Strategies and Recommendations

(1) Vermont utilities and agents that are party to the negotiations of major contracts for nuclear power or capacity should help ensure that the smaller municipal and cooperative utilities gain access to those resource contracts on similar terms and conditions.

(2) The state should continue to advocate for effective oversight of all safety aspects of Vermont Yankee by the U.S. Nuclear Regulatory Commission.

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

(4) The state should work to ensure that Entergy funding of environmental monitoring and emergency preparedness is sustained as Vermont Yankee proceeds with decommissioning activities.

15 State Agency Energy Leadership

The final Comprehensive Energy Plan will incorporate an updated State Agency Energy Plan, currently under development by a working group of the Climate Cabinet and led by the Department of Buildings and General Services. This plan will identify concrete actions and goals for state government to lead by example in its own operations to implement many of the ideas and technologies described earlier in the CEP.

Appendix A: Power Sector Transformation in Other States

New York

Under the direction of the governor and the Public Service Commission, New York in 2014 initiated Reforming the Energy Vision, a formal investigation into power sector transformation. Under New York REV, the Public Service Commission is attempting to align markets and the regulatory landscape with policy objectives of giving customers new opportunities for energy savings, local power generation, and enhanced reliability to provide clean, and affordable electric service.[1] The PSC seeks to "reorient both the electric industry and the ratemaking paradigm toward a consumer-centered approach that harnesses technology and markets."[2] The NY PSC established two tracks for the efforts, the first track focused on markets and the second on ratemaking reforms. These will be brought together in future orders.

In January 2015, the New York Department of Public Service determined that "platform" refers to the Distribution System Platform role articulated by the PSC to describe how markets for electricity-related products and services would develop.

The Commission issued a major order on February 26, 2015, adopting a Regulatory Policy Framework and Implementation Plan ("Track 1 Order"). The Public Service Commission determined in its track one order that the distribution utility will provide the Distribution System Platform. However, the PSC made it clear that if competitive distortions arise, they will revisit this determination.

The next phase of the REV process involved stakeholder efforts. The New York Department of Public Service required staff of the department to convene and coordinate stakeholder working groups including representatives of the New York State Smart Grid Consortium (NYSSGC), and other closely related groups addressing market design and platform technology. This group became the Market Design and Platform Technology (MDPT) Committees.

The working groups were tasked with the following:

- Consider the next level of detail around market design and platform technology needed to move towards the DSP vision in the near term;
- Make recommendations on key market design and platform technology elements (e.g., DSP functions and responsibilities, products to be exchanged, required standards, etc.) needed in the near term and provide reports to the commission; and
- Provide guidance on these issues to inform utility Distributed System Implementation Plans (DSIPs).

[1] http://www3.dps.ny.gov/W/PSCWeb.nsf/All/CC4F2EFA3A23551585257DEA007DCFE2?OpenDocument

[2] New York State Department of Public Service. 2014. Case 14-M-0101 - Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision - DPS Staff Straw Proposal on Track One Issues at 3.

The MDPT issued a draft report on July 15, 2015.[3]

Among the recommendations of the report are the following:

- Enhanced distributed planning: The MDPT proposes that distribution system planners improve analytical capabilities related to DER hosting capacity, identify the locational net value of DER at specific geographic locations on the grid, and identify and prioritize locations where DER should be pursued to provide distribution system capacity and operational relief.
- Market access, platform, and distribution system optimization: Market access here refers to the elements of reform that enable and encourage markets and customer active participation by reducing barriers, increasing access to information, and leveraging the resources of the distribution utility to facilitate these things.

