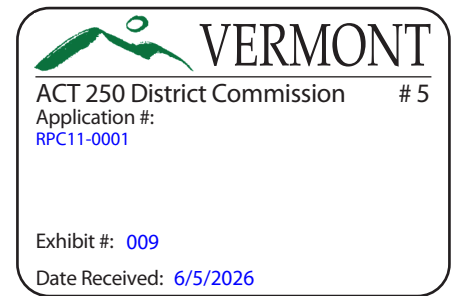


CHAPTER 7: ENERGY

BACKGROUND



A reliable and affordable supply of energy is critical to our region. While many energy issues are national or global in scale, land use decisions and the way in which the region develops has a direct and lasting impact on the types of energy needed and amount of energy input necessary to sustain our communities. The Windham Region can lead by example by analyzing current energy usage, looking for areas of improvement, increasing the efficiency of the region's energy dependent systems, and supporting local energy generation options that benefit communities. For the purposes of this Plan, energy is defined as usable power that is derived from fuel sources such as transportation fuel, heating fuel, or electricity generation sources.

A key premise underlying this energy discussion is the need for significant progress on several fronts:

- **Energy Security:** Much of the Vermont's electricity is generated in facilities outside of the state, and the state has a significant reliance on imported fossil fuels. Diversifying our energy sources will allow the region to reduce dependency on foreign sources and to increase stability and resiliency in the event of supply interruptions or cost fluctuations.
- **Environmental Protection:** Our current pattern of energy use has significant negative impacts on the environment, especially regarding greenhouse gas emissions, other air quality impacts, and subsequent impacts on water quality and other natural resources.
- **Economic Costs:** Households spend a significant amount of money on annual electricity, heating, and transportation costs. Increased conservation and efficiency in all energy uses will allow residents to reduce their energy costs. There are also opportunities for economic and job growth in the clean energy sector, including renewable energy facilities and building weatherization.
- **Equity:** As the Windham Region, and the State, moves forward with energy transitions in order to meet greenhouse gas reduction and renewable energy consumption targets, energy policies and actions need to be accessible to all.

A primary purpose of the Energy Chapter is to implement the [2022 Vermont Comprehensive Energy Plan \(CEP\)](#) and the [2021 Vermont Climate Action Plan](#) within the Windham Region. The CEP lays out an ambitious task for the State: to source 90% of its energy from renewable resources by 2050 (referred hereafter as 90x50 Goal).

The following sections discuss current and anticipated future energy use for the Windham Region, specific

renewable energy targets, and greenhouse gas emission reductions in the electricity, thermal, and transportation sectors. This Plan identifies goals and strategies under the pathways of Conservation and Efficiency, Land Use, Transportation, Renewable Energy Siting, and Equity in order to achieve these energy targets. Additionally, the Plan provides maps showing the potential for solar and wind energy generation in the region, known and possible constraints in renewable energy generation siting, transmission and distribution resources and constraints, transportation infrastructure, and possible locations for siting renewable energy generation.

CURRENT USE

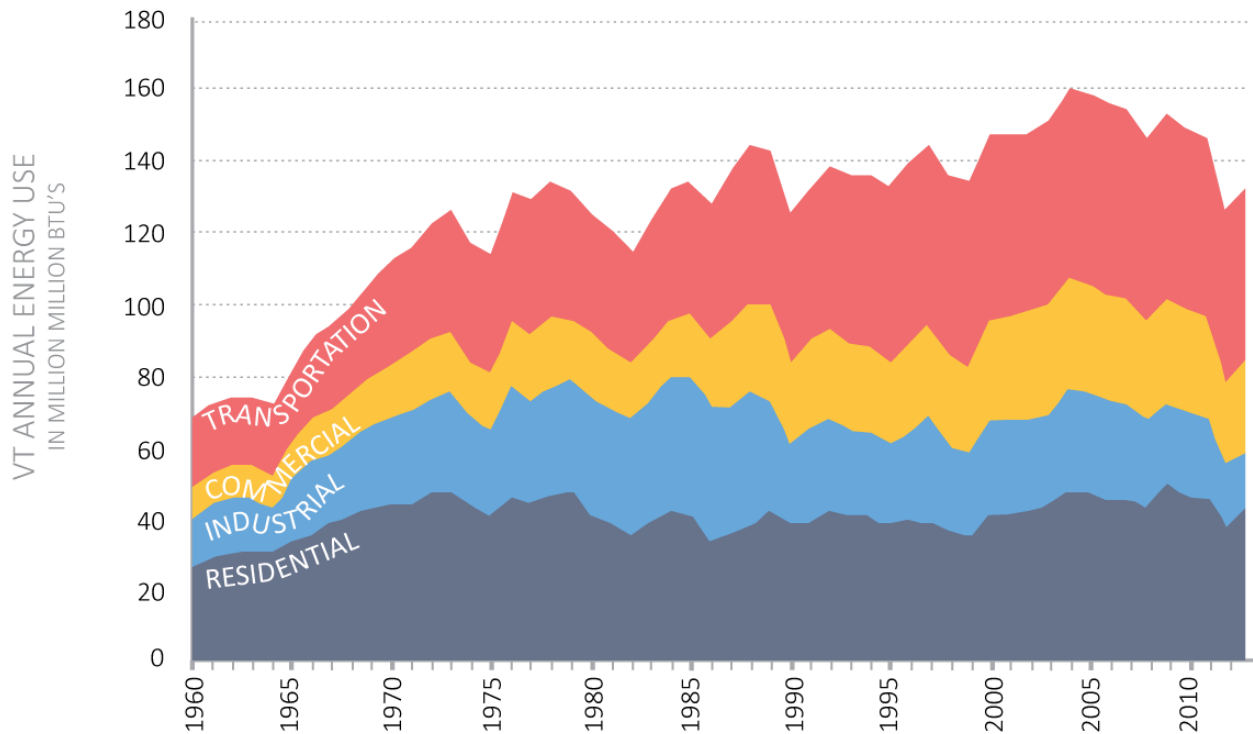
ENERGY CONSUMPTION AND DEMAND

In this plan, energy is divided into three sectors: electricity, transportation, and thermal. This section focuses on the amounts used in total units. The numbers presented are the most accurate estimates based on recent data sourced from the American Community Survey, Department of Labor, the Vermont Agency of Transportation, Efficiency Vermont, Drive Electric, and the Energy Information Administration. The discussion of this data serves as the context for the energy plan; it is the starting point from which the Region will progress to achieve the goal set out in the Vermont Comprehensive Energy Plan (CEP) of 90% renewable by 2050 (90x50 Goal).

NOTE ON ENERGY TERMINOLOGY

A significant technical note should be made here, and that is the distinction between energy measured at the point of consumption, called “end-use,” and energy measured as generated, called “primary-use.” End energy use is measured at the point of use, as it enters—or is delivered to—the consumer’s home, building or vehicle. Primary energy use includes the delivered energy plus the energy that is lost in generation, transmission and distribution. This is especially important in the case of electric generation because thermal power plants can shed up to two units of heat energy for every one unit of electric energy that is produced. End-use consumption is the measure most often used in reports of energy use because it provides a better baseline for comparison. It will be referenced here when that data is available.

FIGURE 1: HISTORIC ENERGY USE IN VERMONT BY SECTOR¹



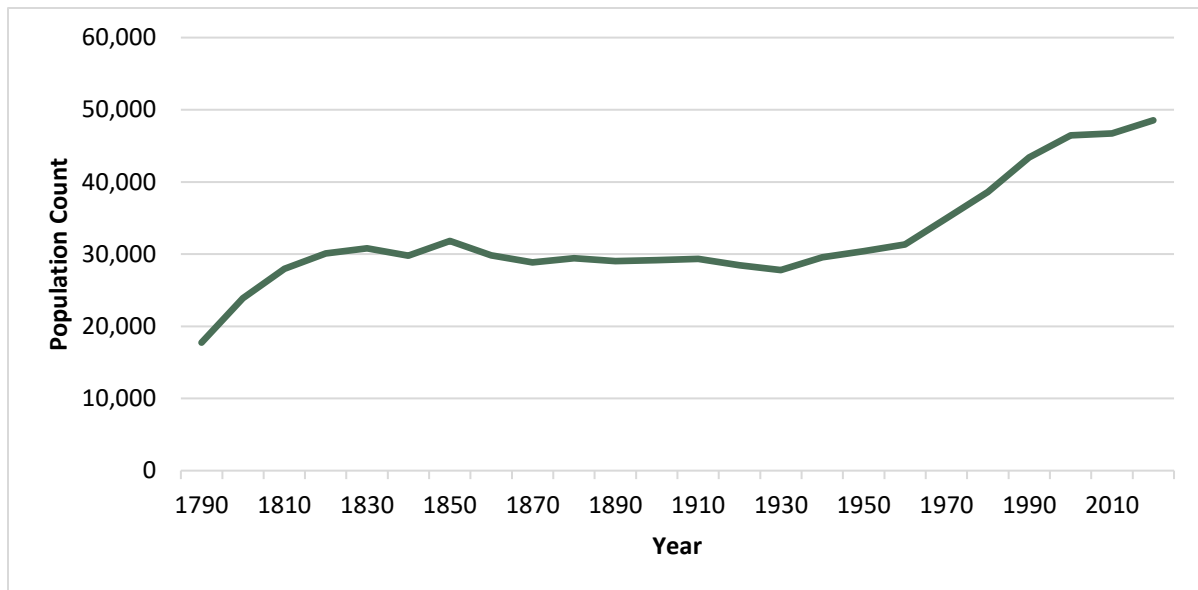
GROWTH AND ENERGY USE

Over the last 80 or so years, both the State of Vermont and the Windham Region have drawn energy from multiple sources, primarily gasoline, liquid petroleum gas, and wood. Overall consumption throughout the 20th century has increased dramatically, with some decline around the “Great Recession” of 2008 (see Figure 1).

Energy consumption has generally tracked with population growth. While still a rural state, the period of 1790 to 1830 saw significant growth within the Windham Region, which then leveled off for more than a hundred years until around the 1950s, when resort development and an in-migration known as the “back to the land movement” started a boom in population growth that has steadily increased through the 2020 Census. Figure 2 below shows the Windham Region’s population over time.

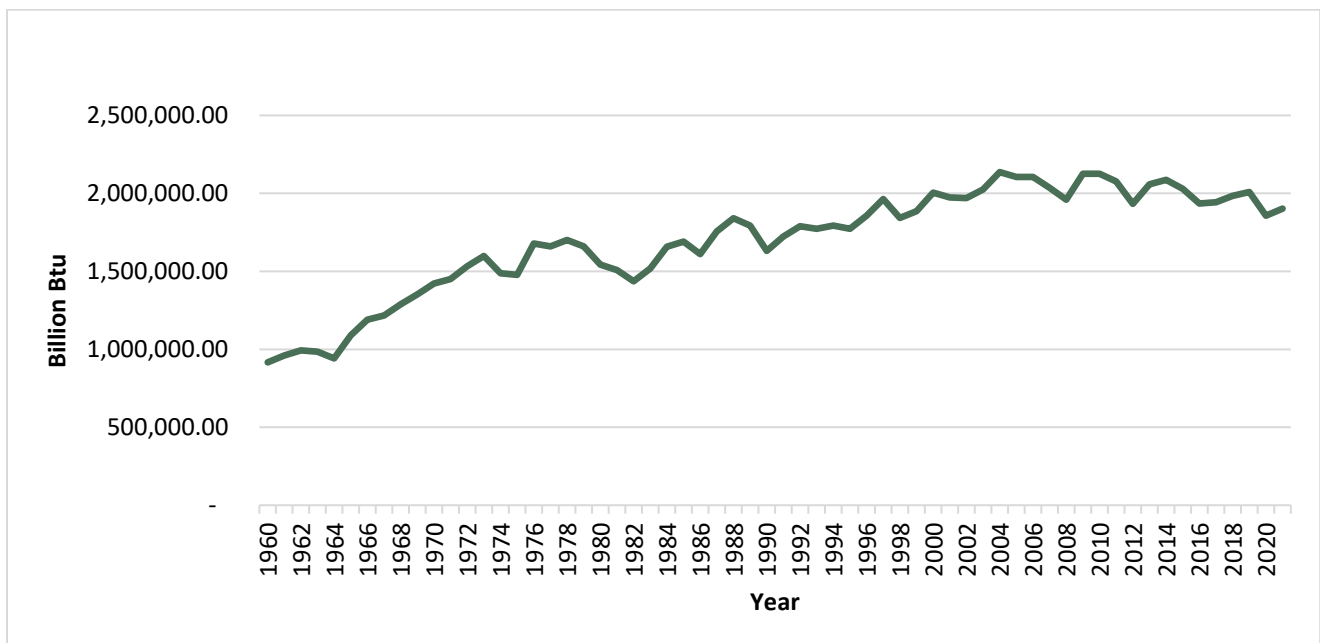
¹ [Windham Regional Energy Plan](#), 2018.

FIGURE 2: WINDHAM REGION POPULATION, 1790 – 2020²



Overall energy demand in Vermont has grown from 916,422 Billion Btu in 1960 to its peak of 2,126,482 Billion Btu in 2009, a 43.1% increase. Since 2009, the demand has fluctuated with an overall decrease to 1,901,952.22 Billion Btu in 2021 (See figure 3).

FIGURE 3: TOTAL END-USE ENERGY CONSUMPTION ESTIMATES IN VERMONT, 1960-2020³



² Data Source: U.S. Census (2010, 2020) Vermont Indicators, <http://www.vcgi.org/indicators> (1790 - 2000).

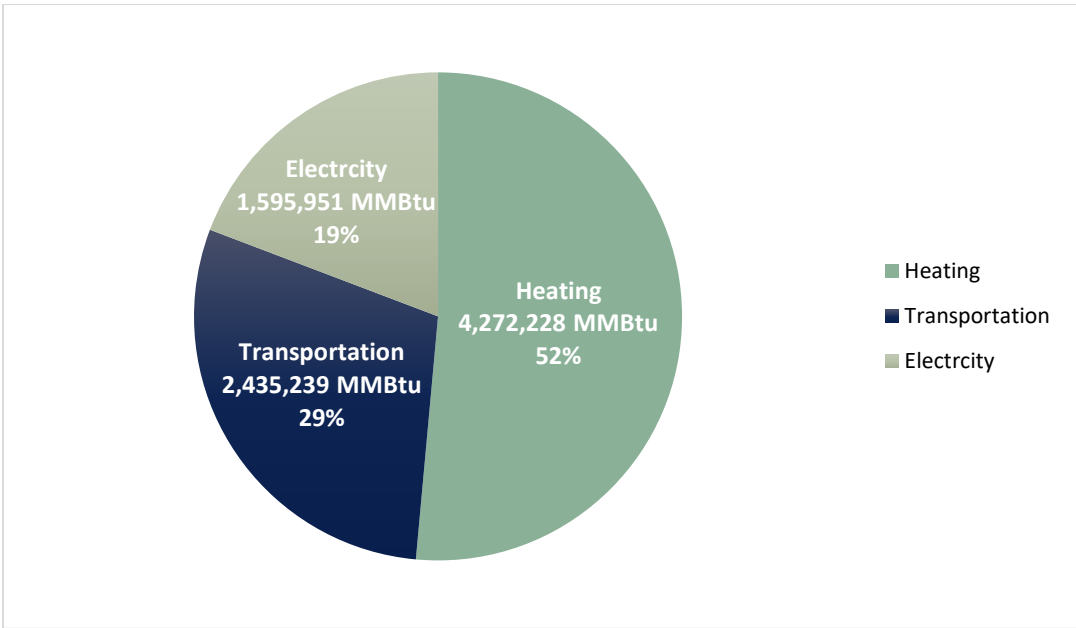
³ US Energy Information Administration: State Energy Data System 1960-2022. <https://www.eia.gov/state/seds/seds-data-complete.php?sid=VT#Consumption>.

