Village of Jacksonville Electric Company

2019 Integrated Resource Plan

Filed with the Public Utility Commission

Vermont Public Power Supply Authority

Executive Summary:

The Village of Jacksonville is located in the southern Vermont town of Whitingham in Windham County along the Massachusetts border. Incorporated in 1923, the Village of Jacksonville Electric Company's (JEC) service territory encompasses the Village of Jacksonville and the Town of Whitingham. JEC remains guided by the Vermont Public Utility Commission (PUC) rules as well as by the American Public Power Association's (APPA) safety manual. As a small municipal utility JEC is careful to balance maintaining reliability and reasonable cost levels with the need to deliver innovative programs to customers that provide practical value.

JEC's distribution system serves approximately 700 total customers consisting of a mix of residential, small commercial, and large commercial customers. Residential customers make up 92% of the customer mix while accounting for almost three quarters of JEC's retail kWh sales. Four large commercial customers (less than 1%) make up 18% of retail usage with the remaining 11% of retail sales going to small commercial and streetlights.

Consistent with regulatory requirements, every 3 years JEC is required to prepare and implement a least cost integrated plan (also called an Integrated Resource Plan, or IRP) for provision of energy services to its Vermont customers. JEC's Integrated Resource Plan (IRP) is intended to meet the public's need for energy services, after safety concerns are addressed, at the lowest present value life cycle cost, including environmental and economic costs, through a strategy combining investments and expenditures on energy supply, transmission and distribution capacity, transmission and distribution efficiency, and comprehensive energy efficiency programs.

ELECTRICITY DEMAND

JEC is facing a period of relatively flat demand influenced by several competing factors, all of which carry some uncertainty. Continued adoption of solar net metering reduces demand although the pace at which net metering will grow in JEC's territory is uncertain. As various incentives aimed at transitioning from fossil fuels to cleaner electricity are made available, increasing acceptance of cold climate heat pumps and similar appliances will likely increase demand, as will an expected increase in the use of electric vehicles.

While no significant change in the demand associated with JEC's largest customers is currently anticipated, the potential does exist. JEC monitors the plans of these large customers in order to anticipate necessary changes to the existing system infrastructure. In the case of a significant expansion by one or more customers detailed engineering studies may be needed to identify necessary system upgrades.

ELECTRICITY SUPPLY

JEC's current power supply portfolio includes entitlements in a mixture of baseload, firm and intermittent resources through ownership or contractual arrangements of varying duration, with most contracts carrying a fixed price feature. Designed to meet anticipated demand, as well as acting as a hedge against exposure to volatile ISO-New England spot prices, the portfolio is heavily weighted toward hydro, solar and other renewable sources.

When considering future electricity demand, JEC seeks to supplement its existing resources with market contracts as well as new demand-side and supply resources. JEC believes that in addition to working with financially stable counterparties, it is important for new resource decisions to balance four important characteristics: new resources should be low cost, locally located, renewable and reliable. Market contracts have the advantage of being both scalable and customizable in terms of delivery at specific times and locations. JEC anticipates regional availability of competitively priced renewable resources including solar, wind, and hydro. In addition to being a factor in meeting future electricity requirements, this category of resource contributes to meeting Renewal Energy Standard goals. Gas fired generation may have a role to play in the future portfolio for reliability purposes. As battery storage technology matures and proves economically feasible, JEC sees potential for storage to play an important load management role and to enhance the local impact of distributed generation.

RESOURCE PLANS

Looking ahead to evaluating major policy and resource acquisition decisions, JEC employs an integrated financial model that takes into account impacts on load and subsequent effects on revenue and power supply costs, as well effects on investment, financing and operating costs. Use of the integrated model allows for evaluation of uncertainty related to key variables, on the way to identifying anticipated rate impacts over time. While rate trajectory is the primary metric JEC relies on to evaluate resource decisions on an individual or portfolio basis there are other more subjective factors to consider, including resource diversity or exposure to major changes in market rules.

JEC faces two major energy resource decisions over the 2020 – 2039 period covered by this Integrated Resource Plan (IRP).

The major resource decisions faced by JEC occur in 2020 and 2024, respectively, which in total, will affect about 57% of JEC's energy supply between 2020 and 2024. The first is the expiration of a contract at the end of 2022, which represents about 50% of JEC's energy supply. The second is the expiration of a group of current market contracts in mid-2024, which represent about 6% of JEC's energy supply.

Options being evaluated by JEC to replace these two contracts include renegotiating the contract expiring in 2022 and extending its term, signing a PPA for an existing hydro plant to provide energy and Tier I RECs, signing a PPA for a solar plant to provide energy and Tier II RECs, or signing a PPA for market energy supplies.

The main sources of uncertainty expected to impact these decisions are the price of natural gas and pipeline transportation prices, load growth, the cost of regional transmission service and, capacity prices, and REC prices. JEC is largely hedged for the long run in the capacity market, reducing the impact of capacity prices.

Analysis of these major resource decisions also addresses the load-related question: what is the rate impact of 1% compound annual load growth?

RENEWABLE ENERGY STANDARD

JEC is subject to the Vermont Renewable Energy Standard which imposes an obligation for JEC to obtain a portion of its energy requirements from renewable resources. The RES obligation increases over time and is stratified into three categories, TIER I, TIER II and TIER III. JEC's obligations under TIER I can be satisfied by owning or purchasing RECs from qualifying regional resources. TIER II obligations must be satisfied by owning or purchasing RECs from renewable resources located within Vermont. Satisfaction of JEC's TIER III obligation involves energy transformation, or reduction of fossil fuel use within its territory. TIER III programs can consist of thermal efficiency measures, electrification of the transportation sector, and converting customers that rely on diesel generation to electric service, among other things. By providing incentive programs to encourage conversion of traditional fossil fuel applications JEC receives credits toward its TIER III obligation. More information regarding JEC's approach to meeting its TIER III obligation is available in Appendix B to this document.

ELECTRICITY TRANSMISSION AND DISTRIBUTION

JEC has a compact service territory as a result of being a small, municipal-owned electric utility and has consistently pursued upgrade initiatives in order to maintain a reliable and efficient system. JEC's distribution system consists of approximately 54 square miles of service territory distribution line and is a sub-transmission customer of Green Mountain Power (GMP). The JEC system receives transmission service from GMP's Wilmington Substation from a 3.8-mile line extension at 12.47 kV. The line is the feed line from the substation west of Wilmington to the junction of Rt 9 and 100 South to the GMP regulators.

In addition to upgrading and routinely maintaining the system to ensure efficiency and reliability, JEC is examining the need to modernize in order to support additional distributed generation on the system and to provide more customer oriented services, including load management programs that reduce costs for both JEC and its customers. JEC is currently engaged with VPPSA in a multi-phased process designed to assess its readiness for AMI, guide it through an RFP process culminating in vendor and equipment selection and ultimately resulting in implementation of an AMI system, provided the resulting cost estimates gained through the RFP process are not prohibitive. JEC plans to consider a staged approach to AMI implementation that would prioritize areas of high customer or load concentration while smoothing the overall cost to the system.

JEC sees potential value to customers by utilizing rate design, direct load control or other incentive programs as tools to manage both system and customer peak loads in unison. Implementation of an AMI system is expected to enhance JEC's ability to deliver these benefits and capture economic development/retention opportunities where possible.

Table of Contents

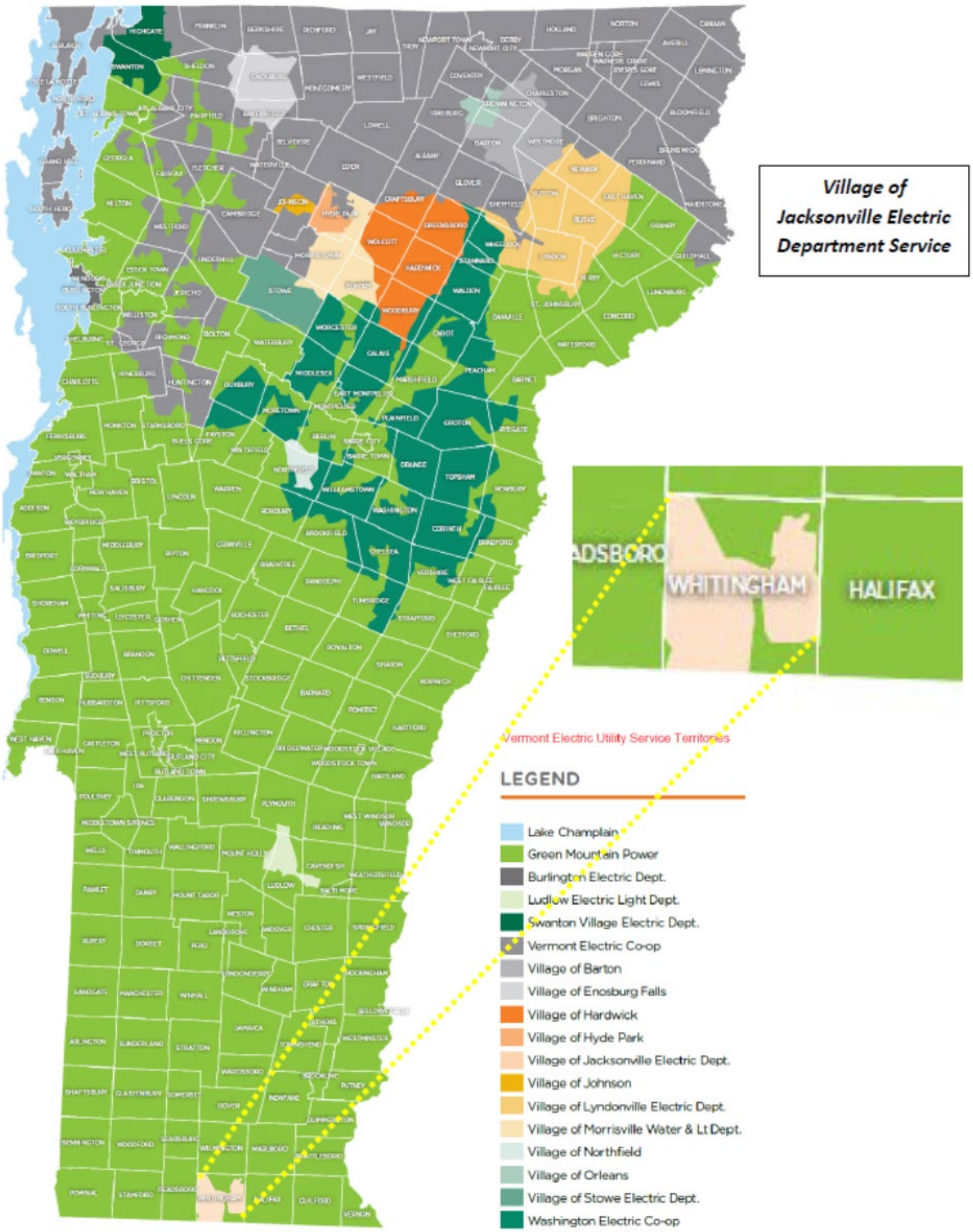
List of Tables

List of Figures

Introduction:

The Village of Jacksonville is located in the southern Vermont town of Whitingham in Windham County along the Massachusetts border. The Village of Jacksonville Electric Company (JEC), incorporated in 1923, serves approximately 700 retail customers. JEC's 54 square mile service territory encompasses the Village of Jacksonville and the Town of Whitingham, which can be seen on the Distribution Territory map below. JEC remains guided by the Vermont Public Utility Commission (PUC) rules as well as by the American Public Power Association's (APPA) safety manual. Well-established practices keep JEC operating safely, efficiently, and reliably.

Figure 1: JEC's Distribution Territory


Village of
Jacksonville Electric
Department Service
WHITINGHAM
HALIFAX
Vermont Electric Utility Service Territories
LEGEND
Lake Champlain
Green Mountain Power
Burlington Electric Dept.
Ludlow Electric Light Dept.
Swanton Village Electric Dept.
Vermont Electric Co-op
Village of Barton
Village of Enosburg Falls
Village of Hardwick
Village of Hyde Park
Village of Jacksonville Electric Dept.
Village of Johnson
Village of Lyndonville Electric Dept.
Village of Morrisville Water & Lt Dept.
Village of Northfield
Village of Orleans
Village of Stowe Electric Dept.
Washington Electric Co-op

Vermont Public Power Supply Authority:

The Vermont Public Power Supply Authority (VPPSA) is a joint action agency established by the Vermont General Assembly in 1979 under Title 30 VSA, Chapter 84. It provides its members with a broad spectrum of services including power aggregation, financial support, IT support, rate planning support and legislative and regulatory representation. VPPSA is focused on helping local public power utilities remain competitive and thrive in a rapidly changing electric utility environment.

JEC is one of twelve member utilities of VPPSA, who is governed by a board of directors that consists of one appointed director from each member. This gives each municipality equal representation. VPPSA's membership includes:

- Village of Jacksonville Electric Company
- Barton Village, Inc.
- Village of Enosburg Falls Electric Light Department
- Hardwick Electric Department
- Village of Hyde Park
- Village of Johnson Electric Department
- Ludlow Electric Light Department
- Lyndonville Electric Department
- Morrisville Water & Light Department
- Northfield Electric Department
- Village of Orleans
- Swanton Village Electric Department

JEC and VPPSA are parties to a broad Master Supply Agreement (MSA). Under the MSA, VPPSA manages JEC's electricity loads and power supply resources, which are pooled with the loads and resources of other VPPSA members under VPPSA's Independent System Operator – New England (ISO-NE) identification number. This enables VPPSA to administer JEC's loads and power supply resources in the New England power markets.

System Overview

JEC's distribution system serves a mix of residential and commercial customers, with residential making up the vast majority of their total customer count.

In 2018, JEC's peak demand in the winter months was 1,215 kW and 928 kW during the summer months, making JEC a winter peaking utility. Annual energy retail sales for 2018 were 4,987,290 kWh and the annual load factor for 2018 was 52.3%.

Table 1: JEC's Retail Customer Counts

Data Element	2014	2015	2016	2017	2018
Residential (440)	648	645	651	653	658
Rural	0	0	0	0	0
Small C&I (442) 1000 kW or less	47	48	50	51	51
Large C&I (442) above 1,000 kW	4	4	4	4	4
Street Lighting (444)	1	1	1	1	1
Public Authorities (445)	0	0	0	0	0
Interdepartmental (448)	0	0	0	0	0
Total	**700**	**698**	**706**	**709**	**714**

Table 2: JEC's Retail Sales

Data Element	2014	2015	2016	2017	2018
Residential (440)	3,581,175	3,483,683	3,547,801	3,500,313	3,502,190
Rural	0	0	0	0	0
Small C&I (442) 1000 kW or less	530,058	529,449	535,470	570,901	568,351
Large C&I (442) above 1,000 kW	807,488	858,073	883,259	866,081	899,706
Street Lighting (444)	17,176	17,176	17,176	17,094	17,043
Public Authorities (445)	0	0	0	0	0
Interdepartmental (448)	0	0	0	0	0
Total	**4,935,897**	**4,888,381**	**4,983,706**	**4,954,389**	**4,987,290**
YOY	**1%**	**-1%**	**2%**	**-1%**	**1%**

Table 3: JEC's Annual System Peak Demand (kW)

Data Element	2014	2015	2016	2017	2018
Peak Demand kW	1,137	1,075	1,140	1,237	1,215
Peak Demand Date	01/30/14	01/07/15	12/20/16	12/28/17	01/02/18
Peak Demand Hour	8	12	8	8	8

Finally, JEC does not own or operate any generation plants. Instead, it supplies electricity to its customers with contractual entitlements to power plants and wholesale market contracts throughout the region.

Structure of Report

This report is organized into six major sections plus an appendix and a glossary.

I. Electricity Demand
This chapter describes how JEC's electricity requirements were determined and discusses sources of uncertainty in the load forecast.

II. Electricity Supply
This chapter describes JEC's electricity supply resources, and the options that are being considered to supply the electricity needs of JEC's customers.

III. Resource Plans
This chapter compares JEC's electricity demand to its supply and discusses how JEC will comply with the Renewable Energy Standard.

IV. Electricity Transmission and Distribution
This chapter describes JEC's distribution system and discusses how it is being maintained to provide reliable service to its customers.

V. Financial Analysis
This chapter presents a high-level forecast of JEC's power supply costs and cost of service.

VI. Action Plan
This chapter outlines specific actions the JEC expects to take as a result of this Integrated Resource Plan.

A. Appendix: Letters List
The appendix includes a series of supporting documents and reports, as listed in the Table of Contents.

B. Glossary

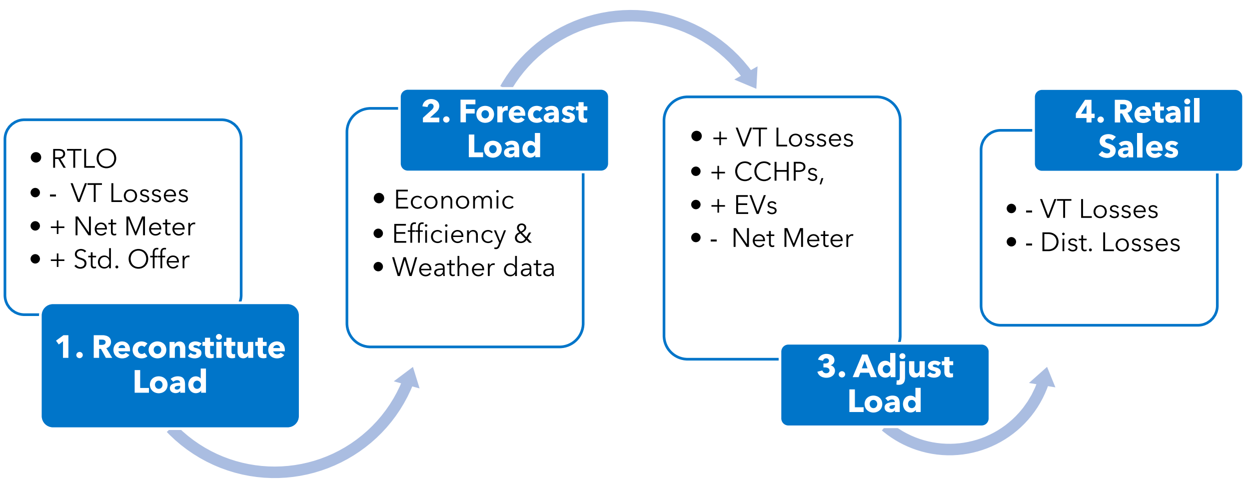
Electricity Demand

I. Electricity Demand

Energy Forecast Methodology: Regression with Adjustments

VPPSA uses Itron's Metrix ND software package and a pair of multiple regression equations to forecast JEC's peak and energy requirements. Importantly, the peak and energy forecasts are based on the same underlying data sets and the same methodologies that are used to set JEC's annual power budget. As a result, the forecasts are updated annually, and variances are evaluated monthly as actual loads become available. The forecast methodology follows a four-step process.

