RAP Energy solutions for a changing world

Policy Options for Achieving Vermont's Renewable Energy and Carbon Targets

Prepared for the Vermont Department of Public Service

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I. Introduction

The purpose of this report is to provide an overview of the most promising technologies and policies available to Vermont as it crafts a plan for achieving the state goals referred to in Act 170 of 2012: 90 percent of the energy consumed across all sectors of the economy in the state will be renewable energy by 2050, and the state will reduce its greenhouse gas emissions by 75 percent from 1990 levels by 2050. The report is intended for use by the Department of Public Service to facilitate a stakeholder process in which discussions will be held about these goals and the means to reach them.

a. Vermont's Goals

The global scale of the climate change challenge, together with health, environmental, and other concerns associated with heavy dependence on fossil fuels, requires significant actions to resolve. Accordingly, Vermont established in the 2011 Comprehensive Energy Plan the goal of sourcing 90 percent of its energy from renewable resources by 2050 as a way to meet the statutory goal, established in Act 168 of 2006, of achieving a 50 percent reduction in carbon levels from a 1990 baseline by 2028 and a 75 percent reduction by 2050. Vermont's goals appear to be consistent with the scale of the global challenge. Vermont now needs to complement its statutory ambition with equally strong, effective policies to achieve these goals. To respond adequately, the policy interventions will need to be early, significant, and sufficient to ensure that the course corrections Vermont makes are consistent with the scale and scope of the challenges ahead.

Vermont's statutory initiative comes at a critical time, as the climate challenge is well established. In 2007, the United Nations' Intergovernmental Panel on Climate Change (IPCC) concluded, "[w]arming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level."[1] These changes over the past 50 years are very likely due to anthropogenic greenhouse gas increases and are likely have had a discernible influence at the global scale on many physical and biological systems.[2] The IPCC conclusions have been reinforced by widespread consensus among the scientific community:

> (i) 97–98 percent of the climate researchers most actively publishing in the field support the tenets of ACC [anthropogenic climate change] outlined by the Intergovernmental Panel on Climate Change, and (ii) the relative climate expertise and scientific prominence of the researchers

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[1] Intergovernmental Panel on Climate Change (2007).
[2] *Id*.

unconvinced of ACC are substantially below that of the convinced researchers.[3]

However, despite the apparent international scientific consensus on the challenge, current baseline projections by the United States Department of Energy (DOE) and the United States Energy Information Administration (EIA), as shown in Figure 1, continue to put the United States on a path of continued reliance on carbon-emitting fuels exceeding climate targets through the foreseeable future.

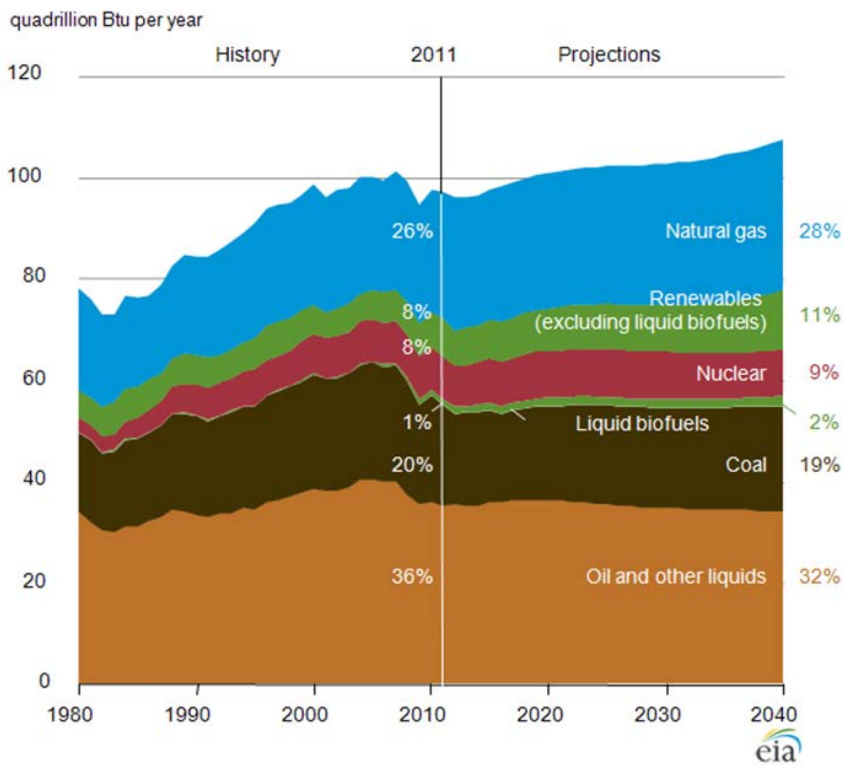

Figure 1: US Primary Energy Consumption by Fuel, 1980-2040

A number of factors will make this dramatic change even more challenging. For example, the slow turnover of the building and transportation vehicle fleet and the cumulative and persistent nature of carbon in the atmosphere underscore the need for decisive action now. Most transportation emissions come from passenger vehicles, with transportation accounting for approximately 28 percent of greenhouse gases nationally and about 47 percent for Vermont.[4,5] The average life of a car on the road today is 10.8 years.[6] According to the most recent

[3] Anderegga, *et al.* (2010).
[4] U.S. Environmental Protection Agency (2013d).
[5] Department of Environmental Conservation Air Pollution Control Division (2010).
[6] Gorzelany (2013).

inventory, fuel use in buildings accounts for about one third of greenhouse gas emissions in Vermont, and the average life of the building stock is quite significant. [7] While it is clear that these sectors require significant changes because of the scale of their impact on the environment, it is equally clear that the required transformation of such long lived and expensive items will be a challenge to achieve. To meet the state's energy and climate goals, the existing building stock will probably require new heating technologies and energy sources, and Vermont may need a significant electrification of the light duty vehicle fleet, coupled with a virtually complete shift from fossil fuel to biofuels for the remaining light vehicles using internal combustion engines (ICE). Biofuels or natural gas may become viable fuel options in the future for ICE-powered heavy duty vehicles.

The magnitude of the problem gives an indication of the scale and timing of the needed changes. It is important to recognize that the nature of Vermont's contribution to climate change is cumulative. Carbon dioxide molecules persist in the atmosphere for 50 to 200 years.[8] Thus, significant, concerted change is required earlier rather than later. Earlier changes are much more impactful than later changes because they prevent further cumulative damage to the environment. Significant steps early also help to reduce the impacts from the lock-in of highly polluting and inefficient capital items that later must be scrapped or retrofitted to maintain a path of achieving the 2050 objectives. Additionally, regional, widespread change is preferred over individual or local change because of the greater scale of impact that can be derived from regional efforts.

Once the scale and urgency of the challenge is understood, the type of policy interventions that make sense to pursue come into greater focus. Not all of the policy pathways to cleaner energy are equally grounded in the public interest. The costs and cost-effectiveness of these strategies will vary. Some of the pathways simply do not address the scale of the challenge, no matter how favorable the economic case. Other strategies leave Vermont more exposed to different types and magnitudes of financial risk. Some pathways are not well suited to pursuing at a municipal or state level due to scale diseconomies. In such instances, Vermont may need to play either the cooperating partner or advocate in the move to affect needed change at the regional, national, or even international level. Further, change cannot happen overnight. Government is advised to resist quick improvement schedules that meet public approval but may not allow the economy to adjust in an orderly way.

[7] Department of Environmental Conservation Air Pollution Control Division (2013).
[8] U.S. Environmental Protection Agency (2013b).

While the challenge is significant, there are some positive notes to sound. The cost of clean energy technologies is decreasing.[9] The electrification of passenger vehicles (the primary source of carbon in transportation) appears both a viable option and, perhaps, an increasingly inevitable pathway accepted by most analysts and pursued by the industry. Further, electric vehicles may prove to be less costly to operate than the current stock of internal-combustion vehicles. Investment in energy efficiency, an essential ingredient in the policy mix, grew dramatically over the last five years. In 2010 alone, Americans spent between $479 and $670 billion on energy efficiency goods and services.[10] Targets for energy efficiency investments are also growing rapidly globally. Electricity load growth stabilized in many regions of the U.S., including in Vermont, which has experienced negative load growth in recent years. There is also a growing appreciation that clean energy solutions are not just the right thing from the environmental standpoint, but also make sense from the standpoint of economic development and national security.[11] Furthermore, many states have taken up the environmental challenge and are moving forward at an impressive pace. 30 states established targets for renewable energy, and California and other states established carbon targets and participate in cap-and-trade programs. Electricity sector planning initiatives for high levels of renewables are taking place across the nation. All of these activities should give Vermont confidence that the climate challenge can be and is being met.

b. Impediments to Change

Before considering what policy options to employ in meeting Vermont's goals, one must first recognize that certain factors contribute to our continued dependence on carbon-emitting fossil fuels. Chief among them are:

- **Public understanding**: Even while the vast majority of the worldwide scientific community reinforces the conclusion that climate change is a manmade phenomenon largely driven by the use of fossil fuel, there are persistent voices in the United States casting doubt on that claim. In a democratic society like the United States, improving public understanding through quality sources of information and education will be a required step in any effort to take the right path on climate change.
- **Market, regulatory, and behavioral failures:** A host of market, regulatory, and behavioral failures are associated with the failure of markets to internalize certain "external" costs associated with the extraction, production, generation, and sale of the energy commodity. This dynamic masks the true cost of fossil fuels to our society and

[9] ClimateProgress.com (2013).
[10] Laitner (2013).
[11] CNA Analysis and Solutions (2009).

globe. These costs are ultimately borne separately by the public in the cost of health care, environmental quality, and national defense, to name only a few.[12]

- **Voter paradox:** As members of the global community, we are, in effect, faced with a dilemma analogous to that of the citizen voter or community volunteer. A rational voter acting only in her immediate self-interest might conclude that her vote is unlikely to produce benefits that will make the effort to self-educate and exercise the participation worthwhile. But, in the aggregate, such decisions (or abdications of responsibility) can lead to a general breakdown of the community. In a similar vein, the global community requires effective contributions from each member nation to overcome the shared threat of which they are all, in varying degrees, the cause. But this circumstance also creates a welcome and ironic opportunity. Early in the fight against global warming, the actions of a single nation or of even a single state, already beneficial to itself, can have wider and altogether disproportionate effects. This is the threat of a good example, and one need look no further than Vermont's leadership role in the development of the Regional Greenhouse Gas Initiative (RGGI) to see ample proof of its power.
- **Regulatory oversight:** The gas and electricity sectors have long existed as regulated natural monopolies. Sometimes regulators fail to create the frameworks necessary to encourage market participants to perform in ways consistent with the broader public interest. They may, for example, fail to adopt rate designs, planning frameworks, critical standards, or regulatory incentives that fairly align the public interest with consumer interests when making purchases or operator interests when planning for future system needs. This dynamic leads to over-investment in fossil fuel generation.
- **Entrenched interests:** The nature of any system is that the pre-existing economic interests also have a strong interest in resisting change that may adversely affect the status quo.

Once one recognizes these failures, policy options can be considered with these failures in mind. Well-conceived policy interventions and effective leadership, supported by a strong public commitment, are essential to ensuring markets are properly incented to overcome the failures noted above and deliver outcomes in line with the larger public good.

[12] Beyond the significant concerns for health and the environment that go under accounted, there are a host of other market failures commonly cited in the literature. The interested reader should refer to Helbling (2012).

II. Technology and Resource Pathways to Meeting Vermont's Goals

In order to achieve the objectives for renewable energy and carbon reduction, it helps to understand the technology pathways available for success. Technology options and pathways can change over time, and there is considerable inertia behind each pathway. Some pathways are more expensive or create greater risk of falling short of targets. Other pathways may be achievable even given the state of existing technologies. The following section discusses qualitatively the technology and resource pathways available to achieve the stated goals. It largely focuses on existing technology and promising developments.

a. Energy Efficiency and Load Management

1. Energy Efficiency

Studies for the state of Vermont to estimate the potential savings from cost effective energy efficiency consistently show the availability of a large reservoir of energy savings. Ratepayer funding from regulated energy sources (electricity and natural gas) has enabled aggressive capture of these savings. However, obtaining savings from the non-regulated sector has proven much more difficult. Significant, achievable savings are still available from the electric sector and the unregulated fuel sector, even assuming only current technology.[13,14,15] Improvements in technology can and will increase the energy efficiency of all sectors and create new opportunities for programs to augment savings opportunities. Capturing this energy efficiency resource will make it easier to achieve the state's goals. For example, to the extent that total energy use is reduced, a smaller absolute amount of renewables will be needed to meet the 90 percent target.

Many opportunities for improvement will come from forces moving at the national level. As is discussed more fully below, electric vehicles are making great strides toward achieving the full utility of gasoline powered vehicles and lightweight components also have the potential to increase the efficiency of gasoline fueled vehicles. Efficiency in the buildings sector is tremendously cost effective, and advances in windows, space conditioning equipment, heat pumps, and LED lighting will open up new opportunities for savings. Smartphone applications allow users to control appliances and lights remotely. Innovation in industry is making the

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[13] Vermont Department of Public Service (2007). A 12 percent reduction in total fuel consumption annually (on a combined MMBTU basis) in the residential, commercial, and industrial sectors is possible.

[14] Cadmus Group (2011). Energy efficiency could achieve a reduction of 25.4 percent of forecasted kWh sales in 2031, and 19.9 percent of 2031 forecasted summer peak demand.

[15] *Id*.

bottom line more competitive, with energy and process efficiency becoming a leading choice for plant managers to shave production costs.

Much can also be done on a regional or state level, working in conjunction with those forces driving efficiency nationally. One role of the state is to recognize trends emerging on a national level and create conditions that foster the adoption of new technologies or business practices in Vermont. The state already has an excellent efficiency resource in Efficiency Vermont, as well as Burlington Electric Department and Vermont Gas Systems. In addition to the efficiency services they provide homeowners and businesses in the state, Efficiency Vermont has built relationships with contractors and retail outlets that will prove invaluable in bringing new technologies to the unregulated fuels market. Leveraging Efficiency Vermont will be critical to the success of additional efficiency efforts in Vermont. Other policies and actions by the state can make it more likely that residents will adopt efficient technologies and habits in the future.

The strong local voice of many concerned citizens and their ability to organize around a crucial issue like energy efficiency, are resources Vermont cannot overlook. Harnessing this power can give Vermont a strong ally in its efforts to meet the state's energy and climate goals.

2. Load Management and Storage Capabilities

Increasing the penetration of renewable energy sources in the electric resource portfolio will necessitate the introduction of balancing resources that can function to match the intermittent nature of renewable supply resources with the load. Some renewable energy is variable because it relies on the wind blowing or sun shining to generate energy; this means energy production can go up and down outside of the control of system operators. This differs from traditional generation, which can be dispatched at will to meet the existing demand for electricity. Balancing resources are those resources the system operator uses to make up the difference between existing demand for electricity and the currently available amount of renewable energy. These balancing resources can come from a variety of sources, including quick response generation or storage capabilities (batteries or vehicle to grid applications hold promise for the future). However, there is considerable inexpensive flexibility and storage capability on the customer load side – from controllable loads, especially those with thermal storage capacity, and demand response initiatives. The old paradigm that generation must be prepared and able to meet whatever load appears on the system is changing with the advent of advanced metering systems, smart grid, and remote load control devices.

Tremendous potential exists to control electric water heaters. In New England, about one third of the water heaters are electric, and controlling these through smart meters or other technology represents an inexpensive, low-tech, already deployed resource that could be harnessed to support renewable integration.[16] ISO-New England already has seen significant growth in its demand response programs, and advances in technology will allow more and smaller loads to participate economically in this market through aggregators and other service innovators.

On the load side, the price of batteries for electric vehicles is decreasing while performance is improving. As penetration of electric vehicles and charging stations increases, vehicles could become an important balancing resource. Vermont and New England could also look to Hydro Quebec with its controllable hydro system as a large scale balancing resource.

b. Fuel Choice

1. Electrification

Several large studies have concluded that achieving carbon reduction objectives on the order of Vermont's goals cannot be accomplished through efficiency improvements alone.[17] Renewable systems must play a major role, and the significant electrification of both the transportation sector and the buildings sector will be necessary to meet Vermont's greenhouse gas reduction goal. Electrification of buildings impacts assets with long lives, so developing responsible policies in the near and long terms to promote electrification of end uses in buildings will contribute to meeting the state's goals, provided they are supplied with sufficient renewable and non-carbon emitting electric generation.

Technology is developing to enable this, and policy can push it faster. Electric heat, long on the list of undesirable technologies, is now poised to cost effectively harness renewable energy in the form of efficient air source heat pumps that can operate adequately in the Vermont climate.

i. End Use: Electric Vehicles

The transportation sector comprises a significant percentage of Vermont's fossil fuel energy use and produces substantial emissions. Advanced vehicle technologies, such as plug-in hybrid electric, full battery electric, and fuel cell electric vehicles, can contribute to the electrification of the transportation sector, replacing gasoline powered cars. When combined with electric generation resources powered by renewables, the use of electric vehicles offers the potential for important reductions in Vermont's fossil fuel use and related greenhouse gas emissions.

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[16] Energy Information Agency (2009).

[17] See European Climate Foundation (2010), Johnston & Wilson (2012), and Maryland Electric Vehicle Infrastructure Council (2012).

In addition, an electric vehicle fleet, coupled with existing smart grid technology can provide utility grid load and supply management benefits. A 2012 Fraunhofer Institute study showed that in California, and in a beneficial but lesser extent in Germany, plug-in electric vehicles can even out the intermittent nature of renewable generation and contribute to the integration of renewables to the grid.[18]

Adoption of electric vehicles experienced a slow start for several reasons, not least of which is the current retail cost of the vehicles. In addition, there is very little infrastructure in place for charging vehicles in public, increasing the so-called "range anxiety" of would-be electric vehicle owners who fear the vehicles will limit their mobility beyond a localized area close to home. Electric vehicles are not likely to become mainstream unless there is a solid array of charging options.[19]

Despite the slow start, every major manufacturer now offers at least one electric vehicle model, and it is evident the automobile industry is trying to create a mass market for electric vehicles. Projections of electric vehicles as a percent of new vehicle sales by 2030 vary widely from 10 percent to 50 percent. Even on the lower end of this scale, significant numbers of new electric vehicles could be added to the fleet over the next two decades.

Successfully increasing electric vehicle penetration will require many actions, but supportive measures implemented in the near term may reduce or remove barriers to commercialization. Highly valued among these actions is solid investment to establish numerous, widespread, and publicly available charging stations. In addition, Vermont communities can provide local zoning and planning regulations that not only allow but actively encourage the necessary infrastructure in support of widespread use of electric vehicles.

The cost of batteries for electric vehicles is decreasing while performance is improving, and electric vehicles are advancing rapidly toward providing equal utility to a gasoline powered vehicle. The DOE "EV Everywhere Grand Challenge" aims to produce a plug-in electric vehicle within 10 years that is "as affordable for the average American family as today's gasoline-powered vehicles"[20]

Present technology (i.e. the Nissan LEAF battery-electric vehicle) uses about 0.34 kwh per mile. At an average electric rate of 14 cents per kwh this results in a cost of $1.40 for 30 miles of

[18] Dallinger, *et al.* (2012).
[19] Maryland Electric Vehicle Infrastructure Council (2012).
[20] U.S. Department of Energy (2013b).

driving (10 kwh for 30 miles).[21] A reasonably fuel efficient gasoline powered car getting 30 miles per gallon would cost $3.60, more than 2.5 times as much, to drive the same 30 miles.[22] Assuming an average of 11,000 miles driven per year, the all-electric vehicle could save as much as $800 annually on fuel costs. Critically important to this discussion and the future electric vehicle market success is the development of electric rate designs such as time of use (TOU) and dynamic pricing that may lower the purchase price of electricity for vehicle charging, helping to make the vehicles cost competitive and encourage their use. In addition, implementing practices that allow electric vehicles to participate as a consumer rate class in wholesale electricity markets will enhance value and encourage greater deployment.

Electric vehicle interconnection and related grid reliability may be an issue at the local electric distribution system level. Vermont's *Comprehensive Energy Plan* encourages distributed utility planning as a method to improve and strengthen the grid delivery system. This approach is consistent with the ability to address any complications created at the local distribution level as electric vehicles are added in increasing numbers in Vermont.

ii. End Use: Heat Pumps[23]

Heat pumps are electrically powered appliances that employ refrigeration cycles (similar to those used in air conditioners or refrigerators) relying on temperature differentials to provide either heating or cooling to the inside of the building. Two popular designs are air to air heat pumps, which extract energy from the outside air, and ground source heat pumps, which employ buried pipes and rely on the soil's relatively constant temperature to provide energy.

Widespread adoption of heat pumps has the potential to displace large volumes of fuel oil, natural gas, and other fuels presently used for heating homes and buildings in Vermont. This technology offers considerable promise to achieve Vermont's renewable energy and greenhouse gas emission goals. Heat pumps rely on electricity, so when their use is combined with a renewable electric supply they can provide 100 percent renewable energy for heating.

iii. End Use: Air Source Heat Pumps

Air source heat pumps are cold climate capable for significant displacement of fossil fuel but generally are not recommended in Vermont for the full replacement of an existing heating system. Rather, they may be targeted at displacing the use of fossil fuels to save money and reduce carbon emissions. Also known as cold-climate heat pumps or air to air heat pumps, this

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[21] Union of Concerned Scientists (2012).

[22] Approximate cost of regular (87 octane) gasoline in Vermont, May 2013.

[23] See http://www.efficiencyvermont.com/for_my_home/ways-to-save-and-rebates/energy_improvements_for_your_home/Cold-climate-heat-pump/overview.aspx.

technology has been used in Europe and Japan for several decades for space heating and cooling, dehumidifying, and domestic water heating.

