Mount Ascutney Regional Commission

REGIONAL PLAN

VOLUME 3: ENERGY

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Acknowledgements

The Mount Ascutney Regional Energy Plan was developed by the Mount Ascutney Regional Commission with support and assistance from the -Vermont Public Service Department.

Public input on the 2026 Regional Plan was sought through a series of presentations during the development of this draft plan. Thanks to the many town officials and members of the public who provided valuable feedback. We would like to extend a special thanks to town energy committee members for your valuable coordination and assistance.

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 for many reasons 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 use 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 ***2022 Vermont Comprehensive Energy Plan (CEP)*** establishes the following set of goals:

1. Meet 45% of energy needs from renewable sources by 2035, and 90% by 2050.
2. Three end-use sector goals:
   a. Transportation: 10% renewable by 2025; 45% by 2040
   b. Buildings: 30% renewable by 2025; 70% by 2042; and,
   c. Electric power: 100% from carbon-free resources by 2032, with at least 75% from renewable energy.

10 V.S.A. § 578(a) calls for **reducing emissions of greenhouse gases** from the 1990 baseline by:

1. 40% by January 1, 2030;
2. 80% by January 1, 2050.

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 120,000 housing units and reduce greenhouse gas emissions by 0.15 MMTCO2e by 2031.
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:

- Heating accounted for 47% of the region's energy use in 2022, followed by transportation at 33% and electricity at 20%.[1]
- As a rural area, we are heavily reliant upon the automobile for personal mobility. According to estimates for the region, more than 219 million vehicle miles were traveled in 2022. Vehicles powered by internal combustion engines (ICE vehicles) accounted for more than 98% of the miles traveled. Significant changes are needed to meet our targets. This will probably be the most difficult sector to address.
- Regional electricity consumption was fairly level for many years, as illustrated in Figure 10. Residential consumption began trending generally upwards in 2020, while commercial consumption began trending downwards. Electrical demand is anticipated to increase in the region with the adoption of electric vehicles and heat pumps. The electrification of heating and transportation will help meet the state and region's energy goals, but may increase our electricity generation demand.
- The region's building stock is old[21], indicating that weatherization can have a significant impact on energy demand for heating. We did not meet our 2020 home weatherization goal. To meet our 2030 goal, we need to increase the number of homes weatherized from 47 per year to 800 per year.
- Fossil fuels are currently used to heat about 76% of all homes in the region.

Targets are established for the region in Section IV. They illustrate the levels of change that will likely be needed 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

To meet the above energy goals, 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:

[1] LEAP Energy Data

[2] 1972 is the median year homes were built in Windsor County

- Supporting municipal energy planning initiatives and educational outreach efforts.
- Increasing public awareness of energy efficiency programs made available through Efficiency Vermont, and provide staff support to assist Efficiency Vermont's education and outreach efforts.
- Encouraging building techniques and technologies that reduce general energy demand or peak energy demand (e.g. day-lighting buildings or utilizing energy storage systems).
- Assisting 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-occupant vehicle 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 telecommuting by encouraging high-speed internet development/access, especially in Windsor and Weathersfield where access is lower than the state average.
- Encourage development of infrastructure necessary for the wider use of electric vehicles (i.e. EV charging stations).

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.

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.

This Plan establishes policies on the development and siting of renewable energy projects. In 2017, the MARC region had about 9.4 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) as shown in Table 3. In 2024, the most recent year for which data are available, the MARC region had 26.2 MW of renewable energy capacity, or 40,237 MWh of renewable energy generation, from existing facilities (i.e.782 solar arrays, 3 residential-scale wind turbines, and 6 hydropower facilities). This amounts to an increase of 124% in the 7 years since 2017. While we have made significant progress, considerably more renewable energy generation will be needed to meet our goal. This region's 2050 target for new renewable energy generation is 113,087 MWh (more than 6 times the baseline renewable energy generation in 2017). The region encourages new renewable energy generation of the types and at the scales 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. 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.

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 of the **2016 Vermont Comprehensive Energy Plan**. The three pilot plans utilized statewide data, and served as a model for similar plans in the remaining regions around the state, including southern Windsor County.

Funding for updating this plan was provided by a Climate Pollution Reduction Grant, administered by the Northwest Regional Planning Commission. The ***Department of Public Service*** also provided information, 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 to qualify as enhanced energy plans under Act 174. In 2024, the Department revised its guidance to be consistent with the updated energy planning standards in the 2022 Comprehensive Energy Plan.

After the original standards were published, regional plans were developed using quantifiable energy conservation and renewable energy generation targets. Vermont Energy Investment Corporation (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 developed regional strategies guided by the resulting quantitative targets.

LEAP was also used by the Department of Public Service and the Vermont Climate Council in the development of the 2022 Comprehensive Energy Plan and 2021 Climate Action Plan to identify pathways that could be used to achieve the Greenhouse Gas (GHG) reduction requirements in the Global Warming Solutions Act of 2020. The Department then "regionalized" the results of the statewide modeling effort into energy use and greenhouse gas emissions outputs for four core sectors: residential, commercial, industrial, and transportation. Those outputs have been incorporated into this updated regional energy plan.

B. Renewable energy generation maps

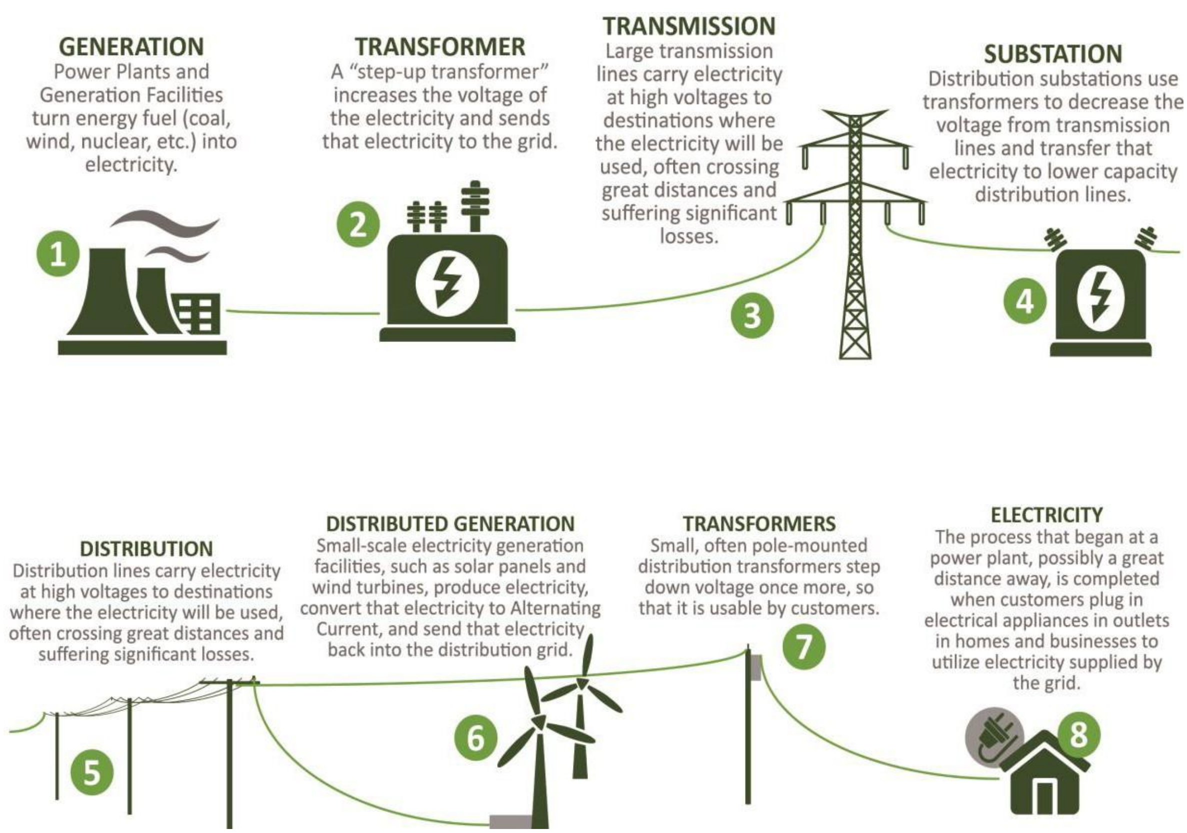
Renewable energy generation maps were created with assistance from state agencies, nonprofit organizations, utility companies, and others for the 2018 Regional Plan. These maps illustrate areas where renewable energy development is more feasible based on the presence of renewable energy resources, after accounting for environmental and other locally identified constraints. For the 2026 Regional Energy Plan, an additional analysis of the mapped areas was conducted to determine whether the additional renewable energy generation facilities needed can be sited without forest clearing. Clearing needs to be minimized to preserve the GHG sequestration capacity of Vermont's forests.

C. ENERGY BASICS[3]

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

Figure 1. Understanding the Grid

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



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 as oil, natural gas, and coal – and nuclear energy. Unlike fossil fuels, which are finite,

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

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. 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”).

B. 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 for many reasons including their finite supply, 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 proceedings. 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 2022 Vermont Comprehensive Energy Plan.

C. ENERGY GOALS

In the 2022 Vermont Comprehensive Energy Plan (CEP), the State of Vermont identified several 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 2022 Vermont Comprehensive Energy Plan (CEP) contain energy planning goals that include but are not limited to:

- By 2025, 25% of energy needs will be met by renewable sources, 45% by 2035, and 90% by 2050
- .

- By 2025 Renewable sources will meet the demand for 10% of transportation needs, and 30% of building energy demand.
- By 2032, 100% of electricity demand will be derived from carbon-free resources, with at least 75% from renewable sources
- Targets for in-state renewable energy generation are set by Tier II of the Renewable Energy Standard and are currently 20% for utilities.
- Major reductions in contributions to greenhouse gas emissions will be made.
- By 2030, 120,000 housing units will undergo weatherization in Vermont.

MARC hereby adopts the goals established in statute and in the 2022 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, and 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.

D. Plan Organization

This Plan is intended to address the Guidance for Regional & Municipal Enhanced Energy Planning Standards as developed by the Vermont Department of Public Service on January 16, 2024. 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 using the Vermont Pathways model, created with Low~~ng-Range~~ Emissions~~nergy~~ Analysis~~lternatives~~ Platform~~nning~~ (LEAP) ~~system~~software. 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.

E. 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, most of the 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. The scarcity and environmental impact of non-renewables, as well as dependence on outside suppliers, leaves 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 -- photovoltaic generation is efficient and cost-competitive with fossil fuels. Wood biomass is a high-yielding heat source, provided it is sustainably harvested and used near its source 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 with heat pumps or locally-sourced biomass offer the best long-term approach to ensuring the region's energy security. Some 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. Impacts on forests threaten the maple syrup industry. A warmer climate and unpredictable weather also impact the skiing industry. More frequent severe weather events will result in damage to infrastructure and property, which will have additional financial impacts. 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% reduction by 2050

(2022 VT Comprehensive Energy Plan)

❖ Economic Needs and Opportunities

In the Region, annual expenditures on energy for residential space heating, transportation, and electricity were roughly $85 million in 2022, equivalent to about $3,546 per person. The burden of paying for the high cost of energy falls on the consumer. Most of the money spent on non-renewable energy leaves the local economy -- if this money could be retained within the local economy, the financial gain would help to improve quality of life for local residents.

The changes required to decrease overall energy use within the region may stimulate economic growth (e.g., many people hire local contractors to complete home weatherization improvements). According to the Public Service's Department's *Clean Energy Industry Report for 2024*, 18,255 people are currently employed in "clean energy" businesses in the state, an increase of 14% since 2015. 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 to reach the state's ambitious energy goals.

Section II: Regional Energy Supply and Consumption

The following section summarizes 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 data provided by various federal, state and regional sources for the years 2022 through 2024, 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

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 $36.5 million is spent on residential heating annually. Of an estimated 15,484 households in the region, approximately 10,445 are occupied year-round. Based on an average annual heating load per residence of 110 MMBtu, the calculated average annual heating cost is $3,492 per household4. Fuel oil is the most widely consumed residential heating fuel in the region for both owner and renter occupied households (56% of all households). After fuel oil, wood (both cord and pellet) is the most common heat source for owner-occupied homes (19%) – for rentals, it's propane (33%). As of 2022, renter occupied homes were four times more likely than owner-occupied homes to use electricity as a heating source. (See charts under Figure 75). However, as more cold-climate heat pumps are installed, reliance on electricity is expected to increase significantly. As of 2024,

Figure 4: A solar hot water system (evacuated tubes) on a house in Weathersfield. (Julia Lloyd Wright)

[4] Calculated by the MARC based on the number of housing units, heating fuel types and average fuel costs for 2022.

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

adoption of heat pump technology was quite uneven among the towns in our region as illustrated in Table 2. Four of the towns in our region had exceeded their 2025 target, four were making good progress, and two could use additional assistance. Outreach and education to increase awareness of potential savings, incentives and assistance programs could help boost fuel-switching in towns that are struggling to reach targets.