Figure 2: Forecasting Process[1]



1. Reconstitute Load

In the past, metered load at the distribution system's tiepoints (boundaries) was used as the 'dependent' variable in the regression equations. However, the growing impact of the net metering and Standard Offer Programs has effectively obscured the historical trends in this data, and this would cause the accuracy of the regression equations to decrease. To preserve the accuracy of the regression forecast, VPPSA "reconstitutes" the Real-Time Load Obligation (RTLO) data by 1.) adding back generation from the net metering and Standard Offer Programs, and 2.) subtracting Vermont's transmission losses. This results in a data set that can be accurately modeled using multiple regression, and creates consistency with the historical data.

The resulting, reconstituted load is used as the dependent variable in the regression equations and forms a historical time series data that the regression equations use to predict future loads. The following table summarizes the data that is used to reconstitute the load.

[1] For a list of acronyms, please refer to the Glossary.

Table 4: Data Sources for Reconstituting RTLO

Data Element	Source
RTLO	ISO-NE
– Vermont Transmission Losses	VELCO[2]
+ Net Metering Program Generation	VPPSA
+ Standard Offer Program Generation	VELCO
= Reconstituted Load	

2. Forecast Load

The regression equations use a series of independent or "explanatory" variables to explain the trends in the reconstituted load data. The equations themselves consist of the explanatory variables that are listed in Table 5.

Table 5: Load Forecast Explanatory Variables

Data Category	Explanatory Variable	Source
Dummy Variables	These variables consist of zeros and ones that capture seasonal, holiday-related, and large, one-time changes in electricity demand.	Not applicable. Determined by the forecast analyst.
Economic Indicators	Unemployment Rate (%)	Vermont Department of Labor
	Eating and Drinking Sales ($)	Woods and Poole
Energy Efficiency	Cumulative EE Savings Claims (kWh)	Efficiency Vermont Reports and Demand Resource Plan
Weather Variables	Temperature – 10-year average heating & cooling degree days.	National Oceanic and Atmospheric Administration (NOAA)

The forecast accuracy of the regression model is very good. Based on monthly data, it has an R-squared of 98%, and a Mean Absolute Percent Error (MAPE) of 1.47%.

3. Adjust Load

Once the regression models are complete and the forecast accuracy is maximized, the load forecast is adjusted to account for the impact (both historical and forward-looking) of cold climate heat pumps (CCHP), electric vehicles (EV), and net metering. As new electricity-using devices, CCHPs and EVs increase the load. However, by its nature, net metering decreases it[3].

Because the historical trends for these three items are still nascent, they cannot be effectively captured in the regression equations. In the case of net metering, VPPSA used the most recent three-year average to determine the rate of net metering growth in Jacksonville. For CCHPs and EVs, we used the same data (provided by Itron) that the

---

[2] Vermont Electric Power Company

[3] For more information on net-metering, please refer to https://vppsa.com/energy/net-metering/.

Vermont System Planning Committee (VSPC) used in VELCO's 2018 Long Range Transmission Plan.

Notice that the adjusted load does not account for the presence of the Standard Offer Program. This is a deliberate choice that enables the resource planning model to treat the Standard Offer Program as a supply-side resource instead of a load-reducer.

4. Retail Sales

A forecast of retail sales is required to estimate compliance with the Renewable Energy Standard (RES), and is calculated by subtracting Vermont transmission and local distribution losses from the Adjusted Forecast.

Energy Forecast Results

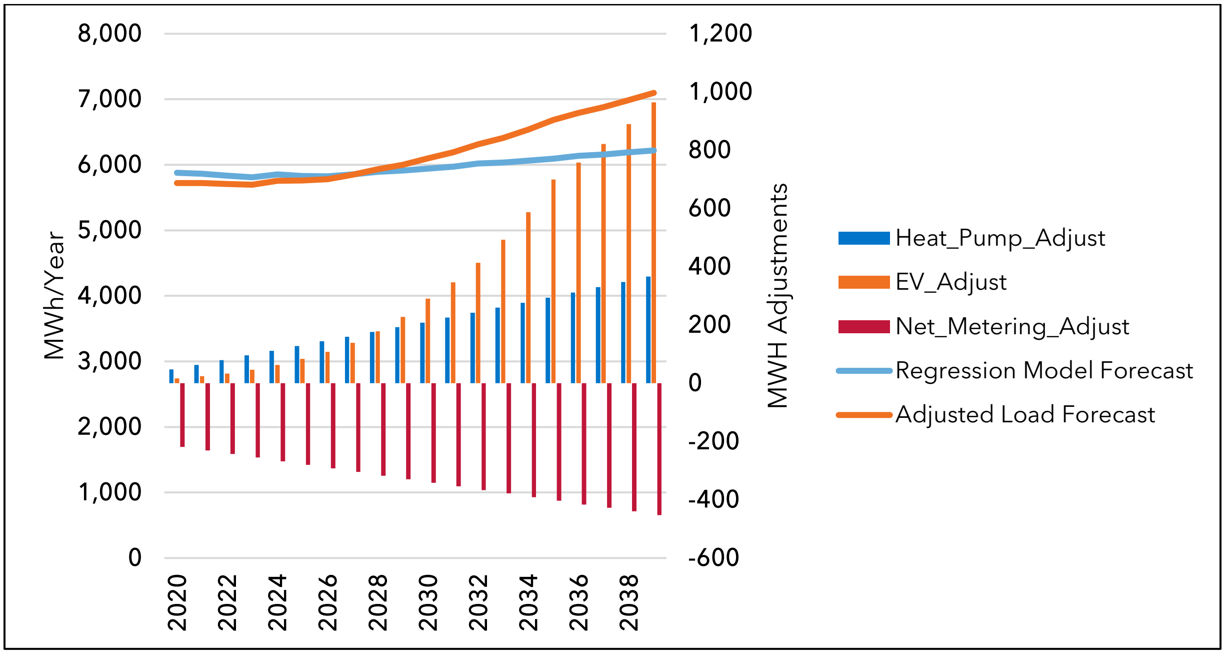
Table 6 shows the results of the Regression Forecast for energy, as well as the adjustments that are made to arrive at the Adjusted Forecast. The Compound Annual Growth Rates (CAGR) at the bottom of the table illustrate the trends in each of the columns. Notice that the Regression Forecast itself is declining by 0.1% per year. After making adjustments for CCHPs, EVs, and net metering, the Adjusted Forecast actually increases by 1.1% per year.

Table 6: Adjusted Energy Forecast (MWh/Year)

Year	Year #	Regression Fcst. (MWh)	CCHP Adjustment (MWh)	EV Adjustment (MWh)	Net Metering Adjustment (MWh)	Adjusted Fcst. (MWh)
2020	**1**	5,878	48	17	-219	5,723
2025	**6**	5,829	128	84	-280	5,761
2030	**11**	5,942	209	290	-341	6,100
2035	**16**	6,095	294	700	-403	6,686
2039	**20**	6,219	366	965	-452	7,098
CAGR		**0.3%**	**10.7%**	**22.5%**	**3.7%**	**1.1%**

The Adjusted Forecast is the result of high CAGRs for CCHPs (10.7%) and EVs (22.5%). But during the first three years of the forecast, these two trends are mostly offset by the net metering program, which grows by the historical three-year average of 3.7% per year. By 2028, the impact of CCHPs and EVs is greater than the impact of net metering, and the load begins to grow more quickly from that year forward.

Figure 3: Adjusted Energy Forecast (MWh/Year)



The accuracy of the underlying regression model is excellent at 94.2% adjusted R-squared, and the mean absolute percent error (MAPE) is low at 2.2%. While all of the trends in the adjustments are uncertain, they are expected to cause significant load growth after 2030.

Energy Forecast – High & Low Cases

To form a high case, we assumed that the CAGR for CCHPs and EV's about doubles to 25% and 40% respectively. Simultaneously, we assume that net metering penetration stops at today's levels. At these growth rates, 2039 energy demand rises by over 300% compared to 2020 electricity use, a result that is driven by the 40% CAGR for EVs. Because of the nature of compound growth, the increase in energy demand does not start to accelerate until after 2030. As a result, there is ample opportunity to monitor these trends during the annual budget cycles and the tri-annual IRP cycles.

Table 7: Energy Forecast – High Case

Year	Year #	Regression Fcst. (MWh)	CCHP Adjustment (MWh)	EV Adjustment (MWh)	Net Metering Adjustment (MWh)	Adjusted Fcst. (MWh)
2020	**1**	5,878	48	17	-219	5,723
2025	**6**	5,829	145	89	-219	5,845
2030	**11**	5,942	442	480	-219	6,645
2035	**16**	6,095	1,350	2,579	-219	9,805
2039	**20**	6,219	3,296	9,909	-219	19,205
CAGR		**0.3%**	**23.6%**	**37.7%**	**0.0%**	**6.2%**

To form a low case, we assumed that the CAGRs for CCHPs and EVs decreases by more than 50% from the base case. In addition, we assumed that the CAGR for net metering doubles. This combination of trends is a plausible worst-case scenario, and results in a forecast that *decreases* by 0.2% per year.

Table 8: Energy Forecast - Low Case

Year	Year #	Regression Fcst. (MWh)	CCHP Adjustment (MWh)	EV Adjustment (MWh)	Net Metering Adjustment (MWh)	Adjusted Fcst. (MWh)
2020	**1**	5,878	48	17	-219	5,723
2025	**6**	5,829	61	27	-321	5,595
2030	**11**	5,942	77	43	-472	5,590
2035	**16**	6,095	99	69	-694	5,569
2039	**20**	6,219	120	101	-944	5,497
CAGR		**0.3%**	**4.7%**	**9.5%**	**7.6%**	**-0.2%**

Peak Forecast Methodology: The Peak & Average Method

The peak forecast regression model forecasts the load during the peak hour each day. Because utility loads are strongly influenced by temperature, this peak usually occurs during an hour of relatively extreme temperatures. In winter, this is during a very cold hour, and in summer it is during a very hot hour.

Unlike the energy forecast model, using average weather in the peak forecast model is not appropriate. Why? By definition, the coldest day and hour is always colder than average, and the hottest day and hour is always hotter than average. As a result, using average weather in the peak forecast model would result in a forecast that is biased and too low. In this context, the key question is, "How can historical weather data be used to develop an accurate representation of future weather, while still maintaining the extremes?"

The answer is the rank-and-average method, which is widely accepted[4] and effectively represents the random, real-life extremes in average historical weather. This method assigns a temperature to each day of the year that is representative of the average of the coldest (or hottest) days. It is important to highlight that the rank and average method produces a "50/50" forecast. While one may expect this to be a method for forecasting extreme weather conditions, in reality extreme weather *is* normal.

Finally, the accuracy of the peak forecast regression model is good. Based on daily data, it has an R-squared of 89.4%, and a MAPE of 2.93%.

[4] For a more in-depth discussion of the method, please refer to Itron's white paper on the topic. https://www1.itron.com/PublishedContent/Defining%20Normal%20Weather%20for%20Energy%20and%20Peak%20Normalization.pdf

Peak Forecast Results

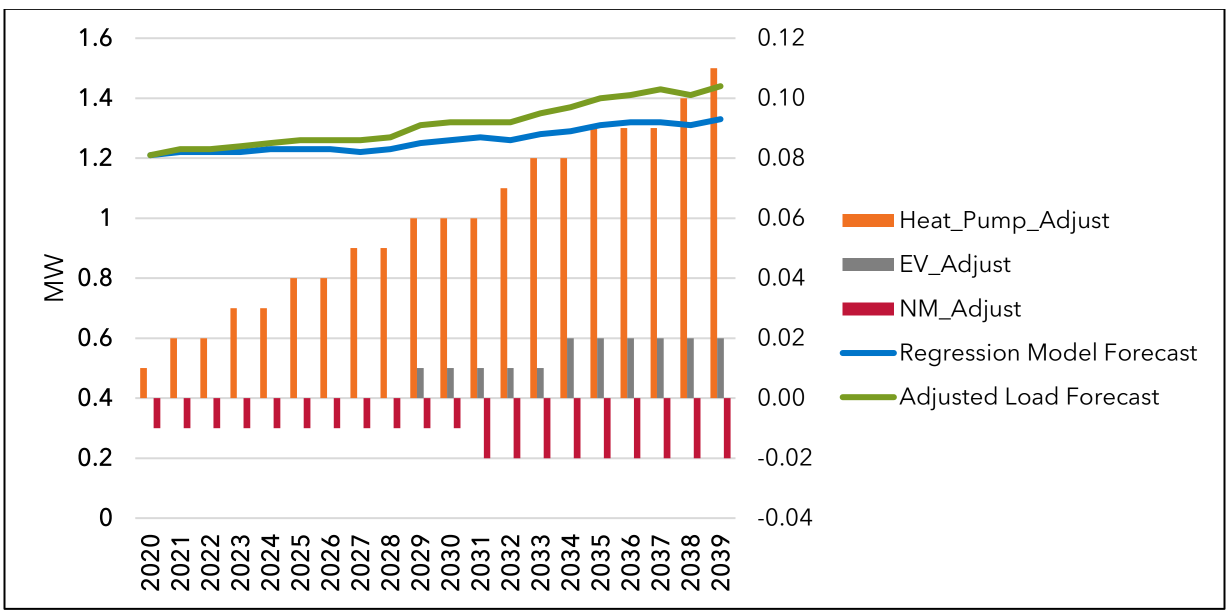
Table 9 shows the results of the Regression Forecast of peak loads, as well as the adjustments that are made to arrive at the Adjusted Forecast. The CAGR at the bottom of the table illustrate the trends in each of the columns. Notice that the Regression Forecast itself is growing by 0.5% per year. After making adjustments for CCHPs, EVs, and net metering, the Adjusted Forecast actually increases to 0.9% per year. Finally, the table shows that the timing of JEC's peak load is forecast to stay in January and December at 0800 (8:00 AM).

Table 9: Peak Forecast (MW)

MMM-YY	Peak Hour	Regression Forecast	EV Adjustment	CCHP Adjustment	Net Metering Adjustment	Adjusted Forecast
Jan-20	0800	1.21	0.00	0.01	-0.01	1.21
Dec-25	0800	1.23	0.00	0.04	-0.01	1.26
Jan-30	0800	1.26	0.01	0.06	-0.01	1.32
Jan-35	0800	1.31	0.02	0.09	-0.02	1.40
Jan-39	0800	1.33	0.02	0.11	-0.02	1.44
CAGR		**0.5%**		**12.7%**	**3.5%**	**0.9%**

The Adjusted Forecast exceeds the Regression Forecast starting in 2020 due to high CAGRs for CCHPs (12.7%). By 2035, EV's are forecast to be responsible for as much peak load growth as CCHP's. The peak load forecast starts at 1.21 MW and ends at 1.44 MW. This amounts to a 0.9% CAGR, and can be seen in Figure 4.

Figure 4: Adjusted Peak Forecast (MW)



Peak Forecast – High & Low Cases

To form a high-case, we assume that neither load controls nor Time-of-Use (TOU) rates are implemented, and then we adopt the same CAGR assumptions from the high case as in the energy forecast. Even under these assumptions, peak load growth does not start to materially impact the system until 2030. Absent a step change in consumer adoption of CCHPs and EVs, electrification is not likely to produce any peak load growth for the next ten years. However, we will continue to monitor these trends annually during our budget forecasting process.

Table 10: Peak Forecast – High Case

MMM-YY	Peak Hour	Regression Forecast	CCHP Adjustment (MW)	EV Adjustment (MW)	Net Metering Adjustment (MW)	Adjusted Fcst. (MW)
Jan-20	**0800**	1.2	0.00	0.01	-0.01	1.2
Dec-25	**0800**	1.2	0.00	0.03	-0.01	1.3
Jan-30	**0800**	1.3	0.01	0.09	-0.01	1.4
Jan-35	**0800**	1.3	0.05	0.28	-0.02	1.6
Jan-39	**0800**	1.3	0.21	0.69	-0.02	2.2
CAGR		**0.5%**		**23.6%**	**3.5%**	**3.1%**

A plausible low case for the peak forecast would involve applying TOU electric rates and load control devices on all of the major end uses, especially CCHPs and EVs. In theory, this strategy could completely offset any peak load growth resulting from CCHPs and EVs. As a result, it is not necessary to quantify a low case scenario. Peak loads would simply match the Regression Forecast without any adjustments.

Forecast Uncertainties & Considerations

Because of strong growth in CCHPs and EVs, JEC's electricity demand is expected to grow by 1.1% annually over the forecast period. The uncertainties facing JEC stem from the growth rate of net-metering, CCHPs and EVs all of which are nascent trends that will almost certainly progress at different rates than forecast.

Net Metering

JEC presently has 9 residential scale (< 15 kW) net metered customers with a total installed capacity of about 48 kW. In addition, there is one customer with two 50 kW arrays. As solar net metering costs continue to decline, the cost of net metered solar could reach parity with the price of grid power. If state policy continues to be supportive of net metering in this event, it could lead to a step change in the adoption rate of net metering, and a quicker erosion of retail sales and revenues for the utility.

Given the small size of the customer base and the nascent trends involved, net-metering represents a key uncertainty for JEC to monitor, especially if larger net metered projects are proposed. For example, a 100 kW net metered solar projects built in 2020 would represent a 67% increase in the base of installed, net metered capacity on the system. In this event, the impact would be captured in interconnection and annual power budgeting processes, and managed accordingly.

Electricity Supply

II. Electricity Supply

JEC's power supply portfolio is made up of generation resources, long-term contracts, and short-term contracts. The portfolio acts as a diversified, financial hedge that buffers JEC and its customers from the cost and volatility of buying electricity from ISO New England on the spot market at the Vermont Zone. The following sections describe each of the 11 power supply resources in JEC's portfolio.

Existing Power Supply Resources

1. Fitchburg Landfill

JEC holds a 1.9% (85 kW) entitlement of a landfill gas-fired generator at the Fitchburg Landfill in Westminster, MA. The 15-year PPA started in 2012, and provides nine participating VPPSA members with 3 MW of firm energy, capacity and renewable attributes for five years. Between 2017 and 2021, the contract supplies 3 MW of firm energy, capacity and renewable attributes plus 1.5 MW of unit contingent energy, capacity and renewable attributes. From 2022 to 2026, the participants will receive 4.5 MW of unit contingent energy, capacity and renewable attributes. The contract includes an option to extend deliveries for an additional five years (2027-2031).

2. Hydro Quebec US (HQUS)

In 2010, a long-term, statewide Purchased Power Agreement (PPA) with Hydro Quebec was signed. LED's entitlement under the contract is 0.023% (49 kW) through 2030, and it steps down as the contract nears expiration in 2038. HQUS energy will, based on an annual attestation, largely qualify for Vermont RES Tier 1 compliance, though the resource does not generate marketable RECs at this time.