Economic activity in the Region has mirrored the population trends, and is another indicator of energy consumption within the Region. Additional employment, industrial output, and higher wages typically increase the demand for energy resources; however, the Vermont economy has been able to accommodate additional (real) economic growth with relatively steady energy input.

WINDHAM REGION CURRENT ENERGY USE AND THE COST OF ENERGY

In 2023, the Windham Region consumed **8,301,324 Million Btu (MMBtu)** across the electricity, heating, and transportation sectors (Figure 5). With each of the three sectors depending heavily on fossil fuels as the primary energy source, a majority of these dollars leave the state and local economy.

FIGURE 5: ENERGY CONSUMPTION IN THE WINDHAM REGION, BY SECTOR⁴



The economic cost of energy to individuals, as well as public and private entities, is one of the biggest concerns expressed about energy consumption in Vermont. During the Vermont Public Service Department’s (PSD’s) 2022-2023 public engagement process for reviewing Vermont’s renewable energy policies and programs, energy affordability and reliability were the number one concerns for residents. Every person and business in Vermont need to be able to afford electricity, transportation access, and heat at prices that they can afford, and cost is an important factor to consider during our Region’s transition to a more reliable, renewable energy future. As important as the

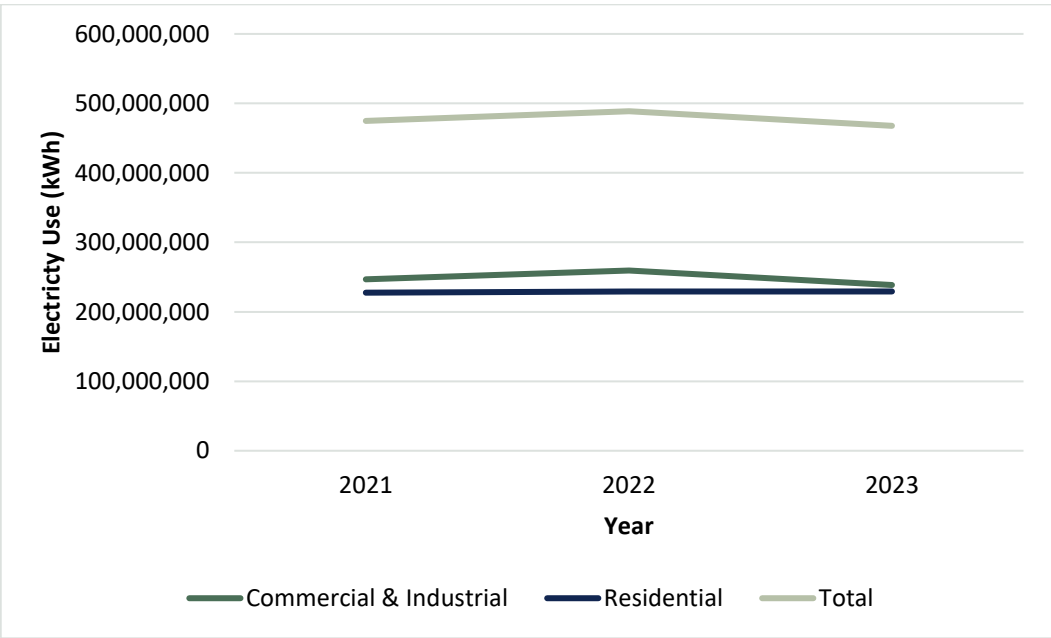
⁴ Estimates for thermal and transportation sector energy use were calculated using the Vermont Public Service Department’s (PSD’s) Municipal Consumption Tool, with input from several key data sources, including the 2023 American Community Survey, the Vermont Department of Labor’s Economic and Labor Market Information, the Vermont Department of Motor Vehicles, Drive Electric, and the US Energy Information Administration. Electrical energy use is reported directly to the Windham Regional Commission by Efficiency Vermont. Refer to Appendix B of the Energy Chapter for a full description of the methods used to calculate regional energy consumption.

cost of energy is, it is also variable and harder to build energy targets around. This plan will focus on amounts consumed as a way to track energy usage.

ELECTRICITY

Efficiency Vermont has compiled electrical usage data from Vermont distributors Vermont since 2014 and reported on regional usage to the Regional Planning Commissions. Since 2014, the highest total amount of electricity used in the Windham Region was in 2016 at 502,864,000 kWh. Since that time, there has been some fluctuation in total usage for the region, but the overall trend has been a decrease. In 2023, the year of the latest data report, total usage was **467,727,049 kWh**, a decrease of 6.9% from 2016.

FIGURE 6: ELECTRICITY USE IN THE WINDHAM REGION BY YEAR AND CATEGORY, 2021 - 2023⁵



EXISTING GENERATION FACILITIES

The Windham Region has a robust history of harnessing its natural resources to generate electricity. The Region has an installed generation capacity of **189.4 MW**. Based on this capacity figure, it is estimated that **623,819 MWh** are produced annually across 1,300 solar sites, 14 wind sites, 6 bio-generation sites, and electricity-generating dams on almost every major waterway.⁶ The following two tables provide a town by town breakdown of the existing generation facilities in all 27 towns in the Windham Region.

⁵ Data compiled from WRC Efficiency Vermont Data Reports between 2022-2024.

⁶ Information on existing generation in the Region comes from ISO New England, which conducts a triannual survey of all distribution utilities in New England.

TABLE 1: INSTALLED GENERATION CAPACITY OF RENEWABLES IN WINDHAM REGION TOWNS (MW)

Town	Solar	Wind	Biomass	Hydro
Athens	0.11	0	0	0
Brattleboro	11.09	0	1.89	0
Brookline	0.18	0	0	0
Dover	0.92	0	0	0
Dummerston	1.02	0	0.14	0
Grafton	0.51	0.00	0	0
Guilford	2.20	0	0	0
Halifax	0.22	0	0	0
Jamaica	0.68	0.01	0	2.41
Londonderry	1.48	0	0	0
Marlboro	0.33	0.00	0	0
Newfane	0.95	0	0	0
Putney	3.34	0	0	0
Readsboro	0.12	0	0	0
Rockingham	2.45	0.01	0	41.29
Searsburg	0.01	36.00	0	0
Somerset	0	0	0	0
Stratton	0.11	0	0	0
Townshend	0.88	0.01	0	0.96
Vernon	0.87	0	0	32.40
Wardsboro	0.11	0	0	0
Westminster	6.20	0	0.45	0
Weston	0.42	0	0	0
Whitingham	0.25	0.01	0	33.60
Wilmington	1.09	0.02	0	0
Windham	0.08	0	0	0
Winhall	4.61	0.00	0	0
REGIONAL TOTAL	40.2	36.1	2.5	110.7

TABLE 2: ANNUAL ELECTRICITY PRODUCTION IN WINDHAM REGION TOWNS (MW)

Town	Solar	Wind	Biomass	Hydro
Athens	150	0	0	0
Brattleboro	14,573	0	11,589	0
Brookline	240	0	0	0
Dover	1,203	0	0	0
Dummerston	1,345	0	871	0
Grafton	675	4	0	0
Guilford	2,889	0	0	0
Halifax	291	0	0	0
Jamaica	891	19	0	10,539
Londonderry	1,947	0	0	0
Marlboro	440	2	0	0
Newfane	1,245	0	0	0
Putney	4,387	0	0	0
Readsboro	154	0	0	0
Rockingham	3,217	17	0	180,828
Searsburg	18	70,956	0	0
Somerset	0	0	0	0
Stratton	140	0	0	0
Townshend	1,153	19	0	4,200
Vernon	1,142	0	0	141,912
Wardsboro	146	0	0	0
Westminster	8,147	0	2,759	0
Weston	553	0	0	0
Whitingham	322	13	0	147,168
Wilmington	1,434	44	0	0
Windham	104	0	0	0
Winhall	6,064	4	0	0
REGIONAL TOTAL	52,870	71,078	15,220	484,651

DISTRIBUTION UTILITIES

Vermont distribution utilities source their electricity through generation and purchasing to meet demand. Figures 7 and 8 show Vermont's electricity characteristics. Figure 7 shows the electricity Vermont utilities generated and bought to meet demand. Figure 8 shows how renewable Vermont's energy is based on retired renewable energy certificates. Charts were provided by the Vermont Department of Public Service.⁷

FIGURE 7 - VERMONT'S RENEWABLE GENERATION AND PURCHASE ENERGY MIX

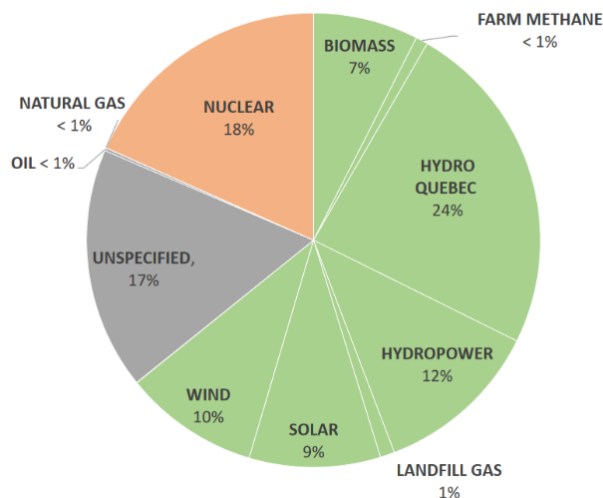
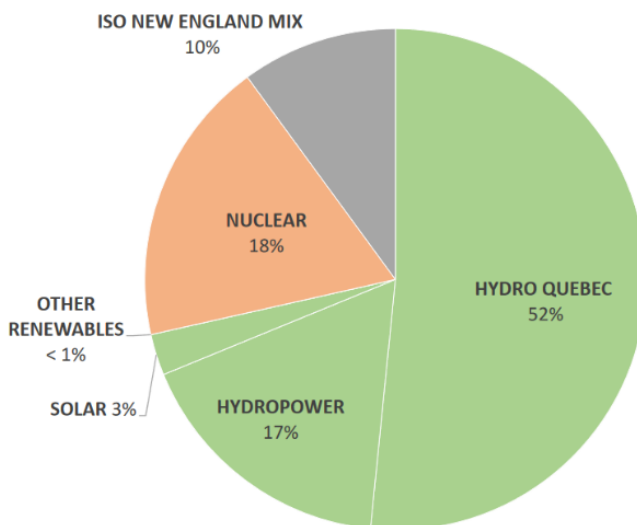


FIGURE 8 VERMONT'S RETIRED RENEWABLE ENERGY CERTIFICATE



⁷ Where Does Vermont's Electricity Come From? Presentation by the Public Service Department on January 31 and February 2, 2023.
<https://publicservice.vermont.gov/sites/dps/files/documents/Webinar%201%20-%20Where%20does%20VT%20electricity%20come%20from.pdf>

Vermont has several policies and programs that address renewable and clean energy in the state. Additional information can be found on the public service department website about the state policies and programs that address renewable electricity and the transitions required to achieve state energy and climate goals, as laid out in the 2022 Comprehensive Energy Plan (CEP) and the 2021 Climate Action Plan (CAP).

Vermont electricity distribution utilities purchased over 5.8 million MWh of electricity to meet the demand of Vermont consumers in 2021. Of this, approximately 64% came from renewable resources and about 18% came from carbon free resources. In 2021, Vermont distribution utilities also retired just over 4 million MWh in renewable energy certificates to meet the utilities' requirements under Vermont's Renewable Energy Standards. Of the retired credits, 72% was accounted for as renewable and, if nuclear is included, 90% of it was low-carbon⁸

The Windham Region is serviced by two electricity distribution utility companies: Green Mountain Power and Jacksonville Electric Company. Green Mountain Power cover the majority of the Windham Region and Jacksonville Electric's service area is the Village of Jacksonville and the Town of Whitingham.

ELECTRIC TRANSMISSION

The Vermont Electric Power Company, Inc. (VELCO) manages the safe, reliable, and cost-effective transmission of electric power throughout Vermont, and is a part of the integrated New England regional network. VELCO updates its Long-Range Transmission Plan every 3 years. The [2024 Long Range Transmission Plan](#) highlights that peak demand is forecasted to grow significantly due to accelerating electrification of the heating and transportation sectors. While the transmission system has sufficient capacity to serve expected future demand for the first 10-years of the 20-year planning horizon, the Plan identifies several challenges that will need to be addressed:

- Substantial infrastructure investments will be necessary to meet future electrical demand—these will either come in the form of traditional grid upgrades (build out of transmission infrastructure, line rebuilds, transformer capacity enhancement, etc.) or alternative approaches, like increased energy efficiency, storage solutions, and smart grid technologies.
- Currently, distributed generation (DG) projects are reviewed on a project-by-project basis without regard to transmission system impact. To prevent further stressing transmission and distribution systems, carefully coordinated statewide planning is required to successfully integrate future distributed generation

⁸ See 3 one-page resources for more info: [Where does Vermont's electricity come from?](#), [Current policies & programs](#), and [Tradeoffs between different sources of electricity](#)- these documents were made available as part of the Say WATT? Regional Event Series in the fall of 2023 during which the Department of Public Service partnered with the RPCs to offer a series of engagement opportunities for Vermonters to weigh in on renewable electricity policies and programs.

and storage without significant grid reinforcements.

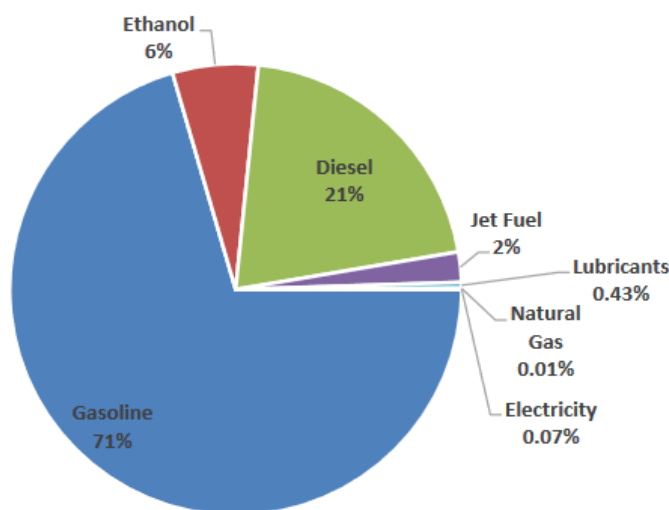
- There are sub-transmission scale reliability issues (categorized as causing high or low voltage, or a thermal overload in which equipment exceeds its rate temperature).

As distribution utilities prepare for increased electrification, coordination between VELCO, the utilities, the Region, and municipalities will be increasingly vital to ensure that Vermont can meet its energy goals, minimize negative impacts to natural resources, maximize benefits to Vermonters, and prioritize those who have been disproportionately burdened by energy costs and reliability issues.

TRANSPORTATION

As Vermont is a rural state, car dependency is not only a social norm but a necessity in most cases. The land use pattern of dispersed settlements encourages car use by creating long distances between destinations. In Windham County, the average travel time to work in 2022 was 22.2 minutes.⁹ Most of these trips were with vehicles with a single occupant. Transportation consumes a large portion of the total petroleum used, and has steadily increased since the 1960's, though the trend is now leveling off.

FIGURE 9: TRANSPORTATION ENERGY CONSUMPTION BY FUEL TYPE IN VERMONT, 2019



When looking at the total number of registered private vehicles in the State, gasoline and diesel-powered vehicles greatly outnumber the number of plug-in electric vehicles (EVs). There has been consistent growth in the number of gasoline-powered hybrid electric vehicles (GHEVs), plug-in hybrid electric vehicles (PHEVs), and all-electric vehicles (AEVs) over recent years. However, the overall small percentage of this vehicle type does little to offset the

⁹ Data USA: Windham County, VT <https://datausa.io/profile/geo/windham-county-vt>

substantial percentage of vehicles fueled by gas and diesel. Fuel efficiency of these classifications of vehicles has a direct impact on the amount of fuel used by the residents of the Region.

