Mount Ascutney Regional Commission

REGIONAL PLAN

VOLUME 3: ENERGY

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Vermont Public Service Department

Vermont Energy Investment Corporation

Bennington County Regional Commission

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Executive Summary

❖ Background and State Energy Goals

Vermonters rely on energy to support their lifestyles. We are heavily reliant on fossil fuels for much of the energy that is currently consumed in both Vermont and southern Windsor County. Fossil fuels are problematic due to a number of factors, including their finite supply, highly variable costs, negative environmental impacts (e.g. extraction operations, fuel distribution, emissions, climate change), and need to be imported from outside of the region. In response, Vermont has established ambitious goals to conserve energy, increase the utilization of renewable energy, and reduce greenhouse gas emissions.

The intent of this plan is to serve as the energy element of the Mount Ascutney Regional Plan per 24 V.S.A. §4348a(a)(3) as well as to meet the requirements of an "Enhanced Energy Plan" in accordance with 24 V.S.A. §4352. The Mount Ascutney Regional Commission (MARC) intends to submit this Plan to the Commissioner of Public Service for a determination of energy compliance, which would enable this document to receive "substantial deference" in Section 248 proceedings. Accordingly, this Plan hereby embraces the following State energy goals:

> Expanding upon the statutory goal of 25% renewable by 2025 [10 V.S.A. § 580(a)], the ***2016 Vermont Comprehensive Energy Plan (CEP)*** establishes the following set of goals:
>
> 1. Reduce total energy consumption per capita by 15% by 2025, and by more than one third by 2050.
> 2. Meet 25% of the remaining energy need from renewable sources by 2025, 40% by 2035, and 90% by 2050.
> 3. Three end-use sector goals for 2025:
>   a. Transportation: 10% renewable;
>   b. Buildings: 30% renewable; and,
>   c. Electric power: 67% renewable.
>
> 10 V.S.A. § 578(a) calls for **reducing emissions of greenhouse gases** from the 1990 baseline by:
>
> 1. 50% by January 1, 2028;
> 2. 75% by January 1, 2050, If practicable using reasonable efforts.
>
> **25 by 25 State goal** [10 V.S.A. § 580]: By the year 2025, produce 25% of the energy consumed within the State through the use of renewable energy sources, particularly from Vermont's farms and forests.
>
> **Building efficiency goals** [10 V.S.A. §581]
>
> 1. To improve substantially the energy fitness of at least … 25% of the State's housing stock by 2020 (approximately 80,000 housing units).
> 2. To reduce annual fuel needs and fuel bills by an average of 25% in the housing units served.
> 3. To reduce total fossil fuel consumption across all buildings by an additional one-half percent each year, leading to a total reduction of … 10% annually by 2025.

4. To save Vermont families and businesses a total of $1.5 billion on their fuel bills over the lifetimes of the improvements and measures installed between 2008 and 2017.
5. To increase weatherization services to low-income Vermonters by expanding the number of units weatherized, or the scope of services provided, or both, as revenue becomes available in the Home Weatherization Assistance Fund.

❖ Regional Energy Profile

Current energy usage is discussed in Section III; some key points are summarized below:

- Transportation accounts for nearly half of the region's current energy costs, with electricity at 25% and heating at about 26%.
- As a rural area, we are heavily reliant upon the automobile for personal mobility. According to Estimates for the region, more than 283 million vehicle miles were traveled in 2015. Significant changes are needed in order to meet our targets. This will probably be the most difficult sector to address.
- Electricity consumption has been fairly level over the past few years. Looking to electric vehicles and heat pumps as strategies to meet the statewide energy goals will place additional demands on electricity, which will need to be off-set by reducing demand in other ways and increasing generation of electricity from renewable sources.
- Our building stock is old[1], indicating that weatherization may have a large impact on energy demand for heating. We are far behind meeting our statutory goal for weatherization of homes by 2020.
- Fossil fuels are currently used to heat about 75% of all homes in the region.
- Heating commercial and industrial buildings is estimated to cost about $8 million annually, or about $9,500 per business.

Targets are established for the region in Section IV. They illustrate the levels of change that will likely be needed in order to meet the stated energy goals. These goals are extremely ambitious. Therefore, the changes needed to meet them are also significant.

❖ Policies and Implementation Actions

In order to meet the above energy goals, the MARC has identified a number of implementation strategies. These strategies are detailed in Section V, and some are highlighted below:

We will encourage the **conservation and efficient use of energy** through various means that include, but are not limited to, the following:

- Support municipal energy planning initiatives and educational outreach efforts.
- Increase public awareness of energy efficiency programs made available through Efficiency Vermont, and provide staff support to assist Efficiency Vermont's education and outreach efforts.
- Encourage building techniques and technologies that reduce general energy demand or peak energy demand (e.g. day-lighting buildings or utilizing energy storage systems).

[1] 1972 is the median year homes were built in Windsor County

- Assist towns and partner organizations with education and outreach efforts to influence behavioral changes needed to meet these goals.

We will promote efforts to **reduce transportation energy demand**, **decrease single-vehicle occupant use**, and encourage **renewable or lower-emission energy sources for transportation** through various means that include, but are not limited to, the following:

- Increase awareness of existing services and programs such as public transportation services and the Go Vermont program.
- Assist towns with the maintenance and improvement of pedestrian and bicycling infrastructure in village centers, and with the connection of residential neighborhoods to common destinations, such as schools and job centers.
- Promote or encourage high-speed internet development/access in order to enable telecommuting.
- Encourage development of infrastructure necessary for the wider use of electric vehicles (i.e. EV charging stations).

The MARC has established policies to encourage **land use patterns and densities that are more likely to result in energy conservation**. These policies can be found primarily in the land use chapter of the *Mount Ascutney Regional Plan*. Policies in the transportation element of the *Regional Plan* also contribute toward this end.

This Plan establishes policies on the development and siting of renewable energy projects. In our baseline year (2015), this region had about 9.41 MW of renewable energy capacity – or 17,942 MWh of renewable energy generation – from known existing facilities (i.e. 276 solar arrays, 4 residential-scale wind turbines, and 6 hydropower facilities). In order to meet the stated energy goals, considerably more renewable energy generation is needed. This region's 2050 target for new renewable energy generation is 194,612 MWh (nearly 11 times the baseline renewable energy generation in 2015). The region encourages new renewable energy generation in the types and in the appropriate scales as discussed in Section V. In general, this Plan calls for a mix of roof-top solar, ground-mounted solar, residential-scale wind, and, where feasible, hydropower at existing dam sites. Commercial-scale wind (i.e. no greater than 50 meters at the height of the hub) may be acceptable if it meets the policies contained in Section IV. The MARC encourages the use of biomass primarily for heating. Smaller-scale biomass power generation facilities may be appropriate if they generate both heat and power, and meet the policies laid out in this Plan.

Megawatt (**MW**) is a unit of electrical power equal to one million watts. A MW is equal to 1,000 kilowatts (kW). This unit of measurement is used in this plan to represent the installed capacity of power generation facilities.

Megawatt hour (**MWh**) is a unit of measure of electric energy. A MWh is equal to 1,000 kilowatt-hours (kWh). A MWh is the amount of electricity generated by a one megawatt (MW) power generation facility producing electricity for one hour (i.e. generation output). On an electricity bill, electricity usage is commonly reported in kilowatt-hours.

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Section I: Introduction

A. Background of Regional Enhanced Energy Planning in Vermont

In 2016, two initiatives advanced energy planning in Vermont: Act 174 (2016) and a pilot program to develop regional enhanced energy plans.

The ***Department of Public Service*** provided funding for a pilot project to support the development of new energy plans by three of the state's regional planning commissions. The Department recognized that local and regional enhanced energy planning would help to advance Vermont's energy goals and facilitate implementation the **2016 Vermont Comprehensive Energy Plan**, The three pilot plans utilize statewide data, and serve as a model for similar plans in the remaining regions around the state, including southern Windsor County.

The ***Department of Public Service*** is funding the development of this plan. The ***Department of Public Service***, the ***Vermont Energy Investment Corporation (VEIC)***, the ***Energy Action Network***, and other organizations also provide staff and technical support for the regional planning process.

Act 174 (2016) enables municipalities and regional planning commissions to obtain "substantial deference" in the Section 248 permitting process for renewable energy generation facilities, but only if they have completed enhanced energy plans. On November 1, 2016, the Department of Public Service published standards that local and regional plans must meet in order to qualify as enhanced energy plans under Act 174.

Each of the regional plans has been developed using quantifiable energy conservation and renewable energy generation targets. VEIC developed these targets, in consultation with the regional planning commissions, using the **Long-Range Energy Alternatives Planning System or LEAP. LEAP is** a computerized system used for modeling future energy supply and demand. The model presupposed achieving the state goal to generate **90% of all energy used in Vermont from renewable sources by 2050**. The output of the energy model predicted total energy usage statewide and in each region projected over time (from 2015 through 2050), broken down by sector and fuel type. The regional planning commissions then worked with local communities to determine what those numbers meant in practical terms, and developed regional strategies guided by the resulting quantitative targets.

The regional planning commissions also worked with officials from several state agencies, nonprofit organizations, interest groups, and utility companies to define parameters used in the creation of renewable energy generation maps. The maps illustrate areas where renewable energy development is more feasible based on the presence of renewable energy resources and accounting for environmental and other locally identified constraints. The regional planning commissions reached out to local communities to identify general guidelines to consider when siting generation facilities.

B. ENERGY BASICS[2]

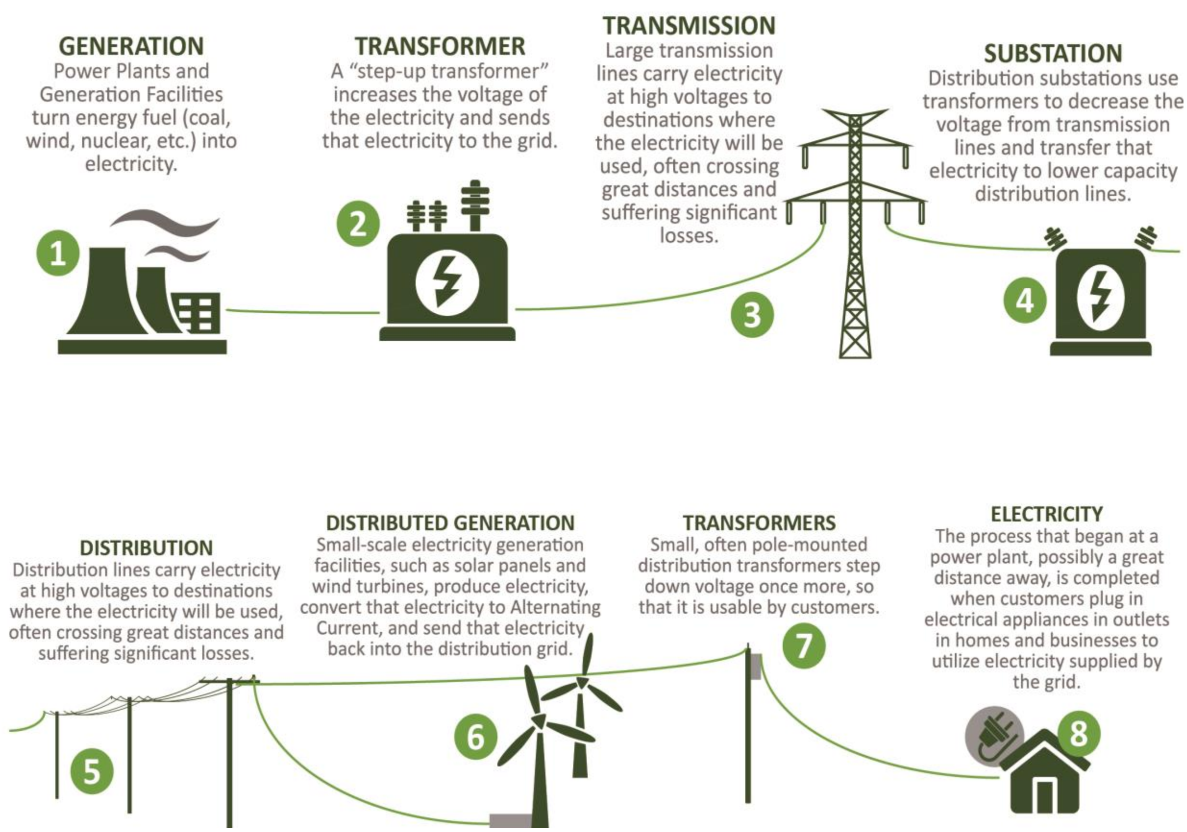
Scientists define energy as the ability to do work. Modern civilization is possible because people have learned how to change energy from one form to another and then use it to do work. People use energy to move cars along roads and boats through water, to cook food on stoves, to make ice in freezers, and to light and heat homes.

Energy comes in different forms: heat (thermal), light (radiant), motion (kinetic), electrical, chemical, nuclear, and gravitational. For the purpose of this plan, we are talking about energy that is used for heating buildings, transportation, and providing electricity.

Energy sources can be categorized as renewable or nonrenewable. Most of the energy consumed in the United States is from nonrenewable energy sources. Nonrenewable energy sources include petroleum products – such

Figure 1. Understanding the Grid

The diagram below outlines the major components in the electrical generation and distribution grid. (Source: Northwest Regional Energy Plan.)



[2] Based on information from the U.S. Energy Information Administration (U.S. EIA) https://www.eia.gov/energyexplained/

as oil, natural gas, and coal – and nuclear energy. Unlike fossil fuels, which are finite, renewable energy sources regenerate. Renewable energy sources include: solar energy from the sun, geothermal energy from heat inside the earth, wind energy, biomass, biofuels, and hydropower from flowing water.

In general, electricity is generated at power plants and moves through a complex system of electricity substations, transformers, and power lines – sometimes called "the grid" – that connect electricity producers and consumers. Figure 1 illustrates how "the grid" functions. Most "local" grids are interconnected for reliability and commercial purposes, forming larger, more dependable networks that enhance the coordination and planning of the electricity supply. In Vermont, VELCO operates the electric transmission system. In our region, Green Mountain Power and Ludlow Electric provide power within their respective service areas. Power is also generated at smaller, decentralized facilities, such as solar panels and wind turbines (i.e. "distributed generation").

C. Purpose of Plan

Vermonters rely on energy to support their lifestyles. We are heavily reliant on fossil fuels for much of the energy that is currently consumed in southern Windsor County. Fossil fuels are problematic due to a number of factors including, their finite supply, highly variable costs, negative environmental impacts (e.g. extraction operations, fuel distribution, emissions, climate change), and need to be imported from outside of the region. In response, Vermont has established ambitious energy goals to conserve energy, increase the utilization of renewable energy, and reduce greenhouse gas emissions.

The intent of this plan is to serve as the energy element of the Mount Ascutney Regional Plan per 24 V.S.A. §4348a(a)(3) as well as to meet the requirements of an "Enhanced Energy Plan" in accordance with 24 V.S.A. §4352. The Mount Ascutney Regional Commission (MARC) intends to submit this Plan to the Commissioner of Public Service for a determination of energy compliance, which would enable this document to receive "substantial deference" in Section 248 proceeding. Accordingly, this Plan hereby embraces the State Energy Goals as referenced in 24 V.S.A. §4302(7), 10 V.S.A. §578(a), 10 V.S.A. §580, 10 V.S.A. §581, and in the 2016 Vermont Comprehensive Energy Plan.

D. ENERGY GOALS

In the 2016 Vermont Comprehensive Energy Plan (CEP), the State of Vermont identified a number of goals and strategies to achieve energy conservation throughout the state. The most significant of these goals is referred to as **"90/50"**. (See Below.)

By 2050, 90% of Vermont's total energy will be derived from renewable sources.

This overarching goal has informed the regional conservation strategies and renewable generation requirements that are articulated throughout this plan.

State Statutes and the 2016 Vermont Comprehensive Energy Plan (CEP) contain energy planning goals that include but are not limited to:

- By 2025, 25% of remaining energy needs will be met by renewable sources, 40% by 2035, and 90% by 2050
- By 2025, total energy consumption per capita will be reduced by 15%, and by 2050 by more than one-third.