3. Kruger Hydro

The Kruger Hydroelectric Facilities consist of six small facilities in Maine and Rhode Island; Barker Lower, Barker Upper, Blackstone, Brown's Mill, Gardiner and Pittsfield. Their output was purchased by VPPSA under three long-term purchased power agreements signed in February 2017. BED has an agreement with VPPSA to purchase 2.03% of their collective output. Finally, these contracts do not include RECs.

4. NextEra 2018-2022

JEC has a PPA with VPPSA to purchase firm, fixed price energy with NextEra, which provides energy from Seabrook Station, a nuclear facility in Seabrook, New Hampshire. JEC has an 2.5% (425 kW) share of the on-peak energy and a 2.2% (264 kW) share of the off-peak energy, which expires on December 31, 2022. While this resource is not qualified under any state RPS, it is tracked separately due to its carbon-free emission profile. Finally, it represents almost two-thirds of JEC's energy supplies in 2020.

5. New York Power Authority (NYPA) – Niagara

NYPA provides power to utilities in Vermont under two contracts: Niagara and St. Lawrence. JEC's share of the Niagara facility is 60 kW, and ends on September 1,

2025. We assume that the contract is renewed through 2039. Finally, the Niagara contract energy qualifies as a Vermont RES Tier 1 resource though the resource does not generate marketable RECs at this time.

6. New York Power Authority (NYPA) – St. Lawrence

JEC's share of the St. Lawrence facility 3 kW. The contract ends on April 30, 2032 but we assume that the contract is renewed through the rest of the forecast period.

7. Project 10

JEC has an agreement with VPPSA to purchase a portion of the power produced by Project 10, an oil-fired peaking generator located in Swanton, VT. JEC's share of Project 10's benefits and costs is 2.4%, and we assume that Project 10 is available throughout the forecast period.

8. Public Utilities Commission (PUC) Rule 4.100

JEC is required to purchase power from small power producers through Vermont Electric Power Producers, Inc. (VEPP Inc.), in accordance with PUC Rule 4.100. JEC's share of VEPPI power in 2018 was 0.0915%, and the current contracts between VEPP Inc. and its power producers will expire in 2020. We assume that there are no new participants in the 4.100 program for the rest of the forecast period. This is consistent with the relatively recent changes to Rule 4.100 that returned PURPA purchasing obligations to the host utility.

9. Public Utilities Commission (PUC) Rule 4.300

JEC is required to purchase power from small power producers through the Vermont Standard Offer Program, in accordance with PUC Rule 4.300. Some of the Standard Offer resources are configured as load-reducers and are not settled in the wholesale markets, resulting in lower reported loads. JEC's share of Standard Offer power in 2018 was 0.1%.

10. Ryegate Facility

JEC receives power from the Ryegate biomass facility, a 20.5 MW generator in East Ryegate, Vermont. In 2018 JEC received 0.0975% of the energy from the plant. Under Vermont statutes, Ryegate is the only plant eligible to meet 30 V.S.A. § 8009, and at this time, we have assumed that there may be a renewal of the current contract upon expiration. As a result, we assume that the generator is available throughout the forecast period. Currently JEC is entitled to a portion of the RECs produced by the facility.

11. Market Contracts

JEC meets the remainder of its load obligations through ISO New England's day-ahead and real-time energy markets, and through contracts (physical and financial) that are less than five years in duration. Market purchases range in size, duration, and counterparty, and are designed to balance JEC's supply resources with its load obligations in ISO New England's markets.

Table 11 summarizes the resources in the portfolio based on a series of important attributes. First the megawatt hours (MWH) and megawatts (MW) are shown to show the relative size of each resource. The delivery pattern indicates what time of the day and week the resource delivers energy, and the price pattern indicates how the resource is priced. Notice that most of the resources are fixed-price. This feature provides the hedge against spot market prices. If the resource produces Renewable Energy Credits[5] (RECs), that is indicated in the seventh column, followed by the resource's expiration date and whether we assumed that it would be renewed until 2039.

Table 11: Existing Power Supply Resources

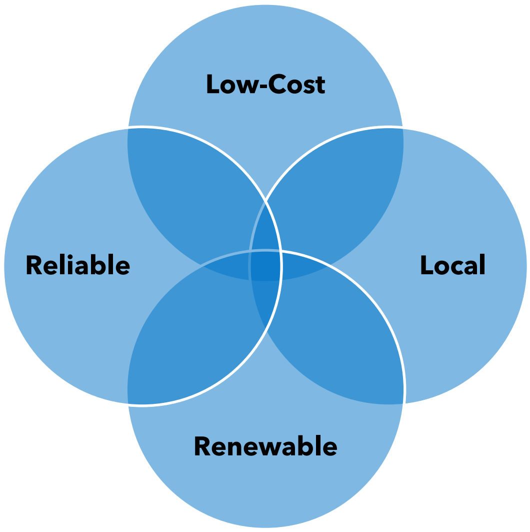
Resource	2020 MWH	% of MWH	2020 MW	Delivery Pattern	Price Pattern	REC	Expiration Date	Renewal to 2039
1. Fitchburg Landfill	642	11%	0.064	Firm	Fixed	✓	12/31/31	No
2. HQUS	285	5%	0.000	Firm	Indexed	✓	10/31/38	No
3. Kruger Hydro	514	8.9%	0.032	Intermittent	Fixed		12/31/37	No
4. NextEra 2018-22	2,981	51%	0.000	Firm	Fixed	✓	12/31/22	No
5. NYPA – Niagara	614	11%	0.106	Baseload	Fixed	✓	09/01/25	Yes
6. NYPA – St. Law.	43	0.7%	0.003	Baseload	Fixed	✓	04/30/32	Yes
7. Project 10	14	0.2%	0.928	Dispatchable	Variable		Life of unit.	Yes
8. PUC Rule 4.100	26	0.5%	0.004	Intermittent	Fixed		2020	No
9. PUC Rule 4.300	150	2.6%	0.001	Intermittent	Fixed	✓	Varies	No
10. Ryegate Facility	159	2.7%	0.019	Baseload	Fixed	✓	10/31/21	Yes
11. Market Contracts	373	6.4%	0.000	Firm	Fixed		< 5 years.	N/A
Total MWH	5,800	100%	1.155					

[5] Note that RECs are defined broadly in this table, and that the "emissions attributes" from non-renewable (but also non-carbon emitting) resources such as nuclear are included in this table.

Future Resources

JEC will seek out future resources that meet as many of the following criteria as possible. Ideally, future resources will meet four criteria by being low-cost, local, renewable and reliable.

Figure 5: Resource Criteria



- ✓ **Low-Cost** resources reduce and stabilize electric rates.
- ✓ **Local** resources are located within the Windham Regional Commission (WRC) area or within Vermont.
- ✓ **Renewable** resources meet or exceed RES requirements
- ✓ **Reliable** resources not only provide operational reliability, but are also owned and operated by financially strong and experienced companies.

These criteria enable JEC to focus on subset of generation technologies, and to exclude coal, geothermal and solar thermal generation which do not meet them. Resources that JEC may consider fall into three categories: 1.) Existing resources in Table 11, 2.) Demand-side resources, and 3.) New resources.

Category 1: Extensions of Existing Resources

This plan assumes that three existing resources are extended past their current expiration date. These include NYPA, Project 10, and Ryegate. The most crucial of these is Project 10, which supplies over 95% of JEC's capacity. Where resource needs remain, market contracts will be used to supply them.

1.1 Market Contracts

Market contracts are expected to be the most readily available source of electric supply for energy, capacity, ancillary services and renewable attributes (RECs). By conducting competitive solicitations through VPPSA, JEC can not only get access to competitive prices (low-cost), but it also can structure the contracts to reduce volatility (stable rates) and potentially include contracts for RECs for RES compliance. Market contracts are also scalable and can be right-sized to match JEC's incremental electric demands by month, season and year. In many cases, the delivery point for market contracts can be set to the Vermont Zone reducing potential price differential risks between loads and resources. Finally, the financial strength of the suppliers in the solicitation can be predetermined. The combination of these attributes makes market contracts a good fit for procuring future resources.

Category 2: Demand-Side Resources

The lowest cost, most local source of energy is often energy that is conserved or never consumed. As a result, JEC will continue to welcome the work of the Efficiency Vermont (EVT) in its service territory. JEC will also continue to work with its customers, both large and small, to uncover demand response opportunities. This includes best practices for demand management as JEC continues to implement its energy transformation programs under RES.

Category 3: New Resources

VPPSA regularly meets with developers throughout New England, and through VPPSA staff, JEC will continue to monitor and evaluate new generation resources in the New England region.

3.1 Wind Generation (On and Off-Shore)

On-shore wind projects continue to be developed in New England, and entitlements to such projects can often be negotiated at competitive prices. RECs are often bundled into the PPA, making this resource a good fit for the low-cost and renewable criteria. Off-shore wind projects are in development, but the costs remain substantially higher than for on-shore wind. As a result, JEC would approach such projects with more reserve.

3.2 Gas-Fired Generation

As Project 10 approaches an investment in a major overhaul and the requirements for reserves, voltage support and other ancillary services shift, JEC will investigate simple and combined cycle (CC) generation. This includes entitlements to new or existing plants in New England, and to traditional peaking generation which continues to provide reliable peak-day service to the New England region. It should be noted that as a participant in ISO New England's markets, the marginal cost of supply is set by these same resources, and that the benefit of owning an entitlement in one is primarily to reduce heat rate risk.

3.3 Solar Generation

Solar development is increasingly common and cost-effective, particularly at utility scales. Plus, it can be deployed locally. Furthermore, solar is expected to be the primary technology that is employed to meet its Distributed Renewable Energy (Tier II) requirements under RES. For these reasons, solar is likely to be a leading resource option, and JEC will continue to investigate solar developments both within its service territory and outside of it.

3.31 Net Metering

While net metering participation rates are presently modest and are forecast to grow modestly, JEC will monitor the participation rate closely as solar costs approach grid parity. Should grid parity occur, not only would net metered solar penetration be expected to take off but the costs of the existing program would likely cause upward rate pressure[6]. As a result, net metered solar is an inferior option when compared to lower-cost and utility scale solar projects.

3.4 Hydroelectric Generation

Hydroelectric generation is widely available in the New England region, and can be purchased within the region or imported from New York and Quebec. Furthermore, it can be sourced from either small or large facilities. Like all existing resources, price negotiations begin at or near prevailing market prices. As a result, existing hydro generation could be both low-cost (or at least at market) and renewable.

3.5 Battery Storage

Any discussion of future resources would be remis without including battery storage. While still in its initial phase of commercialization, there are six use cases where storage is being installed. According to a recent analysis by Lazard[7], use cases fall into two categories:

1. **In-Front-of-the-Meter**
   a. Wholesale (Used as a replacement for peaking generation.)
   b. Transmission and Distribution (Used to defer or replace traditional T&D investments.)
   c. Utility-Scale (Solar + Storage)

2. **Behind-the-Meter**
   a. Commercial & Industrial (Used as a standalone way to reduce demand charges.)
   b. Commercial & Industrial (Solar + Storage)
   c. Residential (Solar + Storage)

All of the In-Front-of-the-Meter use cases are large-scale, and small public power utilities like JEC may be best served by participating in such projects as a joint owner or entitlement holder, not the lead participant. However, where local T&D constraints are present or when utility-scale solar plus storage sites are being developed, JEC will work through VPPSA to quantify the business case. Similarly, the business case for Behind-the-Meter applications will be quantified as those opportunities are identified.

---

[6] An excellent discussion of net metering and rate-design policy issues by Dr. Ahmad Faruqui can be found in the October 2018 issue of Public Utilities Fortnightly. https://www.fortnightly.com/fortnightly/2018/10/net metering-faq

[7] For a current analysis and list of use cases, please refer to the "Levelized Cost of Storage Analysis – Version 4.0", Lazard, November 2018. https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2018/

Regional Energy Planning (Act 174)

As part of the Windham Regional Commission (WRC), JEC is part of a Regional Energy Plan[8] that was adopted in April 2018. The purpose of the plan is to create a roadmap that WRC towns can follow so that 90% of their energy use is renewable by 2050. To do this, the plan calls for a series of actions that have been pursued since the 1990s.

> "Since the 1990s the Windham Regional Plan has had a major greenhouse gas emission reduction and renewable energy transition focus. To support this focus energy has been incorporated as a thread throughout all sections and topics of the plan. We emphasize compact settlement patterns, speak to opportunities to reduce energy consumed through transportation, recognize the critical role of weatherization and thermal efficiency, and encourage the transition from carbon-based fuels to renewable energy sources."[9]

The full plan is included in the appendix, and all future resource decisions will be made with this plan in mind. Specifically, JEC will consult with the WRC on resource decisions that involve potential siting of new resource in Vermont.

[8] The full plan can be found at http://www.windhamregional.org/publications.

[9] Windham Regional Energy Plan, page 4

Resource Plan

III. Resource Plans

Decision Framework

JEC evaluates significant resource decisions using the integrated financial models developed in this IRP. The primary quantitative evaluation metric is cost, expressed in retail $/kWh over the life of the resource being evaluated. The other metrics include location, renewability and reliability as described in the Future Resources Section of the Electricity Supply chapter.

When evaluating significant resource decisions, JEC will identify the key variables whose range of possible outcomes has the largest impact on the retail costs of service per kWh, and will conduct scenario and/or sensitivity analysis. By quantifying low, base and high case inputs for the key variables, JEC will evaluate the risks associated with the decision. However, some decisions, such as simple or short-term resource acquisitions, may not have integrated effects. In such cases, the impact of the resource decision on power costs may be used as a proxy for the relative impact on overall retail costs per kWh.

Major Decisions

As the following sections will explain, JEC faces a series of potential risks and accompanying resource decisions that can prudently fulfill its energy, capacity and RES obligations in the coming years. These include:

1. Extend the NextEra Contract: The expiration of the NextEra contract on 12/31/2022 not only represents over 50% of JEC's energy supply, but also its largest source of emissions free electricity. As a result, the analysis quantifies the cost of a long-term (2023-2039) PPA at the same volumes, but at levelized market prices.

2. Long-Term Hydro and REC PPA: The following analysis will illustrate how a 1 MW hydro PPA with Tier I eligible RECs could reduce market price risk and cost.

3. Long-Term PV and REC PPA: The following analysis will illustrate how a 150 kW PV PPA with Tier II eligible RECs could reduce market price risk.

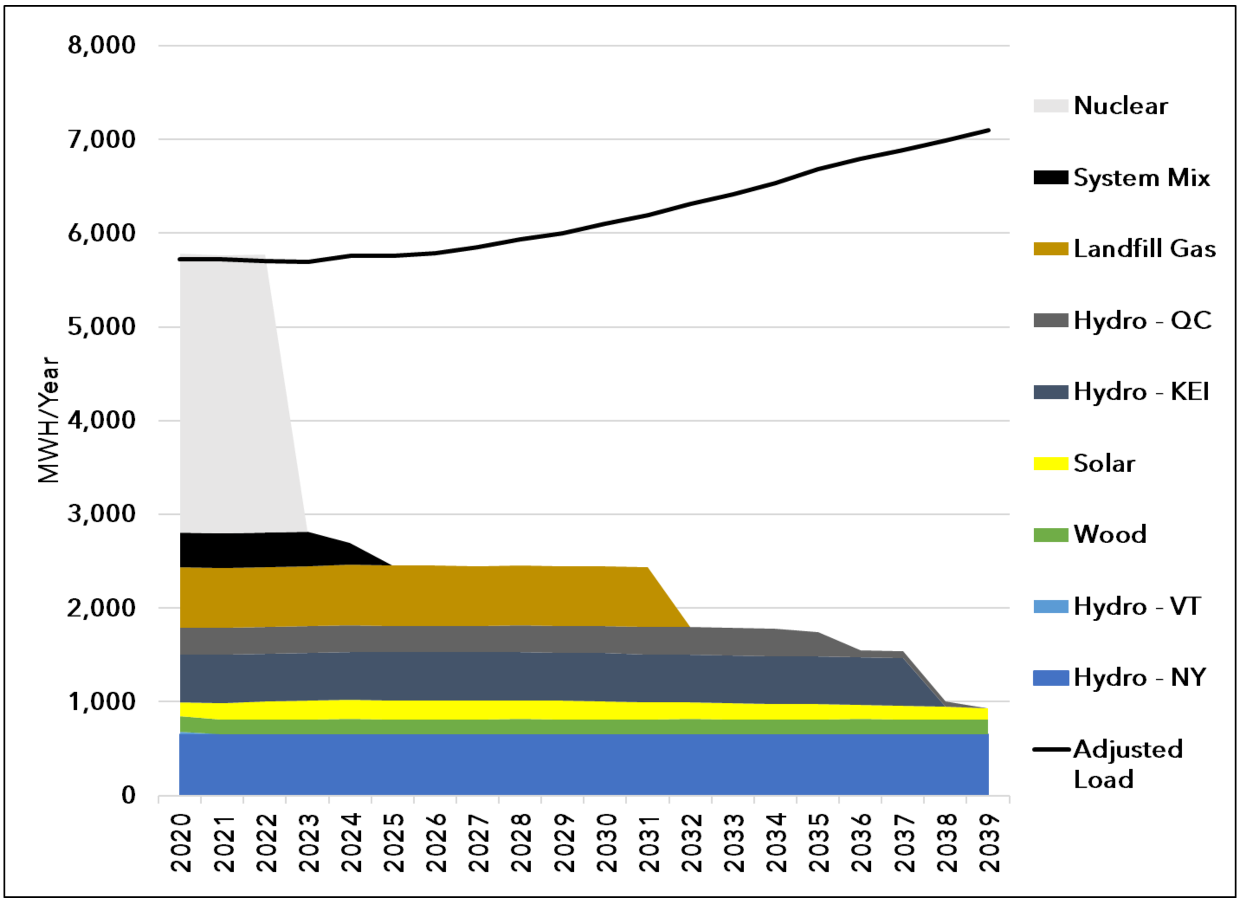
Energy Resource Plan

Figure 6 compares JEC's energy supply resources to its adjusted load. There are two major resource decisions that, in total, will affect about 57% of JEC's energy supply between 2020 and 2024. The first is the expiration of the NextEra contract on 12/31/2022, which represents about 50% of JEC's energy supply. The second is the expiration of current market contracts on 6/30/2024, which represents about 6% of JEC's energy supply.

Leading options to replace these two contracts include:

- NextEra: Renegotiating the NextEra contract and extend its term,
- Solar: Signing a solar PPA to provide energy and Tier II RECs,
- Existing Hydro: Signing a hydro PPA to provide energy and Tier I RECs, and
- Market Contracts: Signing a PPA for market energy supplies.