These topics cover fairly comprehensive and more detailed list of the areas covered and a reference point for the market-related actions and proceedings that are occurring in other states listed above. Other topics that are part of the New York process and typically enter into the larger set of issues around policy and regulatory environments necessary to foster effective use of DERs include the following:

- Rate design: This issue often arises in connection with issues around maximizing the value of DER. Dynamic rates and designs that provide incentives for controlled loads offer considerable potential to better match flexible loads with variable energy resources. Rate design and ratemaking issues are part of the track two process in New York.
- Access to the grid: Similarly, access and interconnection are of great importance in light of the considerable interest in connecting rooftop PV and other resources. Concerns for the stability of the grid sometimes weigh against interconnection in areas with high penetration of PV.
- Business models, incentives, cost recovery and performance-based regulation: How utilities recover costs and are incented to recover costs is of considerable interest as regulators look to encourage utility practices to conform to objectives for DER resources. Business models and incentive regulation are part of the track two process in New York.
- Demonstration projects: Examples of these changes working effectively on the ground are needed to advance the framework for optimal use of DERs. In a December 12, 2014 order, the PSC encouraged the investor owned utilities to partner with third party energy entrepreneurs to undertake demonstration projects that would further the REV vision. Developed in cooperation with universities, local government and local groups, utility demonstration projects were proposed for approval on July 1, 2015. Seven of the proposals were approved for further development.

California

California launched an effort in 2014 pursuant to legislative direction.[4] The state's investor-owned utilities are required to file Distribution Resource Plans with the California PUC to better integrate

[3] https://newyorkrevworkinggroups.com/wp-content/uploads/MDPT_Draft-Report_07.15.2015_final.pdf
[4] Assembly Bill 327.

distributed energy resources onto the grid.[5] These plans were filed July 1, 2015 and will be under review for some time. Unlike some other jurisdictions, this particular California process does not focus on issues such as the business model or cost recovery.[6] However, there is a list of parallel efforts around the broader set of issues that are implicated by an investigation into power sector transformation. Included in these are incentives and mechanisms to encourage market access from distributed generation and customer-side generation,[7] rate design proceedings have resulted in direction to utilities on rate submissions in the coming 5 years,[8] and proceedings related to alternative-fueled vehicles.[9]California's single state ISO is also working with the PUC on aligning wholesale and retail markets to improve the value of demand response.

What stands out in the California efforts is the use of Distribution Resource Plans. The plans filed with the commission address the infrastructure issues as well as many of the issues covered in the New York REV process, including rate design, data access, among others.[10]

Hawaii

Hawaii has the highest electricity rates in the US and good solar resource potential. Rooftop solar in Hawaii has been leading the US in the rate of adoption while also presenting challenges both to the utility intent on maintaining system quality, and customers who would like to participate in programs and capture the value of rooftop PV. In August of 2014, Hawaii opened a major investigation to "investigate the technical, economic, and policy issues associated with distributed energy resources ('DER') as they pertain to the electric operations of" its major electric utilities.[11] The investigation followed the public release of a commission white paper that presented the leanings of the Hawaii Public Utility Commission. The white paper that sets up the investigation covers a wide range of potential reforms, including in the areas of rate design, utility business models and incentives, data access, grid modernization, and planning.[12]

[5] California Utility Cost 769

[6] RMI Outlet, New York and California are Building the Grid of the Future, February 18, 2015, available at http://blog.rmi.org/blog_2015_02_18_new_york_california_building_the_grid_of_the_future

[7] http://www.cpuc.ca.gov/PUC/energy/DistGen/

[8] http://www.cpuc.ca.gov/PUC/energy/Electric+Rates/

[9] http://www.cpuc.ca.gov/PUC/energy/altvehicles/

[10] California Public Utilities Commission, Distribution Resource Plans, viewed on August 21, 2015 and available at http://www.cpuc.ca.gov/PUC/energy/drp/

[11] Public Utility Commission of Hawaii, Order Instituting a Proceeding to Investigate Distributed Energy Resource Policies, Order No., 32269, Docket No., 2014-0194, August 21, 2014, available at http://dms.puc.hawaii.gov/dms/DocketDetails?docket_id=84+3+ICM4+LSDB9+PC_Docket59+26+A1001001A14H14A84843E4191418+A14H14A84843E419141+14+1873&docket_page=4

[12] Public Utility Commission of Hawaii, Regarding Integrated Resource Planning, Docket No. 2012-0036, "Decision and Order No. 32052," filed on April 28, 2014, Exhibit A, "Commission's Inclinations on the Future of Hawaii's Electric Utilities; Aligning the Utility Business Model with Customer Interests and Public Policy Goals." Available at http://puc.hawaii.gov/wp-content/uploads/2014/04/Commissions-Inclinations.pdf

Massachusetts

Massachusetts has launched two proceedings related to power sector transformation. The first of these proceedings centers on planning and investment objectives for grid modernization. The second focuses on rate design.[13] The commission issued orders in these proceedings in 2014 and is in an implementation phase.