- By 2025 Renewable sources will meet the demand for 10% of transportation needs, 67% of electricity demand, and 30% of building energy demand.
- By 2032, 75% of electricity demand will be derived from renewable sources
- By 2050, 50% of electricity will be obtained from locally distributed energy generation.
- Major reductions in contributions to greenhouse gas emissions will be made.
- By 2020, 80,000 housing units will undergo weatherization in Vermont.

The MARC hereby adopts the goals established in statute and in the 2016 CEP for the region. The region will strive to achieve these goals through the detailed policies and actions identified in this plan. Below is a list of some of the methods outlined in this plan to further energy conservation and efficiency efforts within our region:

- Reduce total energy consumption throughout all sectors, including: electricity, space heating, and transportation.
- Support efforts at the local level to choose energy efficient and renewable options.
- Create a diverse mix of energy sources to reduce the impact of supply restriction.
- Utilize local, renewable sources of energy to decrease reliance on out-of-region, and out-of-state forms of fuel.
- Select energy choices that help preserve the environment.
- Strive for both an adequate supply of electricity, as well as a distribution network to meet the region’s needs.
- Maximize energy efficiency by matching fuel type to end use.
- Support adaption and lifestyle changes that contribute to meeting the State’s goals for future energy use and generation.

E. Plan Organization

This Plan is intended to address the Guidance for Regional Enhanced Energy Planning Standards as developed by the Vermont Department of Public Service on March 2, 2017. This document is organized into the following sections:

- Section I is an introduction that presents background information and highlights key issues for the region.

- Section II documents the current energy use in the region, including in the transportation, heating, and electricity sectors.
- Section III lists the regional energy targets that were developed based upon the Vermont Energy Investment Corporation (VEIC)'s Long-Range Energy Alternatives Planning (LEAP) system. The purpose of the targets is only to provide a sense of the scale of change needed to meet the State energy goals.
- Section IV lists policies and implementation strategies (or "pathways") for the region to pursue in order to meet these energy goals. This section includes specific pathways including, but not limited to, energy conservation, transportation, land use, and the siting of renewable energy projects.

F. Key Issues

❖ Energy Security

The state of Vermont has come to rely heavily on energy sources that are primarily from out-of-state sources. For example, the majority of electricity supply for the state is provided by hydroelectric facilities in Quebec and Labrador. Although this electricity is being generated through a renewable source at low cost, continuing the dependency on out-of-state sources could leave the state and region vulnerable to uncertain supply and cost. In Vermont, all gasoline and diesel fuels are imported to support vehicular transportation. Moreover, fossil fuels, such as transportation fuels, have a finite supply, highly variable costs, and well-documented negative environmental impacts. The scarcity of non-renewables, as well as dependence on outside suppliers, will leave the state and the region at risk. Creating facilities to generate renewable energy throughout the state will counter long-term security issues by ensuring consistent supply and helping to manage costs.

To provide the state with better energy security, one of the state goals calls for 25% of the energy used within the state to be produced (from renewable sources) within the state by 2025 [10 V.S.A. §580(a)].

Technologies must be carefully selected to ensure that net energy yields are as high as possible. Electricity generation from wind and hydropower has high energy returns relative to other renewables, provided they are sited in areas where the resource is sufficiently concentrated and relatively close to end users. Solar energy for thermal applications can be effective, and photovoltaic generation is becoming more efficient and cost-competitive. Wood biomass has proven to be a high-yielding heat source, provided it is sustainably harvested and used near its source in order to limit transportation costs. Other "renewable" energy technologies are less promising; the energy required to grow, harvest, and process corn into ethanol, and then to transport it for use, often exceeds the energy content of the resulting fuel.

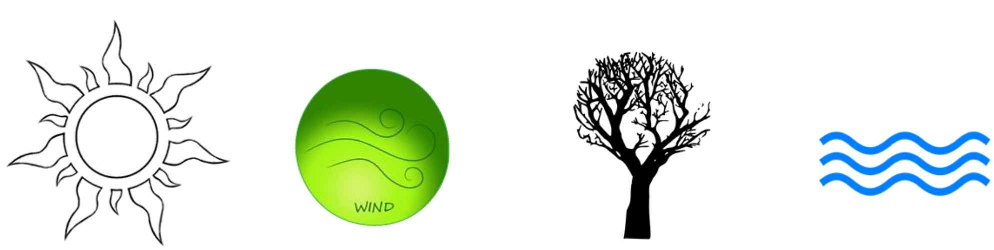


Figure 2: Utilizing energy sources that are renewable and locally-available (e.g. solar, wind, woody biomass, and hydropower) should be more commonplace.

Aggressive energy conservation efforts, electricity generation from properly sited in-state renewable sources, and heating from locally-sourced biomass offer the best long-term approach to ensuring the region's energy security. There is no question that some significant portion of Vermont's future energy supply will have to be imported, but increasing local generation will result in greater security, less risk, and improved efficiency.

❖ Environmental Protection

Over the last few centuries, the reliance on fossil fuels to support our way of life has had a blatant, damaging impact on the environment. For Vermont, climate change has the potential to threaten both our economy and quality of life. These harmful effects have become increasingly apparent due to impacts on forests, which threaten the maple syrup industry. Furthermore, a warmer climate and unpredictable weather will also impact the skiing industry. More frequent severe weather events are likely to result in damage to infrastructure and property, which will have additional financial impacts. The environmental damage alone calls for a change in energy use and the way in which it is obtained, but the threat to our safety and local economy provides even further justification for transitioning to renewable, less-impactful energy sources. See the state's Climate Change in Vermont website for more information.

Figure 3: Reduce greenhouse gas emissions from 1990 levels

40% reduction by 2030

80% to 95% reduction by 2050

(2016 VT Comprehensive Energy Plan)

❖ Economic Needs and Opportunities

In the Region, recent annual expenditures on energy for space heating, transportation, and electricity are estimated to be roughly $117 million, equivalent to about $4,600 per person. The state of Vermont spends over $3 billion on energy expenses annually. The burden of paying for the high cost of energy falls on the consumer. Furthermore, the majority of the money being spent on these forms of fuel, such as gasoline and diesel, are not only leaving both the region and state, but in many cases the country. If this money could be retained within the local economy, the financial gain would have an immense impact and help to improve quality of life for local residents.

The changes required to decrease overall energy use within the region may stimulate economic growth by encouraging businesses to innovate, creating jobs within the state and region. According to the Public Service's Department's *Clean Energy Industry Report for 2015*, there are now 2,500 "clean energy" businesses employing 16,000 people in the state. Transitioning to renewable energy sources has benefits for the state and region including, achieving greater energy security and environmental protection, retaining much of the money spent on energy locally, and creating new business and job opportunities.

❖ Adaptation and Lifestyle

Ultimately, achieving many of the state and regional energy goals will require people to change their behaviors and lifestyles. Reductions in daily energy use will require more than just efficiency improvements. People will have to alter their behavior patterns, using electricity, transportation, and heating systems with greater thought given to limiting energy use and increasing energy efficiency. Changing behavior is very difficult, but it is critical in order to reach the state's ambitious energy goals.

Section II: Regional Energy Supply and Consumption

The following section summarizes the existing conditions and analyzes recent trends related to energy supply and consumption in the region. All estimates and projections presented in this Plan are derived from 2015 base year data from a variety of federal, state and regional sources, unless indicated otherwise. These sources include, the U.S. Census Bureau, Vermont Energy Investment Corporation (VEIC), Vermont Center for Geographic Information (VCGI), Vermont Agency of Transportation (VTrans), Vermont Agency of Commerce and Community Development (ACCD), Vermont Department of Public Service, and others. Examining current energy consumption and sources provides a basis for projections of future renewable energy needs and potential savings from conservation, increased efficiency, and the use of alternative fuel sources.

Energy usage is broken down by the following sectors:

- Residential Space Heating and Home Weatherization
- Commercial/Industrial Space Heating
- Transportation
- Electricity

Figure 4 shows total energy use by sector in Vermont. Transportation is the largest component at nearly 40% of total energy use.

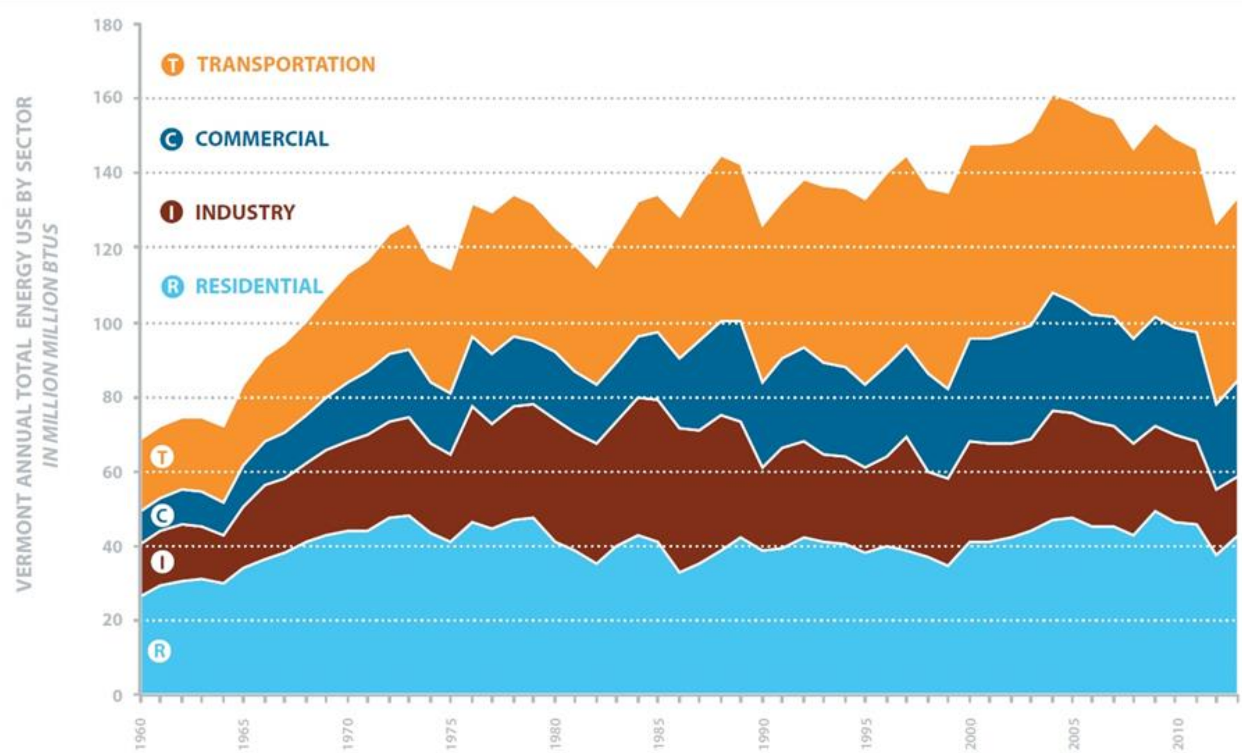


Figure 4: This graph shows the annual energy use by sector in Vermont between 1960 and the baseline year of 2015. (Source: Vermont Energy Investment Corporation)

Examining current energy consumption and sources will help identify inefficiencies and determine strategies for conservation and areas that can be accommodated with renewable sources of energy.

A. Heating

❖ Residential Heating

In the region, roughly $22 million is spent on residential heating annually. Of approximately 14,000 households in the region, about 11,000 are occupied year-round. According to the American Community Survey, the average annual heating cost is $2,100 per household[3]. Fuel oil is the most widely consumed residential heating fuel in the region for both owner and renter occupied households. For owner occupied households, wood, in the form of cord wood and wood pellets, is the second most commonly used fuel source in the region at about 22%. Conversely, propane gas is the second most common fuel source for renter occupied households in the region at about 25%. Renter occupied spaces also utilize electricity as a heating source, while very few owner-occupied homes do (*See Figure 7*[4]). An increasing number of households are using electricity as a heating source, likely due to programs that encourage the use of cold-climate heat pumps.

Figure 5: Renewable energy systems were more the exception than the rule in the region in 2015. However, there are a lot more systems being installed in the last few years, such as this solar hot water system (evacuated tubes) on a house in Weathersfield. (Julia Lloyd Wright)

[3] Calculated by the MARC based on the number of housing units, heating fuel types and average fuel costs for 2015.

[4] U.S. Census Bureau ACS (2011-2015); Fact Finder, table: B25117

When examining potential strategies for improving energy usage, it is important to understand how housing characteristics impact space heating usage. In the region about 30% of the housing stock are rental homes. It may be more challenging to incentivize energy efficiency investments in both lower-income owner occupied units as well as rental properties.

Geothermal heat pumps are now often encouraged for new developments by some local companies, but we do not have good data on how many of those systems currently exist. Wood is the only locally-sourced fuel type, and its use supports the local forestry economy.

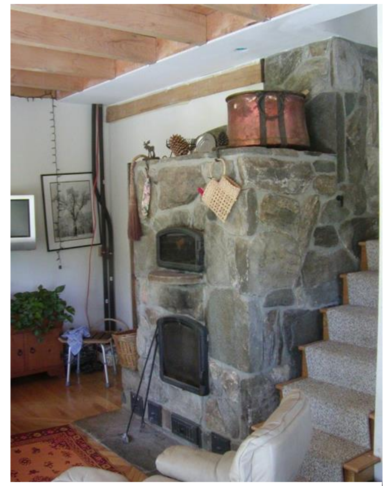


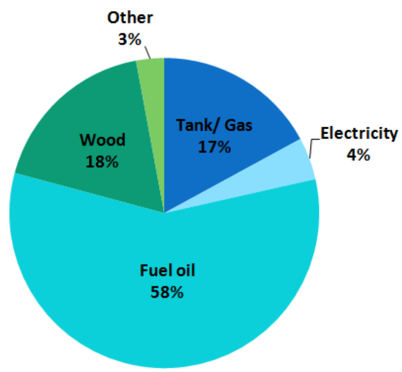
Figure 6: A masonry heater is a very efficient way to heat a home with wood. (Peter Hudkins)

Median house size in the northeast of the U.S. has increased by 61% since 1073. Median house size was 1,450 square feet in 1973, and increased to 2,336 square feet in 2010. While new construction is subject to energy building codes, building smaller new homes will also help to reduce energy demand for heating. In addition, smaller homes – such as tiny houses, cottages, bungalows, co-housing and/or accessory dwelling units – are gaining in popularity and provide needed housing options for our changing demographics.

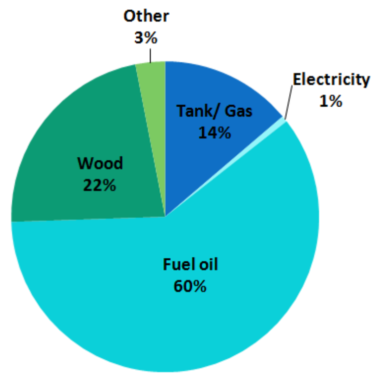
Figure 7. Home Heating Estimates

The following table shows current regional heating fuel use based on fuel and household type.

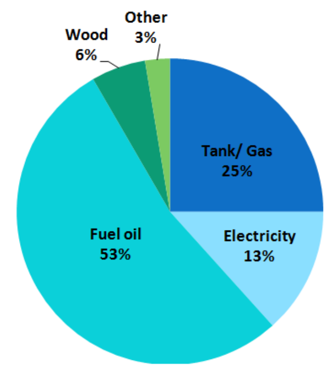
Home Heating Fuel Type	Number of Households	Average Annual Use	Annual Cost
Propane/Gas	1,813	1,810,365 gal	6,245,759
Electricity	469	9,097,715 KWh	1,338,274
Fuel Oil/Kerosene	6,129	4,374,861 gal	12,030,869
Wood	1,900	9,247 cord	2,066,010
Other	312	N/A	
Total	**10,623**		**21,680,912**



All Households in Southern Windsor



Owner Households in Southern Windsor



Renter Households in Southern Windsor

❖ Home Weatherization

Weatherization of homes is an important step in the efforts to decrease energy utilized for space heating and create better efficiency. Slightly more than half of the homes throughout the state, and the region, are more than 50 years old. Therefore, roughly half of the housing stock in the state and region is likely to be poorly insulated and not properly air-sealed. To remedy this issue, the state passed Act 92 (10 V.S.A. § 581) in 2008 that called for **20% of the state's housing units to be properly weatherized by 2017 (about 60,000 homes), and 25% by 2020 (about 80,000 homes)** statewide**.** According to the Comprehensive Energy Plan as of 2014, roughly 18,300 units had been weatherized, which is well shy of this goal[5].