Figure 6: Energy Supply & Demand by Fuel Type



The impact of these two resource expirations on the portfolio is summarized in Table 12. Because the price of the NextEra contract is presently above the market price forecast, its expiration could potentially reduce rate pressure. It will have no impact on RES compliance, but because it includes emissions free nuclear attributes, it will increase JEC's emissions rate if it is not replaced with another emissions free resource. The impact of the market contracts' expiration is not expected to impact rates because they are priced very close to today's market price forecast.

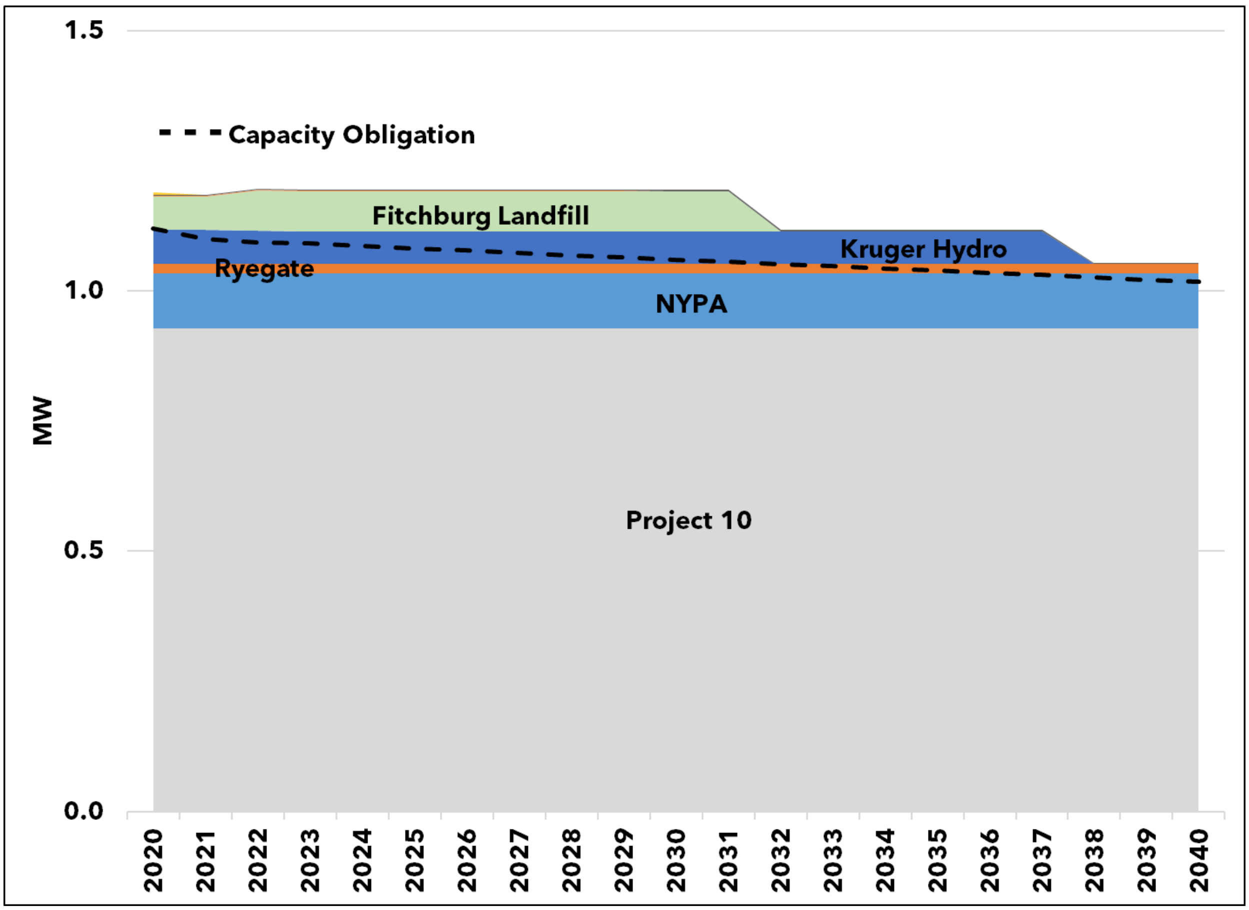
Table 12: Energy Resource Decision Summary

Resource	Years Impacted	% of MWH	Rate Impact	RES Impact
1. NextEra 2018-2022	2023+	50%	Beneficial	None
2. Market Contracts	2024+	6%	Neutral	None

Capacity Resource Plan

Figure 7 compares JEC's capacity supply to its demand. Project 10 provides a large majority of JEC's capacity, with other contributions coming from NYPA, Ryegate, Kruger Hydro and the Fitchburg Landfill.

Figure 7: Capacity Supply & Demand (Summer MW)



No capacity resource decisions are necessary unless the reliability of Project 10 drops for an extended period of time. As a result, maintaining the reliability of Project 10 will be the key to minimizing JEC's capacity costs, as explained in the next section.

ISO New England's Pay for Performance Program

Because JEC is part of ISO New England, its capacity requirements are pooled with all of the other utilities in the region. As a result, if Project 10 is not available, JEC will be provided with (energy and) capacity by ISO New England. However, ISO New England's Pay for Performance[10] (PFP) program creates financial payments (and potential penalties) for generators to perform when the grid is experiencing a scarcity event.

The following table illustrates the range of performance payments that JEC's share of Project 10 creates in ISO New England's PFP Program. Depending on ISO-NE's load at the time of the scarcity event and Project 10's performance level, JEC could receive up to a $2,000 payment or pay up to a $2,000 penalty during a one-hour scarcity event. This represents a range of plus or minus 20% of JEC's monthly capacity budget. However, such events are not expected to occur more than a few times a year (if at all), and frequently last less than one hour.

Table 13: Pay for Performance Ranges for One Hour of Project 10 Operation[11]

ISO-NE Load	Performance Payment Rate	0% Performance	50% Performance	100% Performance
10,000	$2,000/MWH	-$600	$300	$1,200
15,000	$2,000/MWH	-$900	$100	$1,000
20,000	$2,000/MWH	-$1,100	-$200	$700
25,000	$2,000/MWH	-$1,400	-$500	$500

[10] For an overview of the PFP program, please visit https://www.iso-ne.com/participate/support/customer-readiness-outlook/fcm-pfp-proJECt.

[11] Please refer to the following presentation from ISO-NE for the details of how the performance payments are calculated. https://www.iso-ne.com/static-assets/documents/2018/06/2018-06-14-egoc-a4.0-iso-ne-fcm-pay-for-performance.pdf

Renewable Energy Standard Requirements

JEC's obligations under the Renewable Energy Standard[12] (RES) are shown in Table 14. Under RES, JEC must purchase increasing amounts of electricity from renewable sources. Specifically, its Total Renewable Energy (Tier I) requirements rise from 59% in 2020 to 75% in 2032, and the Distributed Renewable Energy[13] (Tier II) requirement rises from 2.8% in 2020 to 9.4% in 2032. Note that this IRP assumes that the requirements for all three Tiers are maintained at their 2032 levels throughout the rest of the study period.

Table 14: RES Requirements (% of Retail Sales)

Year	Tier I (A)	Tier II (B)	Net Tier I (A) - (B)	Tier III
2020	59%	2.80%	56.20%	2.67%
2021	59%	3.40%	55.60%	3.33%
2022	59%	4.00%	55.00%	4.00%
2023	63%	4.60%	58.40%	4.67%
2024	63%	5.20%	57.80%	5.34%
2025	63%	5.80%	57.20%	6.00%
2026	67%	6.40%	60.60%	6.67%
2027	67%	7.00%	60.00%	7.34%
2028	67%	7.60%	59.40%	8.00%
2029	71%	8.20%	62.80%	8.67%
2030	71%	8.80%	62.20%	9.34%
2031	71%	9.40%	61.60%	10.00%
2032	75%	10.00%	65.00%	10.67%
2033-2039	75%	10.00%	65.00%	10.67%

Under RES, Tier II is a subset of Tier I. As a result, we subtract the Tier II percentage from the Tier I percentage to get the Net Tier I requirement in the fourth column. Notice that the net Tier I requirement declines every 2nd and 3rd year until the Tier I requirement increases. When these percentages are multiplied by the forecast of retail sales, the result is a seesaw effect where the Net Tier I requirement declines every 2nd and 3rd year. This can be seen more clearly in Figure 8 in the next section.

The final column shows the Energy Transformation (Tier III) requirement. Because it is designed to reduce fossil fuel use, the Tier III requirement is fundamentally different from Tier I and Tier II requirements. And unlike the Tier I & II requirements…which count only electricity that is produced and consumed in an individual year[14]…Tier III programs account for the "lifetime" the fossil fuel savings. For example, if a Tier III program installs a CCHP in 2020, the fossil fuel savings from that CCHP are counted such that the full ten-years of the CCHP's expected useful life accrue to the 2020 Tier III requirement.

[12] For more information on the RES program, please visit https://vppsa.com/energy/renewable-energy-standard/.

[13] Distributed Renewable Energy must come from projects that are located in Vermont, are less than five MW in size, and are built after June 30th, 2015.

[14] For simplicity, we assume that no banking occurs in this example. In practice, banking excess TIER I and TIER II credits for use in future years is permitted under RES.

Table 15: Alternative Compliance Payment[15] ($/MWH)

Year	Tier I	Tier II & III
2020	$10.00	$60.00
2021	$10.22	$61.32
2022	$10.44	$62.67
2023	$10.67	$64.05
2024	$10.91	$65.46
2025	$11.15	$66.90
2026	$11.39	$68.37
2027	$11.65	$69.87
2028	$11.90	$71.41
2029	$12.16	$72.98
2030	$12.43	$74.59
2031	$12.70	$76.23
2032	$12.98	$77.90

The RES statute provides a second way to comply with its requirements, the Alternative Compliance Payment (ACP). In the event that a utility has not achieved the requisite amount of Tier I, II or III credits in a particular year, then any deficit is multiplied by the ACP, and the funds are remitted to the Clean Energy Development Fund (CEDF).

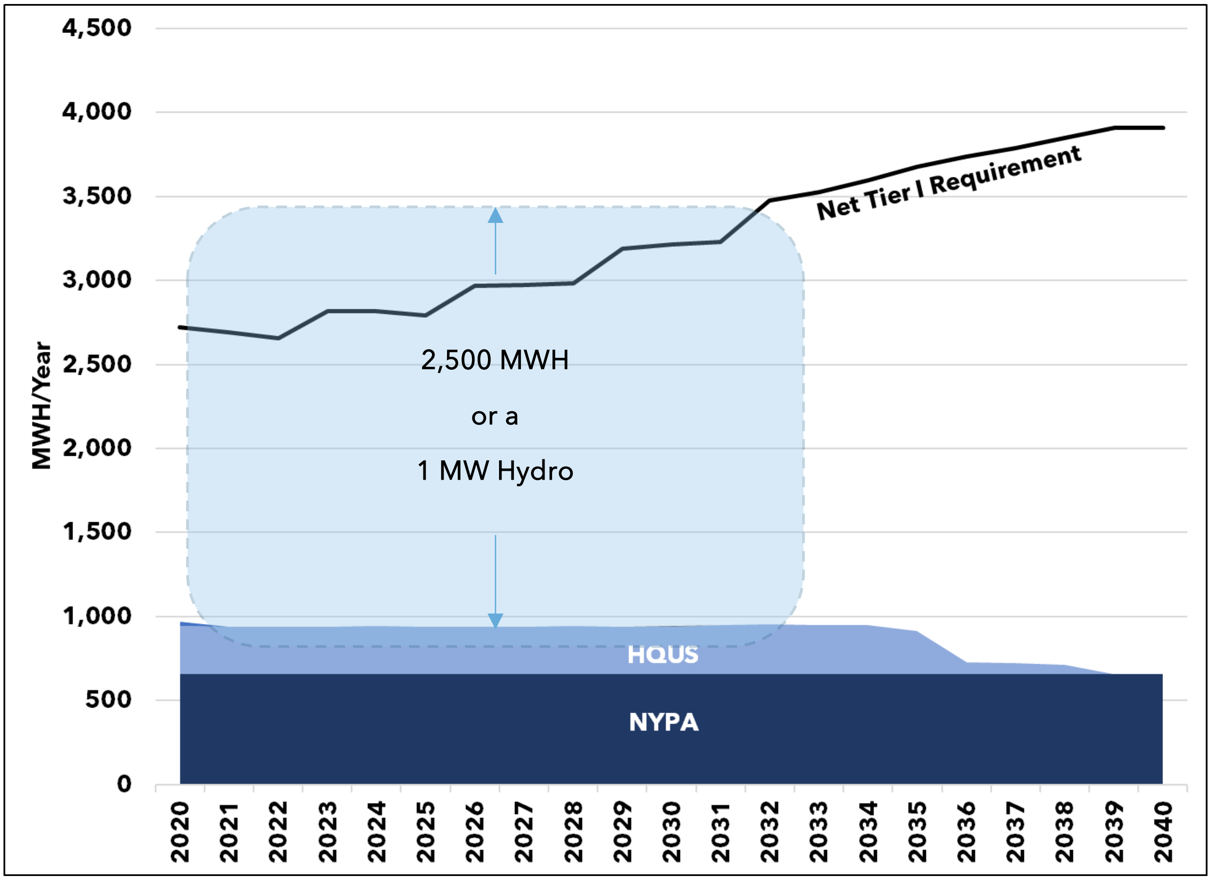
Finally, utilities with a RES deficit may also petition the Public Utilities Commission (PUC) for relief from the ACP. Alternatively, utilities may petition PUC to roll the deficit into subsequent compliance years. As a result, there are multiple ways to comply with RES requirements.

[15] Please note that these are estimates, and grow at inflation.

Tier I - Total Renewable Energy Plan

Between 2020 and 2024, JEC's Net Tier I requirement is about 2,700 MWH per year. The only resources that contribute to meeting it is HQUS, NYPA, and the (miniscule) remainder of PUC's 4.100 program. These resources represent about 950 MWH per year or one-third of JEC's Net Tier I requirement.

Figure 8: Tier I - Demand & Supply (MWH)



In the early years of the 2020s, JEC is likely to meet its Net Tier I requirements by purchasing Maine Class II (ME II) Renewable Energy Credits (RECs). These are presently the lowest cost source of Tier I compliant RECs in the region, and their price has ranged from a low of $1.00 to a high of $2.50 per MWH over the past four years. At the current price of $1.50/MWH, the cost of complying with Net Tier I in the 2020 to 2024 period would be about $3,000 per year.

As mentioned in the Energy Resource Plan, the expiration of the NextEra 2018-2022 PPA creates an opportunity to purchase a resource that provides both energy and RECs. NextEra's supply is equivalent to a 1.0 MW hydro facility[16], and if the output from a hydro resource of this size and capacity factor was purchased (including RECs), the Net Tier I deficit between 2020 and 2024 would be erased through 2032. As a result, this resource choice is one of the major resource decisions that is analyzed in this IRP.

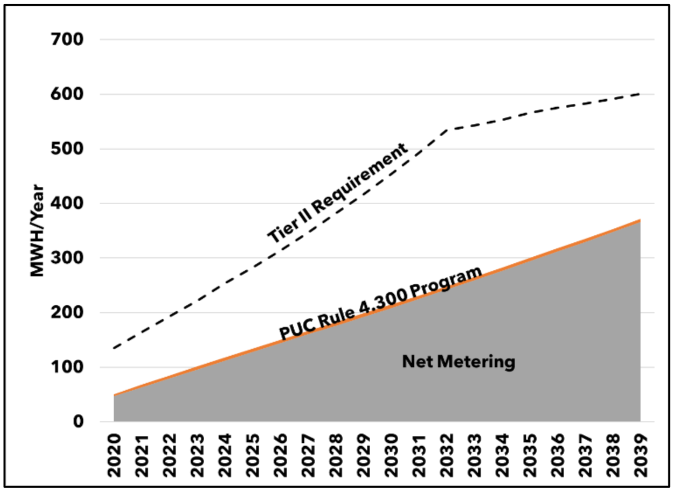
---

[16] We have assumed a 33% capacity factor, which results in roughly 2,900 MWH per year.

Tier II - Distributed Renewable Energy Plan

The dashed line in Figure 9 shows JEC's Distributed Renewable Energy[17] (Tier II) requirement, which rises steadily from 130 MWH in 2020 to 530 MWH in 2032. Between 2020 and 2024, the net metering program (plus a small contribution from PUC's 4.300 Program) is expected to fulfill 40% of JEC's Tier II requirement. As a result, another Vermont-based renewable resource(s) will be required[18].

Figure 9: Tier II – Demand & Supply (MWH)



The size of the solar resource that is required to fulfill Tier II starts at 50 kW in 2020 and rises to about 170 kW in 2032. As part of a partnership between VPPSA and Encore Renewable Energy[19], JEC is planning to enter into a PPA for a share of a 1 MW solar project that is being developed in Jacksonville, VT. In the event that this project is built, JEC plans to have enough RECs to fulfill its Tier II requirement in the early 2020s, plus a surplus that can be used toward its Energy Transformation requirement.

In the event that the Jacksonville solar project is not built, then JEC will most likely work with other VPPSA members to develop a solar project elsewhere in Vermont. In any years where there is a deficit, JEC plans to purchase qualifying RECs to meet its TIER II requirement. In recent years, the cost of these RECs has been 60% to 90% lower than the ACP.

---

[17] The TIER II requirement is also known as "Tier 2".

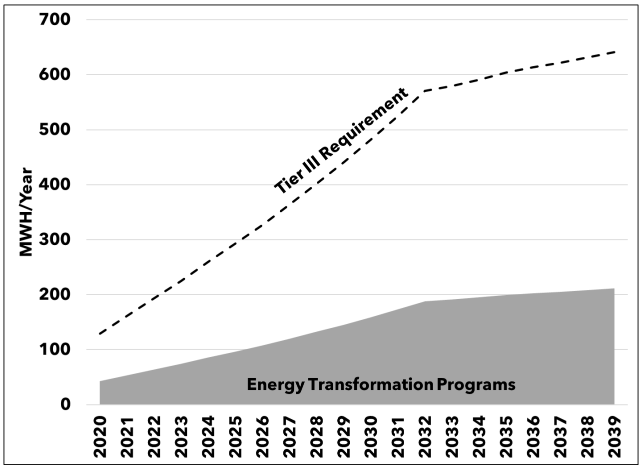
[18] We assume that any surplus MWH are not banked, and are instead applied to JEC's Energy Transformation requirement.

