Total Energy Study:

Report to the Vermont General Assembly on Progress Toward a Total Energy Approach to Meeting the State's Greenhouse Gas and Renewable Energy Goals

December 15, 2013

Table of Contents

Executive Summary

The purpose of this report is to inform the Legislature and the public of progress to date in carrying out the Total Energy Study (TES). The goal of the TES is to identify the most promising policy and technology pathways to employ in order to reach Vermont's energy and greenhouse gas goals. These goals are to: 1) meet 90% of Vermont's overall energy needs from renewable sources by 2050 and 2) reduce Vermont's greenhouse gas (GHG) emissions by 50% from the 1990 baseline level by 2028 and 75% from the 1990 level by 2050. Vermont's greenhouse gas emissions in 2011 were almost unchanged from the state's emissions in 1990. Vermont meets about 16% of its energy needs with renewable energy.

The Public Service Department expects to release, and submit to the Legislature, the Total Energy Study Final Report in the summer of 2014. While the Total Energy Study describes several policy and technology scenarios that are expected to achieve the State's goals, these reports are not intended to be or replace the Comprehensive Energy Plan. Neither this report nor the TES Final Report will articulate or recommend a definitive pathway forward.

The Department has structured its analysis around the development and evaluation of sets of policies and technology pathways. Technology pathways define different ways that the state could meet its objectives in terms of technology or hardware deployed (for example, how much electric power, and from which sources, how many cars powered by what fuels by what date, how many homes weatherized, etc.). Technology pathways generally determine overall cost and economic impacts. Policy sets are the tools deployed by the State government (in concert with policies adopted at the National, regional, and local level) to shape deployment of technologies.

The TES analysis evaluates technology pathways on criteria including: ability to meet the state's GHG and renewable energy goals; total economic impacts; impact on capital flows; and risks such as technology performance risk. The TES analysis of policy sets evaluates them based on: impact (both scope and leverage); responsiveness to external changes; and independence from polices adopted by others. Combining policy sets with technologies pathways, analysis will indicate potential compatibility or incompatibility between policy and technology directions, as well as overall impacts on the pace of State goal achievement.

The effects of a particular policy/technology pathway with regard to most other state policies depend on the details of policy implementation. If energy policy is implemented poorly, it could conflict with other state policy goals. This report summarizes the areas of greatest interaction between comprehensive energy policies and non-energy policies in the areas of economic development, land use, transportation, forestry, agriculture, heath, and natural resources. The policy sets analyzed in this report have been formulated so as to minimize conflicts between energy policy and other state objectives. In many cases, there is the potential for mutually-reinforcing benefits between these policy areas.

Comprehensive and integrated energy policy sets should be constructed with recognition for the structure of the energy sector and energy markets. In particular, the energy sector is rife with market failures; policy structures that have been developed to address those failures. Market failures include prices that do not reflect costs, lack of information, lack of access to capital, and split incentives. Government action can use four leverage points (identified and discussed in the 2011 Comprehensive Energy Plan (CEP)) to shape the adoption of technologies: education and outreach; finance and funding; regulatory reform; and technology and innovation. Because the clean energy transition involves many cases in which upfront costs are increased while savings are accumulated over time through reduced operating costs, financing tools and access to capital will be essential.

This study has identified and constructed five policy sets that represent different comprehensive and integrated approaches to energy and greenhouse gas policy. These are:

- Total Renewable Energy and Efficiency Standard (TREES): Require all providers of energy in Vermont to meet a fraction of their sales with renewable energy or energy efficiency. The required clean energy fraction would be the same for all fuels, and would rise over time. Obligations would be met by "retiring" tradable certificates corresponding to a certain amount of renewable energy or efficiency.
- Carbon tax shift: Creation of an economy-wide carbon tax in the context of tax reform, maintaining at or near revenue neutrality for the State. In this option, other taxes are cut by an amount equal to or close to the amount of revenue raised by the carbon tax. This carbon tax has the effect of sending a price signal much closer to the societal cost of emissions incurred, addressing the market failure of the mismatch between prices and costs.
- Renewable targets with carbon revenue: Draws from the previous two policy sets; here, the state would set a target for the renewable energy content of all fuels, placing a non-binding obligation on energy suppliers. If the target were not met within a given sector, however, the obligation would become mandatory within that sector or that sector's carbon tax would be increased. This obligation structure would be paired with a small economy-wide carbon tax used to raise revenue applied to programs directed at making it easier for obligated parties to meet their target obligations.
- Sector-specific policies: Consists of sector-specific policies, each tailored to address a known challenge or market failure within a given portion of the state's energy economy. The policies within this set could work in an integrated and comprehensive manner to drive the clean energy transition, but there would be no single, overarching policy structure as in the previous three policy sets.
- New England regional policy focus: Policies adopted at the regional level or coordinated with our neighboring states may be more effective than policies adopted by a single state. This reflects understanding that the six New England states are served by an electric grid with a single regional operator and markets, and that biomass is commonly used in a state different from the state in which it is harvested. There is also a potential that the combined market power of New England or Northeast states (and potentially including neighboring Canadian provinces) can move markets and bring new technologies to scale in a way that no single state can do.

Each of these policy sets raises a number of questions regarding implementation and impacts. Ongoing analysis will identify aspects of each policy set that could be combined to a smaller number of policy sets for quantitative analysis to follow publication of this report. Readers are encouraged to address the open questions associated with each policy set in written comments.

Technology pathway analysis conducted for the TES has highlighted the potential and open questions regarding both energy demand and energy supply. Reduction in total energy demand has been reaffirmed as essential to meeting the state's energy targets while maintaining compatibility with other state policy objectives. Energy demand can be managed through efficiency and conservation; demand shifting and load management; and fuel and mode switching. The discussion of fuel and mode switching, in particular, represents a new direction for analysis since the publication of the 2011 CEP.

The five renewable primary energy supply resources available to Vermont are solar, wind, hydropower, methane capture, and biomass. Each has strengths and weakness, described in detail in the 2011 CEP. Assessment of the use of each of these resources depends on their efficiency of utilization, especially for combustible resources, and the scale and location of energy generation infrastructure. This report identifies several areas where non-renewable resources may most productively remain in use, making up the 10% of the state's total energy that is not renewable in 2050. These include flexible electric generators for grid stability; heavy duty transportation and machinery; and some industrial processes.

The Department, working closely with the staff of the Governor's Climate Cabinet, structured the TES process to facilitate significant stakeholder and public engagement that would inform development of a wide set of scenarios that might meet the State's goals, then narrow those scenarios down based on a set of qualitative criteria to result in a manageable number of potential scenarios for further quantitative analysis. To that end, the Department published and solicited comments on a Framing Report and held a number of stakeholder focus groups during the summer and fall of 2013. The Department also hosted a public meeting to share the status of our policy analysis at the State House and via webinar on November 14. The Department continues to welcome public input, and has opened a formal comment period extending until January 22, 2014. Please refer to the Total Energy Study webpage for more information.

1 Introduction

The Public Service Department (Department) is undertaking this "Total Energy Study" (TES) to identify the most promising policy and technology pathways to employ in order to reach Vermont's energy and greenhouse gas goals. Act 170 of 2012, modified by the General Assembly through Act 89 of 2013, initiated this study to address the State goals to 1) meet 90% of Vermont's overall energy needs from renewable sources by 2050 and 2) reduce Vermont's greenhouse gas emissions by 50% from the 1990 baseline level by 2028 and 75% from the 1990 level by 2050.

Vermont's greenhouse gas emissions in 2011 were almost unchanged from the state's emissions in 1990: approximately 8.11 million metric tons[1]. 46% of these emissions were due to transportation; 32% from residential, commercial, or industrial fuel use, and 5% from electricity consumption. The remaining 17% were due to non-energy sources, such as agriculture, industrial processes, and waste. Vermont meets about 16% of its energy needs with renewable energy. This includes approximately 5% of transportation energy, 25% of energy used in residential buildings, 23% of energy used in commercial buildings, and 19% of industrial energy use.

The State's energy and greenhouse gas goals are guided by the statutory foundation of the State's energy policy as stated in 30 V.S.A § 202a(1):

> To assure, to the greatest extent practicable, that Vermont can meet its energy service needs in a manner that is adequate, reliable, secure and sustainable; that assures affordability and encourages the state's economic vitality, the efficient use of energy resources and cost effective demand side management; and that is environmentally sound.

Vermont's renewable energy and greenhouse gas goals are articulated in the 2011 Comprehensive Energy Plan and 10 V.S.A. §578, respectively. These broad targets set the direction, however more detailed pathways to reach the targets have not been defined. The Total Energy Study seeks to provide a more detailed analysis of several policy and technology roadmaps that will move the state from our current renewable energy and greenhouse gas trajectory that falls short of the above goals to a course that achieves them. The study is not intended to provide a definitive pathway forward, but rather to:

- Focus state, legislative, stakeholder, and general public conversation on actions with a high probability of meeting State goals.
- Clearly identify policies that the State should or should not pursue.
- Identify areas where federal or multi-state policies may be required in order to meet State goals (or make desired outcomes more achievable).
- Identify high-level economic and societal impacts from analyzed policy and technology roadmaps.
- Identify challenges and opportunities associated with several possible implementation scenarios that would meet the State goals.

[1] http://www.anr.state.vt.us/anr/climatechange/Vermont_Emissions.html

1.1 Legislative charge

Vermont's greenhouse gas targets were articulated in 2006 through the enactment of 10 V.S.A. §578(a):

> General goal of greenhouse gas reduction. It is the goal of the state to reduce emissions of greenhouse gases from within the geographical boundaries of the state and those emissions outside the boundaries of the state that are caused by the use of energy in Vermont in order to make an appropriate contribution to achieving the regional goals of reducing emissions of greenhouse gases from the 1990 baseline by:
>
> (1) 25 percent by January 1, 2012;
>
> (2) 50 percent by January 1, 2028;
>
> (3) if practicable using reasonable efforts, 75 percent by January 1, 2050.

In 2011, Vermont adopted its first Comprehensive Energy Plan in over a decade. The Plan's intention is clearly articulated:

> [T]o set Vermont on a path to attain 90% of its energy from renewable sources by mid-century. . . . The goal is underpinned by this strategy: to virtually eliminate Vermont's reliance upon oil by mid-century by moving toward enhanced efficiency measures, greater use of clean, renewable sources for electricity, heating and transportation, and electric vehicle adoption, while increasing our use of natural gas and biofuel blends...

Following the release of the Comprehensive Energy Plan the General Assembly sought more detail on the policy and technology pathways that would allow Vermont to reach its goals. The Total Energy Study is required by Act 170 of 2012as modified in Act 89 of 2013:

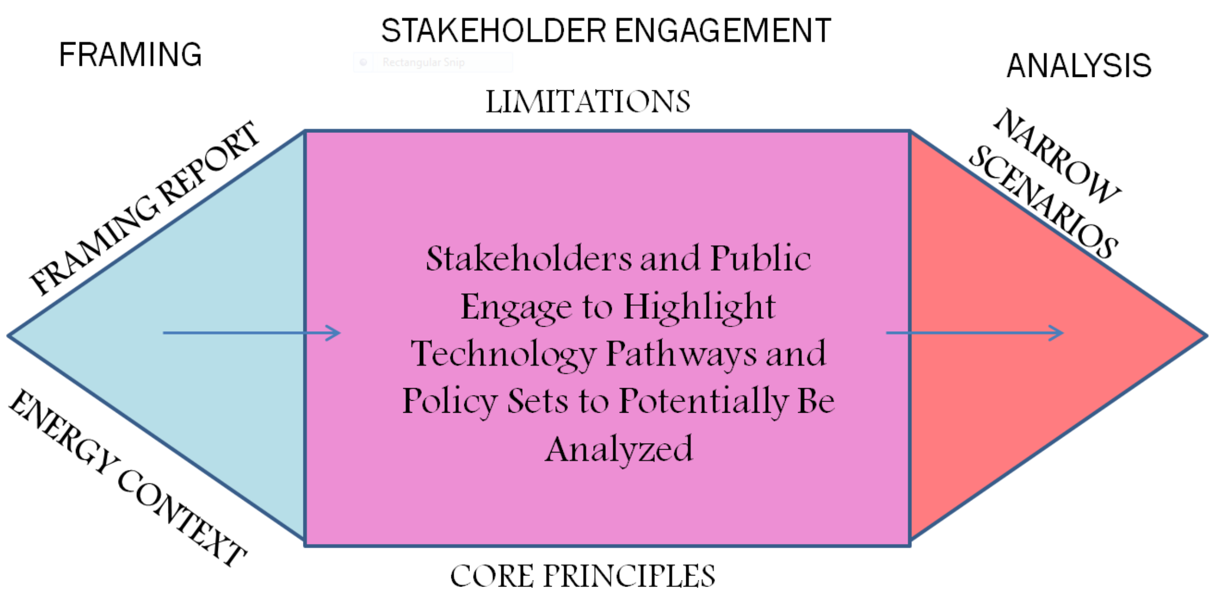
> (a) The General Assembly finds that, in the comprehensive energy plan issued in December 2011, the Department of Public Service recommends that Vermont achieve, by 2050, a goal that 90 percent of the energy consumed in the State be renewable energy. This goal would apply across all energy sectors in Vermont, including electricity consumption, thermal energy, and transportation (total energy).
>
> (b) The Commissioner of Public Service shall convene an interagency working group to study and report to the General Assembly on policies and funding mechanisms that would be designed to achieve the goal described in subsection (a) of this section and the goals of 10 V.S.A. § 578(a) (greenhouse gas emissions) in an integrated and comprehensive manner.
>
> > (1) The study and report shall include consideration of a total energy standard that would work with and complement the mechanisms enacted in Secs. 3 (SPEED; total renewables targets) and 4 (SPEED; standard offer program) of this act.
> >
> > (2) The group's study and report shall consider currently available information on the economic impacts to the state economy of implementing the policies and funding mechanisms described in this subsection.

(3) The group's report shall identify those policies and funding mechanisms described in this subsection that do and do not warrant serious consideration and any areas requiring further analysis and shall include any proposals for legislative action. The report shall be submitted to the General Assembly by December 15, 2013.

(c) Prior to submitting the report to the General Assembly, the group shall offer multiple opportunities to submit information and comment to affected and interested persons such as chambers of commerce or other groups representing business interests, consumer advocates, energy efficiency entities appointed under Title 30, energy and environmental advocates, fuel dealers, educational institutions, relevant state agencies, transportation-related organizations, and Vermont electric and gas utilities.

1.2 Process to date

The Department, working closely with the staff of the Governor's Climate Cabinet, structured the TES process to facilitate significant stakeholder and public engagement that would inform development of a wide set of scenarios that might meet the State's goals, then narrow those scenarios down based on a set of qualitative criteria to result in a manageable number of potential scenarios for further quantitative analysis. The Process generally follows the structure outlined in the following figure:



1.2.1 Framing report and initial public comments

The initial step in the Total Energy Study was to develop a Framing Report intended to facilitate public and stakeholder feedback and discussion. The Department commissioned the Regulatory Assistance Project to identify and provide an overview of the most promising technologies (e.g. electric vehicles, heat pumps, biomass heat, solar power, etc.) and policies (e.g. carbon based fees, renewable portfolio standards, smart growth policies, etc.) available to Vermont to meet its goals.

A request for public comment was issued on June 21, 2013 to receive feedback on the Framing Report and general comments regarding the Total Energy Study. The request solicited comments from the public and stakeholders regarding:

- Whether there are "key policies" or "key technologies" that should be considered that weren't identified by the Framing Report.
- What are the most promising policies and technologies, or combinations of policies and technologies available to the state.
- What are the most important considerations for determining which policies or technologies are worthy of further consideration and study.
- Whether the study should analyze potential pathways possible only with regional coordination or Federal action, or just what Vermont could implement alone.
- What principles should guide the development of the baseline case – i.e. the business-as-usual projection to which possible policy and technology pathways will be compared.

The Department received 19 sets of comments addressing some or all of the above questions. The comments are summarized in Appendix A.

1.2.2 Stakeholder focus groups

Following receipt and consideration of the initial public and stakeholder comments, the Department convened 11 stakeholder focus group meetings to solicit specific feedback on what participants thought were the most promising policies and technology pathways, what principles should guide the choice of policies and technologies, and limitations or constraints that would diminish their potential effectiveness. Participants were also asked to develop their own policy and technology scenarios.. The focus group topics ranged from being technology or sector specific (e.g. residential buildings, electric biomass) to explicitly cross-sectoral concerns (e.g. local/diversified infrastructure; costs and benefits across sectors).

One hundred and thirty-two people representing 79 organizations attended the focus group sessions. Focus group discussions included a wide range of participants from all varieties of businesses and their associations, local and national energy businesses and consulting firms, energy utilities, environmental and citizens advocacy groups, academics, financial institutions, philanthropists, transportation authorities, law firms, town energy committees, planners and other local, state, and federal governmental agencies. The participants are listed in Appendix B.

The Department structured the focus groups to encourage participants to freely express their opinions in frank and respectful discussion, without attribution, through the use of a modified Chatham House Rule[2]. These discussions informed the narrowing of the wide range of policies and technologies

---

[2] "When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed." (http://www.chathamhouse.org/about-us/chathamhouserule) In the TES case, we have revealed the names of the participants, but no attribution for any statement or idea may be revealed.

presented in the Framing Report to five policy sets and four technology pathways that might guide or inform decisions regarding the targeted energy transition. These policy sets and technology pathways are described in Sections 5 and 6 of this report. The focus group discussions also informed the development of the qualitative evaluation criteria (described in Section 2 of this report) that will be used to narrow 20 possible scenarios (five policy sets times four technology pathways) down to three promising scenarios for detailed, quantitative analysis taking place through mid-2014.

As required by Section 29 of Act 89 of 2013, the Department has coordinated with the Public Service Board in the Board's production of a report on the market for unregulated fuels and thermal building efficiency. Board staff attended the most relevant stakeholder focus group, and the Department has participated in the Board's process in developing its report. The TES and the Board's process drew upon the work already completed by the Thermal Efficiency Task Force, informed by subsequent developments in the sector.

1.2.3 Additional public meeting and comments

On November 14th, 2013 the Public Service Department held a public meeting and webinar at the Vermont State House. Twenty-five Vermonters attended the meeting in person and 26 connected via webinar. Between November 14 and December 2nd, the public and energy stakeholders submitted eleven sets of written comments in response to the meeting. The presentation for the public meeting can be viewed on the Total Energy Study webpage.

Appendix A summarizes all written comments received throughout the TES process to date, the focus group discussions, and the public meeting discussion.

1.3 Process in-progress and the future

Following a competitive solicitation, the Department hired Dunsky Energy Consulting (Dunsky) to assist with the analysis of technology pathways, policy sets, and scenarios combining them. Dunsky will also undertake detailed quantitative analysis of at least three unique scenarios to be defined in early 2014.

In the past months, the Department and Dunsky have defined technology and policy test scenarios, along with a baseline scenario to which each alternate scenario may be compared. The baseline scenario (known also as the business-as-usual case) is a quantitative description of the entire Vermont energy system up to 2050. The baseline scenario is being constructed with a various data sets and industry forecasts and takes account of existing State programs and policies.

At the time of this report, the Department and Dunsky are completing their qualitative analysis of the 20 test scenarios defined by the combinations of each of five policy sets and four technology pathways. This is being done using the evaluation criteria articulated in Section 2. The next step is to define three scenarios for continued quantitative analysis. These scenarios will likely be combinations of the most promising aspects of the 20 test scenarios. The Department expects to finalize the descriptions of these three scenarios in early 2014, following input from the Governor's Climate Cabinet, the public, and members of the Legislature as appropriate.

The modeling tool utilized by Dunsky and the Department is designed to optimize an energy system's resources for a given set of constraints, the most important of which are the renewable energy and greenhouse gas targets. Given the constraints defined, the model optimization identifies the least cost energy supply resources for each scenario. The model has the ability to account for complex interactions between the many variables representing the energy economy of Vermont and the New England region. The analysis will produce quantitative estimates of the pacing of each scenario through 2050 and describing their impacts on Vermont. The analysis includes predicting the economic impact of each scenario. Each scenario's quantitative output, including the economic impact (analyzed using a tool such as REMI PI+[3]), will be compared to the baseline scenario.

The Department and Dunsky expect to complete this quantitative analysis in the spring of 2014. Following its completion, the Department will publish the results and provide additional opportunities for public input, both in-person and in writing, to weigh in on and inform paths forward for state energy policy. The Total Energy Study Final Report is expected to be released in the early summer of 2014.

1.4 What this report is not

While the Total Energy Study describes several policy and technology scenarios that are expected to achieve the State's goals, these reports are not intended to be or replace the Comprehensive Energy Plan. Neither this report nor the TES Final Report will articulate or recommend a definitive pathway forward.

The Total Energy Study does not directly address non-energy greenhouse gas emissions (e.g. those from agriculture, waste, or chemicals). For energy greenhouse gas emissions, the Total Energy Study uses the same definitions used by the Agency of Natural Resources (ANR) in developing the State greenhouse gas emissions inventory, based on emissions at the point of combustion (including in electrical generation), not full life-cycle emissions.

This report does provide high level qualitative insights with regard to the economic and environmental impacts of choosing one scenario over another or relative to the baseline pathway. The report does not provide a detailed quantitative analysis of these impacts. Further quantitative analysis will be available in the TES Final Report to be published in the summer of 2014.

Along with subsequent analysis and work products through summer 2014, the TES Final Report will inform the next Comprehensive Energy Plan. Because these efforts address State policy goals with long timeframes (2028, 2050), an iterative energy planning process will continue to be necessary as technology, markets, and State policies evolve.