The efficiency and performance of modern air source heat pumps is significantly greater than those available 30 years ago as a result of technical advances, including variable speed blowers and compressors and improved coil and motor designs. A key to successful performance in Vermont's northern climate is variable frequency drive compressors that allow more highly efficient operation at a variety of load levels and temperatures. In addition, consistent with international accords, older, environmentally damaging refrigerants are being phased out.[24]

Efficiency Vermont is developing a rebate program for Cold-Climate Heat Pumps,[25] and Green Mountain Power offers a limited rental program for legacy Central Vermont Public Service customers.[26]

iv. End Use: Ground Source Heat Pumps

Ground source heat pumps, sometimes referred to as geo-exchange, earth-coupled, geothermal, or water-source heat pumps, have been used since the late 1940s.[27] They rely upon the relatively constant temperature of the soil a few feet below the ground to provide building heating and cooling. Ground source heat pumps offer flexibility of installation and can be adapted to a variety of buildings, lot sizes, and locations, including single- or multi-family dwellings and commercial retrofit or new construction.

Significant barriers to widespread support and deployment of ground source heat pumps in Vermont include the relatively high cost of initial installation, as well as a lack of agreed-upon installation standards and best practices to ensure that the most efficient models of ground source heat pumps are installed.[28]

2. Electricity Supply

i. Solar Electric

Sunlight generally is considered the most abundant renewable energy resource. The *Comprehensive Energy Plan* states, "For illustrative purposes only…Vermont's solar resource could generate 100 percent of the state's annual electricity consumption….[using]~0.25 percent of the states total land area." Electric generation from solar photovoltaic (PV) recently became a significant and growing source of electric generation in Vermont. Continuing advancements in

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[24] U.S. Environmental Protection Agency (2012b).
[25] Efficiency Vermont (2013).
[26] Green Mountain Power (2013).
[27] U.S. Department of Energy (2012).
[28] Vermont Department of Public Service (2011).

efficiency and significantly reduced costs in solar cell technology make it a probable major resource for Vermont's renewable energy future. The cost of PV cells has dropped dramatically (40 percent in last 6 years) as manufacturing achieves economies of scale, and prices are expected to continue to drop further in the future.[29]

Solar PV installations offer many advantages, including quiet operation, low maintenance, and a high coincidence of producing power when it is needed most during hot summer afternoons. PV systems can be installed on rooftops or the ground and can be fixed-rack, fixed-pole, or tracker mounted. In Vermont, residential PV systems are 10 KW or less, while commercial or community PV is 500 KW or less. Generally, PV systems more than 500 KW are considered utility scale, with numerous generating systems in operation or under development in Vermont that are multi-megawatt in size. Significant in-state expansion of solar PV electric generation is expected in the coming years, with PV playing an increasingly important role in Vermont's energy future. The *Renewable Energy Atlas of Vermont* reports more than 1,400 solar PV systems are installed, totaling more than 30 MW of capacity as of May 2013, an increase of approximately 60 percent from the previous year.[30]

ii. Solar Heating

Solar water heating systems can provide hot water for use in homes or businesses and is an excellent way to help heat a swimming pool. Use of solar can reduce significantly fossil fuel usage and related expenditures by 60% to 70% for domestic hot water.[31] Most solar water heaters are active systems with a pumping mechanism that moves water through the panels where it is heated and then into a traditional electric or gas water heater. While they substantially reduce the fuel use, solar water heating in Vermont does not usually completely displace the need for a conventional heater for either domestic hot water or pool heating.

Experienced firms have been successfully selling or installing solar equipment for many years in Vermont. The technology continually improves but has matured to a point where it is both effective and practical in the Vermont climate. Solar water heating systems depend upon manufacturing scale that is suitable for Vermont and may offer potential for additional economic development in the state for production or assembly of components.[32] Vermont currently hosts 331 solar hot water installations.[33]

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[29] Vermont Department of Public Service (2011).
[30] Renewable Energy Atlas of Vermont (2013).
[31] Vermont Department of Public Service (2011).
[32] *Id.*
[33] Renewable Energy Atlas of Vermont (2013).

Vermont's northern climate limits the available solar energy for building heat; however, passive building designs can capture the sun's heat even in winter. Currently, solar heating for buildings seems to offer small potential but warrants some consideration, especially for new construction if buildings can be properly sited with south-facing orientation and designed with a storage medium built in with the initial construction. As with active water heating, in most cases the solar energy gain supplements but does not displace the need for other heating systems.

iii. Wind Power

New wind generation is the least expensive form of new renewable electric generation to build in Vermont.[34] Wind power has been the fastest growing electric generation resource over the past several years in the world, in the U.S., and in Vermont. 100 Countries are using wind power, with worldwide wind power generating capacity at more than 280,000 MW. In 2012, almost 45,000 MW of new wind power capacity was added internationally, a 19 percent increase, which is the lowest percent increase in more than 10 years. These wind turbines provide 580 million MWH per year or 3 percent of the world's electric production.[35]

Approximately 120 MW of large scale wind projects and about 12 MW of small scale wind projects operate in Vermont. The state has several options for increasing the wind power used in Vermont, including in-state utility scale wind projects; small-scale wind turbines that may be net metered installations serving homes, businesses, and communities; and purchases from developments in surrounding states.[36] Surrounding states and the Province of Quebec, as well as the state of Maine, have substantial on-shore and off-shore wind resources with expectations that significant wind power development may be realized in the coming decades.

Recent studies by the U.S. Department of Energy and National Renewable Energy Laboratory (2003 and 2010) conclude that the technical potential for wind development in Vermont is around 6,000 MW of electric generation when all possible locations with suitable wind regimes are taken into account. Practical and reasonable levels of development, once all competing considerations are accounted for, are far less. However wind is one of the most abundant renewable energy resources available to Vermonters.[37]

The New England Wind Integration Study, published in December 2010, reported that wind could reliably meet up to 24 percent (12,000 MW) of the region's electricity needs in 2020

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[34] Vermont Department of Public Service (2011).
[35] World Wind Energy Association (2013).
[36] Vermont Department of Public Service (2011).
[37] *Id*. Sites are eliminated as various factors are considered, including environmental matters, visual issues, ownership patterns, access to transmission, and other factors.

under certain assumptions.[38] Wind generation also can displace fossil fuel generation, primarily from natural gas-fired plants, which currently provide about 50 percent of New England's power. The natural gas-fired fleet is very flexible, can ramp up and down quickly, and can be operated in a manner compatible with large amounts of wind and other intermittent renewable capacity on the New England grid. ISO-New England does not anticipate the backup capacity requirement of wind or other variable resources will be a major cost or impediment to an efficiently integrated system in New England.

Few topics have split the environmental community as much as development and use of large scale wind power. The *Comprehensive Energy Plan* states,

> The windiest areas in Vermont are most often on the higher-elevation ridgelines that can host sensitive habitats for plants and wildlife and are the source of the state's most pristine headwaters. In previously road less areas, permanent road access is built to service the wind facility. These environmental disturbances can impact wildlife and people in the vicinity of a wind facility.[39]

Ridgeline development also raises aesthetic concerns from the visual impacts of both the turbines and required nighttime lighting. These are valid issues that must be addressed regarding wind power development in-state. Siting and permitting are critically important to successful employment of wind. In recent years, there has been a significant effort by a minority of residents to oppose under all circumstances wind power development on ridgelines in locales where utility scale wind power projects have been proposed. It is important for the state to address issues raised by stakeholders in a comprehensive way so proper consideration of competing interests is provided in all cases. For wind siting and all other Section 248 siting proceedings, the Department of Public Service and the Public Service Board should consider developing a mediation program to be used to resolve disputes among parties.[40]

The existing permitting process set forth in Title 30 VSA, Section 248 and administered by the Public Service Board is intended to address all pertinent issues. The recent report by the Governors Siting Committee reaffirmed that this existing Certificate of Public Good (CPG) requirement is comprehensive and properly placed in the responsibility of the Public Service Board.[41] However, the report recommends a number of steps to improve the CPG process,

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[38] ISO-New England (2010).
[39] Vermont Department of Public Service (2011).
[40] *Id.*
[41] Vermont Energy Generation Siting Policy Commission (2013).

including drawing in local and regional planning interests in a more substantial manner. Vermonters care about the natural environment, wildlife, recreation resources, and view shed offered throughout the state; however, they also support the increased use of renewable resources, including two-thirds of the residents supporting utility scale wind turbine development on Vermont ridgelines.[42] Vermont should continue to facilitate development of in-state wind projects in order to achieve the state's renewable energy goals.[43]

iv. In-State Hydroelectric

The *Comprehensive Energy Plan* reports that 68 FERC-licensed hydropower facilities in Vermont with capacity of more than 150 MW, generated about 8 percent of the electricity consumed in Vermont in 2009. Current state policy supports the development of environmentally sound in-state hydroelectric projects.

Opinions differ widely on the amount of additional "environmentally sound" hydropower that is available in Vermont; however, most people agree that the best hydropower sites already have been developed. There are very few undeveloped sites with existing dams 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. The Agency of Natural Resources recently approved sites with generation capability as low as 15 kW and 50 kW. Any large, new hydroelectric facilities in Vermont (greater than 10 MW) would probably require construction of new dams, which raises a number of biological and ecological issues, as well as competing uses of the river and related land resources. The Agency of Natural Resources is updating an assessment of the undeveloped in-state hydro capacity.

The *Comprehensive Energy Plan* suggests that an effective way to increase hydroelectric capacity is to improve efficiency and output at existing hydroelectric facilities through three types of activities: installing more efficient turbines, installing small turbines at the dams that utilize bypass flows, and installing new turbines that can operate efficiently over a wider range of flows. In addition, existing municipal water supply and wastewater treatment pipelines could capture the energy in these systems by installing hydro turbines to the pipelines without otherwise altering the regular operation of the system. Such in-pipe hydroelectric systems have minimal environmental impact and have been successfully installed in Vermont.

v. Imported Large-Scale Renewable Resources

Vermont has a long history of relying on an energy mix from clean renewable energy resources from our neighbors in Quebec. Large hydro and wind resource projects have been developed

[42] Castleton Polling Institute (2013).
[43] Vermont Department of Public Service (2011).

and continue to be developed in Quebec and in Labrador. Large wind projects are being developed in Maine, New Hampshire, and New York. Provided that there are adequate transmission corridors to Vermont, these projects offer potential opportunities to access utility-scale, clean sources of power.

vi. Biomass and Biofuels

Biomass and biofuels presently (and historically) provide an important portion of Vermont's energy supply. Currently, biomass meets about 6 percent of the electric load and 14 percent of heating needs in Vermont. Recent assessments indicate the use of wood and other biofuels could be expanded consistent with sustainable, monitored forest management practices.[44]

vii. Biodiesel and Bioheat

Production of liquid biofuels from plants and agricultural wastes is an opportunity for agriculture in Vermont, especially for biodiesel used in farming equipment. It also offers promise as a transportation fuel for local, short haul purposes, and as a heating fuel for buildings. Vermont farms may realize benefits, including fuel cost reductions and an additional product to market while helping to reduce reliance on traditional fossil fuels. In addition, possibilities for use of biodiesel or mixed fuels from local sources or produced elsewhere, such as B20 (a fuel consisting of 20 percent biodiesel and 80 percent petro-diesel) in trucks and heavy duty vehicles warrants further exploration in Vermont. On-farm research and development is increasing the potential for achieving substantial savings with biodiesel derived from agricultural crops. Promising research into the use of algae as a source of biodiesel suggests potential benefits in the coming decades. The same biofuel can be used for building heating systems (bioheat) and offers another market and an avenue to offset fuel oil and other fossil fuels used for heating.

viii. Woody Biomass

While woody biomass is renewable when harvested appropriately, it is not inexhaustible. The 2012 *Biomass Energy Development Working Group Final Report* indicates good management practices likely will both improve Vermont's forests and provide for on-going, increased yields of biomass for energy.[45]

The *Biomass Energy Development Working Group Final Report* recommends the increased use of wood-fired district heating and also recommends the state develop incentives to encourage the efficient use of wood for home heating. The working group also endorses converting schools, government offices, hospitals, industrial parks, and college campus facilities from oil to

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[44] Governor's Commission on Climate Change (2007), Vermont Department of Public Service (2011), Biomass Energy Development Working Group (2012).
[45] Biomass Energy Development Working Group (2012).

wood fuel. Combined Heat and Power (CHP) is a suggested approach for both new electrical generation and for district heating when fueled by woody biomass. See the CHP section below for a further discussion of this subject.

ix. Non-Woody Biomass

In addition to woody biomass, grass-based biomass may take hold in Vermont for institutional heating or CHP applications. We should not neglect the chance to use otherwise fallow fields for energy production from sustainable, renewable grass crops that also provide water quality protection and a source of income and jobs in Vermont's agricultural sector.

x. Advanced Biofuels

Advanced biofuels are liquid fuels such as ethanol and butanol that can be derived from organic material, including crop and animal wastes, renewable biomass, or food waste. Ideally, biomass crops used for advanced biofuels are perennial plants grown on marginal or otherwise agriculturally unproductive lands and require little or no fertilizer or irrigation. DOE is supporting research and development of new technologies to convert biomass into advanced biofuels, especially transportation fuels for cars, trucks, and planes.[46] This technology is promising but likely will not mature in the short term. It may offer benefits in Vermont over the coming decades.

Because cellulosic ethanol research and development has not made much progress in the region, the Department of Public Service does not assume that wood will be used to produce ethanol.[47] The *Biomass Energy Development Working Group Final Report* went further to suggest biomass for the production of transportation fuels is **not** a wise use of the wood resource, stating that such an approach could take biomass energy away from other beneficial purposes, would do little to affect energy security, and likely would have a negligible effect on gasoline prices.[48] In addition, making liquid fuels from woody feedstock generally requires operation at considerable scale, meaning this is an all-in or all-out proposition for production within Vermont.

xi. Biogas: Farm and Landfill Methane

Small-scale farm methane digester development and use has gained a respectable foothold among Vermont's dairy farms. In addition to providing renewable base load power to the grid, this technology offers other benefits, including efficient farm waste management, odor control, and additional revenue streams to farms. Most existing farm digesters are at larger farm operations, and the technology presently does not lend itself to smaller farms with less than

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[46] U.S. Department of Energy (2013c).
[47] Vermont Department of Public Service (2011).
[48] Biomass Energy Development Working Group (2012).

200 cows. Additional support for research and development of small-scale digesters is needed to advance the use to smaller operations.[49]

The good news is that alternative digester designs (e.g., “mixed-substrate” anaerobic digesters) can, in addition to manure, use certain crops, other farm waste, and food-processing wastes. Smaller farms may be able to take advantage of this approach and employ the technologies. While there are challenges, this technology may be able to generate up to 30 megawatts of renewable base load power by 2025.[50]

xii. Landfill Methane

As refuse decomposes in landfills, methane gas is released, eventually rising to the atmosphere. Large landfills control this flammable gas by collecting it via pipelines buried in the landfill and either flaring it or allowing it to be used for energy. Vermont has a small number of landfill biogas generation facilities. There is a limited capacity for new landfill biogas generation in the state, mostly from the expansion of existing systems or the installation of generators on smaller landfills.

xiii. Fuel-Cells

Fuel cell technology, first developed around 1840, converts fuel such as hydrogen to electricity, thermal energy, and water vapor through a chemical process that does not involve combustion. This process is much cleaner than burning fuel, produces almost no harmful emissions, and, as the by products are electricity and heat, the technology is suitable for combined heat and power applications. NASA used fuel cells for power and heat in space craft beginning around 1965.

DOE advises that fuel cells have revolutionary potential to provide clean, efficient replacement of internal combustion engines for transportation and use of fossil fuel for heating. DOE is sponsoring research and development work aimed at evolving fuel cells for commercial use for transportation and buildings. The automobile industry is moving toward a 2015 commercial launch of fuel cell powered vehicles with seven major international automakers participating in this endeavor. Internationally, interested parties are developing regulations, codes, and standards to accommodate what is expected to be a burgeoning market for this technology. Fuel cells provide potential for several applications in addition to transportation. Stationary uses include small scale combined heat and power sources for homes and small commercial buildings; systems for back-up power, uninterrupted power supply, or remote power

[49] Vermont Department of Public Service (2011).
[50] *Id*.

applications; and larger systems for industrial or large commercial operations, including district heating applications.

The global market for fuel cells and the necessary fuel infrastructure to operate them have not fully developed at this time. DOE advises that,

> To be economically competitive with the present fossil fuel economy, the cost of fuel cells must be lowered by a factor of ten or more and the cost of producing hydrogen must be lowered by a factor of four. In addition, the performance and reliability of hydrogen and fuel cell technologies must be improved dramatically.[51]

However, many people still perceive fuel cells as a maturing technology that can and will play a substantial role in coming decades. Planners and policy makers foresee the benefit of clean, quiet, efficient energy conversion systems that are modular and scalable to a wide variety of size needs. Technological breakthroughs are not necessary, but steady improvements in costs, availability, and fuel supply infrastructure will be needed to allow widespread use of fuel cells to provide energy for transportation, building heating, and electrical generation.

xiv. Combined Heat and Power

Combined heat and power (CHP) technologies produce both electricity and heat energy (usually steam) from a single fuel input, recovering and reusing heat that would otherwise be wasted. Also commonly known as cogeneration, CHP technology provides greater efficiency than realized from producing either product alone. Plants are usually located at or very near the location where the energy is used, which is often an industrial plant or a district heating facility in large commercial or public buildings. Natural gas (or other fossil fuels) is often the primary fuel source for CHP; however, a variety of biomass and biofuels can also be used. Use of fossil fuels for CHP is often encouraged as the substantially improved efficiency creates benefits and reductions in greenhouse gas emissions compared to dual energy systems performing the same work. Vermont rules allow fossil fueled CHP systems of up to 20 kW to qualify for net metering status under 30 VSA Section 219 and to receive the relatively high payment per kwh afforded to net metering resources.

CHP historically has not played a large part in Vermont's energy mix; however, it has been much more successful in Europe, possibly because of higher energy prices experienced there. The use of small scale CHP expanded in Europe in recent years and is employing technology in the 100 kW to several MW range, increasingly in packaged systems that are easily installed and

[51] U.S. Department of Energy (2013c).

operated. CHP is common in industry, but smaller scale applications (e.g., commercial buildings, hotels, office buildings, schools, and medical establishments) are increasingly common, with scaled packaged units available to meet varying needs for power and energy. Modern CHP technology allows small scale use of renewable resources such as organic waste, including a variety of animal and plant wastes, generating biogas to fuel the CHP units. A CHP plant can also operate on natural gas, landfill gas, liquid gas, propane, diesel, and biodiesel.

Recent experience in Europe is transferrable to the United States and Vermont and small scale CHP, fueled by either fossil or renewable fuels, will likely play an expanded role in the state's energy future.

Vermont has clear goals for increasing use of CHP, with the legislature determining that 60 MW of electric generation from qualified CHP plants by 2028 should be achieved. Possible approaches to meet this goal include efforts to develop CHP systems for schools, college campuses, community buildings, and other public buildings. Vermont has at least one local brewery that employs an anaerobic digester to produce combined heat and power and reduce the impact of its waste products. Viable CHP opportunities may be reduced unnecessarily due to Vermont's legislative requirement of 50 percent overall efficiency of systems. This requires that at least 50 percent of the initial energy input be captured for use by generating electricity and producing useable heat for another purpose. If a proposed CHP project envisions heating building(s) as the second use of the energy, there may be no market in the warm weather seasons. In such cases, this lack of a market in warm months may cause a potential CHP facility to fail to meet the 50 percent overall annual efficiency standard. Changing the legislation to accommodate this situation and reducing the annual efficiency standards for CHP projects that provide beneficial building heat could increase the opportunity for CHP development in the state. Continued review and discussion of the annual standard appears to be warranted.

xv. Natural Gas

Natural gas currently provides about 6 percent of Vermont's total energy and is mainly used for building heat, water heating, cooking, and some industrial processes, limited to a relatively small geographic region in the northwestern part of the state.[52] The *Comprehensive Energy Plan* suggests that natural gas offers certain advantages over other types of fossil fuel, including lower levels of many types of emissions, convenient and clean pipeline delivery (avoiding delivery trucks), and efficient technologies for the use of the gas. It is also publicized as an advantage to economic development activities in areas of the state where available.

[52] Vermont Department of Public Service (2011).

Two recent studies highlight the opportunities and challenges associated with natural gas as an energy source in the United States. MIT concluded that the use of natural gas is growing and will probably continue to grow in the United States.[53] Natural gas development, including resources derived from shale gas deposits, has increased, with expectations in the industry of far more resource availability than previously thought. This study suggests that the new natural gas availability, at current prices that are less than alternative fuels, creates opportunities for fuel switching to gas in most energy using sectors, including electric generation, transportation, building heat, and industrial processes.

Another report, prepared by ICF provides a comprehensive review of shale gas resources as it relates to opportunities for electricity production. It recognizes that the resource potential is large, that as a generating fuel natural gas compares favorably to coal and oil, and that there are real but manageable environmental issues related to the development of gas, in particular unconventional gas.[54] The MIT report also concludes that additional research and new regulations at the state and federal levels will be required to minimize environmental impacts and damage from wide-spread shale gas extraction. The MIT report suggests that we can expect increasing amounts of natural gas fired generation facilities to play an important role in providing the flexibility services necessary to support the variable renewable energy such as wind and solar, perhaps in conjunction with flexible distributed resources and demand-response.[55]

Alternatively to the viewpoint taken by parties such as the MIT team, other energy industry analysts suggest that natural gas may be a "bridge fuel," playing a significant role in the United States (and perhaps Vermont) for a relatively short term during the next two to three decades. Due to significant CO_2 emissions resulting from the combustion of natural gas, widespread increases in its use will not allow the achievement of aggressive greenhouse gas reduction goals even when replacing other (even dirtier) fossil fuels.[56] Other researchers, including from Stanford University and Cornell University recently concluded that natural gas should not be used as a bridge fuel at all in New York. Rather, near term New York energy programs and policies should strive for the replacement of all fossil fuels, including natural gas, with renewable energy resources by 2030.[57]

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[53] Moniz, *et al.* (2011).
[54] Bluestein (2012).
[55] Moniz, *et al.* (2011).
[56] Johnston & Wilson (2012).
[57] Jacobson, *et al*. (2013).