FIGURE 10: PRIVATE VEHICLES REGISTERED IN VERMONT BY FUEL TYPE, 2008-2020¹⁰

Fuel Type	PEV ¹		Propane / CNG	Diesel	Gasoline	
	AEV	PHEV			ICEV	Gas: HEV
2008	NA	NA	75	32,140	578,881	4,656
2009	NA	NA	69	30,724	528,930	5,473
2010	NA	NA	59	25,932	524,810	5,877
2011	NA	NA	51	28,513	550,711	7,056
2012	48	140	48	38,684	541,872	7,693
2013	130	466	43	28,209	516,339	7,945
2014	197	670	43	29,879	525,199	9,242
2015	248	865	44	31,239	533,118	9,895
2016	330	1,192	43	31,213	533,021	10,676
2017	695	1,632	40	30,597	548,417	11,556
2018	1,010	1,975	37	30,699	546,340	12,027
2019	1,600	2,116	37	30,961	533,196	12,219
2020	2,063	2,297	37	30,941	515,236	12,341

¹ PEV data includes public as well as private vehicle registrations. Data for all years is through December 31st.

Sources: VDMV, 2021; Drive Electric Vermont, 2021.

According to data from Drive Electric, Electric Vehicle registration in the Windham Region has steadily increased between 2021-2023. This mirrors Vermont's trend, but in order to meet future goals, this rate of increase will have to be even greater than the past few years.

TABLE 3: ELECTRIC VEHICLE REGISTRATION IN THE WINDHAM REGION, 2021 – 2023¹¹

Vehicle Type	2021	2022	2023
All Electric	245	316	497
Plug in Hybrid	289	358	436
Total	534	674	933

¹⁰ Vermont Transportation Energy Profile, 2021.

<https://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/2021%20Vermont%20Transportation%20Energy%20Profile.pdf>

¹¹ Drive Electric: Vermont EV Registrations by Municipality as of Jan 2024, 2024.

<https://veic.maps.arcgis.com/apps/mapviewer/index.html?webmap=7a62de8f69954804889c86a12a9640c8>

INDIVIDUAL VEHICLE MILES

In the Windham Region, transportation accounts for 29% of total energy consumption (Figure 5). The leading fuel for transportation is gasoline followed by distillate fuels (diesel). Because transportation-related energy use is mainly determined by the individual vehicle miles traveled by residents and visitors, addressing fuel consumption via the personal vehicle is a priority. Recently, fuel efficiency improvements have gained traction as a public policy issue. These gains in fleet efficiency, however, may be offset when total vehicle miles traveled increases faster than the population grows, since total petroleum consumption is still increasing.

Vehicle Miles Traveled (VMT) is an estimate of total miles driven by all vehicles on a road network. Factors affecting VMTs include how far vehicles go, frequency of trips, and number of people in a vehicle. According to the Federal Highway Administration, between 2008 and 2020 Vermont consistently ranked higher in VMTs per capita than the national per capita average number of VMTs. This is mostly due to Vermont's rural character. For 2020, Windham County accounted for 507.193 (in millions) VMTs. The entire state of Vermont came in at 5,990.6 (in millions) VMTs. Windham County contributes to 8.5% of Vermont's VMTs. Windham County has 6.74% of Vermont's population and accounts for a higher percentage of VMTs.

The Public Service Department's Municipal Consumption Tool was used to generate estimates for transportation sector energy use in the Windham Region. To account for the higher amount of VMTs per capita in the Windham Region, the average annual VMTs is assumed to be 13,250 VMTs compared to the state average of 12,500 VMTs. According to the 2023 American Community Survey (ACS), the Region has 20,680 primary housing units (not vacant or used for seasonal/recreational purposes). Based on the number of households, it can be estimated that there are 34,424 light-duty vehicles (LDV), which consume 18,785,147 gallons of fossil fuel each year. The total amount of energy consumption for internal combustion engine vehicles is calculated to be **2,435,239 MMBtu**.

FUEL EFFICIENCY

Fuel efficiency has increased over time, but the overall average miles per gallon (mpg) rate in the U.S. peaked in the late 1980s and then began declining. This downward trend should see a reversal in response to the [Federal fuel efficiency standards](#) of 2011, which required a 35.5 mpg average for the U.S. auto industry by 2016. Although this new standard would only affect cars built after that time, the potential exists for it to have an impact on the overall efficiency of the State's current vehicle fleet. The majority of the vehicle fleet in Vermont fell within the 21-27 mpg efficiency range based on the vehicles registered in 2021. This range is likely lower than the federal fuel efficiency standards due to the overall age of the vehicles currently on the road, and that 15% of the Vermont registrations could not be matched to fuel economy.

LAND USE

Settlement patterns and vehicle choice play major roles in high per capita fuel consumption, and the rural landscape of the Windham Region has led to homes being built far from downtown and village centers, where services are accessed. The result of separated residential areas is that trips to markets, schools, and work tend to be only possible with the use of an automobile. In the Windham Region, rural residential sprawl has occurred where homes located along rural roads have been separated from all other aspects of daily life.

Another factor affecting fuel consumption is the location of major employers far from residential areas and the development of strip commercial areas designed and built at scales that encourage automobile access and discourage pedestrian and bicycle traffic. Increased road capacities that encourage more driving at faster speeds may also have helped contribute to the increased per capita transportation energy use. The Vermont Department of Public Service estimates that lowering the speed limit to 55 miles per hour on the Interstate highways would lead to a 3% reduction in State-wide fuel consumption. While such a reduction in speed limits may not be politically feasible, education of drivers regarding driving habits and the costs of faster speeds may encourage individuals to reduce their driving speeds voluntarily.

THERMAL

Estimates for thermal energy consumption are significantly influenced by building type and use case. As a result, the following section describes the methods and assumptions used to separately determine residential and commercial heating consumption in the Windham Region. Industrial building thermal demand is not included in the analysis due to a lack of available data. The 2023 Municipal Consumption Tool was used to derive heating consumption estimates for the Region and to organize key assumptions about the data.

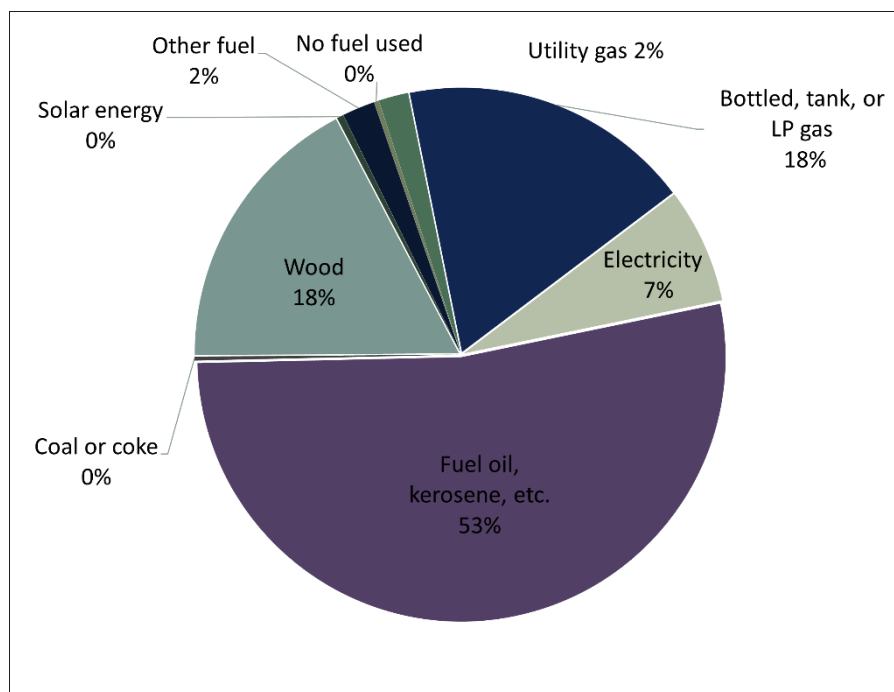
RESIDENTIAL

The average annual heating load for residences in the Region was assumed to be the same as the state average of 110 MMBtu for both space and water heating. According to the 2023 American Community Survey, there are 32,975 housing units in the Region, 20,680 of which are year-round residences (designated as “occupied units” by the Census). 1,459 of these primary residences are heated by electrical heating systems. Efficiency Vermont’s data on regional electrical demand (see “Electricity” section above) accounts for electricity used to heat homes, so to avoid double-counting this category of consumption, these 1,459 residences are subtracted from the analysis, leaving 19,221 residences. The annual thermal energy used in primary homes is therefore, **2,114,310 MMBtu**.

Figure 11 illustrates this energy consumption by fuel type. The Region depends heavily on fuel oil and kerosene, with

this fuel source supplying over 50% of the residential heating needs. As most of the fuel types are not locally produced (fossil fuel sourced), the funds going to this supply are funneled out of the state and Region.

FIGURE 11 WINDHAM REGION RESIDENTIAL HEATING FUEL TYPES¹²



Wood provides 18% of the residential heating needs for the Region. The Windham Region has some of the most robust lumber resources in the state. A study completed by Innovative Natural Resources Solutions (INRS) revealed Windham County has the most volume of standing trees of any Vermont county at 1.6 billion cubic feet and grows over 20 million cubic feet per year (approximately 250,000 cords). The forests in Windham County are more productive than other Vermont counties because they are found at lower elevations characterized by richer soils.¹³ With this abundant resource, the Region has the ability to support a significantly higher percentage of its heating needs with advanced wood heating options while supporting an important local economy.

Electricity is currently only 7% of the energy used to heat homes. However, with State incentives, desires to move to a cleaner heat source, and the additional cooling benefits of Electric Heat Pumps, many residences and commercial establishments are increasingly installing these systems as primary or secondary sources of heat. WRC expects to see the electric sector rise as a source of heating in the region.

In the Windham Region, there is also a high percentage of seasonal homes, at 37.2% of total housing units. Based on the energy model projections from the state, (see Vermont Pathways Output Discussion below,) it can be assumed that seasonal homes only use about 15% of the energy of a primary home, due to more occasional use and a

¹² Data Source: U.S. Census, American Community Survey, 2023.

¹³ INRS, An Initial Wood Supply Analysis for the Windham Wood Heat Initiative, 2015.

presumed higher energy efficiency. However, seasonal homes in the Windham Region are often used for longer periods of time and for more energy-intensive applications, like winter lodging. To account for this dynamic, towns on the eastern half of the region are estimated to use 15% of the energy of year-round homes, while towns on the western half of the region (which are closer in proximity to the region's winter recreation areas), are estimated to use 25% of the energy of primary residences. As such, seasonal homes in the Region are estimated to consume about **306,102 MMBtu** of the Region's total heat consumption.

COMMERCIAL

For commercial establishments, it is estimated that the average annual heating load in the Region is 1,080 MMBtu. For the state, the average is 700 MMBtu to 750 MMBtu, but the average for any given area will be significantly higher or lower, as the mix of businesses from region to region is highly variable. Based on the types of businesses in the Windham Region, the commercial heating load was determined to be higher than the state average.¹⁴ With 1,713 commercial establishments in Windham County, there is an estimated thermal energy demand of **1,849,522 MMBtu** per year. Like the residential sector, the largest percentage of fuel type used for commercial heating is fuel oil and kerosene. With the variable costs of oil from year to year, some businesses have been looking for alternative ways to heat their establishments. For example, in the Windham Region, 49% of public schools are operating Advanced Wood Heat systems, and 6% are operating under solar systems.¹⁵

WINDHAM WOOD HEAT PROGRAM

The Windham Regional Commission and several partners operated the Windham Wood Heat Program from 2015 – 2022. This program, with funding provided by the closure of Vermont Yankee Nuclear Plant, was operated under guidance from the State of Vermont Clean Energy Development Fund. WRC distributed funds through competitive grants to public entities and public facing organizations. Through this program, 9 AWH systems were installed in public schools, 2 in public facing institutions, and 2 in new public facing institutions. Through an independent evaluation, these installations had a verified CO₂ Reduction of 1,009 tons. Annual verified fossil fuels saved were 102,210 gallons of fuel oil and 15 tons of coal¹⁶. Financial assistance was a large driver in commercial establishments converting to renewable heating options.



ADVANCED WOOD HEAT
PELLET BOILER,
MARLBORO
ELEMENTARY SCHOOL
Photo Credit: WRC

¹⁴ Average commercial heating load value was determined using the Municipal Consumption Tool. Possible explanations for the higher than average commercial heating load could include an older (and less efficient) compared building stock in our Region and the specific mix of industries. The "Healthcare and Social Services" and "Manufacturing" sectors are prominent in the Windham Region, and these industry types typically use considerable heat energy.

¹⁵ Windham Wood Heat program analysis completed by the Windham Regional Commission.

¹⁶ Evaluation of the Windham Wood Heat Program, prepared for Windham Regional Commission by West Hill Energy and Computing. 2023.

TARGETS

VERMONT PATHWAYS MODEL OUTPUT DISCUSSION

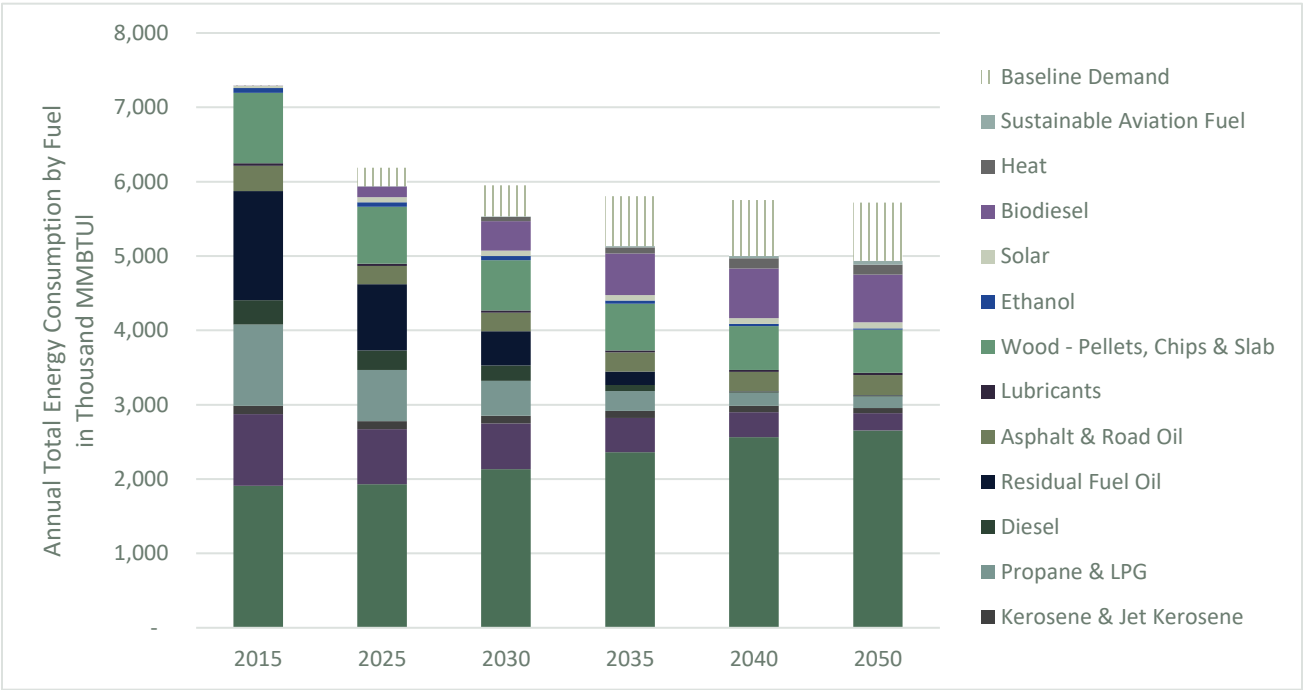
As part of the development of Vermont's 2022 Comprehensive Energy Plan (CEP) and 2021 Climate Action Plan (CAP), Stockholm Environment Institute (SEI) and Northeast States for Coordinated Air Use Management (NESCAUM) developed a scenario model of Vermont's energy consumption and emissions and used the model to construct pathways to meet statutory greenhouse gas (GHG) reduction obligations under the state's Global Warming Solutions Act (GWSA). This model is known as the Vermont Pathways model, and was built using SEI's Low Emissions Analysis Platform (LEAP), a software tool for energy system modeling and emissions accounting. The Vermont Pathways model contains an analysis and projection of residential, commercial, industrial, and transportation energy demand at the statewide level.