1.5 The structure of this report

Section 2 of this Report summarizes the Department's conclusions regarding appropriate criteria to use when evaluating future energy policy and technology scenarios. Section 3 discusses the overlap between policies designed to meet the state's energy and climate goals and policies designed to meet other state

[3] REMI PI+, a software product developed by Regional Economic Models, Inc., is the most commonly used tool for analysis of the economic impacts of policy choices in Vermont.

objectives in areas such as economic development, land use, transportation, forestry, agriculture, health, and natural resources. Section 4 outlines principles used in the design of energy policy sets, five of which are then defined and summarized in Section 5. Section 6 identifies technology pathways, including discussion of both energy demand and supply-side technologies, and the breadth of technology pathway choice available to the state while still achieving both renewable energy and climate change objectives. Section 7 concludes the report with a discussion of the ongoing study process.

Appendices to this report include a list of stakeholder focus group participants and a report summarizing all public comments received to this point in the TES process.

2 Criteria for the evaluation of policy and technology scenarios

In order to narrow the breadth of possible policy and technology scenarios and to choose a reasonable number of scenarios for detailed quantitative analysis, the Department and Dunsky developed qualitative evaluation criteria. The set of criteria developed was informed by the stakeholder focus groups and comments from the general public. These evaluation criteria are intended to support understanding of various advantages and trade-offs. Thus the criteria allow each scenario to be measured and compared against all other scenarios. The evaluation of policy and technology scenarios against these criteria is ongoing. Some initial results are reflected in the discussion contained in this Report; a more complete and quantitative analysis will be available in 2014.

2.1 Evaluating technology options

2.1.1 Ability to meet greenhouse gas and renewable energy goals

Each scenario that will be analyzed is constructed to meet the State's 2028 and 2050 greenhouse gas targets, and the State's 2050 renewable energy target. While there is likely to be some overlap among scenarios, reaching the climate and renewable energy goals does not necessarily require the same technologies in every case.

As described above, a baseline estimation of Vermont's energy system, which falls short of the State's targets, is being developed to compare with the test scenarios. In addition, for the initial narrowing of test scenarios the technology options will be qualitatively evaluated against a scenario developed using the software model. This initial quantified scenario will be constructed to identify the one set of energy supply technologies, and their pacing, to meet the renewable energy and climate goals at low overall estimated energy cost. Each test scenario will be evaluated against this initial scenario to determine how likely the test scenario is to achieve the State's targets at reasonable cost.

The Department recognizes there is diversity of opinion on how to define the "optimum" technology pathway. The initial quantified scenario will be based on optimizing a simple net-present-value of overall energy costs. We are analyzing a diversity of technology pathways to capture the varying benefits and costs of different scenarios.

2.1.2 Total economic impact

Perhaps the next most obvious of evaluation criteria is to consider the overall impact of the policy and technology scenarios on the Vermont economy. The total net direct and indirect impacts to the Vermont economy will be measured in two ways, one of which places a value on reductions in greenhouse gas emissions, the other of which does not. The direct impacts will consider changes in actual expenditures on energy, while the indirect impacts will additionally consider how those changes flow through the Vermont economy. For example, energy efficiency savings were recently shown to have a "multiplier" effect, as the customer savings on fuel costs were re-spent in the Vermont economy, leading to an increased benefit[4]. Other harder-to-quantify costs and benefits, such as impacts on public health, will be considered to the extent possible.

Analysis of economic impact to be conducted in 2014 should provide information about consequences for costs, prices, and manufacturing competitiveness in Vermont. The quantitative analysis will be completed in a format that facilitates input into state economic models such as REMI PI+.

2.1.3 Capital flows

Dunsky and the Department will also identify the capital flows associated with each scenario in order to determine the extent that the benefits and costs of the scenarios remain in-state or are exported out-of-state. The initial qualitative analysis will provide a high level indication of the direction and magnitude of these flows. The detailed quantitative analysis of three scenarios will provide more detail and, to the extent possible, will identify cash flows between individual sectors within the economy so that impacts can be analyzed across different socioeconomic groups, geographic areas, and/or economic sectors.

2.1.4 Risk

The pace, timing, and impact of technological change is nearly impossible to predict. Thus, the ongoing TES will qualitatively evaluate technology options with regard to the impacts of potential variances in initial projections, such as technology implementation cost, availability, and acceptability. This criterion will consider the flexibility of each technology option with regard to the diversity of energy supply technologies.

2.2 Evaluating policy options

2.2.1 Responsiveness

Similar to the diversity of energy supply resources discussed under the "risk" technology criterion, this criterion considers the ability of a policy to take advantage of new opportunities and meet new challenges. For example, if the availability of a technology changes (e.g. due to changes in performance or cost), then the policy may or may not be able to take advantage of those changes. This criterion evaluates a policy's responsiveness and/or vulnerability to change.

[4] See, for example, Appendix 5 of the 2011 Comprehensive Energy Plan, available from http://publicservice.vermont.gov/sites/psd/files/Pubs_Plans_Reports/State_Plans/Comp_Energy_Plan/2011/2011%20CEP_Appendixes%5B1%5D.pdf.

2.2.2 Independence

As discussed in Section 4, Vermont is a small state that is impacted by changes in markets and by policies set in other jurisdictions. The "independence" criterion considers the extent to which a policy is dependent on other jurisdictions' energy policies. There is real value in having Vermont policies compatible with those in neighboring states; indeed the economic impacts (either positive or negative) or even the ability of a policy scenario to facilitate meeting Vermont's energy goals may crucially depend on how other jurisdictions act.

2.2.3 Impact

A policy choice could score well against the above criteria, but only apply to a limited portion of Vermont's energy system. Thus, it is important to consider the overall impact of a policy choice. This will be done in two ways. First, the scope of energy sources and emissions addressed by the policy choice will be evaluated. Second, the possible leverage of the policy to ensure the desired outcome will be considered, taking into account whether a policy is voluntary, prescriptive, or mandatory.

2.2.4 Complementarity

Finally, it is imperative that the policy and technology pathways not undermine other efforts and goals of the state; instead they must work in coordination. Thus, each scenario was also constructed to be complimentary to the State's other energy and non-energy policies. A description of the state policies with which the Total Energy Study must coordinate can be found in Section 3.

2.3 Evaluating technology plus policy scenarios

In addition to the analysis of each technology pathways and policy set against the criteria above, each combination scenario will be evaluated. Evaluation will weigh whether implementation of a policy set is particularly compatible or incompatible with the technology pathway under analysis. It is important to note that Vermont's greenhouse gas and renewable energy goals may be reached at different times under different combinations of policies and technologies. The Study will seek to the extent possible to analyze the pacing of how quickly we will meet our goals under each combination. In addition, analysis may identify the optimal sequence for deployment of technologies or policies within each combined scenario.

3 Coordination with other state policies

Most activities in the Vermont economy have implications for the state's energy use and result in some greenhouse gas emissions. As a result, Vermont's energy and greenhouse gas policies are intimately linked with the state's policies in other areas. The state has developed polices that reflect Vermonters' priorities and expectations across the economy, and the energy policies and technology pathways studied here must be evaluated based on how well or poorly they interact with other state policies.

Through this study process, it has become clear to the Department that because the proposed scenarios are general in nature, the effects of a particular policy/technology pathway with regard to most other state policies depend on the details of policy implementation. If energy policy is implemented poorly, it could conflict with other state policy goals. The Department has attempted to design the scenarios such that neither policy design nor its thoughtful implementation would directly conflict with other state policies.

However, it is important to maintain awareness of the key policy areas where poor energy policy implementation could have a negative effect on other state policy goals. This section addresses areas of policy interaction and how energy policy and technology might be shaped by consideration of each policy area.

3.1 Economic development and equity

One of the key messages the Department heard from stakeholders during this study process was the importance of energy to the state's economic vitality. To that end, the Department has participated in the Agency of Commerce and Community Development's (ACCD) ongoing development of a Comprehensive Economic Development Strategy (CEDS), and ACCD staff have participated in the interagency and stakeholder TES working and focus groups.

There are two primary ways in which energy policy impacts the state's economic development: the cost of energy and the development and growth of Vermont's "clean energy" economy. Regarding the cost of energy, energy policies must be aware of both the marginal cost of a unit of energy, delivered via various fuels, and a customer's total expenditure on energy. (In the electric context, for example, that means both rates and bills.) Both of these have impact on the cost of living and the cost of doing business in Vermont, with implications for regional, national, and global competitiveness. Policy analysis and design should be concerned with inter-sector equity (favoring policies which distribute benefits to the same sector which directly bears the policy's cost), and aware of the implications for shifting economic activity from emissions-intense to less-emissions-intense activities. Further, policy analysis and design should also be aware of the timing of any imposed costs or secured benefits.

Procuring a growing fraction of the state's clean energy resources in the state (both supply- and demand-side resources) serves to bolster local firms delivering those resources, and also provides a platform from which firms can develop products and services offered in global markets. Vermont policies can foster innovation in both business models and technologies.

The cost of energy is borne unequally across Vermont consumers, both commercial/industrial and residential. Therefore, polices that change the costs of energy, or the relative costs of different fuel choices, will have uneven effects. For example, rural Vermonters are more sensitive to the cost of transportation fuels. Energy is also a larger fraction of household expenditures for low-income Vermonters than for higher-income, so policies which increase the cost of energy relative to other goods and services should also be designed with compensating features that ensure that benefits flow back to those bearing greater relative costs, particularly to the state's low- and middle-income residents.

3.2 Land use

The built environment, including both buildings and roads, both shapes and is shaped by energy and climate policies. The state's long-term commitment to compact settlement patterns is highly compatible with efforts to reduce energy use and increase the efficiency of the transportation sector because it increases the ability for Vermonters to live close to where they work and play and makes alternative modes of transportation viable alternatives to single occupancy vehicles. The energy polices considered here, then, should respect and complement the state's progress on implementing smart growth principles. While historic preservation is a key component of maintaining this settlement pattern, energy policy implementation should also respect the need to balance the desire to improve the efficiency of buildings, and to develop or maintain energy resources such as hydroelectric resources, with such preservation.

Energy infrastructure, such as electric generators, transmission lines, district heating systems, and pipelines, also has significant land use impacts. The recommendations of the Vermont Energy Generation Siting Policy Commission directly address potential improvements to the siting process that can increase the potential for compatibility between land use aims and clean energy implementation. One key take-away from that process is the importance of planning, for both energy and land use, and the need for these two kinds of plans to inform each other.

Even as Vermont makes progress on reducing greenhouse gas emissions, previous emissions and emissions from other jurisdictions continue to change the global climate. To this end, technology and infrastructure deployment, including buildings, road, and energy infrastructure, should be pursued in a way that increases resilience in the face of extreme weather, while avoiding undue impact on the state's natural resources, which will likely face increased stresses as well. A dynamic and resilient energy system, fostered by appropriate policies, can lessen the negative impacts on the state from such events.

3.3 Transportation

More than one third of the state's energy consumption, and nearly half of its greenhouse gas emissions, are tied to the transportation sector. Transportation infrastructure choices are also in many cases land use choices, involving them with energy through the mechanisms discussed above regarding land use. Broad energy policies, such as those focused on modal choice or the cost of competing fuels, can also impact how transportation infrastructure is used, and which infrastructure is required. For example, a shift of heavy-duty transportation away from trucks and toward rail has implications for the necessary rail infrastructure; the cost of gasoline has a direct impact on utilization of transit services. Coordination of policies and planning between these two economic foundations – energy and mobility – can advance state goals in both arenas. In addition, a significant fraction of the state's revenue for transportation infrastructure and programs is raised via taxes on energy products (gasoline and diesel). Thus, policies which address either side of this coin impact the other. The state and our regional neighbors have a compelling long-term need for sustainable funding for transportation infrastructure, so long-term energy policy planning must take this need into account.

3.4 Forestry

Vermont has a limited biomass resource that can be harnessed sustainably for energy purposes. Policies which increase or decrease the use of different kinds of woody biomass for energy will impact the state's forests. The Department's analysis of the availability and utilization of biomass for energy is informed by the amount of biomass that can be harvested sustainably and in a way that maintains or improves the health of the state's forest resource. This effectively serves to put a cap on the amount of biomass energy that the state's policies should count on using for energy purposes.

There is also a potential for synergy between forest health, the forest products industry, and meeting the state's energy goals. Sustainably harvested low-grade wood for energy purposes provides an economic driver for maintaining forested land in wood production, and can increase the quality of the forest resource over time. This results in less low-grade wood available for energy uses, but a greater state resource for other, higher-value wood products, and a potential positive impact to the forest products industry. Maintaining forested land as forest also can be compatible with the compact settlement patterns discussed above, and with maintaining habitat connectivity, carbon sequestration, and other environmental services.

3.5 Agriculture

Similar to in the forestry discussion above, energy has potential to be a co-product from Vermont's agricultural sector. As a co-product, it can improve the economics of the state's farms (through monetizing what might otherwise be waste) and also advance natural resource objectives. Anaerobic digester technologies, such as those deployed at a number of Vermont dairy farms, can contribute to addressing the organic-waste-disposal needs created by Act 148. Processing wastes explicitly through digestion can also increase the ability to capture potential water pollutants and nutrients for appropriate disposal or reuse.

Agricultural land can be an appropriate place to site energy infrastructure, including electric generation by various technologies. However, energy facility siting can also have implications for the use of the state's prime agricultural soils, so deployment plans for different types of renewable energy generators should be designed to respect this state resource.

3.6 Health & natural resources

In addition to the forest and farm resources discussed above, energy polices have implications for the state's air and water quality and the vitality of other natural resources. Energy policy structures under consideration should be compatible with policies that promote the maintenance or improvement of natural resources.

Greenhouse gases are global air pollutants whose reduction is inherent in the policies considered in this study. Other air pollutants, however, such as those resulting from combustion of fossil or biomass fuels, can have local and regional impacts on human health (e.g. cardiovascular and respiratory diseases and illnesses, cancer, etc.). Energy policies that reduce combustion for electricity generation, transportation, or heating also reduce such emissions. In addition, policies should reflect the differing ability of different combustion technologies to reduce emissions and the potential (or lack thereof) for "scrubbers" or other technologies to remove pollutants from flue gases.

Energy-related impacts on Vermont's water quality include impacts from dams and hydroelectric generators, introduction of various waste streams (e.g. via run-off), and deposition of air pollutants into water (e.g., via acid rain). Clean energy pathways that the state might pursue are generally consistent with polices to improve water quality by addressing such concerns; one area of potential greater conflict is in Clean Water Act compliance and the use of hydroelectric generators in run-of-river vs. more controlled operation, as well as the expansion of hydroelectric generation to existing dams (rather than the dams' removal).

Siting and construction of energy facilities can have impacts on wildlife habitat and the state's other natural resources, as well as water and air quality. Public and regulatory acceptability of clean energy technology deployment depends on the ability of such developments to mitigate impacts on the state's natural resources, and ideally to improve them.

Policies that advance clean energy can also have direct impacts on human health. For example, land use policies and transportation infrastructure that support compact settlement patterns, with resulting energy savings, also provide a context for walking and biking, with resulting improvements in fitness. Climate change will also have increasing impacts on Vermonters' health, such as through extreme heat events, flooding events, or introduction of diseases or pests. The built environment can directly impact the ability of Vermonters to weather such changes. For example, more efficient buildings can be better able to maintain heat (in winter) and cold (in summer), increasing human comfort and health.

4 Developing "comprehensive and integrated" energy policy sets for analysis

4.1 Market structure and failures

Global, national, state and local energy markets are not free markets – they are strongly shaped by utility regulation, tax policies, incentives, and environmental regulation. Many of the policy sets described in Section 5 address known and identified market failures (such as utility regulation in the context of natural monopolies); others exacerbate such failures. In developing and analyzing energy policy options for Vermont, the Department has identified several market failures that could be addressed in order to increase the alignment between market forces and the public interest.

The market failures identified here exist to different degrees and in different guises in different parts of the energy economy. For example, the natural monopoly world of electricity and pipeline natural gas is shaped by utility regulation and rate-setting, while delivered fuels are subject to competition between suppliers. At the wholesale level, however, electricity and natural gas are traded commodities, similar to oil, gasoline, or propane, operating under a different set of market forces. Public policies (or other forces) that result in a shift of demand to or from price-regulated fuels will have impacts throughout the energy economy, changing the characteristics of different parts of relevant markets.

Market failures identified in the Department's research and raised by stakeholders include:

- **Prices that do not reflect costs:** In order for consumers to make economically efficient decisions that also reflect the public interest, the prices paid for goods and services should reflect the full cost of those goods. For example, the market prices of fossil fuels do not reflect the full environmental cost (both present and future) of the production and combustion of those fuels;

similarly the price of electricity generated by a renewable facility may not reflect the full societal cost of the construction and operation of the facility. Costs borne by someone other than the person paying the final price are called "externalities."

- **Lack of information:** If a consumer lacks complete information her purchasing decisions may fail to serve either her own personal interest or the public interest. For example, the lifetime cost of an appliance or automobile is a combination of the upfront cost and ongoing fuel and maintenance costs (among others). A more efficient appliance may cost more up front but save money in the long term. However, without complete information, the consumer may unintentionally choose the product with a higher overall cost, a phenomenon known as adverse selection.
- **Lack of access to capital:** The more economical long-term energy choice may require greater upfront expense, and if a consumer lacks access to the capital necessary to make that investment, she may not be able to make the choice she would like to optimize her well-being.
- **Split incentives:** In many cases, such as in a landlord-tenant relationship, the parties who make purchasing decisions are not those who pay for operating costs associated with those decisions. This situation is considered a principal-agent problem, a problem commonly observed within organizations where capital and operating costs are treated separately. The nature of a principal-agent problem is that the best collective choice (for the landlord and tenant together, or for the organization as a whole) is not in the best interest of the persons making the decision (the agent).

The policy sets the Department has developed for analysis, described in Section 5, address these market failures in a variety of ways. One way to think about each policy set, however, is that it uses some policy tools to encourage prices to approach the correct societal costs, and other complementary policy tools to reduce other market failures and allow these price signals to be more effective or otherwise shape consumer or producer behavior to address market failures.

4.2 What are the leverage points, and who can wield the levers?

As discussed in the 2011 Comprehensive Energy Plan, attempts by government and others to shape the energy sector or reduce greenhouse gas emissions can be categorized into four leverage points:

- education and outreach,
- finance and funding,
- regulatory reform, and
- technology and innovation.

These leverage points can address the market failures discussed in the previous section, although they also have other roles in meeting the state's energy and climate change goals. For example, education and outreach can address the lack of information; finance tools can address the lack of capital, and regulatory reform can address alignment of prices with costs. These leverage points must work in concert, however, in order to be truly effective.

Different levers, or different aspects of each lever, may also be best operated by different kinds of entities. Potential actors in Vermont include state agencies, political leaders, community leaders, educators, financial institutions, businesses, researchers, and non-profit organizations. Coordination among these different kinds of actors, each wielding the levers they can, can increase effectiveness of each contributor's actions. The state has long recognized this, and it is implicit in the logic behind the development of a regularly-updated Comprehensive Energy Plan and the generally collaborative nature of the energy policy process in the state. The policy sets described here are each constructed with the intent to provide an overall policy framework to facilitate a common understanding of the tradeoffs between the costs and benefits of various policy choices, with which Vermont's broad cast of actors can engage in meaningful debate.

An example, based on one of the underlying shifts the Department has identified as key to the clean energy transition, may be illustrative. Across almost all sectors and energy uses, both efficiency and renewable energy technologies have a greater up-front cost but lower ongoing or operating costs than is the case for existing technologies they might displace. For example:

- Home weatherization increases the capital invested in the building while reducing the home's operating costs.
- Pellet boiler systems are more expensive than fuel oil boilers, but pellet fuel is less expensive than fuel oil.
- Solar PV, wind, and hydroelectric generators incur almost all of their lifetime costs at their time of installation, with no cost for the sun, wind, or water used to generate energy. Fossil fuel generators are relatively inexpensive to construct, but retain significant fuel costs throughout their operation.
- Electric vehicles are generally more expensive than an equivalent gasoline-powered vehicle, but have significantly lower cost per mile of operation.
- Transit vehicles and infrastructure have significant upfront capital cost, but reduce the cost of mobility for their riders as they have lower operating costs than the total costs of all the single-occupancy vehicles they displace.

Given this aspect of the clean energy transition, how can different actors use their leverage in a coordinated fashion to accelerate change and overcome time preferences biased toward the present?

Financial levers, generally wielded by the private financial sector, have a lead role to play in this circumstance because of the ability of financial tools to amortize high upfront costs over time. For cost-effective investments, lower operating costs combined with repayment over time can result in reduced overall recurring costs. This allows the customer to see immediate and ongoing benefit from making a clean energy investment. Where investments are not yet cost-effective, or where financial tools do not yet correctly reflect the risk profile of the investment, funding tools, generally wielded by or under the direction of government agencies, can step in to help bring down the cost of new technologies through market growth or to enable demonstrations that develop data to document risk.

Even with cash-flow-positive financial structures, however, energy consumers need access to good information and encouragement – shared by political and community leaders, educators, non-profit organizations, and businesses – to develop the confidence to proceed in a clean energy investment. State agencies and financial and other regulated firms may need to work together to develop new regulatory structures that encourage cost-effective clean energy investments, rather than present barriers. And technology and business model innovators can develop new technologies, and businesses to deploy them, lowering overall costs while improving quality of life.

Coordination in this context requires, for example, that as new technologies are developed, the private financial sector, technology innovators, and government funders coordinate to provide necessary but not excessive support while demonstrating technical and economic performance, lowering risk, and enabling lower financing costs. In a capital-intensive clean energy context, "green" jobs are likely to be more in installation, rather than operations.[5] This highlights the benefits of coordination between technology innovators, business model innovators, and educators, as well as political and community leaders who can spread the word about these opportunities. The pace of clean energy infrastructure investments shapes the size and scope of the clean energy industry.