Table 1. 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	2,085	2,511,223 gal	$9,040,403
Electricity	612	19,729,554 KWh	$3,563,749
Fuel Oil/Kerosene	5,881	4,654,029 gal	$21,268,912
Wood	1,579	8,685 cord	$2,605,350
Other	288	N/A	
Total	**10,445**		**$36,478,414**

Table 2. Cumulative Residential Heat Pump Installations				
Towns	Actual	Adjusted Targets		
	2024	2025	2035	2050
Andover	97	67	180	265
Baltimore	23	37	99	147
Cavendish	101	168	452	665
Chester	419	475	1,277	1,882
Ludlow	541	505	1,358	2,002
Reading	107	98	265	389
Springfield	643	1,309	3,519	5,186
Weathersfield	283	394	1,059	1,561
West Windsor	164	159	428	631
Windsor	174	594	1,596	2,352
Total, MARC region	2,552	3,806	10,233	15,080
Total Households	15,484	15,546	16,179	17,178
% with heat pumps	16%	24%	63%	88%

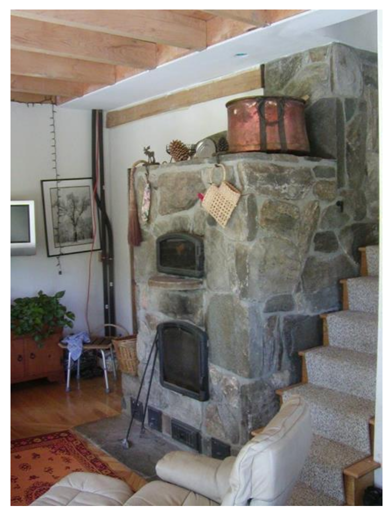


Figure 6: A masonry heater is a very efficient way to heat a home with wood. (Peter Hudkins)

Table 2: Actual 2024 information is from the EAN dashboard, based on data from EVT on the number of outdoor units installed rather than the number of indoor units. Targets provided by the VT Public Service Department were for the number of indoor units and assumed 1.3 units/household, so they were adjusted to estimate the number of outdoor units, which is a more accurate estimate of the number of households.

When examining potential strategies for improving energy efficiency, it is important to understand the factors that affect decisions about space heating, including household income; whether the home is owner-occupied or renter-occupied; and, if renter-occupied, whether the renter is responsible for the cost of heating the home. Whoever is responsible for paying heating costs will be motivated to conserve energy but renters who don't have a vested interest in the value of the home would generally not be motivated to invest in energy efficiency improvements, especially costly ones. Likewise, lower-income households may not have the financial capacity to make costly energy improvements. In the region about 20% of the housing stock are rental homes.

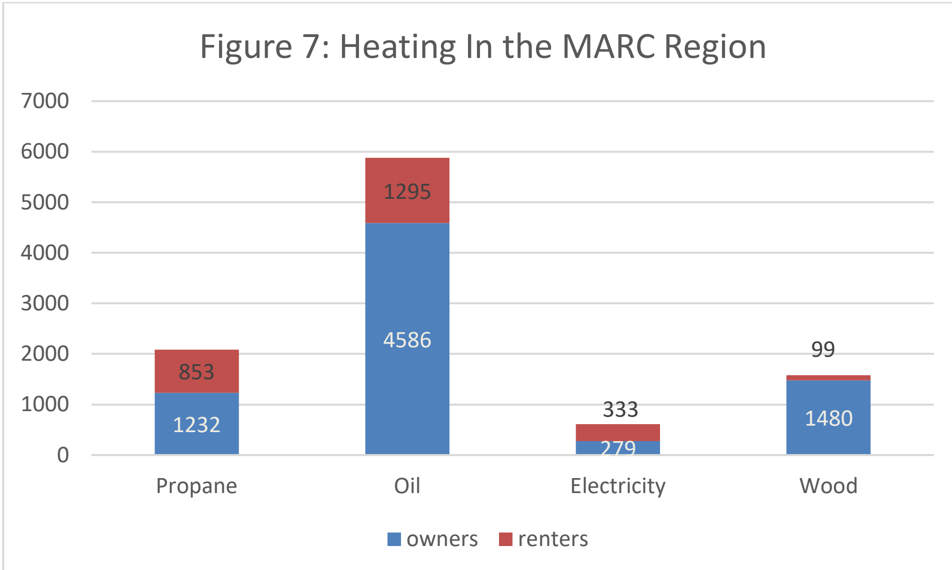
Ground-Source (Geothermal) Heat Pumps (GSHP) provide whole-house heating and cooling and can also provide domestic hot water. While GSHPs are generally more efficient than air-source heat pumps, they are more expensive to install and experienced contractors may be hard to find. According to the Vermont Heat Pump Market Assessment (2025), Efficiency Vermont processed incentives for 47 residential GSHP systems in the period from late 2021 to late 2024.

Because it is a renewable, locally-sourced fuel type, using wood for home heating can be an efficient and cost-effective option that also supports the local forestry economy, especially if an Advanced Wood Heat (AWH) system is used. AWH uses highly efficient combustion technology and therefore produces low levels of emissions. Using wood as a primary or secondary heating fuel also offers resiliency benefits as it can be used during periods of extreme cold, when heat pumps are not as efficient, and during power outages.

The median size of new single-family homes in the northeast of the U.S. has increased by 63% since 1973[6]. Median house size was 1,450 square feet in 1973, and increased to 2,363 square feet in 2024. 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.

Table 3: Heating by Fuel Percentages	Propane	Oil	Electricity	Wood	Coal	Solar	Other
Owners	15.7%	58.5%	3.6%	18.9%	0.4%	0.3%	2.6%
Renters	32.7%	49.7%	12.8%	3.8%	0.0%	0.0%	1.0%
All Households	20.0%	56.3%	5.9%	15.1%	0.3%	0.2%	2.2%

[6] Source: US Census Bureau



❖ Home Weatherization

Weatherization of homes is an important step in the effort to decrease energy used for space heating and create better efficiency. Slightly more than half the homes in the state, and the region, are over 50 years old. Older homes are less likely to be properly insulated and air-sealed. To address this issue, the state passed Act 92 (10 V.S.A. § 581) in 2008, which called for **25% of the state's housing, or 80,000 units to be properly weatherized by 2020.** Although this ambitious goal was not achieved, the 2022 VT Comprehensive Energy Plan (CEP) reported that more than 10,000 housing units were weatherized between 2016 and 2022, bringing the total number of weatherized housing units in the state to approximately 30,000 at the end of 2022.[5].The new target in the CEP is to weatherize an additional 90,000 units statewide, bringing the total number to 120,000 by 2030. Significant headway is being made. According to the Energy Action Network's 2025 Progress Report, 41,390 homes had been weatherized by the end of 2024.

There are several programs throughout the state to help private homeowners and businesses properly weatherize their existing buildings. Programs offered by ***Efficiency Vermont*** and ***SEVCA*** made improvements to about 900 housing units in the region between 2009 and 2015. From 2016 to 2024, Efficiency Vermont reported that an additional 426 weatherization projects were completed in the MARC region, for an average of 47 projects per year. To meet our 2030 weatherization goal of 6,145 completed projects, we would need to complete around 800 projects per year over the next six years. See Table 4 for weatherization target details. There are additional programs, such as ***Vermont Weatherization Assistance Program (WAP)***, that offer assistance to low-income families, with a particular focus on elderly individuals or those with disabilities, but their reach is also limited. In FY 2021, the WAP Program served a total of 1,055 households statewide, including 170 in Windsor County.

A new program, called the Weatherization Repayment Assistance Program (WRAP) allows Vermont households, including renters (with landlord permission), to pay for weatherization projects through a charge on their monthly electric bill.

There are also some local weatherization programs in the region. For example, the Reading Energy Committee has a local program assisting residents, especially retired and lower income homeowners, with air sealing their homes. Program-sponsored improvements have resulted in a reduction in fuel use of 100 gallons/home/winter. MARC encourages more towns to adopt programs like this. Supporting and promoting volunteer-led non-profit organizations like Window Dressers would also help further regional weatherization goals. However, to meet state and regional goals, additional workers will need to be recruited and trained to install weatherization measures.

Table 4: MARC Region Housing Weatherization Targets	**Actual 2024**	**Target 2025**	**Target 2030**	**Target 2035**	**Target 2040**	**Target 2050**
Weatherized Housing Units	1,326	3,581	6,145	7,739	9,332	12,519
Total Housing Units	15,484	15,546	15,859	16,179	16,505	17,178
% Of Units Weatherized	9%	23%	39%	48%	57%	73%
VT-Wide	41,390	69,639	119,510	150,504	181,498	243,485

❖ Commercial and Industrial Heating

The size and use of commercial and industrial structures varies widely. Due to a scarcity of data on the square footage of these structures, MARC used a municipal consumption model provided by the Public Service Department to estimate the amount of energy used for space and water heating in commercial and industrial buildings. The statewide average heat energy consumed (in MMBTUs) by each type of business (e.g. healthcare, retail, food service) was multiplied by the number of businesses of that type in the region. In total, there are about 670 commercial and industrial businesses in the region using a total of approximately 615.8 billion BTUs of energy for space and water heating, which represents roughly 35% of the total thermal energy used in the region.

Oil and propane are the primary fuels used for heating commercial and industrial buildings throughout the region. As of 2020, there were 123 cold climate heat pumps being used by businesses in the area. Industrial buildings are more likely to use wood to heat than commercial buildings – and some industrial buildings heat with coal. As with residential structures, the best renewable fuel for industrial and commercial settings depends on possible energy conservation measures and the age, size and locations of buildings. 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.

B. Transportation

According to the 2022 VT Comprehensive Energy Plan, "Transportation makes up 38% of the total energy consumed in Vermont and produces more Greenhouse Gas (GHG) emissions...than any other sector." In the MARC region, transportation accounts for 33% of the total energy consumed.

Vermont's 2023 Energy Burden Report evaluated the average amount spent on heating, transportation and electricity in each town as a percentage of median household income. On average, 11% of household income is spent on energy, with transportation accounting for 45% of the total. [7] The report estimated household

[7] East Central Vermont Housing and Transportation Affordability

transportation energy costs based on estimated vehicle miles traveled (VMT), average fuel efficiency, and average gasoline prices. The average transportation energy burden statewide is 4%. All of the towns in southern Windsor County have a transportation energy burden that is higher than the state average, except West Windsor, due to its relatively high median household income. Residents who choose to live in rural areas, as opposed to town centers are more heavily reliant on vehicles, often single occupant vehicles, for routine travel needs.

Petroleum-based fuels are the predominant fuel type used for transportation. Between October 2024 and October 2025, almost 289 million gallons of gasoline were sold in Vermont[8]. Residents of the Region own approximately 17,500 personal vehicles and consume an estimated 9.8 million gallons of fuel to travel an estimated 215.45 million miles annually.[9] In addition, medium and heavy-duty vehicles in the region, such as trucks and buses, are estimated to consume close to 1.7 million gallons of diesel fuel per year.

Table 5: Regional Transportation Estimates	
Internal Combustion Engine (ICE vehicles)	
Total Number of Ice Vehicles	17,236
Estimated Gallons of Fuel	9,793,182
Total Miles Traveled, ICE vehicles	215,450,000
Total Est. Fuel Cost, ICE vehicles	$31,142,319
Electric Vehicles	
Total Number of EVs	318
KWh consumed by	1,325,000
Total Miles Traveled, EVs	3,975,000
Total Est. Electricity Cost, EVs	$264,841

Table 5: Based on assumptions included in Municipal Consumption tool provided by VT Public Service Dept., including avg yearly miles of 12,500; avg fuel efficiency of 22 MPG or 3 KWh/mile; unit cost of $3.18/gallon or $0.19988/KWh.

Workers living in this region have relatively long commuting distances, which could be minimized if people were able to live and work in the same town, but due to limited job opportunities, that is often not possible. Many area residents commute to work in the Upper Valley where wages tend to be higher.

Localization of jobs could enable walking or biking to work, and in larger towns like Springfield, public transportation could also be a viable option. 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 with low-density development patterns, walking and biking are unlikely to become common practice without investment in bike/ped infrastructure. Larger towns have sidewalk networks in their downtowns and village centers. VTrans is generally in support of making state routes bicycle-friendly, but doing so could 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 is one public transportation provider in the region Southeast Vermont Transit/the Moover. Travel to destinations such as Boston, New York, Burlington, and Montreal is facilitated by Dartmouth Coach, and Greyhound, which are found just outside the region in White River Junction, Bellows Falls, and Lebanon, NH. The Windsor Amtrak station and a few nearby train stations serve the region to provide access by

[8] VT Legislative Join Fiscal Office

train to northern Vermont and south as far as Washington DC. Other options to reduce transportation fuel demand include telecommuting, which has increased since the pandemic; plug-in hybrid vehicles; electric vehicles; and the use of biofuels. Future technologies may present additional options.

Table 6: Personal EV & PHEV Registrations in the MARC Region

	EV Cars & Light trucks	PHEV Cars & Light trucks	Total EV & PHEV
Actuals			
2020	48	63	111
2021	83	89	172
2022	117	107	224
2023	161	157	318
2024	233	229	462
Targets			
2025	927	135	1,062
2030	4,800	149	4,949
2035	11,361	132	11,493
2040	17,535	86	17,621
2050	24,599	32	24,631

C. Electricity

According to the **Vermont Comprehensive Energy Plan (CEP)**, the state purchased just over 5,300 GWh of electricity from the grid in 2020, decreasing from 5,900 GWh in 2005. This decline is attributed to increased investments in electric efficiency and small-scale solar projects. The 2016 CEP indicated that the state generated 45% of its electricity from renewable sources. The 2022 CEP establishes a goal of meeting 100% of energy needs with carbon-free resources by 2032, with at least 75% coming from renewable sources. In 2024, the Renewable Energy Standard was updated by Act 179 and now requires most distribution utilities, including Green Mountain Power, to procure 100% of their energy from renewable sources by 2030. Municipal utilities, including Ludlow Electric, must procure 100% of their energy from renewable sources by 2035.