To support enhanced energy planning for regions and municipalities, PSD regionalized the final energy demand outputs from the statewide Vermont Pathways model for four core sectors: residential, commercial, industrial, and transportation. A simple disaggregation of those results was conducted for each of the regional planning commissions based on key drivers of energy demand. The model was developed with two scenarios for Vermont's future in mind:

- The Baseline or "business-as-usual" scenario, developed to estimate Vermont/the Region's energy demand under normal policy and programmatic conditions;
- The Central GWSA Mitigation or "CAP Mitigation" scenario, developed to meet the state's GHG reduction requirements.

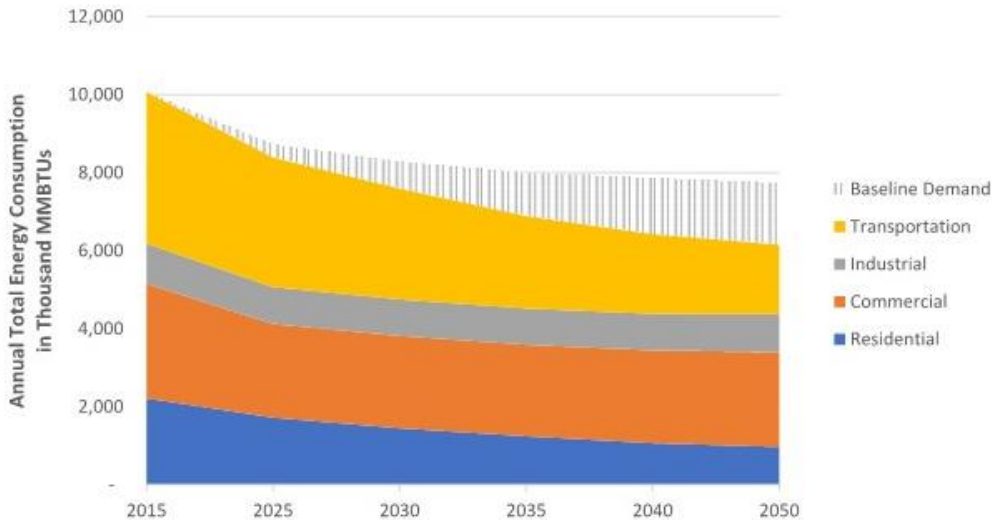
On state and regional levels, energy demand is depicted as decreasing substantially by the year 2050. Figure 12 below illustrates the total Windham Region demand by sector. The Baseline Scenario is the upper curve of the barred area. This barred area illustrates the difference between the energy demand of the Baseline Scenario versus the CAP Mitigation Scenario. Much of this difference is accounted for through assumed conservation and efficiency measures across all energy sectors (transportation, heating, electricity) due to gains in technological efficiency and decreased demand due to conservation measures.

FIGURE 12: WINDHAM REGION ENERGY CONSUMPTION BY SECTOR, CAP MITIGATION SCENARIO



The Windham Region’s energy consumption by fuel type over time is depicted in Figure 13. Throughout the benchmark years, the model assumes fossil fuel consumption is phased out and replaced by more renewable resources. The total volume of fuel decreases due to assumptions about advancements in efficiencies across all sectors.

FIGURE 13: WINDHAM REGION ENERGY CONSUMPTION BY FUEL, CAP MITIGATION SCENARIO



ELECTRICITY

The electric sector is where much of the change will occur over time. The model assumes electrification of the light duty vehicle fleet and electrification of heating and cooling systems, resulting in a dramatic increase in electricity consumption. However, the model also assumes increased efficiency of these technologies over time. The increase in consumption is offset by the increases in efficiency and leads to what looks like gradual increases in the electricity consumed. In the year 2050, electricity is the primary source of fuel for the region and accounts for almost half of the total fuel consumed.

TRANSPORTATION

Transportation currently accounts for 29% of the Windham Region's energy consumption. To achieve the 90x50 goal, the transportation sector will need to radically transform its fleet efficiency and fuel sources. The model assumes consumption of fuels in the transportation sector will drop by 46% from the 2015 base estimates, and that the makeup of the energy mix will change from predominantly gasoline to electricity.

The Vermont Pathways model breaks down the transportation sector into passenger cars, light trucks, medium duty vehicles, heavy duty vehicles, and non-road vehicles. The model applies separate fuel switching assumptions for each of these transportation categories. The notable decreases in consumption are in the passenger car, light truck, and medium duty categories. Figure 14 and 15 show the changes over time for passenger cars and light trucks, respectively.

FIGURE 14: REGIONAL PASSENGER CAR ENERGY DEMAND, CAP MITIGATION SCENARIO

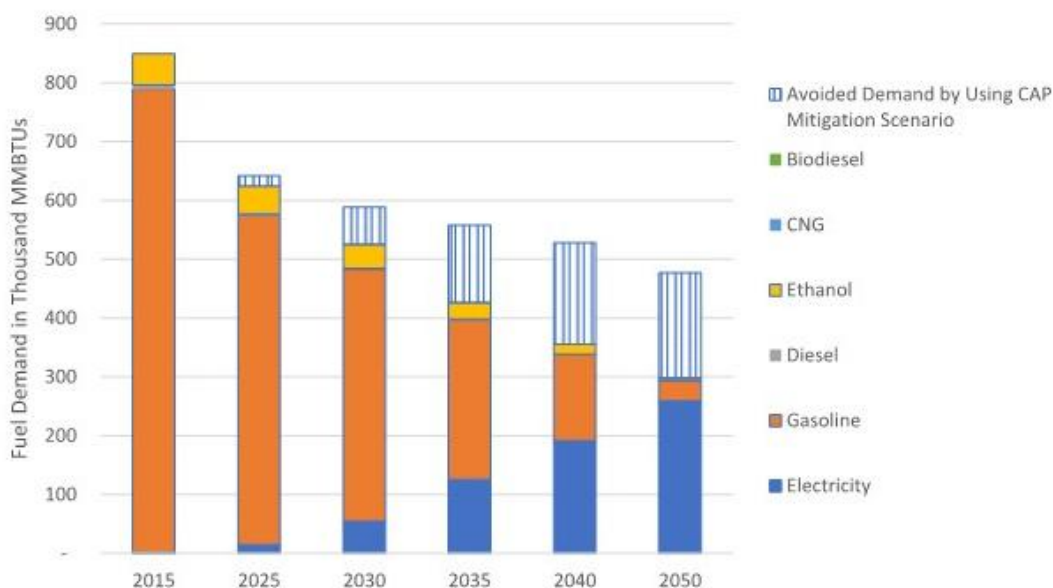
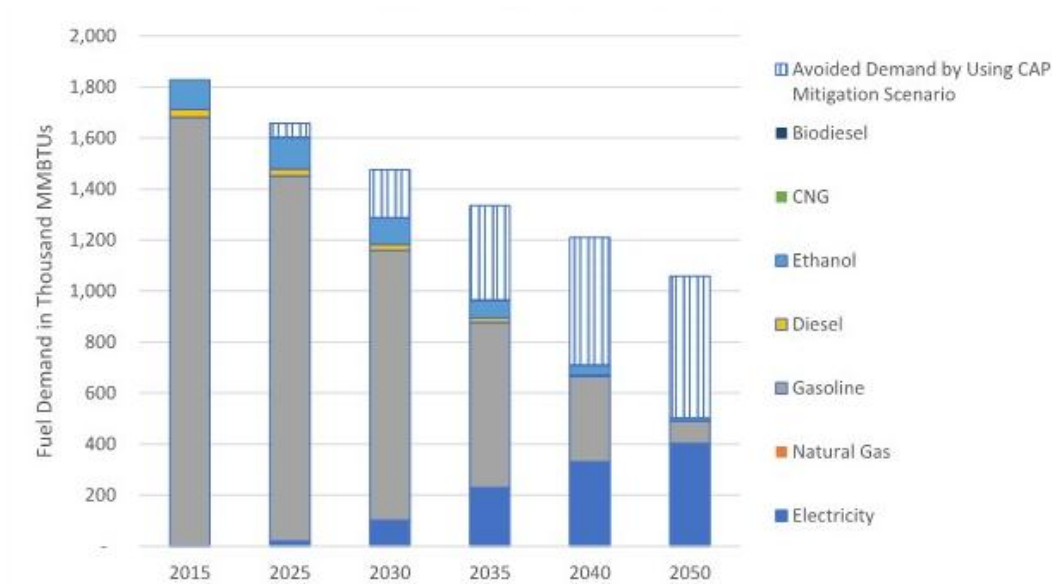


FIGURE 15: REGIONAL LIGHT TRUCK ENERGY DEMAND, CAP MITIGATION SCENARIO

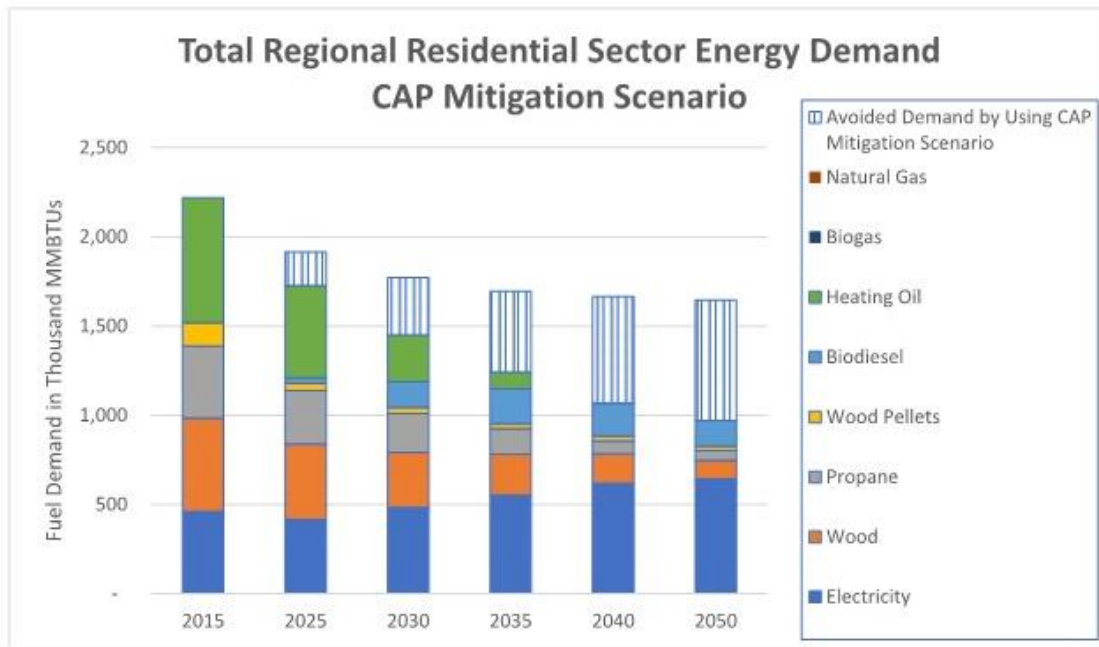


THERMAL

RESIDENTIAL

Today, the heating sector consumes approximately 52% of the energy in the region. The Vermont Pathways model shows a substantial decrease in home heating consumption between 2015 and 2050. In Figure 16 below, the Baseline Scenario is accounted for on the upper limit of the lined bar. Both the Baseline and CAP Mitigation Scenario project a decrease in residential heating consumption over the next several decades. The decrease in consumption is a result of underlying assumptions in the Vermont Pathways model. The model indicates that even in the Baseline Scenario, a larger share of households in the state will adopt heat pump systems, leading to decreased energy use in the thermal sector. The model also accounts for technological advances in the efficiency of heat pumps and the efficiency that residential weatherization progress (with no programmatic or policy shifts) will bring about. Collectively, these modeling assumptions account for the decreases in energy use in the Baseline Scenario portion of the graph in Figure 16.

FIGURE 16: REGIONAL RESIDENTIAL SECTOR ENERGY DEMAND



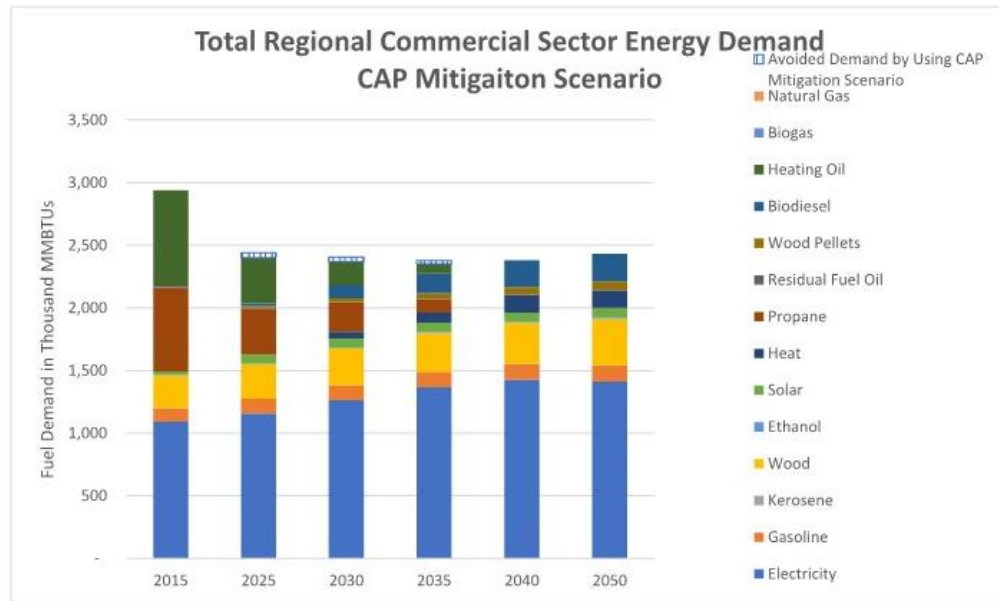
The underlying assumptions in the CAP Mitigation Scenario are similar to those in the Baseline Scenario. In Figure 16, a notable trend is that most of the fuels decrease in volume by 2050. This is where efficiency plays a substantial role in statewide progress on energy. Although the volume of these sources is decreasing, that decrease assumes weatherization and building envelope conservation measures. Therefore, a decreasing volume of fuel is assumed to be capable of heating more space, overall. The two fuel types that show increasing volume are electricity and biodiesel. Second homes account for approximately 35% of the Windham Region’s housing stock. The LEAP model assumes that second homes use 15% of the heating fuel of year-round homes.