4.3 Recognizing the role of the State vs. private sector and other governments

When developing policy sets for analysis, the Department considered the question of the correct role for state government *vis a vis* both other governments (federal and other states) and the private sector. Energy demand, supply, and distribution are shaped by Federal and state government policies but are fundamentally functions of the private sector. The Department's consideration includes an understanding of Vermont's role in the national and global energy sector and economy, and in the context of global climate change.

Vermont is a small state. Vermonters could eliminate our greenhouse gas emissions, or double them, with only marginal direct impact on the climate. Similarly, our actions have only marginal effect on the price of global energy commodities, appliances, vehicles, or infrastructure. At the same time, however, the global climate and the regional, national, and global energy markets have profound impacts in Vermont. In this context, it is in the state's interest to impact the decisions of others, whose collective actions can materially impact the global climate and energy sector. Vermont can demonstrate a successful path forward and inspire broader action by recognizing the imperative to act on climate change and by developing policies that work for Vermont and advance the state's energy, economic, and environmental goals.[6]

---

[5] This shift is not absolute, of course. For example, a growth in transit will result in more transit operators; they are displacing the unpaid role of "single occupancy vehicle driver" that might otherwise have been played by each of their passengers.

[6] An example: Vermont was an early leader in electric energy efficiency. While our average and overall electricity consumption was already low relative to the rest of New England, our commitment to energy efficiency and success delivering programs paved the way for most of our neighboring states to embrace electric energy efficiency. Vermont's investment in energy efficiency is small (in absolute terms) relative to other states, but the

One tension that the Department identified in analyzing the state's role is the potential tension between policies that may be easily generalized and exportable, but perhaps not well suited to Vermont, and polices that are designed to reflect Vermont's uniqueness, but are necessarily less immediately exportable. Our conversations with stakeholders convinced the Department that the latter path is preferable. We should not accept sub-optimal policies for Vermont that risk incurring unnecessary costs in achieving other state goals, including robust economic progress, in order to make our policies more easily exportable. As a rural northeastern state, the technology pathways available to Vermont are not necessarily those available to many other states or nations, and we also face unique challenges. By demonstrating the success of correctly-designed policies, we will inspire others to design the policies that achieve comparable energy and climate impacts elsewhere. Aspects of our policy solutions may be adapted to other jurisdictions facing similar challenges or with similar opportunities, and Vermont should share what we have learned.

Regional collaborations, with both our neighboring states and Canadian provinces, can carry weight beyond what Vermont alone can do. The Regional Greenhouse Gas Initiative (RGGI), for example, is reducing the greenhouse gas emissions from the electric power sector across 9 states. This reduces the GHG emissions of Vermont's electricity portfolio through regulation of power plants in other states. Energy-related infrastructures (such as road, rail, pipeline, and electric grid networks) are commonly addressed at the regional level, so polices that directly impact these networks may particularly benefit from regional consistency. The northeast is also a large enough potential energy market to exercise some "demand pull" if the region's states collectively act to shape markets (such as encouraging the availability of new products such as electric vehicles). Vermont has also played a role as a bridge between New England and Quebec in the flow of energy, goods, and services.

As Vermont looks to lead on energy and greenhouse gas emissions, we must be cognizant of current and emerging regional markets, trends, and policy structures. In particular a Vermont decision to rely on more constrained renewable resources like biomass and hydroelectricity could interfere or interact with choices made by other states or provinces.

The Federal government can take a wide range of actions that are unavailable to Vermont, for example, because Vermont may be preempted from acting in areas of Federal jurisdiction, or more simply due to scale of potential investment. More specifically, Vermont may be too small to sustain large-scale state-funded research and development activities given the potential for the fruits of those investments to flow to other states; the federal government has less concern than any state might about such interstate benefit flows. Vermont may, however, identify technologies particularly well suited to Vermont needs and focus our efforts there (as we have done historically, for example, with anaerobic digesters). Due to preemption, Federal policy-making could (in theory) upend most any policy structures Vermont might establish; in practice state policy innovation has also provided examples that the Federal government can adopt.

---

state benefits from reduced market prices, transmission needs, and emissions saved by other states. Another example has to do with RGGI. Vermont was the first state to Vermont was the first state to call for auctions of the allowances and to dedicate 100% of the auction proceeds to clean energy investments, which have had the effect of lowering demand for, and therefore the price of, the allowances.

Within the state government, different kinds of actors can be most effective with different roles. For example, regulatory programs are the natural purview of long-standing (and stable) agency bureaucracies due to the importance of consistency and subject matter expertise. Technical assistance and funding or finance programs benefit from being more nimble and responsive to market changes and contain the flexibility to develop public-private partnerships. Political leaders more closely reflect the concerns and hopes of their constituents, and serve to both reflect those opinions into policy-making and exercise political leadership by shaping public opinion. There is a feedback loop between state policy-setting, political acceptability, and changes in the public understanding of and opinions toward the clean energy transition.

State actions and policies can also send signals to the marketplace and to citizens regarding the importance or impacts of the clean energy transition. (These signals can be discouraging or encouraging.) For example, state support for installation of electric vehicle charging equipment (EVCE) could have the combined results of increased range confidence among drivers of electric vehicles, increased visibility of electric vehicles as an option, and identification of Vermont as a state on the leading edge of new technology. State operational "lead by example" initiatives have the potential to shape public understanding and opinions by demonstrating, through the operations of government itself, the benefits of a clean energy economy. Political leaders can also use their opportunity to be heard in order to "lead by example" on changes in opinion and culture. State policy leadership itself enhances the Vermont brand and sends a "welcome" signal to clean energy investment and entrepreneurs.

5 Trial policy sets

The Department developed the five integrated and comprehensive sets of potential energy and greenhouse gas policies described in this section in order to evaluate the strengths and weaknesses of each in meeting the State's energy and greenhouse gas goals. The first sub-section describes the baseline of state policies, principles, and tools that will be incorporated into all scenarios being modeled and analyzed. Each of the following subsections describes one set of potential policies identified for further analysis and consideration.

5.1 Common policies across all scenarios

As discussed in Section 3, there are numerous interactions between the course that Vermont takes toward its clean energy goals and state policies and objectives not directly associated with energy. For the purposes of its analysis, the Department has assumed that the non-energy policies, programs, and objectives are maintained to the degree possible while pursuing each of the five policy sets described in greater detail in the remainder of Section 5. Policy sets may include strengthening existing non-energy policies or objectives (for example, land-use policies directed at creating compact development patterns).

Turning to policies or programs directly related to energy, the Department assumes that the general energy policy of the state, embodied in 30 V.S.A. §202a, is maintained:

(1) To assure, to the greatest extent practicable, that Vermont can meet its energy service needs in a manner that is adequate, reliable, secure and sustainable; that assures affordability and encourages the state's economic vitality, the efficient use of energy resources and cost effective demand side management; and that is environmentally sound.

(2) To identify and evaluate on an ongoing basis, resources that will meet Vermont's energy service needs in accordance with the principles of least cost integrated planning; including efficiency, conservation and load management alternatives, wise use of renewable resources and environmentally sound energy supply.

The similarity between the principles contained in §202a and the policy evaluation criteria used in this report is intentional. Section 202a(2) provides grounding for the assumption that cost-effective efficiency, conservation, and load management are to be the first resources utilized, consistent with the principles of least cost integrated planning, under all evaluated scenarios.

Consistent with this policy, the Department assumed continued use of policy levers aimed at addressing market failures due to lack of information and lack of access to capital. In particular, this includes robust and consistent education and outreach regarding clean energy opportunities. Similarly, the state is assumed to have a continuing interest in development and promotion of financial tools that allow Vermonters access to capital to make cost-effective clean energy investments.

5.2 Total Renewable Energy and Efficiency Standard (TREES)[7]

The first policy set the Department identified for analysis requires all providers of energy in Vermont to meet a fraction of their sales with renewable energy or energy efficiency. (A version of this policy was first proposed in the 2011 Comprehensive Energy Plan, under the title of a "Total Energy Standard." The Legislative charge for this study requires consideration of this policy option.) The required clean energy fraction would be the same for all fuels, and would rise over time (for example, to 90% by 2050). Obligations would be met by "retiring" certificates corresponding to a certain amount of renewable energy or efficiency. These certificates could be traded commodities, called "TREE certificates" or "TREE credits." For example, a weatherization contractor could sell TREE credits for home weatherization to an electric utility, or a solar PV developer could sell credits for PV generation to a heating fuel distributor. This is the economy-wide equivalent of a renewable portfolio standard (RPS; a policy tool used in 30 states to regulate electric energy supplies), with incorporated energy efficiency. For the electric supply sector, TREE certificates would be essentially identical to Renewable Energy Certificates (RECs).

Practical implications and open questions in the design and implementation of this policy set include:

- At current, it is much more obvious how to achieve validated credits for some activities than others. For example, the verified savings from Efficiency Vermont or the Renewable Energy Credits generated by a small hydroelectric plant are well established. In contrast, at low levels of blending the biofuel content of heating oil is difficult to track, and there are no established

[7] The Department welcomes comments regarding alternate names for this policy structure.

protocols for measuring and verifying efficiency savings from efforts such as the development of a new transit service.

- Should credits be awarded for generation or savings in the year of obligation or awarded at the time of implementation for an expected project lifetime? Renewable energy credits generally use the latter formulation; “white certificates” in European energy efficiency obligation programs generally use the former. Would the policy work well with both of these kinds of credits?
- If energy efficiency measures are awarded lifetime credits, it could mean that the overall obligation could rise above 100% (e.g. achieved through 30% lifetime efficiency – saving 2% annually for 15 years – and 75% renewable supply). The Department observes that energy efficiency is relatively less expensive than renewable energy supply across most energy sectors, so achievable energy efficiency would generally be obtained first; by the later years when obligations are high, most achievable waste may have been captured.
- Trade, marketing, and advertising guidelines have been developed over the past decade or so that describe green claims, renewable energy claims, etc. (For example, if a utility owns the energy, but not the RECs, from a generator, they can’t claim to be providing renewable energy from that generator to their customers without running afoul of fraud guidelines.) In the TREES context, Vermont would need to develop ways to correctly characterize the attributes of delivered energy services that have been sold as a credit and retired to meet an energy provider’s obligation.
- The TREES could be designed with carve-outs or other sub-obligations to help meet other policy goals. For example, a requirement on electric utilities that some fraction of their credits correspond to small-scale generation distributed across the electric grid could support grid resilience and control transmission and distribution costs, while reducing line losses. There could also be limits on the amount of energy efficiency able to be used in meeting obligations in order to ensure a minimal amount of renewable energy.

One possible structure that would address the uncertainty regarding the creation of TREE credits for sectors and activities without well-established accounting mechanisms is as follows: Begin the TREES program with requirements placed only on suppliers of energy in some sectors or fuels. For example, the policy could begin with just the electric utilities and heating fuel (regulated and unregulated) sales to residential customers. These are sectors in which at least some renewable supply is well characterized and countable, via RECs in the case of electric supply and bioheat, biogas, and pellets in the case of residential heating. Similarly, learning from the regulated energy efficiency structure, there are established ways to quantify credits for energy efficiency in these sectors.

To expand the TREES beyond its initial participants and obligated parties, the first step would be to accept credits from other sectors or fuels. For example, credits earned through industrial process improvements that reduce the use of process fuels could be sold to an electric utility. This would encourage experimentation and the establishment of protocols for the creation of credits in these other sectors. In order to ensure continued progress in the covered sectors, the TREES could include limits on the number of credits from “uncovered” sectors that could be used. This is compatible with expanding obligations to other sectors over time. Knowing that obligations will come, firms will develop ways to earn and quantify TREE credits in those sectors; this in turn eases the expansion of the TREES into those and other sectors.

5.3 Carbon tax shift

The second policy set the Department identified for analysis creates an economy-wide carbon tax as one leg of a tax reform package that maintains or comes close to maintaining revenue neutrality for the State. The Department's modeling simulations will assume that such a carbon tax would have the effect of aligning price signals with the external costs of emissions. A similar policy has been adopted in British Columbia, where a carbon tax on fossil fuel combustion has been in place since 2008. British Columbia maintained revenue neutrality by reducing personal income and business taxes, and by providing property tax relief to "rural and northern homeowners." The tax was ramped up over four years to $30/metric ton. A 2012 evaluation resulted in the continuing of the policy.[8]

Practical implications and open questions in the design and implementation of this policy set include:

- Determining the correct amount for the tax, and updating it over time. The economically efficient price to assign is the price that equals the social cost of carbon emissions. However, there is no state, national, or global consensus on that value. Some potential values include the values used for Federal rulemaking (expressed as a range between $12 and $116 per metric ton, and rising over time[9]) and the value derived to estimate the cost of carbon abatement, used by some energy efficiency program administrators across New England, including Vermont ($100/short ton[10]). Once set, the value of the tax serves two purposes: maintaining state revenues (which would fall if the tax is successful at reducing emissions) and causing decision-makers in the state to make choices that result in lower emissions. There is no inherent guarantee that the correct value for the purposes of state revenue and the correct value for the purposes of hitting state GHG emission targets are the same value, and both may change over time.
- Tax reform may benefit from being phased in over time. For example, the tax could be ramped up at a rate of $10/ton per year until the final value is achieved.
- There is no guarantee that a price on carbon will encourage greater usage of renewable energy, as opposed to switching between fossil fuel sources or using nuclear-generated electricity.

---

[8] "After a review last year, B.C. confirmed it will keep its revenue-neutral carbon tax, the current carbon tax rates and tax base will be maintained, and revenues will continue to be returned through tax reductions…The review covered all aspects of the carbon tax, including revenue neutrality, and considered the impact on the competitiveness of B.C. businesses such as those in the agriculture sector, and in particular, B.C.'s food producers." http://www.fin.gov.bc.ca/tbs/tp/climate/carbon_tax.htm accessed November 19, 2013.

[9] http://www.epa.gov/climatechange/EPAactivities/economics/scc.html

[10] See chapter 4 of http://publicservice.vermont.gov/sites/psd/files/Topics/Energy_Efficiency/AESC%20Report%20-%20With%20Appendices%20Attached.pdf

Supplementary policies may be necessary to encourage enough use of renewable energy to achieve the 90% renewable energy goal and simultaneously cut emissions[11].

- What reduction in other taxes or fees is necessary and appropriate in order to remain revenue neutral? Adoption of a carbon tax of this sort invites a larger discussion about tax reform and provides an opportunity to better align costs with prices throughout the economy. It may be appropriate to reduce other taxes on the same fuels that are charged a carbon tax in order to mitigate net price effects and maintain equity among fuels on a carbon basis. Fuels for which there is already a small carbon payment (such as electricity via the RGGI cap and trade system), could have a reduced payment to avoid double-payment. The energy efficiency utilities (EEUs) exist to meet the obligation of the state's regulated energy providers to provide least cost service, so this policy would not immediately impact these programs, nor would the tax revenue obviate the energy efficiency charge levied to pay for these programs.
- Where are the most appropriate and implementable points to measure greenhouse gas emissions? Measuring fuel use at the point of import into Vermont may be the most straightforward to implement. (There are relatively few energy importers, so relatively few taxpayers, compared with energy consumers.) However, measuring at the state line neglects upstream emissions from fuel refining, drilling, extraction, transportation, etc. Electric utilities can track their emissions through the NEPOOL Generator Information System, which allows the calculation of emissions due to electric generation at facilities throughout New England, but again this does not include upstream emissions. Life-cycle emissions for biomass (woody biomass in particular) also depend on harvesting and replanting rates.

One concern raised by this policy set is that simply setting the "correct" price is unlikely to be sufficient to cause the necessary change in behavior, given other market failures. Therefore, it may be necessary to develop complementary programs, which will have associated costs, in order for the revenue neutral carbon tax to work effectively. These programs would change over time, but would likely include purchase incentives, financing tools including credit enhancements, technical assistance programs, and programs designed to mitigate the impacts of increased energy costs on low- and middle-income Vermonters. There are two primary options for revenue to support such programs. The first is to make the carbon tax not quite revenue neutral – that is, to offset the carbon tax by reduction in other taxes and fees that do not quite cancel the net revenue impact, thereby generating net revenue. The second is to capture some or all of the increase in state revenue that could come with increased economic activity associated with a more economically efficient tax structure. The former of these is more certain and is available immediately; the latter avoids increases in overall tax rates but is uncertain and takes time to develop.

A second concern to be addressed is the tax's impact on energy-intensive commercial and industrial activity. During a period in which Vermont levies a carbon price but other jurisdictions do not, Vermont firms may be at a disadvantage. The extent of this disadvantage depends on the taxes cut to balance the

---

[11] A recent report from the International Energy Agency, available at http://www.iea.org/publications/insights/insightpublications/name,43825,en.html, describes a framework for analyzing the interaction between carbon pricing and energy policies.

carbon tax, however particularly emission-intense firms are likely to see a net tax increase. One option to address this concern, developed based on stakeholder input, would be to exempt firms from the carbon tax if they make particular progress to increase their productivity per unit of emissions. Increases in productivity that would redound to Vermont's benefit could be measured in units such as the firm's payroll or state tax burden. So, for example, a firm could be exempted from all or part of the carbon tax if its payroll per ton of emissions increases at a certain rate, evaluated on an annual basis. Designing this tax incentive program would require a careful balance between state goals regarding economic development and state greenhouse gas reduction goals.

5.4 Renewable targets with carbon revenue

The third policy set the Department identified for analysis combines aspects of the previous two policy sets, while taking a somewhat different approach: In this policy set, the state would set a target for the renewable energy content of all fuels, placing a non-binding obligation on energy suppliers. If the target were not met within a given sector, however, the obligation would become mandatory within that sector. This obligation structure would be paired with a small economy-wide carbon tax, used to raise revenue applied to programs directed at making it easier for obligated parties to meet their target obligations. As an alternative to making the obligations mandatory in the case of failure to meet renewable energy targets, the carbon tax could be increased in such sectors.

Revenue raised with the carbon tax would be paired with regulatory reform to increase the pace of business model innovation throughout the clean energy economy. For example, funds or regulatory changes could be used to increase the pace of adoption of electric vehicles or alternative modes of transportation; adapt regulated utility business models to allow or incent them to make investments or utilize financing tools to make adoption of efficiency or renewable energy easier; or establish funding or financing programs that support fuel dealers expanding their business into becoming energy service providers, more broadly defined.

Practical implications and open questions in the design and implementation of this policy set include:

- How to structure the voluntary targets and trigger mechanism to provide the right amount of incentive to market actors while also achieving the state greenhouse gas and renewable energy goals.
- Voluntary carve-outs could be established with or across sectors, similar to the TREES structure. Whether failure to meet a carve-out target would force the trigger provisions is an open question.
- Allocation of limited carbon tax revenue to the correct programs to best address market challenges would require a flexible and informed priority-setting process that also respects the value of program stability and predictability.
- In the event that the targets are not met, many of the questions or implications of the TREES policy set could apply in the relevant sector.

5.5 Sector-specific policies

The fourth policy set the Department identified for analysis consists of sector-specific policies, each tailored to address a known challenge or market failure within a given portion of the state's energy economy. The policies within this set could work in an integrated and comprehensive manner to drive the clean energy transition, but there would be no single, overarching policy structure as in the previous three policy sets. This reflects the opinion, expressed by some stakeholders, that each sector is unique and may best be addressed by tailored policies. These policies might also be identified as complements to the three policy sets described above to address market failures not addressed by those overarching policy structures.

The set of polices the Department selected for analysis includes:

- Electric supply governed by a Renewable Portfolio Standard (or potentially by renewable energy planning targets of the sort currently established in 30 V.S.A. §8005).
- Continue energy efficiency utility structure for currently regulated fuels.
- Innovation in regulated utility revenue and rate making models to allow and incent utilities to invest in promotion of fuel switching, distributed generation, and development of financing tools.
- Establish energy efficiency obligations on all heating fuel suppliers, for which dealers could procure efficiency (in a manner similar to the TREES discussed above) or pay an alternative compliance payment. The compliance payment would be used to fund thermal efficiency programs. An open question is whether demonstrated use of renewable fuels could be used as a method of compliance (in which case this is a clean energy obligation, rather than an energy efficiency obligation).
- Transportation funding based on vehicle miles travelled (VMT) and vehicle weight, with increased funding support for modes other than single-occupancy motor vehicles in the light-duty market and other than trucks in the heavy-duty market. This funding mechanism preserves an incentive to drive less even in the face of the reduced marginal cost of driving that comes from the adoption of more efficient and electric vehicles. A "utility" model of transportation infrastructure funding, in which per-mile rates are set to meet known revenue requirements, could be deployed here.
- Shape the vehicle purchase decision through use of a "feebate" purchase and use tax structure that requires payment of more tax on less efficient vehicles; and serves as a rebate for purchase of more fuel efficient vehicles Alternatively, or in addition, adjust the gasoline and diesel tax structure to lower the relative price of liquid biofuels for transportation, compared with fossil fuels.
- Strengthen land use policy to drive growth in designated areas and restrict it elsewhere.

Practical implications and open questions in the design and implementation of this policy set include:

- Is the Vermont market of unregulated fuel dealers large and sophisticated enough to support the regulatory infrastructure surrounding energy efficiency obligations? If all firms would choose to pay the alternative compliance payment, it may be more straightforward to raise funds via an excise tax and directly fund independent efficiency programs.