Vermont is expected to continue to have a "winter peaking" electrical demand. VELCO's 202~~1~~4 Long-Range Transmission Plan projects ~~a baseline increase in~~a peak summer load of 1,028 MW ~~from a 5-year average of 950 MW to 1,119 MW~~ in 20~~30~~24, 1,250 MW in 2033, and 1,~~294~~386 MW in 204~~0~~3. Peak winter load is projected to be ~~increase more significantly from a 5-year average of~~1,056 MW in 2024, ~~970 MW to~~ 1,~~219~~445 MW in 203~~0~~3 and 1,~~499~~624 MW in 204~~0~~3. These "VT Roadmap" projections are based on the~~a~~ rapid electrification of the transportation and thermal sectors needed to achieve the greenhouse gas emissions reductions called for in the Global Warming Solutions Act of 2020. ~~gradual increase in the use of electricity for heating and transportation, consistent with current trends. Achieving the dramatic decreases in GHG emission envisioned in VT's Climate Action Plan would require a more rapid increase in the electrification of the thermal and transportation sectors.~~ Changing climate conditions and hotter summers may result in greater future electricity demand in the summer from increased air conditioning use.

Until 2016, Efficiency VT provided electricity consumption data by zip code rather than by individual town Figure 10 shows electricity usage trends for the region as a whole. In 2020, during COVID-19 stay-at-home orders, all towns except Cavendish saw a decrease in usage in the commercial/industrial sector, and all towns except Reading saw an increase in usage in the residential sector. Residential usage has continued to increase since the pandemic, possibly because more people are working from home. In 2022, Ludlow had the highest electricity usage in the commercial/industrial sector, followed closely by Springfield, with Windsor a distant third.

Based on electricity consumption data for each town, provided by Efficiency Vermont, the average annual residential consumption for 2020 through 2022 increased for eight of the ten towns in the region, compared to the average annual residential consumption for 2014 through 2016, as shown in Table 7:

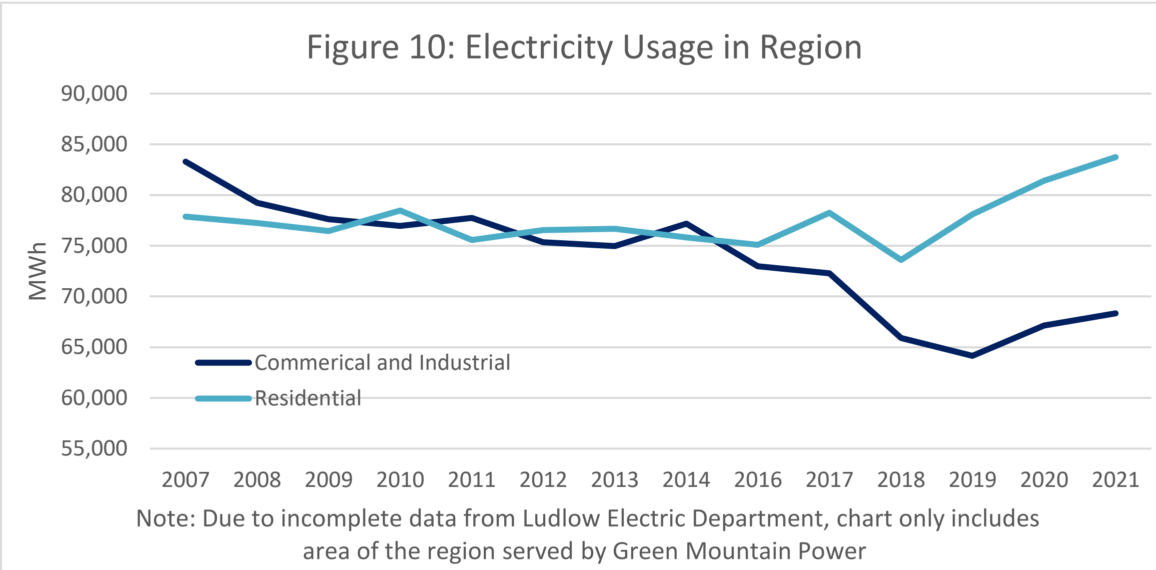


Table 7: Avg. Ann. Residential Electricity Usage by Town

Town	*2014- 2016*	*2020- 2022*	
Baltimore	8.224	7.771	MWh
West Windsor	7.315	7.328	MWh
Weathersfield	7.211	7.617	MWh
Springfield	6.921	7.016	MWh
Windsor	6.731	6.875	MWh
Chester	6.689	7.069	MWh
Reading	6.565	6.659	MWh
Andover	6.465	6.803	MWh
Cavendish	6.255	6.622	MWh
Ludlow	5.491	5.286	MWh

❖ Regional Generation

Ludlow Electric is the electricity provider for portions of Ludlow and Cavendish. Green Mountain Power (GMP) 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). As of 2024, ~~F~~fuel sources for GMP generating facilities including nuclear, hydro, and solar, ~~-~~are 100% carbon-free and 79% renewable.~~primarily renewable, with hydro, nuclear, and wind comprising 82%.~~[9] There are no significant non-renewable energy generation facilities in the region, except for backup

[9] Green Mountain Power: Annual Energy Mix: https://greenmountainpower.com/energy-mix/

generators at substations. Electricity transmission service is provided by the Vermont Electric Power Company (VELCO). Existing transmission lines, three-phase power lines and substations are shown on the Utility Service Map. Ongoing consideration should be given to the condition of our electricity transmission and distribution systems and their ability to support the state and regional goals for renewable energy targets. Based on Exhibit 4-13 in the 2022 Comprehensive Energy Plan, the transmission headroom for the MARC region is 56.7 MW and the distribution headroom is 101.8 MW. The limiting factor is the lower of the two. Emerging technologies, such as battery storage, may help to address capacity issues with the grid.

Renewable Source	# of Sites	Installed Capacity (MW)	Annual Generation (MWh)
Solar	782	23.54	30,938
Wind	3	0.02	44
Hydropower	6	2.64	9,254
TOTAL	**791**	**26.2**	**40,236**

Energy production from renewable sources in the MARC region was 2.24 times higher in December of 2024 than in May of 2017, and is continuing to increase, based entirely on a growing number of solar facilities. There were 276 solar sites in 2015 and there are 782 in 2024. As of December 2024, the region had 23.54 MW of installed capacity of solar energy between both roof-mounted and ground-mounted sites. Assuming that the smaller facilities (less than or equal to 15 KW) are roof-mounted and the larger facilities are ground-mounted, the MARC region has 702 rooftop facilities with a capacity of 5.08 MW and 80 ground-mounted facilities with a capacity of 18.46 MW. Only a few residential-scale wind turbines have been installed to date. The total installed capacity of these turbines, located in Andover, Ludlow, and Weathersfield, 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 2.64 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, regions like MARC that have available transmission and distribution headroom, should increase renewable electricity production to the extent possible.

Section III: Regional Energy Targets

This section establishes future energy targets for the region based on state goals and projected energy needs. It examines energy use and fuel types needed based on projected demand, and the amount of renewable energy needed in the region to meet that demand. Each section discusses its methodology and tools used.

It will be difficult to meet targeted GHG emissions reductions and the 90/50 energy generation goal. This plan outlines pathways to meet those goals.

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 the Department of Public Service. Department staff utilized the **Lo**w~~ng-range~~ **E**missions~~nergy~~ **A**nalysis~~lternative~~ **Pla**tform~~nning~~ **(LEAP)** software system to provide a revised set of "regionalized" modeling results consistent with the 2022 CEP and the 2021 Climate Action Plans. The Department also provided tools to calculate existing energy consumption and project future energy demand and GHG emissions at the municipal and regional levels. Population growth, number of households, vehicle miles traveled, and fuel source assumptions are examples of the type of data input used to model and project consumption.

British Thermal Units Conversions

To facilitate simple conversions between fuels, all energy targets are referenced in BTUs.

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

To determine regional targets, the LEAP model compared two scenarios – the **baseline** "Business as Usual" scenario and the Climate Action Plan's **CAP Mitigation** scenario. The **baseline** scenario assumes a continuation of existing policies and programs, while the CAP Mitigation scenario was designed to meet the state's GHG reduction requirements.

Data showing the region's share of projected statewide energy demand under both scenarios – the baseline and the CAP Mitigation – were provided to MARC, broken down by sector: Residential, Commercial, Industrial, Transportation and Electricity. GHG emissions for each sector were also calculated. To support the goal of achieving the state's GHG emissions reduction targets, the projections included in this plan are from the CAP Mitigation scenario.

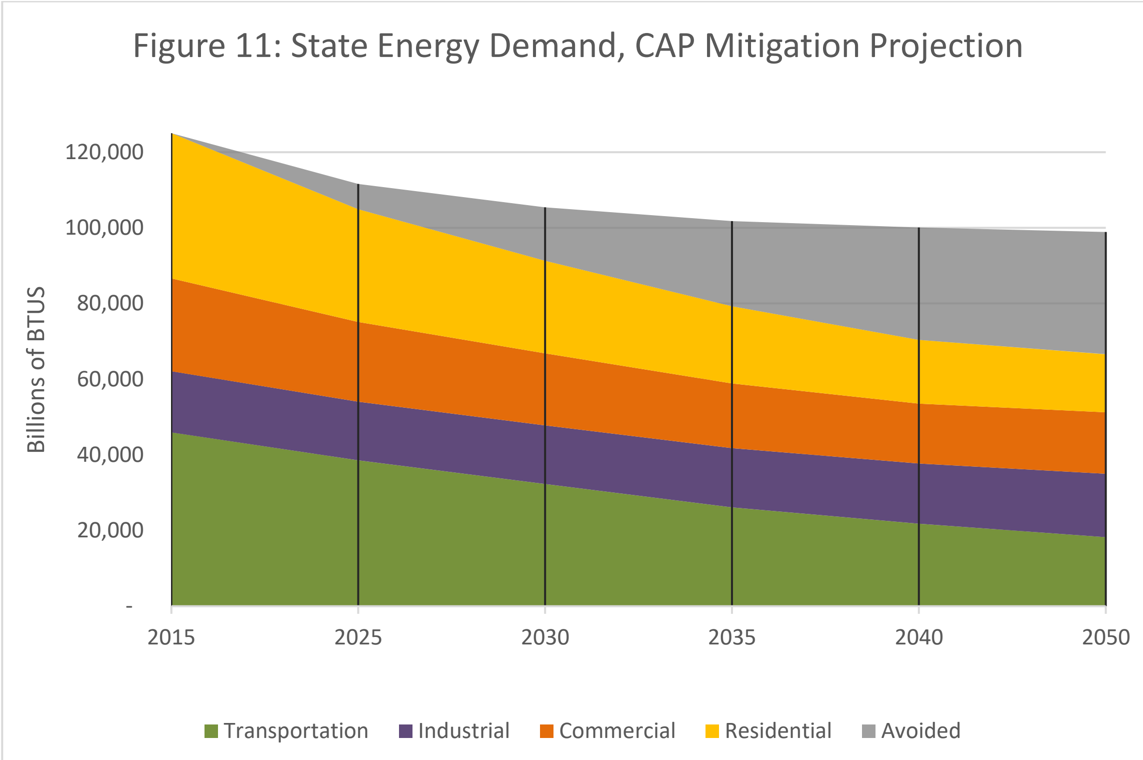


Figure 11: Projected statewide energy consumption by sectors comparing the baseline scenario (gray portion) and the CAP Mitigation scenario (Source: Vermont Public Service Department)

❖ Statewide Energy Targets

The statewide model for energy demand by sector under the CAP Mitigation 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. The difference in energy demand between these two scenarios represents the amount of energy consumption that will need to be eliminated through conservation, efficiencies, fuel switching, and other means to meet the state and regional goals.

B. Regional Energy Targets by Sector

The Regional CAP Mitigation Scenario estimates that a 42.6% reduction in energy consumption will be required to meet our 90/50 goal. This dramatic decline by 2050 is despite projected future conditions (i.e. a modest population increase per VT Housing Needs Assessment projections) and relies primarily on assumptions made for increased efficiency, conservation, EV adoption, and thermal fuel switching. Most of this decline is accounted for by the electrification of heating and transportation, which are much more efficient than combustion-based alternatives.

Overall, the total amount of energy utilized in the region will decline by 42.6% by 2050.