Natural gas is widely used for electric generation in many parts of the country, including New England. Due to the abundance of the resource and current competitively low prices, it is possible its use will increase nationwide in the transportation and heating sectors (and likely in the industrial sector as well), with reduced oil use being a primary benefit. Some consider it a clean and inexpensive fuel compared to other fossil fuels and one that should be used increasingly in the United States.

A number of factors may be promoting the further use of natural gas in Vermont. Investigations of expanding pipeline infrastructure reaching many more consumers, coupled with the apparent abundant supplies and low market prices, suggest natural gas may play an increased role in Vermont's energy future. As discussed more specifically in the policy "Expand the Appropriate Use of Natural Gas," this raises a number of critical state policy questions that will need to be addressed in the coming years. These are difficult questions, reflecting the need for very tough decisions around the extent to which the state can and will benefit from the expanded use of natural gas.

c. Behavior Change Pathways

Individual preferences and habits can influence energy consumption in important ways. New techniques involving group dynamics and social media are being developed to influence individual or organizational behavior and decision-making. When combined with appropriate feedback, powerful influences can be brought to bear on energy consuming habits of end users. These include programs that provide end users with information about their energy use; allow comparisons among groups of customers; and include goal setting, rewards, and other strategies that encourage efficient and timely use of energy. On the commercial side, programs that benchmark buildings and examine the results of equipment tune-ups or operations and maintenance changes can assist these consumers in reducing energy use.

Conventional energy efficiency program design focuses almost exclusively on the link between measures and behavior. While technology-based interventions into purchasing decisions regarding energy using equipment have been successful, savings can be improved if there is an accompanying change in habits. For instance, buying and installing efficient light bulbs is good, but also turning them off when they are not needed is even better.

A case can be made for engaging social scientists to examine the evolution of the social aspects of behavior and how what is considered "normal" is evolving. The implications of that evolution for energy and resource consumption are important, and developing techniques to direct that evolution to a more sustainable path may be desirable. Many elements of our lifestyle, including diet, hygiene, mobility, and comfort flow from resource intensive consumption, which is not sustainable. These patterns will have to change. Consumption patterns represent more than just individual behavior; they represent changing social norms. In Uzzell's words "Trying to persuade people to consume and waste less through behavior change programs will not address the larger and more significant problems concerning the ways under which people need or think they need to live and consume."[58] These arguments suggest we must look at the broader context in which people consume and seek to change that context. Routine consumption is heavily influenced by individual conceptions of normality, shaped by cultural and economic forces. Effectuating change must deal not only with behavior, but also the roots of personal expectations and the definitions of normalcy.

Behavior change programs of all types represent a potential for savings that is supplemental to more traditional utility programs that focus on the adoption of efficient technologies. As the programmatic techniques become refined and applied to more fuels and end uses, this type of behavioral intervention holds promise to produce significant and reliable savings.

[58] Uzzell (2008).

III. Policy Barriers and Solutions

a. Selection Criteria

It is unlikely that any single policy will have the ability to single-handedly address Vermont's needs. Rather, it will be a suite of policies working together. Clearly, some policies will "pack more of a punch" than others. The following criteria can help stakeholders weigh the relative merits of policies and how these policies may fit into a suite of activity in response to climate change and in pursuit of Vermont's statutory goals.

- **Scale:** First and foremost, policies selected should be able to address the scale and magnitude of the legislative targets. Experience suggests that Vermont, and other states and nations, will need to take concerted steps in new directions to achieve their targets. Since the barriers we face are formidable, the policies we employ should be significant in their size and address the sectors and end-use categories that are the primary sources of greenhouse gas emissions. Furthermore, consideration should be given to the life cycle impacts of certain approaches.
- **Cost-effectiveness:** Policies that produce either the greatest net benefit or lowest net cost, should be pursued in advance of other policies. Policies that achieve the greatest net benefit should be given priority.
- **Energy efficiency:** Energy efficiency should be recognized as a first resource. Energy efficiency is usually cost-effective under any criteria and offers wide-ranging, multiple benefits that are often overlooked by policymakers and utilities.[59] Energy efficiency typically is cost-effective under even a narrow view of costs and benefits. When Vermont views its energy efficiency opportunities, it should include these broader categories of environmental impacts and impacts to public health.
- **Geographic scale:** The geographic scale of the impacts is relevant because the scope of the problem is global. Due to a variety of considerations, certain policies may be more effectively advanced at a regional rather than a state level. Policies that cannot be effectively addressed at the municipal or state level (at least for a small state like Vermont) will need to be scaled appropriately to be successful. Vermont's role in such instances will be that of a potential cooperating partner or advocate. Vermont can set a clear example of a policy agenda and an action agenda.
- **Resource opportunities and geographic proximity**: Proximity of resources is also relevant with respect to certain resource categories and policies, particularly with

[59] Energy efficiency, in addition to providing cost savings from foregone energy use, produces a host of other health, environmental, and utility system savings. Many times these benefits are not factored into cost-benefit calculations.

respect to utility-scale sources of electricity generation. Vermont has a long history of relying on clean renewable energy from our northern neighbors in Quebec. Additional large hydro and wind projects are under development in several neighboring states and provinces that offer potentially affordable access through largely established transmission corridors.

- **Uncertainty and risk:** Policies should be well designed to manage both for risk and uncertainty. For example, relying on a single solution may seem attractive, but it leaves the state vulnerable if that single solution fails and no back-up plans are made. All else being equal, the best solutions are those that perform well under a variety of major contingencies and uncertainties.
- **Equity and social justice:** The policies pursued should consider, and, as appropriate, address fundamental concerns of equity and social justice. Often, equity and social justice concerns can be addressed through the design of the policy, or by considering policies as part of package that broadly addresses such concerns.
- **Timeframe:** The timeframes for policy implementation are important for at least two reasons. Certain policies will take time to have their intended impact. Setting the course early is necessary for success because the nature of climate change is based on the longevity of the greenhouse gas molecules in the atmosphere; policies implemented earlier will be of greater impact because they will act over longer periods. Somewhat offsetting this is the persistent, but still uncertain, decline in the costs of clean energy technologies, which may suggest a somewhat measured tempo to preserve later opportunities. Stakeholders will need to balance these competing tendencies when selecting policies.
- **Practicality:** This last category speaks to the issue of other practical issues that may intervene and upset the chosen strategy. Policies should enjoy some degree of political resilience so that a change in administrations or the leanings of the legislature do not unduly upend the path chosen. Energy companies and others will make strategies and investments that will rely to some extent on the stability of the policy environment over time. Policies that can enjoy robust public and political support should be favored, provided they materially contribute toward achieving the state’s energy and climate goals.

b. Featured Policies

The following discussion narrows the myriad of policy options to those consistent with the criteria outlined above. These policies rely on and use many of the technologies described in Part II. Featured policies, the policies we deem most critical and in need of engagement from stakeholders, are discussed first and at greater length. Other, less impactful implementation policies follow and are treated more briefly. It is important to note that if Vermont is to actually reach its energy and greenhouse gas goals, significant change, driven by an informed selection among the policies below, will be required.

Within each policy is a short section titled "Key Considerations." This section deals with some of the overarching considerations that must accompany every policy, rather than dealing with the subject matter of the particular policy. This section serves as a reminder to stakeholders that some general decisions must accompany every specific policy decision.

1. Place a Price on Carbon

Internalize the cost of carbon by imposing an economy-wide mechanism for pricing carbon.

i. Key Considerations

- Funding: Wholesale fuel supplier; distribution utility for electricity generated from carbon emitting sources; end-users.
- Sector Impact: Transportation, Buildings, Electric, Industry.
- Accountability: Measurement and verification by the Department of Public Service for electricity, Department of Taxes for tax, and Department of Public Service, Public Service Board, and Agency of Natural Resources for cap-and-trade oversight.
- Point of Regulation: Wholesale fuel supplier; retail utility for electricity from fossil-fuel generation.
- Scale of Implementation: State and regional for both tax and cap-and-trade.

ii. Policy Description[60]

Carbon pricing attempts to adjust the price of fossil fuels to more accurately reflect the true cost to society (including the costs of environmental effects) of their extraction and combustion. The cost of environmental effects, and in particular greenhouse gas emissions, historically have been omitted from the market price for fossil fuels. Carbon taxes and emissions caps (usually called "cap-and-trade" in the United States) are the two primary policy tools for placing a price on carbon emissions. A carbon tax is levied on the carbon content of fuels used for electric generation, transportation, industrial processes, and building heat. A cap-and-trade system puts a price on carbon by setting limits (a cap) on the quantity of emissions that polluters may produce and by establishing a system of tradable emissions allowances that allow emissions up to the level of the cap.[61] Revenues derived from either pricing policy can be "recycled" and used for a variety of beneficial purposes, including investments in energy efficiency and renewable energy projects that are the building blocks needed to attain the state's goals. The revenue collected can also be refunded to consumers as a dividend for their participation in greenhouse gas reduction initiatives. In addition, pricing carbon emissions of fuels can help mitigate the price advantage that fossil fuel energy historically has had over renewable energy because of the market failure to recognize the additional costs of fossil fuel use.

The broader the geopolitical extent of a carbon pricing policy, the more effective it can be in reducing greenhouse gas emissions. Given that Vermont is and has been for some years a

[60] Mostly drawn from Johnston & Wilson (2012).

[61] A tax provides price certainty, although the resulting quantity of emissions reduced may vary. Conversely, a cap provides certainty on the quantity of emissions that will occur, but prices (and costs to emitters and consumers) are difficult to predict.

member and supporter of the Regional Greenhouse Gas Initiative ("RGGI"), Vermont would benefit from continuing participation in the RGGI cap-and-trade program and may consider encouraging expansion of the program to cover other fuels or other end-use sectors. Vermont's participation in RGGI has reduced greenhouse gas emissions and recycled significant revenue back to the state. See Figure 2. Vermont effectively has invested those revenues in energy efficiency and fuel-switching to cleaner, lower emissions fuels.[62] The state may also benefit from a multi-jurisdictional tax and may want to consider encouraging a multi-jurisdictional carbon tax through the New England Governor's Conference, New England States Committee on Electricity (NESCOE), Northeast Sates for Coordinated Air Use Management (NESCAUM), Vermont's Congressional delegation, and other appropriate forums.

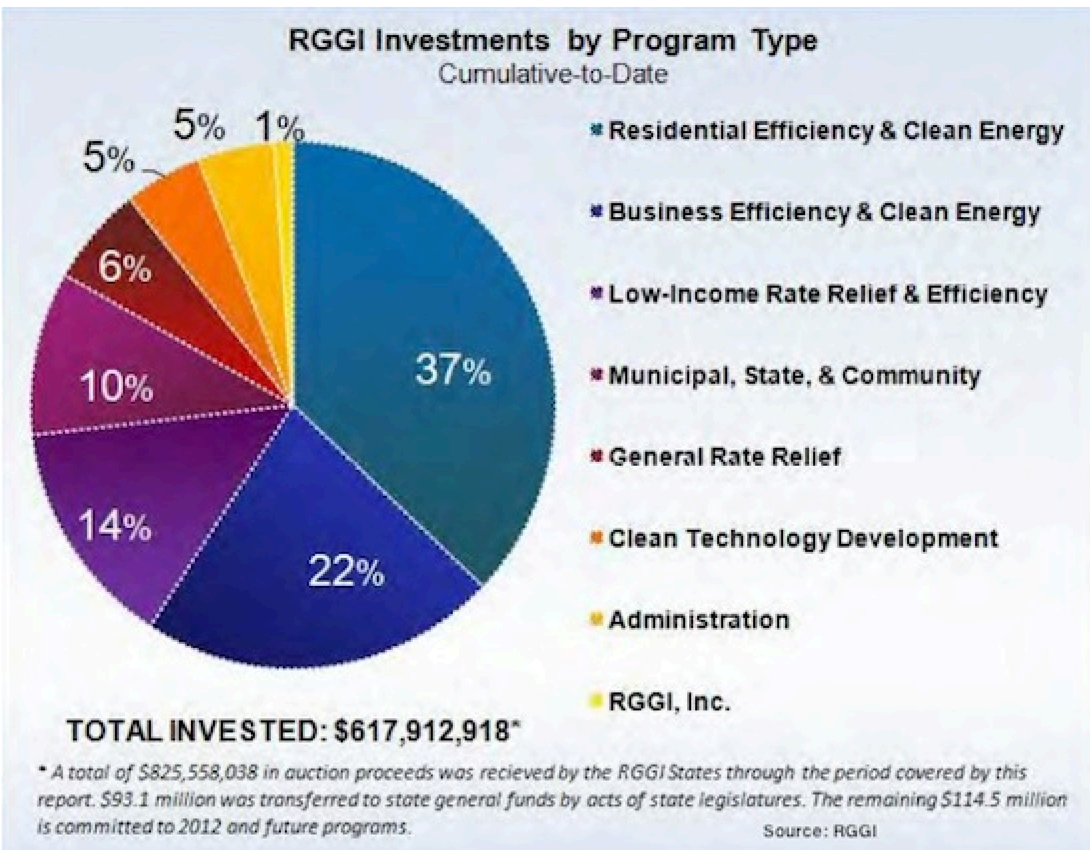

Figure 2 RGGI Investments

62 Hibbard, *et al.* (2011).

There are advantages and disadvantages to both carbon taxes and cap and trade programs.

Carbon Tax	
Advantages	**Disadvantages**
Offers flexibility to affected sources in determining their response to the tax.	Tax does not limit the amount of carbon that can be emitted and desired reductions in emissions may not be reached using a politically viable tax rate.
Encourages a range of technical and institutional abatement options.	Taxes are politically unpopular and risky for elected officials.
Relatively easy to implement; applies to small and dispersed resources, as well as large point sources; straightforward to administer; and requires little more in the way of infrastructure and bureaucracy than a simple sales tax.	State spending decisions for carbon tax revenues may be unpopular and aggravate the unpopularity of a tax with voters.
Provides transparency and cost certainty.	
Creates a strong and continuing incentive to innovate as a mechanism for reducing emissions and associated tax payments.	
Tax revenue may also be invested in low-carbon resources to facilitate the transition to a low-carbon economy.	
Generates revenue that may be used to reduce collection of other taxes, thus making the carbon tax optionally revenue neutral.	

Cap-and-Trade	
Advantages	**Disadvantages**
Is effective to meet emissions reduction targets.	Pricing is market-based and not known in advance.
Flexibility to allow various compliance options such as: • purchase of allowances, • installation of emissions controls, or • emissions avoidance through retirement or fuel switching.	A variety of market mechanisms exist and one must be chosen for implementation: • can be complex to implement and difficult to administer, and • can have imperfections in design or application, such as issuing too many permits.
Uses a market mechanism for transfer of emissions allowances.	
Tends to have fewer political obstacles than carbon taxes.	
Better performers—those with lower emissions—benefit economically from their performance by selling allowances.	
Higher emitting sources can determine the cheapest way to comply with requirements.	
Program revenues rise as emissions decrease.	

Efforts to reduce emissions are shown to be most effective when multiple policy strategies are implemented at the same time, such as combining carbon pricing with policies to encourage energy efficiency and renewable energy. If carbon pricing is relied upon exclusively, experience suggests the carbon price needed to meet Vermont's goals may be so high that emissions reduction goals will not be attainable.[63] In addition to efficiency and renewable energy, other complementary polices Vermont may consider include establishing carbon intensity targets,[64] establishing emissions standards for electric power contracts or supply portfolios, adopting building codes and standards that address emissions, and implementing resource planning strategies—utility Integrated Resource Planning[65] (IRP) or government agency planning—that include assertive requirements to reduce emissions.

Carbon pricing-related policies are most effective if they include mandatory provisions, are long-term in design, and provide for emissions to decrease over time to meet Vermont's goals for the years 2028 and 2050. Carbon pricing lends itself to interstate and regional cooperation (as experienced with RGGI), and is most effective if all carbon emitting (and fossil-fuel using) sectors are encompassed, including electric generation, transportation, industry, and building heating.

iii. Design Considerations

The benefits of pricing carbon, both in terms of renewable energy deployment and in carbon reduction, can be greatly increased by reinvesting the proceeds of the tax or sale of permits into projects or measures that further the goals of renewable energy and carbon reduction.[66] Since these policies have the potential to raise energy prices, care should be taken to address the needs of at-risk populations within the state. Vermont is already doing so in the electric sector where revenues from the auction of RGGI allowances are used to fund low-income weatherization and other thermal efficiency programs.

There are two primary design options when considering a cap-and-trade system. One allocates a fixed number of allowances to current emitters, similar to the SO_2 trading program in the United States.[67] An alternative method provides all of the allowances to a central authority, which then auctions or sells them to emitters as needed; this is how RGGI operates. The

[63] Cowart (2008).
[64] Carbon intensity measures show how much carbon is released per unit of energy produced or used.
[65] Electric utility IRPs currently are required to include plans for how the utilities will get to 75 percent renewable energy use by 2032.
[66] Title 30 V.S.A. § 235 directs proceeds from Vermont's sale of RGGI allowances to programs that support whole building heating and process energy efficiency and facilitate appropriate fuel switching. Half of these programs benefit low-income residential consumers. See http://www.rggi.org/rggi_benefits/program_investments/vermont.
[67] U.S. Environmental Protection Agency (2009).

allocation method promotes trading among affected parties and is revenue neutral within the affected sector. Selling allowances or imposing a tax will generate revenue for the state. Returning the funds to consumers through assistance in meeting the clean energy goals will allow those goals to be met at a lower total cost. Regardless, a tax alone cannot be sufficiently high to generate the response needed to meet the state's aggressive goals. It may, however, be a welcome complement to a well-formed policy portfolio to achieve the same ends.

iv. Ease of Application

A carbon tax is a relatively straight forward mechanism that can be applied at the wholesale supplier or retail sales levels. Although Vermont is served by suppliers outside the state, the tax would only apply to sales made in Vermont. A carbon tax would operate similarly to other taxes already in place. Such a framework could be implemented at the state level.

The institution of a cap-and-trade program to price carbon would require establishing an apparatus to create, auction, and trade emissions certificates. Additionally, sellers of energy products in Vermont would have to report their sales volumes of various products, as well as the renewable content of those products (e.g., B5, B20, B100 #2 oil). Because of the complexity of the tracking system required, participation in a cap-and-trade system would likely be better done on a regional level. Within the electricity sector, Vermont already participates in RGGI. If Vermont choses to broaden the reach beyond electricity, it may want to consider doing so in conjunction with another program. Piggybacking on another program, as Quebec has just done with the California program, should be explored as an option to lower the administrative burden.

v. Select Resources

Cowart, R. (2008). Carbon Caps and Efficiency Resources: How Climate Legislation Can Mobilize Efficiency and Lower the Cost of Greenhouse Gas Emission Reduction. *Vermont Law Review, Vol. 33, pp. 200-223*.

Hibbard, P., Tierney, S., Okie, A. & Darling, P. (2011). *The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States.* Boston, MA: Analysis Group. Retrieved from http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Economic_Impact_RGGI_Report.pdf.

Johnston, L. & Wilson, R. (2012) *Strategies for Decarbonizing the Electric Power Supply*. Montpelier, VT: Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/259.

Measuring Progress Towards the Renewable Energy Goal

In order to determine the level of achievement in meeting the target of 90 percent renewable energy, an accounting mechanism must be set up to tally the renewable and non-renewable portions of the supply mix. The basic equation is Renewable Energy Used (BTU)/Total Energy Used (BTU).The chosen accounting mechanism must be equitable, accurate, straight-forward to implement, and treat all fuels in a consistent manner.

Difficulties arise when measuring the electric sector and when tabulating the contribution of renewables. Three approaches are possible. The most straightforward is to use the electricity or renewable output as such and to disregard the upstream energy inputs. (This approach would assign a value of 3,412 BTU/ kWh to both fossil and renewable electric generation). The most common approach is to express the electricity produced or renewable energy used in terms of the energy content of the fossil fuels that would be required if the same amount energy had been produced with a conventional thermal generator or appliance that relies on fossil fuel. In effect, this approach reflects the displacement of fossil fuel. The third approach is to quantify the actual input energy to the system. This method would quantify the fossil fueled inputs to the system, the amount of heat released by the reactors in nuclear power stations, and the input energy (sunlight and potential energy in water or wind) into a renewable system.

The second approach is recommended because it is both feasible, using existing data and accurately captures the BTU savings involved in renewables conversions, and conceptually consistent with the targets set, which are centered on the displacement of fossil fuels by renewable energy that produce electricity, heat, or power. The energy accounting for purposes of setting and meeting objectives of renewables targets should be based on the energy content in BTUs of the energy resources that were likely displaced by policies that promote electrification and associated renewable energy. For this exercise, renewable electricity production can then rely on the average heat rate of new fossil generation in New England and the BTU value of renewable thermal applications should be based on a reasonable estimate of the average efficiency of new fossil fueled boilers and furnaces in Vermont. We recommend the use of new generators and devices on the theory that they are most relevant to the types of generation that would exist in the target year 2050 that are effectively displaced.

Renewable electricity can then be assigned a value of 6,800 BTU per kWh. Electrification of the transportation system can be accounted for as incremental kWh and net gallons of fuel used. Biofuels and other transportation or building related fuels can be evaluated based on their individual BTU content as input to the system. Renewable thermal applications (including heat pumps) can be evaluated based on the net of the electric demand and the proxy fossil fuel demand displaced.