[19] https://encorerenewableenergy.com/vermont-public-power-supply-authority-and-encore-renewable-energy-partner-to-increase-solar-generation-for-member-communities/

Tier III - Energy Transformation Plan

The dashed line in Figure 10 shows JEC's Tier III requirements, which rise from about 130 MWH in 2020 to about 570 MWH in 2032. Energy Transformation programs are presently budgeted to fulfill about a third of the requirement, and are shown in the gray-shaded area of Figure 10. These programs[20] cover a range of qualifying technologies including EVs, CCHPs, and HPWHs. For perspective, the Tier III requirement is equivalent to installing 9-17 CCHP[21] per year between 2020 and 2025.

Figure 10: Energy Transformation Supplies



JEC is expected to have a substantial deficit which is illustrated in Figure 10. This deficit is equivalent to 6 – 12 CCHP's per year or 50 – 100 kW of solar PV. Alternatively, the deficit could be fulfilled by a custom Tier III project,

Whatever the deficit or surplus position, JEC will follow a four-part strategy to fulfill its Tier III requirements.

1. Identify and deliver *prescriptive* Energy Transformation ("Base Program") programs, and/or
2. Identify and deliver *custom* Energy Transformation ("Custom Program") programs, and/or
3. Develop and complete the Jacksonville Solar or a comparable, Vermont-based solar project, and/or
4. Purchase a surplus of Tier II qualifying renewable energy credits.

[20] More detail on these programs can be found in Appendix B (VPPSA's 2020 Tier 3 Annual Plan) and on VPPSA's website.

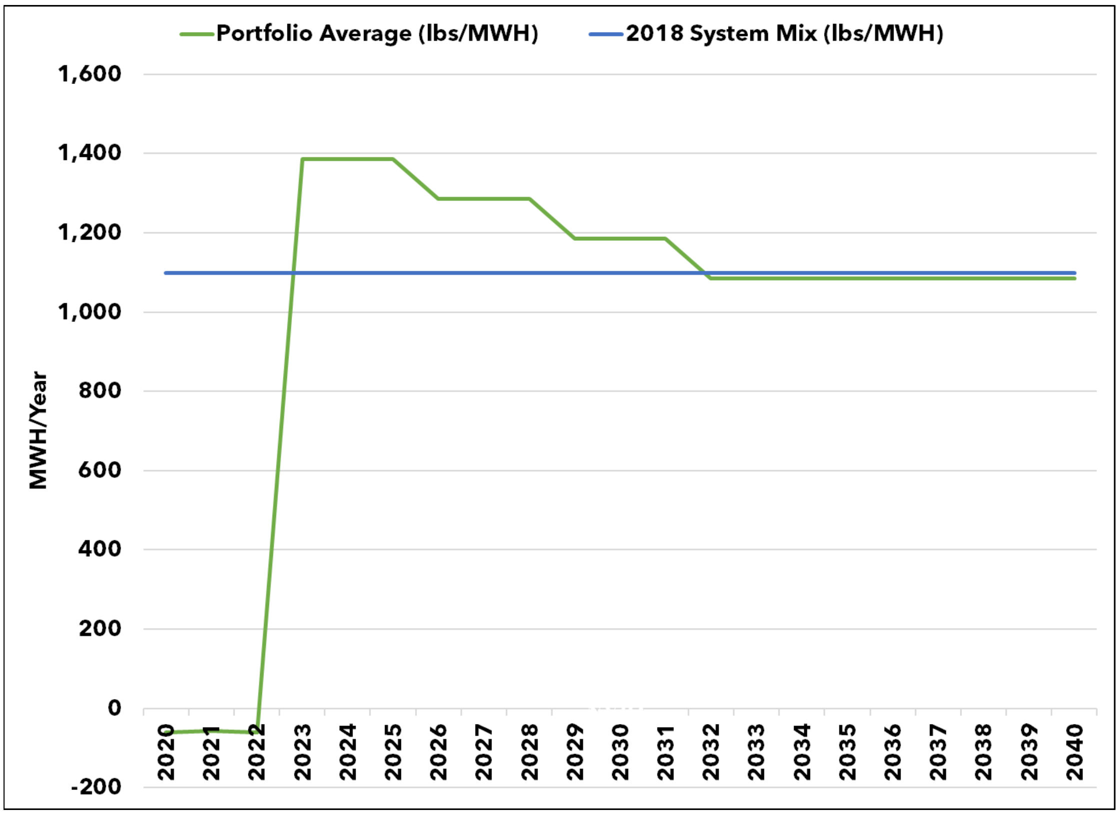
[21] This estimate is based on 15 MWH/CCHP of net lifetime savings, which is an average of all listed single-zone CCHP measures in the 'Act 56 Tier III Planning Tool FINAL PY2019.xls' spreadsheet.

Carbon Emissions and Costs

Figure 11 shows an estimate of JEC's carbon emissions rate compared to the 2018 system average emissions rate in the New England region[22]. The emissions rate between 2020 and 2022 is negative, which simply means that JEC has more emissions free supply than it needs. This situation arises because Tier I requires JEC to be 55% renewable at the same time that the NextEra 2018-2022 contract (which comprises over 50% of JEC's energy supplies through 2022) is also delivering emissions-free, nuclear energy from Seabrook Station. The total of the Tier I requirements and the NextEra contract volumes is greater than JEC's load.

After this contract expires, carbon emissions increase to almost 1,400 lbs/MWH because the NextEra MWHs are being supplied by fossil fuels. We assume that the carbon emissions rate of these MWH will be equal to the 2018 NEPOOL Residual Mix which is a proxy for the fossil fuel emissions rate in the region.[23]

Figure 11: Portfolio Average Carbon Emissions Rate (lbs/MWH)



The carbon emissions rate starts to decline in 2024 as a result of increasing RES requirements and drops below the system average by 2032. After 2032, the emissions rate remains stable because this plan assumes that the RES requirements will be maintained.

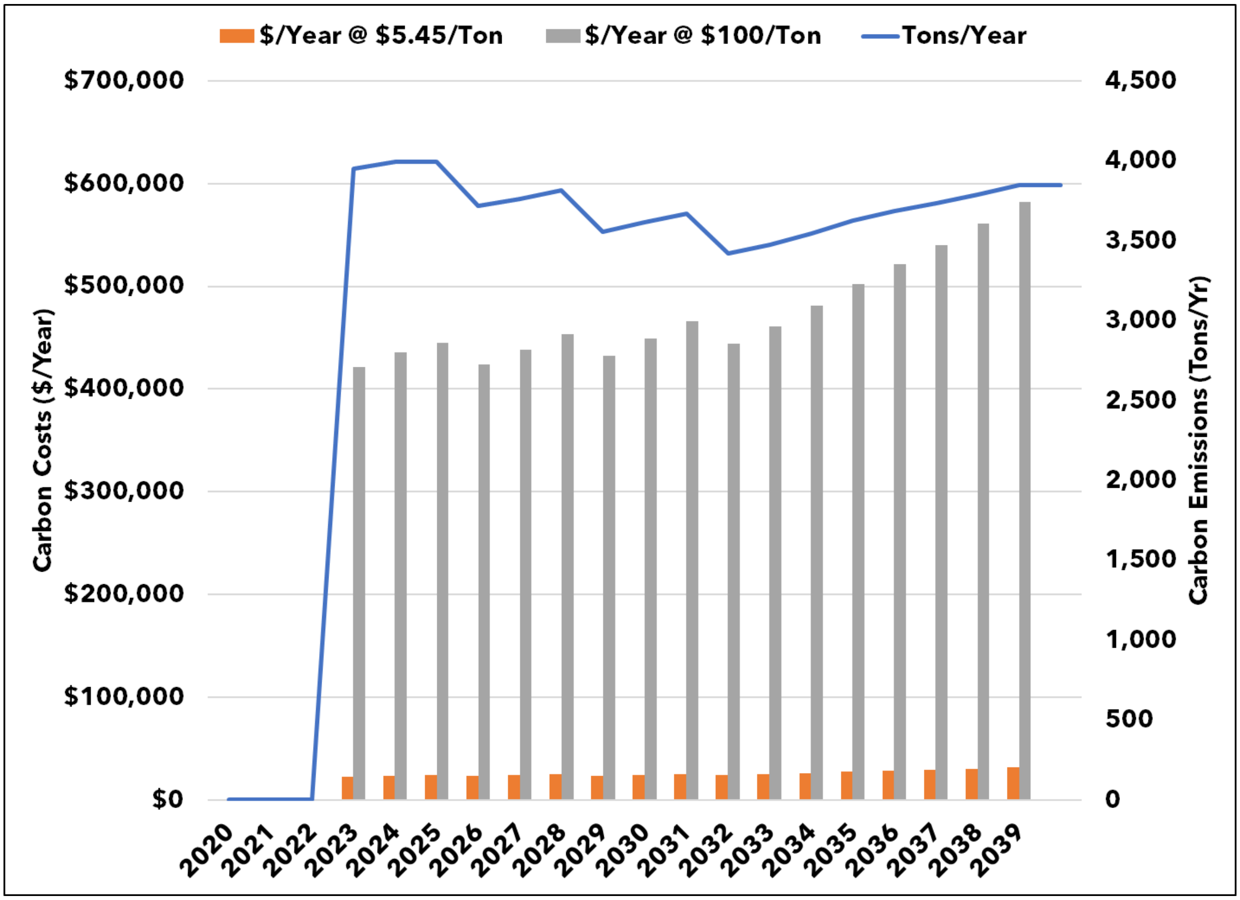
[22] The source of this data is the NEPOOL GIS. https://www1.nepoolgis.com/

[23] For the current value of the NEPOOL Residual Mix, please visit https://www.nepoolgis.com/public-reports/.

These emissions rates were multiplied by the Adjusted Load Forecast from Section I. Electricity Demand to arrive at an estimate of carbon emissions in tons per year. The following figure shows that carbon emissions range from zero tons/year in 2020 up to about 4,000 tons/year in 2023, and then decline as the RES requirement increase through 2032. Thereafter emissions remain stable, and only rise with load growth.

The costs of these emissions were calculated using two sources, the 2019 Regional Greenhouse Initiative Auction[24] (RGGI) results ($5.45/ton) and the 2018 Avoided Cost of Energy Supply[25] (AESC) study ($100/ton). Using RGGI prices (plus inflation), the cost of carbon emissions in 2023 is $23,000/year and about $32,000/year in 2032. Using AESC prices, the range is $420,000/year in 2023 up to almost $580,000 year in 2032.

Figure 12: Carbon Emissions (Tons/Year) and Costs ($)



24 https://www.rggi.org/auctions/auction-results/prices-volumes

25 https://www.synapse-energy.com/sites/default/files/AESC-2018-17-080.pdf

Conclusions

There are three decisions facing JEC that the financial analysis will quantify.

1. New Long-Term Hydro PPA
   Q1: What are the costs and benefits of a 1 MW Hydro PPA at levelized market prices?

2. New Long-Term Solar PPA
   Q2: What are the costs and benefits of a 150 kW Solar PPA?

3. Extension of the NextEra PPA
   Q3: What are the costs and benefits of extending NextEra volumes through 2039 at levelized market prices?

In addition, we quantify one load related question.

4. Load Growth at 1% per year
   Q4: What is the rate impact of 1% compound annual load growth?

Transmission & Distribution

IV. Electricity Transmission & Distribution

Transmission and Distribution System Description:

Distribution System Description:

JEC is a sub-transmission customer of Green Mountain Power (GMP). The JEC system receives transmission service from GMP's Wilmington Substation from a 3.8-mile line extension at 12.47 kV. The line is the feed line from the substation west of Wilmington to the junction of Rt 9 and 100 South to the Green Mountain Power regulators. The JEC feed is approximately 6 miles long to the village regulators. These regulators were set by Green Mountain Power at 120V when installed. Phase balancing was done at that time.

JEC has completed the upgrade of its single distribution system feeder from a 7.2 kV delta configuration to a 12.47 kV wye configuration.

In 2014, JEC initiated rebuilding the feed line along Route 112 and Route 8A. The project was finished in the spring of 2015. During the summer and fall months of 2015, JEC upgraded lines at Maple Hill Lane, Sadawga Road, Dam Road, and Kentfield Road. In 2017, JEC identified a voltage issue on the end of the line along Kentfield Road and a voltage conversion to 7,200 volts was undertaken to resolve the issue. JEC completed line upgrades on Green Road, Burrington Hill Road and Route 8A. Additionally, a number of poles, jointly owned with Consolidated Communications, were replaced on Route 112 and Route 8A in 2018.

As funds become available, #6 copper lines will be replaced with 1/0. There are not a lot of #6 copper lines left to be replaced. Most of the conductor on the system now is 1/0 aluminum AAAC. JEC's system was installed during the 1930's, so age and condition have both been considered when determining whether to upgrade lines.

JEC-owned Internal Generation:

JEC does not own or operate any generation plants within its service territory.

JEC Substations:

JEC does not operate any substations.

Circuit Description:

JEC has only one circuit, called 56G1. In 2018, there were 40 outages in total, where 14 of them were caused by trees[26].

To prevent future outages and maintain reliability, JEC continues to trim trees and add animal guards to equipment. JEC is committed to a comprehensive vegetative management plan. Tracking and reporting of outages is performed by GMP.

T&D System Evaluation:

System reliability is important to JEC and its customers. JEC has a number of initiatives underway to improve reliability. Each of these initiatives is summarized below.

Outage Statistics

JEC tracks all outage statistics as part of its Service Quality Reliability Plan (SQRP). These outage statistics allow us to examine causes by circuit and develop plans for the most cost-effective reliability improvements. The following table summarizes SAIFI and CAIDI results for the past 5 years. JEC's Vermont Public Utility Commission Rule 4.900 Electricity Outage Reports, reflecting the last five years (2014-2018) in their entirety, can be found at the end of this document.

Table 16: JEC Outage Statistics

	Goals	2014[27]	2015	2016	2017	2018
SAIFI[28]	**2.4**	3.5	2.9	3.3	0.9	3.0
CAIDI[29]	**3.0**	2.3	0.5	2.3	3.8	1.4

Animal Guards

JEC installs animal guards on all new services and on rebuilds. Additionally, whenever maintenance is done on existing services, animal guards are installed if they are not already in place.

[26] Outage statistics shown are net of major storm outages

[27] SAIFI and CAIDI statistics shown are net of major storm outages

[28] System Average Interruption Frequency Index

[29] Customer Average Interruption Duration Index

Fault Indicators

JEC does not use flashing light indicators. Fault indicators are not necessary on the distribution system, as these lines are too short.

Automatic reclosers

JEC has one automatic recloser at the boundary with GMP.

Power Factor Measurement and Correction

Currently JEC does not monitor power factor. There are currently no plans to conduct additional testing.

Distribution circuit configuration

Voltage Conversions

In 2017, JEC identified a voltage issue on the end of the line along Kentfield Road. To correct the matter, a voltage conversion to 7,200 volts was undertaken, which resolved the issue. Line upgrades on Green Road, Burrington Hill Road and Route 8A were completed in 2017.

Feeder back-ups/Phase balancing

Phase balancing was conducted when JEC installed new regulators on the GMP feed in 2013. The system is fed solely from the GMP system and has remained relatively static since the new regulators were installed.

System Protection Practices and Methodologies;

Protection Philosophy

JEC uses reclosers to protect either a segment of the line or the entire line. The distribution system protection involves a combination of reclosers and fuses. All side taps of the main line distribution feed are fused.

Smart Grid Initiatives

Planned Smart Grid

Beginning in 2018, JEC began participating in a multi-phased, VPPSA joint-action project intended to (1) assess individual member readiness for AMI, (2) guide participating members through an RFP process culminating in vendor and equipment selection and (3) guide members through the implementation phase. At the end of the initial assessment phase individual members will make the choice to go forward with the RFP process, or not. Upon completion of the RFP phase of the project, individual members will have the information needed to examine the business case and make a decision to commit to implementation of an AMI system, or not.

At this time JEC is participating in the initial readiness assessment phase of the project, gaining information pertaining to its initial readiness, potential required changes to staffing and operating processes, as well as potential benefits to municipal electric, water and wastewater systems. As the assessment phase wraps up later in 2019, JEC will decide whether to proceed to the RFP phase of the process.

JEC is mindful of the many facets of the evolving grid and their impact on the value of implementing AMI. Advanced metering may play a key role in taking advantage of more sophisticated rate design and load management/retention opportunities as we see continued expansion of net metering, heat pump installations, and adoption of electric vehicles.

JEC recognizes the potential value of utilizing rate design, direct load control or other incentive programs as tools to manage both system and customer peak loads in unison to create value for both the utility and the customer. In the absence of an AMI system, or pending development and implementation of an AMI system, JEC will explore the use of pilot programs or tariffs that may be implemented using currently available technology. Initial efforts in this area will focus on larger customers with the greatest opportunity to manage loads in a way that will reduce both system and customer costs, capture economic development/retention opportunities and reduce carbon footprint where possible.

Working with VPPSA, Efficiency Vermont, and other stakeholders, JEC stays abreast of these developments and the strategies needed to maintain a safe, reliable, and economically viable distribution system.

JEC is also mindful of the increasing importance of cybersecurity concerns, and the relationship of those concerns to technology selection and protection. While JEC is not presently required to undertake NERC or NPCC registration, VPPSA is a registered entity, and JEC's membership in VPPSA provides JEC with knowledge and insight regarding ongoing cybersecurity developments and risks. On a more local level, JEC endeavors to purchase and protect its IT systems (with assistance from VPPSA as needed), in a manner intended to minimize security risks to the system and its ratepayers. JEC remains mindful of the balance between the levels of cyber security risk protection and the associated costs to its ratepayers.

Other System Maintenance and Operation:

Reconductoring for Loss Reduction

JEC has been gradually replacing small conductor over the last five years and plans to continue to replace small aged conductors over the next two years. All conductor being used now is 1/0 aluminum AAAC. Most of the conductor on the system now is 1/0 aluminum AAAC.

Transformer Acquisition

JEC primarily purchases reconditioned transformers from major distributors such as WESCO and T&R. JEC receives technical data sheets from the vendor when buying 3-phase or larger transformers and considers life-cycle costs for these decisions..

Conservation Voltage Regulation

JEC replaced the voltage regulators at the end of the GMP line in December 2013 due to the increased load coming online caused by the local high school being rebuilt.

JEC does not have conservation voltage regulation.

Distribution Transformer Load Management (DTLM)

JEC does not have a formal DTLM program. JEC consults GMP, which makes recommendations on transformers used for different applications, when there are questions.

Substations within the 100- and 500-YEAR Flood Plains

JEC does not have any substations.

The Utility Underground Damage Prevention Plan (DPP)

Currently, JEC does not have a formal Damage Prevention Plan (DPP) in place. JEC does not have any underground facilities, so there's no need to develop a DPP at this time. As the quantity of JEC's underground lines increase, JEC will look at developing a formal Damage Prevention Plan. At that time, JEC will look to other VPPSA utilities and VPPSA to help develop that plan.