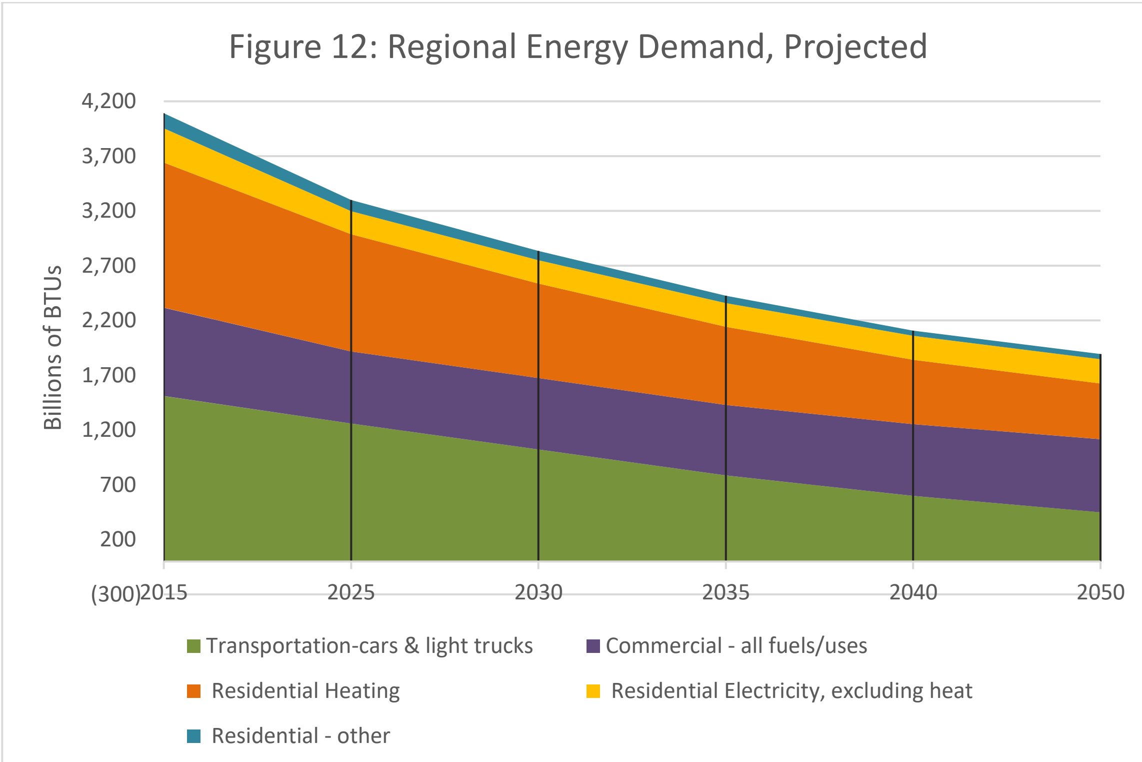


Figure 12: MARC Regional Energy Targets by Sector (Source: Regional CAP Mitigation Scenario)

A substantial increase in efficiency, conservation, and electrification of energy consumption will be needed across all sectors to meet CAP mitigation scenario targets. Residential heating and transportation will be transformed, with a dramatic change over the next 25 years. Transportation energy consumption by passenger cars and light duty trucks will drop by 64.3% from 2025 to 2050, and residential heating will decrease by 52.6%, in order to meet the 90/50 goal by 2050.

C. Regional Energy Use by Fuel Type

Needed regional changes to meet 90/50 energy targets generally mirror state-wide changes. Figure 13 below illustrates the following changes in regional energy consumption by fuel type across the residential, commercial and transportation sectors:

- A reduction in total energy consumption by approximately 43%;
- A shift from nonrenewable to renewable 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 need to fall from an estimated 61.6% of total energy consumption in 2025 to 8% by 2050, according to the CAP Mitigation analysis. Direct energy consumption from renewable fuels, such as wood, ethanol and biodiesel, will increase from 18.2% in 2025 to 24.8% of total regional energy consumption over the same period. Electricity consumption, which is estimated at 20.2% of regional energy demand in 2025, will make up the difference, increasing to 67.2% of total energy consumption in 2050. The breakdown of electricity generation by fuel source and transition to renewable fuels is described in the section on target electricity generation.

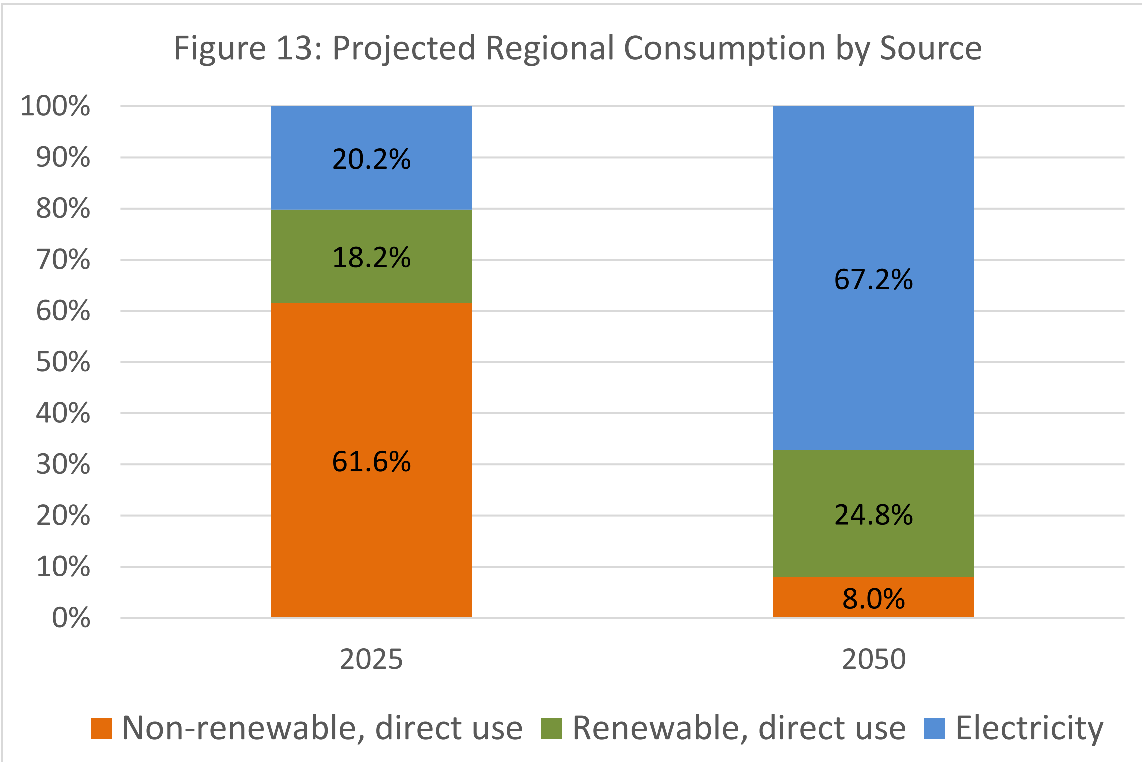


Figure 13: Regional targets for energy consumption across the residential, commercial & transportation sectors. Note that data is scaled to percentage of demand and does not reflect the reduction in overall demand. Electricity will largely be generated from renewable sources by 2050.

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

To meet energy goals, today's primary transportation fuels, 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 MARC 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 primarily by heat pumps. Targets for heat pump adoption are shown in Table 2. Due to the elimination of other fuel sources, the target for electricity increases as a proportion of total energy consumption, going from 20.2% in 2025 to 67.2% by 2050. Figure 14 below gives a closer look at the breakdown by fuel source.

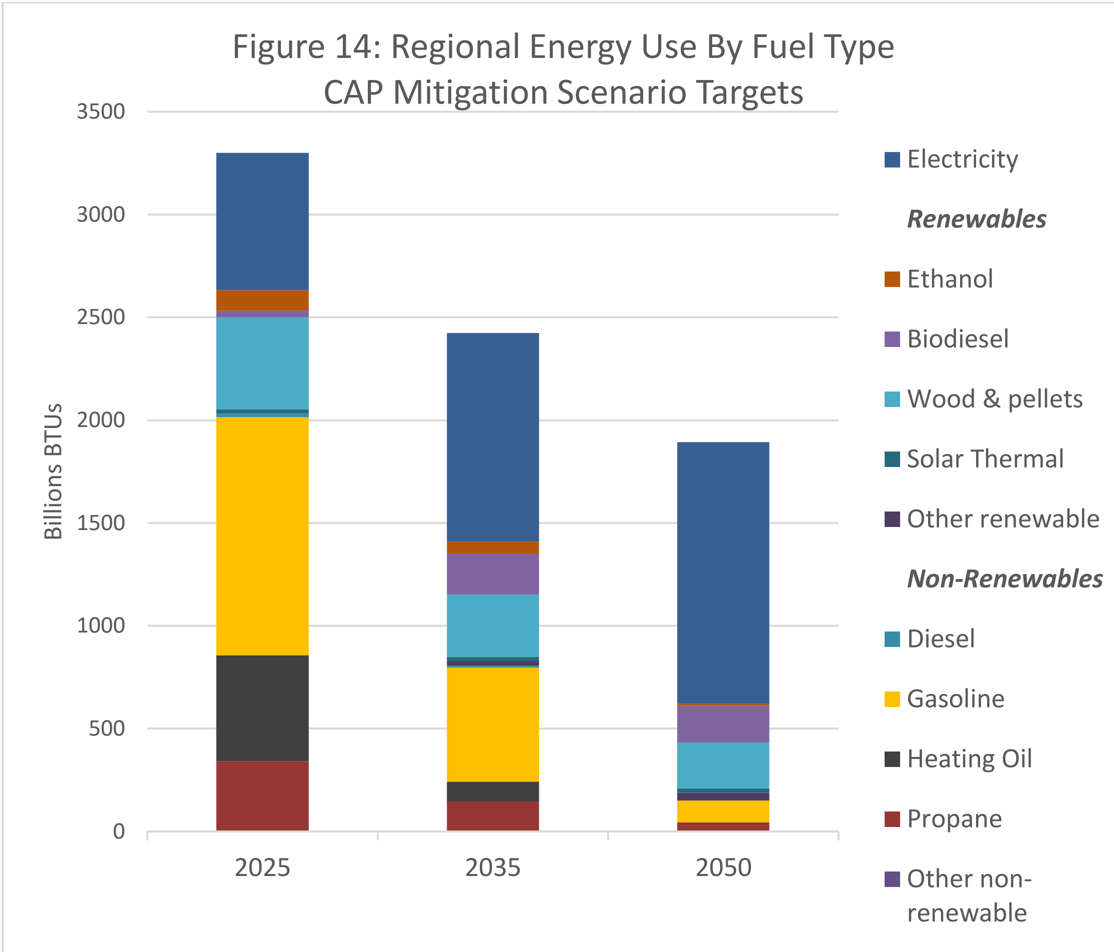


Figure 14: Mt. Ascutney Regional Energy Targets by Fuel Type (in billion BTUs)

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 decrease by 43.8% from an estimated 1,382 MMBtu in 2025 to 777 MMBtu in 2050,** with the amount of energy from non-renewable sources decreasing from 655 MMBtu in 2025 (47.4% of total energy used) to 190 MMBtu in 2035 (19.1% of total energy used) to just 43 MMBtu in 2050 (5.5% of total energy used). as depicted in Figure 15 below**.** For comparison, total residential energy demand for the region was 1,438 MMBtu in 2022 with 905 MMBtu (62.9%) from non-renewable sources. Figure 16 breaks down residential energy targets for the region by fuel type for 2025, 2035 and 2050.

21

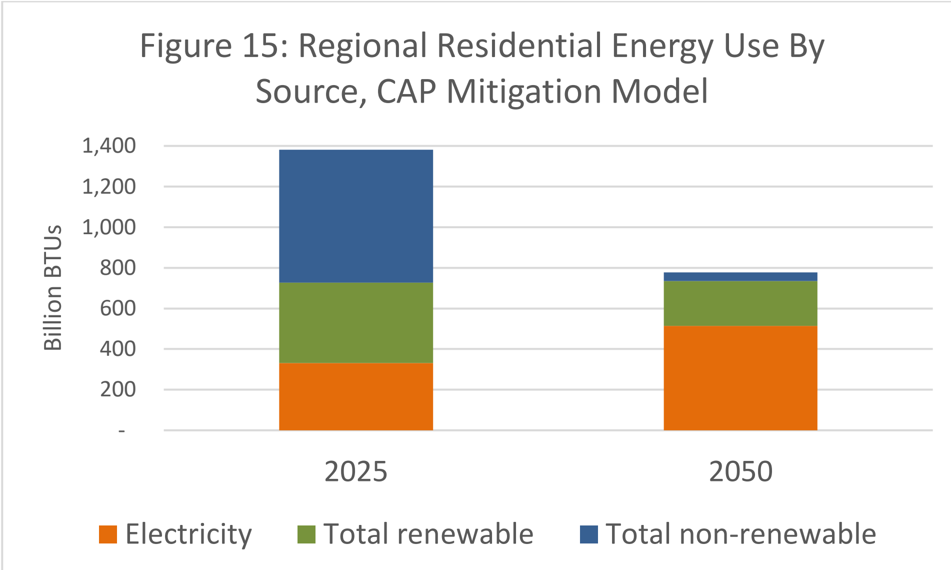


Table 9: Regional Residential Thermal Energy by Source, Projected (Billion BTUs)

Fuel	2025	2035	2050
Electricity	122	225	292
heat pumps, air	*63*	*149*	*209*
heat pump, water heater	*11*	*35*	*48*
other electrical heat	*48*	*41*	*35*
Wood & pellets	370	208	103
Biodiesel	24	131	81
Oil & Propane	555	149	31
Total	**1,070**	**713**	**508**

While the electrification of the heating and transportation sectors will increase total electricity use, total energy use will decrease. Transitioning to more efficient appliances and lighting, and weatherizing existing homes, will help to achieve the reduction needed to meet our targets. Residential and non-residential electric efficiency targets for the region are presented below. The estimated average annual savings per residence (or per premises for non-residential entities) used to calculate these targets is based on 20% of the average annual usage in the MARC region in 2022, as reported by Efficiency Vermont. Average annual residential usage in 2022 was 6,946 KWh, while average annual non-residential usage was 36,139 KWh.