2. Enact a Total Energy Standard

Introduce a total energy standard to create a goal for renewable energy across the economy.

i. Key Considerations

- Funding: Wholesale fuel supplier; third party vendors.
- Sector Impact: Transportation, buildings, electric, industry.
- Accountability: Public Service Board or Regional Greenhouse Gas Initiative.
- Point of Regulation: Many.
- Scale of Implementation: State and regional.

ii. Policy Description

A total energy standard (TES) sets goals or requirements for an economy-wide portion of energy consumption to be met with renewable energy. Energy efficiency can also play an important role in a TES because it can reduce the quantity of renewable energy necessary to meet the standard. The standard is broadly defined to include all energy use in all sectors of the economy. Units of measurement are BTUs and can be measured in absolute terms, such as a set number, or in relative terms, such as BTU per unit of gross state product (GSP) or relative to population. Variants can target the composition of the energy supply over a limited number of energy consuming sectors or over a subset of the fuels used by those sectors. Such a system uses market mechanisms to encourage achievements in the most cost-effective way. Goals are met through tradable certificates or some other method of efficient exchange with other sectors that may find achieving the stated goals to be more costly. At least in principle, this type of market-based approach allows achievement of the desired goals with a minimal impact on the economy as a whole. A disadvantage is that accounting and attribution can be challenging, given the proportion of smaller size projects likely to be undertaken in Vermont. If a TES is to be mandatory, obligated parties must be created and have mandatory participation levels.

A total energy standard offers flexibility and the ability to initially cover a limited section of the economy and later expand. A total energy standard can drive the adoption of renewable resources, energy efficiency resources, or both. Targets also can be tailored for the different sectors covered by the standard. For example, the transportation sector can have an obligation to achieve a certain biofuel content in vehicle fuel sold in the state.

A total energy standard can be a goal or can be made mandatory by assigning a series of obligations. Parties must be assigned a portion of the overall goal for which they are responsible. For an obligation to be successful, there must be consequences for not meeting the objectives. Obligations could include tradable certificates, which could be bought and sold to assist in reaching the goal. Determining an obligated party may be difficult for some sectors. For example, a requirement could be that all sellers of heating oil must achieve a certain proportion of renewable content in their sector. This renewable energy does not have to be used by any one firm's customers but must be used within the sector, or tradable credits must be acquired from another sector. Obligations also must be constructed with penalties or consequences for non-compliance. Similar to Vermont's SPEED requirements, a total energy standard can impose a stricter control measure if the targeted sectors fail to meet their goals. [68]

iii. Design Considerations

In establishing a total energy standard, a number of aspects must be considered, in addition to those mentioned above. A legal authority must be established for those who promulgate the standard. A sufficiently long timeframe must be set for achieving the objectives so parties can make strategic decisions in an orderly way, especially if investment in new equipment is the preferred strategy for complying entities or entities want to sell compliance credits. A procedure also must be established for parties to report savings to an appropriate authority capable of verifying savings claims. Consideration should be given to performance incentives if appropriate. Enable third parties to participate in the system if appropriate. For example, energy service companies (ESCOs) may be able to market the product from their efforts to obligated parties. A system for measurement and verification must be established with robust feedback to participants. If trading is desired, a system of certificates and a market must be established to facilitate this activity. Finally, consideration should be given to cost recovery for obligated parties.[69]

A total energy standard is an excellent method to achieve economy-wide objectives for renewable energy. Broad-based standards covering multiple fuels and sectors have been applied in only a few countries and usually on larger suppliers. For example, the cap and trade program in California, mandated by AB 32, targets electric generation and emitters of more than 25,000 metric tons of carbon per year. As a small state, Vermont may have difficulty establishing the regulatory mechanisms necessary to support such an effort in the efficiency realm, and may have better success with a regional approach similar in scope to RGGI.[70] However, a total renewable energy standard could be successful on a smaller scale, assuming proper consideration is given the design elements discussed above.

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[68] SPEED is a Vermont program to encourage the development of renewable energy resources in Vermont, as well as the purchase of power generated by renewable generators by the state's electric distribution utilities. See www.vermontspeed.com. The 2005 SPEED statute included a provision requiring the imposition of a binding renewable portfolio standard if the 2012 voluntary SPEED goal was not met.

[69] Taken generally from Crossley, *et al.* (2012).

[70] The RGGI program has discussed expanding its coverage. On December 30, 2009, the governors of the participating states and Pennsylvania signed a "Memorandum of Understanding" to "work to develop a low-carbon fuel standard to reduce greenhouse gas emissions from cars and trucks despite objections from the oil industry."

iv. Select Resources

Budischaka, C., Sewell, D.,Thomson, H., Mach, L., Veron, D & Kempton, W. (2013). "Cost-minimized combinations of wind power, solar power and electrochemical storage, powering the grid up to 99.9% of the time." *Journal of Power Sources* 225 (2013) 60-74. Retrieved from http://www.udel.edu/V2G/resources/BudischakEtAl-2013-CostMinimizedWindSolarPJM.pdf.

California ISO. (2013). *Integration of Renewable Resources*. Folsom, CA: California ISO. Retrieved from http://www.caiso.com/informed/Pages/StakeholderProcesses/IntegrationRenewableResources.aspx.

U.S. Environmental Protection Agency. (2013c). *Renewable Fuel Standard (RFS)*. Retrieved from http://www.epa.gov/otaq/fuels/renewablefuels/.

Schnepf, R. & Yacobucci, B. (2013). *Renewable Fuel Standard (RFS): Overview and Issues*. Washington, DC: Congressional Research Service. Retrieved from http://www.fas.org/sgp/crs/misc/R40155.pdf.

3. Leverage Markets to Achieve Efficiency and Renewable Goals

Create value streams that can be accessed by third parties or individual homes or businesses that reward energy efficiency or renewable energy actions.

i. Key Considerations

- Funding: Varies.
- Sector Impact: Buildings, electric.
- Accountability: Public Service Board, Department of Public Service, Agencies of Agriculture and Transportation, and permitting authorities.
- Point of Regulation: Could be done at multiple levels.
- Scale of Implementation: Local or state.

ii. Policy Description

Markets can spur creative solutions to energy and environmental objectives. The goal of this policy is to harness the power of market forces toward Vermont's energy goals by "figuring out" ways for participants to profit from helping Vermont meet its climate and emissions goals. By identifying and removing policy and regulatory barriers that hinder the development of new business models or by enacting new policies that foster the development of new business models, Vermont can open the door to private innovation in the service of the state's environmental and energy goals.

The Public Utility Regulatory Policy Act (PURPA) is a historic example of a policy that transformed the electric industry by allowing private developers of renewable energy to have access to utility revenue streams. This brought new capital into the sector and created a business dynamic that extended well beyond the provision of electricity.

As solar PV prices continue to fall, new opportunities will arise to incorporate this technology into the resource portfolio. Vermont is already experiencing a new business model in the form of solar leasing that allows customer participation with no upfront cost. Other examples could include an electric vehicle manufacturer offering a discounted product, in return for customer participation in a load response program operated by the company. An appliance manufacturer might offer a similar program—a control device included in a water heater could be activated to provide services to the electric grid and create an additional revenue stream to the manufacturer.

To encourage new business models and opportunities, particularly in the energy sector, regulators and stakeholders must carefully scrutinize the existing body of regulations to determine if existing regulations undermine business innovation and then decide how to alter regulations so they enhance rather than undermine innovation. Policies can and should be created that empower non-utility actors, particularly those in demand-side efforts, to enter into and compete in the electric power markets. Vermont already has experience in this activity through its work with New England ISO.

The complementary systems and policies discussed elsewhere in this report can assist in creating the market dynamics that foster new market entrants. Revenues from a carbon pricing scheme can be directed to support new entrants into electricity markets. Efficiency savings certificates or white tags may also enable various non-traditional players to enter the market. To achieve the goals set out by Vermont, participation and effort from many sectors will be necessary. Tapping into the power of the private sector can create large dividends in achieving this goal.

iii. Select Resources

Cappers, P., MacDonald, J. & Goldman, C. (2013). *Market and Policy Barriers for Demand Response Providing Ancillary Services in U.S. Markets*. Berkeley, CA: Lawrence Berkeley National Laboratory. Retrieved from http://emp.lbl.gov/sites/all/files/lbnl-6155e.pdf.

New England Demand Response Initiative. (2003). *Dimensions of Demand Response: Capturing Customer Based Resources in New England's Power Systems and Markets*. Boston, MA: Raab Associates. Retrieved from http://www.raabassociates.org/Articles/FinalNEDRIREPORTAug%2027.doc.

York, D. and Kushler, M. (2011). *The Old Model Isn't Working: Creating the Energy Utility for the 21st Century.* Washington, DC: American Council for an Energy-Efficient Economy. Retrieved from http://aceee.org/files/pdf/white-paper/The_Old_Model_Isnt_Working.pdf.

4. Expand Binding Energy Efficiency Targets[71]

Enhance and expand binding energy efficiency targets for the buildings and power sectors.

i. Key Considerations

- Funding: Utilities and fuel suppliers.
- Sector Impact: Transportation, buildings, electric, industry.
- Accountability: Retail utilities, including Efficiency Vermont, fuel suppliers.
- Point of Regulation: Retail utilities, including Efficiency Vermont, fuel suppliers.
- Scale of Implementation: State.

ii. Policy Description

Binding energy efficiency targets are statewide obligations requiring achievement of a level of energy efficiency savings. Generally established through statute,[72] these limitations are imposed on specific entities, such as a regulated utility, an industrial customer, an unregulated fuel supplier, or an independent provider (e.g. Efficiency Vermont). The targets or caps can be set in a variety of forms: "a specific energy or demand goal (kWh or kW), savings (percent as compared to base or baseline), emissions reduction (tCO2e), or in terms of energy or emissions intensity (kWh or tCO2e per GDP)."[73] Whatever form they take, efficiency targets should be long-term, mandatory, and sufficiently aggressive to be meaningful but not so aggressive as to render their achievement impossible. Optimally, targets will become more stringent over time. A scheme that includes both incentives for performance and penalties for non-compliance is more likely to achieve success.

The method for judging performance must be transparent and the party conducting that analysis independent. The method for establishing baseline usage must be clear and coherent; this is often made easier if the jurisdiction has access to plentiful historical data on consumption levels and patterns. Once baselines are established, all parties must understand how performance against those baselines will be measured, verified, and compliance determined. In addition to measurement and verification, there must be a clear method through which obligated entities can recover costs and be assessed incentives or penalties. In some instances, it may make sense to verify efficiency savings by awarding the obligated entity a certificate of compliance (sometimes referred to as a white certificate), which allows for the creation of peripheral markets through which these certificates can be traded.

[71] This subsection relies heavily on the work of Wasserman & Neme (2012).
[72] Vermont statute requires sufficient utility funds be directed to energy efficiency to acquire all reasonably available, cost-effective energy efficiency (30 V.S.A. § 209, d (4)). Additionally Vermont has an advanced oversight and management structure for managing utility funded energy effici8ency programs.
[73] Wasserman & Neme (2012).

In order to encourage deep savings levels, Vermont should look to lifetime savings targets that can be derived from annual consumption figures.

Regulated utilities have been the focus of these obligations, but it is possible to extend the obligation to non-regulated fuel suppliers as well, in the form of a requirement to obtain a certain level of savings per gallon or BTU of fuel sold in Vermont. In the United States, energy efficiency obligations typically have not been placed on non-regulated fuel suppliers. However, three European countries - France, Ireland, and Denmark - have created energy efficiency obligations on retail suppliers of non-regulated fuels.[74] In France, the obligation extends to importers of transport fuel who can meet their obligation through savings in the commercial or residential sector. Obligations can also be segmented to have a certain amount come from low income consumers. Since this is a new concept, one possible initial step would be to have non-regulated fuel suppliers report their energy saving activities.

iii. Select Resources:

Wasserman, N. & Neme, C. (2012). *Policies to Achieve Greater Energy Efficiency*. Montpelier, VT: Regulatory Assistance Project. Retrieved from www.raponline.org/document/download/id/6161 .

Nowak, S., Kushler, M., Sciortino, M., York, D., & Witte, P. (2011). *Energy Efficiency Resource Standards: State and Utility Strategies for Higher Energy Savings*. Washington, DC: American Council for an Energy-Efficient Economy (No. U113). Retrieved from http://www.aceee.org/node/3078?id=3926.

Crossley, D., Gerhard, J., Lees, E., Kadoch, C., Bayer, E., Xuan, W., Watson, E. Wasserman, N. & Sommer, A. (2012). *Best Practices in Designing and Implementing Energy Efficiency Obligation Schemes*. Montpelier, VT: Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/5003.

[74] Crossley, *et al*. (2012).

5. Expand the Use of Voluntary Agreements for Energy Efficiency

Enhance and expand programs for agricultural or industrial users to undertake energy efficiency projects in return for recognition or relaxed requirements in other areas.

i. Key Considerations

- Funding: N/A.
- Sector Impact: Buildings.
- Accountability: Department of Public Service, Public Service Board, and participating customers.
- Point of Regulation: Contract.
- Scale of Implementation: State.

ii. Policy Description

Voluntary agreements are usually entered into by a government (state or national) that is imposing an energy efficiency or pollution requirement on a large energy user that seeks to satisfy that requirement outside of typical, programmatic mechanisms already in place. These agreements, like a private contract, often have incentives (i.e., avoiding some tax consequence) if the target is hit and monetary penalties (i.e., the imposition of taxes) linked to a failure to meet obligations. Given Vermont's large population of small to mid-sized farms, the agricultural sector may be a promising area in which to consider voluntary agreements.

Voluntary agreement programs can be divided into three broad categories: "1) programs that are completely voluntary, 2) programs that use the threat of future regulations or energy or greenhouse gas emissions taxes as a motivation for participation, and 3) programs that are implemented in conjunction with an existing energy or greenhouse gas emissions tax policy or with strict regulations."[75] As might be expected, the more binding the agreements are, the more likely they are to achieve real energy or emissions reductions.[76]

Voluntary agreements can take many different forms: they can be set "in terms of absolute energy consumption or consumption per unit of the consumer's output, such as MWh per unit of value added or per unit of service provided."[77] In any category or form, it is critical to establish a clear baseline of performance against which progress will be measured and a clear methodology of evaluating and measuring performance.

iii. Select Resources

Price, L. (2005). *Voluntary Agreements For Energy Efficiency Or GHG Emissions Reduction In Industry: An Assessment Of Programs Around The World.* Berkeley, CA: Lawrence

[75] Price (2005).
[76] *Id*.
[77] Wasserman & Neme (2012).

Berkeley National Laboratory *(No. LBNL-58138)*. Retrieved from http://ies.lbl.gov/iespubs/58138.pdf.
Wasserman, N. & Neme, C. (2012). *Policies to Achieve Greater Energy Efficiency*. Montpelier, VT: Regulatory Assistance Project. Retrieved from www.raponline.org/document/download/id/6161.

6. Electrify the Buildings Sector

Electrify end uses in the buildings sector, fueled with renewable electricity.

i. Key Considerations

- Funding: Consumers with incentives that support fuel-switching to electricity.
- Sector Impact: Buildings.
- Accountability: Voluntary through inducement by incentives.
- Point of Regulation: Voluntary, unregulated fuel switch.
- Scale of Implementation: Local and state.

ii. Policy Description

As discussed above in the pathways section, meeting the state's renewable energy and carbon goals necessitates a shift away from fossil fuels to electrically powered systems for building heat and industrial activity. As described below, and in the earlier review of technology options, there are promising ways to cost-effectively improve the heating and cooling performance of both the new and pre-existing building stock.

The use of fossil fuels is entrenched solidly in the infrastructure of buildings, and a pathway to change is required to move a large number of Vermonters to electrify this infrastructure. For much of the past three decades, state energy policy focused the building sector away from the increased use of electricity, especially for space heating. To be effective, a new policy of electrification will have to be combined with a substantial and enduring consumer education and information program, as well as be tailored to work in tandem with other policies, such as a renewable portfolio standard or a total energy standard. Electrification policies must be long-term policies designed to play out over decades, not years, as substantial costs and investments are incurred to ensure reliability and functionality during the evolution of both the energy supply and use sectors.

To enhance the implementation of this policy, energy efficiency, conservation, and electric demand management measures can be implemented aggressively to reduce the overall energy requirements of structures, and the electric generation sources serving Vermont must also be transitioned to using renewable fuels. Power sector planning must also adapt and take into account the need for additional generation and delivery requirements, beyond a base-case scenario, due to the demands created by electrification. Consideration should be given to developing a utility business model able to support this transition, including potential changes in the ancillary services[78] markets to the electric grid through smart grid-enabled controls on

[78] Ancillary services are those "[s]ervices needed to support the transmission of energy from generation to loads, while maintaining reliable operation of the transmission system. These include regulation and frequency response,

end uses. These services likely will be in higher demand as the power supply transitions to one with a higher percentage of intermittent resources.

Historically, policies regarding fuel switching have been difficult to develop. From the consumer viewpoint, the government is recommending a specific fuel, directing the consumer to assume the price and other risks associated with that fuel. From an energy business standpoint, state policy is directed at moving customers from one category of service-provider to another. Further, this must be done against Vermont's historical background of discouraging electric heat through Act 250. However, to achieve the state's energy and climate goals, this type of initiative may be precisely in keeping with the scale of the ambition.

Several strategies are possible. Working with Act 250 commissions to explain the policy rationale for heat pumps and other efficient electric technologies can help to address applications in new construction. Supporting technology demonstration projects in Vermont can help with consumer anxiety remaining from prior efforts with less efficient heat pumps. On a larger scale, there is a federal tax credit available for ground source heat pumps. This may be extended to efficient air source heat pumps. Heat pumps can also be eligible for any and all incentives directed to thermal initiatives. PACE loans, Efficiency Vermont thermal programs, and other thermal initiatives can include heat pumps as eligible to participate. In retrofit applications it generally does not make sense to install a unit capable of meeting the peak heating load of the structure, so it is frequently desirable to leave the existing heating system in place. Having a backup system enables certain heat pump installations to be a demand response candidate. Utility rates can be developed to encourage and reward customers who can use alternate systems on the coldest, peak load winter days.

iii. Select Resources

European Climate Foundation. (2010). *Roadmap 2050: A Practical Guide to a Prosperous, Low-Carbon Europe*. Hague, Netherlands: The European Climate Foundation. Retrieved from http://www.roadmap2050.eu/project/roadmap-2050.

Johnston, L. & Wilson, R. (2012). *Strategies for Decarbonizing the Electric Power Supply*. Montpelier, VT: Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/259.

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spinning reserve, non-spinning reserve, replacement reserve, and reactive supply and voltage control." Lazar (2011).

7. Use Efficient Rate Design to Unlock Demand-Side Resources

Employ a pricing framework enabled through technology to allow demand-side resources to more efficiently manage loads and supporting system adequacy.

i. Key Considerations

- Funding: Retail utilities and ratepayers.
- Sector Impact: Buildings, electric, industry.
- Accountability: Public Service Board.
- Point of Regulation: Retail utilities.
- Scale of Implementation: State.

ii. Policy Description

Effective rate design provides price signals to encourage efficient use of electricity and natural gas resources. Time-varying pricing of various forms will be helpful in managing challenges to system reliability. Effective use of advanced forms of dynamic pricing may also begin a path toward more responsive end-user loads that will help promote cleaner generation resources by increasing system flexibility.

Vermont utilities implemented smart meter technology throughout the state in 2012 and 2013. In the short term, smart meters provide benefits through reduced meter reading expenses, better outage management, and improved customer information capabilities. To date, rate offerings have not exploited this technology to provide customers with the ability to participate in managing utility loads and providing other services needed by the utility.

As the electric sector transitions from one that has traditionally developed supply to meet anticipated demands, to one that integrates variable renewable resources to meet the net demands of consumers (net of renewable contribution), pricing strategies can offer a potent opportunity to influence customer behavior in a way that promotes policy objectives. Vermont utilities took the first step by deploying infrastructure capable of advanced communications with the loads it serves. Designing service and rate offerings that extract value from consumers, while providing them benefits, is the next step in this process.

iii. Select Resources:

Crossley, D. (2013). *Effective Mechanisms to Increase the Use of Demand-Side Resources*. Montpelier, VT: The Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/6359.

Dallinger, D., Shulbert, G., & Weitschel, M. (2012). *Grid Integration of Intermittent Renewables Using Price Responsive Plug- in Electric Vehicles*. Berkeley, CA: Lawrence Berkeley National Laboratory. Retrieved from http://eetd.lbl.gov/news/events/2012/05/02/grid-integration-of-intermittent-renewables-using-price-responsive-plug-in-el.

Faruqui, A., Hledik, R. & Palmer, J. (2012). *Time-Varying and Dynamic Rate Design*. Montpelier, VT: The Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/5131.

Lazar, J. (2013). *Rate Design Where Advanced Metering Infrastructure Has Not Been Fully Deployed,* Montpelier, VT: The Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/6516.

8. Enhance and Enforce Building Energy Codes

Adopt and enforce building energy codes. Develop and promote stretch codes more stringent than current ASHRAE or IECC codes. Expand the conditions where code review is applicable and ensure enforcement.[79]

i. Key Considerations

- Funding: Fee for building permits.
- Sector Impact: Buildings.
- Accountability: Building owner, designer.
- Point of Regulation: Building permit, certificate of occupancy.
- Scale of Implementation: State and local.

ii. Policy Description

Buildings are long-lived assets with only occasional opportunities for retrofit and upgrade. Designing and building them right the first time is much more cost-effective than retrofitting them later. Properly enforced codes ensure buildings are built right the first time.

Building codes and standards are statewide rules (often implemented locally) that mandate a minimum level of safety in the design and construction or rehabilitation of both commercial and residential buildings. The primary objective of building codes is to protect human safety, but they also serve other purposes, such as requiring a certain level of energy efficiency from the materials, techniques, and systems used in construction. Improving the energy efficiency of new construction and of buildings being renovated or rehabbed by adopting and implementing progressive building codes is one of the most cost-effective ways in which to save energy and to reduce the emissions of greenhouse gases.[80]

At state or local discretion, the impact of codes can be expanded in several directions by making them more stringent or by making them applicable in more situations. National organizations, such as ASHRAE or the International Code Council, promulgate model standards that have been thoroughly vetted by trade groups and interested stakeholders to assure compliance with health and safety codes. Vermont has adopted such a standard, and legislation passed in 2013 allows for the development of a "stretch" code. A stretch code has more stringent requirements and increased requirements for inspection relative to a standard code. In the new legislation, those who demonstrate compliance with the stretch code gain presumptive conformance with Act 250, criteria 9(F). A stretch code can also be made

[79] Energy Futures Group, *et al.* (2012).
[80] National Action Plan for Energy Efficiency (2009) and Levine, *et al*. (2012).

mandatory if adopted by certain communities. Massachusetts developed such a code, and adopting it is a requirement to qualify for the state's green community designation.[81]

Codes also can be expanded to be applicable in more situations. Requirements to upgrade efficiency at the time of a building's sale will bring more structures into compliance, as well as offer prospective buyers the chance to finance improvements with their mortgage. Other associated policies that may improve the effectiveness of building codes and standards are disclosure requirements when selling a building and building energy performance labeling.[82] Each of these options can further increase the number of structures that are subject to code compliance.