COMMERCIAL AND INDUSTRIAL

The Vermont Pathways model assumes that the least amount of change in energy consumption and fuel mix will be in the commercial and industrial sectors. This is due to an assumed growth in these sectors over time. Figure 17 illustrates industrial consumption in the region. In total energy units, there is very little difference between the Baseline and CAP Mitigation Scenarios. There are, however, two noticeable trend assumptions underlying the fuel mix ratio: that electricity consumption decreases substantially over time, and that wood is increasingly used as a fuel source. Residual fuel oil and liquid petroleum gas (LPG) both remain more or less constant over time as they are denser fuels with no efficient substitute as of yet. These results are directly from the Total Energy Study.¹⁷

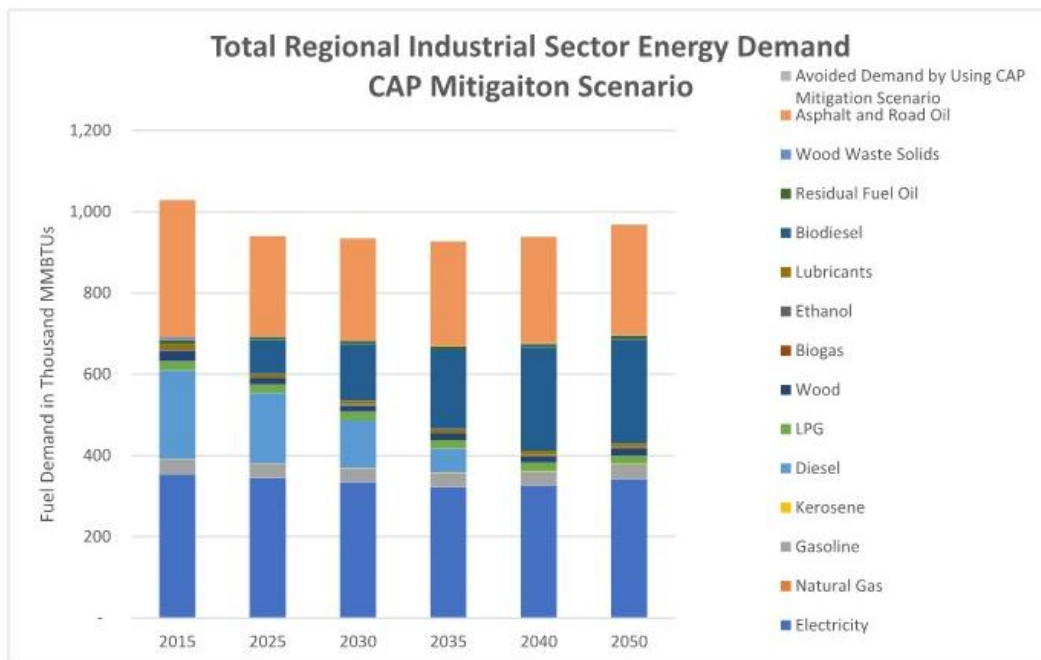
¹⁷ We note that when heating oil prices were rising, the Region saw a significant switch towards compressed natural gas by some of the major industrial facilities in the area. It is possible that if natural gas remains competitive, that the Region will see an increase in natural gas consumption. This gas is trucked into the region.

FIGURE 17: REGIONAL INDUSTRIAL SECTION ENERGY DEMAND



Commercial Energy Demand portrayed in Figure 18 also varies little between the Reference and 90x50 CAP Scenarios. However, the 90x50 scenario assumes that heating oil and propane are replaced by an increase in electricity, biodiesel and biogas, and that overall energy consumption decreases by 17%. The commercial sector is assumed to grow over time, accounting for only moderate decline in total energy consumption.

FIGURE 18: REGIONAL COMMERCIAL SECTOR ENERGY DEMAND



TARGETS AND CURRENT STATUS COMPARISONS

The projections from the Vermont Pathways model indicate how much change is needed in Vermont's energy and emissions profile to achieve the greenhouse gas emissions reduction requirements of the GWSA. Though the actual pathway is likely to divert from what is presented, the model allows the Windham Region to plan for the future by establishing targets for energy efficiency, conservation, and fuel-switching across the various sectors.

The following sections present these energy targets and discuss their implications for the Region. Targets for thermal efficiency, conservation, and fuel-switching for heating and transportation were derived from the Vermont Pathways model and its regionalized outputs. Some adjustments were made to the outputs of the Vermont Pathways model following guidance from the Public Service Department. The 2022 EEU Market Potential Study was used to produce targets for electrical efficiency and conservation. For a full description of the methods used to derive these targets, refer to Appendix B of the Energy Chapter.

Targets were developed for the years 2025, 2035, and 2050. It is important to note that the Vermont Pathways model does not perfectly capture the realities of the Region's energy profile and that targets are intended to be aspirational by nature—they are not requirements. Unless otherwise noted, regional energy targets embody the rate of progress needed to meet the CAP Mitigation Scenario objectives. Wherever possible, the following sections compare current data to the projected rate of progress embedded in the Vermont Pathways model. For full Windham Region Vermont Pathways results, please refer to Appendix A of the Energy Chapter.

In addition to developing regional energy targets, WRC broke this analysis out to each of the Region's 27 municipalities. These expanded and disaggregated municipal-level targets are available in Appendix C of the Energy Chapter.

THERMAL SECTOR: CONSERVATION AND EFFICIENCY TARGETS

The most approachable strategy that residents and businesses can take to help the Region meet its 90x50 targets is pursue thermal efficiency and conservation upgrades to residential and commercial structures. Outputs from the Vermont Pathways model indicate that the Windham Region must rapidly increase the number of weatherizations in the thermal sector to work toward this end.¹⁸

About a third of the Region's housing stock was built before 1940. The relative age of the housing stock means that many homes fail to meet a high standard of thermal efficiency. Even homes in the Region built after 1940 often lack insulation in certain areas of the building envelope, or the existing insulation is inadequate for the space. Weatherizing the Region's residential and commercial building stock is vital to increase the efficiency of building

¹⁸ WRC assumes a 6% growth rate in the number of households in the Region between each target year.

envelopes so they can retain indoor temperatures instead of leak warm (or cool) air through roofs, doors, windows, and walls.

TABLE 4: REGIONAL RESIDENTIAL WEATHERIZATION TARGETS AND CURRENT STATUS

Weatherizations (EVT, 2023)	2025 Target	2035 Target	2050 Target
397 Households: 1% of households in the Region	4,478 Households: 22% of households in the Region	9,678 Households: 44% of households in the Region	15,656 Households: 67% of households in the Region

Table 4 highlights how the Windham Region needs to greatly increase the number of household weatherizations. Efficiency Vermont (EVT) tracks data (see above) on residential building efficiency projects, however, it only tracks efficiency measures installed through the “Home Performance with ENERGY STAR” program. EVT’s data does not capture residential projects where weatherization work is being completed as part of a home renovation where the owner might not utilize program incentives, or for smaller weatherization projects that homeowners might accomplish, such as having window inserts installed through the [Window Dressers](#) program. One way to increase the number of residential weatherization projects is to work with regional organizations such as SEVCA and Window Dressers to provide information and education on programs and incentives available to homeowners. Other related actions include working with municipal energy committees to implement municipal weatherization programs that benefit homeowners and allow municipalities to document their progress and share it on a broader regional scale.

THERMAL SECTOR: FUEL SWITCHING TARGETS

The heating sector is the largest source of regional energy consumption (see “Windham Region Current Use and the cost of Energy” section). For the 90x50 goal to be attainable, thermal sector fuel conversion must be actively pursued to accompany efficiency and conservation improvements, reduce greenhouse gas emissions, enhance resilience, and achieve long-term cost savings.

The data in Table 5 illustrate the extent to which the fuel sources in the residential sector are anticipated to shift in the Vermont Pathway model’s CAP Mitigation scenario. Many of the targets from the model reflect the state’s priorities for thermal sector fuel conversion and renewable heat. For example, the Vermont Pathways model indicates that a rapid increase in the number of cold climate heat pumps is necessary to achieve state energy and climate goals. These targets embody policy objectives articulated by the 2022 CEP and the 2021 CAP, which

emphasize rapid electrification of thermal sector energy sources. As a result, electrical heating energy is projected to increase significantly in the Vermont Pathways model. One area of the CAP Mitigation scenario in the Vermont Pathways model that may not accurately reflect the dynamics of the Windham Region is wood heat. According to the Census, 17.5% of homes in the area use wood for home heating, making it the third most widely used fuel source in the Region, and most common renewable heating option. Windham County has the largest volume of hardwoods and softwoods of any county in the state, and residents of Southern Vermont have a long history of harnessing these resources for fuel and warmth. As a result, wood heat has a distinct cultural significance for our Region. For these reasons, wood heat energy is not anticipated to decrease as the Vermont Pathways model suggests—if anything, it will likely increase over time. Other notable trends from the Vermont Pathways model are a complete abandonment of oil for heating by 2050, and the incorporation of biofuel blended alternatives to supplement this decrease. Propane heating energy is also modeled to decrease over time.

TABLE 5: REGIONAL RESIDENTIAL FUEL SWITCHING TARGETS

Fuel Type	2025 Targets	2035 Targets	2050 Targets
Electricity (Thousand MMBtu)	152	281	365
Wood/Wood Pellets (Thousand MMBtu)	463	260	129
Propane (Thousand MMBtu)	217	106	39
Heating Oil (Thousand MMBtu)	478	81	0
Biodiesel (Thousand MMBtu)	29	164	102
Percentage of Renewables in the Heating Sector	48%	79%	94%

For the Region to meet its 90x50 objectives, a substantial number of cold climate heat pumps (CCPs) need to be installed in area homes and businesses. Towns have already made notable progress toward the 2050 residential heat pump goal, however. According to Efficiency Vermont, there have been 2,614 residential CCHP installations as of 2023. While there is still a significant amount of progress to be made here, the trajectory is hopeful. Heat pump water

heater installation targets indicate a need for **18,583 units by 2050**, with current Efficiency Vermont estimates showing 650 in our Region as of 2023.

For commercial buildings, the Vermont Pathway model's projected rate of heat pump adoption is even steeper. By 2050, there should be **31,144 commercial CCHP installs** in the Region according to the CAP Mitigation Scenario. It is difficult to estimate how many area businesses will be electrified based on this information, since commercial buildings vary wildly, and the number of heat pumps required for each commercial space will be different from building to building. However, with 293 commercial CCHP installs as of 2023, there will need to be a sharp uptick in the number of electrified businesses regardless.

TABLE 6: REGIONAL COLD CLIMATE HEAT PUMP AND WATER HEATER INSTALLATION TARGETS FOR RESIDENTIAL AND COMMERCIAL ESTABLISHMENTS

	CCHP Installations (EVT, 2023)	2025 Targets	2035 Targets	2050 Targets
Residential Cold Climate Heat Pumps	2,614	6,187	16,635	24,515
Residential Heat Pump Water Heaters	650	4,067	13,544	18,583
Commercial Cold Climate Heat Pumps	293	8,052	24,352	31,144

TRANSPORTATION SECTOR: FUEL SWITCHING TARGETS

The Vermont Pathways model indicates that the Region's light duty vehicle fleet (LDV) will need to transform radically by 2050. By 2050, the Region's LDV traffic is targeted to be fueled predominantly by electricity, while gasoline-powered transportation is significantly curbed. To meet transportation electrification goals, the Vermont Pathways model demonstrates that **970 EVs and plug-in hybrid electric vehicles (PHEVs)** will be necessary by 2025 (Table 7). The light duty truck target is 937 vehicles by 2025. EV registration data from Drive Electric for all categories of vehicles show that in 2023, there were a total of 933 EV and PHEV vehicles registered in the Windham

Region.¹⁹ The EV registrations need to maintain this rate of growth in order to meet our 2025 target.

While electric vehicles have zero tailpipe emissions (assuming a net-zero electricity source), they still have lifecycle carbon costs associated with their manufacturing and use. From a climate pollution and land use planning perspective, incentivizing a shift away from private automobile use is the most effective way to link climate, energy, and transportation planning goals. However, the Windham Region is highly rural, and pursuing strategies to encourage the adoption of electric vehicles is necessary, given the ubiquity of car ownership. Education, outreach, regional collaboration, and public-private partnership are critical here. Many organizations provide incentives and rebates to residents looking to adopt an electric vehicle or install charging equipment, including VTrans, Green Mountain Power, and Charge Vermont. Organizations like Drive Electric play a crucial role in educating citizens about electric vehicle technology while connecting residents, business owners, and municipalities with financing options. To achieve the ambitious targets outlined below, the programs mentioned above must be broadly advertised through continuous public outreach and inter-organizational collaboration.

TABLE 7: REGIONAL TRANSPORTATION TARGETS FOR USE OF RENEWABLES

	2025 Targets	2035 Targets	2050 Targets
Regional Passenger Car EV and PHEV Stock	970	8,524	19,821
Regional Light Duty Truck EV and PHEV Stock	937	11,994	24,250
Percentage of LDV Transportation Energy from Renewable Resources	9%	33%	84%

ELECTRICAL SECTOR: EFFICIENCY AND CONSERVATION TARGETS

It is challenging to derive electrical efficiency targets because the Vermont Pathways model assumes a rapid increase in electrical demand from fuel-switching in the thermal and transportation sectors. As a result, targets for electrical efficiency and conservation are determined separately using projections from the Public Service Department. PSD

¹⁹ Drive Electric: Vermont EV Registrations by Municipality as of Jan 2024, 2024.
<https://veic.maps.arcgis.com/apps/mapviewer/index.html?webmap=7a62de8f69954804889c86a12a9640c8>

periodically publishes a Market Potential Study that estimates the potential for Vermont’s Energy Efficiency Utilities (EEU) to achieve efficiency savings in the electrical and natural gas sectors. The study also helps inform targets for the EEUs, which is relevant to the development of regional electrical efficiency targets and enhanced energy planning. The Public Service Department’s electrical efficiency data supplements the Vermont Pathways model and provides a proxy estimate for the amount of electrical demand embedded in it. Since the estimates are not from the model directly, there are not separate targets for the Baseline and CAP Mitigation Scenarios.

Electrical efficiency targets are expressed as the amount of cumulative electrical energy saved energy from EEU programs, or the total amount of MWh savings expected by a given target year. The 2022 EEU Market Potential Study provides targets focused from the saving from energy efficiency in appliances and equipment. These are then, disaggregated to the regional-level based on county population and the EEU’s geographic performance target.

TABLE 8: REGIONAL ELECTRICAL EFFICIENCY TARGETS FOR RESIDENTIAL AND NON-RESIDENTIAL BUILDINGS

	2025 Targets	2035 Targets	2050 Targets
Residential Cumulative Annual Energy Efficiency Savings (MWh)	4,847	27,815	51,312
Non-Residential Cumulative Annual Energy Efficiency Savings (MWh)	8,715	43,771	39,470

ELECTRICAL SECTOR: RENEWABLE GENERATION TARGETS

The final set of targets for the electric sector are those for renewable generation. Renewable generation targets help quantify the rate of progress needed in the Region to support state climate goals and foster energy security and independence through the adoption of distributed generation technologies. In addition, target-setting presents an opportunity to plan for the deployment of renewable resources while critically assessing regional conditions, opportunities, and constraints related to renewable development.

Renewable generation targets come from the Public Service Department’s Generation Scenarios Tool. The tool uses electrical demand data from the Vermont Pathways model as an input into the target-setting exercise. From here, the statewide projected electrical demand for a given future year (like 2050) is disaggregated to the regional level based on an equal proportion of regional land area and population. Regions are then responsible for determining the

percentage of this future electrical demand that should be met with renewable resources. Table 9 shows the renewable generation targets for the Windham Region for 2025, 2035, and 2050. These targets represent the amount of in-region renewable energy needed to meet 25% of forecasted electrical energy demand, according to the Generation Scenarios Tool.

TABLE 9: REGIONAL RENEWABLE ENERGY GENERATION TARGETS

	2025 Targets	2035 Targets	2050 Targets
Renewable Generation Capacity Targets (MW)	96.6	143.3	186.9
Annual Renewable Electricity Production Targets (MWh)	135,786	201,407	262,763

The Windham Region’s **25% in-region capacity target for 2050 is 186.9 MW**, and its annual electricity production target is **262,763 MWh**. As of 2024, the Windham Region has an **installed renewable generation capacity of 189.4 MW** and is estimated to **generate 623,819 MWh** of renewable energy annually. Given this, it is fair to say that the Windham Region is already meeting its baseline renewable generation target for 2050. Nevertheless, the Region supports the continued siting and deployment of renewable technologies to further contribute to state energy goals and encourage the numerous localized benefits of distributed renewable generation.