Selecting Transmission and Distribution Equipment

JEC primarily purchases reconditioned transformers from major distributors such as WESCO and T&R. JEC receives technical data sheets from the vendor when buying 3 phase or larger transformers and considers life-cycle costs for these decisions.

JEC buys its T&D equipment from the same reputable supplier that most large utilities in Vermont use.

Maintaining Optimal T&D Efficiency

System Maintenance

JEC's system maintenance includes a number of components. Each is discussed briefly below.

JEC inspects its distribution system on an annual basis. As part of the inspection, JEC is able to identify areas that are in need of upgrades. Additionally, during monthly meter readings, the meter reader inspects for trees and limbs in need of trimming and for any other problems on the system

Conductor

JEC has been gradually replacing small conductor over the last five years and plans to continue to replace small aged conductors over the next two years. All conductor being used now is 1/0 aluminum AAAC. Most of the conductor on the system now is 1/0 aluminum AAAC.

Pole Inspection

All of JEC's poles are joint-owned with Consolidated Communications. Consolidated Communications acquired the system from Fairpoint and hired OSMOSE for pole inspections and to treat poles. Any poles that were reJECted by this inspection have been replaced. Since that time poles are inspected periodically and replaced as necessary. Recently, a number of poles were replaced on Route 112 and Route 8A.

Equipment

JEC has replaced almost all of its porcelain disconnects on its system. Any time work is being performed on a pole, any insulators and connectors that need to be replaced are replaced.

System Losses

Nearly all #6 copper lines have been changed out with 1/0 in efforts to reduce line losses. JEC monitors system energy losses by tracking metered system load at its interconnections to GMP and comparing it to metered energy sales to its customers.

Tracking Transfer of Utilities and Dual pole Removal (NJUNS)

JEC does not use NJUNS but has looked into this resource. JEC could not discern any benefit from participating in the NJUNS.

Relocating cross-country lines to road-side

JEC recognizes the significant cost associated with maintaining off-road assets. JEC has a policy in place where every attempt shall be made to make all new construction road-side. Additionally, when rebuilding off-road infrastructure JEC looks carefully at relocating assets to road-side when feasible. There are places where JEC cannot relocate the lines near the road, so they have to remain cross-country. JEC is planning to relocate/reconstruct a 3-phase line in Whitingham.

Distributed Generation Impact:

Currently, JEC has 9 residential solar net metering customers, with a combined total installed capacity of 48 kW. In addition, there is one customer with two 50 kW arrays.

Interconnection of Distributed Generation

JEC recognizes the unique challenges brought on by increasing penetration levels of distributed generation. JEC adheres to the procedures set forth in Rule 5.500 for the interconnection of new generation. Per rule 5.500, a fast track screening process is utilized to expedite the installation of smaller generators which are less likely to result in issues that affect existing distribution customers. If a proposed installation fails the screening criteria, a Feasibility Study and/or System Impact Study is performed to fully identify and address any adverse effects that are a direct result of the proposed interconnection. These studies, performed by JEC or their representatives, typically include a review of the following issues that may arise as a result of a new generator interconnection:

- Steady state voltage (per ANSI C84.1)
- Flicker (per IEEE 1453)
- Temporary overvoltage due to load reJECtion and/or neutral shift
- Effective grounding (per IEEE 1547 & IEEE C62.91.1)
- Overcurrent coordination
- Equipment short circuit ratings
- Effect of distributed generation on reverse power and directional overcurrent relays
- Voltage regulator and load tap changer control settings (bi-directional operation)
- Unintentional Islanding
- Thermal loading of utility equipment
- Power factor and reactive compensation strategy
- Impact to underfrequency load shed
- Increased incident energy exposure (arc flash)

In addition, recognizing that the aggregate of many smaller installations which individually pass Rule 5.500 screening criteria can present problems that would otherwise go unnoticed, JEC will maintain detailed records of installed generation including location, type, and generating capacity. This information will allow JEC to periodically review how much generating capacity is installed on a particular feeder or substation transformer and identify any concerns as penetration increases over time.

For example, one issue of growing concern is the aggregate of smaller distributed generators being large enough to require voltage sensing on the primary side of substation power transformers for ground fault overvoltage protection. If a transmission (or sub-transmission) ground fault occurs and the remote terminals operate to clear the fault, an overvoltage due to neutral shift can occur when the ratio of generation to load in the islanded portion of the system is greater than 66% (presumes a standard delta primary, grounded-wye secondary substation power transformer). JEC continues to monitor trends for interconnection protection for abnormal conditions. Supplementing the process outlined in Rule 5.500 with detailed recordkeeping and periodic reviews of how much distributed generation is installed by feeder will help member utilities identify these types of issues before they occur.

As distributed generation penetration increases within JEC's service territory, JEC may consider performing a system-wide hosting capacity study and/or providing hosting capacity maps as a tool to steer development of future medium to large-scale distributed generation to the most suitable locations. This type of hosting study can result in significant up-front costs that must be borne by JEC. As a reasonable compromise, JEC may suggest that potential developers locate facilities within reasonable proximity to an existing substation and within portions of the system with low penetration levels of existing distributed generation, both of which should increase the likelihood that the facility will be able to successfully interconnect.

Inverter requirements

Consistent with ISO New England requirements related to inverter "ride-through" settings, JEC now requires owners/developers of all new DER installations to self-certify installation of inverters compliant with the Inverter Source Requirement Document (SRD) of ISO New England, with settings consistent with IEEE 1547-2018 and UL 1741 SA. This document is included as Appendix E at the end of this document. JEC recognizes the need to standardize efforts aimed at certifying inverter compliance with the ISO SRD and will work with VPPSA and the PSD to achieve use of common forms and process in this regard.

Vegetation Management/Tree Trimming:

JEC carries out its scheduled trimming in the fall with the aim of completing it around the end of the year.

JEC recognizes the correlation between tree trimming spending with strategic planning and delivery of service. As a result, JEC has committed itself to spending a level annual budget of $50,000.

JEC manages vegetation in two ways: 1) roadside trimming is done by brush hogging, which reduces foliage and saplings to ground level and is expected to last 5 years; and 2) visual inspection is conducted yearly in the fall and danger trees are identified, listed and sent to a tree removal company for quotation. Additionally, the meter reader, during monthly meter reads, reports all limbs on the lines and the limbs are removed.

JEC has a program to identify danger trees within its rights-of-way and to either prune or remove those trees. Again, the success of this program is measured by whether danger trees are a root cause of system outages. Danger trees are identified by utility personnel while patrolling the lines, reading meters, or inspecting the system. Once a danger tree is identified, it is promptly removed if it is within JEC's right-of-way. For danger trees outside of the right-of-way, JEC contacts the property owner, explains the hazard, and with the owner's permission removes them. Where permission is not granted, JEC will periodically follow up with the property owner to attempt to obtain permission.

JEC has not used herbicides.

The emerald ash borer has become an active issue near JEC's territory. JEC is monitoring developments and coordinating efforts with VPPSA and VELCO and will make use of any guidance that becomes available as a result. If and when the emerald ash borer does surface in JEC's territory, affected trees will be cut down, chipped and properly disposed of.

Table 17: JEC Vegetation Trimming Cycles

	Total Miles	Miles Needing Trimming	Trimming Cycle
Distribution	50 miles	40	5-year average cycle

Table 18: JEC Distribution Vegetation Management Costs

	2016	2017	2018	2019	2020	2021
Amount Budgeted	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000
Amount Spent (FY)	$29,665	$44,500	$37,700	Deliberately left blank	Deliberately left blank	Deliberately left blank
Miles Trimmed	9 miles	14 miles	10 miles	8 miles to be trimmed	8 miles to be trimmed	8 miles to be trimmed

Table 19: JEC Tree Related Outages

	2014	2015	2016	2017	2018
Tree Related Outages[30]	15	7	7	11	14
Total Outages	33	19	30	35	40
Tree-related outages as % of total outages	46%	37%	23%	31%	35%

Storm/Emergency Procedures:

JEC has contracted with GMP and utilizes their emergency services to restore all emergency power outages. GMP updates the www.vtoutages.com site during major storms especially if JEC experiences a large outage that is expected to have a long duration. JEC's customers call the GMP outage number to report power outages. GMP then dispatches crew to JEC in order to restore power.

[30] Outage statistics shown are net of major storm outages

Previous and Planned T&D Studies:

Fuse Coordination Study

There are no fuse coordination studies currently under way or planned for the short-term future. However, JEC continues to install fuses on side taps in order to isolate side taps to improve system robustness. Fuse coordinate was done in 1996 after the T&D study. Fuses were changed out at that time.

System Planning and Efficiency Studies

JEC does not have any pending formal T&D studies. Distribution studies were last conducted in 1996.

Capital Spending:

Construction Cost (2016-2018):

Table 20: JEC Historic Construction Costs

Village of Jacksonville Electric Company		Historic Construction		
Historic Construction		**2016**	**2017**	**2018**
Office furniture and equipment	Gen	**796**		
Poles, towers and fixtures	Dist	**80,309**		
Line transformers	Dist	**6,013**		
Office furniture and equipment	Gen			
Poles, towers and fixtures	Dist		**10,935**	
Line transformers	Dist		**29,526**	
Office furniture and equipment	Gen			**1,138**
Structures and improvements	Gen			**4,338**
Poles, towers and fixtures	Dist			**48,334**
Line transformers	Dist			**17,691**
Total Construction		**$ 87,117**	**$ 40,462**	**$ 71,501**
Functional Summary:				
Production		-	-	-
General		796	-	5,476
Distribution		86,321	40,462	66,025
Transmission		-	-	-
Total Construction		87,117	40,462	71,501

Projected Construction Cost (2020-2022):

Table 21: JEC Projected Construction Costs

Village of Jacksonville Electric Company		Projected Construction		
Projected Construction		**2020**	**2021**	**2022**
Poles, towers and fixtures	Dist	**40,000**		
Line transformers	Dist	**20,000**		
Poles, towers and fixtures	Dist		**40,000**	
Line transformers	Dist		**20,000**	
Poles, towers and fixtures	Dist			**40,000**
Line transformers	Dist			**20,000**
Routine/Recurring/Misc plant & General		**5,000**	**5,000**	**5,000**
Total Construction		**$ 65,000**	**$ 65,000**	**$ 65,000**
Functional Summary:				
Production		-	-	-
General	25%	1,250	1,250	1,250
Distribution	75%	63,750	63,750	63,750
Transmission		-	-	-
Total Construction		65,000	65,000	65,000

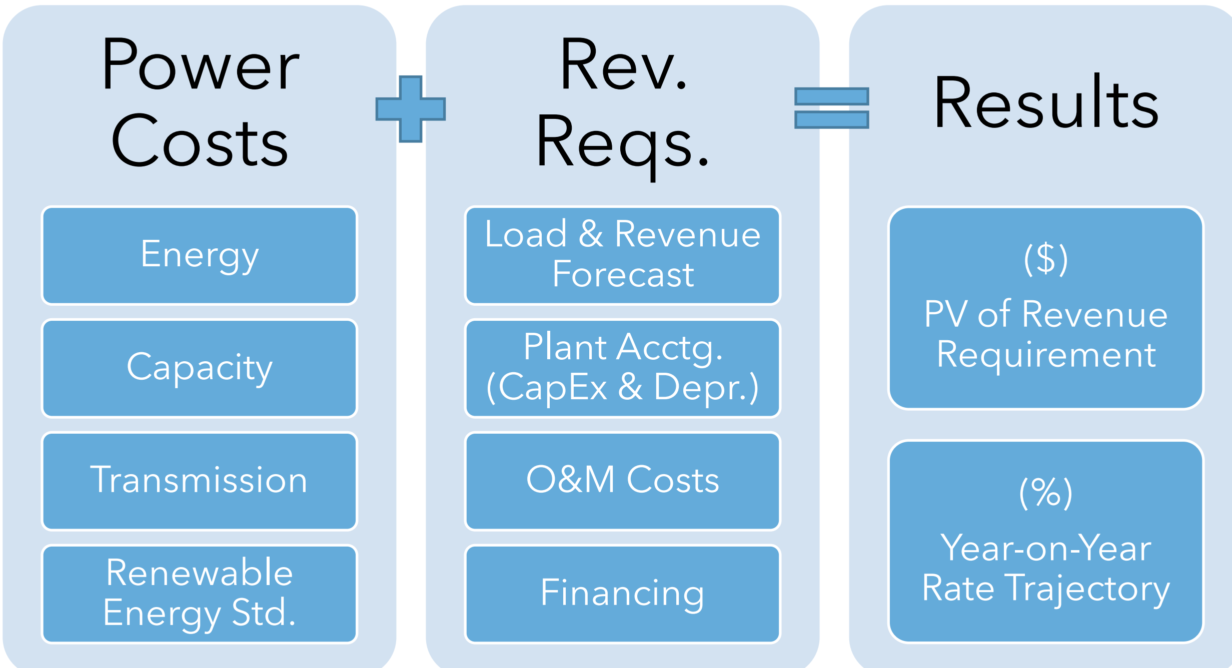
Financial Analysis

V. Financial Analysis

Components

The financial analysis represents an integrated analysis of JEC's power supply costs and its revenue requirements. The results include the present value of JEC's revenue requirements (a proxy for least cost) and the annual change in retail rates. The following figure illustrates the primary components of the analysis.

Figure 13: Primary Components of the Financial Analysis



The power supply cost models consist of four primary spreadsheets that estimate the cost of energy, capacity, transmission, and the costs of complying with the Renewable Energy Standard. The power supply models are monthly, and roll up to annual numbers for integration with the revenue requirements model. The revenue requirements model contains annual estimates of JEC's load, revenue, plant accounting activity (including capital expenditures and depreciation), O&M costs, and ultimately, a profit and loss statement. Its outputs are annual revenue requirements, average rates, and the annual change in rates.

Importantly, the power cost spreadsheets are the same models that are used to create JEC's annual power cost budget, and are formatted to be consistent with the spreadsheets that are used for monthly budget to actual analysis. As a result, they are operational as well as planning tools.

Methodology

The financial analysis estimates the costs and benefits of three major decisions that were identified in Section III. Resource Plans, and one load-related uncertainty. These include:

Decisions

1. New Long-Term Hydro PPA
   Q1: What are the costs and benefits of a 1 MW Hydro PPA at levelized market prices?

2. New Long-Term Solar PPA
   Q2: What are the costs and benefits of a 150 kW Solar PPA?

3. Extension of the NextEra PPA
   Q3: What are the costs and benefits of extending NextEra volumes through 2039 at levelized market prices?

4. Load Growth at 1% per year
   Q4: What is the rate impact of 1% compound annual load growth?

Pathways

There are six possible combinations of the three resource decisions, as shown in Table 22.

- Pathway 1 is the reference case.

- Pathways 2-4 show the costs and benefits of using long-term contracts to hedge JEC's short position in energy and RECs.

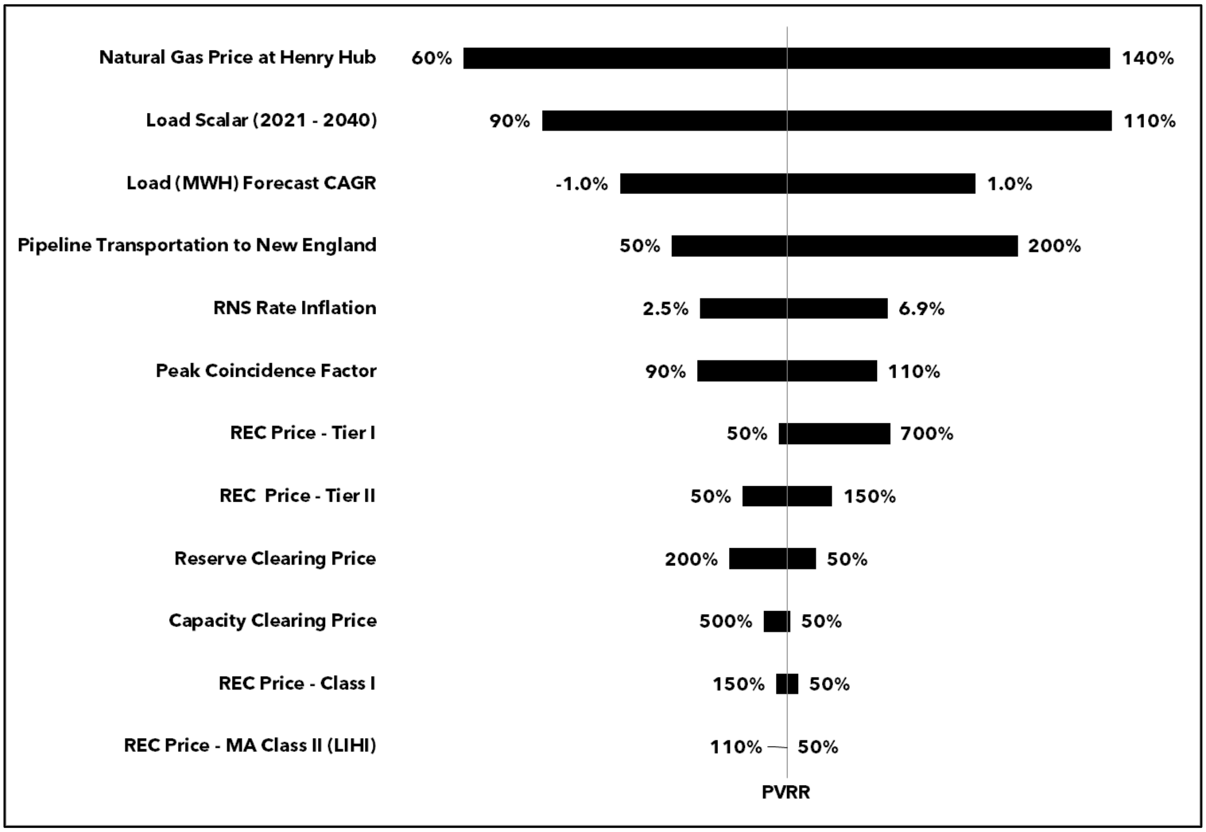
- Pathways 5-6 show the cost and benefits of extending the NextEra contract to hedge JEC's short position in energy and using a solar PPA to hedge JEC's Tier II requirements.

Table 22: Event / Decision Pathways

Pathway	Name	Extend NextEra PPA to 2039	1 MW Hydro PPA in 2023	150 kW Solar PPA in 2021
1	Reference Case			
2	Hedge Tier I with Hydro PPA		✓	
3	Hedge Tier II with Solar PPA			✓
4	Hedge Tier I & II with PPAs		✓	✓
5	Hedge Energy w/ NextEra PPA Extension	✓		
6	Hedge Energy w/ NextEra PPA Extension + Solar PPA	✓		✓

The financial analysis estimates the cost of each of these pathways, and then runs sensitivity analysis on 12 different variables that are known to have a material impact on JEC's revenue requirements. Low, base and high ranges were set up using historical data for each of these variables, as shown in Figure 14.