Michigan

The Michigan process involves a wide group of business leaders and energy advocates involved in a dialogue on the future of the state's energy policy.[14] The effort to date has been divided into three phases, with the implementation phase (Phase III) scheduled to begin in late 2015. It is still too early in this process to identify the areas on which Michigan intends to focus, but in general state regulators recognize that DER presents both opportunities and challenges that will have to be addressed.[15] A recently issued background report covers five topics: (i) codes of conduct for utilities, (ii) performance regulation, (iii) rate design, (iv) decoupling, and (v) infrastructure planning.[16]

Minnesota

Minnesota has engaged around the issues of DER through a stakeholder process led by the Great Plains Institute (GPI) called the e21 Initiative (short for 21st Century Energy System). The first product of this effort was a report that centers on issues of aligning the business model of the utility and the sector with the desired outcomes for DER. The effort focuses on two sets of issues: the limited options available to customers and the misalignment of utility regulatory incentives through traditional regulation that ties profits to sales.[17]

Among the recommendations of the Minnesota plan is the creation of an integrated resource analysis framework to replace integrated resource plans (IRPs). The concept here is to create an accessible planning process that provides timely and useful information to multiple parties that could use or participate in a more dynamic framework for meeting sector objectives at least cost.[18]

The Minnesota commission has opened a process on grid modernization and has not yet acted on other e21 recommendations.

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[13] Massachusetts Department of Public Utilities, Grid Modernization Home Page, viewed 8/19/15 available at http://www.mass.gov/eea/energy-utilities-clean-tech/electric-power/grid-mod/grid-modernization.html

[14] Roadmap to Implementing Michigan's New Energy Policy, Project Overview, available at http://www.michiganbusiness.org/cm/Files/Energy_Office/Project-Overview.pdf

[15] Public Sector Consultants, Roadmap to Implementing Michigan's New Energy Policy - Baseline Report, May 2015 available at https://www.nextenergy.org/wp-content/uploads/2015/08/MEO-DOE-Baseline-Research-Report.pdf

[16] RAP, Roadmap to Implementing Michigan's New Energy Policy, Paths to the Future Report, August 2015 available at www.raponline.org

[17] Great Plains Institute, e21 Initiative: Phase I Initiative, December 2014 available at http://www.betterenergy.org/sites/www.betterenergy.org/files/e21_Initiative_Phase_I_Report_2014.pdf

[18] GPI, at

Rhode Island

System Integration Rhode Island (SIRI) is a small collaborative designed to find ways to improve existing processes in order to capture the value of distributed resources. Like the Minnesota process, the SIRI initiative is an ad hoc stakeholder process whose recommendations will require the attention by regulators to become effective.

District of Columbia

The Public Service Commission of the District of Columbia issued and order opened an investigation into modernization of the energy delivery system for increased sustainability. The Commission states that "opens this proceeding to identify technologies and policies that can modernize our energy delivery system for increased sustainability and will make our system more reliable, efficient, cost-effective and interactive." [19] The Commission process is still in the early stages with initial comments due in August 2015, and the first workshop in September of 2015 that is intended to discuss future plans for the investigation.

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[19] Public Service Commission of the District of Columbia, June 12, 2015, Order Opening Investigation, Formal Case No. 1130, In the Matter of the Investigation into Modernization of the Energy Delivery System for Increased Sustainability, available at https://www.energymarketers.com/Documents/orderno_17912_FC1130.pdf

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