Much of the energy currently generated in the Region comes from hydroelectric dams on the Connecticut and Deerfield Rivers. The Windham Region is fortunate to benefit from powerful hydrologic resources that allow for substantial in-region energy generation. Very few regions have a similar abundance of these same resources, meaning that the Windham Region has a distinct obligation to support other areas of Vermont that lack the same renewable resource endowment. More coordination between energy planning partners, including utilities, regional planning commissions, and the Public Service Department, should be pursued to organize efforts across and between regions on this front.

GENERATION POTENTIAL

The Region’s potential for new energy generation was determined using resource availability data from the Act 174 mapping exercise. The mapping analysis identified areas with sufficient resource abundance (like solar radiation or wind speed) to accommodate generation, and precluded areas that have known or possible environmental

constraints (see “Land Use and Siting” section below for further context). According to the mapping exercise, the Region has **45,816 acres with prime resource availability** for solar (no known siting constraints) and **136,971 acres with secondary resource availability** (no known constraints but at least one possible constraint). For wind, WRC maps indicate that there are **59,327 acres of prime resource lands** available for 30 meter hub height wind, with an additional **204,875 acres of secondary resource lands**.

The acreage values from the mapping exercise were then used to determine generation potential, which is the maximum build-out of renewables under environmental constraints and conditions. Table 10 shows the energy generation potential of every town in the Region in MWh. The results from this exercise indicate that there is significant land available for the development of renewable resources in the Region. Even though the Region is currently exceeding its baseline 2050 generation target, the generation potential analysis shows the extent to which further progress can be made in this area.

For a full description of the of the methods used to determine generation potential, refer to Appendix B of the Energy Chapter.

TABLE 10: REGIONAL RENEWABLE ENERGY GENERATION POTENTIAL

Town	Rooftop Solar (MWh)	Ground-Mounted Solar (MWh)	Wind (MWh)
Athens	1,316	51,608	288,802
Brattleboro	95,338	315,600	241,969
Brookline	2,071	63,754	180,169
Dover	27,052	599,528	1,199,801
Dummerston	11,239	269,497	125,763
Grafton	5,938	156,668	855,760
Guilford	10,035	214,867	479,011
Halifax	5,338	609,157	1,079,067
Jamaica	6,444	543,304	985,012
Londonderry	15,707	855,542	262,931
Marlboro	6,150	775,282	1,548,342
Newfane	6,698	265,462	540,946
Putney	13,966	278,289	125,067
Readsboro	5,121	280,452	1,365,759
Rockingham	27,015	249,483	209,818
Searsburg	958	81,769	764,553

Somerset	71	187,774	892,050
Stratton	12,321	436,892	1,773,192
Townshend	7,548	171,854	730,775
Vernon	15,713	113,831	26,426
Wardsboro	4,702	375,646	892,318
Westminster	22,592	394,582	410,248
Weston	6,255	739,539	628,010
Whitingham	10,320	907,575	1,397,482
Wilmington	23,048	1,025,608	1,615,344
Windham	2,728	153,533	921,120
Winhall	15,695	407,986	1,289,990
REGIONAL TOTAL	361,379	10,525,080	20,829,724

BIOGENERATION

Biomass is unique from other renewable energy generation technologies as the generation capacity is not inextricably linked to the site. Biomass resources are harvested from a location and then transported to a generation facility. There are no electricity generating wood fired plants in the Windham Region. As of January 2024, there are 4 biomass generation projects that produce 15,220 MWh annually.

Approximately 472,000 acres (82%) of the Windham Region is forested. The region's forestry industry is one of the state's leading producers, especially of high-quality northern hardwoods and white pine. Windham County also has the most standing timber, 3.46 billion board feet, in the State. This yields well over 100,000 green tons of low-grade wood material. With the forests producing significantly more than what is being harvested, this number is projected to increase in the future. Seventy-two percent of the region's forests are in private, non-industrial ownership, with industrial firms and Federal, State and local governments sharing the rest.

The Region could be ideal as a hub for biomass usage and generation by tapping into this abundant resource and applying it to the heating sector. Through incentives offered by the State of Vermont, and a program called Windham Wood Heat that was administered through WRC between 2015 – 2022, many schools and public serving institutions converted to advanced wood heating.

Environmental impacts must also be considered with biomass power. The combustion of wood produces heat and



**BULK PELLET STORAGE
FOR ADVANCED HEAT
SYSTEM, DUMMERSTON
ELEMENTARY**
Photo Credit: WRC

emissions including hazardous air pollutants (HAPs), fine particle pollution (ash), and volatile organic compounds (VOC). The pollutant of greatest concern to human health is fine particles (10 microns or less in diameter), which may be inhaled and cause a number of respiratory illnesses. Several other emissions are also of concern to air and water quality, including carbon monoxide (CO), carbon dioxide (CO₂), sulfur oxides (SO_x), and nitrogen oxides (NO_x). Emissions of NO_x (if kept below 1,300 Celsius) and SO_x from burning wood are significantly lower than coal and petroleum and are comparable to those of natural gas. Particulate levels in wood emissions are similar to those from burning coal and petroleum and substantially higher than the levels in the emissions from natural gas. Particulate emissions can be controlled to acceptable levels with smoke stack equipment such as scrubbers, bag filters, and electrostatic precipitators; however, this equipment is only cost effective on large commercial-sized combustion systems. Particulate emissions from smaller equipment, especially residential-sized units can be a concern.²⁰

The CO₂ in wood combustion emissions is considered by some to be “carbon-neutral” because it is basically equivalent to the amount of CO₂ trees need to grow the same quantity of wood. Hence the combustion of wood does not contribute to the net increase in atmospheric levels of CO₂ (a greenhouse gas) as does the combustion of fossil fuels. However, because this concept is not universally accepted, the impacts of this power source must be considered as carefully as those of other combustion fuel sources.

In addition to biomass, there are 4 methane sites in the Windham Region. These include the Brattleboro Waste Water Treatment Plant, the Windham Solid Waste Management District landfill, Westminster Farms, and Miller Farm. One of the nation's first commercial landfill gas-to-electricity projects was constructed in Brattleboro in 1982. Vermont Energy Recovery Systems uses the methane produced at the Windham Solid Waste Management District's Brattleboro landfill to generate and sell electricity to Green Mountain Power.

Methane is also emitted from volatile solids or animal waste. Anaerobic digesters produce electricity from the methane recovered from cow manure and/or other organic matter. In addition to producing energy and reducing the amount of methane emitted into the atmosphere, this process also reduces water pollution and produces a high-quality fertilizer as a by-product. Westminster Farms, Inc. was the first of this category in the Region.

²⁰ Extension, <http://www.extension.org/pages/43735/what-are-the-air-emissions-of-burning-wood>

HYDRO

Hydroelectric power accounted for approximately 2.35% of the total energy consumed in Vermont in 2022.²¹ Most hydropower is generated or purchased by Vermont Utilities for the Region's electricity needs. Hydropower accounts for 36% of the electricity mix and is the largest portion of the renewable energy portfolio of Vermont utilities. Hydro power is sourced from Hydro Quebec and smaller, privately owned facilities that exist around the region. In the Windham Region, there are 7 hydro facilities that produce 484,651 MWh, which means that hydropower represents the largest share of the Region's current renewable mix.



BROCKWAY MILLS DAM &
SOKOKI FALLS, ROCKINGHAM
Photo Credit: Laurel Green

The major supplier of hydropower for Vermont is Hydro Québec (HQ), a Canadian company. In 2010, 20 Vermont utilities signed a 26-year power contract with HQ to purchase up to 225 MW of electricity from January 2012 through 2038. In addition, HQ and the Vermont utilities agreed to share any future revenues related to environmental attributes of HQ power generation flowing into Vermont.²²

In 2022 Hydro Quebec purchased the hydro-electric dams along the Connecticut and Deerfield Rivers in Vermont and New Hampshire from Great River Hydro, LLC. In the Windham Region, Hydro Quebec (still operating under the name Great River Hydro) operates hydroelectric stations and associated storage reservoirs and dams on the Connecticut and Deerfield Rivers. The Bellows Falls Dam and Vernon Dam are located on the Connecticut River. The Bellows Falls Dam has a generating capacity of 49 MW. The Vernon Dam is the oldest dam, in service since 1909, and has a generating capacity of 37 MW. The Searsburg Dam and Station, located on the Deerfield River, is rated at 5 MW. The Harriman Dam and Station, located in Wilmington and Whitingham, includes three generating units capable of producing 41 MW of electric power. Sherman Reservoir lies mostly in Vermont but its electric generation occurs in Massachusetts, with a capacity of 6 MW.

All hydro facilities of significant size are licensed by the [Federal Energy Regulatory Commission](#) (FERC). New projects may also require a permit from the U.S. Army Corps of Engineers. These federal permits trigger state review delegated under the federal Clean Water Act. The FERC permitting process can take two to seven years to complete. Periodically these plants have to renew their licenses. Generally, the re-licensing process results in permit conditions that require plant owners to sacrifice some operating flexibility in order to mitigate the environmental impacts of

²¹ US Energy Information Administration Vermont State Energy Profile. 2022 Vermont Energy Consumption Estimates.

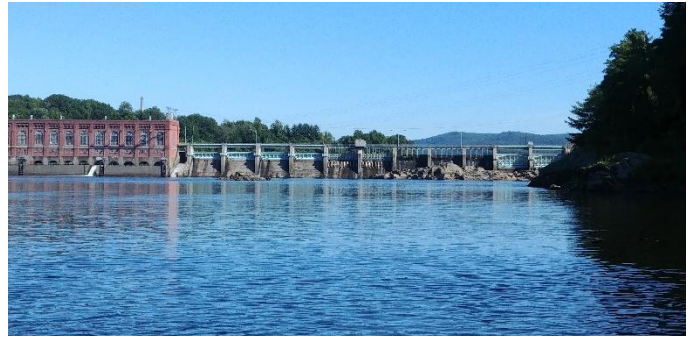
<https://www.eia.gov/state/print.php?sid=VT>

²² Vermont Department of Public Service, Biennial Report July 1, 2006 - June 30, 2010, July 2011,

http://publicservice.vermont.gov/sites/psd/files/Pubs_Plans_Reports/Biennial_Reports/2010%20Biennial%20-%20Publication%20Draft.pdf

their facilities. For some hydro facilities, this has resulted in a 10 to 20 percent loss of energy production.²³

The current licenses for each of the [Wilder, Bellows Falls, and the Vernon Hydroelectric Projects \(TransCanada\)](#) and the [Turners Falls Hydroelectric Project and Northfield Mountain Pumped Storage Project \(FirstLight\)](#) expired in 2018. All projects utilize water from the Connecticut River to generate hydroelectric power. The licenses were issued by the FERC for terms of 30 to 50 years. TransCanada and FirstLight are currently working on relicensing process for these dams using FERC's [Integrated Licensing Process \(ILP\)](#).



DOWNSTREAM OF VERNON DAM AND
HYDROELECTRIC FACILITY

Photo Credit: Kathy Urffer.

According to assessments completed by the State, it is clear that the best hydropower sites have already been developed. There are very few undeveloped sites that could support capacity greater than 1 MW, and relatively few in the 500 kW to 1 MW range. There are many potential smaller community and residential-scale sites sized below 200 kW. Incentives such as net metering, group net metering, and the Standard Offer Program are necessary to facilitate the development of smaller sites.

According to the ANR, the hydro resource is already heavily developed in Vermont. Further development would likely result in intermittent manipulation of stream flows and water levels, a possible increase in flood hazards resulting from the disruption of natural river processes, some loss of riverine aquatic habitat, and barriers to movement of fish and other aquatic life. ANR's 2008 Report [The Development of Small Hydroelectric Projects in Vermont](#) identified the following criteria as necessary for any new hydroelectric generator to have acceptable environmental impacts:

- No new dam or other barrier to aquatic organism movement and sediment transport.
- Run-of-river operation.
- Bypass flows necessary to protect aquatic habitat, provide for aquatic organism passage, and support aesthetics.
- Fish passage where appropriate.
- No change in the elevation of an existing impoundment or in water level management.

²³ Vermont Department of Public Service, *Biennial Report July 1, 2006 - June 30, 2010*, July 2011, http://publicservice.vermont.gov/sites/psd/files/Pubs_Plans_Reports/Biennial_Reports/2010%20Biennial%20-%20Publication%20Draft.pdf

- No degradation of water quality, particularly with respect to dissolved oxygen, temperature, and turbidity.
- No change in the upstream or downstream flood profile or fluvial erosion hazard.

Because there are few undeveloped sites that are candidates for new hydroelectric plants, three effective ways to increase capacity by improving efficiency and output at existing hydroelectric facilities include: installing more efficient turbines, installing small turbines at the dams that utilize bypass flows, and installing new turbines that can operate efficiently over a wider range of flows. These upgrades are often possible without changing current operating requirements, i.e., power production can be increased without additional environmental impacts. In addition, existing municipal water supply and wastewater treatment pipelines could capture the energy in these systems by installing hydro turbines to the pipelines without otherwise altering the regular operation of the system. Such in-pipe hydroelectric systems have minimal environmental impact.

SOLAR

As of 2023, the Public Service Department reports that 10.2% of the energy purchased or generated by Vermont utilities comes from photovoltaic (PV) solar (before Renewable Energy Credit retirements,) and that 4% of the State's electric power mix comes from PV solar (after Renewable Energy Credit retirements). Solar energy can be used either to generate electricity or to generate heat. For 2024, it is estimated that solar installations in the Region generate 52,870 MWh of electricity, with 36,450 MWh coming from 15 kW and larger sites.²⁴ The Region possesses 40.2 MW of installed PV capacity, meaning that solar accounts for 21% of our capacity mix

In 1998, the Legislature enacted a Net Metering law (30 V.S.A. § 219a) requiring electric utilities to permit customers to generate their own power using small-scale renewable energy systems of 15 kW or less. The excess power generated by these systems can be fed back to the utility, basically running the electric meters backwards. The law has been amended multiple times, but still continues to be an important tool in residential solar installations. According to the Vermont Public Service Department, as of January 2024 the Windham Region had a total of 1,298 net-metered sites and 24,715.47 kW of installed capacity.²⁵ The region also had two non-net metered sites with a capacity of 4,160 kW.