- The Framing Report (pages 71-72) identifies a number of questions regarding the design of a renewable portfolio standard; each would need to be answered before such a policy was adopted.
- One additional idea raised by stakeholders was to cover only portions of the electric utility sales with an RPS (such as requiring that the electricity used for transportation be 100% renewable, or requiring only sales to particular end-use classes to meet the renewable percentage requirements). The benefits (price stability) and costs (potential increased energy costs) should flow through to the affected sectors.
- VMT-based transportation funding may be better adopted at a regional or national level than in a Vermont-only context, due to the large number of Vermonters who drive in other states (and pay those state's gas taxes), and the large number of out-of-state cars and trucks on Vermont roads.

5.6 New England regional focus

The fifth policy set the Department identified for analysis takes as its starting point the notion that policies adopted at the regional level or coordinated with our neighboring states may be more effective than policies adopted by a single state. It also reflects understanding that the six New England states are served by an electric grid with a single regional operator and markets, and that biomass is commonly used in a state different from the state in which it is harvested. There is also a potential that the combined market power of New England or Northeast states (and potentially including neighboring Canadian provinces) can move markets and bring new technologies to scale, in a way that no single state can do. Common policies across state lines would also level the playing field for many firms that compete in the regional market.

The set of polices the Department selected for analysis in this set includes:

- An electric supply renewable portfolio standard designed to match and pace with the rest of the region. Establish common regional definitions for eligibility of different kinds of renewable resources, including biomass.
- States have common and synchronous adoption of VMT-based transportation funding that encourages more efficient vehicle purchase and raises revenues for alternative modes.
- Establish and maintain synchronized regional standards for liquid biofuels/bioheat, as well as common programmatic promotion of pellets and/or heat pumps.
- Establish regional biomass harvesting and procurement standards, as well as pellet standards.
- Each state continues adoption of the California low-motor vehicle emission standards.
- Common vehicle purchase incentive structures, such as for electric light duty vehicles or natural gas heavy duty fleet vehicles.
- Establish a regional low carbon fuels standard, requiring increased availability and utilization of advanced biofuels, natural gas, and electricity for transportation.

- Plan and coordinate regional infrastructure for EVs (such as travel corridors and shared payment methods like EZ Pass), as well as for rail service and freight movement.
- Programmatic funding from a common regional tax or fee structure, such as through expansion of the Regional Greenhouse Gas Initiative (RGGI) to cover fossil fuel use outside of the electricity sector, and the associated revenue.

Practical implications and open questions in the design and implementation of this policy set include:

- How to establish and maintain a common regional framework and emission/renewable energy goals across multiple sectors in the face of political pressures that may vary over time and between states.
- Whether the policies adopted region-wide would be sufficient to reduce Vermont's emissions, and increase the use of renewable energy in Vermont, at the pace necessary to meet the State's goals.

6 Technology pathways

Technologies deployed as the state achieves its greenhouse gas and renewable energy goals can be broadly described as falling into demand-side and supply-side technologies. The electric grid serves as an intermediary between demand and supply and has its own potential for technological innovations; it is incorporated into both the demand and supply discussions below. This section describes the understanding of many of these technologies that the Department has constructed during the Total Energy Study process. It concludes with a short discussion of the analysis the Department is conducting to understand the breadth of the range of energy options (particularly energy supply options) available to the state that also allow the state to meet its targets.

The 2011 Comprehensive Energy Plan describes the context and opportunities in energy demand and supply in much greater depth than is included here. The reader is asked to refer back to that plan; this report tells only a small portion of the story, and focuses on new insights gleaned during this study process.

6.1 Energy demand

Reducing the state's total energy demand will be an essential component of all technology pathways that achieve the State's greenhouse gas and renewable energy goals. The Department assumes that Vermont will maintain its commitment, established in 30 V.S.A. §202a(2), to the principles of least-cost integrated planning, applied across the energy sector. Pursing least cost service requires ambitious and extensive efforts on reducing and controlling energy demand, as well as in capturing the potential to meet needs with new modes or fuels.

6.1.1 Efficiency & conservation

Energy efficiency is defined as actions taken to reduce the energy used to deliver a set amount of energy service. For example, an LED light bulb delivers the same service (light) at a fraction of the energy demand of an incandescent bulb. Energy conservation, on the other hand, denotes reductions in energy use that are related to reductions in the energy service provided. For example, turning down the thermostat in the winter saves energy but also reduces the service provided (in this case, comfort). Assigning any given action to be either 100% efficiency or 100% conservation, however, is often not possible. For example, using a bus to get to work instead of a personal vehicle uses less energy, but may also provide less service (in that the trip cannot be undertaken at the exact time of the rider's choosing, and may take a different amount of time). Reconceiving energy services can result in even greater savings – teleworking, for example, might eliminate the need for the trip to work at all.

The preliminary quantitative analysis conducted by the Department has shown that reducing the total amount energy consumed in Vermont (or in electric generators serving Vermont) will be key to achieving the State's goals. The more complete to be completed in the spring of 2014 will likely confirm this, and is expected to reveal a need to reduce the state's total energy use by factor of two or more by 2050. This would imply a dramatic increase in the energy productivity of the state's economy.

In this context, there is great potential to deploy a range of "technologies," very broadly defined, that can reduce energy use while maintaining or increasing quality of life. These technologies include those mentioned above, and also:

- Compact development of towns and growth centers
- Infrastructure for alternative transportation modes, including transit, walking, and biking
- Building weatherization, especially air sealing and insulation
- Development or adoption of new industrial processes that produce the same or increased output for a given amount of energy input

This list is by no means exhaustive; its intention is to incorporate disparate deployment decisions into the rubric of energy efficiency and conservation, so they contribute to the development of comprehensive and integrated solutions.

6.1.2 Load shifting and demand response

Energy flow and consumption depends on a number of shared infrastructures, including the electric grid, fuel pipelines, road and rail transportation networks, and many of the state's buildings themselves. Increasing the productivity of energy use can be accomplished in part by using these shared infrastructures more effectively and completely. Greater integration of data and information technology into the management and use of these infrastructures is a promising tool to create this increase in productivity, when accompanied by the technologies that allow utilization of data and control systems.

Grid modernization (the so-called "smart grid") provides a key example of the potential of this approach. The electric grid is designed to be able to provide a peak level of service for only a few hours per year, at times of greatest load. By better understanding the flows of energy on the grid, and then shifting and shaping those flows (even without using less energy), we can: put more energy through existing wires and transformers; avoid the need to pay for upgrades to the grid; and better integrate variable electric generators into the grid. Better control over electricity use will allow such use to be more elastic, in the economic sense – better able to respond to price signals. This, in turn, makes price signals (like those discussed in the context of market failures) more effective at shaping market decisions and driving societally-beneficial outcomes.

Regulatory flexibility and innovation will be necessary to harnessing and appropriately shaping these technological developments. Privacy concerns regarding energy use data and security concerns regarding control systems will need to be carefully and completely addressed. Where shared infrastructures result in rate-regulated monopolies, rate design will be a primary tool.

This same model of harnessing information technology could be expanded to the use of other shared infrastructure, or enable the sharing of current unshared infrastructure. This extends from telework enabling each of several firms to use the same physical office space, to car sharing networks, and pop-up stores.

6.1.3 Fuel and mode switching

One way to reduce energy use overall is to find new ways, potentially using different fuels, to provide similar energy services. These switches may not provide the same service, and so they are prime examples of the kind of actions that are neither perfectly described as efficiency or as conservation (such as the bus ridership discussed previously). The most common examples are:

- Use of alternative modes of transportation,
- Switching fuels for vehicles (e.g. to biofuels or electricity), and
- Switching fuels for heat (e.g. to electric heat pumps or wood pellets).

Transitions between modes and between fuels have historically been driven by changes in technology, by market prices, and by public policy. These three forces will also shape how these transitions are adopted to help Vermont meet its goals. Public policy innovation and flexibility will be required to adapt existing structures, including regulatory and tax structures, to new modes or fuels. Each of these transitions involves a broad array of interests. Transportation, in particular, involves an array of interests that have not historically been at the table regarding energy use. In contrast to the structure of the 2011 Comprehensive Energy Plan, in the future it will not make sense to think of “electric,” “thermal,” and “transportation” as three distinct fields.

The fuel transitions garnering the most attention in Vermont now are driven by advances in technology: cold-climate air-to-air heat pumps and electric vehicles. These technologies have the potential to dramatically lower the energy required to heat Vermont homes and move Vermonters around the state. Both are new technologies, rapidly evolving, and causing disruption in the marketplace. They offer the potential for dramatic reductions in the cost of heat and transportation without changes in the cost of the underlying fuel. If these two technologies are adopted at scale (tens to thousands to hundreds of thousands of units in the state), they will have impacts on the way the grid is operated and built. We do, however, have time to study and examine these technologies as their performance is proven and they are adopted at greater scale before they have large impacts on the grid (or, in the case of electric vehicles, on transportation funding). If either or both of these technologies deliver on their promise, Vermont will see a significant economic benefit due to reductions in expenditures on fuel, and environmental benefit due to the displacement of fossil fuel combustion with electricity (provided the electricity is supplied by predominantly renewable sources). At this time, public policy should be aware and supportive of these technologies, given their potential, however the extent of their current and potential impacts needs to be better understood. The example of these technologies is one of the reasons that the Department selected responsiveness to technology change as one of the criteria for policy evaluation.

The Department examined the extent of overall increased electric use if heat pumps and electric vehicles were adopted universally between now and 2050, and the resulting impacts on infrastructure. The approximate range of gross electric use increases in the context of these new end uses is between 20% and 50%. That is, the state is unlikely to use more than 50% more electricity in 2050 than we do today; a more likely figure would be an increase of 30%, even if the state's path forward skews heavily in the direction of electrification rather than utilization of biomass-derived fuels. The extent of increased electric use relative to current totals depends on several factors: the extent of electric efficiency implemented in other currently-electric end-uses; the extent of weatherization applied to buildings at the time of or following installation of heat pumps; and whether the low marginal cost of driving electric or other highly efficient vehicles hampers efforts to reduce VMT.

Given the state's current load shape and grid capacity utilization, and assuming that demand does not become elastic enough to entirely flatten the state's load profile, this would result in some moderate increase in the state's peak electric demand. It is likely, however, that the peak would increase by significantly less than the energy increase (that is, significantly less than 30%). That is because electric vehicles are likely to be a relatively elastic demand, predominantly charged late at night. It may mean, however, that Vermont returns to being a winter-peaking state, with heating load coinciding with the current winter peak. The same infrastructure can support a higher winter peak than summer (due to thermal load constraints), but it is likely that mass deployment of these two technologies would result in need for some new grid infrastructure -- not for a dramatic overhaul of the grid. Given the multi-decadal nature of this shift, careful planning could control this cost.

One additional kind of fuel or mode switch for discussion is the use of combined heat and power (CHP). (This technology also serves as a bridge between demand and supply.) In this case, what would have been a waste product (excess heat) is captured and utilized, increasing overall energy efficiency. In heat-led CHP, electricity is a by-product generated using the excess high-quality heat from a process that uses most of the energy as heat. In electric-led CHP, the waste heat from an electric generator is captured and utilized. Heat-led CHP is significantly more efficient than electric-led CHP, but it is harder to find 12-month-per-year heat-led applications in Vermont.

Combined heat and power could be implemented in concert with district heating systems, although the seasonality of building heat requirements may make the integration of electric generation impractical or uneconomic. Even without electric generation, however, district heat is another kind of mode switch for energy use. Rather than have each building in a downtown or campus provide its own heat, a centralized facility, taking advantage of economies of scale, can provide heat for the district. Biomass and biogas heat, which benefit from scale and centralized fuel handling, are particularly amenable to this mode/fuel switch.

6.2 Energy supply

Vermont's aspires to meet 90% of its energy demand in 2050 using renewable resources. This section addresses the potential sources of that energy, and includes some discussion of the likely composition of the 10% of energy use that is not renewable (and the 25% of 1990-level greenhouse gas emissions remaining).

The five renewable primary resources available to Vermont are solar, wind, hydropower, methane capture, and biomass. Each of these can be used to generate electricity; solar is also used for heat and light, while biomass and methane capture are also used to produce fuels for heat and/or transportation. These fuels are discussed in great detail in the 2011 Comprehensive Energy Plan.

Vermont's biomass resource is extensive, but also limited. Sustainably harvested low-grade wood for energy use has the potential to both improve the quality of the state's forests (thus increasing the forest resource for non-energy applications), and improve the economy. There is also significant, but less well understood, potential to harness the state's agricultural resources for energy crops (such as perennial grasses) or use agricultural wastes (such as manure) on a more extensive scale for both electricity and heat. Food and other organic wastes could also have energy implications in the context of Act 148's coming restrictions on organic materials in landfills.

When considering combustion of biological fuels in particular (but also fossil fuels), the efficiency of combustion and utilization is a key consideration. Greater efficiency is essential to make limited resources stretch to meet the state's needs (in the case of biomass); for fossil fuels greater efficiency minimizes the greenhouse gas emissions per unit of energy service delivered. Different types of application have different efficiency, and the state should prioritize use of combustible fuels in this order: heat-led combined heat and power (CHP); heating only; transportation; electricity-led CHP; and electricity only.

In considering future electric supply portfolios, in the context of meeting most of the state's non-electric energy use with biologically derived resources, the Department examined the question of the scale of resources appropriate to meet the need. Future electric portfolios will depend on extensive build-out of one or more types of resources, including likely increases in each of the kinds of renewable electric generation that currently serve Vermont. Given Vermont's resources, accessing necessary resources will require either import (especially if the state were to pursue extensive hydroelectric power) or the construction of some generation resources at what is commonly referred to as "utility scale" (generation in the tens of MW or larger per facility).

When Vermont achieves its goal of 90% renewable energy across all sectors, it will still get 10% of its energy from fossil fuel and/or nuclear sources. Stakeholders have assisted the Department in identifying areas for which renewable resources are more difficult to integrate. These are the most likely areas to draw upon this remaining portion.

- Natural gas or oil electric generators needed to maintain grid balance and stability on a moment-by-moment basis (as discussed above). The extent to which these generators are necessary depends on the extent to which biomass or hydroelectric resources can be controlled in a similar fashion, the availability of electric energy storage technologies, and the elasticity of electric demand.

- Heavy-duty transportation and machinery require energy densities beyond that available with existing battery energy storage technologies. Primary options beyond fossil diesel fuel are biodiesel and natural gas. Vermont does not have the market pull to direct this market toward one or the other of these options; at the moment it appears there is significant market interest in natural gas for long-distance trucking; natural gas is already in use by several heavy-duty fleets in Vermont.
- Liquid and solid biofuels require some amount of energy to produce. Some of this energy is likely to be fossil fuel energy, particularly for liquid fuels imported to Vermont from states that lag behind Vermont's renewable energy mix.
- Industrial process uses of natural gas (and other specialized fuels) can be substituted to some extent by biogas or renewable natural gas, but supply of such alternatives is unlikely to meet demand. The desire to maintain competitiveness in the state's manufacturing sector will likely drive expansion of natural gas accessibility (via pipeline or truck). Even if competing jurisdictions share Vermont's greenhouse gas and renewable energy trajectory, supply limitations of alternatives that can meet the demands of some industrial processes will restrict the sector's ability to meet 90% of its energy needs with renewable sources.

6.3 Variation among possible paths forward

Vermont's greenhouse gas and renewable energy targets are aggressive. Concerted effort will be required across all sectors in order to achieve them. It remains an open question, however, the breadth of the range of technology deployment pathways that remain available for Vermont to choose at reasonable cost. Reductions in energy demand will be essential to achieving the State's goals, and greater energy demand reductions will increase the flexibility to choose different energy supply options. Two primary axes of variation among energy supply pathways emerged in our research and stakeholder conversations:

1) Scale: small scale/local/distributed versus larger/perhaps out-of-state
2) Fuel mix: Electrification versus the direct use of biomass. Of the four primary sources of renewable energy (wind, water, sun, and biomass), only biomass can be used directly for heating and transportation. All can generate electricity.[12]

As part of its analysis, the Department will explore four technology pathways that span the two dimensions (scale and fuel mix) discussed above. Each pathway selects one answer to each of the two questions inherent in the two dimensions: 1) More local/small scale or more large/potentially imported? 2) More direct use of biomass, or more electrification? By evaluating both the costs and benefits of

[12] The question of biomass versus electrification also has feedback implications for the state's energy demand because electrical end-use technologies (particularly heat pumps and electric vehicles) can be much more efficient than their combustion-based alternatives. Overall energy demand implications also depend on how the electricity is generated.

these four pathways, the Department hopes to learn the size and scope of the remaining options facing Vermont that can be achieved with acceptable costs and benefits.

The technology pathway the state follows, with likely variation in the distribution along both of these axes over time, will have a significant impact on both the state's net cost of infrastructure and fuel and the economic benefits that flow to the state as a result of capital flows into and out of the state. For example, smaller-scale electric generators are likely to be more expensive than larger (due to the lack of economies of scale), and are also more likely to be in Vermont as opposed to out. Solid biomass is likely to be sourced in Vermont or close by, while liquid biomass (unless produced from in-state agricultural products) is more likely to come from out of state. The interaction of these two effects, in the context of increased efficiency reducing capital outflows for the purchase of fossil fuel, will shape the net economic benefit accruing to the state as a result of the clean energy transition. The Department's further analysis seeks to identify optimal pathways, recognizing that the definition of "optimal" may vary according to different perspectives, in terms of both total cost and benefit and net economic impact on the state.

7 Next steps

This report serves as a snapshot of the status and interim results of an ongoing research and analysis project, which will be completed in the summer of 2014. As such, it raises questions for which it does not provide answers. The Department will continue to work with its sister Agencies and Departments, as well as with the public, legislators, and other stakeholders, to expand and refine analysis of policies and technologies Vermont might pursue in service of greenhouse gas emissions reduction and increased use of renewable energy.

The Department welcomes comments on this report, or the TES process in general, through January 22, 2014. Comments may be submitted electronically to PSD.TotalEnergy@state.vt.us.

The Department plans to release the results of additional analysis during 2014, with additional opportunities for comment and public engagement. A Total Energy Study Final Report will be issued in the summer of 2014. Please refer to the Total Energy Study webpage throughout the spring for updates.

Total Energy Study: Legislative Report

December 15, 2013

Appendix A Public Comment Summary

Appendix B Energy Stakeholders Participating in Focus Groups

Appendix A Public Comment Summary

Table of Contents

Appendix A Public Comment Summary

1 Introduction

The purpose of this Appendix is to provide a synopsis of comments on the Total Energy Study (TES) solicited and received from energy stakeholders and the public between June 21st and December 2nd, 2013. Commenters responded to various requests from the Public Service Department (PSD):

1. Energy stakeholders submitted written responses to the PSD's Request for Information regarding the Total Energy Study Framing Report.

2. Energy stakeholders participated in eleven focus groups during the summer of 2013. Some submitted written comments as a follow up to the discussions.

   One hundred and thirty two representatives participated from 79 organizations of varieties of businesses and their associations, local and national energy businesses and consulting firms, energy utilities, environmental and citizens advocacy groups, academics, financial institutions, philanthropists, transportation authorities, law firms, town energy committees, planners and other local, state, and federal governmental agencies. Refer to Appendix B for a list of participants.

3. The public and energy stakeholders attended a TES Public Meeting and Webinar on November 14th at the State House and on-line.

4. The public and energy stakeholders submitted written comments from November 14 through December 2nd.

All who provided input are invested in Vermont's future. All statements below were summarized from the summer focus group discussions, the public meeting, and written comment. No comments have been validated. Comments suggesting that a particular action should or should not be taken, should not be interpreted as evidence that the action has or has not already been taken.

This appendix is organized in the following fashion.

- Section 2 Energy Goals and Principles includes comments related to Vermont energy and greenhouse gas goals and methods used to measure energy demand, energy consumption, the renewables component, and greenhouse gas emissions. Section 2 includes comments related to the overarching statutory goals of Vermont's energy policies. Section also includes comments regarding how the public, the private sector, or the Legislature might drive or react to State energy policy.
- Section 3 End Use Demand Technologies & Services and Section 4 Energy Supply Technologies & Services include comments related to technology and service requirements, existing markets, and resources.

- Section 5 Energy Policy Development includes comments regarding priorities, pacing, evaluation criteria and other principles which energy policy analysis and development should consider during the design of new policies. Section 5 also summarizes comments related to the five primary policy sets described in the Total Energy Study Legislative Report.

2 Energy Goals and Principles

2.1 Energy Goals and Their Measurement

The Legislature required that the TES analyze how to reach the currently defined State energy and greenhouse gas goals. Therefore, few commenters expressed an opinion for or against the current goals as set by the legislature. Many commenters did point out that in order to achieve these energy goals, massive change is needed and that we are entering a new energy frontier. One commenter stated that operating our society at current levels is incompatible with substantial greenhouse gas (GHG) reductions. A few commenters advocated for setting all energy goals such that their achievement directly supports meeting the GHG goals. A particular concern was expressed that if total energy consumption grows, Vermont might reach our renewable goals but not our GHG goals. One commenter advocated for moving beyond our goals to 100% renewables with near-zero GHG emissions as soon as possible.

Many commenters discussed data representations of Vermont's energy portfolio (e.g. pie charts of total energy by resource type) often calling for more clarity in how certain activities are measured and presented, such as the buying and selling of Renewable Energy Credits (RECs), reduction in demand, electricity feedstock resources , and energy losses (heat, transmission). Several commenters appreciated the PSD's more recent visual presentations of total energy supply which differentiate RECs that are sold. Several commenters requested that natural gas purchased through regional electric markets be quantified and shown in Vermont's representations of total energy consumption.

Renewable Energy Goals: Most commenters agreed that Vermont policy should prioritize reducing reliance on fossil fuels. Most commenters agreed that to reach Vermont's renewable energy goals, energy efficiency and conservation are critical primary strategies.