There are several programs throughout the state to help private home owners and businesses properly weatherize their existing buildings. Programs offered by ***Efficiency Vermont*** and ***SEVCA*** have made improvements to about 900 housing units since 2009 in the Region. Additional programs, such as ***Vermont Weatherization Assistance Program,*** offer assistance to low income families, with a particular focus on elderly individuals or those with disabilities. Strategies that educate the public and make these programs more widely available will help in meeting weatherization goals for the state and the region. Local weatherization programs have had varying levels of success, but generally not anywhere near the scale needed to meet the goals set out in state statute.

Table 1: Weatherization of Housing Unit Goals

Region	# Units Since 2009	2017 Goal	2020 Goal
State of Vermont	20,909	60,000	80,000
Southern Windsor County	900	2,100	2,600

[5] 2016 Vermont Comprehensive Energy Plan

❖ Commercial and Industrial Heating

Determining the heating costs for commercial and industrial structures is more difficult than for residential structures due to the lack of data regarding the square footage of existing non-residential buildings. Calculating estimates for the size of the buildings were made[6], which allowed for estimates of energy use and costs associated with that use. In this region, commercial and industrial buildings utilize roughly 40% of space heating fuel. It must be taken into account that, within the region, there is a wide range in size and use of commercial and industrial space. There are about 900 businesses in the region inhabiting over 8,000 estimated square feet of space on average. Commercial and industrial heating-related costs are estimated to be as high as $8 million annually in the region, which is about $9,500 per business. Many of the larger industrial buildings, those of approximately 10,000 square feet and larger, are located in Springfield and Windsor. The MARC estimated that total energy use by the commercial and industrial sector exceeded 360 billion BTUs of fuel oil and gas[7].

Oil and propane are the primary heating fuels for commercial buildings throughout the region with wood used commonly as well. Industrial buildings also primarily utilize oil and propane, but wood sees wider use as a heating source in industrial than in commercial buildings. In addition, some industrial buildings heat with coal as well. As with residential structures, the age, size and location of these buildings will dictate what renewable fuel sources make the most sense to switch over to, as well as what energy conservation measures can be taken. In general, weatherization can reduce heating demand regardless of fuel source. As such, weatherization is encouraged as a priority investment to make before pursuing heating system upgrades.

[6] Based upon estimate of average commercial/manufacturing floor space per employee from the U.S. Energy Information Administration

[7] Based on the number of units, estimated floor space, heating fuel types and average fuel costs for 2015.

B. Transportation

The transportation sector dominates energy use more than any other sector in the state and region. This is due to the heavy reliance on automobiles for private transportation in this rural area. The 2014 *Housing and Transportation Affordability* study evaluated the majority of Windsor County, including all of the towns within the region. The study presupposed that a household's transportation budget was affordable if it did not exceed 15% of annual household income. The study found that the majority of the area in the study exceeded that 15% affordability target for a median household income ($41,000).[8] This study estimated household transportation costs for a certain income level and based on a variety of prevailing conditions (e.g. demographics, housing and work locations, commuting patterns, proximity to services, and other factors). As a rural area with many residents traveling to jobs and services in locations outside of the region, transportation costs tend to be higher. We observe that when people purchase homes, the focus is often to find as big and as nice of a home as the household can afford, which is usually located in a more rural area. However, the choice to live in rural areas, as opposed to within town centers, generally means a greater reliance on transportation for routine travel needs. This transportation usually takes the form of single occupant vehicle (SOV) travel.

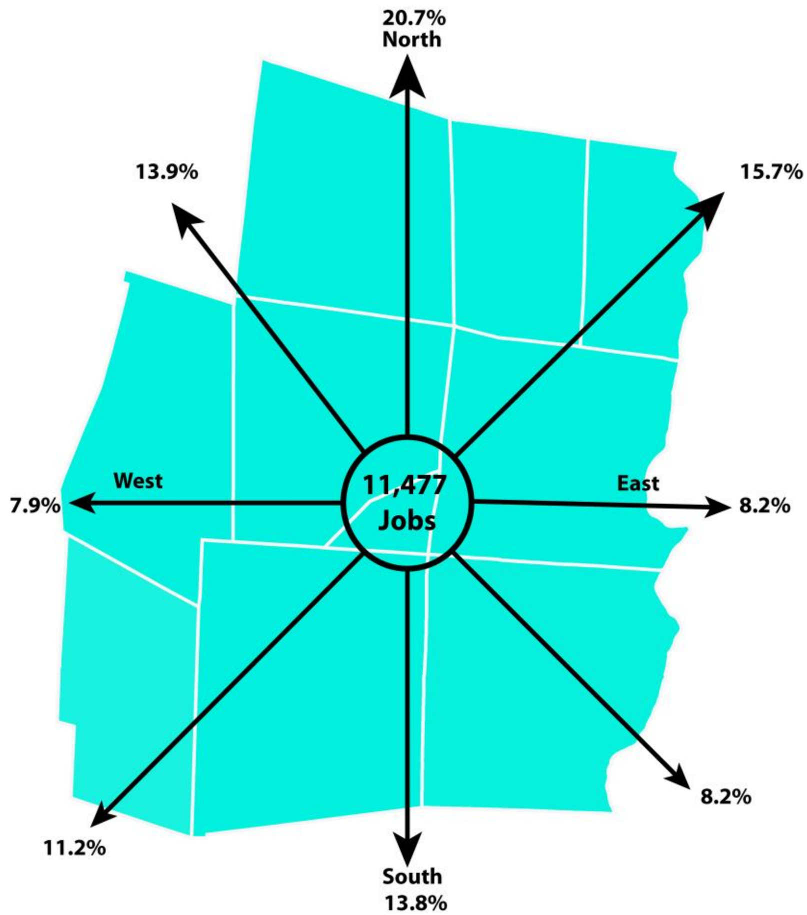


Figure 8: Commuting out of the Region. The graph above illustrates commuting patterns for residents in the region who are working outside of southern Windsor County.

Not surprisingly, petroleum-based fuels are the predominant fuel type used for transportation. Vermonters utilize roughly 306 million gallons of gasoline per year. Residents of the Region consume an estimated 17 million of those gallons to travel an estimated 283 million miles annually.[9] Moreover, heavy duty vehicles, such as trucks and buses, add an additional 2 million gallons of diesel fuel consumption per year within the Region. There are nearly 19,000 personal vehicles in the region, which residents generally rely on for meeting their travel needs. Workers living in this region have relatively long commuting distances. For example, a typical resident in Springfield commutes approximately 22.2 miles per day to reach

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[8] East Central Vermont Housing and Transportation Affordability

[9] https://www.afdc.energy.gov/states/vt

jobs in and around the region, largely in SOVs. All resident Springfield workers combined commute over 97,000 miles per day.

Table 2: Regional Transportation Estimates	
Total Number of Vehicles	18,790
Estimated Gallons of Fuel	16,803,287
Total Miles Traveled	283,300,512
Total Estimated Cost	$57,551,257

While Springfield is the traditional job center for the region, many Springfield jobs are filled by people that live elsewhere and many Springfield residents travel to work in other towns. This results in greater travel distances for work, which could be minimized if people chose to live and work locally. Our relatively rural and low-density development patterns in the region generally result in SOV travel, although the Upper Valley commuter bus has good ridership.

Transportation issues within the region harken to a much larger economic problem facing the region: limited job opportunities result in residents commuting outside of the region, typically to the Upper Valley where wages tend to be higher. Localization of jobs would enable walking or biking to work, and in some larger towns, such as Springfield, public transportation could be utilized better. However, this transition would require a greater mix of employment options within the region and/or significant behavior changes.

Since the region is predominantly rural, walking and biking could only become common practice in limited areas. Larger towns have sidewalk networks in the built-up areas. VTrans is generally in support of making state routes bicycle-friendly, but to do so can be expensive. As a result, bicycling facilities are not as robust as many residents would like them to be. A practical solution for reducing the region's use of non-renewables in the transportation sector would be carpooling, as many residents in the region are employed in the Upper Valley. *Go Vermont* is a program currently supported by the state that provides online ride matching services. Currently, the park and ride lots found along I-91 are heavily used. There are two public transportation providers in the region, Southeast Vermont Transit and Ludlow Municipal Transit. Travel to destinations such as Boston, New York, Burlington, and Montreal are served by Dartmouth Coach, Vermont Translines and Greyhound, which are found just outside the region in White River Junction and Lebanon, NH. The Windsor Amtrak station and a few nearby train stations serve the region to provide access by train to northern Vermont and New York City. Other options to reduce transportation fuel demand include telecommuting, plug-in hybrid vehicles, electric vehicles, and the use of biofuels. Future technologies may present other options.

Units of Measurement

1 Kilowatt (KW) = 1,000 watts of electrical power

1 Megawatt (MW) = 1,000 KW

1 Gigawatt (GW) = 1,000 MW

1 Kilowatt Hour (KWh) = power consumption of 1,000 watts for 1 hour

1 Megawatt Hour (MWh) = 1,000 KWh

1 Gigawatt Hour (GWh): = 1,000 MWh

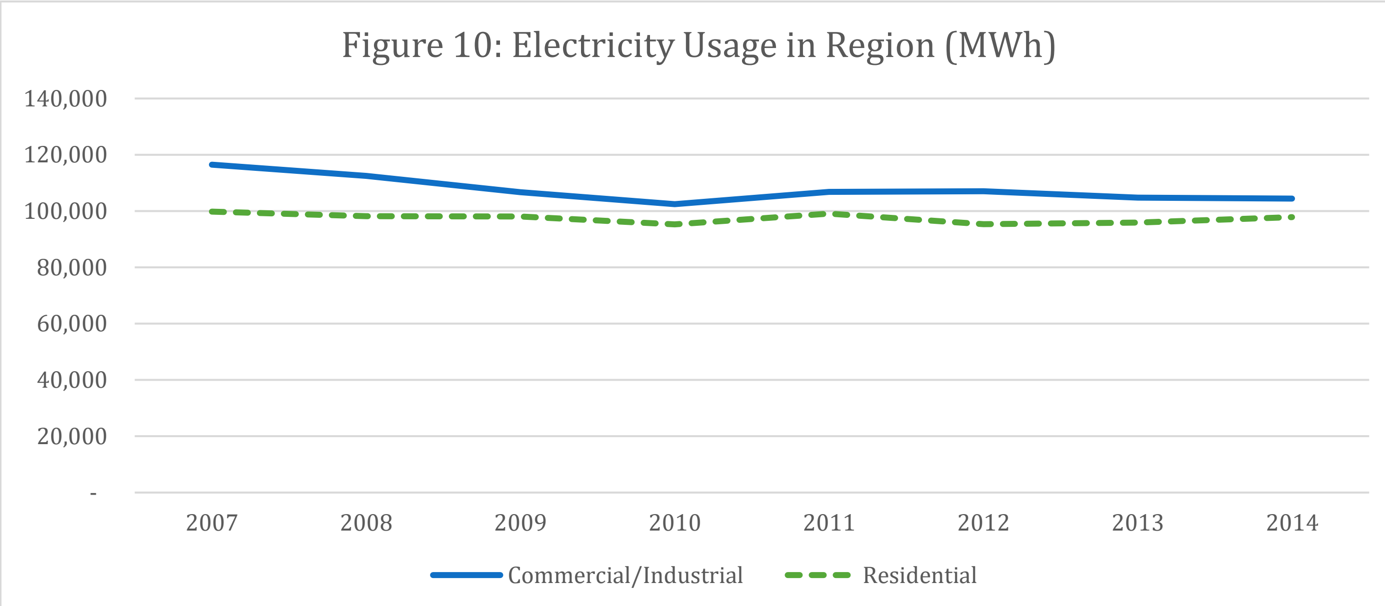
C. Electricity

According to the **Vermont Comprehensive Energy Plan (CEP)**, the state consumed roughly 5,500 GWh of electricity in 2014. This amount was down from 2007, when it was closer to 6,000 GWh, and had stayed relatively constant until 2014. This consistency over this eight-year period may be partly due to the growing popularity of energy efficient appliances and lighting. In 2014, the CEP indicated that the state generated 45% of its electricity from renewable sources. Further, the CEP projected that by 2017 this would increase to 55%, and, by 2032, to 75%.

Throughout Vermont's history, electricity use in the winter has been consistently higher than in the summer. However, on average, electricity consumption during both seasons has consistently risen since 1990 according to Vermont Electric Power Company (VELCO). Consumption of electricity is projected to rise over the next twenty years, as more heating/cooling needs in the region will be sourced with electricity, contrary to the flat trends in recent electricity use depicted in Figure 10. Changing climate conditions, and the trend toward hotter summers, may result in greater future electricity demand in the summer as residents rely more on air conditioning.

Figure 9. Map of Regional Zip Codes. Data organization regarding electricity consumption was based upon the zip codes outlined above.

As used in the LEAP model, electricity consumption was determined based on zip codes, not individual towns. The map in Figure 9 illustrates how the zip codes correlate to each town. Figure 10 shows electricity usage trends for the region as a whole. Electricity consumption in the residential sector has been relatively constant since 2007, and there was a slight decrease in the commercial/industrial sector in that time period. As one would expect,Springfield (05156), Ludlow (05149), and Windsor (05089) as regional hubs for commecial development, show the greatest electricty consumption in the commercial and industrial sector.



Efficiency Vermont has also made available electricity consumption data for 2014 through 2016 at the town-level. Below is a summary of the average residential electricity consumption in 2015 for each town:

- Baltimore 8,224 KWh
- West Windsor 7,315 KWh
- Weathersfield 7,211 KWh
- Springfield 6,921 KWh
- Windsor 6,731 KWh
- Chester 6,689 KWh
- Reading 6,565 KWh
- Andover 6,465 KWh
- Cavendish 6,255 KWh
- Ludlow 5,491 KWh

❖ Regional Generation

Ludlow Electric is the electricity provider for portions of Ludlow and Cavendish. Green Mountain Power (GMP), a public utility, provides electricity to the remainder of the region and beyond. GMP's power supply comes from several generation facilities throughout New England and Quebec, as well as from short-term system or open-market purchases and individual Purchase Power Agreements (PPA). Fuel sources for GMP generating facilities are primarily renewable, with hydro, nuclear, and wind comprising over 65%. [10]

[10] Northwest Regional Planning Commission, Regional Energy Plan, Adopted June 28, 2017

There are no significant non-renewable energy generation facilities in the region, with the exception of backup generators at substations. Electricity transmission service is provided by the Vermont Electric Power Company (VELCO). The existing transmission lines, three-phase power lines and substations are shown on the Utility Service Map. Consideration should be given to the condition of our electricity transmission system and its ability to support the state and regional goals for renewable energy targets. The MARC should engage with VELCO as it relates to this issue when updating Vermont's Long-Range Transmission Plan. Emerging technologies, such as battery storage, may help to address capacity issues with the grid.

Table 3: Renewable Energy Generation in Southern Windsor County

Renewable Source	# of Sites	Installed Capacity (MW)	Annual Generation (MWh)
Solar	276	6.6	8,087
Wind	4	0.02	65
Hydropower	6	2.8	9,790
TOTAL	**286**	**9.4**	**17,942**

At this time in this region, energy production from renewable sources is limited. The region currently has 6.6 MW of installed capacity of solar energy between both roof-mounted and ground-mounted sites, the majority of which are residential units.[11] Only a few residential-scale wind turbines have been installed to date. The total installed capacity of these turbines, located in Cavendish, Ludlow, and Springfield, is roughly 0.02 MW. Active hydropower sites include the Green Mountain Power hydroelectric facility in Cavendish and five smaller facilities in Springfield that are all located along the Black River. These hydro facilities have over 2.8 MW of installed capacity. In addition, the Wilder and Bellows Falls hydropower facilities are located outside of the region, but affect some areas within southern Windsor County that lie along the Connecticut River. Biomass is presently used exclusively for heat.

In order to meet the 90/50 goal outlined in Vermont's Comprehensive Energy Plan, major increases in renewable electricity production for both the state and the region will be needed.

[11] http://www.vtenergydashboard.org

Section III: Regional Energy Targets

Attaining state energy goals will require each region to set targets for energy use, conservation, and generation. This Section projects regional energy needs, and establishes future energy targets to meet state goals. The **Long-range Energy Alternatives Planning (LEAP)** software system, which was relied upon for estimating projections and determining the regional energy targets, is described below. The purpose of establishing energy targets is to provide guidance and a sense of the scale of change needed to meet the energy goals. Individual targets presented in this plan are not intended to be interpreted as actionable goals.