As the demand to install solar on residential and commercial properties increase, the electric grid at its current capacity can handle the increase to



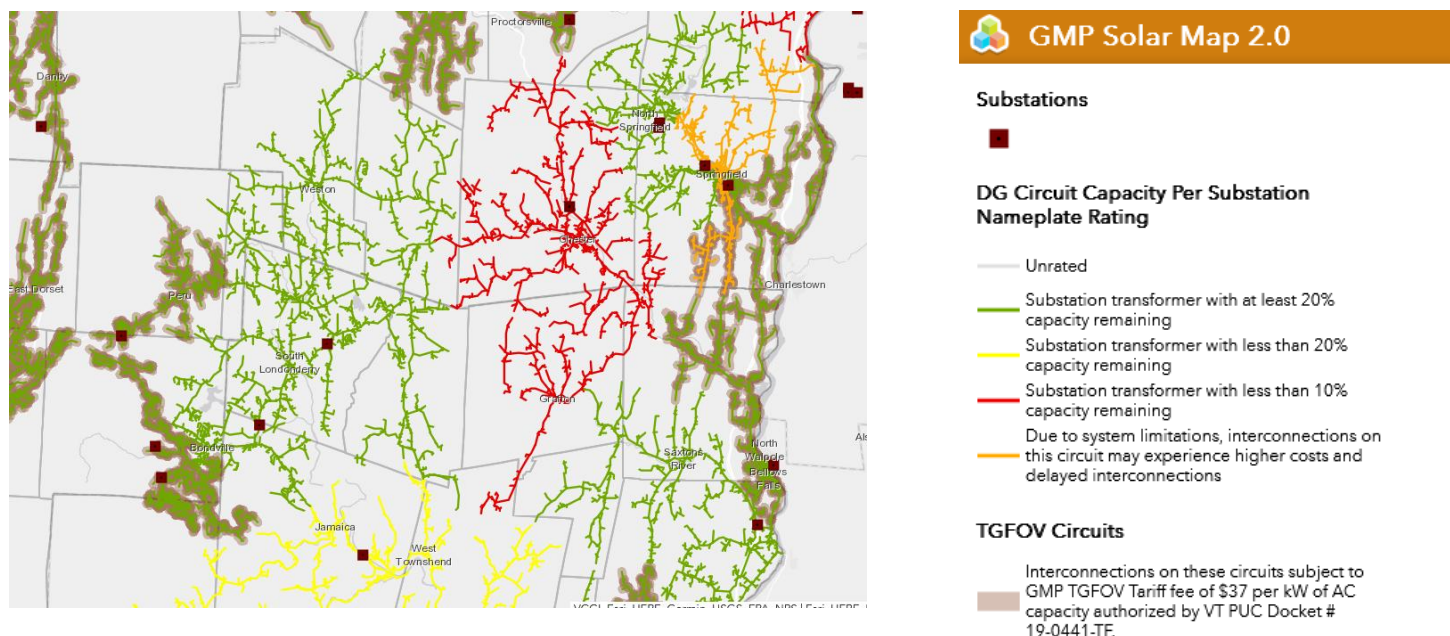
SOLAR INSTALLATION, SCHOOL
OF INTERNATIONAL TRAINING,
BRATTLEBORO
Photo Credit: WRC

²⁴ Estimate derived from Public Service Department data on distributed photovoltaic solar generation in Vermont.

²⁵ Data Source: Public Service Department list of renewable distributed generation in Vermont (<5MW), distributed to RPCs in January 2024.

varying degrees depending on availability of appropriate transmission lines and the capacity of substations. Green Mountain Power created an interactive Solar Map in an effort to help Vermonters generate power closer to where it is needed to increase reliability and costs. The map allows Vermonters to see where solar energy is being generated and how it ties into the grid.

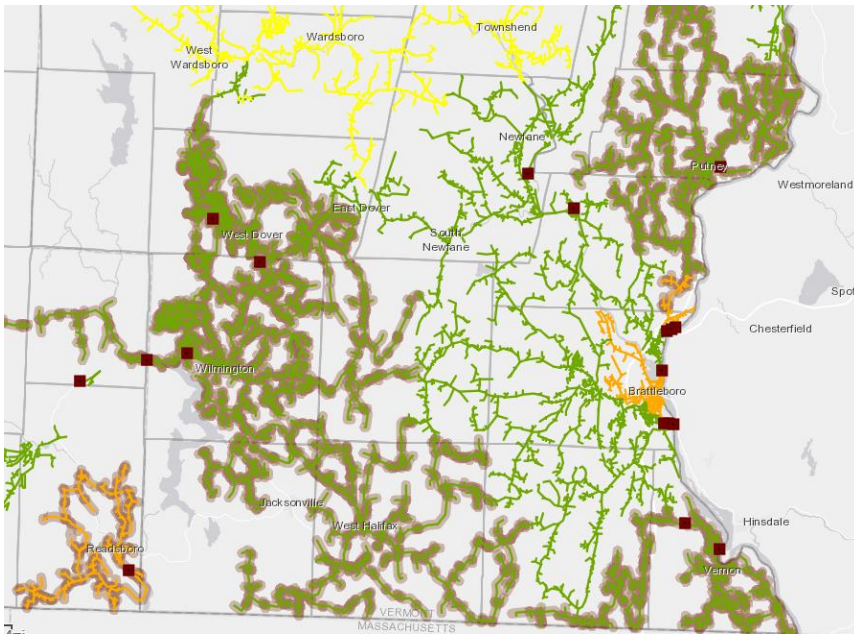
FIGURE 19: GREEN MOUNTAIN SOLAR HOSTING CAPACITY MAPS



Above: Northern Portion of the Windham Region

GMP has created a color system to show Vermonters where capacity for new solar is abundant and where the grid is at or approaching capacity. The map itself is meant to help educate Vermonters about projects across the state and their impact on the grid system.

Below: Southern Portion of the Windham Region



A potential drawback of PV (solar) power is cost. When compared to the current market price forecast for electricity, the price of PV remains high. There is data that suggests that state and federal incentives have served as major drivers in the rate of solar facilities installation. Despite cost issues, PV power has several advantages that make it a power source that the state should continue to support. PV is largely a peak electric load-following resource, meaning that during peak summer loads, the PV systems are at their highest production, resulting in peak shaving and grid reliability benefits. In addition, PV power is generated without noise, requires low levels of maintenance, emits no pollution, and is extremely distributable.

While there is currently relatively little controversy about solar energy as a source of power, potential conflicts arise with the siting of solar installations. Ground-mounted systems tend to be larger in scale than roof-mounted systems, and generally are sited on undeveloped or agricultural land. Depending on placement, solar fields can have negative impacts on forest connectivity and prime agricultural fields. Complaints have arisen about aesthetics and the panels interrupting the scenic quality of an area. Installations covering large acreage should not only deem a project suitable based on solar capacity, but should evaluate the impacts that the installation has on the natural resources and historic settings of the site. In some cases, the installation should provide mitigation in the form of retained agricultural soils or forested patches on site or conserved agricultural or forest land of equal value elsewhere in the region. Roof-top systems have the advantage of requiring zero additional development of open land, though conflicts can arise if these systems are installed in areas with historic district overlays, or where neighboring trees may shade out the system for a substantial period of the day. Towns should consider these issues and address them in their plans and zoning bylaws.

WIND

Wind energy is categorized by the Energy Information Administration (EIA) as an “other renewable,” a category that provided about 1.7% of the energy used in Vermont in 2022²⁶. Wind energy is used primarily to generate electricity, but not as a source for heat. As of 2019, the Windham Region had 14 wind generation projects with a total annual production of 71,078 MWh.

In 1997, Green Mountain Power developed Vermont’s first modern, commercial wind-generating station in Searsburg, consisting of 11 turbines with combined total power rating of 6 MW. The Vermont Public Service Board approved the project, despite its relatively high cost due to its perceived value as a demonstration project. In 2009, the Public Service Board (now known as the Vermont Public Utility Commission) granted a Certificate of Public Good permitting Deerfield Wind to construct a 30 MW facility, consisting of 15 wind turbines, in Searsburg and Readsboro.



DEERFIELD WIND INSTALLATION,
SEARSBURG & READSBORO
Photo Credit: WRC

Small-scale, net metered installations that serve homes, businesses, and communities are also located throughout the region. Small-scale wind facilities are most often represented by a single turbine, which can generate from less than 1 kW up to 100 kW for a small commercial machine. A number of factors affect the success of a small wind project. To harness the best wind spectrum, turbine siting is absolutely critical within the microclimate of the landscape. Turbines must be positioned so they extend as high as possible above obstacles like trees. Technical expertise to maintain the system is also essential. As of January 2024, there were a total of 8 net metered wind facilities, and 1 non-net metered, in the region with a combined capacity of 2,320 kW.

Wind power is considered a complement to solar in a renewable energy portfolio. When solar power is low or unavailable, during cloudy days or at night, the wind is often more potent. For example, during Vermont’s winter, when sunlight is diminished, average wind speeds measure at their annual high. Wind power is intermittent in nature, like many other renewable sources of power; thus, resource planning for effective power grid integration is essential.

Wind power is clean and renewable, but turbine placement can be difficult and controversial because of natural resource impacts, aesthetics, noise, and the need for turbine placement elevations between 2,500-3,300 feet, locations in Vermont that tend to be sensitive with thin soils and steep slopes. The windiest areas in the region are

²⁶ US Energy Information Administration: Vermont State Energy Profile. Based on Vermont Energy Consumption Estimates for 2022.
<https://www.eia.gov/state/print.php?sid=VT>

most often on the higher-elevation ridgelines that are sensitive habitats for plants and wildlife, and are the source of the region's most pristine headwaters. In areas where road access does not exist, new permanent roads must be built to service the wind facility. Other potentially negative environmental impacts include bird and bat mortality, habitat disruption and fragmentation, erosion, pollution from facility maintenance, turbine noise, and visual flicker.

PATHWAYS AND RECOMMENDED ACTIONS

This section provides a discussion on achieving goals in a just and equitable manner, as well as recommending strategies to achieve the energy targets for the Windham Region across the three main energy pathways: conservation and the efficient use of energy in buildings, land use, and transportation. The Land Use and Transportation Chapters in the Regional Plan also complement this section and contain additional policies and strategies for achieving the Region's energy goals. Several broad issues have been identified throughout the Regional Plan that will need to be continued to be examined and addressed in order to achieve energy goals.

- Achieving regional goals has been accomplished in a just and equitable manner.
- The correlation between low density settlement patterns and increased energy consumption.
- The lack of adequate infrastructure to support more compact, mixed-use settlements (i.e. municipal water and wastewater systems).
- The importance of promoting and investing in walking, biking, and shared transportation options, and reducing single-occupancy vehicle use.
- The need to plan and invest in new types of infrastructure to accommodate electric and other non-fossil fuel transportation options.

EQUITY

To meet the ambitious 90x50 goals, there will need to be significant changes to the energy systems in Vermont. As the Windham Region moves towards our region's targets, now is the time to plan to address these changes in a just and equitable manner. There are numerous inequities that have been built into the current energy system that was built piecemeal over time. Some communities have a higher energy burden than others and lower and middle income residents have less access to renewable energy opportunities, despite the State programs offered to help these populations. As the Region and Vermont moves forward, we need to find ways to make the energy transition accessible to all.

ENERGY BURDEN

Efficiency Vermont has been examining energy burden for municipalities throughout the state of Vermont. Their study is a way to understand the impact of energy costs on residents, since energy expenses often compete directly with other household costs such as food, housing, and healthcare.

Energy Burden is determined by the following formula:

- $\text{Energy Spending} / \text{Household Income} = \text{Total Energy Burden}$

According to the [2023 Energy Burden Report](#), the average Vermont household energy burden is 11 percent. About half of that spending (45 percent) is for transportation. Heating, or thermal energy, accounts for another 35 percent, with 20 percent for electricity.²⁷ Table 11 shows the municipalities in the Windham Region and their Energy Burden as reported in the 2019 and 2023 Energy Burden Reports.

TABLE 11: EFFICIENCY VERMONT ENERGY BURDEN BY TOWN IN WINDHAM REGION, 2019 AND 2023

Energy Burden by Town in the Windham Region (2019)				Energy Burden by Town in the Windham Region (2023)					
Town	Median Household Income	Total Energy Burden	Total Energy Burden Rank	Town	Median Household Income	Total Energy Burden	Total Energy Burden Rank	Delta 2019 Energy Burden	Change in Median Household Income from 2019
Readsboro	\$35,625	15.0%	Highest	Dover	\$45,625	15.2%	Highest	5.2+	(4,738.00)
Athens	\$41,406	13.0%	High	Brattleboro	\$41,001	13.5%	High	2.5+	(3,358.00)
Brattleboro	\$44,359	11.0%	High	Halifax	\$50,357	13.7%	High	2.7+	(438.00)
Londonderry	\$52,377	11.0%	High	Londonderry	\$55,465	13.3%	High	2.3+	3,088.00
Putney	\$49,506	11.0%	High	Searsburg	\$52,500	13.3%	High	3.3+	2,500.00
Rockingham	\$42,596	13.0%	High	Wilmington	\$59,821	12.1%	High	1.1+	8,787.00
Wardsboro	\$47,841	12.0%	High	Athens	\$67,656	10.1%	Moderate	-2.90	26,250.00
Wilmington	\$51,034	11.0%	High	Brookline	\$65,139	10.4%	Moderate	1.4+	(2,153.00)
Winhall	\$53,750	11.0%	High	Jamaica	\$57,800	11.8%	Moderate	1.8+	4,362.00
Dover	\$50,363	10.0%	Moderate	Newfane	\$59,792	11.5%	Moderate	1.50	4,236.00
Dummerston	\$62,594	9.0%	Moderate	Putney	\$57,500	11.0%	Moderate	0+	7,994.00
Grafton	\$52,188	10.0%	Moderate	Readsboro	\$60,833	11.3%	Moderate	-3.70	25,208.00
Halifax	\$50,795	11.0%	Moderate	Westminster	\$64,297	10.4%	Moderate	-0.60	14,826.00
Jamaica	\$53,438	10.0%	Moderate	Whitingham	\$62,167	10.8%	Moderate	0.8+	6,772.00
Newfane	\$55,556	10.0%	Moderate	Winhall	69931	12%	Moderate	1+	16,181.00
Searsburg	\$50,000	10.0%	Moderate	Dummerston	\$85,357	8.1%	Low	-0.90	22,763.00
Townshend	\$54,716	10.0%	Moderate	Grafton	\$68,125	10.0%	Low	0.00	15,937.00
Vernon	\$69,500	9.0%	Moderate	Guilford	\$77,431	8.9%	Low	-0.10	14,817.00
Westminster	\$49,471	11.0%	Moderate	Marlboro	\$80,250	8.6%	Low	0.6+	13,722.00
Whitingham	\$55,395	10.0%	Moderate	Rockingham	\$61,514	9.7%	Low	-3.30	18,918.00
Windham	\$58,750	9.0%	Moderate	Townshend	\$73,068	8.7%	Low	-1.30	18,352.00
Brookline	\$67,292	9.0%	Low	Vernon	\$78,393	8.8%	Low	-0.20	8,893.00
Guilford	\$62,614	9.0%	Low	Wardsboro	\$78,500	9.6%	Low	-2.40	30,659.00
Marlboro	\$66,528	8.0%	Low	Windham	\$78,750	8.5%	Low	-0.50	20,000.00
Weston	\$72,692	8.0%	Low	Stratton	\$107,500	7.0%	Lowest	0.00	26,750.00
Stratton	\$80,750	7.0%	Lowest	Weston	\$110,000	6.4%	Lowest	-1.60	37,308.00
Somerset				Somerset					

Orange Delta Value indicates Towns with a different EB rank

One of the biggest factors that led to a change of a towns energy burden ranking come from the change in the Median

²⁷ Efficiency Vermont 2023 Energy Burden Report. <https://www.efficiencyvermont.com/Media/Default/docs/landing-pages/energy-burden-report/2023-EfficiencyVermont-EnergyBurdenReport.pdf>

Household Income in a community. Some of the most significant changes between the 2019 and 2023 Energy Burden Reports include:

- Dover has become the highest energy burden town at 15.2%.
- Most towns saw an increase in median income per household, some substantial. Decreases in median income were seen in Dover, Brattleboro, Halifax, and Brookline.
- 6 Highest or High energy burden towns in 2019 changed to lower burden levels in 2023: four (Readsboro, Athens, Putney and Winhall) to moderate energy burden, and two (Rockingham and Wardsboro) to low energy burden. (Somerset does not have data.)
- New High and Highest Energy Burden towns include Dover, Halifax, and Searsburg.

The Windham Region needs to fully address equity and justice as it moves forward with regional energy planning. A robust equity framework requires the consideration of equity across various topic areas, including efficiency, transportation, compact land use, and renewable generation.