Measuring the Renewable Energy Component of Total Energy: Several commenters requested clarity on how energy savings from efficiency and conservation will be accounted for in the measurement and projection of declining energy usage. More specifically, will these savings be treated as demand reductions against total energy consumption or reductions in supply? Several commenters recommend the former.

One commenter stated that U.S. Energy Information Administration (EIA) data projections used in PSD planning are based primarily on expected demand, which is shown to increase through 2050. This person believes that EIA demand projections are overstated and recommends following biophysical economics methods to account for physical and economic constraints which are likely to lead to an inevitable fall off in consumption around 2030.

One commenter stressed that when measuring the renewable component of the energy mix, we should include the investment of fossil fuels needed to manufacture and install new technologies like electric vehicles (EV) and photovoltaics (PV). This person contends that relevant GHG measurement and policies should account for the embodied energy in all goods and services produced and consumed in Vermont.

Measuring the renewable resource component of Vermont's total energy supply requires that renewable and non-renewable resources are converted into common units. The standard practice is to convert power outputs from renewables to a British Thermal Unit (BTU) equivalent. One commenter recommends that kilowatt-hours be used as the common measure, given that a majority of Vermont's energy will most likely be derived from electricity in the future.

One commenter highlighted the issue that combustible fuels suffer a loss of heat that renewables such as wind, hydro, and solar do not. Therefore, the use of BTU equivalents will tend to overestimate heat loss from the renewable component of our energy mix. One commenter recommended that "source energy" measurement be more transparent and accurately show the "energy intensity" of Vermont's economy, methodologies for which the EIA has published research. This commenter urges that all efforts should be made to prevent waste in energy generation from being counted in the renewable energy component of our energy mix.

GHG Goals: Many commenters support exploring new and systematic approaches to address Vermont's energy goals. Most are deeply concerned about the impacts of global carbon emissions.

GHG measurement: Several commenters wanted Vermonters to understand that many GHGs will persist in the atmosphere for thousands of years. The timing of emissions reductions is important in meeting GHG goals due to multi-decade lag effects and positive feedback loops. The emissions rate must be less than the global absorption rate to slow or prevent climate change. If all GHG emissions stopped today, climate change would still cause substantial problems. To make better decisions in directing and pacing policy and technology pathways, GHG measures should be presented in terms of a carbon budget and account of compounding atmospheric effects. Many commenters supported the use of lifecycle analysis when measuring GHG emission, though all are aware of the accounting complexities and wide variability in measurement techniques. One commenter cited particular technologies: hydro dams are responsible for GHGs emitted in the decomposition of flooded biomass; intermittent renewable sources require more spinning reserves which emit GHGs; earthworks for new generation and transmission infrastructure clears carbon-storing vegetation; crop-based biofuels may require additional nitrogen fertilization; increased bioenergy production may reduce carbon sequestration benefits from existing land uses. One commenter requested that lifecycle analysis for bioenergy sources include all nonrenewable energy inputs used in their manufacture. Commenters were in general agreement that further dialogue is needed within Vermont regarding the right GHG measurement methodologies and that the terms "clean" and "renewable" should be applied with care.

Several commenters noted that planning documents need to include explicit discussion of research on natural gas GHG measurement. Some measures put lifecycle shale gas emissions near that of coal when accounting for shale gas infrastructure development and operation, including pipeline extension, well pads, access roads, large volumes of water, and release of fracking fluids that may not be recovered or rendered harmless.

There was frequent discussion among commenters about the on-going controversy over how to measure GHG emitted from bioenergy. Some experts consider bioenergy old carbon and thus carbon emitting. Other experts count bioenergy as new carbon and thus carbon neutral. A few voiced concerns over if and how lifecycle accounting would be applied. Will biogenic emissions be counted at-the–stack, when burned, or via lifecycle accounting? Will GHGs from cut firewood be counted? Well informed policy design on the accounting methods can shape reduction in net emissions.

2.2 Projecting the Future: Total Energy Study Modeling

One commenter clarified that the TES will not be a package of strategies but is part of an ongoing process to provide policy directions aiming to optimize benefits for customers, energy systems providers, and the general society. One commenter compared the process to piecing together a daunting puzzle, making a design out of much data, many pieces, and many ideas. One commenter would like to see more evidence that the State is following a systems approach when planning for change related to energy systems, global climate, economic, and social systems, including more information on the connections among policies proposed.

The TES modeling exercise involves comparing a baseline scenario to alternative scenarios comprised of different combinations of policies and technologies. Commenters agreed that TES modeling must distinguish baseline efficiency and conservation savings from new efforts. For instance, CAFE standards should be treated as baseline measures while the impacts from any new state policies to encourage efficient vehicle ownership should be counted as additional savings above the baseline. Several commenters expect that projecting the baseline current policies forward will show how dramatically far Vermont is from meeting its energy goals.

One commenter recommended that each TES Model run prioritize efficiency and conservation programs first and then apply renewable resources. The model should track and measure the impact of new, above baseline policies without counting demand reduction towards Vermont's renewable energy goal. However, another commenter noted that the model needs to dynamically compare the cost effectiveness of efficiency and renewables simultaneously. As renewable technology costs decline they are becoming more cost competitive than efficiency under particular conditions.

2.3 Statutory Goals

2.3.1 "adequate, reliable, secure and sustainable"

Refer to Section 4 Energy Supply Technologies & Services

2.3.2 "assures affordability" and "least cost planning"

Several discussions and written comments noted that forward looking energy planning publications and presentations need to include specific information on costs to residential and commercial/industrial consumers. There needs to be more discussion about consumer choice; consumers need the freedom to state their preferences for energy resources and technologies. One commenter stressed that consumers need opportunities to weigh in regarding their willingness to pay for carbon reduction programs and more renewables.

2.3.2.1 Least Cost Planning

One commenter noted that all energy planning documents listing Vermont's key energy statutes in their introduction should include 30 V.S.A. §202a(2) which requires least cost integrated planning by law.

Several commenters rallied for updating the least cost planning framework historically applied to the electric supply sector, to integrate both the supply and demand sides of the transportation and building energy sectors. Scenario analysis using least cost rules should be indifferent to the scale of projects within any sector; scale will be determined by the energy demand consumers. One commenter suggested another advantage of least cost planning is that an assessment of capital availability can be captured when levelizing the costs of ownership across technologies.

Commenters agreed that efficiency is most often the least cost solution.

Commenters discussed the lack of outcomes in the 2013 legislative session to advance energy policy. Cheap natural gas conflicts with long term efficiency and renewable goals. Some commenters said new legislation was stalled because citizens and legislators are not motivated given that new energy investments have large up-front costs and little if any immediate payback.

New wind energy development was commonly identified as the cheapest new renewable technology. One commenter stressed that consideration of transmission, integration, and environmental costs show wind to be less competitive, especially as costs fall for PV, hydro dam upgrades, and combined heat and power (CHP).

The integration of renewables requires new grid operations technologies and could require increased reliance on fast ramping, higher emitting natural gas plants, energy storage, and in the worst case, temporary curtailment of renewable generators. Several commenters raised questions about how these costs are accounted for when comparing technologies.

One commenter underscored the need to optimize the deployment of renewable generators and energy storage capacity. Energy storage costs are high in terms of capital and operation. Energy planners need data and models to assess the future optimum mixture of renewables that will minimize the need for energy storage and thus minimize total system costs. Data at the right resolution and frequency should be collected from wind, solar, and hydro resources at key locations across Vermont. New legislation and regulation might be needed to make this data available from operators.

Cost Benefit Analyses: Many commenters requested that cost effectiveness analyses and screening tools include total environmental and societal costs (including health impacts) of projects on a lifecycle basis or that the specific costs and benefits be considered under separate criterion. One commenter stressed that until there is consistency in the accounting of full costs and benefits, including insurance, subsidies, tax breaks, etc. across technologies and energy sectors, rational decisions cannot be made by consumers and politicians. While advancing these methods is beyond the TES, a forum for discussion should be defined.

Some commenters highlighted that cost benefit screening tools need to consider particular renewable technologies which become more cost effective as markets deliver lower prices due to economies of scale. For instance, in certain buildings solar can be more cost effective than efficiency measures.

Some commenters voiced the opinion that there are economic benefits to simultaneously developing efficiency and renewable markets in Vermont. Screening tools that give competitive advantage to low cost efficiency measures need to be strategically adjusted in tune with new policies that give greater weight to renewable technologies, especially as the relative installation and operating costs change. Screening tools should be designed to recommend efficiency and/or renewables for a building based on owner specified monthly or annual operating (and financing) expenses.

Energy Return: A few commenters suggested that all energy technologies and projects be evaluated in terms of energy return on energy invested (EROEI) and energy payback time.

2.3.2.2 Price Signals and Markets

Commenters discussed the impact of price signals. In order to adjust markets and influence consumers, energy price signals need to be large and consistent. One commenter contended that the magnitude of energy pricing adjustments needed to impact behavior would have to be effected at the federal level to be feasible. One commenter mentioned that without other dials to turn (e.g. funding), price signals need to be as high as European style energy taxes. Commenters discussed the need to avoid the "P-scream," which happens when prices become too high and create backlash among consumers.

Commenters generally supported using transparent market mechanisms to influence energy systems. The true costs of energy production and consumption should be internalized, however lower income residents need to be protected via vouchers or subsidies. Some commenters stated that price signals are effective public relations campaigns and the right price signals will shift the culture toward lower energy consumption.

Other commenters noted that consumers often do not respond to price signals, new technologies, and markets as expected. Commenters said policies and programs need to be designed with careful consideration of human behavior. Consumer behavior needs to be studied. For instance, significant gasoline price increases and volatility have not lowered Vermont's average Vehicle Miles Traveled (VMT) proportionally. One commenter noted that if gas prices incorporated the true costs of production and externalities, electric vehicle purchases and operation costs would be more competitive.

Commenters recommended tiered rates such that higher prices above standard thresholds are set to reward conservation and protect low-income households. Some commenters noted that tiered pricing for certain resources, such as gas or heating oil, has less potential to incentivize immediate behavior change, but would encourage behavior change for conservation or investment in less energy intensive technologies if phased in and maintained. One commenter recommended tiered pricing be applied to total energy use.

One commenter countered the concern stated by others to always protect the most “vulnerable” from policies that institute pricing mechanisms which are set to influence behavior. This person noted that at some point the government will not have the resources to provide on-going subsidies that encourage unsustainable behavior, for instance when gas moves to $6 per gallon.

2.3.3 “encourages the state’s economic vitality”

Many commenters noted that the impact of energy policy on economic development is not discussed or analyzed with enough frequency or depth.

Commenters noted that Vermont’s ability to attract and retain businesses and employees must be cultivated. Many commenters emphasized that price and rate competitiveness must be preserved. There is concern that Vermont’s relatively high electricity costs put us at a regional and national disadvantage, although we remain competitive due to other factors, in particular quality of life. As energy transformation unfolds, these costs and existing competitive advantages need to be carefully balanced. One commenter stated that Vermont’s energy goals, e.g. "90% by 2050", need push-back from PSD. Striving to reach the goals could raise energy prices sufficiently and cause harm to Vermont’s economic development. Analysis is needed not just to study “how to reach the goals”, but also to understand “how to mitigate the economic impacts of reaching the goals”.

Many commenters held the view that prioritizing the development of in-state renewable energy resources will maximize local economic benefits by creating jobs and keeping dollars in-state.

Some commenters emphasized that the internalization of externalities would be most successfully implemented on a regional, national, or international basis.

Commenters stated that Vermont should be wary of locking-in technology that would make the state less flexible to adopt emerging technologies.

Several commenters noted that transportation and land use policies supporting Smart Growth principles and well designed local/regional transportation systems are beneficial for local economies. One commenter stressed that planners need to be better at concretely demonstrating the economic benefits of funds spent to implement Smart Growth principles.

2.3.4 “efficient use of energy resources and cost effective demand side management”

Refer to Section End Use Demand Technologies & Services

2.3.5 “environmentally sound”

One commenter stated that energy planning needs to broadly assess the cumulative effects of environmental impact; project-by-project assessment does not capture the full picture. For example, transmission build out to reach an array of distributed and remote generators can cause habitat fragmentation.

One commenter warned Vermonters to avoid environmental imperialism and prioritize using resources locally for our energy supply.

One commenter was against siting biomass district heat plants in the vicinity of homes due to concerns over air quality health impacts.

2.4 The Actors and Their Motivation for Action

Many commenters stated that to implement Vermont's energy goals, a sense of urgency is warranted by the Governor, citizens, and Legislature. Commenters stressed the need for significant immediate action sustained over decades; Vermont should not wait for easier conditions, lower technology costs, or broader public support. One commenter said that the need for massive change in our energy systems and the effort to get there needs to be communicated in a positive way rather than from a place of fear and scarcity.

One commenter was concerned that small municipal utilities do not have the capacity to manage the evolving complexity and transformation of energy systems. Their capacity needs to be addressed in planning and perhaps through new policies that help small utilities pool resources, following the VPPSA model.

2.4.1 The Public

Commenters emphasized that a sustained effort of public outreach and education is critical. Consumers need simple, credible messages. Myths need to be dispelled. Some commenters stated that consumers need to be empowered to make different choices about their energy consumption. Education on energy systems and climate change in schools is important.

Commenters stated that service providers need to speak a common language using standard definitions. Social-norming will permit neighbors to share comparable information. One commenter suggested that consumers might be more energy aware if they received one bill rather than multiple bills for energy costs.

Several commenters noted that consumers are sensitive to how they use energy (it's a lifestyle issue) especially with regards to how they heat or cool their living spaces and their reliance on cars. A human touch is needed when providing services to consumers. Service providers need to take the hassle out of mysterious projects and effort.

One commenter noted that Vermonters need to understand the complex trade-offs in all choices regarding our energy future, and be open to the benefits of home-grown energy sources which could include increased security and an improved quality of life.

Several commenters stressed that the public would experience a psychological shift to become more engaged as energy resources are localized, similar to the trends that have swept Germany. The "keep it local" buzz is effective.

2.4.2 The Private Sector

One commenter representing Vermont businesses noted that the private sector should "innovate and creatively partner" with the state government. Numerous comments took as their starting point that private businesses, such as energy providers, will be critical actors in any energy transition.

2.4.3 The Political Landscape for Action

Commenters felt it is important that the TES analysis be non-partisan. One commenter stressed that until least cost planning and cost benefit analyses assess the full costs of our energy choices consistently across technologies, state and local politicians will not be given the "lift" required to promote clean energy policies.

Several commenters suggested that energy stakeholder groups need to work together and avoid neutralizing each other in their approaches to influence legislative action. One commenter said politicians are motivated by cost issues, thus the most compelling message is that the right energy policies will result in lower costs; also that the Governor and leaders in the legislature need to stand behind Vermont's energy goals, heed expert recommendations from studies, and lead from their platforms. One commenter suggested that politicians need to sell the benefits of energy independence and job creation. Commenters noted that policies with broad benefits are worth the effort to move through a potentially difficult political process. A few commenters expressed the need to take back the term "tax". Good tax policy is an effective mechanism to shift behavior.

One commenter contended that the magnitude of energy market shifts required to motivate adequate behavior change must be enacted through proactive political action. However, it might take a crisis to spur such action, at which point the markets will have already dramatically adjusted.

3 End Use Demand Technologies & Services

3.1 Overarching Energy Efficiency & Conservation

Commenters agreed that lowering energy demand is critical. The cheapest energy is that which is never used. Demand side management should be applied across all energy sectors. One commenter suggested that the largest energy users in the Vermont should receive specific attention to help them reduce their consumption.

Behavior Change: A number of commenters discussed behavior change as an important opportunity for demand reduction. One commenter mentioned Vermont's work to develop a Genuine Progress Indicator as a forum to broaden discussion regarding how energy choices align with quality of life. Planners also need data on how different technologies impact behavior; for example wood stoves favor zoned heating, solar hot water users schedule usage on sunny days, and low operating costs for electric vehicles might encourage higher vehicle-miles-traveled.

One commenter recommended that the State review all options for implementing energy efficiency programs, noting the Vermont Energy Investment Corporation's track record, but remaining open to new administrative structures.

Rebound effects: Many commenters are concerned that reduced costs from increased efficiency and fuel or mode switching might cause consumers to use more energy. For instance, one commenter predicted that higher miles per gallon (MPG) cars or EVs that are cheaper to operate will encourage more driving. To prevent this rebound, a few commenters stressed that efforts to increase efficiency need to be coordinated with increases in energy prices.

3.1.1 Building and Industrial Energy Efficiency

Most commenters support continued investment in weatherization as a critical pathway; this is a mature technology. Policies, standards, education for consumers, and certification for building trades are needed to prevent sub-standard new construction and renovation. Other New England states are doing a better job than Vermont.

One commenter emphasized that there is lot of efficiency left to capture but in residences of people who need public assistance. All the major efficiency work in the commercial and industrial sectors is complete.

Commenters noted that State funds for all current building efficiency incentives are collected from electric sector charges. There is a need to align Efficiency Vermont's (EVT) electric and thermal goals with higher level goals in Vermont's 2011 Comprehensive Energy Plan (CEP). There is a lack of clarity from the PSD on how to adjust EVT goals.

Several commenters emphasized that larger commercial and industrial entities have the expertise and capacity to strategically design and carry out progressive projects to lower their energy demand. These entities want to self direct their efficiency investments. Several commenters mentioned that the Energy Service Company model is not evolving because companies don't want to commit to long term contracts. One commenter mentioned that energy efficiency spending requirements need to be visible to corporate headquarters (which may be located outside of Vermont).

Building Energy Codes, Net Zero Buildings: Building to Net Zero standards does not cost much more than building to current efficiency standards. Commenters noted that in order to analyze the potential of Net Zero building technology, data collection is key. Data needed includes time series data of new construction per year, the state of current building stock, estimates of energy usage per square foot. One commenter asked whether Net Zero should be defined based on energy usage or carbon emissions. One commenter suggests that a better term for the standard should be Net Neutral, signifying the inclusion of building owner investments in renewable generation.

There is a need to identify buildings that are patched together and therefore extremely expensive to retrofit. A decision needs to be made as to whether those buildings will be exempt from new standards or eligible for more lenient standards.

Most commenters noted that the enforcement of building energy codes is critical. One commenter noted that code enforcement is effectively voluntary now but that incremental change is in the works. The issue is very local. Neighbors are known to encourage each other to cut corners to reduce up-front capital costs. Education about savings and other benefits is widely needed.

Several commenters noted that standards need to specify appropriate building sizes based on the structure's function. One commenter suggested that generation on-site be required for a building or complex of buildings that exceed specified energy consumption standards set for their building function, e.g. for residential, and commercial categories.

Some commenters want buildings to meet a minimum efficiency standard at the time of sale. Other commenters warn that restrictive policies like mandatory efficiency upgrades before sales will be insurmountable in terms of administration and will hamper the real estate market, especially when the market is strained.

Building Efficiency Labeling/Scoring: Many commenters support implementation of building efficiency labels or scores, similar to the Environment Protection Agency's MPG rating for cars. Vermont can start with a voluntary effort. One commenter suggested that the efficiency label be required at the time of sale. Some commenters want scores to include locational efficiency measures which evaluate a building user's transportation energy requirements (e.g. food, schools, medical, and recreation).

Scores need to reflect the cost effectiveness of both efficiency measures and the use of renewable energy supply for heating and electricity. A baseline standard for building efficiency is needed. Vermont needs to formulate policies on sharing building score data; a body of knowledge is needed to direct programs, but privacy must be protected.

Building Trade Training: The pace of technology development is out-running contractor knowledge. More young people need to be recruited and educated.

Consumer Service: Commenters emphasized that consumers need guidance and hand-holding to implement the right solutions. Along with building efficiency certification and licensure for tradespeople, a system of referrals (clearinghouse) is needed to encourage consumers to hire contractors who are trained and up-to-date on the most current technologies. Trades people need to refer each other. Realtors have expertise in both guiding and hand-holding consumers.

3.1.2 Transportation Efficiency and Mode Switching

Commenters requested information on the percent of single occupancy vehicle travel that makes up the total energy use in the transportation sector and what portion is commercial in nature.

Several commenters noted that work place transportation demand management is the surest means to influencing how most people travel. Vermont needs effective regional associations of employers and transportation providers.

Transit services to key regional and metropolitan areas need to be improved. Several commenters noted that public transportation has attracted ridership with wireless internet. Employers are recognizing telecommuting in transit.

Transit Buses & Shuttles: One commenter stated that good design for transit services includes scheduled stops every 15 minutes at each point. Another stated that we need to shift to community oriented transportation (e.g. small shuttles loops, route shifts upon request). One commenter recommended that Vermont coordinate bus routes statewide so that schedules and stops allow for convenient transfers.

Rail: One commenter recommended reestablishing overnight service to New York City. Vermont could collaborate with Amtrak to survey potential riders and plan the best schedules to improve ridership. Another commenter stated that Amtrak is not the answer and believes there is tremendous opportunity to reduce VMT and build the economy with a state-owned commuter train between Bennington and Burlington. One commenter supports the transfer of non-perishable freight by rail instead of trucks.

Smaller Electric Vehicles: One commenter asked that planners include in discussions and modeling the potential to replace car use with smaller vehicles including electrically powered neighborhood vehicles, bicycles, and scooters. Smaller vehicles are effective for commuting.

Some commenters recommended that a transportation data group be convened to devise measures and goals for keeping VMT flat. Information is needed at a more granular level of resolution. We need to understand the impact of Smart Growth on VMT and how to build barriers against reliance on single occupancy vehicle trips.

The discussion of transportation demand reduction continues into the next section on Land Use Practices.