Zero net energy buildings, a step beyond stretch codes, are being constructed in Vermont and New England. A zero net energy building requires extremely efficient structures that generate sufficient renewable energy onsite to offset the total amount of energy consumed in the building over the course of a year. Higher initial costs are recovered through energy savings over the life of the building. While probably not appropriate at this time as a code requirement, increasing awareness of the possibility can inspire building owners and designers to reach for that goal.

Enforcement is a key, but often neglected, aspect of effective building codes and standards.[83] In the U.S., enforcement tends to take one of four shapes: state, local, third-party, or self-enforcement.[84] In Vermont, enforcement differs between residential and commercial energy codes. For residential development, the enforcement is a local responsibility, through code officials in the larger towns. Some enforcement also happens through Act 250, for those developments covered by that law. The Department of Public Safety is not supposed to issue a Certificate of Occupancy for commercial developments unless the developer has shown that the structure meets code. However, since enforcement resources are scarce, safety related issues often take precedence over energy issues. The state, through the Department of Public Safety, is responsible for developing building safety codes. The Public Service Department is responsible for developing energy codes but lacks resources to enforce them. Vermont's current residential code is based on the 2009 IECC Mandatory code, and the commercial code is based on the 2009 IECC, ASHRAE 90.1-2007 Mandatory code.[85] Vermont is on a timetable to update these codes every three years.

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[81] Executive Office of Public Safety and Security (2013).
[82] Building Energy Disclosure Working Group (2011).
[83] Levine, *et al*. (2012).
[84] *Id*.
[85] Online Code Environment and Advocacy Network (2013).

Because enforcement efforts have a cost, it is critical that proper and sufficient funding streams are established. The *Vermont Energy Code Compliance* study provides recommendations on achieving higher levels of compliance.[86] The return on this investment in the form of energy savings and greenhouse gas reductions justifies the investment.

iii. Select Resources

Executive Office of Public Safety and Security. (2013). *Stretch Energy Code – Information*. Retrieved from http://www.mass.gov/eopss/consumer-prot-and-bus-lic/license-type/csl/stretch-energy-code-information.html.

Levine, M., de la Rue de Can, S., Zheng, N., Williams, C. , Amann, J., & Staniaszek, D. (2012). *Building Energy-Efficiency Best Practice Policies and Policy Packages*. Berkeley, CA: Lawrence Berkeley National Laboratory. Retrieved from http://eaei.lbl.gov/sites/all/files/GBPN_Final.Oct_.2012.pdf.

National Action Plan for Energy Efficiency. (2009). *Energy Efficiency Program Administrators and Building Energy Codes*. Washington, DC: U.S. Environmental Protection Agency. Retrieved from www.epa.gov/eeactionplan.

[86] Energy Futures Group, *et al*. (2012).

9. Increase the Use of Local Biofuels

Increase the production and use of locally grown woody biomass, while simultaneously supporting and incenting the greater use of farm and landfill methane and liquid biofuels using renewable, agricultural-based resources.[87]

i. Key Considerations

- Funding: Consumers through purchases of heating and other fuels; ratepayers through inclusion of costs in rates.
- Sector Impact: Transportation, buildings, electric, industry.
- Accountability: Department of Public Service, SPEED facilitator, Agencies of Agriculture and Transportation, and permitting authorities.
- Point of Regulation: Self-regulation through incentives, project developers, and fuel processors.
- Scale of Implementation: Local or state.

ii. Policy Description

Woody biomass and biofuels can be advanced through effective public education and the use of local and statewide tax supports or relief. Biofuels and woody biomass also can be promoted through purchase and investment practices of municipalities, the state, and the schools.

iii. Wood and Woody Biomass

The Governor's Commission on Climate Change released a report recommending a goal of increasing production and use of woody biomass for energy by 30 percent by 2028, and the state's 2011 *Comprehensive Energy Plan* reported that heating from wood (now 14 percent of Vermont's heating needs) can be doubled.[88]

Woody biomass is renewable when harvested appropriately, however it is not inexhaustible. Vermont must consider the importance of policies furthering the sustained use of woody biomass while protecting human health, forest ecology, and environmental and related matters. In addition, stakeholders should consider that wood burning employing current technologies releases CO_2, particulates, and other harmful emissions. While use of wood and other biomass for heating and other energy purposes may create local economic and employment benefits and is renewable (when properly managed), it may not significantly reduce CO_2 emissions on yearly or decadal timescales.

It is likely that financial incentives will be needed to promote the increased use of this resource, especially if designed to encourage the change-out of old, inefficient wood-burning units with more efficient, cleaner-burning appliances; for the conversion to pellet-burning units; and for

[87] Governor's Commission on Climate Change (2007).
[88] *Id.* and Vermont Department of Public Service (2011).

the installation of district heating systems. Promoting and incenting fuel-switching from fossil fuel to wood heat, particularly in schools, government offices, hospitals, industrial parks, college campuses, and for municipal district heating, may offer potential to increase significantly the use of the state's wood resources.

Stakeholders must consider if production of electricity or transportation fuels is a desired and wise use of the Vermont wood resource. For instance, making liquid fuels from woody feedstock generally requires operations at considerable scale, meaning this is an all-in or all-out proposition regarding the available wood supply. Likewise, utility scale electrical generation, even when combined with combined heat and power technology, could use a significant amount of available harvested wood, taking the feedstock away from other uses, such as direct combustion for building heat. Limits to the wood and woody biomass resource in Vermont may require choices regarding the use of the available fuel.[89]

iv. Farm-based Biomass and Methane

Grass and other plant-based biomass may become a viable alternative in Vermont for institutional heating or combined heat and power applications. Production of this resource (i.e. growing a switch grass hay crop) is consistent with existing farming practices, can employ currently underutilized farmland, and can contribute to good farmland management. Promotion of plant-based biofuel production at the local level and incentivizing the development of convenient processing facilities may offer benefits for both a useful fuel supply and farm revenue streams. Locally-produced biodiesel fuel may be able to contribute meaningfully to fuel-switching away from petroleum-based diesel fuel for use in farm equipment and possibly for local fleets of heavy duty vehicles (HDVs) that have daily travel circuits within range of the fueling site. Presently, some Vermont farms grow plants that can be processed into high quality biodiesel for on-farm and HDV use. As with grass-based biofuel, this area offers potential for expansion, especially with farm incentives to grow feedstock and to develop and expand local processing capabilities.

Farm methane digester development and use has gained a respectable foothold among Vermont's dairy farms. While there are a limited number of farms large enough to use only animal manure for this process, alternative digester designs (e.g., "mixed-substrate" anaerobic digesters) can use both livestock manures and certain crops, other farm waste, and food-processing waste. Smaller farms may be able to take advantage of this approach and employ the technologies. While there are challenges, this technology may be able to generate up to 30 megawatts of renewable base load power by 2025.[90]

[89] Biomass Energy Development Working Group (2012).
[90] Vermont Department of Public Service (2011).

v. Landfill Methane

There is a limited capacity for new landfill biogas generation in the state. However, stakeholders may weigh the possibilities for expansion of existing systems or installation of generators on smaller landfills.

vi. Select Resources

Biomass Energy Resource Center. (2009). *Grass Energy: The Basics of Production, Processing, and Combustion of Grasses for Energy*. Retrieved from http://www.biomasscenter.org/resources/fact-sheets/grass-energy.html.

Governor's Commission on Climate Change. (2007). *Plenary Group Recommendations to The Governor's Commission on Climate Change*. Montpelier, VT: Governor's Office. Retrieved from http://www.anr.state.vt.us/air/Planning/docs/GCCC%20Appendix%202_Plenary%20Group%20Recommendations%20&%20Appendices.pdf

Legislative Council. (2012). *Biomass Energy Development Working Group Final Report*. Montpelier, VT: Legislative Council. Retrieved from http://www.leg.state.vt.us/REPORTS/2012LegislativeReports/272678.pdf.

Vermont Department of Public Service. (2011). *Comprehensive Energy Plan*. Montpelier, VT: Vermont Department of Public Service. Retrieved from http://publicservice.vermont.gov/publications/energy_plan/2011_plan.

10. Expand the Appropriate Use of Natural Gas

Support the expanded use of natural gas to displace higher carbon content fuels in all sectors of the economy.

i. Key Considerations

- Funding: Vermont Gas, ratepayers.
- Sector Impact: Buildings, electric, industry.
- Accountability: N/A.
- Point of Regulation: Vermont Gas, land use.
- Scale of Implementation: Local or state.

ii. Policy Description

Among fossil fuels, natural gas is the least carbon intensive, and its combustion results in the emission of fewer air pollutants, including particulates, sulfur dioxide, nitrogen oxides, and mercury. While natural gas still produces significant emissions, when it displaces a more carbon-intensive fuel like oil it can lower greenhouse gas emissions and help Vermont to meet its emissions reduction targets. There are a number of applications where natural gas potentially can serve as a bridge fuel to help Vermont meet its energy needs while driving toward a total or nearly total renewably-powered future:

- Natural gas electricity generation can replace dirtier fossil fuel generation (i.e. coal or oil).
- Natural gas can contribute toward needed system balancing and flexibility for variable energy renewable generation resources, furthering their expanded use on the grid.
- Methane made from renewable sources can be injected into a natural gas pipeline to create a partially renewable fuel.
- Natural gas can be used to power vehicles. For example, heavy-duty vehicles could achieve a nearly 29 percent reduction in CO_2 emissions when compared to diesel vehicles, depending on natural gas leakage rates.[91]
- Natural gas is a promising and cost effective alternative to oil or coal for building heat in areas where it is available.[92]
- Natural gas can be used to power industrial processes including combined heat and power systems.

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[91] California Air Resources Board (2009).

[92] An additional advantage of fuel switching to natural gas for heating is that customers currently using non-regulated fuels would be eligible for participation in utility sponsored efficiency programs. This could open new opportunities for customers not yet taking advantage of beneficial utility programs to insulate their homes and install more efficient appliances.

Vermont Gas Systems actively is exploring expansion plans for its gas pipeline and local distribution system with the goal of reaching more communities and customers in the Champlain Valley. As a result, natural gas may play an increased role in Vermont's energy future. While natural gas has attractions, its use does not come without potential hazards. Vermont stakeholders will need to analyze the extent to which they consider natural gas a beneficial bridge fuel. These policy questions, revolving around the extent to which the state can and will benefit from expanded use of natural gas, include discussions of items such as:

- Do we as a state consider natural gas to be cleaner than other fossil fuels and offer enough advantages to support expanding its use?
    - If we do support expanding its use, in what time frame and for what duration do we believe natural gas will provide a benefit to meeting Vermont greenhouse gas reduction goals?
    - What market and climate conditions, and which energy using sectors, will support expanding natural gas use in Vermont?
    - Will expanding the use of natural gas in Vermont help or hinder meeting the required renewable goals?
    - Is it beneficial, both economically and environmentally, to offer support to marketing and development efforts of Vermont Gas Systems for service expansion and increase access for consumers to natural gas? This would likely foster opportunities to substitute natural gas for other fossil fuels over at least the next 2 – 3 decades (as opposed to attempting to introduce substantially more renewable energy over the same time period from possibly undefined sources)?
    - Natural gas service expansion likely will provide near term benefits, including relatively inexpensive energy and economic development opportunities. However, will substantial expansion of the gas delivery infrastructure be consistent with long term renewable goals beyond 2 - 3 decades into the future?
    - Is continuing to provide incentives from the energy efficiency utilities and Vermont Gas for fuel switching from electric, fuel oil, and propane to natural gas consistent with the renewable energy and greenhouse gas reduction policies? Could a near term transition to natural gas, instead of switching to renewables, result in the use of natural gas over an extended period of time, and over what time frame would this lessen the introduction of renewable energy resources to provide the same services?

The Legislature has banned shale gas extraction in the state, raising the question about use in Vermont of shale gas from other jurisdictions. Vermont's gas is presently supplied from Alberta, Canada, but the extensive pipeline and delivery system in North America possibly offers potential for future supplies to come from other regions, including northeastern U.S. shale gas deposits. What should Vermont public policy be regarding the use in Vermont of gas from nearby shale gas deposits, in the context of relatively low energy prices, useful jobs, and economic investment in the northeastern U.S.?

iii. Select Resources

Bluestein, J. *et al.* (2012). *New Natural Gas Resources and the Environmental Implications in the U.S., Europe, India, and* China. Montpelier, VT: Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/6097.

California Air Resources Board. (2009). *Detailed California-Modified GREET Pathway for Compressed Natural Gas (CNG) from North American Natural Gas*. Sacramento, CA: California Environmental Protection Agency. Retrieved from http://www.arb.ca.gov/fuels/lcfs/022709lcfs_cng.pdf.

11. Electrify the Light-Duty Vehicle Fleet

Set targets for the increased electrification of transportation sectors.

i. Key Considerations

- Funding: Consumers, incentives from carbon pricing revenues.
- Sector Impact: Transportation.
- Accountability: Voluntary through inducement by incentives.
- Point of Regulation: Voluntary, unregulated fuel switch.
- Scale of Implementation: Federal and state.

ii. Policy Description

As discussed above, the electrification of the transport sector must be a major component to allow the transportation sector to meet the renewable and carbon goals established in Vermont law. Achieving a meaningful penetration of electric vehicles will require a combination of strategies to overcome the current limitations and consumer concerns surrounding electric vehicles and to create a supply network that is able to supply sufficient quantities of electricity reliably and conveniently.

The technology pathway for electric vehicles looks promising as battery prices are decreasing and new materials are reducing the weight and price of vehicles. As a small state, Vermont is in a very good position to act as an enabler, promoting policies and strategies to support an expanding electric vehicle fleet. The Transportation Renewable Fuels Standard discussed below can provide a strong incentive for electric vehicle adoption. Additionally, the state can continue its demonstration program and expand it to include vehicles in the state fleet. Advantages can be given to electric vehicles through registration fees, feebate programs, and similar programs where vehicles achieving lower fuel efficiency standards pay a higher registration fee, with some of that given to support a lower fee for more fuel-efficient vehicles. Similar incentives can be developed for businesses that maintain car fleets.

Electrification of significant elements of the light vehicle fleet is critically important to meeting Vermont's goals. Electric vehicle availability, supporting infrastructure, cost, and governing policies cannot be entirely controlled by relatively small Vermont. The evolution to greater electrification of the transportation sector doubtless will require a coordinated effort from many actors. However, there are some steps Vermont can take to help electric vehicles to compete with petroleum vehicles. One step is the establishment of a visible charging network as a state priority. In connection with this, Vermont could also establish an electric vehicle charging station tax credit for homeowners and businesses. The PACE program could be expanded to include home or business charging stations as eligible measures. Utilities could be permitted and encouraged to include charging stations as rate base items. Moreover, legal and other barriers, as discussed below, could be removed to allow third-parties to operate charging stations and resell electricity to customers.

The state must advance this policy through widespread education and information efforts. In this regard it may wish to sponsor education, outreach, and planning initiatives on the use of electricity as a replacement fuel for vehicles. This educational effort can explore both technical feasibility and costs and benefits. Associated with the education effort, the state can include an official website for Vermont-specific electric vehicle information. The state can create information guides for local governments to facilitate the use of electric vehicles and related equipment and charging infrastructure. These guides can be aimed at supporting necessary additions to the transportation and energy sections of existing regional and local plans, as well as for the zoning and building codes. Another step is Vermont's continued adoption of California's zero emission vehicle (ZEV) program. The goal of the ZEV program is to commercialize ZEV technologies (e.g., pure battery electric, plug-in hybrid electric, and hydrogen powered vehicles) to achieve substantial reductions of emissions of greenhouse gases and other air pollutants. Under the ZEV program, major auto manufacturers must sell an increasing percentage of ZEVs over time in the states with ZEV programs.

On the electric supply side, utilities must plan for the increased load from the supply side and attend to distribution system issues. An increased load will mean an increased need for renewable supplies of power. Additionally, clustering of plug in vehicles in neighborhoods served by lower voltage distribution systems could require improvements to the system. Utility rates and procedures may need an overhaul too. Currently, third parties cannot sell electricity at retail, so a charging station owner cannot charge by the kWh. Also, Vermont utilities do not have tariffs to allow them to sell to a "mobile account" (i.e., charging at a remote location and having the cost reflected in the monthly home or business electric bill). Providers are able to get around this by charging for parking with an option to recharge, assessing a flat fee for a charging service, or in the case of Tesla, not charging for recharging at all. In conjunction with the Public Service Board, a utility business model should be developed to support this transition, which would include measures to facilitate siting of charging stations. In addition, electrified end uses have the potential to provide increased ancillary services[93] to the electric grid through vehicle to grid (V2G) technologies or smart grid-enabled controls on end uses. These services likely will be in higher demand as the power supply transitions to one with a higher percentage of variable resources.

[93] "Services needed to support the transmission of energy from generation to loads, while maintaining reliable operation of the transmission system. These include regulation and frequency response, spinning reserve, non-spinning reserve, replacement reserve, and reactive supply and voltage control." Lazar (2011).

In addition to the above, there are a number of strategies that Vermont can take to promote transportation electrification of Vermont's light duty vehicle fleet:[94]

- Increase consumer awareness and demand for electric vehicles through public outreach.
- Reduce electric vehicle costs.
- Simplify and prioritize home charging installations.
- Optimize placement of non-residential charging infrastructure.
- Ensure that the electricity infrastructure (e.g., vehicle recharging facilities and distribution transformers) is sufficient to accommodate the rapid adoption of electrification.
- Encourage and coordinate local and regional government efforts.
- Support fleet purchases of electric vehicles.
- Research and demonstrate opportunities for electric vehicles to support Vermont's electricity grid.

iii. Select Resources

European Climate Foundation. (2010). *Roadmap 2050: A Practical Guide to a Prosperous, Low-Carbon Europe*. Hague, Netherlands: The European Climate Foundation. Retrieved from http://www.roadmap2050.eu/project/roadmap-2050.

Maryland Electric Vehicle Infrastructure Council. (2012). *Final Report to the Governor and Maryland General Assembly by the Electric Vehicle Infrastructure Council*. Hanover, MD: Maryland Department of Transportation. Retrieved from http://www.mdot.maryland.gov/Office%20of%20Planning%20and%20Capital%20Programming/Electric_Vehicle/Documents/Final_Report_Full_Document.pdf.

California Plug-In Electric Vehicle Collaborative. (2013). *Resources for Policy Makers*. Retrieved from http://www.evcollaborative.org/policy-makers.

Governor's Interagency Working Group on Zero Emission Vehicles. (2013). *2013 ZEV Action Plan, A Roadmap Toward 1.5 Million Zero Emission Vehicles on California Roadways By 2025*. Retrieved from http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf.

[94] Plug-in Hybrid & Electric Vehicle Research Center (2010). See also California Council on Science and Technology (2011).

12. Establish a Transportation Renewable Fuels Standard

Advance the state's commitment to the establishment of a Renewable Fuel Standard (RFS) for the Northeast region by establishing targets for use of various renewable energy-based fuels, including electrification, in the transportation sector.

i. Key Considerations

- Funding: Wholesale fuel suppliers and consumers through purchases.
- Sector Impact: Transportation.
- Accountability: Fuel suppliers.
- Point of Regulation: Fuel suppliers.
- Scale of Implementation: State and regional.

ii. Policy Description

The transportation renewable fuels standard (RFS) is a policy of promoting the use of electricity from renewable generation sources, as well as a course of action "whereby a minimum percentage of biofuels is to be used in the state or regional transportation fuel supply each year."[95] The policy pathway should have electricity included in the standard, to affect actions as described in the previous policy on electrifying light vehicles.

A transportation RFS also must focus on liquid transportation fuels, and it is advisable for the conversation to be expanded to include agricultural equipment fuels. Typically, fuels in this discussion include wood and woody biomass derived products, biodiesel, and other biofuels like ethanol. Other approaches in this area include a clean fuels standard (CFS) and low-carbon fuel standards (LCFS). The LCFS regulatory framework is distinct from the RFS in that it forces transportation fuels to compete based on carbon intensity. This differs fundamentally from RFS-like programs that mandate specific percentages or volumes of biofuel. Another important feature of a fuel standard is that it is designed to reduce the intensity of greenhouse gas emissions from fuels on a per unit basis, rather than to cap transportation emissions. Federal law establishes a RFS for the nation aimed at promoting the use of a minimum volume of biofuels additives to the petro-fuels in the transportation sector (i.e. adding ethanol to gasoline).[96] Continued support by Vermont for the establishment of a CFS for the Northeast region through the Northeast States for Coordinated Air Use Management is fully consistent with this RFS approach.

Renewable fuel standards work best with a regional or national scope; however, efforts by Vermont to expand the availability and use of renewable fuels transportation and on-farm agricultural equipment may offer benefits in energy supply, emissions reduction, resource

[95] Schnepf & Yacobucci (2013).
[96] See the 2005 and 2007 Energy Acts.

production and markets, and other areas. RFS programs must be long-term because significant infrastructure evolution is required, including manufacturing, transport, and distribution of fuels and end-user adaptations to accommodate such fuels as they become available and economically competitive.

RFS fosters the use of fuels from renewable resources that displace fossil fuels, support local economies and job growth, and lead to lower greenhouse gas emissions. Renewable fuels may fill a niche for reducing fossil fuel use in transportation sectors where electrification is not effective or convenient.