Energy burden provides a compelling framework with which to identify and prioritize overburdened populations through targeted implementation work in the efficiency and conservation sector. Currently, energy burden stands as the best and most widely available indicator to pursue equitable programmatic work focused on increasing efficiency across the various energy sectors. Methods to incorporate energy burden into a broader energy efficiency program include education and outreach targeted at high energy burden towns. Activities and programs can be made additionally inclusive through grassroots public participation and the use of clear and accessible language. WRC supports the continued refinement of energy burden as an indicator of energy equity and hopes to see the report produced with higher geographic specificity to support municipal enhanced energy planning and efficiency work.

Equity can also be incorporated into various energy planning endeavors through the continuous and rigorous involvement of stakeholders (including town officials, renewable developers, contractors, frontline and impacted populations, community groups, municipal energy committees, etc.) in conversations surrounding energy efficiency, conservation, and siting of renewables. Incorporating diverse voices into energy policy and program development allows for the opportunity to bring historically marginalized populations to the table in decision-making processes.

OTHER MEASURES TO DETERMINE ENERGY INEQUITY

An additional metric to measure energy equity be an indicator that maps regional access to renewable energy, allowing for a visual representation of where environmental benefits and burdens associated with renewable development are located in the Region. Such a framework has yet to be established in Vermont, but WRC supports

its working to integrate a more robust framework alongside other energy planning partners.

The concept of energy equity is intertwined with and builds on the long history of the movement for environmental and climate justice. These related concepts focus on equitable access to environmental benefits, addressing the proportional distribution of environmental burdens and benefits, fostering meaningful involvement in decision making, and recognizing that people of different racial and ethnic groups, cultures, and socioeconomic status have different needs, all the while seeking to transition to a more sustainable society.²⁸

WRC is incorporating recommendations from the State Comprehensive Energy Plan to be considered in all WRC energy planning. These recommendations are included in the WRC Energy Policies and Implementation Actions.

CONSERVATION AND EFFICIENCY

Significant reductions in energy use and costs can be realized through conservation and efficiency measures. As discussed early in this section, approximately 52% of the Region's energy consumption is from building heating and cooling systems and approximately 19% is from electricity used in buildings. Vermont has implemented energy building standards for residential and commercial buildings. These standards were established to set minimum efficiency requirements for new construction and renovation project. Currently, compliance with these standards is self-certified and the CEP notes this diminishes the effectiveness of these standards. Towns can help raise awareness about the State's energy building standards through their permitting process.

Reducing the amount of energy needed to heat residential and commercial buildings can be accomplished through weatherization and making buildings more energy efficient. Examples of weatherization include improving insulation, upgrading windows and doors, and completing air sealing. These strategies are particularly helpful in older buildings that may have little or deteriorated insulation and inefficient windows and doors. Weatherization can reduce heating costs and help improve indoor air quality by keeping out pollutants and pests.

When planning for new building construction, building orientation and site design can assist with accomplishing efficiency goals. If buildings are designed and oriented to take advantage of southern exposures, they can add roof-mounted solar panels and use passive solar heating during winter months. Maintaining tree cover or planting new trees around a building provides shade and can help cool buildings during the summer months. Tree stands can also block prevailing winds during the winter months, helping to reduce drafts.

Another means of improving efficiency is installing new energy efficient appliances and heating systems. The Energy Star program administered by the U.S. Environmental Protection Agency (EPA) helps consumers and businesses

²⁸ Vermont Climate Council, Just Transitions Subcommittee, August 2021. Guiding Principles for a Just Transition.
<https://aoa.vermont.gov/sites/aoa/files/Boards/VCC/Draft%20Guiding%20Principles%20for%20a%20Just%20Transition%20June%202021.pdf>

choose appliances that meet energy efficiency specifications set by the EPA. There is growing support for installing electric heat pumps in place of heating systems that rely on fossil fuels. When powered by renewable-generated electricity, heat pumps can significantly reduce carbon emissions. They also have the added benefit of providing building cooling during summer months. Advanced wood heating systems that use cord wood, pellets, or wood chips offer the ability to efficiently heat buildings renewably, and also strengthen the local forestry industry.

Efficiency Vermont provides residents and businesses with energy assessments that identify cost-effective projects to improve efficiency. The organization has identified a network of certified contractors that can complete these projects for property owners. Efficiency Vermont also provides low-interest loans, rebates, and income-based assistance to help defray the costs associated with completing projects. Local organizations in the Windham Region that provide technical support for weatherization projects include Southeastern Vermont Community Action (SEVCA) and NeighborWorks, which serves homeowners in Bennington County.

Finally, though not yet developed to its full capacity, energy storage has the potential to dramatically aid the Region in reaching the 90% renewable by 2050 State goal. Storage for renewable energy generation could boost capacity substantially while also feeding into microgrids. Increased distributive generation, storage, and microgrids will allow communities to be more resilient in the event of power outages.

LAND USE

Land use is an important indicator of energy consumption. Dispersed settlement patterns result in higher energy consumption due to the lack of efficiency in building design, inability for efficient heating distribution, increased energy input to deliver services to businesses and residents, and a reliance on single-occupancy vehicles for transportation. Land development is primarily regulated by local zoning regulations and through the Act 250 process. Many zoning bylaws allow for a dispersed settlement pattern and can make it difficult to develop in a compact manner within existing centers. In addition, many communities lack public water and wastewater systems needed to support more housing, and new and expanding businesses.

For future development, a critical strategy for the Region is to encourage compact, mixed-use settlements that result in lower overall energy consumption. This can be accomplished through zoning regulations that include provisions for smaller lot sizes, higher residential densities, and a greater variety of permitted land uses in village and downtown centers. Residential and commercial buildings in village and downtown centers tend to be smaller in scale and use land more efficiently. This helps reduce energy needs for heating and cooling. Settlements with a variety of businesses, uses, and services allow residents to travel less to meet their needs. These centers are also better able to support pedestrian and bicycle infrastructure given the proximity of residences, businesses, and

services, as compared to more rural settings.

In addition to providing land use regulations that support compact development, economic and community development investments are also needed to sustain the vitality of community centers. One tool is the State Designation program, which provides tax incentives for building and façade improvements for eligible, income-producing buildings. Communities can make investments in pedestrian infrastructure and streetscape improvements to create a more welcoming environment, such as sidewalks, lighting, landscaping, seasonal plantings, and signage.

Another strategy for energy conservation through land use planning is supporting local agricultural and forestry enterprises. By putting an emphasis on locally produced food, the Region can cut the amount of fuel needed to transport products from greater distances. Supporting local forestry operations helps sustain cord wood and wood pellet production for advanced wood heating system. Conserving forestland also provides for carbon sequestration benefits. Towns can support local agriculture and forestry by identifying these land areas within their community and developing regulations to ensure these areas are not subdivided and fragmented.

LAND USE AND ENERGY SITING

In order to achieve renewable energy generation goals for the region, new infrastructure will be needed to be installed. The need for siting new energy generation assets needs to be balanced with natural resources and land use.

When siting any new energy generation infrastructure, attention must be given to areas that are considered inappropriate or potentially inappropriate for the location of energy development. This is broken down into known constraints and possible constraints. Development should be located to avoid state, regional and local known constraints, and to minimize impacts to state and local possible constraints.

- **Definitions:**

- *Known Constraints:* Signals likely, though not absolute, unsuitability for development based on statewide, regional or local regulations or designated critical natural resources
- *Possible Constraints:* Signals conditions that would likely require mitigation, and which may prove a site unsuitable after site-specific study, based on statewide or regional/local policies

- **State Known Constraints** (as defined in Vermont Act 174)

- Vernal Pools from Vermont Center for Ecostudies (confirmed)

- DEC River Corridors
- FEMA Floodways
- State-significant Natural Communities
- Rare, Threatened, Endangered Species
- National Wilderness Areas
- Class 1 and Class 2 Wetlands
- Regionally or Locally Identified Critical Resources
 - i. Examples could be source protection area for public drinking water supply, town-designated scenic roads and viewsheds
 - ii. Land use policies applicable to other forms of development in this area must be similarly restrictive

● **State Possible Constraints** (as defined in Vermont Act 174)

- Vernal Pools from Vermont Center for Ecostudies (potential and probable)
- Agricultural Soils
- FEMA Special Flood Hazard Areas
- Protected Lands (State fee lands and private conservation lands)
- Act 250 Agricultural Soil Mitigation areas
- Deer Wintering Areas
- The following features from ANR's Vermont Conservation Design:
 - i. Highest Priority Interior Forest Blocks
 - ii. Highest Priority Connectivity Blocks
 - iii. Highest Priority Physical Landscape Blocks
 - iv. Highest Priority Surface Water and Riparian Areas
- Hydric Soils

- Regionally or Locally Identified Resources
- **Regional Known Constraints**
 - Compliance with State Known Constraints
- **Regional Possible Constraints**
 - Lands over 2,500 feet in elevation
 - Vermont ANR identified bear travel corridors
 - Shore lands
 - Steep slopes over 25 percent
 - Prime Agricultural Soils or Vermont Significant Soils
 - Siting a system that would require large amounts of forest clearing
- **Town/Local Constraints**
 - Any unsuitable areas as identified in a duly adopted municipal plan

Constraints are based on statewide, regional or local policies that are currently adopted. As with all maps included in Regional Plan, the map of constraints is intended to provide a general overview of existing conditions. The accuracy of information presented in the maps is limited due to scale. Errors and omissions may exist. These maps are not sufficient for delineation of features on-the-ground. To determine whether a site has constraints, surveyed information, engineering studies or other site-specific information will likely be necessary.

TRANSPORTATION

Transportation and land use are closely connected as it relates to energy use. Approximately 39% of the total energy consumed in Vermont annually is for transportation. The Region's transportation network is a result of how communities have developed over time. The primary employment and commercial centers in the Region are Brattleboro, Bellows Falls, and the Deerfield Valley towns of Wilmington and Dover. Outside of these more densely settled areas, and some village centers, most of our residents live in rural settings and need to commute long distances for work, shopping, and services. As a result, personal transportation is a necessity for most residents.

With few population and commercial hubs, supporting a public transportation system is extremely challenging. The region benefits from having the MOOver bus transit service, which has routes serving communities in the Connecticut River Valley, Deerfield Valley, and along Route 9, and an Amtrak line with stations in Brattleboro and Bellows Falls. However, bus and train schedules are still limited and not all communities in the Region have access to these services, leaving them underutilized. Supporting the continuation of service on existing bus routes and expanding the service area is critical. In particular, there is a need for bus transit on Route 30 from Brattleboro to Winhall. Improvements have been made to the Vermonter Amtrak route in recent years that have shortened the length of trips to major destinations such as New York City, Springfield, MA, and New Haven, CT. Massachusetts is seeking to make improvements to rail service between Boston and the western part of the state, which would benefit the Windham Region as well.

Alternative transportation options, such as shared transportation (carpooling, public transportation, car share) and active transportation (walking and biking), should be supported and improved to reduce energy consumption. Shared transportation is a broad term covering public transportation, carpooling, car share organizations, bike shares, and others. Access to information about shared transportation options is often a barrier to increasing their rate of use. The Vermont Agency of Transportation manages the [Go! Vermont](#) website, which provides information on local bus and train routes, and supports carpooling by providing matches for individuals with similar schedules and destinations.

Complete Streets is an approach to transportation planning that accounts for all users, including vehicles, pedestrians, bicyclists, and public transit riders. By considering different modes of travel, we can make roads safer and reduce the need for using a private vehicle. Towns can consider adopting a Complete Streets policy to consider these issues when planning for and making road improvements. Adding pedestrian infrastructure, like sidewalks, can be difficult due to high construction costs and limited space because of historic settlement patterns. Spread out development and significant elevation changes make commuting by bicycle more challenging. Many of the Region's roads are also dirt, which can be more difficult for bicyclists, especially during mud season in the Spring. The State offers several grants to help communities plan and construct sidewalks and bicycle facilities to help reduce municipal costs. Programs like bike shares and rebates for electric assist bikes also encourage use of this mode of transportation.

As single occupancy vehicles will continue as a necessity for most residents, incentivizing and encouraging the transition to electric vehicles (EVs) is important. This can be accomplished by increasing the number of charging stations, including high-speed charging stations, throughout the Region and offering free parking for charging EVs. Towns can identify preferred sites for charging stations and encourage local businesses to install charging station. The transition to EVs presents a financial barrier as well. As EVs become more affordable with increased demand

and improved infrastructure, conversion to EVs will become more viable.

ENERGY POLICIES

ENERGY CONSERVATION, EFFICIENCY AND RESILIENCE

1. Support energy efficiency and conservation measures that reduce costs, usage, and emissions.
2. Encourage energy conservation in municipal buildings, businesses, and homes.
3. Support education around energy conservation and efficiency.
4. Promote decreased use of fossil fuels for heating.
5. Support utility, municipal, and property owner efforts to make our electrical power infrastructure more resilient to damage, both weather and human related.
6. Support improved energy conservation and efficiency strategies as a preferred alternative to the construction of new energy generation and transmission capacity.
7. Promote energy storage and systems that can supply energy to support critical functions in times of primary supply interruptions.
8. Support the State in achieving its Total Renewable Energy and Comprehensive Energy Plan goals.
9. Encourage new development in the region that meets the state building energy standards and exhibits best practices in terms of energy conservation and energy efficiency.

TRANSPORTATION AND LAND USE

10. Promote a shift away from single-occupancy vehicle trips through strategies appropriate to the region.
11. Promote a shift away from gas/diesel vehicles to electric or other non-fossil fuel transportation options.

RENEWABLE ENERGY DEVELOPMENT AND SITING

12. Ensure that all energy generation, transmission, and distribution projects further the regional goals for providing a reliable, sufficient, and economical energy supply to the region, promoting energy conservation

and efficiency, and furthering the development of energy sources that have zero or low Green House Gas (GHG) emissions.

13. Encourage a shift toward zero and low-GHG emission energy sources.
14. Support the continued availability and increased use of net metering electrical systems, including both individual and group net metering installations.
15. Support renewable energy solutions that cross town boundaries.
16. Support efforts of the State and regional organizations to increase training for new energy contractors and provide avenues for residents and businesses to easily find approved energy contractors.
17. Support sound energy facility siting practices and ensure that new developments give adequate attention to facility siting requirements, development constraints, natural resource protection, and land use compatibility.
18. Development shall be located to avoid state, regional and local known constraints, and to minimize impacts to state and local possible constraints, as defined in the Energy Element of the Regional Plan.
19. Stormwater runoff should be identified and mitigated for all new energy facility projects.
20. WRC recommends the location of renewable energy generation facilities in accordance with the relevant guidelines below. To determine an appropriate location for a facility, first review the constraints in this Plan and then look at the guidelines below to determine how and where WRC encourages renewable energy generation facilities. Inability to meet these guidelines does not necessarily preclude the ability to develop renewable energy generation projects:
 - a. Encourage the placement of facilities on previously impacted land, such as gravel pits, landfills, brownfields, former industrial land, etc.
 - b. Rooftop solar installations are highly encouraged whenever possible, but must comply with State, Regional, and Local historic preservation requirements.
 - c. Ground mounted solar installations are recommended after consideration is first given to rooftop solar.
 - d. Utility scale ground mounted solar arrays should be located outside of Village Centers and Downtown Centers to promote compact development patterns.

- e. Renewable energy generation facilities are encouraged to be installed as close as possible to existing distribution and infrastructure with adequate capacity.
- f. Encourage the placement of renewable energy facility sites along currently maintained town roads.

EQUITY

- 21. The Windham Regional Commission, in conjunction with the Department of Public Service, should develop diversity, equity, and inclusion strategies to advance the transition to a just and equitable energy system for Vermonters and to guide actions moving forward.
- 22. Equity should be considered as core criteria in all decision-making, alongside least-cost and environmentally sound principles.
- 23. The Windham Regional Commission supports the establishment and implementation of frameworks for consistently addressing issues of equity and justice across Regional and Municipal energy policies.