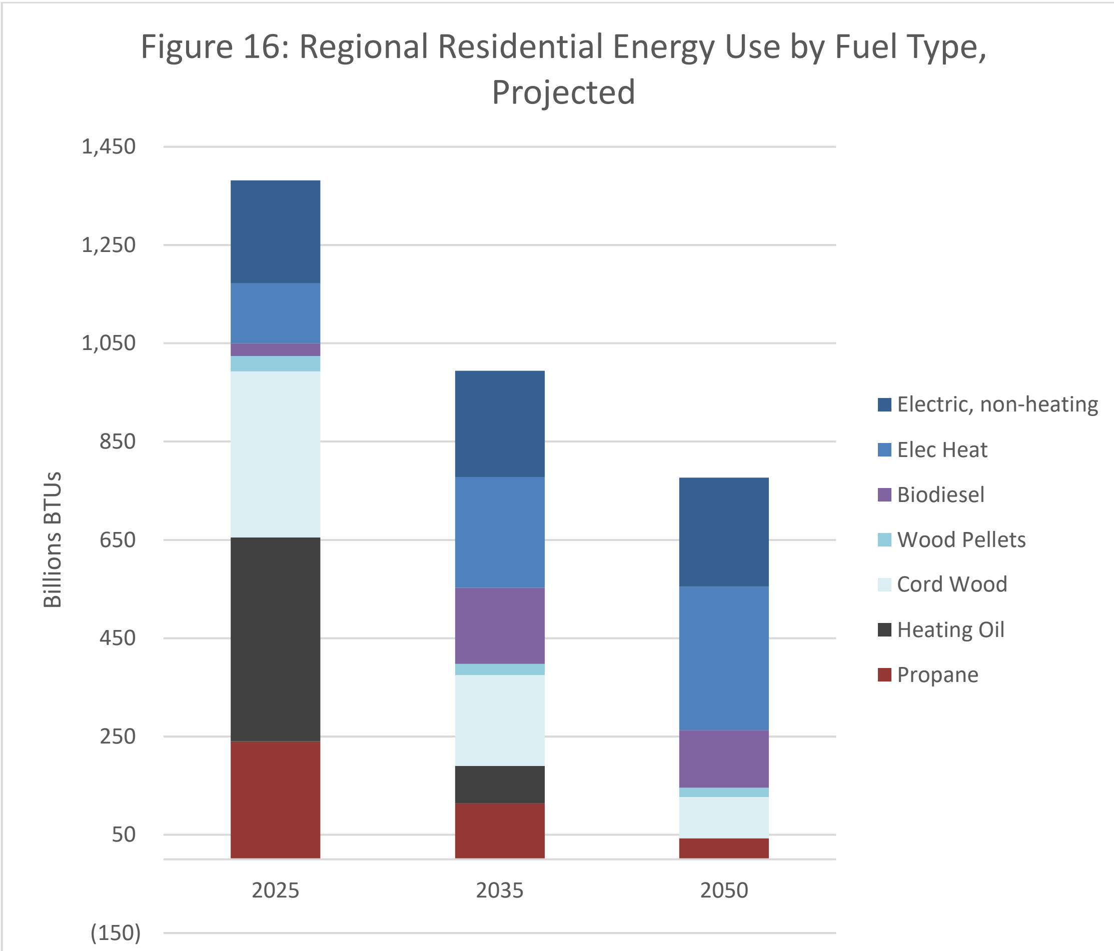
Residential Electric Efficiency Targets			
	2025	**2035**	**2050**
Cumulative Annual Electricity Savings (KWh)*	1,931,000	11,082,000	20,444,000
# of residences with improved electric efficiency	1,390	7,978	14,719
# of residences in the MARC region	15,546	16,179	17,178
% of residences with improved electric efficiency	9%	49%	86%
**data provided by the Department of Public Service from the 2022 Energy Efficiency Market Potential Study.*			

Non-residential Electric Efficiency Targets			
	2025	**2035**	**2050**
Cumulative Annual Electricity Savings (KWh)*	3,472,000	17,440,000	15,726,000
# of premises with improved electric efficiency	480	2,413	2,176
# of non-residential premises in the MARC region	2,941	3,153	3,501
% of premises with improved electric efficiency	16%	77%	62%
**data provided by the Department of Public Service from the 2022 Energy Efficiency Market Potential Study.*			

Note the decrease in cumulative non-residential electric efficiency from 2035 to 2050 in the table above. This is due to a gradual decrease in the savings realized from switching to LED lighting as market penetration for this efficiency measure is achieved. The projected number of non-residential premises in the region is based on an average growth rate of 0.7% per year from 2016 to 2022.

The replacement of inefficient fossil-fuel heating systems with heat pumps or Advanced Wood Heating (AWH) systems will also help achieve the reduction in overall energy use needed to meet our targets. As illustrated in Table 9, the CAP Mitigation model projects that heat pumps will account for 6% of thermal energy demand in 2025, while electricity overall will account for 11%. The amount attributed to heat pumps is projected to increase to 21% in 2035 and 41% in 2050. At the same time, the percentage of homes heated with wood or wood pellets is expected to increase to 35% in 2025 and then gradually decrease to 20% in 2050. Except for 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. [10]

[10] These targets are based on the CAP Mitigation Scenario.



For comparison, in 2022, fuel oil (56%), propane (20%) and cord wood (15%) were the three primary heating fuels in our region, comprising over 90% of total home energy use. In 2022, residential dwelling units burned over 4.6 million gallons of oil per year. To meet state energy goals, heating oil will have to be phased out completely by 2040. and reliance on propane will have to decrease significantly. By 2050, propane will represent 6% of thermal energy demand. While Vermont's 2022 Comprehensive Energy Plan supports the use of wood as a heating source, and includes meeting 35% of Vermont's total thermal demand with wood heat by 2030, the plan also focuses on transitioning to Advanced Wood Heat, especially in commercial applications. In residential applications, the focus is on replacing fossil-fuel systems with heat pumps and replacing inefficient wood stoves with Advanced Wood Heating systems. The modeling done to support the 2022 Comprehensive Energy Plan and the 2021 Climate Action Plan assumes that weatherization will result in average useful energy savings of 20% for single-family households and 38% for multi-family households. To achieve the residential weatherization targets provided for the MARC region under the CAP mitigation scenario, **23% of homes will need to be weatherized by 2025, increasing to 48% by 2035, and 73% by 2050** as shown in Table 4**.** Percentages were calculated assuming that the number of housing units in the region increases at a rate of 0.4% per year, which is the average growth rate for Windsor County from 2010 to 2020[11]. Strategies to achieve these goals can be found in the following section.

Heating oil and propane were the predominant fuel types used by households in our region in 2022, with 74% of

[11] VT Housing Needs Assessment, 2025 - 2029

homeowners and 82% of renters using one of these two fuels to heat their living space. As fossil-fuel heating systems in existing multi-unit rental properties reach the end of their useful life, replacing them with heat pumps or advanced wood heating systems (for larger properties with on-site maintenance staff) may be a reasonable alternative. Ground-sourced heat pumps (i.e. geothermal heat pumps) could also be appropriate for new construction applications. It is expected that weatherization and efficiency improvements will need to be made in both renter - and owner-occupied spaces to increase heating efficiency and help decrease overall consumption.

E. Commercial & Industrial Energy Targets

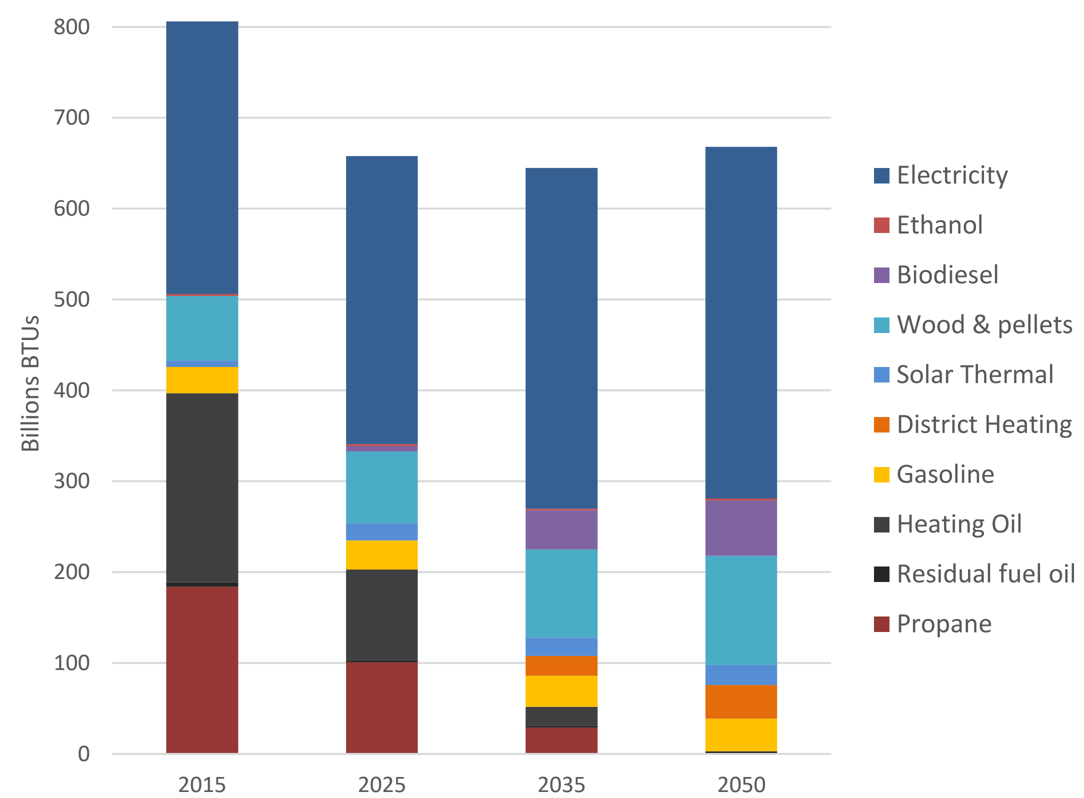
The commercial and industrial sectors are not projected to have as dramatic a decline in energy consumption as the residential and transportation sectors**.** After an initial decrease of 18% in energy demand between 2015 and 2025, energy demand in the commercial sector is expected to decrease by only 2% between 2025 and 2035. Then, between 2035 and 2050, energy demand is expected to increase by 3.4%. However, the percentage of energy from renewable sources, including electricity, wood, biofuel and solar, will increase over that same time period from 47% of total energy use in 2015 to 64% in 2025, 87% in 2035, and~~to~~ 94% in 2050. While ethanol use is projected to remain minimal and constant, the use of electricity, Advanced Wood Heating systems, solar energy and biofuel will increase as propane and fuel oil consumption decreases to near zero. By 2050, electricity consumption will represent 58% of the commercial sector's overall energy usage. Wood will follow at 18%.

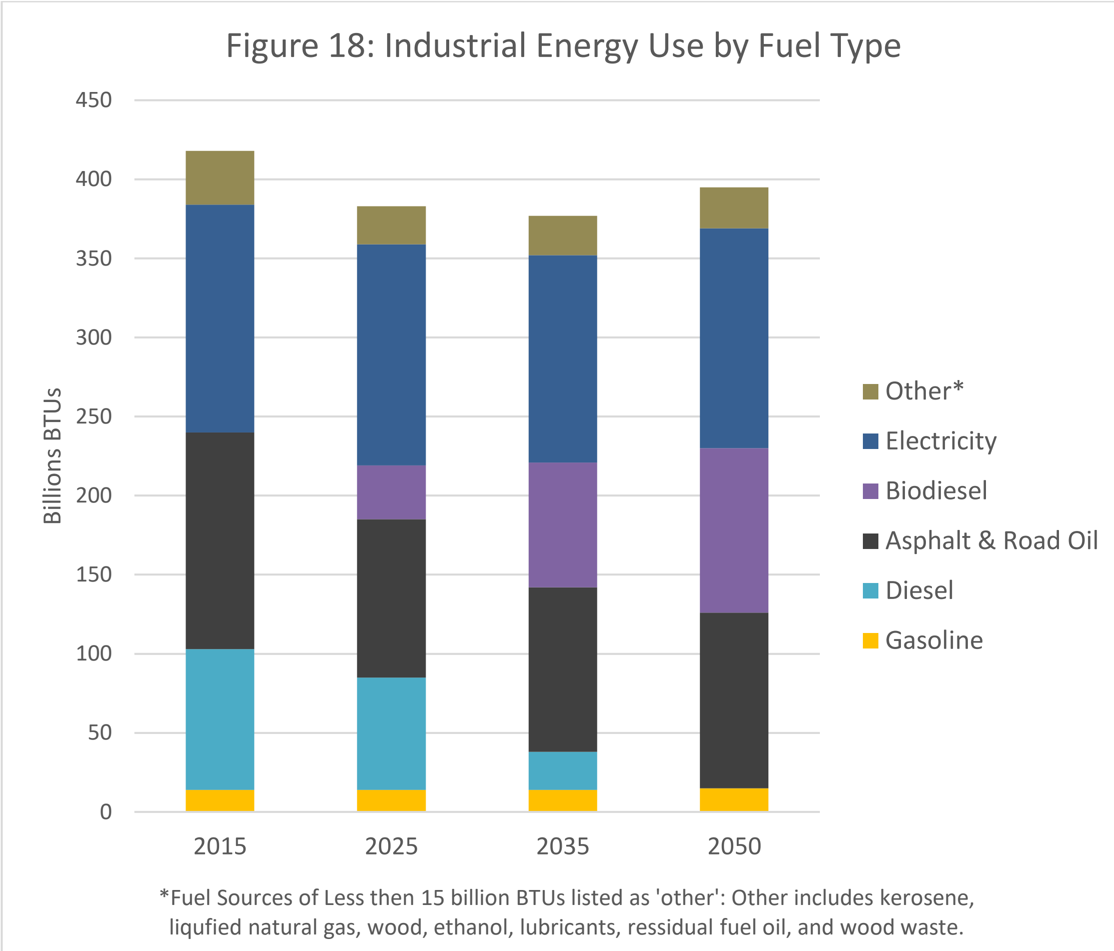
The use of wood for heating large commercial spaces is expected to rise as fossil-fuel based heating systems are replaced with Advanced Wood Heating systems. To achieve the targets in the CAP Mitigation scenario, 12% of commercial buildings would need to be heated with wood in 2025; 15% in 2035, and 18% in 2050. With an estimated 670 commercial buildings in the region, this would equate to heating 80 buildings with Advanced Wood Heating systems by 2025, 100 buildings by 2035; and 120 buildings by 2050. Vermont's 2022 Comprehensive Energy Plan specifically mentions schools as good candidates for AWH. Some schools in the region, including the Weathersfield School in Ascutney and the Springfield High School and Technical Center, have already converted to wood chip or wood pellet heating systems. In addition to new Advanced Wood Heating systems, the CAP Mitigation model calls for the installation of heat pumps in commercial facilities. The model called for the installation of 123 heat pumps by 2020; and calls for 2,210 by 2025; 6,684 by 2035; and 8,548 **by 2050.** (See Table 11.)