Availability of and access to fueling stations and technical assistance will be needed to expand retail siting of renewable fuel infrastructure. Vermont requires additional investment and coordination among stakeholders, especially in the liquid biofuels sectors.

A renewable fuel standard is most effective when deployed in conjunction with complementary state and regional policies, such as energy efficiency, increased electrification in transportation and building heating, district or community heating initiatives, and a state school heating conversion program, such as Fuels for Schools.[97] In addition, the policy is consistent with initiatives for a statewide bioenergy industry targeted at transportation and other energy consuming sectors.

iii. Select Resources

U.S. Environmental Protection Agency. (2013). *Renewable Fuel Stand (RFS)*. Retrieved from http://www.epa.gov/otaq/fuels/renewablefuels/.

Schnepf, R. & Yacobucci, B. (2013). *Renewable Fuel Standard (RFS): Overview and Issues*. Washington, DC: Congressional Research Service. Retrieved from http://www.fas.org/sgp/crs/misc/R40155.pdf.

Vermont Department of Public Service. (2011). *Vermont Comprehensive Energy Plan*. Montpelier, VT: Department of Public Service. Retrieved from http://publicservice.vermont.gov/publications/energy_plan/2011_plan.

Maryland Electric Vehicle Infrastructure Council. (2012). *Final Report to the Governor and Maryland General Assembly by the Electric Vehicle Infrastructure Council.* Hanover, MD: Maryland Department of Transportation. Retrieved from http://www.mdot.maryland.gov/Office%20of%20Planning%20and%20Capital%20Programming/Electric_Vehicle/Documents/Final_Report_Full_Document.pdf.

[97] Biomass Energy Resource Center (2013).

13. Transition the Heavy-Duty Vehicle Fleet to Biofuels or Natural Gas

Adopt and support policies to transition the heavy duty vehicle fleet away from petroleum based fuels.

i. Key Considerations

- Funding: Developers, state transportation funds.
- Sector Impact: Transportation.
- Accountability: N/A.
- Point of Regulation: Many.
- Scale of Implementation: National and state.

ii. Policy Description

Diesel fuel use accounts for a significant portion of Vermont petroleum use, mostly for heavy-duty vehicles (HDV) and off-road vehicles used in agriculture. Since much of the diesel fuel used in Vermont is from heavy duty vehicles whose trips do not originate in Vermont and may not end in Vermont, transitioning heavy-duty vehicles away from petroleum based diesel fuel may require different approaches for these different types of uses. Various alternatives are available to overcome the legacy of market barriers and existing conditions created from years of fossil fuel dependence. These range from pure market instruments such as carbon taxes to prescriptive mandates and voluntary actions. As with any emissions abatement strategy in the transportation sector, success requires a complementary approach involving increased vehicle fuel efficiency, reduced carbon intensity of fuels, and reduced vehicle miles traveled (VMT). To date, much policy in this area is driven by federal fuel efficiency standards, which were recently announced for HDVs, and federal actions regarding biofuel production and blending requirements. This policy is directed at lowering the carbon content or increasing the renewable content of fuels used.

iii. Biofuels

As a result of their design characteristics, diesel engines are better able to combust a range of hydrocarbons to provide motive power. This can include everything from used fryer grease to advanced refined fuels that closely resemble diesel fuel. This characteristic has encouraged many backyard fuel producers to set up operations in Vermont. However, the over the road trucking industry needs a fuel dependably blended to serve their needs. Even so, vehicle manufacturer's warrantees and guidelines vary regarding the use of biofuels. Vermont will have to depend on manufacturers to work this out.

Implementation of a biofuels policy for Vermont can start with increasing the availability of blended fuels. Many stations are reluctant to install the necessary tanks and other required equipment because, in addition to the cost, they are reluctant to take on the challenges of handling and storing biodiesel and the challenges of the Vermont permitting system. Technical assistance could help here. Financial incentives, through a reduced fuel tax, exemption from a carbon pricing scheme discussed above, or other measures could ease that reluctance.

Working with in-state operators of trucking fleets may produce results, especially if there are some tangible benefits or recognition awarded to the operator. Agricultural operations also can use biofuels and grow crops to produce biofuels. Self-producing the fuel for the farm machinery can contribute to the financial viability of the farm and make it more self-reliant.

iv. Natural Gas

As discussed above in the natural gas policy, while natural gas is a lower carbon content fuel than gasoline or diesel fuel, it is still a hydrocarbon. Natural gas is neither sufficiently renewable nor sufficiently low in carbon to meet the goals established for Vermont. Stakeholders must consider if it may be best viewed a bridge fuel – one that can save carbon in the short term while other alternatives are being developed, but a fuel that does not represent a solution for meeting 2050 goals. The questions posed in the natural gas sector are appropriate to include in a discussion about natural gas in the transportation sector. Vermont should consider if there are relative benefits that justify the use of natural gas as a fuel in the coming decades, especially in the heavy duty transportation section. However, such use is likely to be a decision made by influences outside of Vermont. The national trucking industry, for instance, may adopt a technology independent of any action taken by Vermont.

v. Select Resources

U.S. Environmental Protection Agency. (2013c). *Renewable Fuel Standard (RFS)*. Retrieved from http://www.epa.gov/otaq/fuels/renewablefuels/.

Moniz, E. J., *et al.* (2011). *The Future of Natural Gas An Interdisciplinary MIT Study*. Boston, MA: Massachusetts Institute of Technology. Retrieved from http://mitei.mit.edu/publications/reports-studies/future-natural-gas.

Jacobson, M., *et al*. (2013). "Examining the feasibility of converting New York State's all-purpose energy infrastructure to one using wind, water, and sunlight." *Energy Policy*, 57 (2013) 585–601. Retrieved from http://www.stanford.edu/group/efmh/jacobson/Articles/I/NewYorkWWSEnPolicy.pdf.

14. Reduce Vehicle Trips and Increase Mobility Options, Enabled by Smart Growth

Adopt and support policies to encourage non-motorized and public transport by fostering their consideration in development.

i. Key Considerations

- Funding: Developers, state transportation funds.
- Sector Impact: Transportation.
- Accountability: N/A.
- Point of Regulation: N/A.
- Scale of Implementation: National, state, and local.

ii. Policy Description

The purpose of this policy is to encourage greater levels of walking, bicycling, and the use of public transit options as alternatives to driving, by making it safe, convenient, and popular. Because much of the state's energy is used to move people from homes to work, shopping, school, or social gatherings, a compact development pattern allows the energy used in moving those people to be reduced. Compact development means trips are often shorter, which facilitates people walking, biking, and using alternative modes of transportation to reach their destinations. Transit systems are also less viable outside of compact settlement areas. Conversely, sprawl reduces transportation options and leads to increased reliance on single occupancy vehicles.

The state's long-standing land use planning goal is to plan development to maintain the historic settlement pattern of compact village and urban centers separated by rural countryside.[98] This requires the encouragement of concentrated mixed-use development within our community cores. This goal is integral to a variety of public interests, including reduced development pressures on agricultural, productive forest, and natural resource lands and the creation of strong community centers with economic development in those centers. The goal also has a major influence on the functionality of the transportation system and, as a result, on energy consumption.

Many town ordinances and town planning efforts attempt to separate residential areas from commercial and industrial activities. While there are valid reasons for this, it also leads to people living farther away from where they work and shop, which increases the likelihood that

[98] The Downtown Development Act establishes programs to support downtowns, villages, and growth centers in the form of transportation grants, rehabilitation tax credits, Tax Increment Financing (TIF) districts, and relaxed Act 250 thresholds, as well as prioritizing state funding to these areas.

they will use a vehicle rather than alternative modes of transportation. Fortunately, Vermont is already a national leader in employing Smart Growth principles.

Areas to develop and implement policies include:

- Explore implementation measures (incentives, regulations, and outreach) critical to enabling and encouraging land use decisions that support "smart growth" and assess progress toward that vision.
- Strengthen and streamline state smart growth "designation" programs, link state programs and funding sources to "designation" criteria, and review Act 250, Act 248, and Agency of Natural Resource programs to determine what provisions support or impede development within designated areas and other smart growth locations.
- Improve data collection regarding the composition of the Vermont vehicle fleet, penetration of alternatively fueled vehicles, and use patterns.
- Define techniques to better integrate land use, transportation planning, and economic development efforts at the state, regional, and local levels.
- Encourage telecommuting and teleconferencing by developing telecommunications infrastructure.
- Conduct the necessary scenario analysis combined with other planning techniques to determine the degree of build-out of rail, transit, bike/pedestrian, park and ride, and other facilities identified in the *Comprehensive Energy Plan* needed to meet the state's goals. Identify the costs and revenue sources available to accomplish these objectives.
- Encourage transit-oriented development, with the goal to create walkable communities integrated with an efficient mass transit system where residents have access to amenities without depending on a personal vehicle to access them.[99]
- Support the continued implementation and enhancement of Vermont's Complete Streets legislation passed in 2011.[100]
- Keep the needs of all users – drivers, pedestrians, transit users, and bicyclists – in mind when facilities are designed or constructed.
- Ensure projects supported by state funding are designed flexibly to include pedestrian and cycling amenities.
- Infuse projects with the unique "sense of community" that is alive in so many areas of Vermont.

Integral to compact growth strategies is improving the availability of public transit. Vermont should adopt policies to balance its state and federal transportation investments to support efficient and timely public transportation service. Services should be designed to encourage and

[99] TransitOrientedDevelopment.org (2013).
[100] Smart Growth America (2013).

enable increased public transit ridership, carpooling, and other commuting strategies. Strategic leveraging of Vermont community resources, such as town energy and transportation committees, can create opportunities for targeted outreach to increase public awareness of transit options.

iii. Public Transportation Improvements

Vermont should consider implementing policies that expand public transportation by offering increased service on existing routes, subsidizing fares, expanding routes where justified, or building new infrastructure. A fare structure can be subsidized so all riders receive an incentive to use public transportation, or specific classes of riders can be subsidized through low-income support programs or by policies like time-of-day fare differentials. Increased service can come in the form of more frequent service, expanding scheduled stops, or adding new routes.

Passenger rail transportation opportunities come from improving interconnections to neighboring states and Canada, although establishing passenger rail service from Montpelier to Burlington or Burlington to Rutland has attracted interest in the past. Increasing the efficiency of freight rail activity for local shipping has some potential, although most rail traffic in Vermont is thru traffic, with origins and destinations outside of the state.

iv. Ride-sharing, Car-sharing, and Other Commuting Strategies

Vermont should consider implementing policies to expand services and provide incentives to travelers to choose transportation options other than a single occupancy vehicle. Carpoolers need a collector lot at the beginning of their journey and parking at the end. Expanding carpool lots at strategic junctures around the state will open up possibilities for ridesharing, while rewarding carpoolers with reserved parking at their destinations will provide an additional incentive to join a carpool. Go Vermont (http://www.connectingcommuters.org/) is a web-based service matching commuters with potential ride sharers. Additionally it functions as an intake point for commuters interested in establishing a vanpool. These services should be broadened where appropriate. Social media can be used to inform and improve service in this area.

v. Select Resources

Fehr & Peers. (2013) *Traffic Calming*. Retrieved from http://trafficcalming.org/.

TransitOrientedDevelopment.org. (2013). *Transit Oriented Development*. Retrieved from http://www.transitorienteddevelopment.org/.

Smart Growth America. (2013). *National Complete Street Coalition*. Retrieved from http://www.smartgrowthamerica.org/complete-streets.

Form Based Codes Institute. (2013). *What Are Form Based Codes?* Retrieved from http://www.formbasedcodes.org/what-are-form-based-codes.

Bhatt, N., Peppard, C. & Potts, S. (2010). *Getting Back on Track: Aligning State Transportation Policy with Climate Change Goals*. Washington, DC: Natural Resources Defense Council.

Retrieved from http://www.nrdc.org/smartgrowth/files/GettingBackonTrack_report.pdf.

Cambridge Systematics, Inc. (2009). *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions*. Washington, DC: Urban Land Institute. Retrieved from http://www.rockefellerfoundation.org/uploads/files/6e40c2cf-a33e-4f7a-ba1f-39069e6e1214.pdf.

15. Use Creative Price and Tax Mechanisms to Encourage Use of Transportation Alternatives

Develop pricing initiatives and tax incentives to influence transportation choices.

i. Key Considerations

- Funding: Consumers, Agency of Transportation, insurance companies.
- Sector Impact: Transportation.
- Accountability: Agency of Transportation.
- Point of Regulation: Auto registration, insurance purchase.
- Scale of Implementation: State and federal.

ii. Policy Description

Fees assessed to motorists are both fixed and variable. The gasoline tax is a variable fee, based on the number of gallons of gasoline purchased. Registration fees and insurance premiums are generally fixed and independent of miles driven. Policies that enable the conversion of some of these fixed costs associated with the use of the transportation system into variable costs can make those costs avoidable through efficient transportation decisions. This includes local and regional pricing strategies, such as pay-as-you drive fee assessments and variable registration fees. These pricing policies provide an incentive for drivers to change their behavior with respect to driving miles or purchasing a vehicle.

Instituting a carbon tax or emissions fee generally will raise the cost of fuel, resulting in increased incentives for drivers to be more efficient with their choices. Any policy like this must include safeguards for the most vulnerable in the population to ensure adequate mobility for them. This can be done through revenue recycling to promote efficiency in a particular sector or through direct subsidies.

Weight-based registration fees are another policy that turns a portion of the vehicle registration fee into a variable cost and promotes more efficient transportation choices by consumers. This can include feebates, whereby fees are increased on a less desirable option with corresponding fees decreased or rebated for more desirable options. For example, California's proposed "Clean Car Discount" program imposed a fee of up to $2,500 on new, high-carbon emitting vehicles (starting in 2011) and then rebated the fee to buyers of new, low-emission vehicles, thereby shifting some of the external costs resulting from the operation of a less efficient vehicle onto those who create the impact.[101]

[101] See A.B. 493 at http://www.leginfo.ca.gov/pub/07-08/bill/asm/ab_0451-0500/ab_493_bill_20070220_introduced.html.

A vehicle miles traveled (VMT) tax is a policy of taxing motorists based on the number of miles they travel each year.[102] It has been proposed in other states as an infrastructure funding mechanism to replace the fuel tax, which has been generating significantly less revenue due to the effects of more fuel efficient vehicles and higher gasoline prices. A tax levied on the miles travelled will have the effect of discouraging excess travel and encouraging more efficient means of travel. The principle can also be applied to insurance payments. Pay-as-you-drive insurance appeals to consumers because it offers the possibility of lower rates. Insurance companies like it because telematics devices, which are required in most pay-as-you-drive plans, transmit accurate driving data and let insurers match the price of their coverage to the actual risk posed by drivers.

Implementing a VMT requires a system to collect fees. This could be as simple as a self-reporting system with spot checks or as sophisticated as a GPS system to monitor usage. A successful usage-based policy must inform motorists of their resulting obligations on a regular basis. Additionally, the taxes or insurance premiums must be collected on a regular basis, possibly at a fuel refilling station.

In addition to sending appropriate price signals to impact marginal driving decisions, usage-based fees collect taxes in a more equitable manner than fixed fees. Over time, other costs and fees could be included, such as a pollution tax or congestion fees, either of which can be time of day based.

iii. Select Resources

Cambridge Systematics, Inc. (2009). *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions*. Washington, DC: Urban Land Institute. Retrieved from http://www.rockefellerfoundation.org/uploads/files/6e40c2cf-a33e-4f7a-ba1f-39069e6e1214.pdf.

Cambridge Systematics, Inc. (2009). *Moving Cooler: Technical Appendix*. Washington, DC: Urban Land Institute. Retrieved from http://www.acogok.org/Programs_and_Services/Transportation_and_Data_Services/documents/MovingCooler_Appendix%20A_Strategies.pdf.

[102] National Surface Transportation Infrastructure Financing Commission (2009).

16. Adopt a Renewable Portfolio Standard

Implement a Renewable Portfolio Standard (RPS) that sets specific and aggressive targets for new electric generation from renewable sources over the period of 2015 to 2050. The RPS obligations should be mandatory for all Vermont electric utilities serving retail customers.

i. Key Considerations

- Funding: Ratepayers through inclusion of costs in rates.
- Sector Impact: Electric.
- Accountability: Measurement and verification by Public Service Board.
- Point of Regulation: Retail utilities.
- Scale of Implementation: State.

ii. Policy Description

A RPS requires an electric utility to buy or generate a minimum amount of renewable energy as a percentage of the utility's overall retail sales. While Vermont does not presently have a RPS, Vermont electric utilities have met the 2004 legislative goal of serving all kWh load growth during the years 2005 to 2012 from SPEED resources.[103] In addition, the SPEED program establishes in-state generation goals, expanded by legislation in 2012—127.5 MW must be phased-in over several years, supplied by generation sources of 2.2 MW or smaller. Vermont may now consider expanding both of these approaches or adopt a new RPS policy that more aggressively promotes the development of renewable generation.

Vermonters strongly support the use of clean power and, as with environmental and social laws, many wish to see Vermont stand out as a national leader in the development and use of renewables. The goal of acquiring 90 percent of Vermont's energy from renewable sources by 2050 will require that renewables be deployed more extensively and at a faster rate than current prices with lack of pricing for externalities would dictate. A RPS policy that sets aggressive goals decades into the future can help foster this enhanced deployment. The RPS can be used to support overlapping benefits—development of renewable energy provides cleaner energy sources and also practical opportunities for significant economic development, expansion of the tax base, and growth of local jobs. In addition, an aggressive RPS can stimulate development and use of emerging technologies, distributed generation, in-state generation, and customer-sited generation.

Stakeholder consideration of a full RPS program in Vermont may include the following steps:

- Review the legislative definition of qualifying renewable resources.

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[103] A SPEED electrical resource is power produced by a renewable source for which the renewable attributes are not required to be retained to qualify. See footnote 65.

  - Determine if any changes to the existing definition are appropriate.
  - Determine if out-of-state renewable generation is appropriate to meet Vermont's RPS requirements.
  - Consider the treatment of small and large hydroelectric facilities:
    - Consider if in-state, new, large dams qualify.
    - Consider if imports from Hydro-Quebec qualify.
- Consider whether to promote any particular technology or energy resources:
  - Establish sub-targets (e.g., "set-asides" or "carve-outs") that encourage set amounts of a particular resource, or
  - Establish favorable payment policies to promote particular technologies.[104]
- Determine whether existing renewable facilities can participate in a new RPS program.
- Establish penalties for utilities that fail to reach the specified renewable targets.
  - Would harsher penalties apply if failure to meet any intermediate or sector goals?
- Consider mitigating the cost of the program to ratepayers.
  - Allow the Public Service Board discretion to suspend temporarily the program or allow exceptions if ratepayer costs become burdensome.
- Consider utility recovery of the additional cost of procuring renewable power.
  - How much cost recovery is allowed and how to collect it?
    - treatment of RPS related costs in normal rate-making,
    - a ratepayer surcharge, or
    - utilities to include costs in rate base.
- Determine the treatment of the penalties utilities incur associated with non-compliance.
  - Do ratepayers, shareholders, or both pay?
  - Treatment of public power utilities that have no shareholders.
- Set year-by-year program targets to meet the 90 percent by 2050 goal.
  - Consider year-by-year sub-targets ("set-asides") for specific technologies.
- Consider the benefits of a central procurement program where all ratepayers participate equally vs. utility specific requirements where each utility acts individually.
  - Is it useful to employ a hybrid approach that allows a utility to obtain resources either through central procurement or through their own individual efforts?
- Consider whether different rate classes should have the same renewable requirements. (e.g. industrial rate class energy could be less renewable in order to maintain inter-jurisdictional competitiveness)

The market mechanisms upon which the RPS relies provide price competition among suppliers and between different technologies and energy resources. To the extent these markets provide competition, they are likely to stimulate efficiency and creative innovation as renewables compete among themselves and with conventional sources. RPS is most effective when established to mandate medium- and long-term goals that progressively increase over time.

[104] Grace, *et al.* (2011).

With no traditional RPS requirement in place, Vermont allows the sale of renewable attributes from renewable energy generation (known as renewable energy credits or RECs) to be sold into markets in other states. Critics of this practice argue that this is double counting the renewable attribute and that allowing Vermont REC sales defers additional development of clean resources that would have otherwise been required to meet regional clean energy goals. As a result, Vermont is left with higher priced power stripped of its clean attributes. Supporters of the practice note that Vermont has in place a planning requirement for electric utilities to determine how they will accomplish targets of 55 percent renewables in their supply mix in 2017, climbing to 75 percent renewable in 2032. In addition, supporters contend that Vermont ratepayers benefit from the sale of the RECs into out-of-state markets and argue that the practice should continue or, at a minimum, the sale of RECs from existing generation should be "grandfathered" by any new policy. State policy going forward can address the treatment of REC sales from existing and future renewable generation sources. State policy should be clear on the sale of renewable attributes and clarify whether such a sale eliminates that source from meeting the 90 percent goal.

As with most policies to encourage renewable energy use and carbon emissions reduction, RPS works best to meet established goals when combined with energy efficiency, conservation, electric demand response, and federal production tax credits.

iii. Select Resources

Database of State Incentives for Renewables & Efficiency. (2013). *Portfolio Standards/Set Asides For Renewable Energy*. Retrieved from http://www.dsireusa.org/incentives/index.cfm?SearchType=RPS&&EE=0&RE=1.

Grace, R., Donovan, D. & Melnick, L. (2011). *When Renewable Energy Policy Objectives Conflict: A Guide for Policymakers*. Silver Spring, MD: National Regulatory Research Institute. Retrieved from http://www.nrri.org/pubs/electricity/NRRI_RE_Policy_Obj_Conflict_Oct11-17.pdf.

Yang, C., Williams, E. & Monast, J. (2008). *Wind Power: Barriers and Policy Solutions*. Charlotte, NC: Duke University's Nicholas Institute. Retrieved from http://nicholasinstitute.duke.edu/sites/default/files/publications/wind-power-barriers-and-policy-solutions-paper.pdf.