This section first looks at the methodology used for determining the state and regional energy targets under the 90/50 goal scenario, and dissects these targets by energy use sector and by fuel type over the projected period (2015 to 2050). The section closes with an analysis of the projected additional demand for electricity in the region derived from the projected use targets, and how this demand may be met through generation from renewable sources.

In general, it will be difficult to accomplish the significant levels of change and investment that will be needed to reach our energy goals. However, this is a working plan that represents one potential pathway to attain our 90/50 energy goal. As conditions change, this plan should be updated accordingly in the future.

A. LEAP Model & Methodology

LEAP System and Energy Targets

To generate the regional targets needed to meet overall state guidelines for energy conservation, RPCs throughout the state partnered with Vermont Energy Investment Corporation (VEIC). VEIC staff utilized the **Long-range Energy Alternative Planning (LEAP)** software system to produce an energy use model to project future energy usage for the region. The model is based on current energy usage and projections.

British Thermal Units

BTUs are the standard measurement throughout the plan to allow for easy conversion between different fuel sources.

Measurement	BTUs
1 gallon of gasoline	124,000
1 gallon of diesel	139,000
1 gallon of heating oil	139,000
1 gallon of propane	91,330
1 cord of wood	20,000,000

This complex model allows users to project energy consumption and demand for types of fuel with inputs that reflect current trends in usage and future energy needs in the region. Population growth, number of households, commercial building square footage, vehicle miles traveled, and fuel source assumptions are examples of the type of data input used to model and project consumption.

To determine regional targets, the **LEAP** model compared two scenarios – the ***"reference scenario"*** versus the *"**goal scenario**."* The ***reference scenario*** is essentially a "do-nothing" scenario which assumed a continuation of existing policies and energy usage in combination with an increase in vehicle fuel efficiency based on industry

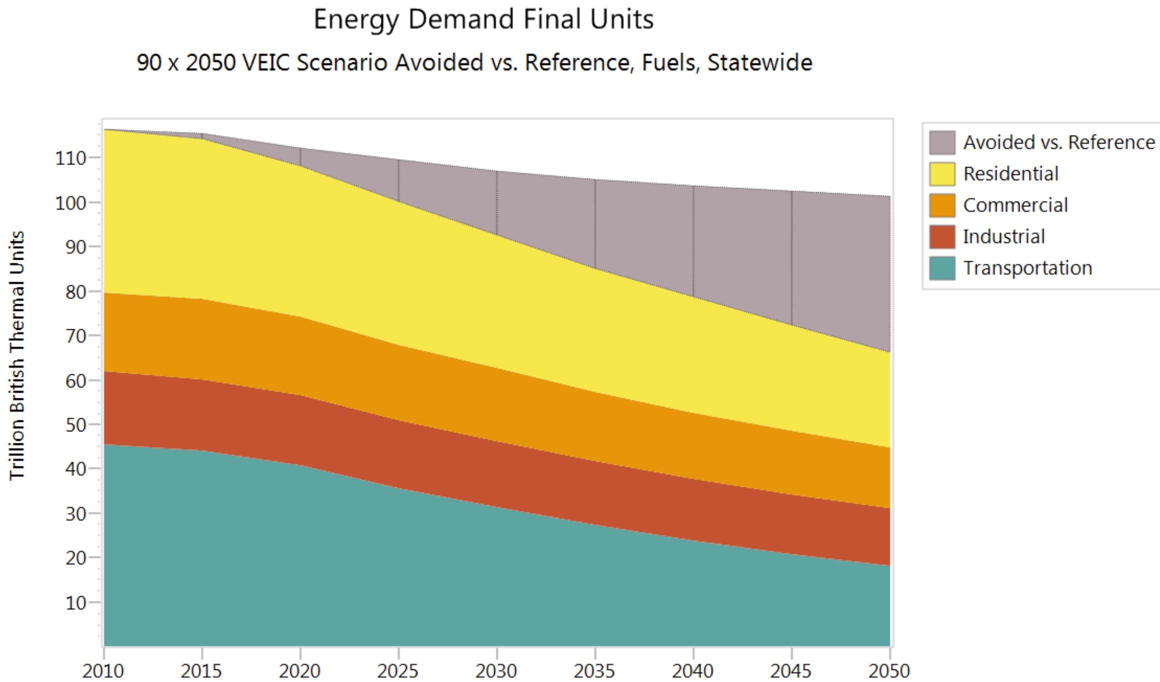


Figure 11: Projected statewide energy consumption by sectors comparing the reference scenario (gray portion) and the 90% by 2050 goal (Source: Vermont Energy Investment Corporation)

projections. The regional ***goal scenario*** was designed to represent a regional energy supply/demand projection that attains Vermont's goal of meeting 90% of energy demand with renewable sources by 2050.

Statewide Energy Targets

The statewide model for energy demand by sector under the goal scenario is shown in Figure 11. Implementation of the statewide energy plan versus a continuation of current policies is projected to reduce total statewide consumption by significant levels. This difference in energy demand between these two scenarios represents the amount of energy consumption that will need to be eliminated through conservation, efficiencies, and other means in order to meet the state and regional goals.

B. Regional Energy Targets by Sector

The Regional LEAP Goal Scenario estimates that a 50% reduction in total energy consumption will be required to meet our 90/50 goal. This dramatic decline by 2050 is despite projected future conditions (i.e. a very modest population increase per ACCD population projections), and relies primarily on the assumptions made for increased efficiency and conservation. As residential heating makes the switch to heat pumps (i.e. cold-climate heat pumps or ground-source heat pumps as defined in Appendix C) and transportation to electric vehicles and away from fossil fuels, these sectors will be powered by electricity that is generated with renewable sources. Due to the greater efficiency of electricity compared to fossil fuels, overall energy consumption is expected to decrease. This can be seen in Figure 12 below. As with the statewide scenario, most of this decline will come from the regional residential heating and transportation sectors.

Overall, the total amount of energy utilized in the region will decline by 50% by 2050.

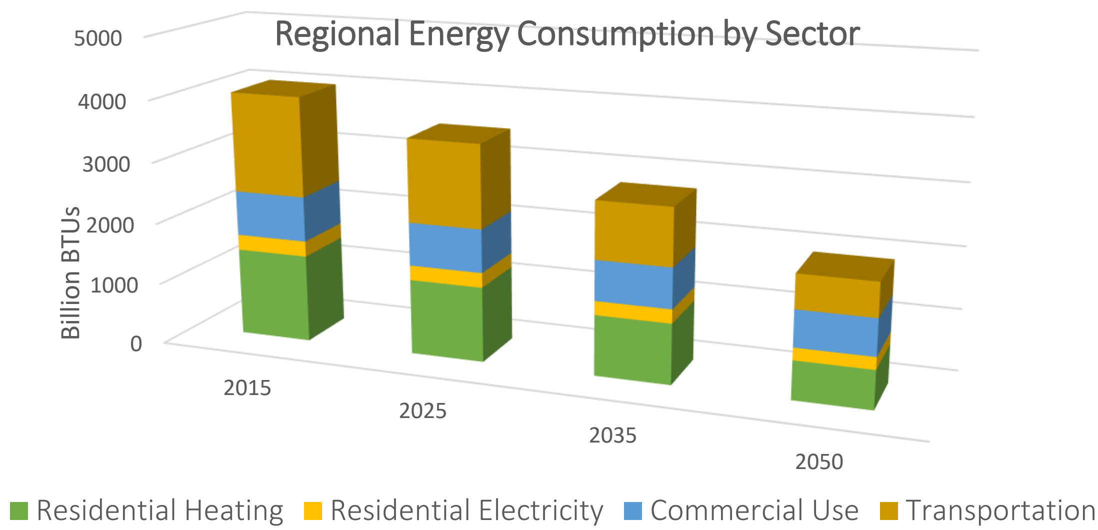


Figure 12: Southern Windsor County Regional Energy Targets by Sector (Source: LEAP Regional Model Goal Scenario)

The regional targets clearly show that a substantial increase in efficiency, conservation, and electrification of energy production and consumption will be needed across all sectors Residential heating and transportation in particular will be transformed, with the most dramatic change over the next 30 years. Transportation energy consumption will need to drop by over 65%, and Residential Heating by 56%, in order to meet the 90/50 goal by 2050. Note that these aspirational targets are primarily intended to show the scale and types of changes needed to achieve the energy goals. They represent only one potential pathway to 90/50.

C. Regional Energy Use by Fuel Type

In order to meet 90/50 energy targets, the changes required for the region generally mirror the changes necessary for the entire state. Figure 13 below illustrates the following changes in regional energy consumption by fuel type across all sectors:

- A dramatic reduction in total energy consumption by approximately 50%;
- A shift from nonrenewable to renewable direct energy sources; and,
- Growth in demand for electricity generated from renewable sources.

The direct consumption of energy from nonrenewable fuels such as diesel, gasoline and heating oil will fall from 69% of total energy consumption to 8% by 2050, according to the LEAP analysis. Direct energy consumption from renewable fuels, such as wood for heating, ethanol and biodiesel, will increase from 18% to 53% of total regional energy consumption over the same period. Electricity consumption, which currently makes up only 13% of regional energy demand, will make up the difference and increase to 39% of total energy consumption due to the increase in utilization of electricity for space heating and transportation. Currently, generation of electricity by renewable sources is minimal as a percent of total generation, but will become the primary fuel source by 2050 in order to meet state goals. The breakdown of electricity generation by fuel source and transition to renewable fuels is described in the section on target electricity generation.

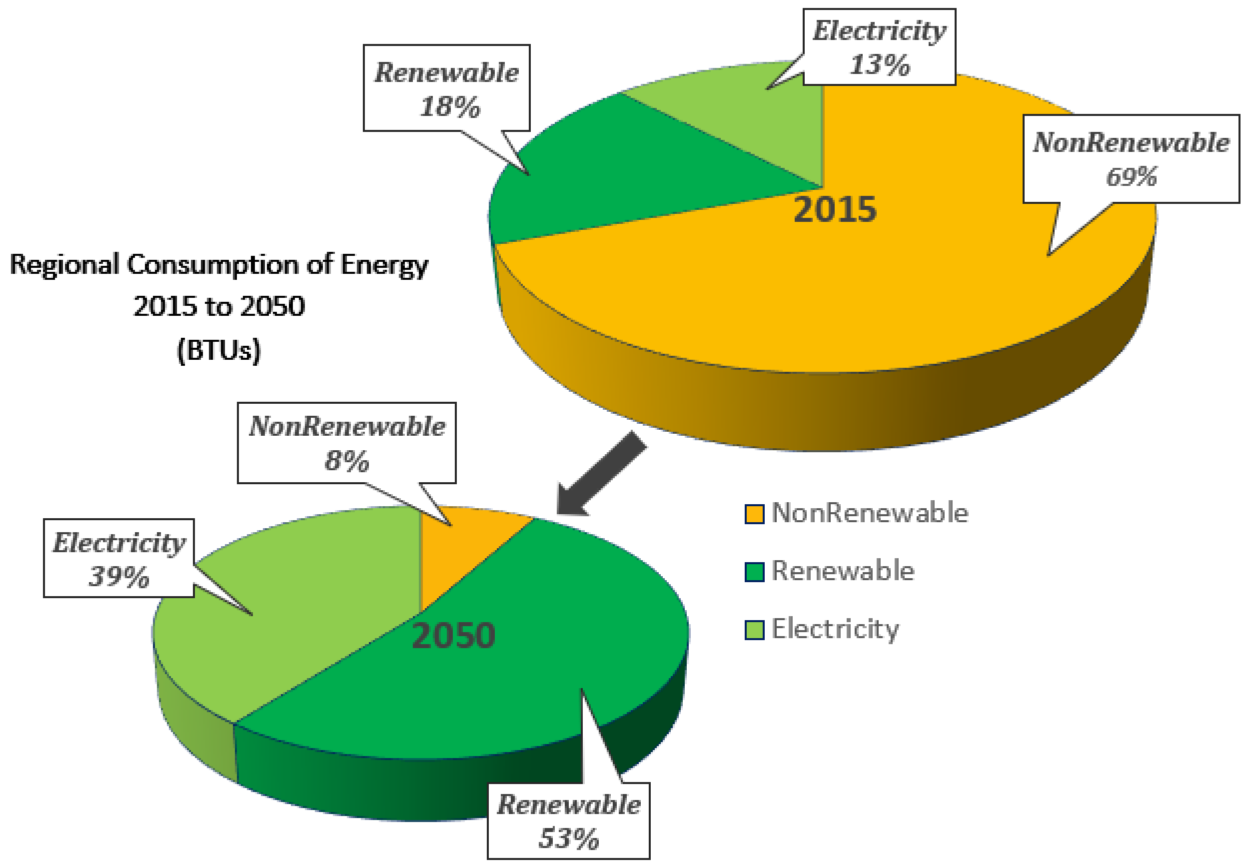


Figure 13: Regional targets for energy consumption across all sectors. Note how the size of the 2050 pie chart shrinks to about half the size of 2015, reflecting the overall reduction in energy demand needed to meet energy goals. Electricity will largely be generated from renewable sources by 2050. The other energy sectors are broken down by renewable and non-renewable, reflecting the significant shift away from non-renewables by 2050.

90% of regional energy demand will be generated with renewable sources by 2050.

Figure 14 below gives a closer look at the breakdown by fuel source. In order to meet the energy goals, transportation fuels that today are primary sources of fuel, such as gasoline and diesel, will need to be almost entirely eliminated by 2050. It is anticipated that, along with increased vehicle electrification, biodiesel will be utilized as an alternative to the fuels used now by the trucking fleet. More on these changes can be found in the transportation and space heating portions of this section. Although compressed natural gas is expected to be utilized by other regions throughout the state, the Region has no pipeline and it will therefore not be incorporated in this plan as a “bridge” fuel. Under this scenario, fuel oil for heating is replaced by heat pumps and wood, including cord and pellet. Due to the elimination of other fuel sources, wood increases as a proportion of total energy consumption, going from 15% in 2015 to 28% by 2050.