3.1.3 Lowering Energy Demand with Land Use Practices

One commenter described that the "Quintessential Vermont" is a mix of forest, farms, homes, quaint small towns, and more-affluent recreation/tourist destinations. Many commenters pointed out that current preferences for choosing residences in rural areas add to the challenge of meeting Vermont's energy goals. Several commenters noted that affordable housing needs to tie in with access to jobs and transportation. One commenter mentioned that Vermont's aging population requires special consideration for town and transportation designs.

Commenters acknowledged there are good land use policies in place but they are not being consistently executed by local governments. Another commenter questioned whether local and regional planners are supporting Smart Growth principles; there is a lack of funding. One commenter noted that many towns lack zoning altogether or have zoning laws that encourage dispersed development.

Several commenters noted that community development efforts are needed to encourage people to live in mixed-use community centers. As we approach 2050 businesses should be increasingly located near existing urban cores. One commenter expressed a vision for walkable and bikeable town centers that would include locker rooms and showers for employees and safe sidewalks and bike route systems. Commenters suggested creating more car-free areas. One commenter noted that parking requirements for buildings are often inflated and this encourages reliance on car travel.

One commenter was concerned that Smart Growth policies will receive back lash from the public, many of whom prefer living in suburbs or exurbs. Another commenter noted that people are leaving Vermont to live in dense mixed-use communities. Another commenter noted that because of a lack of growth pressures in Vermont, Smart Growth policies are not receiving attention in the political arena.

3.2 Load Shifting and Demand Response

Commenters agreed that after optimizing investments in energy efficiency, energy systems need to shift from managing loads to optimizing demand response.

Smart Grid: Commenters noted that smart grid technology allows both grid operators and building owners to reduce thermal and electrical energy consumption, permits distributed generation and renewables to be safely connected to the grid, and can reduce investment in new utility infrastructure (by shifting loads to off peak). The costs of smart grid upgrades are covered by these savings.

One commenter noted that Vermont is a national leader in deploying Smart Grid technology with 90% of Vermont electric customers having smart meters.

3.3 Fuel Switching

Commenters actively discussed the electrification of the building energy and transportation sectors. Also, bioenergy technologies provide opportunities for switching off fossil fuels.

Some feel that the electrification pathway is in synch with Vermont's least cost energy planning directives. One commenter believes that technology advances will offer opportunities to electrify many segments of energy use. Of particular note is the potential total energy savings from switching from petroleum fuels to electricity via air-to-air heat pumps and electric vehicles. One commenter suggested that Vermont can learn from electrification programs being successfully implemented in other states such as California, and abroad, such as Israel.

One commenter emphasized that renewably generated electricity will not be able to replace all energy derived from fossil fuels. Also, some biofuels have lower energy density than petroleum fuels.

Several commenters stated that industrial entities have limits in their ability to replace fossil fuels with renewable resources for processes requiring very high temperatures; electrical supply cannot generate such high temperatures cost effectively. They mentioned that CHP could work. One commenter noted that for lower temperature processes, there is potential for fuel cell technology where the source energy originates from natural gas, or propane and perhaps hydrogen for sites beyond natural gas pipelines.

3.3.1 Transportation

Electric Vehicles: Many commenters support policy directions that promote the electrification of transportation through the deployment of light-duty EVs and electric vehicle charging equipment (EVCE). One commenter noted that EVs are three times more efficient than conventional vehicles. EVs are entering the market more quickly than hybrids were at a comparable stage of market development. One commenter noted the limited lifetime of current EV batteries.

One commenter noted the Drive Electric Vermont website as the state resource about electric vehicles. At least one guide about EVCE siting and installation is available for local governments from the Chittenden County Regional Planning Commission.

One commenter stated that the expense of buying an EV makes the technology beyond reach for moderate and low income people. A few commenters mentioned that three year EV leasing programs are becoming competitive with those for conventional cars.

One commenter stated that electrifying transportation could save Vermonters almost $1 billion a year in annual energy costs and could result in lower utility rates. One commenter is concerned that the global economic system will not have the capital resources (due to rising raw material and manufacturing costs) to manufacturer EVs in the quantities required.

Other Fuels: One commenter pointed out that because diesel accounts for only 18% and gasoline accounts for the bulk of Vermont's transportation fuel use, the primary challenge for meeting Vermont's transportation energy goals, is to move away from gasoline-powered vehicles.

Several commenters support aggressive policy to replace some uses of gas or diesel with biofuels produced locally, especially for on-farm use.

Several commenters were cautious about investing in EV infrastructure, mentioning that fuel cell technology may still have potential and natural gas vehicles are already on the market. One commenter stressed that fuel cells are not an energy source but are energy carriers that will require renewable resources to generate hydrogen in order to stay on target with renewable energy goals. One commenter stated that fuel cell technology is not likely to reach a favorable EROEI when efficient production, hydrogen storage, and transportation are all accounted for.

Another commenter suggested that Vermont incentivize the purchase of flexible fuel vehicles.

Heavy Duty Vehicles: One commenter suggested that fueling stations offering biofuels and natural gas for heavy duty transportation (freight, transit busses) should be exempt from carbon pricing.

3.3.2 Building and Industrial Energy

Water Heating: One commenter noted that converting hot water heating is one of the more cost effective efforts available in building efficiency and suggested an analysis be done comparing solar hot water heating to air-to-air heat pumps powered by PVs.

Space Heating: Many commenters agreed that policies encouraging fuel switching or equipment upgrades should be prioritized and linked to building retrofits.

Several commenters promoted policy development for aggressive adoption of bioenergy technologies for space heating, including district heating for town centers and building complexes, pellet boilers for small residential and commercial buildings, as well as advanced woodstoves for rural residences. The solid biomass technology and markets are mature. Cold climate Europe has adopted these heating technologies. Several commenters suggested homes switch from fuel oil or gas to wood pellets.

Several commenters emphasized that fuel dealers should be key partners in related programs.

One commenter noted that heat pumps cost effectively harness renewable sources of electricity. And efforts should be made to alter Act 250 mechanisms which have discouraged electric heat.

Several commenters support aggressive adoption of air-to-air heat pumps; this technology is proven, cost effective, and can be cost competitive with natural gas. One commenter noted that heat pumps are applicable in commercial settings for water heating, and clothes drying.

One commenter was particularly against air-to-air heat pumps. Space heat loads have a significant impact on peak and could require load shifting from on-site energy storage. In order to keep space heating prices affordable, buildings would require near-zero energy construction or retrofits. In the past, consumers have viewed electric heat as uncomfortable.

A number of commenters requested more discussion of geothermal or ground-source heat pumps in energy planning discussions and related documents. One commenter detailed the costs and benefits of geothermal technologies for Vermont buildings.

Passive Solar Design: Several commenters suggested that passive solar design is a proven technology and should always be included in discussions and analyses of building efficiency policies. One noted that passive solar design can be a significant contribution to space heating and the design has the best return on investment over heating fuels.

4 Energy Supply Technologies & Services

Commenters requested that Vermont carefully analyze the economic benefits and other tradeoffs of developing in-state resources versus purchasing out-of-state resources on the market or via long term contracts. Commenters noted that due to Vermont's size and environmental policies, we should continue to plan for out-of-state resources. Long term contracting mechanisms and standards (size, environmental impact, emissions, etc.) can help Vermont meets its goals.

One commenter recommends that Vermont prioritize in-state resource investments in order to ensure the greatest economic benefits and long term control over our energy resources.

One commenter stated that long-distance energy distribution systems, including transportation infrastructure, produce energy losses, overloads, accidents, and vulnerability. One commenter supported local distributed electric generation and biofuels production and stated that these local resources could supply much of Vermont's residential demand. Several commenters looking long range added that competition for energy resources could become extreme in the future and cause energy exporters like Hydro Quebec and wind farms in our neighboring states to limit export supply. Vermont may not have the economic leverage to compete for well priced long term contacts, especially with metropolitan areas. Several commenters stated that renewables alone will not make up for declines in conventional energy resources.

Some commenters asked how TES is viewing utility business models. One commenter stated that the current Energy Efficiency Utility (EEU) model is a patch on a utility system that is no longer meeting our needs.

4.1 Electric Supply and the Grid

Several commenters noted that if the regional grid can supply lower cost and cleaner power as compared to in-state resources, Vermont should take advantage of it. One commenter predicted that if the rest of New England enacts similar renewable energy goals, electric prices will climb higher faster. Another commenter stated that because Vermont is small and nimble, we will be able to advance toward our renewable goals more quickly. One commenter added that ISO New England (ISO-NE) treats efficiency as a demand resource; it is accounted for and paid in the market as a generation source.

Distributed Generation: Several commenters noted that with distributed small-scale generation, the framework for utility regulation needs to adjust to new relationships between the utility, suppliers, and customers. Some commenters stated that distributed generation systems will be increasingly called to replace the role of centralized systems, including ancillary services. One commenter surmised that when energy users have a more intimate role with producing energy they are more prone to conservation. Local and at-home generation fits Vermont's do-it-yourself traditions. Another commenter believes that distributed generation will filter into the landscape over a long time, a hundred years.

One commenter noted that distributed resources minimize environmental harm and reduce transmissions costs/losses. However, other commenters posed that distributed resources will lead to more landscape and habitat fragmentation.

Several commenters stated that commercial and industrial entities will increasingly integrate rooftop PV and energy storage technologies.

Large Scale Generation: Commenters noted concern regarding the build out of large scale renewables in advance of grid improvements which are needed to pair demand response with improved energy storage to manage intermittency. Several commenters noted it is important that renewable resources are tracked and associated with the original generating unit.

Energy Siting: Several commenters acknowledged the work of the Energy Generation Siting Policy Commission. One commenter noted that grid interconnection was overlooked in the report.

Transmission and Distribution: One commenter requested that planning efforts specifically address the need to modernize the grid in-state and under the ISO-NE. Commenters noted that distributed in-state generation is already causing constraints requiring grid upgrades, but these upgrades will be less costly than those needed if all of Vermont's power was imported. A number of commenters stated that commercial and industrial entities who own equipment which is sensitive to power dynamics are concerned that the reaction of distributed PV to voltage disruption could trip off a cascading effect across the grid.

Energy Storage: Some commenters proposed that Vermont encourage construction of energy storage in strategic areas. One commenter speculated that significant investments in energy storage will be needed in the next ten years. One commenter questioned how energy storage development will interact with the Sustainably Priced Energy Enterprise Development (SPEED) and net metering programs. Some commenters requested that future documents include more specifics about Vermont's plans and the costs to invest in energy storage technologies.

Several commenters noted that the potential of EVs as a dynamic energy storage facility is promising but is not likely to be widely available for some time. One commenter suggested that planning for vehicles powering the grid should always include designs for using vehicles as local backup energy storage, e.g. buildings, micro-grids.

Electrification: The impact on load from heat pumps and electric vehicles was frequently discussed. Several commenters estimate that the increased electric load, peak demand, and related transmission and distribution upgrades for these uses is a concern and thus electrification should not be a major policy option. One commenter noted that increased load from electrification is a distribution system issue, not a transmission issue. One commenter predicted that growing constraints in natural gas supplies will impede Vermont's progress toward electrification.

In dispute, other commenters stated that the increased load from electrifying the transportation sector can be offset by electric demand reductions resulting from continued electric efficiency work. Several commenters referred to study findings that show Vermont could electrify a large portion (up to 50%) of its cars without adding new electric supply. One commenter noted that without the right rate structures, EV charging can cause new peak loads (e.g. evenings when commuters arrive home). Time of Use utility rates, as well as special EV rates, can help manage load from charging EVs. One commenter noted that EVs charge from the grid and generate energy efficiency systems charges like any other electric appliance.

There has been some concern regarding if/how EVCE owners can collect fees for charging EVs at public EVCEs without falling under electric utility regulations. Several commenters pointed out that EVCE owners can avoid fees based solely on electric usage and instead set fees based on the duration of use or by session.

Wind: Many commenters recognize wind as a viable and important technology pathway for Vermont. One noted wind has a favorable EROEI. Several commenters stressed that siting wind turbines in-state requires careful deliberation. Several commenters identified existing alternative or potential out-of-state wind resources which Vermont should consider. Working with New England Governors to procure off-shore wind could advance wind development. The potential of off-shore wind needs more attention in analyses, given that Vermont's access to those resources could require transmission investment.

One commenter contends that Vermont's preoccupation with wind development is severely hampering Vermont's efforts to move ahead on other renewable resources. Wind power is not a viable in-state resource – all sizes of wind turbines are causing problems for neighbors and communities are divided. The wind industry has overestimated the availability of good wind sites, wind capacity and grid constraints will make development and operations more expensive, and turbines cause tremendous environmental damage. Another commenter noted that Vermont should consider landscape impacts in other states as well as in-state.

One commenter requests that opposition around aesthetic and environment impacts of wind siting be considered in light of how other types of energy generators and commercial uses of energy impact Vermont's ridgelines, such as ski resorts and logging. Vermont should focus on the larger benefits of protecting the whole of Vermont's habitats from GHG climate change impact. Also noted is the comment that many people find views of wind turbines in the landscape acceptable and that the majority of Vermonters support wind development as a direction for State energy policy.

Solar: Many commenters state that installing residential and commercial rooftop PV and PV covering Vermont's built landscape (e.g. parking lots) should be a policy priority. One commenter requests that key policies discourage large solar fields on agricultural lands until opportunities on the built landscape are maximized.

Hydro Power: A number of commenters said existing dam sites should be developed across the state; these sites should be considered low-hanging fruit. Several commenters support more development ecologically responsible run-of-river hydro and requested that these projects be identified as a distributed renewable technology. One commenter suggested that any hydro system with a good EROEI and minimal environmental impacts be considered for Vermont's electric portfolio, whether in-state or out-of-state. One commenter identified specific alternative out-of-state low impact and run-of-river hydropower operations which Vermont should consider. One commenter suggested that we consider energy from TransCanada as local energy.

Nuclear Power: One commenter noted that the TES Framing Report did not mention nuclear power as an option although the study is meant to leave everything on the table.

One commenter recommended that Vermont ramp up to install 100 mega watt (MW) Liquid Fluoride Thorium Reactors (LFTRs) paired with Vermont Electric Power Company (VELCO) substations. With LFTRs and renewables, town centers could become energy net zero and power EVs.

4.2 BioEnergy Supply

Commenters agree that Vermont needs to develop its limited bioenergy resources with great caution so as not to adversely impact Vermont's landscape, food prices, or other value added uses of these resources. Most commenters agreed that Vermont's forest and farms need to be managed for sustainability. Bioenergy resources should be used as efficiently as possible.

Many commenters support that bioenergy resources are best utilized for space heating. One commenter stated that even though biomass does not yield fast carbon benefits, it can replace fossil fuels at 100% in many applications, and thus there is a strong policy justification for using biomass resources, at scale, for space heating.

Experts stated that Vermont has potential to produce energy crops from carefully selected grass species in specific pockets of Vermont as a primary crop or incorporated more widely to optimize farming practices for food production and land use. Examples of such practices include planting energy crops on marginal soils, along buffers, or as beneficial rotational crops. The cost effectiveness and EROEI of energy crop farming needs to be analyzed based on yield (tons per acre) and should include transportation costs. One commenter stated that switchgrass is not viable when evaluated for EROEI. More research is needed about current energy crop varieties and those not yet grown in Vermont. There is a need to establish best practices for cost effective bioenergy production while maintaining and improving food crops production, and land use planning to identify sites that are best suited for energy crops, food crops, or both.

Some commenters explained that Vermont needs to carefully monitor bioenergy resources across the region. For instance, how is the new 75 MW Berlin NH biomass electric plant impacting wood prices and supply for Vermont residential customers and businesses?

Experts noted a number of Vermont based research publications and projects that provide a wealth of knowledge in the field of bioenergy production, with specific topics including costs of production, grass fuel, on-farm biodiesel, algae, soybeans, canola, and sunflowers for biodiesel, oil and meal extraction.

Solid Biomass: Commenters noted that the limited woody biomass supply from Vermont forests should be used to optimize Vermont economic interests through value-added wood products as well as for affordable energy production; these uses must be carefully balanced. All commenters stated that sustainable harvesting is critical. Some commenters consider that biomass use for heating and certain CHP applications, and replace fossil fuels, will reduce carbon emissions and have favorable EROEIs. Most commenters support that biomass resources should not be used to produce liquid fuels or purely for electric power because these energy conversions are extremely inefficient and wasteful.

One commenter stated that our forests should be managed by professional foresters who prescribe thinning and harvesting of mature trees about every 20 years, followed by grazing (domesticated or wild animals). Due to climate change, increasing drought, fire danger, and invasive species require updated forest management protocols in Vermont.

Combined Heat and Power: One commenter recommended that CHP plants be incentivized for year-round heat capture; those that utilize heat only seasonally would receive partial incentives. One commenter was against large plants located near residences due to concerns over air quality impacts on the health of neighbors.

Methane Digesters: One commenter noted that digesters should be supported as a key technology for Vermont sized dairy farms. Burning bio-methane for energy has a number of environmental benefits.

Liquid Biofuels: Commenters discussed a vision for producing more liquid biofuels in-state and whether we should think more aggressively than the 25x25 Alliance recommendations. Commenters stated that farmers need technical assistance and access to technology to make “good” biodiesel on farm. To diversify Vermont should explore commercializing algae biodiesel production so as not to rely on soy biodiesel. And farmers should investigate farm cooperatives for production. Another commenter said Vermont should encourage research and development but not pay for it. One commenter noted that good marketing is needed. For instance, Vermont could run a campaign that promotes biofuels as a local Vermont grown energy resource and emphasizes that trucking costs are reduced. Another commenter noted the challenge is completion with commodity crops from elsewhere are produced at a much larger scale. This commenter questioned whether growing biodiesel is good use for Vermont agricultural lands.

Commenters noted the chicken and egg problem. Until there is more demand for biofuels in Vermont's market, more proximate production facilities will not attract investors. One commenter mentioned that a nearby facility is producing 100,000 gallons per month now and there is a plan to build a 7-million gallons per year plant. Also, demand will be limited until vehicle and equipment manufacturers accept higher blends under their warranties. Some manufacturers are now allowing up to a 5% blend.

One commenter stated that a national heating fuel goal is to have B100 replace fossil heating oil by 2040.

Experts support further research studying which varieties of grass species are cost effective and beneficial for the Vermont agricultural economy. One commenter recommended that policy mechanisms should be analyzed to encourage farmers to grow biofuels to power their farm equipment. One commenter supported continued research for cost effective liquid biofuels production and distribution to supply space heating.

One commenter noted that planning discussions should explore the potential of producing Renewable Natural Gas from landfills, wastewater treatment facilities, and farms.

4.3 Natural Gas Supply

Commenters were concerned that cheap natural gas is causing people to ignore efficiency. Several commenters noted that natural gas may be riskier than expected with pipeline congestion and volatile prices showing up as consequences of growing popularity.

A number of commenters are not comfortable with declarations that natural gas is a valuable bridge fuel. A common concern is that infrastructure investment would "lock-in" this technology beyond its optimum timeframe as a bridge to renewable technologies. Several commenters stated that natural gas will not be a bridge solution for any longer than 15-30 years. One commenter cited known supply challenges with existing reserves and concluded that production will peak in a few years. Several commenters noted there is increasing competition for natural gas supplies across New England and in foreign markets. Prices are likely to rise due to this demand. One commenter noted that pipeline constraints have caused some price spikes in the electric market. Another commenter considers that pipeline expansion investments will be difficult to recoup. Several commenters stressed that before Vermont adopt policies establishing natural gas as a bridge to transition from higher carbon fossil fuels to renewable fuels, we need independent research analyzing natural gas pipeline infrastructure costs, long term natural gas price stability/volatility, and lifecycle emissions and costs of shale gas, and ethical considerations given Vermont's ban on fracking.

4.4 Fossil Fuels Supply in General

A few commenters noted that fossil fuels dominate because of their superior power and energy density, historically high EROEI, and scale. Several commenters noted that certain industrial processes will continue to require fossil fuels, especially when high temperatures are critical. One commenter noted that because businesses make expensive long term investments in equipment, they are not as flexible to purchase new technologies in the near term. There is a multi-trillion dollar infrastructure supporting their continued use. Useful fossil fuels will be burned. However, a number of commenters predict that petroleum prices will escalate and will drive the move away from fossil fuel use.

A number of commenters stated that the ten percent of resources that will remain nonrenewable should be reserved for critical purposes that cannot be met through conservation, efficiency, or renewables. One commenter recommended that Vermont not waste petroleum on materials that have organic substitutes, such as cellulose insulation, organic fertilizers. Petroleum consumption should be conserved for critical applications such as lubrication and pharmaceuticals.

One commenter stressed that shale from hydraulic fracturing needs more regulation on chemicals, pressures allowed, well monitoring, and sanctions. Wyoming and Colorado and Environmental Defense Funds are good models for regulation.

5 Energy Policy Development

Many commenters favor a systems approach to developing and analyzing policies. A systems approach will drive change in the overall structure in which energy consumption decisions are made. Cross sector policies are imperative in order to meet our energy goals efficiently. One commenter stated that while reviewing alternative policy options, energy planners should be aware how different suppliers and consumers in different economic sectors require different approaches and how federal and other New England states initiatives impact VT's efforts.

Several commenters visualized effective long term policy as carrots (funding, financing), sticks (regulation, fees), and tambourines (education). One commenter identified four types of policies that could lead to reduced energy consumption and therefore lower GHGs: 1) increase energy costs, 2) decrease the derived utility of an energy resource, 3) decrease access to energy resources, and 4) enforcement of lower consumption by an external agent. One commenter asked State energy planners to consider how to apply currently successful energy policy and programs more broadly within or across energy sectors by adapting, adjusting, supplementing, or altering priorities.