M.J. Beck Consulting. (2013). *The RPS Edge*. Retrieved from http://mjbeck.emtoolbox.com/?page=Renewable_Portfolio_Standards.

17. Import Utility Scale Renewables, Including Large-Scale Hydroelectric Power, from Canada

Look to regional trading partners as suppliers of renewable energy generation.

i. Key Considerations

- Funding: Ratepayers through inclusion of costs in rates.
- Sector Impact: Electric.
- Accountability: N/A.
- Point of Regulation: Retail utilities.
- Scale of Implementation: State and Region.

ii. Policy Description

Vermont has purchased significant amounts of electricity (up to approximately one-third of the state's power supply) from Hydro-Québec for the previous several decades. Presently, purchase contacts are in place through 2038 that will provide Vermont with over 200 MW of electric power from Hydro-Québec supplied by at least 90% hydro-electricity, which the Vermont Legislature has determined qualifies as renewable power.[105] The DPS advises that this contract provides a long term source of electric generation with low air emissions, relative price stability, renewable fuel, freedom from relying on a single generator, and other potential benefits.

Hydro-Québec and Nalcor Energy in Newfoundland and Labrador are expected to have surplus generation, mostly from hydroelectric power, for sale into the New England market in coming years.[106] Vermont utilities should investigate securing purchase contracts and delivery options for additional, stable, long-term hydropower supply potentially available from Canadian provinces.[107]

The New England Wind Integration Study suggestes that up to 12,000 MW of wind power could be available by 2020 under certain assumptions.[108] Most of this is in Northern New Hampshire, and Maine. Additional supplies of wind power could become available from Northern New York State as well. These projects may be able to achieve economies of scale, enabling Vermont to procure renewable resources at a lower cost than may be available through smaller scale projects.

TransCanada owns and operates eight hydroelectric dams on the Connecticut and Deerfield Rivers totaling roughly 500 MW. Many of these generating facilities are either located in Vermont or easily accessible through exiting electrical transmission. The DPS advises that "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

[105] Vermont Department of Public Service (2011).
[106] Hydro-Québec (2009) and Nalcor Energy and Newfoundland and Labrador Hydro (2011).
[107] Vermont Department of Public Service (2011).
[108] ISO-New England (2010).

any new opportunity to purchase these hydro facilities if they become available."[109] Vermont policy should include such purchased power agreement or facility acquisition to the extent such "acceptable price and quantity terms" are obtainable.

[109] ISO-New England (2010).

18. Improve Vermont's Standard Offer (Feed in Tariff) Program

Enhance and improve the state's standard offer program for renewable energy generation.

i. Key Considerations

- Funding: Ratepayers through inclusion of costs in rates.
- Sector Impact: Electric.
- Accountability: Measurement and verification by Public Service Board and SPEED facilitator.
- Point of Regulation: Retail utilities.
- Scale of Implementation: State.

ii. Policy Description[110]

A fixed-price standard offer or feed-in tariff (FIT) is designed to increase the amount of renewable energy projects developed in a jurisdiction by guaranteeing a price and a term for the purchase of the output of a project at a level and duration sufficient to support the investment decisions that must be made by project developers. The contract price is often set through an administrative process, although Vermont has moved toward a market-based pricing scheme in its recent solicitation. In either case, once set, the price is guaranteed, or "fixed," for the life of the contract, usually 10 to 25 years, long enough to secure project financing and amortize other fixed costs.[111] A successful FIT strikes a reasonable balance of risk allocation between project owners who produce power and utility consumers who pay for and consume it. FIT stands in contrast to RPS, which sets the amount of renewable energy to be secured and allows the price to be set by market forces (i.e. competitive bidding). FITs are the most widely used policy in the world to increase the pace at which renewable energy projects are developed.[112] Vermont's FIT is called the Standard Offer Program.

In Vermont, unlike most other states, a third-party purchasing agent functions as a middleman in the transaction. Payment is made by this purchasing agent to the individual project owners; the renewable power, RECs, and costs are then allocated and billed, pro rata, to the Vermont utilities by the purchasing agent.[113] The per-kWh charge for renewable power differs based on the generation technology and is intended to reflect the costs of owning and operating different types of renewable systems rather than the market value of the power. Wind resources, for example, receive a different level of payment per kWh than solar resources.

[110] Some of the material from this subsection is drawn from an unpublished report by John Nimmons, John Nimmons Associates, for the Regulatory Assistance Project.
[111] It is not uncommon for the price to decline at a set rate over the term of the contract, but the price is still guaranteed.
[112] Couture, *et al.* (2010).
[113] This applies to all Vermont distribution utilities, except Washington Electric Coop, which received a legislative exemption.

Vermont's most recent solicitation completed May 1, 2013 introduced a new offer-based bid structure, combined with price caps, in an effort to infuse market forces into the price.[114] This market-based strategy attempts to address a key challenge for FITs: setting the price correctly so developers have sufficient incentive to build but consumers are protected from overpaying for energy.[115] A number of jurisdictions have tried different ways of establishing the "right" price: set the price based on the value of the electricity supplied, set the price based on the generation cost of eligible technologies, or use a variety of competitive benchmarks or auctions to establish the price.[116]

A well-designed FIT scheme will guarantee access to the grid for the renewable energy projects. In addition, the administration should be simple, the transaction costs low, time requirements brief (i.e. queues for interconnection), and policies stable. In an effort to clarify the relationship between Public Utility Regulatory Policies Act (PURPA) avoided cost rates for renewable technologies and FITs, the Federal Energy Regulatory Commission (FERC) overturned a long-standing PURPA precedent that required utilities to pay avoided costs to renewable facilities. This construct under PURPA had restricted the discretion of states to set rates for renewable energy that were sufficient to enable a return on an investment. As a result of this FERC decision, payments to renewable generators can be differentiated based on the requirements of each renewable energy technology.

FITs can be varied according to different needs or situations.[117] For instance, one variation, called a premium FIT, has two payment parts: a reduced FIT payment (i.e. the price per kWh but at a lower price than a fixed FIT), plus the hourly market price for electricity. This construct exposes the generator to market variability in the price of electricity. Floors and caps can be added to ensure the variability is not too great. A FIT's flexibility enables it to be crafted to work with other policies, such as a RPS or other quota system.

Vermont should more fully develop the locational incentives included in its FIT design. Through the Vermont System Planning Committee process, Vermont has identified areas of transmission congestion in the state. Encouraging generators to locate their projects in these stressed zones

[114] That solicitation produced a number of bids and the selection of 6.4 MW of solar projects to be awarded contracts. The bid price was between 13 and 15 cents per kWh.

[115] The standard FIT contract ought to resolve ownership of the REC in order to accurately value the transaction and to treat the generator (large and small) fairly.

[116] Grace, *et al.* (2009).

[117] When exercising this flexibility, states should be cautious to avoid a level of compensation that may appear to be an entitlement to any particular technology. Just as gasoline prices and home prices vary from time to time to reflect market realities of supply and demand, so may FIT prices.

could help defer transmission upgrades and create additional value for ratepayers. For example, generators locating in a stressed area could receive an adjustment in their bid price to reflect this additional value. This adjustment could be published with the bid solicitation to encourage favorable location choices by developers.

The purpose of FIT is to encourage the development of resources that contribute to carbon and renewable energy goals but may be unable to compete at market prices for the present moment. As technology evolves, new applications are developed, and others mature and achieve economies of scale, a reevaluation of resource types suitable for FIT will be warranted. Vermont may also look to broaden its FIT by incorporating other beneficial technologies, such as combined heat and power.

iii. Select Resources

Couture, T., Cory, K., Kreycik, C. & Williams, E. (2010). *A Policymaker's Guide to FIT Policy Design*. Golden, CO: National Renewable Energy Laboratory. Retrieved from http://www.nrel.gov/docs/fy10osti/44849.pdf.

Delmas, M. and Montes-Sancho, M.J. (2011). "U.S. State Policies For Renewable Energy: Context and Effectiveness*." Energy Policy*, *Vol. No. 39* (Issue No. 5), 2273 - 2288. Retrieved from http://www.sciencedirect.com/science/article/pii/S0301421511000449.

Grace, R., Rickerson, W., Corfee, K., Porter, K. & Cleijne, H. (2009). *California Feed-In Tariff Design and Policy Options.* California Energy Commission. Publication Number: CEC-300-2008-009F. Retrieved from http://www.energy.ca.gov/2008publications/CEC-300-2008-009/CEC-300-2008-009-F.PDF.

19. Facilitate Renewable Energy Siting, Permitting, and Interconnection

Maintain adequate and robust planning and approval processes to facilitate renewable energy siting, permitting, and grid interconnection (including distributed generation and net metering generation facilities).

i. Key Considerations

- Funding: Renewable generation project developers.
- Sector Impact: Electric.
- Accountability: Public Service Board and SPEED facilitator.
- Point of Regulation: Project developers, retail utilities, and Vermont Electric Power Company (VELCO).
- Scale of Implementation: Local and state.

ii. Policy Description

Vermonters want approval processes for energy siting and permitting (for all energy resources) and for grid interconnection for electric generation that create public trust, address potentially competing interests, and consider all relevant economic and environmental costs and benefits. Fully encompassing siting and related permitting rules must consider all legitimate interests, allow for decisions to be made in a reasonable amount of time, and create the opportunity for stakeholder confidence. All appropriate siting and permitting criteria, including those related to grid interconnection of electric generation, should be employed in regulatory deliberations.

While Vermont's existing approach works well given the present volume of requests, a significant increase in future renewable energy projects, including electric generation and related interconnection requests, has the potential to overburden the administrative capability of utilities and regulatory agencies and may compromise reliability on elements of the existing electric distribution and transmission systems of Vermont electric utilities.[118]

iii. Siting and Permitting

State level authority, such as Public Service Board Section 248 permitting and Act 250, addresses a variety of energy-related issues, but regional planning and local zoning also play roles for various energy infrastructures. The areas to be considered include electrical generation siting, permitting of biomass and biofuels processing facilities, energy-related building codes, and local zoning ordinances. The use of local renewable resources for energy production must continue to be balanced with other, competing public interests.

Existing siting and permitting rules are in place at all levels and many currently are being reviewed to assess how well they function in light of present day considerations and interests.

[118] See Vermont Public Service Board Rule 5.500 and 30 VSA, Section 248.

The Governor's Energy Generation Siting Policy Commission's report, issued on April 30, 2013, suggests more emphasis should be placed on planning at state, regional, and municipal levels, with simpler siting process for small projects and relatively more effort for larger ones. More community-led projects are encouraged, as is enhanced public participation. The Commission's report also suggests state agencies develop guidelines and checklists to enhance the protection of the state's natural resources; address public concerns; and provide clarity, accessibility, transparency, and predictability to the siting and permitting process.[119]

Efforts to maintain a clear and unambiguous pathway for the presentation and evaluation of renewable energy project proposals will reduce the time required and improve the process for permitting a renewable energy site. Strong siting and permitting guidelines and rules established at the state level may provide for state and local entities (including regional planning commissions) to operate under the same imperatives to consider all views without compromising the benefits of renewable energy to the state. Such rules, established with a long-term scope in mind and consistently applied across all jurisdictions, potentially affect all proposed renewable energy infrastructures and their developers, stakeholders, regulators, and local permitting entities. There may be value to this review and evaluation process if relevant state agencies prepare generic siting guidelines for developers of renewable energy projects, especially for permitting under Act 250 (buildings and industrial development) and Public Service Board Section 248 (electricity and natural gas).

iv. Facilitate Grid Interconnection for Distributed Generation and Net Metering Facilities

Vermont has effective grid interconnection rules, processes, and procedures for distributed generation and net metering developments. However, the anticipated future growth of interconnection requests to meet Vermont's goal of 90 percent renewable energy may overtax the present arrangement.

Vermont legislation in 2005 called for a statewide renewable portfolio goal and for the Public Service Board to set interconnection standards for up to 50 MW of distributed generation. The Public Service Board adopted Rule 5.500 in 2006 to establish a standard application form and mandate that utilities provide information to developers about applying for interconnection.[120]

[119] Vermont Energy Generation Siting Policy Commission (2013).
[120] Rule 5.500 set standards for distributed generation interconnection if generators were not covered under federally-approved (FERC) rules administered by the Independent System Operator of New England (ISO-NE). These rules also apply to net-metered systems larger than 150 kW but smaller than 500 kW.

An assertive approach is advisable, in advance, to address methods for handling the likely utility and regulatory resource needs (administrative, process, and technical) that are expected in coming years. Stakeholders may find it useful to assess the nature of utility support for interconnection requests and objectively assess future needs in terms of timeliness of response, information flows, and overall effectiveness of the process if there are significant increases in volume. Likewise, determination of an effective regulatory process to address substantial growth in the volume of requests for interconnection under Vermont rules may be useful.

The Vermont Public Service Board entered orders on March 1 and May 30, 2013 in Docket No. 7873, in which it established a Screening Framework and Guidelines "regarding transmission-constrained areas in which renewable generation having particular characteristics may provide sufficient benefit to the operation and management of the electric grid." While finding that there are no such transmission constrained areas at this time, the Public Service Board ordered "affected utilities to continue to analyze any identified constraints and to submit Reliability Plans next year consistent with the requirements of the Screening Framework and Guidelines."[121]

Continued support for enacting a distributed utility planning approach is consistent with this policy and the Public Service Board Screening Framework and Guidelines obligations, including related matters of performance-based ratemaking and reliability benchmarking. This approach may be consistent with electric utility distribution system planning to assess and identify the most receptive and most restrictive circuits (at least at the sub-station level) and propose priority for improvements to ease restrictions to accommodate distributed generation and net metering development activity. California currently conducts a process to acquire renewable generation projects between 3 and 20 MW (the Renewable Auction Mechanism or RAM). Related to the RAM, certain California utilities offer interactive on-line maps of their transmission and distribution systems providing information regarding capability to interconnect distributed generation to the distribution substations and transfer power onto the transmission system.[122] Such an approach, with oversight by the Public Service Board, would be useful in Vermont.

v. Select Resources

California ISO. (2013). *Integration of Renewable Resources*. Retrieved from http://www.caiso.com/informed/Pages/StakeholderProcesses/IntegrationRenewableResources.aspx.

[121] Vermont Public Service Board (2013).
[122] California Public Utilities Commission (2013).

Vermont Department of Public Service. (2011). *Comprehensive Energy Plan*. Montpelier, VT: Vermont Department of Public Service. Retrieved from http://publicservice.vermont.gov/publications/energy_plan/2011_plan.

Vermont Energy Generation Siting Policy Commission. (2013). *Energy Generation Siting Policy Commission Final Report*. Montpelier, VT: Vermont Energy Generation Siting Policy Commission. Retrieved from http://sitingcommission.vermont.gov/sites/cep/files/Siting_Commission/Publications/FinalReport/Final%20Report%20-%20Energy%20Generation%20Siting%20Policy%20Commission%2004-30-13.pdf.

c. Implementation Policies[123]

Once Vermont decides which of the aforementioned key policies it wishes to employ, it must make important decisions regarding how the policies will be implemented. These implementation decisions can have as strong effect on the policies' ultimate success as do the decisions regarding the key policies themselves. Therefore, it is critical that for each policy selected three key questions be considered and answered:

1. What entity will be responsible for overseeing and delivering the services associated with the policy?
2. How will the services associated with the policy be funded?
3. How will accountability be ensured?

Each of these questions is considered further in the sections that follow.

1. Administration

Identify the entity responsible for overseeing and delivering the services associated with a policy.

While both private and public entities can have an appropriate role to play in ensuring the successful delivery of programs to increase the use of renewable energy and decrease emissions of greenhouse gases, in order to ensure the success of programs it is important to decide which entity is the right one to charge with the overall responsibility for administering the program.

There are a number of potential administrating entities from which to choose, each with certain strengths and weaknesses: an end-user, the utility, a governmental entity, a quasi-governmental entity, or a third party (non-profit or for-profit). Furthermore, whether an entity is appropriate as an administrator may depend on the particular policy. For example, a government administrator may be appropriate for Policy A, but less so for Policy B. These decisions will depend on the details of the situation and of the policy.

When determining which entity is most appropriate to administer the program or service, it is advisable to consider the following factors:[124]

- **Trusted relationships with the market**: The administrative entity must already possess or be able to quickly develop relationships with existing market participants. The entity needs to understand the end use customers, their investment considerations, and how

[123] This discussion of implementation policies relies heavily on Wasserman & Neme (2012).
[124] Wasserman & Neme (2012).

best to motivate them to adopt the desired behavior. All of the respective players need to trust the entity and its ability to deliver programs and recommendations without bias.

- **Access to appropriate data**: The administrative entity should already possess or be able to gain access to appropriate energy use data to effectively design programs and measure progress toward goals.
- **Strong data tracking systems**: The administrative entity should already possess or be able to acquire easily the technological equipment and know-how to track relevant energy and customer data, program data, and outcomes. In addition, the entity must demonstrate the willingness and ability to keep this information safe and confidential.
- **Strong evaluation, measurement, and verification (EM&V) systems and expertise**: The administrative entity must be able to demonstrate the ability to credibly track, verify, and report on program outcomes. The entity must be able quickly to establish transparent mechanisms and processes so that participants rely on the accuracy of the administrative entity's findings. This is particularly true where a financial outcome hinges on the administrator's decision (i.e., if a payment is going to be made for attainment of an energy savings goal).
- **Regional coordination:** The administrative entity should be well positioned to engage in regional coordination with other obligated entities and with adjoining or overlapping service territories. This ability allows for a wider, more uniform message to be communicated to end-users. It also allows for broader program reach, with potentially deeper impacts.
- **Incentives and penalties**: The administrative entity must be empowered and able to implement incentives and penalties with end users to improve the outcomes of programs.

Vermont is fortunate to be home to the Vermont Energy Investment Corporation, a third-party, non-profit organization that administers many of Vermont's energy efficiency and renewable energy programs. VEIC is an excellent example of how a third-party administrator can administer programs successfully to increase renewables and decrease greenhouse gas emissions. California also has excellent program administration by using its investor-owned utilities to fund and carry out efficiency programs. The California utilities also hire out 20 percent of their efficiency work to third-party entities.[125]

[125] Wasserman & Neme (2012).

i. Select Resources

Sedano, R. (2011). *Who Should Deliver Ratepayer Funded Energy Efficiency? A 2011 Update*. Montpelier, VT: Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/4707.

Wasserman, N. & Neme, C. (2012). *Policies to Achieve Greater Energy Efficiency*. Montpelier, VT: Regulatory Assistance Project. Retrieved from www.raponline.org/document/download/id/6161.

York, D., Kushler, M. & Witt, P. (2008). *Compendium of Champions: Chronicling Exemplary Energy Efficiency Programs from Across the U.S.* Washington, DC: American Council for an Energy-Efficient Economy. Retrieved from http://www.aceee.org/node/3078?id=100.

2. Funding

Identify a clear, secure, long-term source of funding for the services associated with a policy.

Ensuring a reliable, long-term source of funding for programs may be the single most important thing to "get right" when establishing new policies and programs.[126] It is important that once funding is committed, it continues uninterrupted so that programs can be implemented, the workforce can be trained, the public can be educated, and the market can mature. Swings in funding levels will frustrate these efforts and reduce the chances of meeting the state's targets.

It is important to ensure that those who pay for a program receive as many of the benefits of that program as is possible. Driving program participation is one way to ensure that consumers can benefit from programs. Care also must be given to more vulnerable segments of the population who may not be able to participate in programs absent some form of subsidization from the larger populace. There are a number of different funding mechanisms that can be considered, depending on the policy options that are chosen:

- **Public benefits charge**: A public benefits charge is a mandatory charge imposed by the government or one of its agents, which is collected from all energy users for a purpose that benefits the public. A typical example is an additional charge on an electric bill beyond the cost of fuel and service to fund energy efficiency programs.
- **Direct government investment**: Direct government investment involves allocating a portion of the state's general revenue to the operation of energy efficiency and renewable energy programs. This investment can take a variety of forms, such as a direct allocation of funds in the form of grants or rebates, establishment of loan/loss reserve funds, subsidized loans, etc.
- **Cap-and-trade proceeds:** This mechanism takes revenues from the regional cap and trade program (RGGI) and reinvests all or a portion of those revenues into energy efficiency and renewable energy programs. Vermont currently employs this technique, reinvesting nearly all of its RGGI revenues back into non-regulated fuel efficiency programs.
- **Carbon tax proceeds:** This mechanism is essentially the same as the cap-and-trade mechanisms discussed above, except the source of the funds derives from a carbon tax, not from the cap-and-trade program.
- **Public-private partnerships**: This mechanism involves the government working directly with private-entities by providing financing of loans and credit arrangements where the financing is invested into energy efficiency and renewable energy projects. The practice

[126] International Energy Agency (2010).

helps to jump start the market and is designed to encourage private financing, which will eventually supplant the need for government backed financing. The Property Assessed Clean Energy (PACE) program is a variation on this theme.[127]

- **Market based mechanisms**: Market mechanisms, as the name suggests, are funding tools that rely upon markets to generate funds to support efficiency and renewable programs. Two examples include: (a) allowing energy efficiency and demand side programs to bid their energy saved into energy and capacity markets operated by ISO-New England, thereby earning a revenue stream; or (b) employing tradable white certificates, which are documents that certify a certain amount of energy has been saved and can be bought and sold in a marketplace.

i. Select Resources

Allen, R. and Rao, A. (2011). *Affordable Heat: Whole-Building Efficiency Services for Vermont Families and Businesses*. Montpelier, VT: Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/4439.

International Energy Agency. (2010) *Energy Efficiency Governance*. Paris, France: OECD/IEA. Retrieved from http://www.iea.org/publications/freepublications/publication/eeg.pdf.

Taylor, R. P., Govindarajalu, C., Levin , J., Meyer, A. S., & Ward, W. A. (2008). *Financing energy efficiency: Lessons from Brazil, China, India and Beyond*. Washington, DC: The World Bank. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2008/02/18/000333037_20080218015226/Rendered/PDF/425290PUB0ISBN11OFFICIAL0USE0ONLY10.pdf.