Table 11: Commercial Thermal Fuel Targets			
System Type	**2025**	**2035**	**2050**
AWH systems	80	100	120
New Heat Pump units	2,210	6,684	8,548

Billion BTUs

Figure 17: Regional Commercial Energy Use by Fuel Type





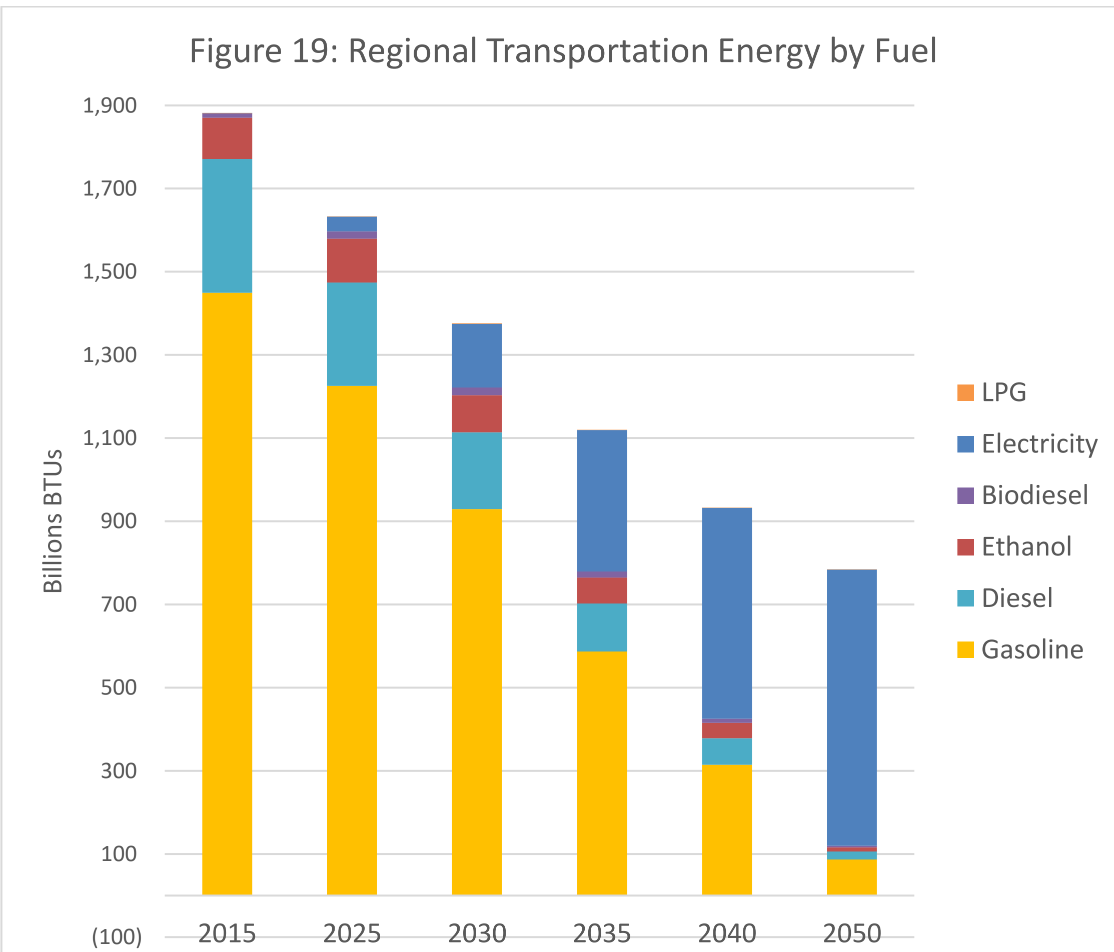
After an initial decrease in energy demand of 8.4% between 2015 and 2025, energy demand in the Industrial sector is expected to decrease by only 1.6% between 2025 and 2035. Then, between 2035 and 2050, energy demand is expected to increase by 4.8%. The percentage of energy from electricity, wood and ethanol is expected to remain constant at around 38% between 2015 and 2050, but the introduction of biodiesel as an energy source and a gradual increase in its use, together with the elimination of diesel, will result in an overall increase in the percentage of energy from renewable sources in the industrial sector from 38% renewable in 2015 to 47% renewable in 2025, 58% renewable in 2035, and 64% renewable in 2050.

In addition to converting heating fuel sources, it will be necessary to weatherize commercial and industrial buildings to reduce energy demand

F. Transportation Energy Targets

The CAP Mitigation scenario estimates that the transportation sector accounts for 40% of the region's total energy use in 2025, with cars and light trucks accounting for 77% of total transportation energy demand. To meet the 90/50 goal, energy demand by cars and light trucks will need to drop by 64.3% by 2050. As shown in Figure 19, non-renewable fossil fuels, gasoline and diesel, are estimated to be the predominant transportation fuel types consumed in 2025 at 90%. Fossil fuel consumption in the transportation sector will need to drop to 13.5% by 2050 to meet renewable energy and GHG reduction goals. Replacing fossil fuels with electricity will be the primary means of accomplishing this dramatic decrease in fossil-fuel consumption. In 2025, electricity is estimated to account for only 2% of energy used for transportation. By 2050, it will have to account for 85%.

In 2022, it is estimated that passenger cars and light trucks in the region used about 9.8 million gallons of gasoline to travel more than 215 million miles. During the same time period, electric vehicles used1.3 million kWh of electricity to travel almost 4 million miles. Diesel fuel utilized for medium and heavy-duty vehicles, such as trucks and buses, add almost 1.7 million gallons of additional fuel consumption per year. As noted above, a major shift from fossil-fuels to renewable sources of energy is needed in the transportation sector. Lifestyle changes will also be necessary to reduce overall transportation energy demand. The CAP Mitigation scenario estimates that a steady decline in gasoline consumption will need to occur over the next 25 years, from the current 9.8 million gallons to about 550,000 gallons by 2050. Diesel fuel consumption will need to experience a similar reduction to a negligible amount by 2050.



As the transition is made away from non-renewable fossil fuels, electricity is expected to become the primary fuel source for the transportation sector. Although fewer than 2% of passenger cars and light trucks were electric in 2022, and the electricity consumed by EVs represented less than 1% of total transportation energy consumed in the region, the CAP Mitigation scenario assumes that electricity will account for 83% of the energy used by passenger cars and light trucks by 2050. As range is extended and more electric vehicles are equipped with all-wheel-drive, this scenario becomes more realistic. However, affordability is still a significant factor, especially now that federal incentives have been eliminated.

Public Charging stations are available in Windsor, Chester, Ludlow, Springfield and Cavendish. Although most EV drivers charge their vehicles at home, public chargers are important resources for commuters, tourists, and anyone unable to charge at home. As of 2025, Baltimore, Andover, Reading, Weathersfield and West Windsor do not have publicly available charging stations. Baltimore and Andover are very rural and may not need one at this time. Reading has expressed interest in hosting a charging station and West Windsor is actively pursuing grant funding to install one. The Charge Vermont program, launched in 2023, offered incentives for installing EV charging equipment at multi-unit dwellings, workplaces and community attractions. To accommodate the projected increase in the use of electric vehicles, more funding for programs like Charge Vermont will be needed. Green Mountain Power offers a variety of grants, rebates, incentives and other programs, including in-home level 2 EV chargers when enrolled in their Home Charging Program.

Electricity is also expected to replace diesel as the primary fuel source for medium and heavy-duty vehicles. The CAP Mitigation data estimates that, by 2050, 87% of the energy used by medium and heavy duty vehicles will come from electricity. Ethanol, which is blended with gasoline, is often labeled as a renewable fuel but, as the number of Internal Combustion Engine (ICE) vehicles decreases, the use of ethanol will likewise decrease.

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. **Modeling done to support the 2022 CEP and the 2021 CAP assumes that, despite a slight increase projected in population, vehicle miles traveled will decrease by 10% by 2050 across all vehicle classes.** 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 with Transportation Demand Management (TDM) strategies that support and promote public transit, ride sharing, rail, and bike-ped infrastructure. Broadband infrastructure that enables telecommuting will also help reduce VMT. For more information, see the ~~Land Use and~~ Regional Transportation Plan, especially Goal #3 & 11; Policy #22; and the Sections on Housing & Transportation Affordability, Climate Change & Environmental Stewardship, and Resilient Transportation Systems. ~~chapters for more information.~~See also the Land Use chapter of the Regional Plan, especially Goal #4 and pages 3-2, 3.12, 3-20 and 3-21.

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

Table 13: Renewable Transportation Fuel Targets

Vehicle Type	2025	2035	2050
Electricity	2%	30%	85%
Biodiesel	1%	1%	1%
Ethanol	6%	6%	1%

G. Electricity Generation Targets

❖ State Electricity Generation Targets

As mentioned in Section II, most Vermont's electricity is provided by out-of- state sources, most notably Hydro Quebec. Since the closure of Vermont Yankee nuclear power plant in 2014, Vermont's in-state production has been from small (<50MW) generators – mostly from renewable sources. For the purposes of this 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.

As shown in Figures 17 - 19, a dramatic increase in electricity demand will be required for the state and the region to achieve the 90/50 goal. Because the original modeling on which the prior Regional Energy Plan was based was developed before the Renewable Energy Standard (RES) was enacted, it included an assumption that 50% of Vermont's electricity would be generated from in-state renewable sources. The Renewable Energy Standard (Act 56 of 2015) initially set a 10% in-state renewable generation requirement, which was subsequently increased to 20%. According to the CEP, Vermont's total annual electricity demand was just over 5,300 GWh in 2020, and is projected to increase to 11,944 GWh by 2050. This increase is primarily due to the electrification of the transportation sector.

❖ Regional Electricity Generation Targets

The need for electricity within the region is expected to more than double between 2025 and 2050, as shown in Figure 21 The remainder of this section will discuss the projected regional electricity generation targets and one scenario for providing that additional generation capacity.

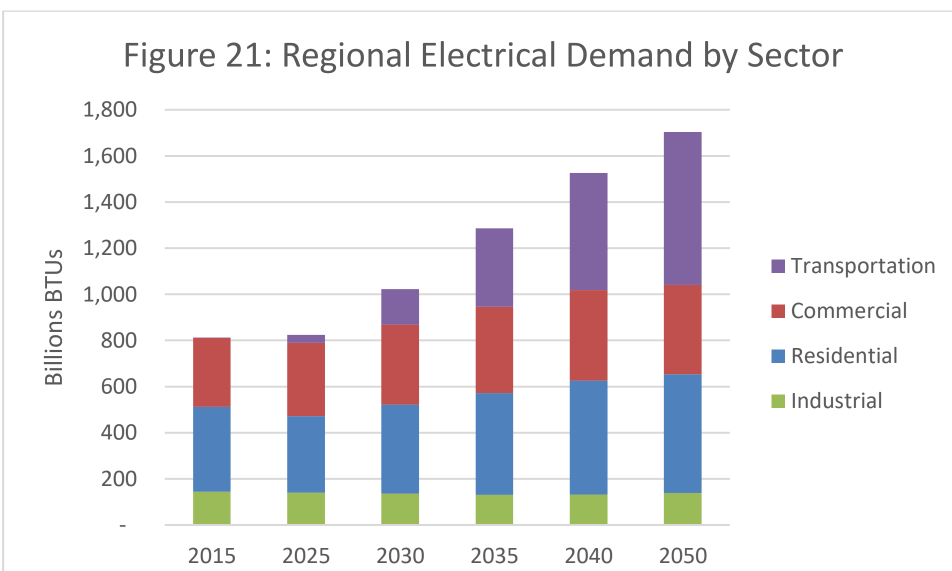


Figure 21: MARC region Electricity Demand Targets by Sector

The Public Service Department (PSD) ~~of Public Service~~ and the regional planning commissions developed targets for regional generation. As noted above, statewide annual electricity demand is projected to increase to 11,944 GWh by 2050 under the CAP Mitigation scenario. Generation targets were allocated to regions based on the region's share of the state's population and land area. Beyond that, regions could choose to set a 20% target, consistent with the Renewable Energy Standard (RES), or a 25% target. Given that most of the towns in the MARC region appear to have enough transmission and distribution headroom to accommodate a higher amount of renewable generation, MARC's targets were set at 25%. By 2035, the region's smallest town, Baltimore, may lack sufficient distribution headroom to accommodate the amount of additional generation needed to meet the town's target~~,~~. By 2050, the town of Windsor may also lack sufficient distribution headroom if no upgrades to the system are made.