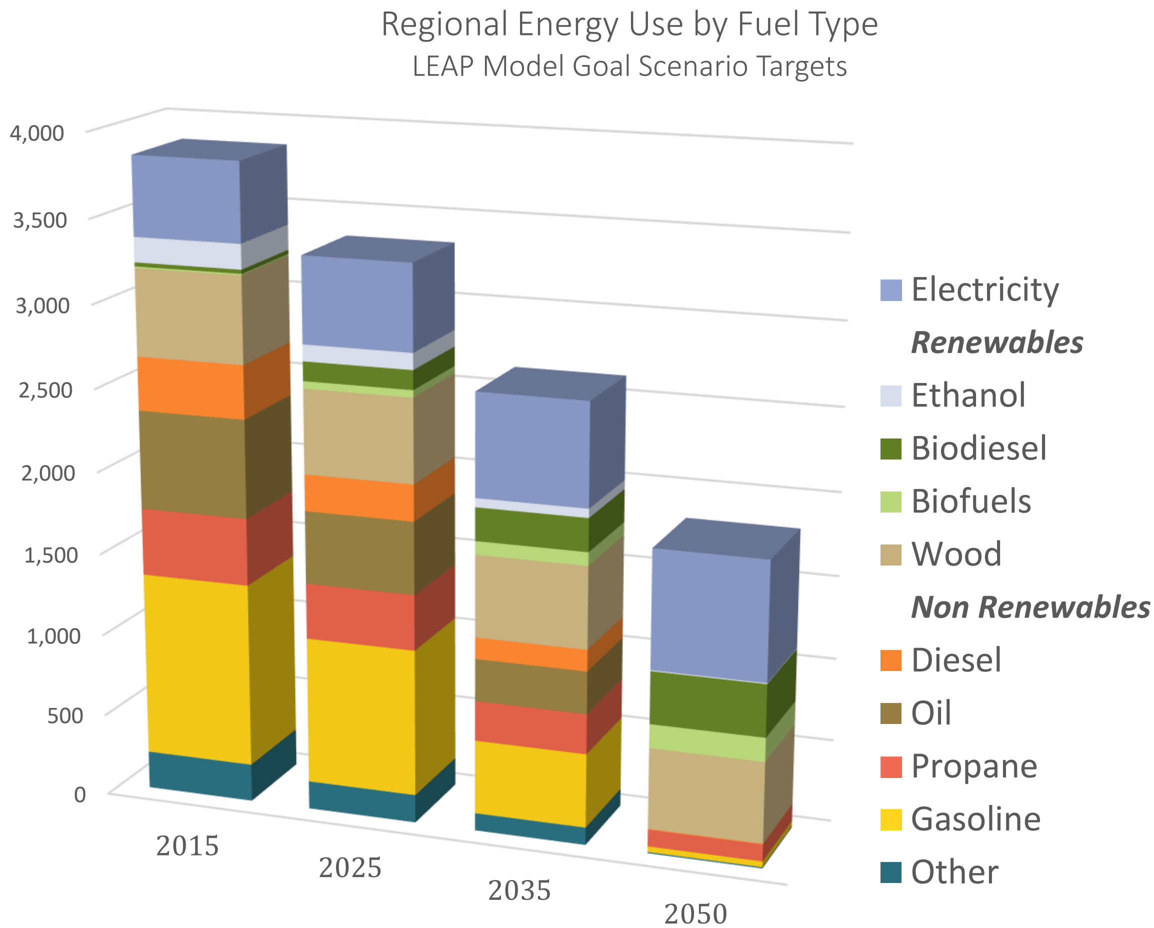


Figure 14: Southern Windsor County Regional Energy Targets by Fuel Type (in billion BTUs)

D. Residential Energy Targets

Regional residential energy targets encompass all energy consumption in the home. **To achieve the 90/50 goal, the amount of energy used in homes will need to be reduced by more than 50%, with a reduction in non-renewable sources from 60% to 6% as depicted in Figure 15 below.** Of the total residential energy demand in 2015, home heating accounted for 85% and the remainder for other uses including appliances and lighting**.**

Figure 15: Southern Windsor County Residential Energy Consumption Targets for Goal Scenario

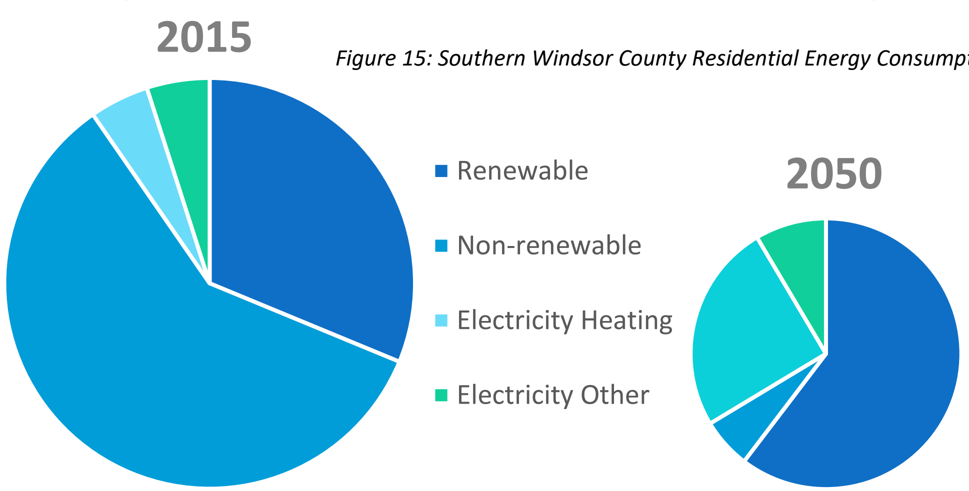


Table 4: Residential Thermal Fuel Targets by Percent of Total Systems			
System Type	**2025**	**2035**	**2050**
Wood Heating	34%	40%	55%
New Heat Pumps	3%	8%	18%

The transition to more efficient appliances and lighting, as well as proper weatherization of existing homes, will help to reach this reduction. It is anticipated that inefficient heating systems will be replaced, or at least supplemented by air source heat pumps, to further reduce dependence on non-renewable forms of heating. It has been projected that, by 2025, heat pumps will only account for 3% of residential heating energy demand. By 2050, however, it will have risen to 18%[12]. With the exception of a small amount of propane remaining for kitchen appliance use, by 2050 almost all fossil fuels will be eliminated as energy sources in the residential sector.[13]

Figure 16 breaks down residential energy consumption in the region by fuel type. Cord wood, fuel oil and propane are the three primary heating fuels, today comprising over 80% of total home energy use. Currently single family homes burn over 5.5 million gallons of oil per year, but by 2050 this will be reduced to a negligible amount. By 2050, fuel oil together with propane will all but disappear to be replaced by more efficient heat pumps. Wood as a heating source for homes will have increased from 30% to 50% of residential energy use. Although cord wood falls off, the use of more efficient wood pellets will increase.

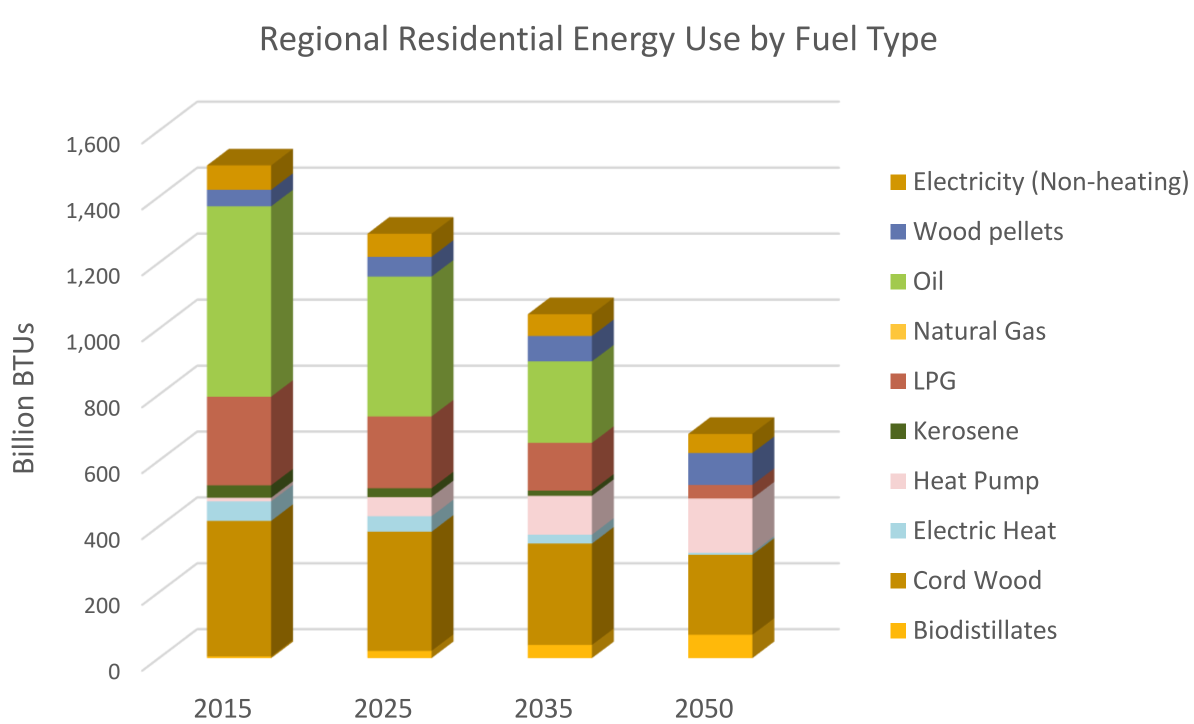


Figure 16: Southern Windsor County Residential Energy Consumption Targets by Fuel Type

[12] These targets are based upon the LEAP Model System for the Regional Goal Scenario.
[13] These targets are based upon the LEAP Model System for the Regional Goal Scenario.

The LEAP model assumes that weatherization and conservation improvements in the region will account for more than 30% of the overall drop in residential heating demand. The Regional Planning Commission has predicted that in order to achieve residential thermal efficiency throughout the region, **17% of homes will need to be weatherized by 2025, increasing to 31% by 2035, and 63% by 2050.** Strategies to achieve these goals can be found in the following section.

As mentioned in the previous section, multi-family housing units, and especially renter occupied households, predominantly utilize fuel oil and propane for heat at the present time. The LEAP model expects these, often large, complexes to shift to wood chips or pellets as a primary heating source in the future. These wood-burning systems are regarded as being more efficient and more cost-effective. Some buildings have already begun the transition. For example, the Old Windsor Village, in the town of Windsor, has insulated the building, upgraded the windows, and converted to a pellet heating system. Smaller rental properties are more likely to convert to air-sourced heat pumps (i.e. cold-climate heat pumps). Ground-sourced heat pumps (i.e. geothermal heat pumps) are best for new construction applications. It is anticipated that weatherization and efficiency improvements will be made in both renter- and owner-occupied spaces in order to increase heating efficiency and help decrease overall consumption.

E. Commercial & Industrial Energy Targets

The commercial and industrial sectors are not projected to have as dramatic a decline in energy consumption as the residential and transportation sectors**.** This sector is projected to reduce overall energy consumption by only 20% and will, therefore, represent a larger portion of total regional energy usage at over 30%. While electricity use is projected to remain relatively constant, use of wood and biofuel will increase as propane and fuel oil consumption falls. By 2050, commercial/industrial electricity consumption will represent roughly half of the sector's overall energy usage. Wood will follow at 25%.

The utilization of wood for heating is estimated to rise for both commercial and industrial space, due to increased use of biomass heating in larger buildings instead of oil and propane. **It is expected that by 2025, 33 new wood heating systems will be installed in facilities within the region. Then by 2035 a total of 73 new units are expected to be installed, and finally, by 2050, 149 new units will be installed.** Some larger facilities have already converted to wood chip or wood pellet heating systems, such as the Weathersfield School in Ascutney and the Springfield High School and Technical Center. In addition to new wood heat systems, new heat pumps will also be installed in some facilities. **By 2025, 14 heat pump units will be installed, followed by 30 units by 2035, and 62 units by 2050.** (See Table 5.)

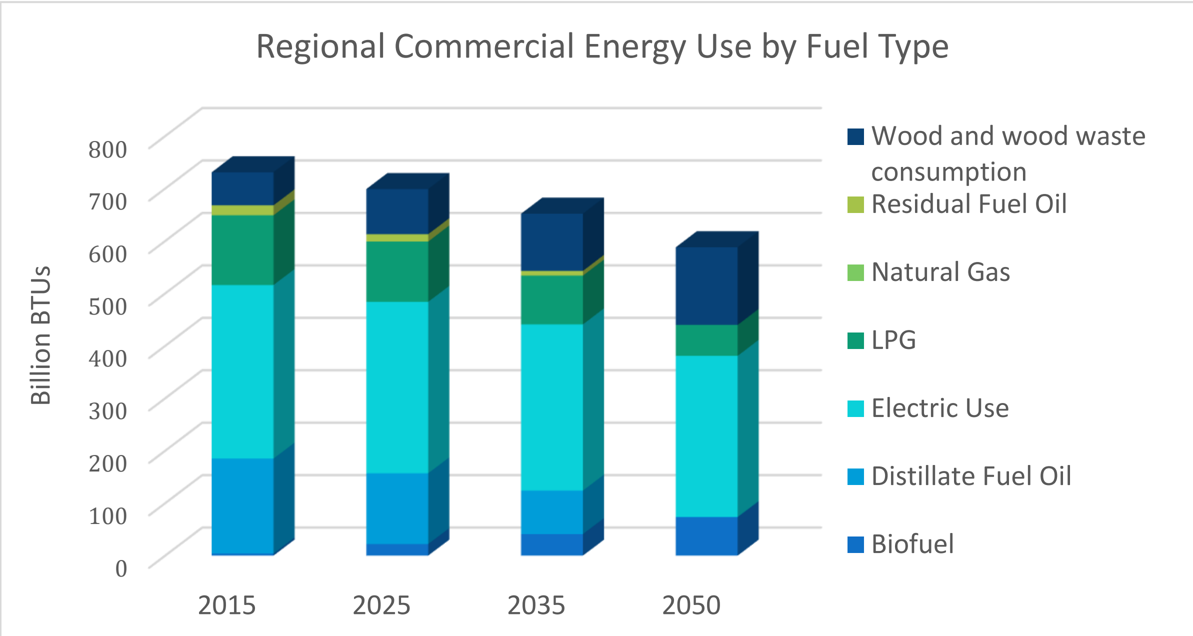


Figure 17: Southern Windsor County Commercial Energy Consumption Targets by Fuel Type

Within the commercial sector, the LEAP model assumes that oil-based fuels will be reduced dramatically over time, and completely eliminated by 2050. In the industrial sector, similar non-renewable fossil fuels, such as coal, will also be removed from the fuel source mix by 2050. Conversely, propane is anticipated to remain as a fuel source for both sectors, but at half the current usage in the commercial sector by 2050. In addition to converting heating fuel sources, it will be necessary to weatherize commercial and industrial buildings to conserve resources. **The model has estimated that by 2025 only 4% of commercial establishments are expected to be weatherized properly, followed by 7% by 2035, and then only 15% by 2050[14].** These targets seem low; exceeding these targets is preferable.

Table 5: Commercial Thermal Fuel Targets by Number of Systems			
System Type	**2025**	**2035**	**2050**
New Wood Heating	33	73	149
New Heat Pumps	14	30	62

Although transportation is a key cost component for regional commerce, due to the reliance on shipping materials both in and out of the region, the future energy demand for the transportation sector will be addressed in the section below.

Table 6: Weatherization Targets as a Percent of Total Establishments			
Sector	**2025**	**2035**	**2050**

[14] These targets are based upon the LEAP Model System for the Regional Goal Scenario.

Residential	17%	31%	63%
Commercial & Industrial	4%	7%	15%

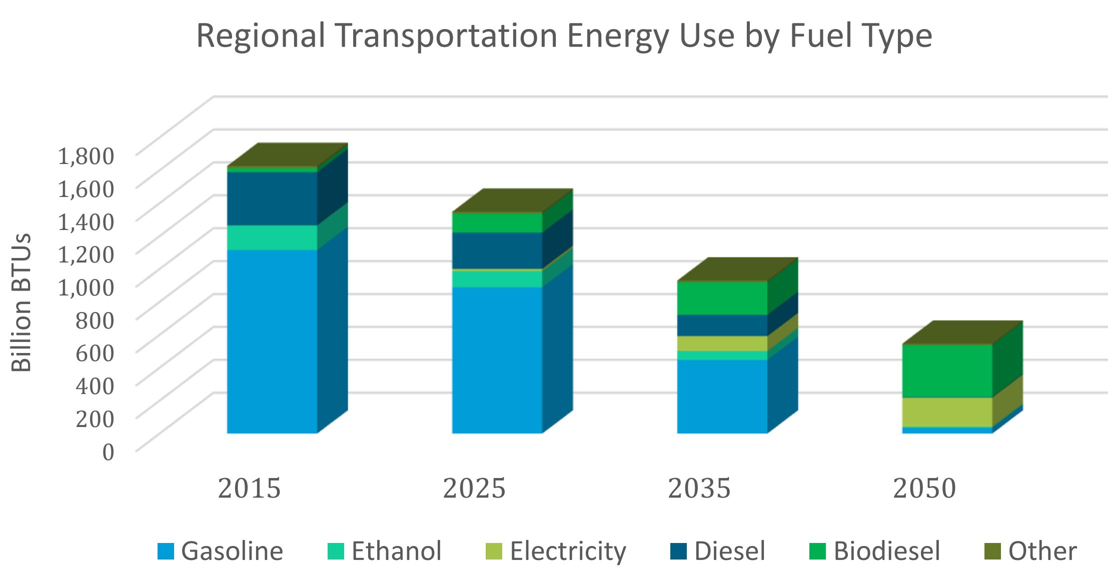
F. Transportation Energy Targets

The transportation sector currently accounts for 40% of the region's total energy use. **The LEAP model has projected that the transportation sector will require an overall reduction in energy demand of up to 65% to meet the 90/50 goal**. As shown in Figure 18, non-renewable fossil fuels, gasoline and diesel, are currently the predominant fuel types consumed in transportation at 88%. However, fossil fuel consumption will drop to 7% by 2050 with their replacement by biofuels and electricity.