Figure 14: Sensitivity Analysis of Key Variables – Pathway 1 (Reference Case)



In Pathway 1 (Reference Case), the price of natural gas and pipeline transportation are expected to be the greatest uncertainties that JEC faces. This is expected because a about half of JEC's energy resources expire by the end of 2022, which leaves 50% of the portfolio exposed to the price of natural gas and pipeline transportation.

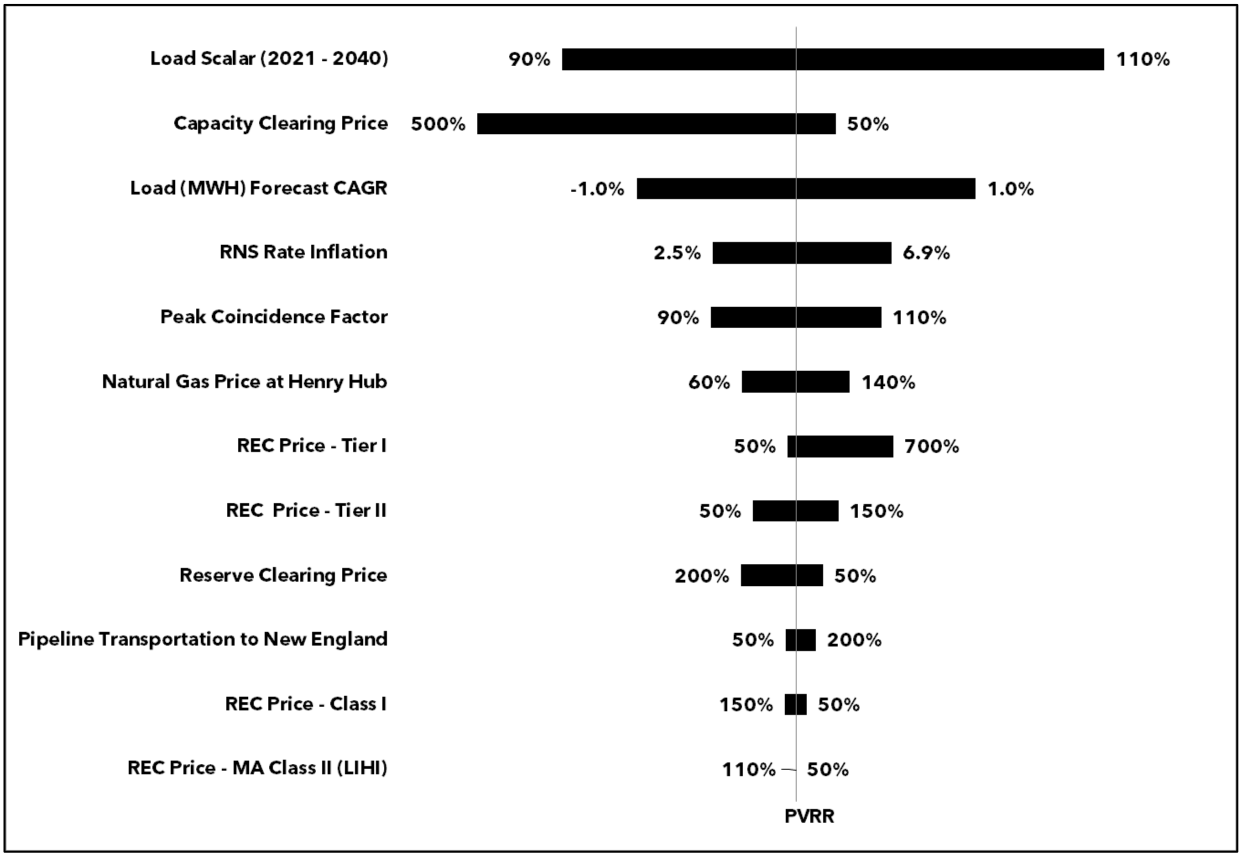
Changes in load and the pace of load growth are the next most important variables, followed by the cost of transmission (aka RNS rate inflation), and the peak coincidence factor. While REC prices do impact the analysis, they are the seventh and eighth most important variables. Finally, capacity prices are not a major variable in the analysis because Project 10 effectively hedges JEC's capacity costs.

The risks that JEC's faces in Pathway 2 are markedly different from Pathway 1, even though the range of financial outcomes is quite similar[31]. In this pathway, the hydro PPA hedges JEC against changes in natural gas and pipeline transportation costs, and as a result, those risks drop from #1 and #4 in Pathway 1 to #6 and #10 in Pathway 2. What rises to the top in

[31] Please refer to Figure 15 for a scatter plot of financial outcomes by pathway.

Pathway 2 are changes in load, load growth and capacity prices. The primary takeaway from this case is this. The hydro PPA is bundled and includes energy, capacity and RECs, and the capacity creates a surplus of capacity. This means that higher capacity market prices would actually *benefit* JEC, but it also means that they hydro PPA creates capacity market exposure that was not present in Pathway 1.

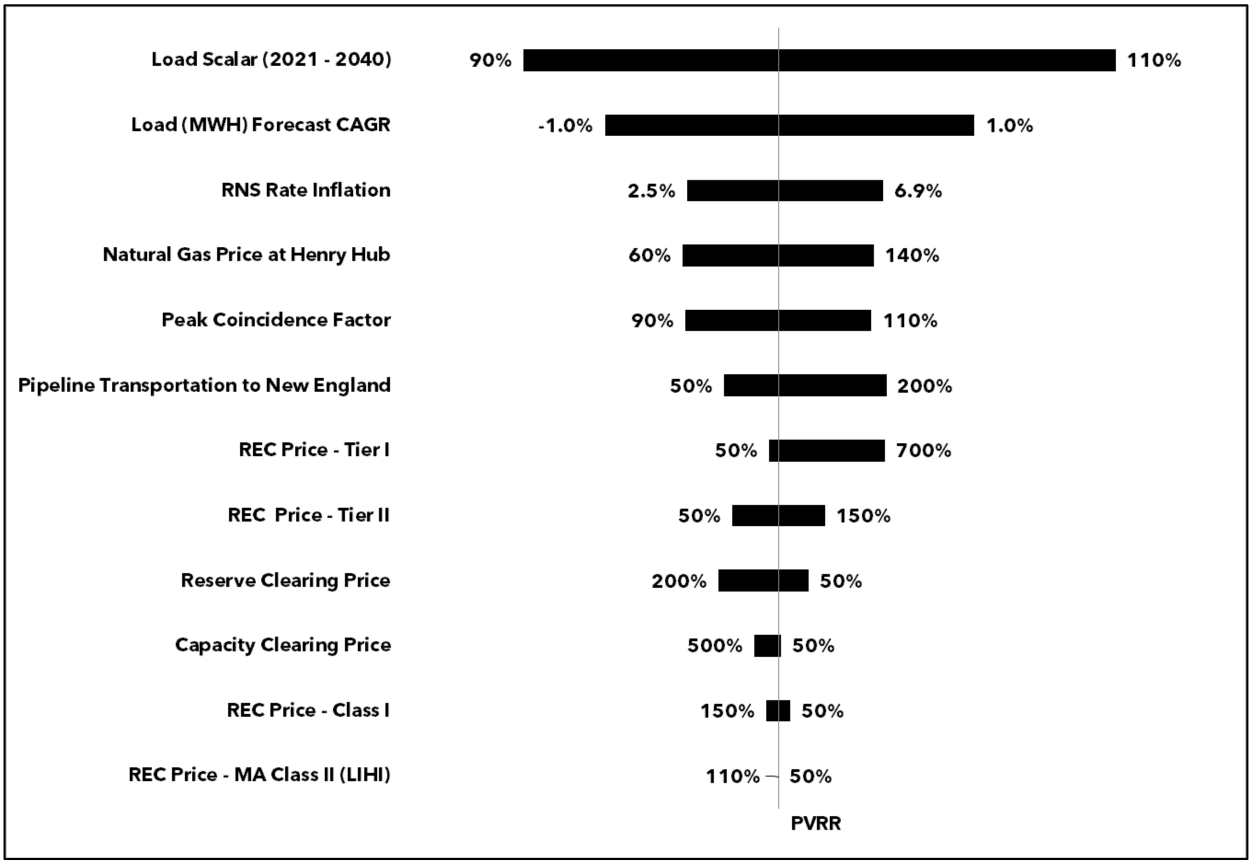
Figure 15: Sensitivity Analysis of Key Variables – Pathway 2 (Hedge Tier I with a Hydro PPA)



The risks of Pathway 3 are very similar to Pathway 1 because the solar PPA does very little to hedge energy requirements. Similarly, the risks of Pathway 4 are very similar to Pathway 2 because the hydro PPA effectively hedges energy price risks and elevates capacity price risks. As a result, their sensitivity analysis charts are not shown.

Figure 16 shows the risks of extending the NextEra PPA from 2023-2039 at today's market prices. Changes in load and load growth top the list, followed by the growth rate of Regional Network Service (RNS) transmission costs. This mix of risks is appealing because it minimizes market price risks from all three major source of it; energy, capacity and REC price risk. As the following section shows, these risks are minimized while maintaining the same cost levels that are expected in the other pathways. The addition of the solar PPA in pathway six only improves this picture, as it reduces Tier II REC price risk while slightly lowering overall revenue requirements. As a result, Pathways 5 and 6 are both attractive.

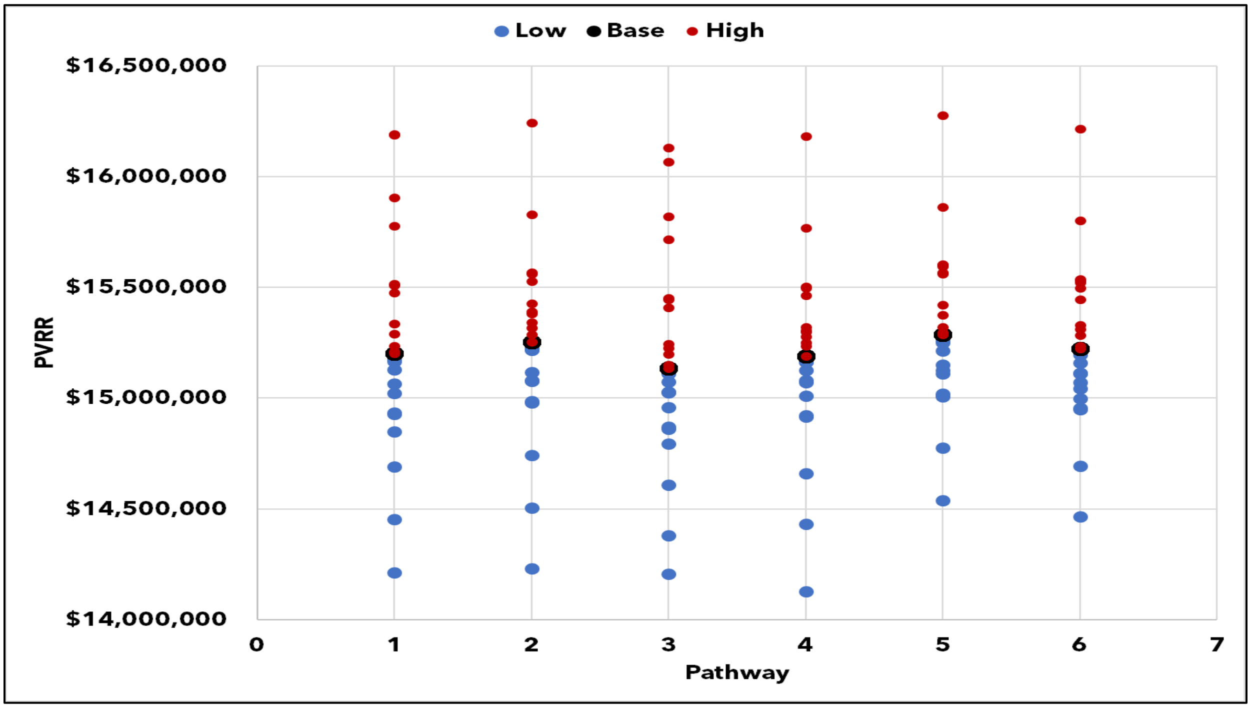
Figure 16: Sensitivity Analysis of Key Variables – Pathway 5 (Hedge Energy with NextEra PPA Extension)



Revenue Requirement Results

The high-level results of the financial analysis appear in Figure 17. The first pathway shows the range of results when the NextEra contract is allowed to expire in 2023. The second through the fourth pathways show the range of results when the NextEra contract is replaced with a combination of a hydro and a solar PPA. Finally, the last two pathways show the impact of extending the NextEra contract through 2039.

Figure 17: Scatter Plot of Financial Analysis Results (PV of Revenue Requirement)



- **Pathway 1:** This range of outcomes is the reference case and it shows how much variability JEC can expect from changes in market conditions over time.

- **Pathway 2**: The overall cost and the range of costs in Pathway 2 are similar to Pathway 1. However, the risks that JEC faces are markedly different. Because the long-term hydro PPA effectively hedges JEC from both energy and REC price risk, energy and REC market prices are not top-tier risks. Instead, changes in load, load growth and capacity prices rise to the top. Specifically, the long-term hydro PPA causes JEC to become long on capacity which increases its sensitivity to the capacity market. As a result, JEC may wish to sign an energy-only hydro PPA if possible. In any event, the financial outcomes are dependent on negotiating a PPA whose price is at or lower than the levelized cost of energy plus Tier I RECs in the price forecast.

- **Pathway 3-4:** The range of Pathway 3 is slightly narrower than Pathways 1 and 2, and it is marginally less costly. This indicates that the 150kW solar PPA does reduce price risk and costs, but only at the margins. The magnitude of the savings and risk reduction in Pathway 4 is similar to, but slightly higher than Pathway 3. Hedging both energy and RECs reduces costs slightly, but the range of financial outcomes is largely the same due to the surplus capacity position that the hydro PPA creates.

- **Pathway 5-6:** These pathways show the impacts of extending the NextEra contract at forecast market prices, and adding a solar PPA to hedge Tier II requirements. The range of financial outcomes narrows from the reference case, but the risks that JEC faces change as shown in Figure 16.

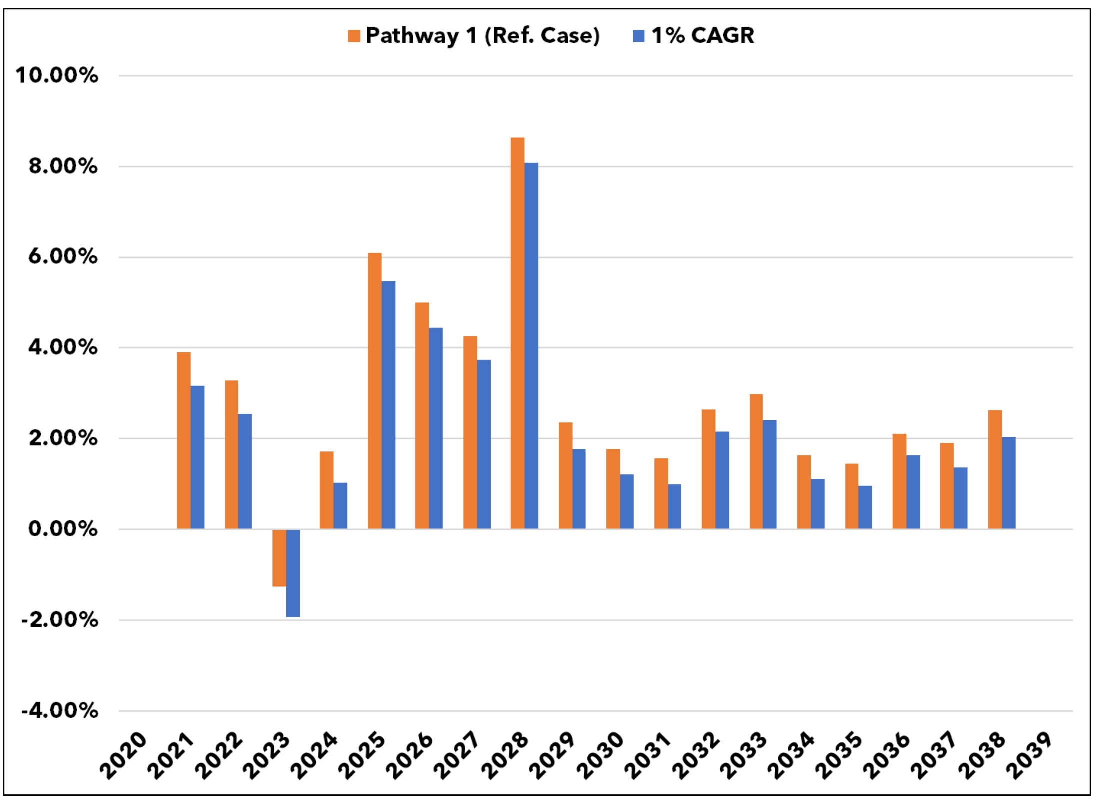
Preferred Pathway

The lowest cost and least risk pathway appears to be Pathway 6 – Hedge Energy with NextEra Extension + Solar PPA. This pathway produces similar cost outcomes to the other pathways, but it minimizes market price risks. It should be noted that Pathway 4 – Hedge Tier I and Tier II with PPA's (Hydro and solar) could also minimize price risk, but only if the hydro PPA did not include capacity and was from a large resource instead of a small, run-of-river resource.

Impact of 1% Compound Annual Load Growth (CAGR)

Promoting energy-efficient load growth is an implied goal of the RES's Energy Transformation (Tier III) requirements. This section quantifies the impact that a 1% increase in annual load growth would have on retail rates. As Figure 18 shows, the impact is uniformly to lower rates. This is intuitive but is an important outcome to quantify. If this level of load growth were to occur between 2020 and 2032, for example, the 1% compound annual load growth could reduce rates by about 7% in 2032 as compared to the reference case.

Figure 18: Rate Impact of 1% CAGR Load Growth



Summary and Conclusions

The answers to the questions that were posed at the beginning of this chapter are now evident.

Decisions

1. New Long-Term Hydro PPA
   Q1: What are the costs and benefits of a 1 MW Hydro PPA at levelized market prices?
   A1: The long-term hydro PPA reduces energy price risks, but it also increases capacity price risks because it makes JEC long on capacity. It does little to alter the JEC's long-term revenue requirements.

2. New Long-Term Solar PPA
   Q2: What are the costs and benefits of a 150 kW Solar PPA?
   A2: The long-term solar PPA marginally lowers costs and is effective in reducing Tier II REC price risks. However, is not large enough to hedge JEC's energy market price risk.

3. Extension of the NextEra PPA
   Q3: What are the costs and benefits of extending NextEra volumes through 2039 at levelized market prices?
   A3: Extending the NextEra volumes at levelized market prices does reduce risk and stabilize costs. Specifically, it leaves JEC with minimal market price risks from energy capacity, and maintains similar cost levels. This primary drawback of this strategy is that JEC would have to continue hedging REC price risk using short-term purchases.