The ~~resulting~~ 2050 renewable generation target for the MARC region is 113,087 MWh, which is further broken down by town, based on each town's share of projected electricity demand. The target for each town is shown in Table ~~8~~14.

Table 14: 2050 Renewable Energy Generation Targets	Projected 2050 Electricity Demand (MWh)	Percent Of Regional Target ~~Contribution~~	2050 Target (MWh)	Existing Generation (MWh) as of 12/31/2024	Additional Generation Needed (MWh)	Total Incremental MW (2050)	Existing Distribution Headroom (MW)
Andover	8,785	1.76%	1,990	1,010	979	0.74	3.3
Baltimore	4,856	0.97%	1,100	76	1,024	0.78	0.5
Cavendish	22,023	4.41%	4,987	6,326	0	-1.03	4.4
Chester	62,310	12.48%	14,110	4,623	9,487	7.16	8.0
Ludlow	66,273	13.27%	15,008	814	14,194	10.64	13.8
Reading	12,896	2.58%	2,920	366	2,555	1.91	3.0
Springfield	171,750	34.39%	38,894	14,303	24,591	18.60	40.2
Weathersfield	51,678	10.35%	11,703	3,693	8,010	5.94	10.3
West Windsor	20,901	4.19%	4,733	1,628	3,105	2.31	6.3
Windsor	77,907	15.60%	17,642	7,399	10,244	3.86	3.5
Total Regional Target	**499,380**	**100%**	**113,087**	**40,237**	**74,189**	50.90	93.3

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) to achieve the goals established in the *2022 Vermont Comprehensive Energy Plan*. Both significant renewable generation and significant energy demand reduction are required to meet the region's goals. To meet the 90% by 50 state goal, the MARC region will generate113,087 MWh of renewable energy per year by 2050. (~~This~~ This target is equivalent to installed capacity of 86.1 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

A mix of renewable generation types is more desirable than relying on a single technology. The targets presented in Table 9 represent a reasonable path for how the MARC region can meet its overall renewable generation target.

Table 9: Renewable Generation Targets (MWh)	2025	2035	2050
Rooftop Solar	7,094	11,252	17,472
Ground-Mounted Solar	41,573	64,945	84,365
Wind (residential scale)	580	858	1,120
Hydro	9,288	9,625	10,130
Total Renewable Generation Target	**58,535**	**86,680**	**113,087**

These targets were determined based on resource mapping, competing land uses, 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. As of 12/31/24, the region has developed 3.8% of its current rooftop solar potential. By 2050, that percentage will increase to 10%.
2. The undeveloped potential for generating hydro power at 22 existing dam sites will be approximately 50% developed by 2050.
3. One percent (1%) of the region's renewable energy generation will be produced by residential-scale wind turbines. (Utility-scale and commercial-scale wind generation are not considered in this scenario.)
4. Ground-mounted solar arrays, located on preferred sites in prime areas to the extent feasible, will

generate the balance of renewable energy needed to reach the region's generation targets.

These targets represent a very small percentage of the total generation potential for the region. The 2050 ground-mounted solar target (84,365 MWh) is equivalent to about 64.2 MW of installed capacity, covering an estimated 562 acres of land (or 5.1% of the region's un-constrained solar generation area). The 2050 wind target is only 0.02% of the un-constrained wind potential in the MARC region, or about 34 residential-scale (30m) wind turbines.

❖ 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. They include areas with sufficient 'raw' resource potential and exclude areas of known or possible constraints (listed below). An additional analysis, funded by a Climate Pollution Reduction Grant, was conducted on the remaining potential areas to determine whether the generation facilities needed to meet the region's goals can be sited while avoiding 'forested areas' as defined below.

❖ "Known Constraints"

Known constraints involve conditions which would likely make development not feasible. Areas of known constraint are excluded from "Prime Generation" resource potential maps in this plan. (Maps E-2 and E-3) Known constraints include the following:

a) Vernal pools with a surrounding 50-foot buffer;
b) Vermont Department of Environmental Conservation (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" are areas which may render a site un-suitable for energy development after a site-specific survey has been conducted. These constraints signal conditions that would likely require mitigation and will likely increase the cost or difficulty of developing energy generation. Areas of possible constraint are excluded from "Prime Generation" resource potential maps in this plan. Possible constraints include the following:

a) Agricultural soils (Natural Resources Conservation Service - mapped prime agricultural soils, soils of statewide importance or soils of local importance);
b) Unconfirmed (but possible) vernal pools;
c) Act 250 agricultural soil mitigation areas;
d) FEMA special flood hazard areas (floodplain);

e) Protected lands (state fee lands and private conservation lands);
f) Deer wintering areas;
g) Vermont Agency of Natural Resources (ANR) conservation design highest priority forest blocks, connectivity blocks, surface waters, and riparian areas; and,
h) Hydric soils.

"Forested Areas" are areas of land with forest coverage which are part of 'habitat blocks,' (of any priority) as mapped by Vermont Agency of Natural Resources. This does not represent areas of *any* tree coverage, but rather areas of complete forest ecosystems. Forest ecosystems are valuable from an ecological, climate, and economic perspective and should be preserved whenever possible. Generation potential maps in this plan indicate 'forested' and 'unforested' areas. In terms of policy, Forested Areas should be considered Possible Constraints, and Regionally Identified Resources.

PREFERRED SITES

If energy is generated on a designated 'preferred' site, it is sold for a higher price through net-metering programs. Because of this, designating sites as 'preferred' is a powerful way to incentivize energy development. The following site categories are 'preferred' automatically under state law:

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.

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~~in addition to the state-determined categories, and few areas were designated as preferred. 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. Known, large, preferred areas with good solar potential include large buildings and open land in the North Springfield industrial park, vacant areas in the Ludlow industrial parks, large resource extraction sites in the Ludlow and Weathersfield. There are large areas of remediated brownfields with Solar potential in downtown Windsor, between the railroad and the river, but this land may be better used for housing or other development. See maps E-2, E-3.

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, as the presence of development (including renewable energy generation) may have significant impact on sensitive ecological areas such as vernal pools or wetlands.~~.~~ Currently, no ~~other~~ areas in the region have been designated as 'unsuitable' beyond areas of known constraint. See maps E-2, E-3

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 2017 and 2024. According to data provided in support of this enhanced energy planning process, as of May 2017, this region had 276 known solar project sites with a total capacity of nearly 6.6 MW. By 2024, there were 782 distributed solar project sites with a total capacity of 23.54 MW (in addition to the utility-scale, 19.6 MW Coolidge Array in Ludlow, which is not included in existing generation or generation targets).

The Potential Solar Resources Map shows 'prime' and 'prime – unforested' areas of solar potential. The Electricity Distribution Infrastructure map shows the locations of transmission lines and three-phase power lines. The solar potential data is based on a computer model that accounts for slope direction, slope steepness, and solar radiation values as well as areas of 'known constraint' such as wetlands, flood zones, and endangered species habitat. Figure 22 depicts the proportional relationship between the total land area in the region, prime solar potential land area, and estimated land area needed to meet the ground-mounted solar target.

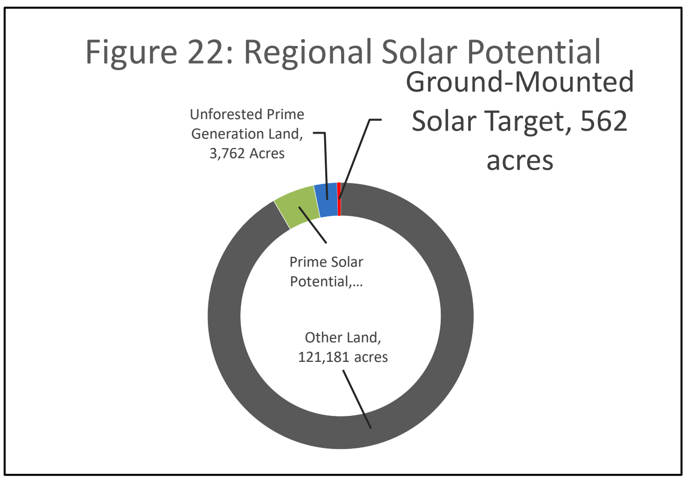


Figure 22: Proportional relationship between total land area in the region, land area of prime solar potential, and the estimated land area needed to address our renewable target

Approximately 43,4000 total acres of prime and secondary solar potential are in the region; about one third of the region's total land area. There are nearly 4,300 acres of prime solar potential land without habitat cover in the region. To meet the region's ground-mounted solar generation goal, we will need approximately 560 acres of land, or, less than 0.5% of the region's land. These areas represent a combination of public and privately-owned lands.

Ideally-sited solar projects will be out of view, on otherwise-underutilized land, near existing appropriate distribution and/or transmission infrastructure, and as close as possible to centers of electrical demand. However, given many competing priorities, it is not realistic to expect every solar array to meet all these criteria perfectly. For example, the 20 MW Coolidge Solar Project in Ludlow cannot reasonably be visually screened from the road due to its size. However, its topography localizes the visual impact and its proximity to the existing Coolidge Substation makes it a well-sited array.

Wind Resource Potential

According to available data in December 2024, there are three known wind turbine sites in this region, with about 0.02 MW of installed capacity -- generating approximately 44 MWh of energy. There have not been any commercial- or utility-scale wind power proposals in this region to date. Notable local opposition has been observed for utility-scale wind turbine proposals in Grafton and Windham, located adjacent to this region.

The region's wind generation potential is most plentiful in areas of high elevation in Ludlow and Andover. However, residential-scale wind generation may be possible throughout most of the region at lower elevations. The Wind Resources Map shows the region's prime, and un-forested wind potential sites. The wind potential data is based on 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.

Table 10: Summary of Generalized Wind Turbine Types

Scale	Hub Height	Lower Wind Speed Cutoff	Generalized Capacity
Residential	30 meters	4.5 m/s	≤ 10 kW
Community/Commercial	50 meters	5.5 m/s	≤ 100 kW
Utility	70+ meters	6.5 m/s	≥ 1 MW

Local concern has been expressed about potential wind projects. The siting of utility-scale wind is a divisive issue in this region and across Vermont as a whole. 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. Given these political obstacles (and the relative costs of generation), MARC assumes no utility-scale wind facilities will be constructed in the region.

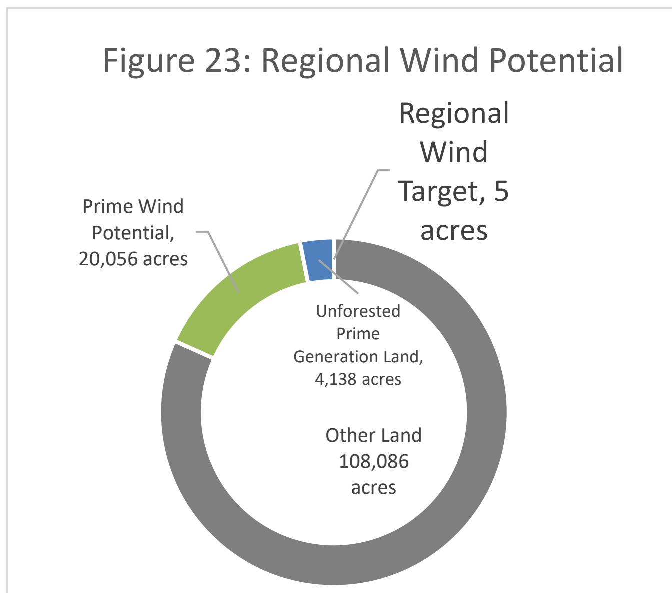


Figure 23: This graph illustrates the proportional relationship between the total land area in region, estimated wind potential land area, and the approximate land area needed to meet our wind target in Table 9.