Privately owned vehicles in the region use roughly 17 million gallons of gasoline to travel up to 300 million miles annually. Diesel fuel utilized for heavy duty vehicles, such as trucks and buses, add an additional 2 million gallons of fuel consumption per year. This reliance on non-renewable fuels will require a major transition in the trans[illegible]

Figure 18: Southern Windsor County Transportation Energy Consumption Targets by Fuel Type

neces[illegible] consumption will need to occur over the next 35 years, from the current 17 million gallons to only 350,000 gallons by 2050. Diesel fuel consumption will also need to experience a similar reduction to a negligible amount by 2050.



As the transition is made away from non-renewable fossil fuels, the transportation sector will need to employ alternative fuels sources, such as electricity. The LEAP model assumes that the widespread adoption of electric vehicles will represent one of the key means of achieving the energy goals. Electric cars will become more prevalent in Vermont as a viable option for private vehicles if extended-range and all-wheel-drive features become readily available and affordable features. Based on LEAP data, electric vehicle adoption will get off to a slow start. **By 2025, electric passenger car usage will meet only 1% of transportation energy demand, but will rise substantially over the next 25 years to 70% of demand by 2050.**

Charging stations are presently located in two sites in Springfield; one is in the parking lot next to the town office, and several plug-ins are located at the I-91 Exit 7 park and ride facility. In order to meet the projected increase in electric car use, there will need to be a significant increase in the number of available charging stations throughout the region.

It is expected that biodiesel will slowly replace diesel as the primary fuel source for heavy duty vehicles. The LEAP data estimates that the number of passenger vehicles using biodiesel will be 1% by 2025, and will only rise to 13% by 2050. For heavy duty vehicles, however, biodiesel will be the primary renewable fuel, reaching 32% by 2025, 58% by 2035, and 96% by 2050. However, biodiesel is not currently a widely utilized fuel, and engine warranties may not cover damages if biodiesel is used at certain fuel blend concentrations (e.g. above B20). Ethanol, which is used as a blend with gasoline, is often labeled as a renewable fuel. Yet, ethanol will see decreasing use over the next 35 years due to its complex and resource intensive production process.

To achieve the major reduction in total energy use for the transportation sector required to meet the 90/50 goal, the transition away from non-renewable sources alone will not be sufficient. A decline in ***vehicle miles traveled*** **(VMT)** will also be required. **The LEAP model has assumed that, despite a slight increase projected in population, the vehicle miles traveled should remain relatively constant over the next 35 years.** Changes in lifestyle and land-use patterns will contribute to reductions in VMT. These changes will be accomplished by consolidating growth and investment within village and town centers. VMT can also be reduced by shortening commute distances and increasing public transportation usage, telecommuting, bicycling, and carpooling.

The anticipated changes in the transportation sector needed to meet the 90/50 goal, specifically the transition away from fossil fuels, would lead to a decline in the number of traditional fueling stations. This transition would need to be managed to minimize the impacts on Vermont (e.g. automotive fueling businesses, transportation fund revenues, tourism industry).

Table 7: Transportation Fuel Targets by Percent of Total Vehicles			
Vehicle Type	**2025**	**2035**	**2050**
Electric	1%	14%	70%
Biodiesel	1%	4%	13%
Heavy Duty Biodiesel	32%	58%	96%

G. Electricity Generation Targets

State Electricity Generation Targets

As mentioned in Section II, the majority of the Vermont's electricity is provided by out-of-state sources, most notably Hydro Quebec, as well as limited in-state sources. This leaves the state of Vermont vulnerable. The closing of the Vermont Yankee nuclear power plant further limited the amount of electricity generated within the state. To compensate for this loss in electricity generation, some regions have utilized natural gas and wood biomass powered generators. Other renewable sources of energy will be able to further bridge this growing gap of electricity production. Nuclear has very high life-cycle costs for energy production, and there is no permanent long-term plan for waste storage. It seems unlikely that a new nuclear power plant will be permitted in Vermont. For the purposes of this

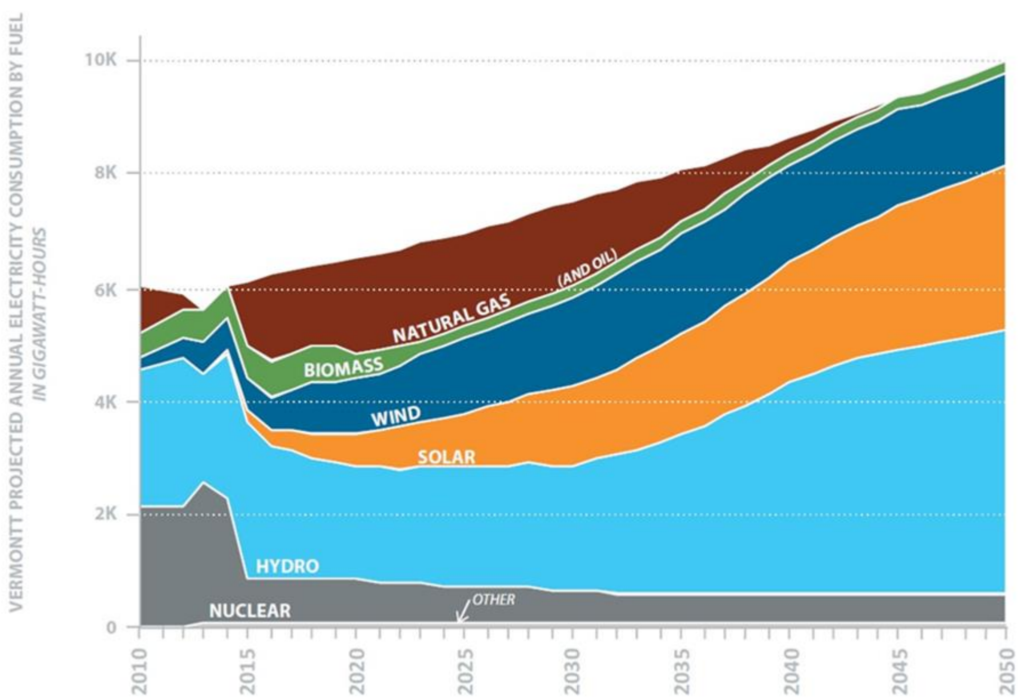


Figure 19: Projected Electricity Consumption Annually in Vermont (VEIC)

plan, we are assuming that no new non-renewable power plants (i.e. nuclear or fossil fuel-based power plants) will be constructed in this region.

Due to the dramatic increase in electricity consumption required for the state to achieve the 90/50 goal, it is estimated that 50% of Vermont's electricity will need to be produced in-state. Figure 19 shows that by 2050 total state annual electricity demand will increase from 6,000 GWh to 10,000 GWh. This increase is primarily due to the transition for heating and transportation away from fossil fuels to electricity. Anticipating the increased demand for electricity production, the LEAP model has predicted that hydro, solar, and, wind power will be the prevailing sources of electricity production throughout the state. Hydroelectric is estimated to provide half of the state's electricity production by 2050, however, the majority of this supply will be imported. Projections also indicate that nuclear power, along with natural gas, will decrease over time as sources of electricity. By 2050, there should be little to no fossil fuel-based -electricity production in the state. Figure 19 also shows that in-state solar and wind generation will provide 5KGwh or 50% of total electricity demand by 2050.

Regional Electricity Generation Targets

As noted earlier, the need for electricity within the region will double over the plan period, and will become a considerable portion of the region's overall energy usage by 2050. The increase in regional electricity consumption by sector is shown in Figure 20. The remainder of this section will discuss the projected regional electricity generation targets as modeled by LEAP and one scenario for providing that additional generation capacity.

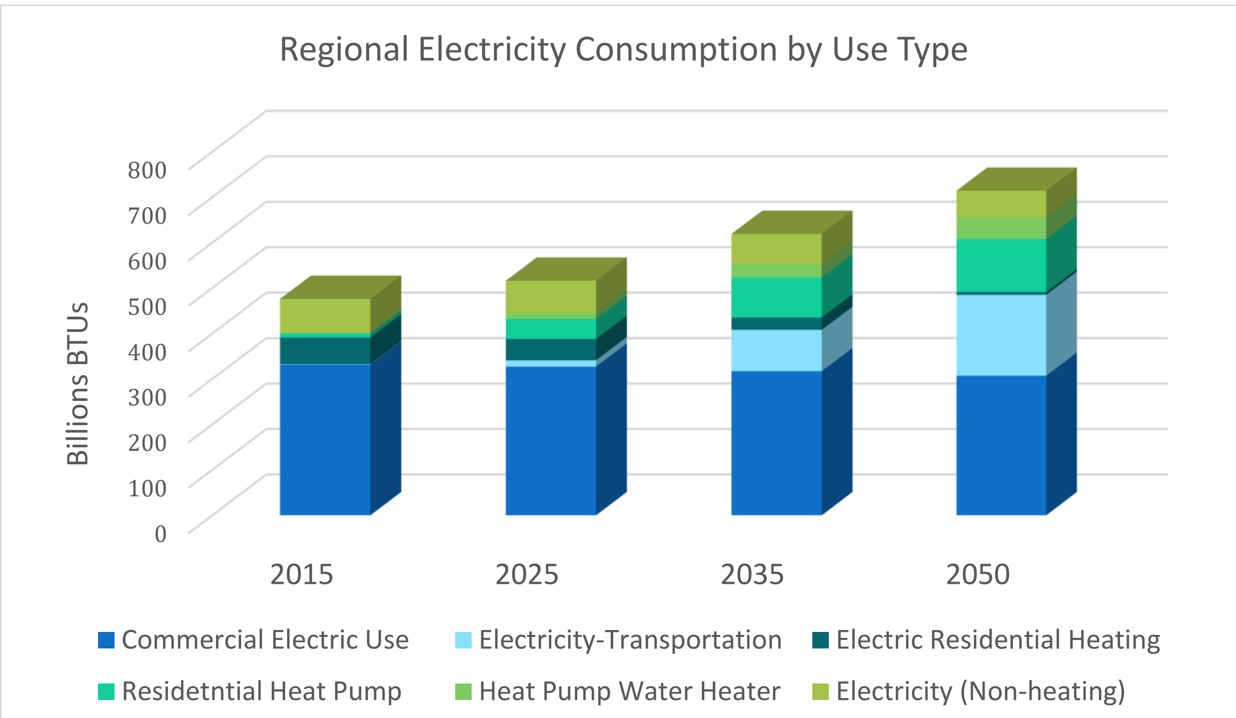


Figure 20: Southern Windsor County Electricity Consumption Targets by Use Type

The Department of Public Service and the regional planning commissions developed targets for regional generation. Targets were allocated to regions based on estimates generated by the LEAP model. Population and current and prospective generation potential were among the variables considered when determining the regional generation target. The intent of the targets is to achieve the overall state goals of generating 50% of statewide electricity demand in-state, and to have 90% of all energy come from renewable sources.

The resulting regional renewable generation target for the southern Windsor County region of 194,612 MWh was then broken down by town and is outlined in Table 8. The target MWh generation for each town in the region was determined by the regional planning commission. Each town's target is based on several factors, each as a percentage of the regional total: town population; the potential land area for ground-mounted solar generation, which is determined from resource mapping (See the maps in Appendix B); and each town's commercial/industrial electricity usage. For reference purposes only, the potential land area used for this exercise was based on solar potential within 1 mile of 3-phase power lines in each municipality.

Table 8: Renewable Energy Generation Targets By Town	Population	Percent Contribution	Target (MWh)
Andover	550	5%	10,261
Baltimore	292	2%	3,496
Cavendish	1504	7%	13,588
Chester	3110	12%	24,015
Ludlow	2140	11%	21,825
Reading	708	4%	8,298
Springfield	9258	32%	62,386
Weathersfield	2794	11%	21,811
West Windsor	1136	5%	9,884
Windsor	3496	10%	19,078
Total Regional Target	**24,988**	**100%**	**194,612**

H. Renewable Energy Generation Targets

❖ Statement of Policy on the Development and Siting of Renewable Energy Resources

The intent of this plan is to provide for the development of renewable energy resources per 24 V.S.A. §4302(c)(7) in order to achieve the goals established in the *2016 Vermont Comprehensive Energy Plan*. In order to meet 90% of Vermont's energy need from renewable sources by 2050 a significant amount of new renewable energy generation will be necessary, in addition to conservation efforts. Our target to meet the 90% by 2050 state goal is to develop 194,612 MWh of new renewable energy generation output. (This target is equivalent to installed capacity of 158.7 MW of ground-mounted solar.) The purpose of this sub-section is to articulate how we wish to achieve the Region's target.

❖ Renewable Generation Targets

As further described blow, developing a mix of renewable generation types is desirable in order to meet the overall renewable targets established in this plan. The targets presented in Table 9 represent one possible scenario for how southern Windsor County can meet the region's overall renewable generation target.

Table 9: Renewable Generation Targets (MWh)	2025	2035	2050
Rooftop Solar	6,630	10,605	23,861
Ground-Mounted Solar	41,235	82,661	158,876
Wind (residential-scale)	613	3,066	6,132
Hydro	175	974	5,743
Total New Renewable Generation Target	**48,653**	**97,306**	**194,612**

This particular scenario for regional renewable generation targets was determined based on resource mapping, assumptions on site cost feasibility, and regional preferences regarding industrial wind generation. (See the related discussion in Section IV). Resource mapping, which is described in more detail in the sub-section below, identifies site generation potential for both solar and wind. Site generation potential is determined based on known and potential land use constraints. The following assumptions were then applied to determine the region's renewable generation targets.

1. Maximize the potential that the region has for rooftop solar.
2. Maximize the potential for generating hydro power at 22 existing dam sites.
3. Determine contribution from residential-scale wind turbines. (Utility-scale and commercial-scale wind generation are not considered in this scenario.)
4. Determine ground-mounted solar generation from preferred sites and most cost efficient mapped areas.

As more fully explained in the Energy Resource Map sub-section below, these targets represent a very small percentage of the total potential for the region. In 2050, our ground-mounted solar target is only 2.4% of the region's solar potential. This 2050 ground-mounted solar target is equivalent to about 130 MW of installed capacity, which might require an estimated 1,040 acres of land to accommodate the solar arrays and related facilities. The wind target is only 0.02% of the total potential in southern Windsor County, representing the installation of about 200 residential-scale wind turbines, each approximately 30 meters high measured at the hub.

There are a few projects in development that are not incorporated in the existing conditions baseline for the region. These projects, discussed in more detail below, are either recently approved but not yet constructed and online, or petitions for a Certificate of Public Good are still pending. It is the MARC's assumption that once approved and online, these pending new facilities will contribute toward meeting the new renewable generation targets.

❖ Energy Resource Maps

This section describes how energy resource maps are generated and interpreted when analyzing the region's potential for solar and wind generation.

POTENTIAL AREAS

The wind and solar maps both include "potential areas," which depict the portions of the region that have the potential for renewable energy generation based upon computer models and GIS mapping data. These areas do not represent "preferred sites" nor do they indicate with exact precision where solar and wind projects are desired to be constructed. Rather, they delineate where the potential for generation exists, and aid in evaluating whether sufficient land area exists to meet our regional renewable generation targets. In fact, some sites located outside of the mapped potential areas may prove to be viable for renewable energy generation.

Potential areas reflect two types of constraints: "known constraints" and "possible constraints." Both are described below:

"Known Constraints" involve conditions which would likely make development not feasible. Known constraints include the following resources:

a) Vernal pools with a surrounding 50-foot buffer;
b) DEC river corridors;
c) FEMA floodways;
d) State significant natural communities and rare, threatened and endangered species;
e) National wilderness areas; and,
f) Class 1 and Class 2 wetlands.

"Possible Constraints" have potential for renewable energy generation, but have one or more of the constraints listed below. These constraints signal conditions that would likely require mitigation and which may render a site unsuitable after a site-specific study has been conducted. Currently adopted and in-force state, regional or local policies may prevent development in areas with Possible Constraints.

a) Agricultural soils (NRCS-mapped prime agricultural soils, soils of statewide importance or soils of local importance);
b) Act 250 agricultural soil mitigation areas;
c) FEMA special flood hazard areas (floodplain);
d) Protected lands (state fee lands and private conservation lands);
e) Deer wintering areas;
f) ANR conservation design highest priority forest blocks; and,
g) Hydric soils.

The accompanying maps show "prime" areas for both solar and wind resources. These prime areas represent potential areas that avoid both types of constraints (i.e. "known constraints" and "possible constraints").