One commenter stated that individuals and organizations may be unable to achieve energy goals without public policies and programs that remove barriers and support individual action. The efforts of committed individuals and organizations are impeded by limited funding resources and uncertainly regarding which actions are most effective. One commenter stated that policy mechanisms and impacts need to be translated into tangible descriptions and metrics which average people can understand and implement in their everyday lives. Some commenters recommended that the best means to communicate energy policies and their impacts with the public is to present data in terms of average household expenditures.

Some requested that all energy policies be intelligently designed and coordinated to achieve Vermont's GHG goals. One commenter warned that policies not get hung up on targets and measuring exact emissions each year.

5.1 Energy Policy Priorities and Pacing the Change

Commenters discussed the long range of the CEP & TES planning periods. We have thirty-seven years to 2050. Looking back as far, who would have predicted the rapid deployment of the internet, ultra small computers, and wireless communications? One commenter said technology will improve many times over during the course of the 2050 timeframe and these advances will be big steps forward environmentally, sustainably, and economically. Thus in setting policies to evoke change, policies need to be flexible and responsive to technology improvement and cost reductions. One commenter noted that we should expect the process will not be smooth and that there will be many policy changes.

Many commenters emphasized that the public and communities need to understand a vision for good energy policy along with the cost of inaction. The benefits of action need to be well articulated. The public needs to be given and understand the value associated with alternative pathways in terms of economic impacts, GHG, and non-energy benefits. Consumers and communities need to be educated to understand the relative costs of energy choices and thus how their energy consumption is measured.

A number of commenters noted that the key to gauging successful policies is to systematically track progress toward meeting energy goals. This effort requires policies that establish prescriptive methods for measuring total energy consumption, renewable energy resources, and GHGs. Several commenters emphasized that the original energy sources need to be identified for accurate accounting of renewables, especially for out-of-state resources.

Commenters offered that significant change in policy directions can be phased in, stepping up targets and charges through 2050. However, many commenters stressed that GHG reductions need to be realized as soon as possible to reach our goals. Several commenters emphasized that a sense of urgency is required. Some commenters suggested that prices be adjusted to include societal costs on less desirable technologies in addition to focusing policies on incentivizing desirable technologies. One commenter contends that energy costs will rise faster than income, thus investment in energy development will be less expensive now relative to the future.

Several commenters mentioned federal policy as the biggest barrier to supporting community scale investment and a change in the current political climate is not likely. State vision is needed on this front. Commenters requested a deeper understanding of what will give capital markets support in order to attract private investors to fund a new energy system. Investors need confidence in contract structures. Many commenters supported passage of a Renewable Portfolio Standard. Also they supported rate design to drive down demand for electricity. Most commenters supported near-term investment in residential building energy efficiency as critical. Several commenters emphasized that Vermont also give more near term priority and specification to strategies that promote switching to efficient thermal renewable energy, such as heat pumps, biomass, and solar. Another commenter noted that conversion of hot water heating to renewables is a low hanging fruit.

Many discussions and written comments noted the work of the Thermal Efficiency Taskforce (TETF) and expressed disappointment with the lack of outcomes during the 2013 legislative session with regards to legislative action on the TETF recommendations.

Many commenters stated that Vermont's transportation sector needs more momentum in the formation of energy policy and should be given more immediate priority. Several commenters emphasized that consumption and emissions from the transportation sector should be tackled aggressively. One commenter noted that transportation consumes 34% of the Vermont's total energy use and contributes 59% of our total GHG emissions (EIA).

Many commenters view that long term Vermont's energy will be primarily sourced from electricity. The movement of people will be met through compact communities and electric vehicles. Building heating needs will be met through weatherization, heat pumps, biomass, and solar hot water. Electric needs will be met through efficiency, conservation powered by renewable generators.

Many commenters requested more emphasis on fuel switching to biodiesel for use in vehicles and to heat buildings.

One commenter stressed that PSD policy development and publications should balance analyses of community-based decentralized generation, micro-grids, and other distributed energy infrastructure, more equally with analyses of large-scale generation. The most promising policies provide models and incentives to communities to build community-based energy rather than policies that divide community and give utilities, developers, and large investors an advantage. Local energy control will encourage more personal responsibility.

Some commenters suggested that in order to advance Smart Growth and transportation demand management (TDM) policies, planners and policy makers should tie in the needs of Vermont's aging population for community level transportation and denser communities with accessible services.

Several commenters emphasized that Vermont will need to respond to national energy market changes rather than be the driver. Other constraints on the pace of change are funding, technology advancement, and time for infrastructure build-out; however inelastic cultural norms may be the biggest constraints. One commenter stated that reductions in energy consumption might only come as a result of economic systems not being able to supply affordable energy. The charge of public policy is to smooth the transition to an energy system that is affordable.

Commenters consider that Vermont's collaboration with regional and national partners is important on many fronts. One commenter noted that Vermont is no bigger than a mid-sized city and cannot take on major changes that require cooperation of whole industries.

A few commenters are convinced that fossil fuels will have a sustained allure in terms of energy density, convenience, and the might of existing infrastructure. Also higher consumer efficiencies make abundant marginal fuels more tolerable. Therefore fossil fuels will be burned globally as long as they are economically available. Even with extremely aggressive conservation, significant climate change can only be delayed 10-15 years. Thus, policy should focus on climate adaptation as the key outcome.

Commenters discussed the need for the State to develop a vision and lay the ground work for moving energy policy, regardless of federal politics. Federal funding for energy development is plausible. It is possible that fossil fuel subsidies will be reduced in the next two to three years. One commenter stated that federal action is not likely to address progressive energy goals or tax reform in the near future. Small tax tweaks are possible.

Some commenters suggested that the State's role is not to pick "winners and losers" but is to support a framework for technology-neutral market mechanisms to operate. The State should make sure there is access to capital, measure, and judge externalities, and make sure good information is available to empower smart decisions by consumers. One commenter added that to the extent that tax policy is used to drive energy markets and consumption, the State should not let such policies outpace technology or the ability to capitalize advances in technology.

5.2 Policy Evaluation Criteria

Several commenters requested a clearer definition of the ultimate goals in Vermont's energy decisions, because some directions seem to be in conflict. For instance, a priority is to keep dollars in-state by favoring in-state energy resources, yet the State and utilities are committing to and sometimes expanding long term contracts with Hydro Quebec.

Most commenters expressed value for locally produced generation. They asked whether the term "local energy" implies local within a town, region, watershed, or other designations. Several commenters requested clear definitions for the terms "distributed generation" and "community-owned".

Given that currently the majority of Vermont energy arrives from out-of-state, all commenters agreed that Vermont policy and technology pathways need to be analyzed in the light of long term views regarding regional energy demand, and regional and national market trends, as well as opportunities to influence policy directions beyond Vermont.

One commenter emphasized that in order to address GHG in the near term, policies chosen need to be designed for quick implementation.

Several commenters stated that the TES evaluation of policy and technology options must provide a reasonable assessment of economic benefits.

Several commenters suggested that Vermonters should use the same evaluation criteria to consider in-state and out-of-state resources, such as wind and hydro.

One commenter emphasized that the results of cost benefit analyses should be regarded with priority when evaluating policies and technologies. This practice will attract the participation of businesses and industries. Most commenters requested that all aspects of equity be considered in policy development and cost benefit evaluation, with special attention toward protecting low income people from increased costs, disincentives, or regulations dictating particular actions.

Several commenters emphasized that policies need to be simple to understand and implement. Costs to administer policies should be evaluated. One commenter suggested that transaction costs for regulators and regulated entities should be reasonable. This person noted that large overhead costs for managing complex administrative functions favor implementation solely by large organizations.

Several commenters emphasized that policies should allow flexibility in how commercial and industrial entities plan, finance, and implement energy investments. They warn against narrow or prescriptive State policies that would incentivize smaller impact projects over larger projects with broader or longer term benefits.

One commenter stated that maintaining Vermont's small rural communities and prioritizing community benefits, and community sized development are the most important criteria when evaluating long term energy policy. One commenter noted that community resilience is highly valued. We should avoid a top down approach to implement Vermont's energy goals.

All commenters agreed in principal that policies which are flexible to changes in markets and technologies are preferred. One commenter suggested that diversifying risks with an eye on total energy costs over the long term is the most important evaluation criteria.

A number of commenters recommended adding a criterion to rate policies by their expediency to be passed in legislation and to be implemented with legislative action, as well as their potential to be overturned. Also policies should be identified as revenue generating, requiring public funds or payments, or revenue neutral.

5.3 Priorities for Climate Adaption and Mitigation

One commenter stated that taking steps to address the environmental and human welfare crisis posed by climate change is a moral obligation.

A couple of commenters described flaws in the prevailing logic that fossil fuels will be largely replaced with increased renewable resources and energy efficiency. One presented this explanation. Because renewables have a lower EROEI than fossil fuels and their increased use will results in lower utility for the cost and this will result in lower consumption and pressure on society. As lower EROEIs and shortfalls occur in liquid fuel production, addressing societal needs will be prioritized over climate change. Worldwide energy and economic pressures dominate policy choices, thus the burning of ever more expensive fuels from marginal sites will continue to be deemed important. Attempting to appropriately address energy transformation to reduce GHGs would be political suicide. A solution through technology innovation is false but is likely to win because it appeases economic and environmental interests. The only solutions are mitigation and the reservation of valuable resources in the economy to preserve essential goods and services.

One commenter calculated that Vermont's reduction in fossil fuel use will simply make more fossil fuel available elsewhere. Vermont is but a speck contributing less than 0.03% of world GHG. If Vermont stopped all GHG emissions today the world would only be 4 days better off come 2050.

5.4 Funding & Financing Principles

Commenters agreed with the TES Framing report's emphasis that in order to meet Vermont's energy goals, stable long-term polices need to be backed by adequate funding. One commenter noted that the TES economic analysis needs to bring forward how affordable alternative pathways are in terms of sustained investment in infrastructure and institutional capacity. Commenters agreed that where appropriate, Vermont should invest in programs that permit broad deployment of chosen technologies, such that declining costs result from economies of scale, creating a feed-back loop that quickens deployment of new technologies. Several commenters support incentives and financing programs that are prescriptive and performance based.

One commenter stated that because we have delayed so long to adequately fund the energy transformation needed to address climate change, now the initial investment will be large (and unattractive). However, if we invest appropriately now, the long term benefits will be enormous.

One commenter stated that as technology advances, investments cannot be recapitalized; only a small number of people and a smaller number of businesses will be able to continually upgrade. Taxes cannot provide the revenues needed to capitalize technology investments in order to reach our energy goals. Attempts to rely on taxes to reach energy goals will likely be overturned in legislation later.

Many commenters discussed the need to collect more and better energy efficiency and renewable energy project data. The treatment of energy savings needs to be standardized. Without better information those making financing decisions, such as commercial/industrial executives and bankers, cannot accurately project energy savings and risks, or perform rigorous comparisons across projects. With the data these decision makers would be more secure regarding the benefits of proposed energy projects. Several said a statewide database is needed of state loan project performance. One commenter stated a concern that due to the size of Vermont's market, we will not have enough data.

Several commenters requested more flexibility with constructs in place for commercial and industrial entities related to their Energy Efficiency Charge (EEC) and EEU programs. Several suggested that EEC opt-out provisions be more widely available. Some said a portion of their EEC could continue to feed the EEUs, but that the remaining should be solely in their control given their internal expertise to finance. One commenter noted that Massachusetts had allowed op-outs from their EEC but that over time companies realized they were saving more by paying into the fund and participating in the program.

Several commenters noted that larger commercial and industrial entities have access to capital. They are primed to use internal financing for cost saving energy investments, especially those with a two and a half year payback. Also, these entities prefer to carry out larger projects which blend investments with short and long term payback. One commenter explained that because large investments in equipment and production facilities are long term (e.g. 40 years) they are not as flexible to adopt technology innovations as they appear in the market. Several commenters noted that businesses are having to simultaneous address many competing costs, including health care.

Some commenters had concerns with governmental agencies offering financing. The State’s role is to make markets work and to ensure there is access to capital.

Several commenters held that there is plenty of private funding available. Creative public-private partnerships, such as the Vermont Business Energy Conservation Loan Program, are great avenues for advancing energy policy in both commercial and residential applications. One commenter noted that Vermont can set models which other states and nations can emulate. These partnerships invite the private sector to champion programs and could be a key organizational structure for achieving energy goals.

Commenters discussed the need for rate and regulatory certainty in order to build transaction size and volume and to attract sufficient capital. Then capital markets can be leveraged with support from State sponsored incentive programs. Several commenters believe that financial incentives are effective in motivating behavior change. One recommended that all policy sets for the residential sector include incentive and interest-rate buy-down programs and stressed that these programs need to have predictable incentive levels over the long term; transitions in the programs rattle consumer confidence, delay projects, and are disruptive to vendor businesses and banks. Some commenters recommended a State funded loan loss reserve account. One commenter suggested propping up leasing programs.

Some commenters expressed a preference for the socialization of investments in energy distribution infrastructure, including energy storage. One commenter conveyed a strong position that the private sector, rather than government, should be called upon to build out a public EVCE network when the market is ready. One commenter noted that EVCE installations are now eligible under the Property Assessed Clean Energy (PACE) financing program.

Commenters noted that regardless of financing availability, consumers are not borrowing. Available financing is not necessarily the primary barrier. The majority of the public is not yet aware of, does not fully understand, or is not sold on the benefits of new energy technologies. One commenter observed that customers who are financing energy upgrades are interested to invest and install in both efficiency and renewable technologies at one time.

Commenters noted that consumers are wary of up-front capital costs. Consumers understand monthly payments. When people buy a car they don’t think about the term or details, rather they ask “Is it a payment I can handle?” Lease and on-bill financing programs show immediate savings on monthly statements. One commenter suggested creating a one-time bond issue with a cafeteria plan to raise significant funds for deep incentives.

Some commenters discussed crowd sourcing and cooperatives as attractive avenues for community ownership or small jointly owned and scaled projects.

Commenters mentioned that the market has no solution for people with low credit ratings. Credit guarantees and similar mechanisms are not a clean solution.

Some commenters mentioned that public serving institutions can't use tax credits and thus must depend on tax equity financing.

Many commenters consider that monetized RECs are effective incentives for supporting local energy development.

Several commenters noted that the electric sector is funding electric and thermal efficiency programs, while the thermal sector is not contributing. One commenter offered specific values for funds spent to save energy by efficiency programs – over $76 million is spent by energy efficiency utilities, $27 million is spent on transportation demand management, and over $9 million is spent on thermal efficiency programs (from the Regional Electric Greenhouse Gas Initiative and the Weatherization Assistance Program).

5.5 Primary Policy Sets

5.5.1 Nearly-Revenue-Neutral Carbon Tax Shift

Carbon pricing was actively discussed as a promising foundational mechanism that has leverage across the economy and deserves serious consideration as a primary strategy. One commenter noted that carbon pricing through taxation will lead to decreased consumption, resource sharing, purchase of more efficient technologies, and perhaps a change in living patterns if it is implemented long-term. Some transportation stakeholders agreed that a carbon price would change behavior leading to the adoption of Smart Growth principles.

Commenters understood that Carbon Tax Shift policies involve charging a carbon price for wholesale purchase of petroleum fuels. The policy would be mandatory and implemented for the long term. Although there is complexity in determining where in the value chain to apply the carbon price and how to price carbon relative to different energy resources, a carbon price is somewhat invisible (easy to administer) at the level of the energy consumer and producer. One commenter requested clarification regarding whether a carbon price would be charged solely on carbon dioxide (CO_2) emissions or whether other more potent GHG emissions, such as methane and sulfur hexafluoride (SF_6), would also be included.

Keeping in mind Vermont's conservative tax policy, a Nearly-Revenue-Neutral Carbon Tax Shift was generally regarded as having merit because revenues would directly lessen economically harmful taxes like income and/or sales tax. One commenter noted that voter education would be critical in order to explain that the Carbon Tax Shift would reduce taxes overall.

Some commenters suggested that carbon pricing would motivate all sectors of society to invest in efficiency and renewables, including consumers, energy producers & sellers, the finance sector, and government. Many commenters noted that with recent history in mind (gasoline price increases), a price on carbon would need to be large in order to shift consumer behavior. One commenter suggested that to inspire shifts in vehicle purchases and VMT, a $100 per ton tax which equates to about $1 per gallon of gasoline, would be reasonable. This commenter noted that Vermonters are already paying for GHG impacts through expenses for disaster recovery and climate adaption, and that these responses are not organized, systematic, or equitable; carbon pricing offers a long term systematic approach.

Some commenters representing the broad business sector were wary of an outcome that a Carbon Tax Shift would result in even higher energy costs and would put businesses' ability to manage costs at risk. One commenter was particularly concerned about the impact on the few VT corporations that use large quantities of fossil fuels. How would a Carbon Tax Shift reduce their GHGs? Would the tax motivate them to leave VT?

Some commenters discussed a carbon price range of $80-$100 per ton as potentially effective. One commenter requested background on how a carbon price would be derived. Commenters asked how the State would determine which taxes would be reduced from carbon revenues and what the impact of those reductions would be. Some commenters thought that reducing the gas tax would cancel the desired effects. One commenter suggests that the gas tax not be lessened with carbon revenues because that would certainly stall Carbon Tax Shift policy.

Several noted that a Carbon Tax Shift would only be possible if implemented at the federal level. Many commenters considered the discussion of a Carbon Tax Shift to be moot because it is politically infeasible.

A Cap and Trade mechanism was not favored by commenters due to the challenges of tracking emissions and trade at a retail level. One commenter noted that a Carbon Tax Shift would have a more immediate impact on behavior.

5.5.2 Total Renewable Energy and Efficiency Standard (TREES)

Note: In previous documents and discussions this policy set was named the Clean (Total) Energy Standard.

Commenters were intrigued in discussions of a TREES policy but the program design was not clear. Several commenters noted that a well designed TREES policy would be more effective than combinations of sector-specific policies. Some felt that TREES would be more politically feasible in legislation than a Carbon Tax Shift.

Several commenters thought that policies based on renewable targets could be extremely complex to administer across all energy sectors, however if the policies are not applied across all sectors entities would design operations around policy loopholes. Which entities would be regulated and how would enforcement work? Some commenters recommended that TREES should impose responsibility on energy suppliers. Such policies should offer flexible approaches to those suppliers through credit trading and targeted outcomes can be achieved quickly and efficiently.

One commenter noted that tracking renewable targets is especially difficult for unregulated fuels. This commenter requested a concrete illustration of how TREES would evaluate efficiency and renewable contributions to insure a level playing field for these technologies, yet with an "efficiency first" priority. Managing offset credits is notoriously difficult.

One commenter suggested that this policy start with low targets across sectors and ratchet up the targets in a predictable fashion. Current electric sector targets which are relatively high should not be lessened. This commenter warned that TREES should be equitable for residential users or their energy dealers; that is that the required level of investment or credit offsets purchased need to be consistent with their level of responsibility for GHGs. One commenter emphasized that it should be apparent as to how these policies and any uses of any revenues generated result in lower GHGs.

One commenter expressed that incremental expansion seems appropriate. The State should consider that because transportation comprises the greatest proportion of Vermont's energy consumption, this sector should not be left for last. Dealing with the non-regulated fuels is more difficult, but it is also more important.

One commenter considered the challenges of administering annual accounting of the baseline energy demand upon which TREES fees and incentives are set. Rather than accumulating and computing the past years efficiency and renewable energy investments and resulting savings, an administratively daunting task, the recommendation (mimicking RPS alternative compliance payments) was to set in-lieu fees per energy user for the year forward. Fees would be set based on energy savings from a prescribed level of efficiency or renewable investment. Each user would choose to pay the fee or prove that they made appropriate investments. All fees collected that year would fund other users who wish to make such investments. The commenter noted that this process would operate in a fashion similar to a Carbon Tax Shift.

5.5.3 Renewable Targets with Carbon Revenue

One commenter suggested this hybrid of the Nearly-Revenue-Neutral Carbon Tax Shift and the Total Renewable Energy and Efficiency Standard (TREES) policy sets may be more politically feasible.

A good number of commenters agreed with transferring a portion of carbon revenues to fund energy programs. They said that Vermont needs to support alternatives to paying higher energy prices that make the impacts of higher prices more equitable, especially for low income people. Even if the carbon price signal is low or does not impact markets as expected, funneling a portion of revenues from a Carbon Tax Shift to efficiency programs would compound the impact to lower Vermont's total energy consumption.

Several commenters were concerned with the challenges of administering any policies that require particular actions or payments based on renewable targets that are, especially those that are cross sector. Read more regarding these issues under the TREES comments above.

Several commenters noted that Vermont's electric supply contributes a small portion of our total GHG emissions and policy mechanisms to incent renewables are in place, thus the electric sector does not need as much attention in the development of new policies. One commenter recommended that renewable targets should be set to drive fuel switching in the transportation and heating sectors.

Another commenter asked whether Vermont has enough big GHG emitters to raise enough revenues from a carbon tax under this policy structure.

5.5.4 Market and Business Model Innovation Policies

Most commenters noted that energy policy needs to allow long term flexibility to support the adoption of innovation in new and existing technologies.

One commenter mentioned that 15 years ago a primary energy innovation was the development of the efficiency utility model but today the innovative models to be tested will integrate efficiency and renewable energy programs either within a utility structure or a market structure which seeks sustainability and energy neutrality, rather than energy efficiency alone. Commenters considered if and how new business models for energy utilities can develop. Rule changes are needed to allow the models to evolve. Can utilities be the voice for total energy, efficiency, technology choices, and financing?

One commenter wondered if the public would be attracted to invest in energy development through umbrella cooperatives. Such structures could generalize the utility model and reduce NIMBY resistance. Cooperatives could be run by local governments. Commenters discussed the German energy transformation which has been successful in attracting public investment. Although the German model results in higher energy prices, these are offset by direct income received by individuals who have invested.