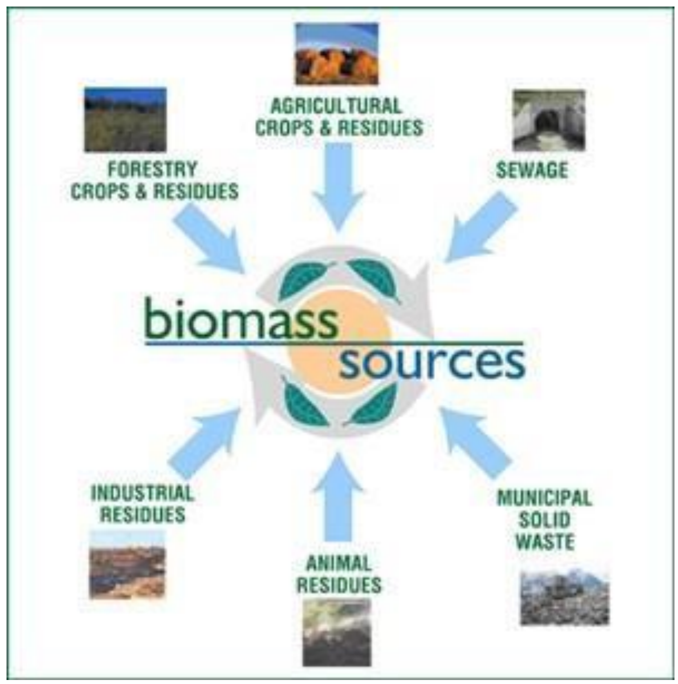
If a municipality, through its local planning process, identifies a preferred location(s) for utility-scale wind facilities within their boundaries, MARC may consider amending this plan to account for this local preference. Coordination and consensus among neighboring municipalities will be a critical 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.

Hydroelectric Resource Potential

Six existing hydro facilities are in the MARC region, totaling 2.64 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. Several other existing dams in this region have some generation potential but do not currently generate hydro-power.[12] 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. Although cost and permitting procedures may discourage the development of new hydro facilities, our renewable energy generation scenario, summarized in Table 9, assumes that the undeveloped potential for generating hydro power at 22 existing dam sites will be approximately 50% developed by 2050.

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 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.[13] In 2022, approximately 15%, of the region's homes used cord wood or wood pellet heating systems. By 2050, 20% of all homes will need to use Advanced Wood Heating systems to meet the 90/50 goals. There are several 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.

While biomass is a necessary and appropriate way to generate heat, due to its carbon, trucking, and ecological impacts, MARC considers biomass to be inappropriate for electrical generation, outside of certain co-generation applications. As such, we have not planned for any biomass generation to be constructed in the region.

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

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

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 business 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. This framework is expected to evolve over time to better meet the needs of the region.

General Energy Conservation Strategies

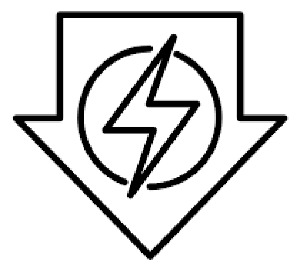
1) Encourage towns to establish energy committees to serve as advisory committees in accordance with 24 V.S.A Chapter 117 §4433 and §4464.
2) Work with town energy committees and other organizations to provide outreach and education for businesses concerning energy conservation practices for new construction 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) Encourage towns to include provisions for evaluating the energy efficiency of infrastructure improvements, and related cost savings, when developing or updating local purchasing policies Encourage statewide discussions with stakeholders (e.g. trucking industry, fuel dealers) about the transition towards our energy goals for 2050.

A. Electricity Conservation

Electricity consumption will become a greater contributor to the region's overall energy consumption over time. To realize the state goals as assumed by the LEAP model, additional electricity production will be required throughout the region, despite reductions in over-all energy use The following strategies highlight necessary steps in conservation. Implementation steps to support increased electricity generation are included below, in Section D.

Electricity Target

- By 2050, electricity consumption will increase to 67% of overall energy use in the region.



1) Support programs, such as those run by Efficiency Vermont, that promote the use of energy efficient equipment and devices and provide education on energy conservation.
2) Support and encourage the use of energy efficient appliances.
3) Encourage expansion of energy storage systems within the region both as a resilience measure to provide backup power during outages, and to help balance times of peak energy production with times of peak demand.
4) Promote building/design techniques that take advantage of daylight to minimize the need for daytime use of artificial lighting.
5) Support and encourage participation in the Vermont Energy Education Program (VEEP) to foster an appreciation for energy savings.
6) Work with towns and town Energy Committees to implement energy conservation measures in municipal facilities such as installation of efficient appliances, lighting, and switches.
7) Encourage towns to include links to Energy Efficiency Utility (EEU) resources on municipal websites.

B. Transportation Conservation

Transportation Targets

- In 2022, the transportation sector accounted for 33% of the region's energy use.
- Between 2025 and 2050, energy consumption by cars & light trucks will need to drop by 64.3%
- Privately owned vehicles consumed 9.8 million gallons of gasoline per year – this will need to be reduced to 550,000 gallons by 2050.

Overall, the region's transportation sector will require a 52% reduction in energy consumption, including a 64.3% reduction by cars and light trucks. This massive reduction in energy use will require considerable changes to transportation throughout the region. This goal will be met primarily through electrification of vehicles, less reliance on single-occupant vehicles, and compact land-uses which reduce distances travelled. 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 improve ridership and encourage transit trips in place of single occupancy vehicle trips.
3. Promote the GO Vermont program, which provides ride share, vanpool, and public transportation information and options.
4. Identify key areas, such as centers and growth areas, where improvements to bicycle and pedestrian access would encourage mode shift and work to improve access and infrastructure in those areas.
5. Improve internet access at speeds of at least 100/100 Mbps to enable telecommuting and reduce the need to drive to work.
6. Prioritize projects that close gaps in the active transportation and transit networks, for example by providing 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, reducing the need to travel
8. Promote the Drive Electric Vermont webpage, which informs drivers of financial incentives, dealers, and charging stations for EVs.
9. Partner with Drive Electric Vermont, towns, 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.

10. Partner with Drive Electric Vermont, the Vermont Clean Cities Coalition, and other organizations to promote the expansion of workplace charging, by continuing to fund incentives that help employers cover the costs of installing charging stations.
11. Promote and seek grants to fund the installation of DC fast-charging infrastructure at strategic locations along major travel corridors and in transit hubs.
12. Support continued funding for the installation of EV charging stations at tourist destinations and multi-unit dwellings. Promote the use of electric-assist bicycles (AKA e-bikes) as an alternative to single occupancy vehicles.

13. Encourage towns to adopt land use regulations that require the provision of secure bicycle storage facilities and EV-only parking spaces whenever a new parking area is established, or an existing parking area is expanded, for a business, commercial, civic, or multi-unit residential use.
14. Provide towns with site plan language to include in municipal land use bylaws that ensures safe bicycle and pedestrian access and circulation.
15. Review transportation and development projects to ensure that complete streets principles are implemented.
16. 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.

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.
- Wood as a heat source will increase in the Commercial sector with the installation of Advanced Wood Heating systems.

❖ Residential Heating Efficiencies

1) Promote the adoption of residential building energy label ordinances in the Region's towns as Montpelier has done.
2) Educate local zoning staff about their statutory role in promoting the use of residential 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 documents compliance with the State Energy code [24 V.S.A. §4449(a)(2)].
3) Encourage developers of multi-unit residential projects to follow the residential stretch energy code.
4) Educate the public on energy codes for both residential and commercial buildings.
5) Promote the use of geothermal heat pumps for new construction.
6) Encourage the use of landscaping, passive solar design, and siting principles in new buildings to reduce heating loads.
7) Encourage towns to support the use of advanced wood heat in residential settings by promoting wood stove change-out programs.
8) Encourage local planning commissions to support the construction of net-zero-ready buildings in municipal plans.

❖ Commercial Heating Efficiencies

1) Work with towns, partner organizations, and Energy Efficiency Utilities 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, manufacturers, 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 builders to incorporate net-zero ready construction methods in new buildings.
5) Educate local zoning staff about their statutory role in promoting the use of 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 documents compliance with the State Energy code.
6) Encourage local planning commissions to consider incentives (e.g. density bonuses) for developments that exceed the state's stretch energy code and locate in and around village centers and downtowns.
7) Support the establishment of wood fuel processing facilities.
8) Encourage businesses to consider replacing aging, inefficient fossil fuel heating systems with Advanced Wood Heat (AWH).

❖ Weatherization

1) Inform towns and residents about Energy Efficient Utility (EEU) programs, the state Weatherization Assistance Program for low-income households, and the new Weatherization Repayment Assistance Program (WRAP), and encourage residents to participate.
2) Encourage more efficient buildings through weatherization and use of high-performance building methods.
3) Encourage towns to conduct energy audits on municipal buildings and include the recommendations in Capital Plans.
4) Inform municipal officials about grants and loans available to fund energy improvements to municipal buildings.
5) Support vocational education programs that train workers to conduct energy audits and install weatherization measures.
6) Support local weatherization initiatives.
7) Promote the weatherization efforts of non-profit organizations like Window Dressers.
8) Work with partners to improve upon the availability and accessibility of data about completed weatherization projects within the region.

Renewable Energy Generation

Total regional renewable generation of 113,087 MWh by 2050

❖ General Renewable Energy Generation Strategies

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

1) Support renewable energy generation facilities that conform to our policies on the development and siting of renewable energy resources.
2) Structure policies 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.
5) Support community solar and microgrid projects that bring direct benefits to local communities, businesses, and municipalities and that conform to our policies on the development and siting of renewable energy resources.
6) Encourage the implementation of newer technologies that improve energy production and/or reduce impacts as they become available.
7) Encourage infrastructure improvements, such as transmission and energy storage projects, that facilitate energy generation in preferred locations.

❖ Solar Generation

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

1) Support rooftop solar projects.
2) Encourage the location of solar projects on preferred sites, as identified in this Plan.
3) Support residential-scale ground-mounted solar projects.
4) 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.
5) The setback standards in 30 V.S.A. §248(s) apply to all applicable ground-mounted solar projects.
6) 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

Figure 24: This is a photo of the Town-owned 150 kW solar project in Cavendish, 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)

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.

7) 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.
8) 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.
9) Ground-mounted solar facilities must avoid "known constraints".
10) 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 or less used 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, turbine 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

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 many significant 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;
- Elevated flood risk;
- 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).

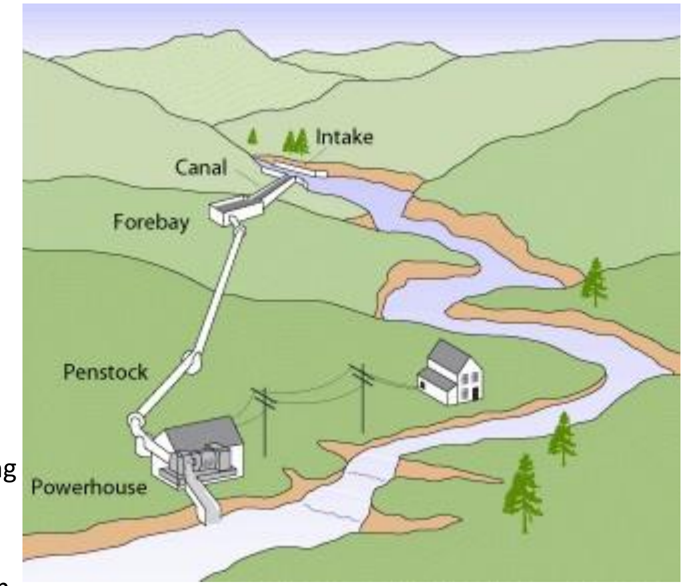


Figure 26: Illustration of a micro-hydropower system (U.S. Department of Energy)

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 the environment.
2) The applicant must provide adequate levels of data and analysis to evaluate the impacts that the hydropower facility will have on river dynamics and flood resiliency.
3) 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
4) A mitigation and enhancement fund shall be considered as one way to help address potential negative impacts of dam operations.

❖ Biomass

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 27: Wood chips in an industrial biomass application.


Figure 28: Wood stove (Peter Hudkins)

0The Mount Ascutney Region has limited potential for biogas at commercial scale; however, the MARC supports efforts to generate heat or power from biogas that is a bi-product of 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.

Assessment of Potential Equity Impacts

The purpose of this section is to evaluate what communities may be most impacted by the policies and standards in this Enhanced Energy Plan. Lower-income households are the least able to pursue many of these identified actions.

Most of the energy strategies in this plan are aspirational, where we encourage action or promote programs or information to help people make good energy efficiency-related decisions. The mandatory policies in this plan are targeted toward commercial- or utility-scale renewable energy generation targets. As such, the primary implications or burdens will not fall on individual property owners, rather energy developers.

Many energy efficiency strategies – such as weatherization, electric vehicle purchases, and investment in solar panels on a home – are cost prohibitive, especially for low- or moderate-income households. We attempt to highlight programs that can assist in those situations, such as through SEVCA, volunteer efforts like Reading's Energy Committee, or similar programs. Given the current costs of housing, property taxes, health insurance, transportation and other daily necessities, it is unfortunately likely that incentive programs will not be sufficient for some people to take advantage of some of these strategies. These are systemic, societal issues beyond our ability to address adequately.

This plan pursues a lot of lower-cost strategies that would benefit these demographic groups, such as travel by public transportation, walking or electric bicycles. Additionally, our policies promoting compact settlement patterns and encouraging new housing in walkable villages, would benefit all residents regardless of income levels by promoting land use patterns that better enable active transportation and transit, and provide better access to jobs and services.

For more discussion of equitable access to clean and renewable energy, see Chapter 8 Benefits and Burdens.

Regional Enhanced Energy Plan, Volume 3, Maps