The accompanying maps also show "secondary" areas for both solar and wind resources. These secondary areas do not have any "known constraints" based on available GIS data, but they have one or more "possible constraints" present.

See the Constraints Map for more detail.

PREFERRED SITES

The following sites indicate preferred locations for siting a generator of a specific size or type in this region:

a) Rooftops of existing buildings;
b) Remediated brownfield sites;
c) Disturbed portions of extraction sites (i.e. gravel pit, quarry);
d) Vacant lands within industrial parks; and,
e) Any preferred sites that are clearly and specifically identified in a municipal plan that has received an affirmative determination of energy compliance.

The MARC reached out to our towns as part of the process to develop this plan. Local planning commissions and energy committees found it very challenging to identify specific preferred sites on a map. No specific preferred sites were located on a map for this Regional Energy Plan. The MARC will work with developers and municipal boards to consider proposed preferred sites under PUC Rule 5.100 for any specific sites not clearly within the above categories.

UNSUITABLE AREAS

This category represents areas that are not suitable for renewable energy generation projects (i.e. “no go” areas). Unsuitable sites include the presence of one or more of the “known constraints” as described above. However, there may be other unsuitable areas that cannot be mapped at this time (i.e. archeological resources).

The MARC will provide technical assistance to our member towns to develop local enhanced energy planning maps, including but not limited to identifying local constraints and preferred sites.

Solar Resource Potential

The growth of solar power generation projects in this region has been significant between 2013 and 2017. According to data provided in support of this enhanced energy planning process as of May 2017, this region has 276 known solar project sites with a total capacity of nearly 6.6 MW. Common issues with ground-mounted solar projects include, but are not limited to, choosing a suitable site for the scale of the project, setbacks from roads and adjacent buildings, landscaping/screening, maintenance, and site decommissioning.

The Potential Solar Resources Map shows where prime and secondary ground-mounted solar potential sites are located in relation to transmission lines and three-phase power lines. The solar potential data is based upon a computer model that takes slope direction, slope steepness, and solar radiation values into consideration. Figure 21 depicts the proportional relationship between the total land area in the

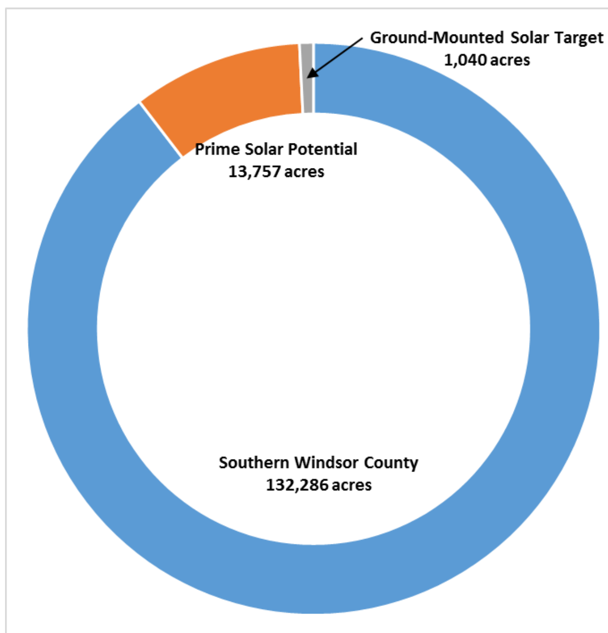


Figure 21: Proportional relationship between total land area in the region, land area of prime solar potential, and the estimated land area needed to address our renewable target via ground-mounted solar in Table 9.

region, prime solar potential land area, and estimated land area needed to meet the ground-mounted solar target.

Approximately 43,700 total acres of combined prime and secondary solar potential land areas were in the region. That is about 33% of the region's total land area. Reducing the solar potential area to include only those areas within 1 mile from 3-phase power lines resulted in a reduced solar potential land area of just over 18,000 acres, or nearly 14% of the land area of the region. There are nearly 6,175 acres of prime solar potential land within 1 mile of 3-phase power lines. If we were to meet our region's total renewable energy target through ground-mounted solar alone, we would need an estimated 1,270 acres, which is about 1% of the total land area in the region. These areas represent a combination of public and privately-owned lands.

Certain projects are perfectly sited, such as a 150 kW photovoltaic array constructed on town-owned land on a south-facing slope behind the Cavendish wastewater treatment facility. It is hidden from view from most vantage points. There are no neighbors, and travelers on the adjacent section of VT Route 131 would never know it is located there. (See Figure 23.)

In 2016, a petition was withdrawn for a 4.5 MW ground-mounted solar project proposed to be located on the prison lands in Windsor due to local opposition and concern for both the scale of the project and impacts upon scenic resources and wildlife habitat. The MARC did not take a formal position on the project.

In 2017, the Public Utility Commission issued a Certificate of Public Good (CPG) for a 20 MW solar power generation facility in Ludlow and Cavendish known as the Coolidge Solar Project [Docket #8685]. This project is not included in the existing conditions data presented in this plan due to the timing of the CPG. Despite the project's large size, the visual impacts are highly localized due to its location in a bowl-shaped area. The Coolidge Solar Project is in very close proximity to the existing Coolidge Substation.

Wind Resource Potential

According to available data (May 2017), there are four known wind turbine sites in this region, generating about 0.02 MW of installed capacity and nearly 65 MWh of output. There have not been any commercial- or utility-scale wind power proposals in this region to date. Notable local opposition has been observed for recent utility-scale wind turbine proposals in Grafton and Windham, located adjacent to this region.

The wind potential (i.e. utility-scale) is greatest in the western portion of the region. However, residential-scale wind generation may be possible throughout most of the region at lower elevations. The Wind Resources Map shows where prime and secondary wind potential sites are located in relation to transmission lines and three-phase power lines. The wind potential data is based upon a numerical weather model and a micro-scale wind flow model to produce a high-resolution (200m) wind resource map. The models are the product of a collaborative effort between the Massachusetts Technology Collaborative, the Connecticut Clean Energy Fund and the Renewable Energy Trust Northeast Utilities. It is intended as a preliminary assessment of wind potential areas.

Table 10: Summary of Generalized Wind Turbine Types			
Scale	**Hub Height**	**Lower Wind Speed Cutoff**	**Generalized Capacity**
Residential	30 meter	4.5 m/s	≤ 10 kW
Community/Commercial	50 meter	5.5 m/s	≤ 100 kW
Utility	70+ meter	6.5 m/s	≥ 1 MW

A significant portion of the potential wind areas are located further than one mile away from transmission and three-phase power lines, which makes them more expensive and less feasible to develop for wind power generation. Local concern has been expressed about potential wind project impacts including forest fragmentation, damage to wildlife habitat, degradation of scenic resources and ridgelines, and excessive noise[15]. These concerns are consistent with the Land Use policies and Goals established in the Regional Plan with respect to natural, cultural, and scenic resource preservation and the constraints placed on industrial development[16]. Input received while doing outreach in Andover and Ludlow, in particular, showed very little support for utility-scale wind projects, especially since a project often involves 10-15 turbines and the related clearing for access roads and interconnection. The siting of utility-scale wind is a divisive issue in this region and across Vermont as a whole.

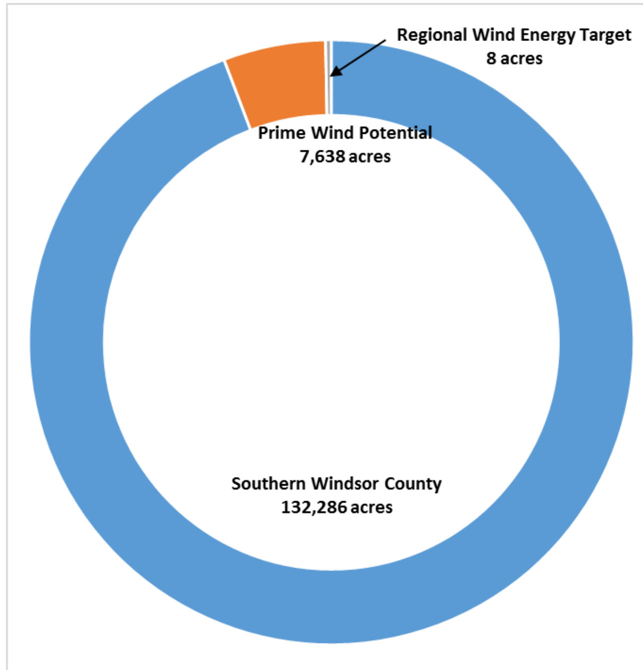


Figure 22: This graph illustrates the proportional relationship between the total land area in region, estimated wind potential land area, and the approximate land area needed to meet our wind target in Table 9.

The MARC remains committed to providing for wind generation as a component of meeting our regional renewable energy targets, but only through the construction of appropriately-scaled wind generation facilities. Through consultation with our towns, and based upon an analysis of generation potential and likely negative impacts, the MARC has concluded that utility-scale wind power does not conform to this plan.

If a municipality, through its local planning process, identifies a preferred location(s) for utility-scale wind facilities within their boundaries, the MARC may consider amending this plan to account for this local preference. Coordination and consensus among neighboring municipalities will be a critical component of any process to amend the regional plan in this regard. Additionally, the MARC shall only consider such an amendment if the location, or locations, identified by the municipality do not include “known constraints” and mitigate impacts to “possible constraints” as identified in this plan.

[15] Including both infrasound, low-frequency noise as well as the typical loudness and frequency noise impacts

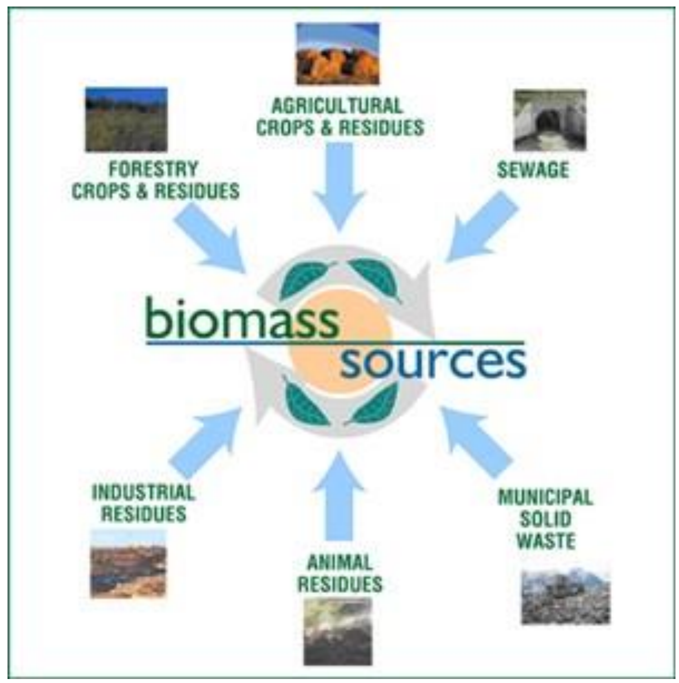
[16] Many wind potential areas coincide with both the Resource future land use category as well as notable sites identified in the Scenic Lands and Open Space Policies.

Hydroelectric Resource Potential

Six existing hydro facilities are located in the southern Windsor County region, totaling almost 2.8 MW of capacity (see Map 4). These existing hydro dams include the GMP facility in Cavendish and five dams in Springfield: Fellows, Gilman, Comtu Falls, Lovejoy and Slack Dam. A number of other existing dams in this region do not presently generate hydro-power.[17] The process to permit a hydro facility is complex and, as a result, we are assuming that new hydro facilities can only be established or re-established at existing dam sites. However, the cost and attendant permitting procedures may discourage the development of new hydro facilities. Our renewable energy generation scenario summarized in Table 9 represents generating power at the existing dam sites in the region, as depicted on Map 4. The generation potential for each dam site is based upon estimates provided by the Vermont Sustainable Jobs Fund.

The hydropower facilities along the Connecticut River are not located within this region. However, towns along the eastern boundary of the region are adjacent to the impoundment area of the Bellows Falls facility and, as a result, are affected by dam operations.

Biomass Resource Potential



Biomass is primarily to be used in the region for heating buildings. Approximately 80% of the land in the region is forested, representing a potentially significant renewable local energy resource. According to the 2010 analysis by the Biomass Energy Resource Center, Windsor County as a whole annually produces approximately 104,055 green tons of Net Available Low-grade Growth (NALG) wood. This represents the estimated amount of wood used for biomass fuel that can be sustainably harvested from Windsor County above and beyond current levels.[18] Around 1,900, or approximately 18%, of the region's homes currently use cord wood or wood pellet heating systems. By 2050, 55% of all homes should use Biomass as a heating fuel in order to meet the 90/50 goals. There are a number of wood chip or wood pellet heating plants in larger commercial and industrial buildings in this region currently, and it is anticipated that this use will increase with time.

Supplying sustainably harvested wood products for heating is also beneficial to the local economy. The MARC supports wood processing industries as long as they conform to the best practices outlined in the Regional Plan. The Regional Plan supports forestry management practices that further "regional goals concerning open space, wildlife habitat, air and water quality, scenic resources, access to recreation, and the tourism economy" and

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[17] Existing and Potential Hydro Sites from Vermont Sustainable Jobs Fund, 2010,

[18] Biomass Energy Resource Center, Vermont Wood Fuel Supply Study (2010 Update), 2010.

logging operations that "follow Vermont's Acceptable Management Practices, and help conserve valuable forest, air, water, wildlife, and recreation resources."[19] By adhering to these principles, this region has the potential to support an expanded, sustainable use of biomass resources that also benefits the local economy.

In 2014, a proposed 25-35 MW wood-fired biomass power generating facility in North Springfield was denied by the Public Utility Commission due, in part, to expected annual greenhouse gas emissions and the low level of thermal efficiency at which the project would operate [Docket No. 7833]. The impact of wood deliveries on the road network was a concern for some towns in the area and for the MARC. However, the merits of each proposed project should be duly considered.

[19] Pages 71-72.

Section IV: Energy Strategies

The following section provides policies and strategies to achieve the regional targets and goals outlined in the previous section. These strategies represent implementation pathways that are intended to meet the need for both energy conservation and generation in the region that will make progress towards our energy goals.

By 2050, 90% of Vermont's total energy will be derived from renewable sources.

The following are policies and strategies to be executed by the MARC as well as private citizens and businesses owners. Although residents of the region cannot be forced to change current energy patterns, steps to encourage conservation through education and incentives can be provided. The implementation strategies outlined below represent the initial framework designed to achieve the 90/50 goal, and are expected to evolve over time to better meet the needs of the region.

General Energy Conservation Strategies

Total regional energy use to decrease by 50%

1) Encourage towns to establish energy committees to serve as advisory committees in accordance with 24 V.S.A Chapter 117 §4433 and §4464.
2) Work with town energy committees and other organizations to provide outreach and education for businesses concerning energy conservation practices for new construction and retrofits.
3) Encourage towns to support their local energy committees (e.g. providing meeting spaces, conducting public outreach, releasing press releases, putting out calls for volunteers, coordinating with schools and services, and asking for input from the committees on all matters related to energy).
4) Support local efforts to identify businesses/facilities that are large energy consumers (manufacturing, industrial parks, and schools) and encourage their participation in Energy Efficiency Utility (i.e. Efficiency Vermont) programs.
5) Support municipal efforts to encourage the development of locally-controlled renewable energy projects.
6) Encourage statewide discussions with stakeholders (e.g. trucking industry, fuel dealers) about the transition from our current energy situation towards our ambitious energy goals for 2050.

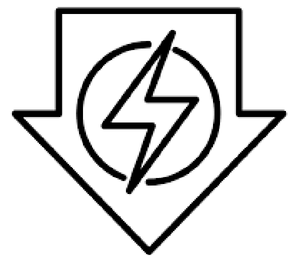
A. Electricity Conservation

Electricity Targets

- By 2050, electricity consumption will increase to 35% of overall energy use in the region.
- Increase in electricity consumption indicates 50% will need to be produced in state.

As outlined in the previous section, electricity consumption will become a greater contributor to the region's overall energy consumption over time. In order to realize the state goals as in the manner assumed by the LEAP model, additional electricity production will be required throughout the region. However, despite the increased need for electricity use, overall energy consumption must be reduced. The following strategies highlight necessary steps in conservation. Implementation steps to support increased electricity production are included below, in Section D.