[127] PACE generally involves municipal governments offering a bond to investors. The proceeds of the bond sale are loaned to residents and businesses to put towards energy retrofits. The loans are repaid through an annual assessment on the property tax bill.

3. Accountability

Establish a transparent, independently-administered system to ensure that energy savings and emissions reductions are truly being achieved and appropriately accounted for.

Accountability refers to the processes and policies that ensure energy efficiency and renewable energy programs are being operated with integrity and transparency and that energy savings and energy production can be tracked, counted, and confirmed. Accountability gives policymakers, market participants, and others confidence that Vermont's policy goals are being achieved in an efficient and cost-effective manner. Two key methods of building accountability are listed below:

- **Evaluation, measurement, and verification (EM&V):** EM&V are the rules and practices by which energy efficiency and renewable energy programs are evaluated, measured, and verified. The process involves clearly establishing rules and methods for calculating energy usage, energy savings, the source of energy production, and the level of and reductions in emissions. These rules must be established and regularly updated to remain valid. Further, consideration must be given to how much of a program budget should be dedicated to EM&V; it must be enough to satisfactorily perform the job but not so great as to unnecessarily draw funds from actual program activities.
- **Performance incentives or penalties:** This mechanism relies on a robust EM&V process that will unequivocally determine whether obligated entities have or have not achieved the targets for which they were aiming. For those entities that hit their goal, a performance incentive can be awarded. For those entities failing to hit their targets, a performance penalty can be assessed.

i. Select Resources

ISO-New England. (2012). *ISO New England Manual for Measurement and Verification of Demand Reduction Value from Demand Resources - Manual M-MVDR*. Holyoke, MA: ISO-NE, Inc. Retrieved from http://www.iso-ne.com/rules_proceds/isone_mnls/m_mvdr_measurement_and_verification_demand_reduction_revision_4_06_01_12.doc.

Schiller, S.R., Goldman, C.A., & Galawish, E. (2011). *National Energy Efficiency Evaluation, Measurement And Verification (EM&V) Standard: Scoping Study Of Issues And Implementation Requirements*. (No. LBNL-4265E). Berkeley, CA, US: Lawrence Berkeley National Laboratory. Retrieved from http://eetd.lbl.gov/EA/EMP/reports/lbnl-4265e.pdf.

IV. Resources and Experience

a. Introduction

Vermont is not alone in charting a path towards renewable and sustainable energy. Other states and national organizations are considering similar issues, and Vermont can learn from their efforts. The following resources include relevant, earlier Vermont studies and similar efforts outside the state. This section provides a brief summary of the major efforts to date and how they can be used to inform Vermont's choices. Recent studies demonstrate that technology exists that can enable us to achieve targets for renewables and carbon reduction without significant cost-impacts, even given modest expectations for commercialization of technology and technology cost improvements.

b. State and National Policy Resources[128]

i. **Vermont Governor's Commission on Climate Change:** The Commission considered the greenhouse gas situation in Vermont and developed a comprehensive set of 38 policy recommendations to reduce greenhouse gas emissions from all sectors, including energy supply and demand; transportation and land use; agriculture, forestry, and waste management; and included 7 recommended policies that cut across multiple sectors.

ii. **U.S. Environmental Protection Agency**: Web site linking to 32 state initiatives on climate action planning. This website provides information, strategy, and policy recommendations for a state climate change action plan to reduce greenhouse gas emissions. EPA offers technical assistance, analytical tools, and outreach support.

iii. **Vermont Comprehensive Energy Plan (CEP):** This statewide energy plan covers electricity, heating, and process fuels; energy in transportation; and land use decisions. It recommends the state goal of 90 percent of total energy from renewable sources by 2050. The CEP promotes efficiency and conservation as first priorities in all energy sectors and recommends a renewable portfolio standard of 75 percent renewable electricity within 20 years. In addition, it encourages planning for the integration of electric and alternative fuel vehicles and recommends aggressive goals for energy efficiency, bio-blended fuels, and renewable energy technologies for building heat in new construction. It endorses state government "leading by example" with prudent investment in energy efficient buildings and deploying renewable energy systems.

[128] Clicking on the title of the reports in the following sections will take you directly to the report's location in the Appendix A.

iv. **Biomass Energy Development Working Group Final Report ("BioE Report"):** The Working Group met over the course of three years to address the promotion, development, and growth of the Vermont woody biomass industry while maintaining forest health. It produced 47 recommendations in areas of modeling (6), enhancement and development of woody biomass industry (22), and forest health (19). Recommendations involved fiscal and regulatory incentives for sustainable biomass energy, standards, and policies for the design of new, sustainable renewable energy from biomass, guidelines for maintaining forest health, and suggestions for additional research and analysis.

v. **Energy Generation Siting Policy Commission Final Report:** The Commission was asked to provide guidance and recommendations on siting of electric generation projects, to identify best practices (including research of approaches of other New England states) for siting, and public participation and representation in the siting process. The Commission held informational sessions, public hearings, and deliberative meetings and received testimony. The result of this work is 28 recommendations in five main areas, which include 1) emphasis on planning at all levels of government; 2) create a tier system to classify generating projects by nameplate capacity, with Public Service Board resources focused more on large or more complex proposals; 3) increased opportunity for public participation in the siting and permitting process; 4) increased transparency, efficiency, and coordination; and 5) creating a standardized, accessible, and comprehensible system of environmental and other relevant guidelines.

vi. **Integration of Renewable Resources:** California has a renewable portfolio standard of 33 percent renewable generation by 2020. In support of this goal, the California ISO is working with a variety of electric industry stakeholders, including utilities, asset owners, regulators, and other control areas, to identify and solve issues related to integrating large quantities of renewable resources, including variable resources like solar and wind, into the California grid.

vii. **U.S. State Policies for Renewable Energy: Context and Effectiveness:** This UCLA study looks at how effective state renewable policies are at encouraging investments in renewable capacity. The researchers conclude that a renewable portfolio standard (RPS) is ineffective, but a mandatory green power option is effective. They also report that the RPS is more effective with investor-owned utilities than with publicly owned utilities.

viii. **Final Report to the Governor and Maryland General Assembly by the Electric Vehicle Infrastructure Council:** The Council met sixteen times in 2011 and 2012 and produced plans to 1) expand the adoption of plug-in electric vehicles; 2) support the creation of a statewide charging infrastructure network; and 3) make recommendations for a number of state policies and programs for actions at the state and local levels of government to promote owning an electric vehicle in Maryland.

ix. **Designing the Right RPS: A guide for Selecting Goals and Program Options for a Renewable Portfolio Standard:** This paper addresses issues surrounding design and goal setting for state RPS programs. It also considers experience thus far in several states and discusses features that contribute toward efficiently meeting cost effective RPS goals.

x. **New England Governors' Renewable Energy Blueprint:** New England has a large renewable energy resource potential. This report identifies both challenges and solutions to them to help bring these resources to market. New England has the ability to address economic and environmental issues, perform regional cooperation, and has considerable recent experience successfully siting significant transmission facilities. These and other skills and resources can increase New England's ability to develop and market renewable energy resources within the existing energy markets.

c. Relevant State and National Technology Studies

i. **Renewable Electricity Futures Study:** This paper reviews the ability of commercially available renewable electricity generation technologies to supply, and the U.S. electric grid to absorb, varying levels of renewable generation. It concludes that high levels (80 percent renewables) are possible by 2050, despite challenges for grid operation that must and can be solved. The study concludes that the cost of an 80 percent renewable scenario is comparable to published costs of other clean energy scenarios.

ii. **California's Energy Future Project:** This project researches ways to meet California's admirable and achievable goals for reducing greenhouse gas emissions. Separate reports have been produced on a variety of topics including biofuels, building and industrial efficiency, transportation, electric generation (both fossil fuel with carbon capture and sequestration and renewables), nuclear power options, and an overall summary report.

iii. **Roadmap 2050: A Practical Guide to a Prosperous, Low-Carbon Europe:** In 2009 European leaders set an objective to reduce greenhouse gas emissions by at least 80 percent below 1990 levels by 2050. This study was prepared to create an underlying source of information on what the technical and economic impacts of this goal might be, including consequences in the electricity sector. It discusses needed policies and regulations in the coming years, as well as broad changes necessary in society to accomplish the goal.

iv. **Cost-Minimized Combinations of Wind Power, Solar Power, and Electrochemical Storage, Powering the Grid Up to 99.9 Percent of the Time:** This report models renewable power (wind, solar, and storage) to meet demand for a large grid system that is 20 percent the size of the U.S. grid. Multitudes (28 billion) of combinations were run to determine least cost scenarios. Results show that nearly all hours of the year can be met by renewables using storage about 11 percent of the time (972 hours/year). Although least-cost combinations have large amounts of excess generation compared to load (3 times), the study concluded that 90 percent of the hours of the year electric load could be served at costs below today's when assuming 2030 technology costs.

v. **Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions:** This study considers impacts on greenhouse gas reductions from about 50 actions and strategies intended to either reduce the amount of vehicle travel or alter transportation services in ways that improve fuel efficiency. The study looks at costs and usefulness of reducing vehicle miles and increasing the efficiency of vehicles and the transportation network in which they perform.

vi. **Moving Cooler: Technical Appendix:** Emission reduction strategies and actions are organized into nine strategy categories each of which is assessed at three increasingly aggressive levels of speed of implementation.

vii. **A Policymaker's Guide to FIT Policy Design:** This guide provides an analysis of design and implementation of policies for a successful feed-in-tariff (FIT), as well as provides proven FIT design best practices for stimulating development of renewable generation. The study draws on experience from Europe (with nearly 20 years of FIT experience) and current examples in the U.S. and Canada where FITs also have been used.

viii. **California Feed-In Tariff Design and Policy Options:** This report discusses the possibilities of using various feed-in tariff designs to help meet California's renewable generation goals. The report assesses a number of FIT policy design options including tariff structure, pricing, and eligible resources. It evaluates and compares six policy paths to be considered further and reviews interaction of the FIT with other policies. The conclusion is a recommendation for a California FIT for renewable technologies of 20 MW or less in capacity. Numerous issues on design, pricing, planning, regulation, and implementation are considered as well.

ix. **Strategies for Decarbonizing the Electric Power Supply:** Decarbonization policies are reviewed and highlighted, including carbon pricing, carbon intensity measures, resource planning, portfolio and contract standards, and complementary environmental standards. In addition, the report discusses technology strategies such as carbon capture and storage and renewable resources. Policies to discourage the use of fossil fuel resources and encourage the use of low-carbon resources are also explored.

x. **Vermont Wood Fuel Supply Study 2010 Update:** This report calculates the potential supply of low-grade wood available for energy purposes above and beyond current levels of harvesting in Vermont and 10 adjoining counties in surrounding states.

xi. **The Future of Natural Gas: An Interdisciplinary MIT Study:** The paper provides research and insight into natural gas availability, price, and future utilization potential. The authors also state it "seeks to inform discussion about the future of natural gas…addressing a fundamental question: what is the role of natural gas in a carbon-constrained economy?"

V. Summary and Conclusion

Vermont has visionary renewable energy and climate goals. Significant effort is needed to design and implement the policies to reach them. The 19 policies featured in this report have the potential to be substantive, practical, and cost-effective means toward Vermont's goals. They warrant considered discussion and feedback from stakeholder groups. Importantly, the featured policies are both specific and actionable. Some represent policies the state is already implementing and should continue or expand, while others represent new or different approaches. Combined with the supplemental list of policies, the state has a multitude of options as it considers how best to meet its climate and renewable energy goals.

One of Vermont's greatest challenges, its size, also serves to its advantage. With its small area and population, Vermont has the advantage of local engagement, organization, and enthusiasm around energy and environmental concerns. Vermont is also fairly limited in it resource commitments: it relies heavily on outside contracts for power and relatively expensive outside sources of liquid fossil fuels for heating. With its reasonably close proximity to clean resources outside the state, the resource and technology pathways forward look even more promising for the development of distributed resources and those that can be developed locally. As a result, Vermont can be somewhat nimble in its approach to the resource and policy path forward and can act relatively quickly.

Vermont historically has relied on clean energy resources in the power sector, and the Comprehensive Energy Plan and statutes set clean energy targets across all sectors. Vermont can now translate these goals into actionable policies that put us on a path toward their achievement. In doing so, Vermont can play its part in providing solutions and can also provide some measure of leadership. Vermonters have already demonstrated their support for renewable energy and their desire to mitigate climate change. In such an atmosphere, Vermont can demonstrate to the rest of the country the level of effort and commitment it will take to turn the tide of climate change.

The featured policies are intended to inform, guide, and focus a series of stakeholder meetings occurring over the coming months. These meetings are part of a process to refine a list of resources and policy pathways the state should pursue to meet its goals. The process will also quantify, to the extent possible, the impacts that can be expected from their implementation.

Vermont has an opportunity to combine the enthusiasm and resourcefulness of its communities with the guidance and expertise of its policymakers and energy regulators to establish a plan of action appropriate to tackle the pressing climate and energy issues of the day. The policies outlined here, refined and edited by the process envisioned can create that action pathway.

VI. Appendix A: References

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VII. Appendix B: Inventory of Available Policies

The following list contains policies that, while important in their own right, do not rise to the level of key policies required to achieve the state's carbon and energy goals. Often, these individual policies will be coupled with a key policy to improve that key policy's performance. Policies are listed in alphabetical order.

Policy	Description
Administration of energy efficiency programs	These policies ensure the administration of energy efficiency programs is optimally conducted by providing guidelines for how to best oversee and deliver energy efficiency programs.
Appliance and equipment standards	These policies prohibit the production and sale of appliances and electronic products that do not meet certain minimum thresholds for efficient energy performance. Typical products covered by these standards include air conditioners, water heaters, refrigerators, and televisions. The standards can be "ratcheted up" so that, over time, products become steadily more and more efficient.
Bonding	Bonds can be sold, with the proceeds directed to fund renewable energy or energy efficiency projects.
Contractor licensing requirements for renewable energy	The state can require renewable energy contractors to be licensed and certified, ensuring that they are credible, insured, and capable of building projects to Vermont's standards.
Corporate tax	Vermont can impose a tax on corporations and direct the proceeds to fund renewable energy or energy efficiency projects.
Decoupling	This policy separate's a regulated utility's ability to profit from the volume of energy it sells to its customers. It is intended to remove the disincentive to cooperate with energy efficiency efforts. Vermont already successfully employs decoupling.

Policy	Description
Demand response programs	These policies encourage electricity consumers to reduce their normal energy consumption based on the price of electricity or in response to incentive payments intended to induce lower electricity use at times of high prices or system instability.
Electric grid infrastructure	The Public Service Board could require electric companies to conduct a reliability analysis of the power system on a regular basis. The analysis should include a review of the distribution system's requirements.
Energy efficiency information centers	Vermont could fund the operation of informational clearinghouses to provide information about the benefits of and availability of energy efficiency.
Energy efficiency resource standards	An energy efficiency resource standard or obligation reduces or flattens electric load growth by setting certain energy efficiency targets statewide. Local distribution utilities are charged with achieving specific reductions in energy use (MWh), peak demand (MW), or both. Efficiency programs are designed and implemented with the goal of achieving the prescribed targets.
Energy pricing	This policy is based on the notion that energy consumers should see the "real" price of the energy they use in as close to real time as possible, so that the consumer can make an economically informed and efficient choice. Real time pricing of electricity is an excellent example of this policy.
Energy savings performance contracting	Government agencies can enter into contracts with energy services companies (ESCOs) to install energy-efficient systems in government owned buildings. The contracts generally require ESCOs to audit the building, design an efficiency project, and install the new equipment. The renovation must accrue enough cost savings from forgone energy usage that the project can pay for itself within a set time period. Any savings in excess of the cost of the project are paid to the ESCO.

Policy	Description
Energy standards for public buildings	These policies set strict efficiency and renewable energy standards for the construction of new governmental buildings. These policies can create markets for advanced energy savings and renewable energy projects.
Equipment certification requirements for renewable energy	The state can require the mechanical systems used in renewable energy projects to be certified as qualifying as renewable energy systems.
Grants	Vermont can consider offering grants to citizens who elect to purchase and install renewable energy or energy efficiency projects in their home or business.
Green building incentives	Vermont can encourage the construction of new buildings with the highest levels of energy efficiency and use of renewable energy systems by reducing permitting costs, streamlining approval processes, offering tax incentives, and providing other benefits. These policies can take several forms and can occur at all levels of government.
Green power purchasing	The Public Service Board may require local electric distribution companies to offer ratepayers the option of purchasing energy generated from renewable sources.
Investment tax credits	The state can offer tax credits to taxpayers who invest in renewable energy or energy efficiency projects.
Land use and smart growth	Local and state zoning entities can adopt zoning and planning standards that discourage reliance upon motorized transportation, encourage transportation savings, and encourage increased population densities and pedestrian-friendly and transit-oriented development designs.
Loan guarantees	This policy involves offering loan guarantees to people who take out loans to finance the construction of renewable energy or energy efficiency projects.

Policy	Description
Loan programs	The state may offer loans, at discounted interest rates, to finance the construction of renewable energy or energy efficiency projects.
Low Emission Vehicle (LEV) program	Adopting California's Low Emission Vehicle and Greenhouse Gas Standards ensures that new vehicles sold within the state meet the most stringent emissions standards and helps foster development of advanced vehicle technologies such as plug-in hybrid electric, full battery electric, and fuel cell electric vehicles.
Mandatory energy audits and use disclosure	Vermont may require homeowners to engage a professional to conduct an energy audit of their homes. The information from this audit would then be required to be disclosed to future potential buyers of the home.
Mandatory energy labels	The state may require manufacturers to include the relative energy consumption and efficiency level of certain electronic devices on the item's packaging.
Net metering	The Public Service Board may direct electric distribution companies to develop and publicize clear standards for the interconnection of and payment for small-scale, distributed, renewable energy generation projects (i.e. home solar panels or wind turbines).
Non-public transportation improvements	Encourage individuals who do not use or have access to public transportation to employ other methods to encourage more efficient commuting strategies. Examples include ride-sharing or car-sharing, vanpooling, ride matching services, intercity passenger rail promotion, and mega buses.
Nontraditional rate structures: inclining block	This policy requires electric distribution companies to implement a rate in which electricity become more expensive the more of the commodity that is used. Usually, this is accomplished by set blocks of usage that increase in price.

Policy	Description
Nontraditional rate structures: time of use	This policy requires electric distribution companies to implement a rate in which electricity is more expensive at a particular time of day or time of the year. For example, power purchased during the peak times of the day or year is more expensive than power purchased at other times.
Output–based environmental regulations (OBR)	OBR encourages the use of efficient technology by measuring emissions per unit of energy output (i.e., electricity or thermal energy). These are policies that recognize conversion efficiency of the electric generation or industrial processes and rewards use of more efficient machinery.
Personal tax	Vermont may impose a personal tax and direct the proceeds to fund renewable energy or energy efficiency projects.
Production tax credits	This policy offers a tax credit to renewable energy projects that produce energy, usually on a per kWh basis.
Property tax exemption	The state may exempt from the property tax certain renewable energy property or energy efficiency investments as an inducement to undertake these projects.
Property tax	Vermont may impose a property tax on real property and direct the proceeds to fund renewable energy or energy efficiency projects.
Public benefit funds	These policies require electric distribution companies to place a surcharge on ratepayers' bills, and invest the funds in activities designed to increase public welfare, such as using the funds to support low-income assistance programs or to fund renewable energy projects.
Public transportation improvements	These policies support the operation of and encourage the increased use of public transportation services, such as light rail, bus, and taxi service.

Policy	Description
Renewable energy certificate (RECs) creation and purchase	Renewable energy credits (RECs) are certificates that verify that a unit of energy was generated from a renewable source. The REC (which represents the attributes of energy) can be separated and sold apart from the energy itself. This can create an additional revenue stream for renewable energy projects. According to the EPA, "a REC represents the property rights to the environmental, social, and other non-power qualities of renewable electricity generation. A REC, and its associated attributes and benefits, can be sold separately from the underlying physical electricity associated with a renewable-based generation source."
Renewable energy rebates	Vermont may require electric distribution companies or other entities to establish a funding mechanism to provide rebates to ratepayers that choose to purchase and install renewable energy systems for their homes or businesses.
Require certain fuel blends or types at the pump	These policies require gas stations to carry and sell fuels that produce fewer carbon emissions, including, cellulosic ethanol and corn based ethanol blends, biodiesel, or natural gas.
Require green power	The state may require entities, usually government entities, to acquire a set portion of their energy purchases from renewable sources.
Research, development, and demonstration	Vermont may fund research, development, and demonstration projects associated with energy efficiency, renewable energy, and alternate fuels. This investment can move the market forward more quickly than waiting for private investment in these areas.
Sales tax exemptions	This policy exempts certain renewable energy and energy efficiency products and services from state sales tax in order to incentivize their purchase.

Policy	Description
Tax incentives	Tax incentives encourage investment in and operation of certain types of businesses–in this case, companies related to renewable energy and energy efficiency—by reducing the tax burden these companies face. For example, Vermont may create tax incentives to reward companies that develop alternative fuels for transportation, or that build and install small-scale distributed generation apparatus, or that design and build better batteries to support economy wide electrification.
Transportation efficiency, land use, and smart growth	These policies create more transportation-efficient land use patterns, which allow walking and biking to supplant motor vehicle trips and reduce the length of the remaining motor vehicle trips. Smart growth policies focus development along transportation corridors and include zoning and planning standards that allow and support increased population densities.
Transportation pricing	These transportation-related policies are intended to increase the cost of driving, particularly in urban centers, and thereby dissuade individuals from driving personal automobiles. An example of one such policy is congestion pricing, which imposes a charge on privately owned vehicles driven in particularly congested portions of an urban center. Another example is increasing the cost of parking in urban centers.
Vehicles participate in electricity markets	These policies establish rules to allow electric vehicles to participate in ISO-New England's wholesale electricity markets. For example, Vermont could require its regulated utilities to implement programs to use electric vehicles as storage when there is excess renewable energy on the electric system.