One commenter recommended creating funding programs that incentivize and reward the collective efforts of organizational members, while also providing technical assistance and low cost financing options to members.

One commenter stated that the best market lever is to feebate everything and use feebate excesses to lower other taxes. The administration of such policies should be transparent. There should be an intention to leave something for younger generations. These examples were offered:

- Tax carbon, rebate carbon free
- Tax feedlots, rebate grass-fed
- Tax distances transported
- Tax gas guzzlers, fund "lottobates" to divvy up the annual kitty for EV purchases with earlier buyers getting bigger rewards

Many commenters held that the CEP goal of 25% of vehicles powered by renewables by 2030 will be achieved primarily through electrification. This goal requires a bold and innovative approach. Several commenters emphasized that least cost integrative planning should be applied across the transportation sector. One commenter stressed that the providing adequate electric supply for EVs is not the issue; rather the issue is to design regulatory structures to allow efficient use of electricity.

One commenter proposed that EV related policies and vehicle-to-grid policies be integrated with renewable electric policies and opportunities to experiment be explored. One commenter suggested incentivizing EV purchases by creating battery share agreements.

Several commenters recommended that sector-specific regulations impacting EEUs be loosened to allow effective cross sector programming aimed at reducing overall energy consumption. One commenter suggested that funding for studies be moved to support Public Purpose Energy Service Companies.

Another commenter recommended that the TES modeling effort closely analyze the seamless integration of EEU funds and efficiency programs for electric sector savings now administered under the Demand Resource Plan and for thermal sector savings now administered under the Heating and Process Fuels Plan. All current and new EEU entities such as EVT, the Burlington Electric Department, and Vermont Gas Systems would operate under this integrated framework. EEUs should not be constrained by a sector-specific resource approach and should be allowed to support programs that increase total energy efficiency across sectors for greater societal benefits. Currently under these constraints, EVT is finding it cannot assist customers to maximize their total energy savings. The impact of these constraints is contrary to State energy goals.

That commenter expanded the issue of constrained services, describing that the deployment of Smart Grid technology now opens additional untapped potential to work with customers and utilities on time of use rate design and choosing appliances and usage behaviors that are most efficient, including those that run on or generate renewable resources.

In addition, this commenter recommended that efficiency utilities work directly with the PSD, VELCO, and distribution utilities (electric, gas) to maximize the benefits of distributed resources in-state and regional transmission and distribution planning and to manage peak load.

5.5.5 Energy Sector-Specific Policies

A number of commenters suggest that the promise of implementing policies specific to each energy sector should be evaluated in terms of how well they complement larger policies and trends. One commenter suggested that there be an equal balance between incentives for renewables as for energy efficiency. One commenter recommended that sector-specific policies should be implemented in combination with carbon pricing. A concern is that sector-specific policies should be equitable for all end users.

Building Efficiency: One commenter suggested that the State reinitiate deeper energy reviews of Act 250 applications for commercial development. Another commenter suggested the State, utilities, and commercial entities put renewed attention toward developing utility and company contracts to require investments efficiency or renewable generation. Several commenters requested that commercial and industrial entities be permitted to utilize electric resistance heat as a backup, in particular when very cold weather causes heat pumps to become less efficient or fail.

Commenters requested policies that support financing and funding for more efficient multi-family housing. Make these buildings simpler to construct. Favor smaller projects (e.g. 15-20 units). Larger projects (e.g. 80 units) often involve complicated partnerships. Requirements for supporting urban density need to be higher. For low income housing, there needs to be a willingness to spend public funds. One commenter recommended that the Home Performance with Energy Star program incentive levels be propped up and consistent for a long time in order to increase participation numbers again.

Small Scale Renewable Incentive Program (SSREIP): One commenter requested long term funding for SSREI in order to maintain consistent incentive levels with no delays in approval; SSREIP has had three transitions in the past year and these have resulted in disruptions for both customers and vendors.

Net Metering: One commenter emphasized that many businesses in the renewable electric supply chain are reliant on Vermont's net metering program. One commenter asked what the limitations are on total net metered capacity in terms of grid management for small municipal utilities. One commenter would like homeowners with renewable generators to be allowed to sell excess electricity to utilities. One commenter recommends the State subsidize solar that is net metered and is used to charge EVs.

SPEED and Standard Offer: Some commenters warned that Vermont should carefully consider the scale and cost-effectiveness of resources eligible for the Standard Offer. In other states with aggressive Standard Offer programs, certain benefits such as deferred upgrades have not always resulted and sometimes greater investment is needed to handle intermittent generation from distributed renewables. Other commenters wish that the SPEED program be expanded further as a key to increasing renewable installations in-state. One commenter recommended that SPEED be customized to meet geographic needs and opportunities.

Many commenters were deeply concerned and disagree with the double counting of RECs under the SPEED program. One commenter asserted that RECs are already discounted due to the uncertainty of Vermont's REC system in light of new limits placed by other states.

Several commenters disagree with the structure of current subsidies which give greater reward to developers, leaving little voice and benefit to local communities and creating opposition to projects based on aesthetics.

One commenter noted that in 2016 the Business Energy Investment Tax Credit is set to expire and federal action is uncertain.

Permitting: One commenter supports a "thoughtful but progressive" permitting process but is concerned that the current process is too drawn out. Vermont's attainment of long term renewable goals is at risk unless the permitting process is streamlined.

Agricultural Sector and Methane Digesters: One commenter suggested that GHG goals should cover Vermont's agricultural sector in addition to the traditional energy sectors (residential, commercial & industrial, and transport) because methane makes up notable percentage of Vermont's GHGs. Also agricultural programs at both the state and federal levels are underfunded or understaffed. This commenter recommended that Vermont provide more funding or a tax credit for installing methane digesters which have proven effective on farms to generate electricity and heat.

Electrification: One commenter stressed the need to develop new institutional coordination across energy sectors between electric grid planning and operation organizations and those preparing for the roll out of thermal and transportation electrification technologies. A shared vision among these organizations will help ensure effective policies and infrastructure investments. Adequate coordination can drive and respond to the new technology adoption, prevent impediments to adoption and avoid risks to the electric grid (e.g. reliability, security). One commenter recommended that the State appoint an "Electrification Officer" to coordinate across State agencies and key players in the private sector, as has done in the telecommunications and health care industries and in Oregon for electrification.

One commenter recommended subsidies for heat pump and EV purchases but requiring product "green tags" to insure they are powered by clean electricity. One commenter recommended tax incentives for ground-source heat pumps similar to other states.

One commenter noted that efforts to optimize non-residential charging infrastructure should follow sitting criteria that compliments other State goals such as Smart Growth and economic development. Another commenter suggested that building energy codes include requirements for multi-family dwellings and public building owners to add a minimum number of EVCEs. One commenter suggested socializing the demand charge on Level 3 EVCEs; this would permit new business models.

Fuel Cells: One commenter suggested that Vermont adopt incentives for fuel cell technologies modeled after those in New York and New Jersey.

Biofuels: Ideas offered from commenters include incentivizing farmers to grow and use local biofuels, tax incentives or cost saving mechanisms for companies investing in biofuels production or mixing equipment, increased support for in-state blending facilities, mandating the State vehicle fleet and buildings use biofuels, tax credits or discounts for bioheat and vehicle uses of biodiesel, developing a regional biofuels network to provide technical assistance for converting vehicles, voluntary or mandated targets for fuel companies to produce or sell specified blends of biofuels.

Fossil Fuels: One commenter recommended that Vermont should produce fossil fuels locally where possible, encouraging renewables and well regulated oil and gas drilling.

Transportation: Many commenters do not support the institution of special fee structures and incentives that would further diminish transportation infrastructure funding which is already at risk (due to vehicle efficiency standards) in favor of fuel switching. One commenter stressed a need to reconcile the fundamental conflict between current infrastructure funding mechanisms and current VTrans policy goals to reduce transportation energy consumption (through mode and fuel switching).

Several commenters stated that alternative fuel vehicles should be treated equitably along with conventional vehicles. Several commenters recommended tax credits, lower insurance premiums, and other financial incentives for purchases of EVs and other alternative fuel vehicles. One commenter recommended a near-term Cash for Clunkers program to exchange sports utility vehicles for EVs. One commenter recommended rebate programs for fuel efficient vehicles, noting France's as a model. Another commenter was concerned that policies that disincentivize larger conventional personal vehicles could work against the many people in Vermont who need vans or pick-up trucks for work (more efficient technologies are not yet available for those vehicle types).

Many commenters felt that EV adoption needs to be paced and placed to match expanded renewable electric capacity. A few commenters supported subsidies paring EVs with PV installations, especially for residential customers. One commenter suggested funding prototypes to test vehicle-to-grid technology.

Another commenter views that setting electrification as a primary strategy at this time falsely assumes Vermonters will adopt EVs and that other vehicle technologies will not surpass the potential of EVs. Several emphasized that the overall cost to Vermont economy of converting to an electric fleet is a significant obstacle.

One commenter suggested that similar to the electric sector's geotargeting initiatives, transportation stakeholders should identify and focus funding on existing and emerging (e.g. the Jay Peak area) TDM hot spots across the state. Local plans should be revised to capture TDM incentives for employers and communities. One commenter recommended public-private partnerships to assist businesses of 50+ employees with operating shuttles between park and rides and businesses.

One commenter suggested that employers report data on employee commuting GHG emissions. Tax credits could be offered to performing employers and would incentivize travel by transit, carpooling, or telecommuting. One commenter mentioned a goal of reaching 50% of commute trips done by walking or biking.

Other policies mentioned include programs support eco-driving and carsharing. One commenter recommended incentives to buy back second cars in order to encourage alternate modes of transportation as well as car/vanpooling and carsharing.

Land Use Policy: Several commenters noted that Smart Growth as a key policy to support both economic development and the environment by fostering infill development, multi-modal transportation, and cut vehicle trips. What policies with "real teeth" will support Smart Growth principles to become integral in planning and zoning at the local level?

Commenters discussed some critical needs. Local planners need technical assistance for planning and design including visualization tools to better convey how desirable a denser and mixed use built environment can be. Future densities could mimic densities that existed in the early 1900's. Several commenters suggested that town center densities reach 8 units per acre. These designs need to integrate all infrastructure services including transportation, water, sewer, flood management, etc. Funding for sewer systems is critical to allow denser communities. Building height regulations need to be readdressed. One commenter stated that good community design allows for a 20 minute walking zone and frequent transit stops every 15 minutes.

One commenter suggested incentivizing developers to build in dense areas. Vermont should allow for growth in our existing hamlets; suburbs need to be repurposed. Industrial sites could also be considered as growth zones, if they are served by critical infrastructure or strategically placed in other ways.

One commenter suggested diverting health care funds to promote walking and biking. Some commenter suggested that parking requirements be set based on a maximum rather than a minimum, especially for employers. Funds saved can be invested in enhanced transit services.

One commenter suggested that Smart Growth policy should explore measures of location efficiency. One commenter recommended raising property taxes a fraction of a percentage for residences located far from centralized communities. Another mentioned that high gas prices will be the biggest driver. While transit, carpooling, and telecommuting are good, these modes can work against Smart Growth policy. Another commenter raised the issue that affordable EVs will likely create barriers for support of Smart Growth principles.

5.5.6 New England Regional Energy Policy Focus

Commenters generally agreed that regional collaboration is essential on many fronts. One commenter stated that all policies listed in the TES Framing Report would require some degree of regional coordination to be effective. Energy planners should consider the opportunities for collaboration and resource sharing. Vermont is small and nimble to drive innovation, this is an opportunity other states do not have. Also other New England states are more constrained by their heavy reliance on natural gas.

Regardless, commenters stressed that Vermont should learn from work in process by other states. Regional collaboration can support new policies in each state separately as well as coordinated efforts. One commenter noted that non-governmental organizations with chapters in New England states and a mission to lessen climate change impacts are able partners to drive policy in other states. Another commenter asked if other states are in fact interested in energy policy collaboration what current efforts are underway.

One commenter mentioned that Vermonters are already doing a lot compared to other areas of New England, especially relative to major cities where over consumption is common. There is concern that Vermont's interests could be overshadowed by the metropolitan areas. Another commenter noted that Vermont's accomplishments could be offset if our efforts drive Vermont jobs and emitting activity to neighboring states, with the additional potential that products are transported back in-state, causing additional emissions.

Many comments believe carbon pricing and clean energy standard policies will not work without an RPS and regional collaboration. One commenter noted that Vermont cannot price externalities in cost-benefit screening tools without similar action across New England.

Many commenters support passing an RPS. One suggested promoting high EROEI technologies and energy sources through the RPS. One commenter noted that an RPS will drive up energy prices but the short term impacts have longer term benefits. One commenter suggested that if Vermont adopts an RPS, REC sales could be fully dedicated to investment in renewable energy programs, including the Clean Energy Development Fund.

Certain energy resources outside Vermont dwarf our in-state resources. Thus Vermont needs to be part of multi-state partnerships planning large scale siting and transmission requirements, with careful consideration of environmental consequences.

Transmission: Several commenters noted that regardless of Vermont's accomplishments on energy goals, trends of increasing demand in other ISO-NE states will result in Vermont paying for expensive transmission reliability upgrades. Vermont needs to actively advocate for transforming federal and state systems and regulations that discourage non-transmission alternatives (such as efficiency, renewables, and energy storage). Vermont also needs to advocate for equitable treatment in transmission financing. One commenter identified other ISO-NE grid management practices which are counter to Vermont's energy goals, including day-ahead spot market purchases of natural gas can result in curtailment of large renewables, load forecasters are not allocating resources to adequately project load growth and reliability issues related to potential thermal and transportation electrification. A full review of grid management policies is needed in light of distributed and renewable generation, net metering, and electrification of other energy sectors.

Several commenters stressed the need for regional biomass harvesting, procurement, and biomass carbon accounting standards to ensure fair trade and stewardship. Trends in solid biomass trade in the region need to be carefully monitored.

Transportation: One commenter suggested that Vermont join with other states to lobby Congress and automakers to expand fuel efficiency standards to include larger vehicles. Vermonters drive heavier vehicles, such as pick-up trucks, vans, and four-wheel drive vehicles, to handle large loads and rural conditions.

One commenter recommended that Vermont incentivize transportation fuel switching by setting a market value on compliance with a set level renewable fuel production or consumption, by utilizing and expanding the federal Renewable Identification Number system. One commenter was skeptical of the potential for a low carbon fuel standard (LCFS) to be a successful policy in New England. There are few sources of liquid fuel in New England and it is not clear how a LCFS would help promote the adoption of EVs.

Several commenters support institution of a VMT tax to encourage modes of transport other than single occupancy vehicles. One suggested the VMT tax could be imposed through odometer readings at the annual vehicle inspection. One noted that a VMT tax will be the best way to affect behavior, but a gas tax is more feasible politically. One commenter noted that a VMT tax is good in concept, however it would penalize people who have long commutes or have family circumstances that require long trips (e.g. for medical services). Some commenters stressed that reliance on a VMT tax for revenues would be out of synch with the implementation of Smart Growth principles which work to reduce VMTs.

Total Energy Study: Legislative Report

Appendix B

Energy Stakeholders Participating in Focus Groups

The following stakeholders participated in the Public Service Department's Total Energy Study (TES) focus groups during the summer of 2013. The people and organizations below have diverse opinions. Their participation in no way implies their support or disagreement with the TES Legislative Report.

- Adam Sherman – Biomass Energy Resource Ctr.
- Al Teague – Rock-Tenn Missisquoi Mill
- Amanda Beraldi – Green Mountain Power
- Amy Milne-Allen – Vt. Chapter, Appraisal Institute
- Andi Colnes – Energy Action Network
- Andy Boutin – Pellergy
- Andy Shapiro – Energy Balance
- Ann Ingerson – The Wilderness Society
- Annette Smith – Vermonters for a Clean Environment
- Arthur Berndt – Maverick Lloyd Foundation
- Avram Patt
- Barry Bernstein – Better World Engineering
- Ben Walsh – Vt. Public Interest Research Group
- Betsy Ide – Green Mountain Power
- Bob Hedden – Hedden Company
- Brian Dunkiel – Dunkiel Saunders
- Brian Shupe – Vt. Natural Resources Council
- Bryan Mornaghi – Northern Power Systems
- Charles McKenna – Sierra Club
- Chris Granda – Granda Associates
- Cullen Meves – Windham Regional Commission
- Darryl Mays – Go Juice
- Dave Snedeker – Northeastern Vt. Development Association
- David Blittersdorf – All Earth Renewables
- David Hallquist – Vermont Electric Coop
- David Mullett – Vt. Public Power Supply Authority
- Doug Smith – Green Mountain Power
- Elizabeth Courtney – Vt. Natural Resources Council
- Ellen Kahler – Vt. Sustainable Jobs Fund
- Emily Levin – Vt. Energy Investment Corp.
- Frank Blake – Price Chopper
- Gabrielle Stevins – Renewable Energy Vermont
- Gaye Symington – High Meadows Fund
- Gus Seelig – Vt. Housing Conservation Board
- Guy Page – Vt. Energy Partnership
- Hantz Presume – Vt. Electric Power Company
- James Moore – Sun Common
- James Sullivan – Bennington Regional Planning Commission
- Jamison Ervin – Waterbury LEAP
- Janet Doyle – IBM
- Jason Van Driesche – Local Motion
- Jeff Forward – Richmond Climate Action Committee
- Jeff Wolfe – groSolar
- Jim Hand – Hand Motors
- Jo Bradley – Vt. Economic Development Authority
- Johanna Miller – Vt. Natural Resources Council
- John Hulbert – PBM Nutritionals
- Jon Erickson – UVM Gund Institute

- Jonathan Dancing – Building Performance Professionals Assoc. of Vermont
- Josh Castonguay – Green Mountain Power
- Julie Campoli
- Karen Glitman – Vt. Energy Investment Corp.
- Karen Horn – Vt. League of Cities and Towns
- Kate McCarthy – Vt. Natural Resources Council
- Ken Gagnon – Gagnon Lumber, Inc.
- Ken Nolan – Burlington Electric Dept.
- Kevin Jones – Vt. Law School
- Leigh Seddon – Energy Action Network
- Lisa Ventriss – Vt. Business Roundtable
- Luddy Biddle – NeighborWorks of Western Vermont
- Lukas Snelling – Energize Vermont
- Luke Shullenberger – Green Lantern
- Mary Powell – Green Mountain Power
- Matt Cota – Vt. Fuel Dealers Association
- Maureen Hebert – Vt. Technical College
- Meredith Birkett – Chittenden Co. Transportation Authority
- Michael Dworkin - Vt. Law School
- Michael Zahner – Vt. Chamber of Commerce
- Michelle Boomhower – Chittenden Co. Regional Planning Comm.
- Michelle McCutcheon-Schour – UVM Transportation Research Ctr.
- Mike Raker – Agricultural Energy Consultants
- Nils Behn – Aegis Wind
- Owen Bradley – Vt. Gas Systems
- Patricia Richards – Washington Electric Co-op
- Paul Cameron – Brattleboro Climate Protection
- Paul Costello – Vt. Council on Rural Development
- Paul Hutchins – Rock of Ages
- Paul Zabriskie – Central Vt. Community Action Council
- Peter Adamczyk – Vt. Energy Investment Corp.
- Peter Gregory – Two Rivers-Ottaqueechee Regional Planning Commission
- Peter van der Hoof – Casella Waste Systems
- Phillip Mosenthal – Optimal Energy
- Richard Faesy – Energy Futures Group
- Riley Allen– Regulatory Assistance Project
- Robert Chamberlin – RSG, Inc.
- Sam Swanson – Pace Energy & Climate Ctr.
- Sandra Levine – Conservation Law Foundation
- Sarah Carpenter – Vt. Housing Finance Authority
- Sarah Galbraith – Vt. Sustainable Jobs Fund
- Sarah Hoffmann - New England Conference of Public Utilities Commissioners
- Scott Harrington – Vt. Gas Systems
- Scudder Parker – Vt. Energy Investment Corp.
- Steven Letendre – Green Mountain College
- Stu Slote – Navigant Consulting
- Tim Maker – Community Biomass Systems
- Tom Buckley – Burlington Electric Department
- Tom Evslin – NG Advantage
- Wayne Nelson
- William Driscoll – Associated Industries of Vermont

Continue to the next page.

State and Federal Government

- Alex DePillis – Agency of Agriculture
- Beth Pearce – Vermont State Treasurer
- Billy Coster – Agency of Natural Resources
- Brian Woods – Dept. of Environmental Conservation
- Dale Azaria – Agency of Commerce and Community Development
- Dick Valentinetti – Dept. of Environmental Conservation
- Dylan Giambatista – Office of the Treasurer
- Elaine O'Grady – Dept. of Environmental Conservation
- Gina Campoli – Agency of Transportation
- Harmony Wilder – Dept. of Buildings and General Services
- Jacob Smith – Office of Senator Sanders
- Jeff Merrell – Dept. of Environmental Conservation
- Jon Kaplan – Agency of Transportation
- Ken Jones – Agency of Commerce and Community Development
- Margaret Cheney – Vermont Legislature
- Michael Snyder – Dept. of Forest Parks & Recreation
- Paul Frederick – Dept. of Forests Parks & Recreation
- Ron Shems – Vt. Natural Resources Board

Public Service Department Staff

- Christopher Recchia, Commissioner
- Darren Springer, Deputy Commissioner
- Asa Hopkins, Director of Energy Policy and Planning
- Kelly Launder, Assistant Director, Planning and Energy Resources Director
- TJ Poor
- Karin McNeill
- Edward Delhagen
- John Woodward