1) Support programs, such as Efficiency Vermont, that promote the use of energy efficient equipment and devices.
2) Support and encourage manufacturers to provide energy efficient utilities and appliances.
3) Encourage expansion of energy storage systems within the region to reduce peak energy demand and provide backup power.
4) Promote building/design techniques that take advantage of day-light in order to minimize the need for daytime use of artificial lighting.
5) Influence behavioral changes to reduce electricity consumption at the individual level.
6) Support and encourage school participation in the Vermont Energy Education Program to foster an early appreciation for energy savings.



B. Transportation Conservation

Transportation Targets

- The transportation sector accounts for 40% of the region's energy use.
- By 2050, overall transportation energy consumption will need to be reduced by 65%
- Privately owned vehicles consume 17 million gallons of gasoline per year – this will need to be reduced to 350,000 gallons by 2050.

The region's transportation sector will require a 65% reduction in overall energy consumption, which is the largest reduction in usage for any sector. This massive reduction in energy use will require considerable changes in how transportation is utilized throughout the region. This will be best achieved through conservation, utilization of fuel efficient vehicles, and land use pattern changes. The following strategies highlight necessary steps to reduce transportation energy use.

1) Assist with efforts to increase awareness of existing public transportation services
2) Work with public transportation providers to evaluate and plan for future service modifications.

3) Promote the GO Vermont program, which provides ride share, vanpool, public transportation, and park and ride options.
4) Identify key areas where improvements to bicycle and pedestrian access would be beneficial (in downtowns and surrounding areas for example) and work to improve access and infrastructure in those areas.
5) Encourage upgrades to internet speeds throughout the region in order to enable telecommuting as a way to reduce the need to drive to work.
6) Prioritize projects that close gaps in the transportation network, for example by providing pedestrian or bicycle connections between residential neighborhoods, village centers, schools, and work destinations.
7) Promote a jobs/housing balance that allows more residents to live and work within the same community in order to decrease single-occupant vehicle travel, reduce greenhouse gas emissions, and conserve energy.
8) Goals and policies in the land use and transportation chapters of the Mount Ascutney Regional Plan serve as statements of policy on patterns and densities of land use likely to result in conservation of energy.

1) Electric Vehicles Promote the Drive Electric Vermont webpage, which informs drivers of financial incentives, dealers, and recharging stations for EVs.
2) Contact local vehicle dealers to encourage them to offer EV and fuel-efficient vehicles both for sale and lease.
3) Partner with Drive Electric Vermont, nonprofit organizations, vehicle dealers, and/or state agencies to organize high-visibility events where people can see and test drive EVs, such as county fairs, energy fairs, and summer festivals.
4) Partner with Drive Electric Vermont, the Vermont Clean Cities Coalition, and other organizations to promote the expansion of workplace charging, in particular by continuing to fund incentives that help employers cover the costs of installing charging stations.
5) Promote and seek grants to fund the installation of DC fast-charging infrastructure at strategic locations along major travel corridors and in transit hubs such as park-and-ride locations.
6) Expand the use of electric vehicles throughout the region by supporting education, availability, and infrastructure.
7) Promote the use of electric-assist bicycles.

C. Thermal Efficiency

Steps to reduce energy consumption for residential and commercial building heat will require a focus on weatherization measures and the installation of alternative heating systems. As previously stated, members of the community cannot be forced to weatherize their private homes or businesses. Therefore the strategies suggested below are intended to provide resources and education to further incentivize thermal efficiency.

Thermal Efficiency Targets

- Weatherization and conservation measures will help decrease residential heating demand by 30%
- Wood as a heat source will increase in both Commercial and Industrial sectors with the installation of biomass heating systems.

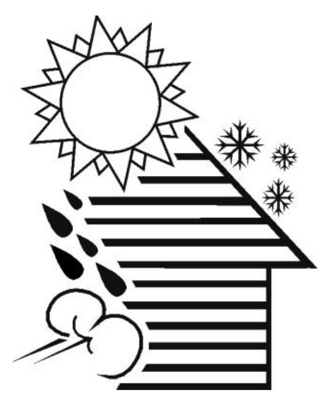
Residential Heating Efficiencies

1) Inform residents about Efficiency Excellence Network (EEN) contractors by providing links to EEN information through our website.
2) Promote the use of Vermont's residential building energy label/score.
3) Educate and promote State energy codes for residential structures (RBES).
4) Educate local zoning staff about their statutory role to promote the use of residential and commercial building energy standards by:
    a) Distributing State energy code information to all applicants seeking a zoning permit for a structure that is heated or cooled.
    b) Issuing a certificate of occupancy only after the applicant provides a certificate that ensures compliance with the State Energy code.
5) Encourage all residential Act 250 projects to follow the residential stretch energy code.
6) Promote and educate the public on energy codes for both residential and commercial buildings.
7) Encourage geothermal heat pumps for new construction.

Commercial Heating Efficiencies

1) Work with towns, partner organizations, and EEUs to offer workshops and educational opportunities for businesses on efficiency in new construction, retrofits, and conservation practices.
2) Identify large energy usage customers, such as large businesses, manufactures, and schools, as targets to encourage participation in commercial and industrial EEU programs.
3) Encourage all commercial Act 250 projects to follow commercial stretch energy guidelines.
4) Encourage new buildings to incorporate net-zero ready construction methods.
5) Educate and promote State energy codes for commercial structures (CBES).
6) Assist local planning commissions in considering incentives (e.g. density bonuses) for developments that exceed the state's stretch energy code to locate in and around village centers and downtowns.

Weatherization



1) Inform towns and residents about Energy Efficient Utility (EEU) programs and the state Weatherization Assistance Program for low-income households and encourage residents to participate.
2) Encourage reductions in energy wasted through heating by creating more efficient buildings through weatherization and use of high-performance building methods.
3) Support local weatherization initiatives.
4) Work with partners to improve upon the availability and accessibility of data about completed weatherization projects within the region.

D. Renewable Energy Generation

General Renewable Energy Generation Strategies

Total regional renewable generation of 194,612 MWh by 2050

The following tactics focus on implementing strategies for increasing renewable energy production, which will contribute to achieving the 90/50 goals for all previous sectors (Electricity, Transportation, and Thermal Efficiency).

1) Show support for renewable energy generation facilities that conform to our statements of policy on the development and siting of renewable energy resources.
2) Promote and/or structure policies and incentive programs to promote installation of solar projects where there is electricity demand and on locations where the land has already been impacted by previous development (e.g. roofs, parking lots, landfills).
3) Promote the utilization of passive solar design and siting principles to be incorporated into new buildings in order to reduce heating loads.
4) Support updates to municipal building standards and energy codes that promote incorporation of solar photovoltaics for new construction and major renovations.

Solar Generation

Figure 23: This is a photo of the Town-owned 150 kW solar project in Cavendish as described on page _. This is an example of a perfectly sited project. Because it is not visible from any major public roads and has no neighbors, no landscaping is warranted. (Credit: Peter LaBelle)

The following statements of policy apply to the development of solar energy generation projects in the Mount Ascutney region:

1) Encourage the exploration of newer technologies that improve energy production and/or reduce impacts as they become available.
2) Encourage infrastructure improvements that further our energy goals (e.g. larger container sized battery storage systems).
3) Support rooftop solar projects.
4) Encourage the location of solar projects on preferred sites, as identified in this Plan, as long as they are appropriately designed and scaled for the character of the area in which they are located.
5) Support residential-scale ground-mounted solar projects.
6) Ground-mounted solar projects of 150kW and greater must demonstrate that the proposed project siting is appropriate in scale as it relates to the character of the area in which it is to be located, and that all reasonable options have been considered in siting the facility.
7) The setback standards in 30 V.S.A. §248(s) apply to all applicable ground-mounted solar projects.
8) All ground-mounted solar projects of 150 kW or greater[20] that are within view of major roadways (i.e. interstate highways, state highways, US routes, and Class 1 and Class 2 town highways) must provide adequate landscaping in order to appropriately screen the project from the view of the traveling public.
    a) This landscaping must consist of a mix of native plants that provide adequate screening during all months of the year (i.e. conifers or a mix of deciduous and conifers).
    b) All landscaping materials will be planted at a size that provides adequate screening within 5 years of being planted.
9) The applicant must maintain any landscape plantings required for mitigation, including the replacement of any dead or diseased vegetation serving as part of the landscape mitigation measures, throughout the life of the project or until the project ceases commercial operation.
10) The applicant is expected to provide a plan for the site to be adequately decommissioned at the time when the project ceases commercial operation in accordance with PUC Rule 5.900.
11) Ground-mounted solar facilities must avoid “known constraints”.

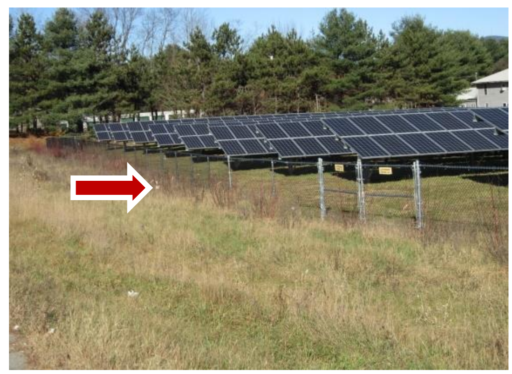


Figure 24: This project is an example of inadequate landscaping/screening. Note deciduous shrubs do not provide year-round screening, small plants will take many years to grow up to provide effective screening, and a lack of mowing the grass between the landscaping and roadway, which is to the left of the photo.

[20] This includes all applicable projects that are not exempt under PUC Rule 5.800.

12) Ground-mounted solar facilities must not have undue adverse impacts on "possible constraints". In addition, applicants shall demonstrate that the project will not have undue adverse impacts on significant wildlife habitat, wildlife travel corridors, stormwater, water quality, flood resiliency, important recreational facilities or uses, scenic resources identified in this plan, or inventoried historic or cultural resources. Project proposals must consider placement of such facilities in locations where impacts are minimal or employ reasonable measures to mitigate undue adverse impacts on the applicable resources.

Wind Generation

The following statements of policy apply to the development of wind energy generation projects in the region:

1) The MARC supports the installation of residential-scale wind turbines (i.e. not to exceed 30 meters in height, measured at the hub).
2) The MARC encourages consideration of newer technologies (e.g. vertical axis wind turbines).
3) Commercial-scale wind turbines (i.e. not to exceed 50 meters in hub height) must demonstrate that the proposed project siting is appropriate in scale as it relates to the character of the area in which it is to be located, and the applicant must also demonstrate that all reasonable options have been considered in siting the facility.
4) All wind turbines and related facilities (e.g. access roads, power line interconnections) must avoid "known constraints".
5) All wind turbines and related facilities must not have undue adverse impacts on "possible constraints". In addition, applicants shall demonstrate that the project will not have undue adverse impacts on public safety (e.g. ice shedding, ice throw), significant wildlife habitat, wildlife travel corridors, stormwater, water quality, flood resiliency, important recreational facilities or uses, scenic resources identified in this plan, or inventoried historic or cultural resources. Project proposals must consider placement of such facilities in locations where impacts are minimal or employ reasonable measures to mitigate undue adverse impacts on the applicable resources.

Figure 25: This photo is an example of a vertical axis wind turbine.

Hydroelectric Generation

This plan assumes that the construction of new dams is highly unlikely due in part to the negative impacts dams have on rivers and streams. Dams act as a barrier that interferes with natural river dynamics, resulting in negative consequences such as:

- Sediment build-up above the dam (up-stream), and erosion of the stream bed below the dam (down-stream);
- Lowered dissolved oxygen levels;
- Higher water temperatures;
- Impeded nutrient flow - nutrients are blocked from flowing downstream of the dam;
- Fragmented aquatic passage; and/or,
- Trapped pollution in the sediment build-up above the dam (up-stream).

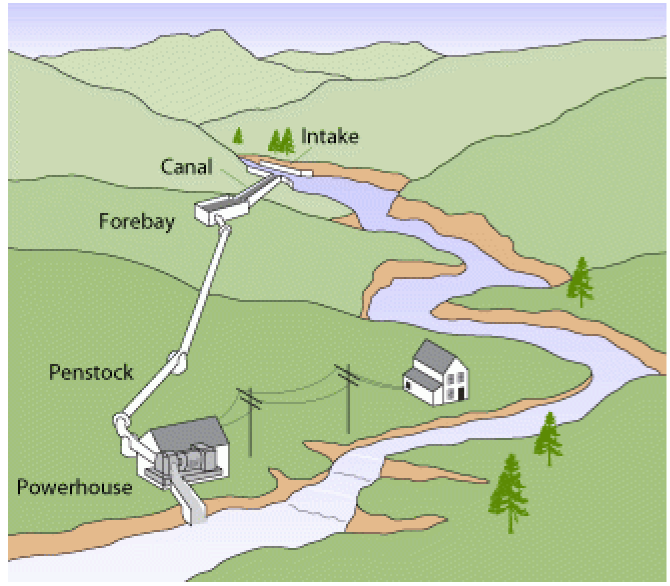


Figure 26: Illustration of a micro-hydropower system (U.S. Department of Energy)

Additionally, the recurring fluctuation of water levels as a result of hydropower operations can cause piping erosion. Common issues of concern include, but are not limited to, erosion, methylmercury, fish passage and recreation.

The following statements of policy apply to the development of hydropower projects that impact the Mount Ascutney Region:

1) Encourage exploration of micro-hydropower that has minimal impacts on environment.
2) Support efforts to discuss the possibility of exemptions to FERC or other permitting requirements for micro-hydropower projects.
3) The applicant must provide adequate levels of data and analysis in order to evaluate the impacts that the hydropower facility will have on river dynamics and flood resiliency.
4) When hydropower facilities are to be licensed or relicensed, best management practices must be considered to avoid or minimize undue adverse impacts. Such practices include but are not limited to: providing adequate fish passage, moderating ramping rates, maintaining daily operating logs to be sure that the water levels remain within license limits, and requiring an independent gage to be installed to verify dam operations.

5) A mitigation and enhancement fund shall be considered as one way to help address potential negative impacts of dam operations.

Biomass


Figure 27: Wood chip heating system at Weathersfield School.

While the primary intent of this energy plan is to support the use of biomass for heating, biomass power generating facilities that are modest in scale (possibly 10 MW or less) and that produce both heat and power may be desirable in certain locations (i.e. industrial parks).

The following statements of policy apply to the development of biomass projects that impact the region:

1) The MARC supports biomass for the purpose of heating buildings (e.g. wood stoves, masonry heaters, wood pellet stoves, wood chip boilers).
2) Wood processing industries shall meet all applicable goals and policies in the Land Use, Economic Development and Natural Resources sections of the *Regional Plan*.
3) Biomass power plants must demonstrate that the proposed project siting is appropriate in scale as it relates to the character of the area in which it is to be located, and the applicant must also demonstrate that all reasonable options have been considered in siting the facility.
4) Applicants for a biomass power plant must demonstrate that they have an adequate and sustainable wood supply for the proposed facility.
5) Biomass power plants must not have undue adverse impacts on air quality or the regional transportation system. If such a facility is proposed, transporting fuel via railroad is strongly encouraged.


Figure 28: Wood stove (Peter Hudkins)

Southern Windsor County has very limited potential for biogas at any commercial scale. There may be some opportunities; for example, capturing methane from anaerobic digesters to generate heat or power at wastewater facilities. The MARC, supports efforts to generate heat or power from biogas that is a bi-product from the ongoing uses at existing facilities, such as municipal wastewater facilities, composting facilities, or farms.

Presently, there are no food waste composting facilities in this area of the scale that would contribute toward energy generation. The Solid Waste Implementation Plan (SWIP) for the Southern Windsor/Windham Counties Solid Waste Management District does not call for any such facilities at this time.

Appendix A – Energy Data Summaries

The following section provides data for the ten individual towns in the MARC Region.

Appendix content is available to view at marcvt.org/2022-Regional-Plan/.

Appendix B – Regional Energy Maps

This section provides the following maps for the MARC region:

- Land Use
- Utility Service Areas
- Existing Solar Resources
- Hydropower Resources
- Wind Resources
- Woody Biomass Resources
- Geothermal Resources
- Constraints

Appendix content is available to view at marcvt.org/2022-Regional-Plan/.

Appendix C – Glossary

Appendix content is available to view at marcvt.org/2022-Regional-Plan/.

Appendix D – Acronyms

Appendix content is available to view at marcvt.org/2022-Regional-Plan/.