Load Growth

4. Load Growth at 1% per year
   Q4: What is the rate impact of 1% compound annual load growth?
   A4: The impact of 1% CAGR in loads would be to decrease the rate impact in 2032 by about 7% compared to the reference case.

These and other conclusions are carried into the Action Plan in the following section.

Action Plan

VI. Action Plan

Based on the foregoing analysis, we envision taking the following actions.

1. Automated Metering Infrastructure (AMI)

- JEC will participate in an evaluation of AMI readiness which, if results are positive, will lead to preparation of an RFP leading to vendor and equipment selection and ultimately to implementation of an AMI system. Upon completion of the RFP phase of the project, JEC will have the information needed to examine the business case and make a decision to commit to implementation of an AMI system, or not. JEC recognizes that cost reduction, while desirable, is but one of many factors that must be weighed in making the decision to go forward with AMI JEC sees the potential for a number of future benefits that, while difficult to quantify in cost/benefit terms, will clearly be desirable to various stakeholders. These benefits include (but may not be limited to) improved system control/optimization, ability to deliver/administer more creative customer and load management initiatives, and ability to accommodate emerging initiatives such as EV charging. JEC also notes that unanticipated initiatives may emerge over time that positively impact the perceived value of having an AMI system in place. JEC is considering the potential benefit of a staged implementation that would initially focus on limited areas of high load or customer concentration.

2. Energy Resource Actions

- Manage year to year energy market requirements using fixed-price, market contracts that are less than five-years in duration.
- Consider a extending the NextEra PPA to hedge energy market risks.
- Alternatively, consider a hydro PPA from a large resource to hedge energy and Tier I price risks. A large hydro resource can deliver firm energy and hedge energy as effectively as the NextEra PPA, plus, it could also hedge Tier I REC prices. However, such a PPA should <u>not</u> include capacity because JEC's capacity needs are already well hedged.
- Consider a solar PPA to hedge Tier II REC price risks.

3. Capacity Resource Actions

- Manage and monitor the reliability of Project 10 to minimize Pay-for-Performance (PFP) risk and maximize capacity, reserves, and PFP benefits.

4. Tier I Requirements

- Consider a 1 MW hydro entitlement that includes bundled energy and renewable energy credits (but not capacity) to reduce both energy and Tier I costs and risks.
- Make forward purchases of qualifying RECs on the regional market to manage REC price and ACP risk.

5. Tier II Requirements

- Develop and complete the Jacksonville Solar or other comparable, Vermont-based solar projects.

- Make forward purchases of qualifying RECs on the Vermont market to manage REC price and ACP risk.
- Investigate adding battery storage to upcoming solar projects to increase their value and decrease overall project costs.

6. Tier III Requirements

- Identify and deliver prescriptive and/or custom Energy Transformation programs to achieve at least 1% annual load growth, and/or
- Develop and complete the Jacksonville Solar or other comparable, Vermont-based solar projects, and/or
- Purchase a surplus of Tier II qualifying renewable energy credits.

7. Active Load Control Pilot Program

- Investigate options for engaging customers in active load control programs and tariffs, including end-uses such as electric thermal storage, CCHPs, and HPWHs.

8. Peak Load Management Pilot Program

- Explore ways to align reductions in customer demand charges with utility coincident peak costs through use of a pilot tariff.

9. Net Metering

- Monitor the penetration rate and cost of solar net metering for future grid parity, and advocate for appropriate policies to mitigate potential upward rate pressure.

10. Storage

- Monitor cost trends and potential use cases, and
- Identify Behind-the-Meter use cases and sites, and
- Develop project-specific cost-benefit analysis.

Appendix

Appendix A: Windham Regional Energy Plan

This appendix is provided separately in a file named:

Appendix A - Windham Regional Energy Plan.pdf

Appendix B: 2020 Tier 3 Annual Plan

This appendix is provided separately in a file named:

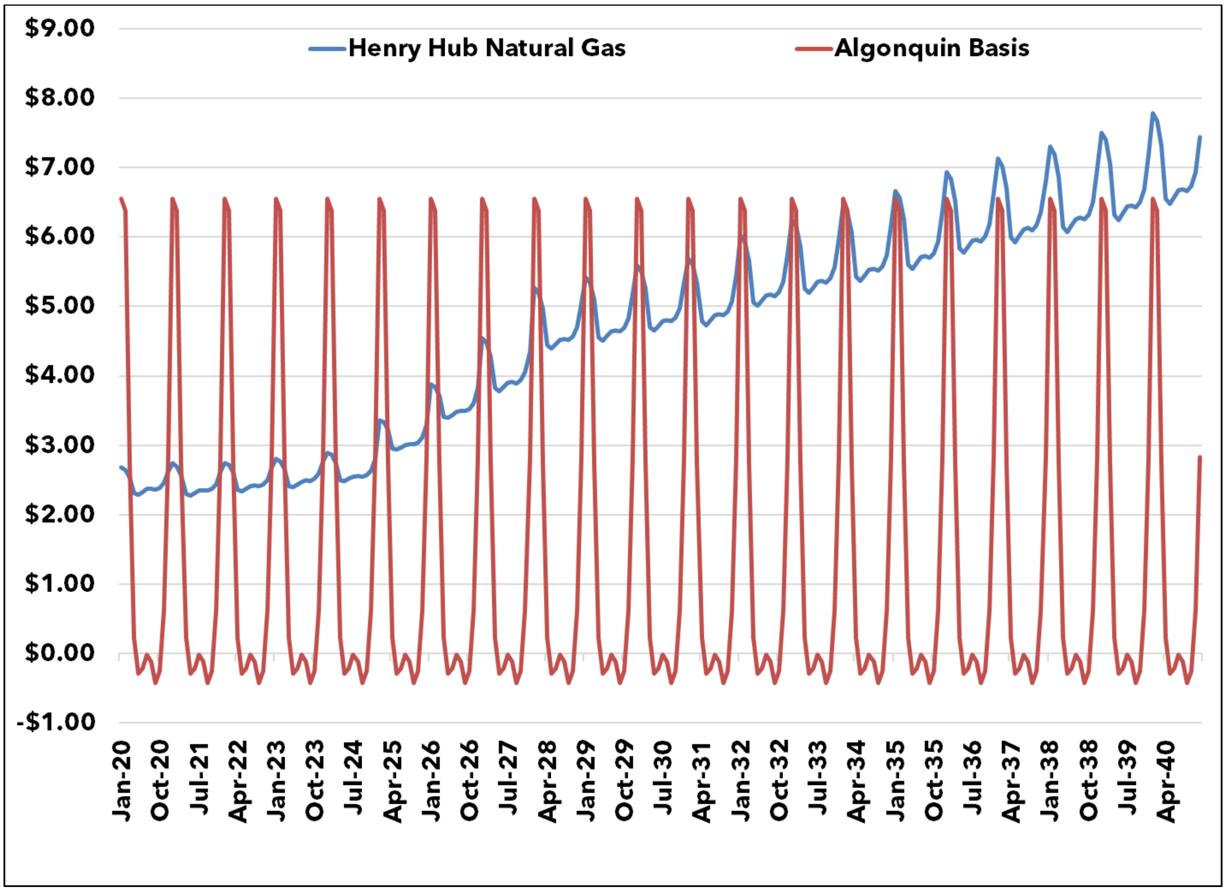
Appendix B - VPPSA Tier 3 2020 Annual Plan.pdf

Appendix C: Pricing Methodology

Energy Pricing

Energy prices are forecast using a three-step method. First, a natural gas price forecast is formed by combining a 3-month average of NYMEX Henry Hub futures prices for the period 2020 to 2021 with the Energy Information Administration (EIA) Annual Energy Outlook (AEO) Henry Hub forecast for the period 2022 to 2039. The forecast of Henry Hub Natural Gas prices can be seen in Figure 19.

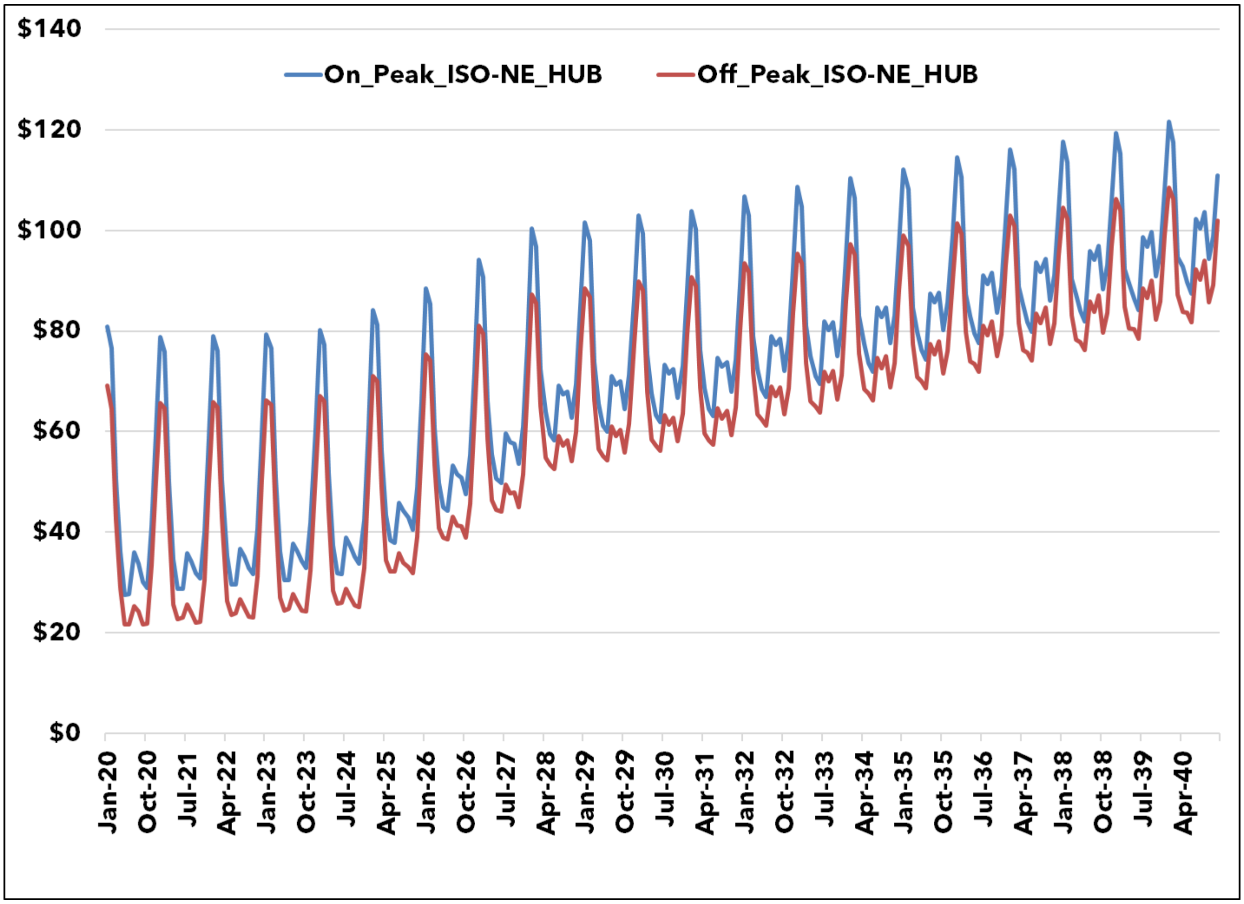
Figure 19: Henry Hub Natural Gas Price Forecast (Nominal $/MMBtu)



Second, we use NYMEX futures prices (between 2020-2021) to find 1.) the cost of transportation (basis) to the Algonquin Hub and 2.) the cost of on and off-peak energy at the Massachusetts Hub (MA Hub). These prices are used to calculate an implied heat rate (MMBtu/MWH) and a spread between on and off-peak electricity prices. These values (sometimes called shapes) are used for the remainder of the forecast period.

Third and finally, we multiply the natural gas price forecast by the implied heat rate to get the on-peak electricity price. From this value, we subtract the spread between the on and off-peak prices to get the off-peak price. The results can be seen in Figure 20.

Figure 20: Electricity Price Forecast (Nominal $/MWH)

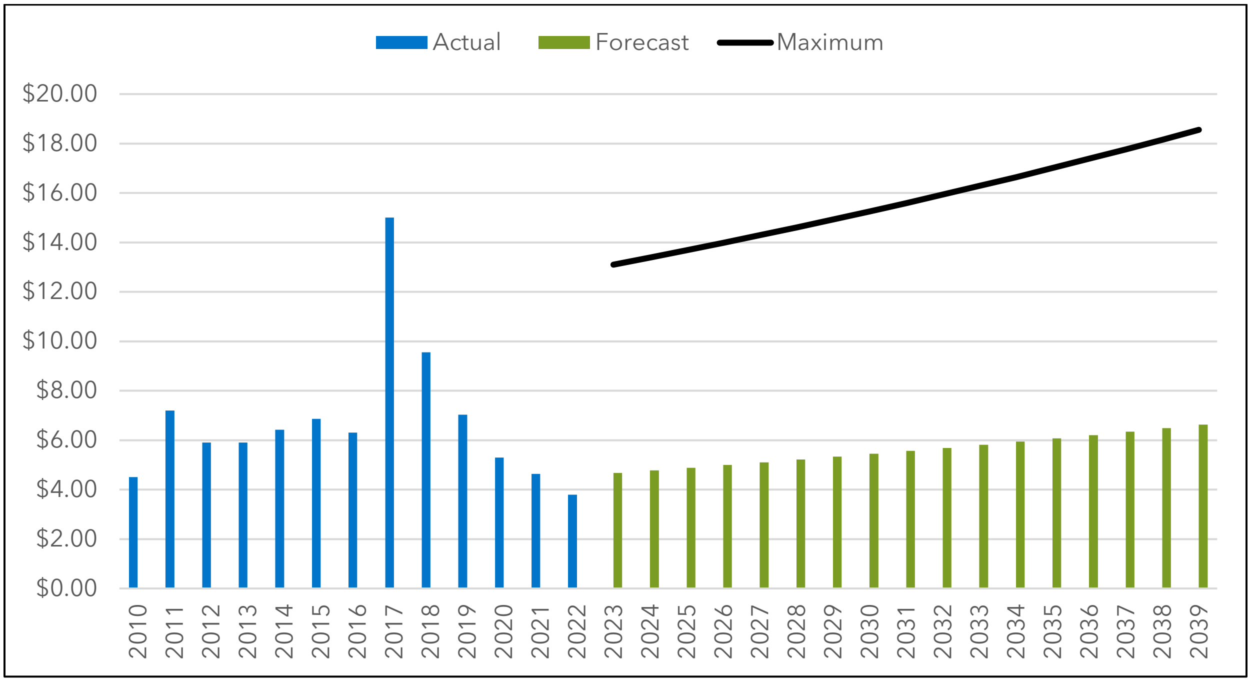


Finally, and in keeping with the function of ISO-NE's Standard Market Design, we use a five-year average basis between LMP nodes to adjust the price forecast at the MA Hub to the location of JEC'Ss load and resources.

Capacity Pricing

The capacity price forecast is an average of the last three years of actual auction results plus inflation, and it grows from $4.68 per kW-month in 2023 to $6.77 per kW-month in 2039. Significant upside price risk does exist, as shown by the Maximum line in Figure 21. This line represents the Forward Capacity Auction Starting Price plus inflation.

Figure 21: Capacity Price Forecast (Nominal $/kW-Month)



Appendix D: PUC Rule 4.900 Outage Reports

Jacksonville

This report is pursuant to PSB Rule 4.903B. It is to be submitted to the Public Service Board and the Department of Public Service no later than 30 days after the end of the calendar year.

Electricity Outage Report -- PSB Rule 4.900

Name of company	Jacksonville
Calendar year report covers	2014
Contact person	Ken Couture (GMP)
Phone number	(802) 655-8780
Number of customers	699

System average interruption frequency index (SAIFI) =	**3.53**
Customers Out / Customers Served	
Customer average interruption duration index (CAIDI) =	**2.27**
Customer Hours Out / Customers Out	

	Outage cause	Number of Outages	Total customer hours out
1	**Trees**	15	704
2	**Weather**	6	117
3	**Company initiated outage**	1	14
4	**Equipment failure**	4	6
5	**Operator error**	0	0
6	**Accidents**	1	3
7	**Animals**	3	4
8	**Power supplier**	3	4,765
9	**Non-utility power supplier**	0	0
10	**Other**	0	0
11	**Unknown**	0	0
	Total	33	5,612

Jacksonville

This report is pursuant to PSB Rule 4.903B. It is to be submitted to the Public Service Board and the Department of Public Service no later than 30 days after the end of the calendar year.

Electricity Outage Report -- PSB Rule 4.900

Name of company	Jacksonville
Calendar year report covers	2015
Contact person	Ken Couture (GMP)
Phone number	(802) 655-8780
Number of customers	701

System average interruption frequency index (SAIFI) =	**2.87**
Customers Out / Customers Served	
Customer average interruption duration index (CAIDI) =	**0.53**
Customer Hours Out / Customers Out	

	Outage cause	Number of Outages	Total customer hours out
1	**Trees**	7	225
2	**Weather**	1	6
3	**Company initiated outage**	1	62
4	**Equipment failure**	3	393
5	**Operator error**	0	0
6	**Accidents**	0	0
7	**Animals**	1	2
8	**Power supplier**	1	350
9	**Non-utility power supplier**	0	0
10	**Other**	0	0
11	**Unknown**	5	29
	Total	19	1,068

		Jacksonville		
This report is pursuant to PSB Rule 4.903B. It is to be submitted to the Public Service Board and the Department of Public Service no later than 30 days after the end of the calendar year.				
Electricity Outage Report -- PSB Rule 4.900				
	Name of company	Jacksonville		
	Calendar year report covers	2016		
	Contact person	Ken Couture (GMP)		
	Phone number	(802) 655-8780		
	Number of customers	703		
	System average interruption frequency index (SAIFI) =			**3.25**
	Customers Out / Customers Served			
	Customer average interruption duration index (CAIDI) =			**2.29**
	Customer Hours Out / Customers Out			
	Outage cause	**Number of Outages**	**Total customer hours out**	
1	**Trees**	7	3,916	
2	**Weather**	4	149	
3	**Company initiated outage**	1	1	
4	**Equipment failure**	9	105	
5	**Operator error**	0	0	
6	**Accidents**	0	0	
7	**Animals**	3	7	
8	**Power supplier**	1	980	
9	**Non-utility power supplier**	0	0	
10	**Other**	0	0	
11	**Unknown**	5	69	
	Total	30	5,227	

Jacksonville

This report is pursuant to PSB Rule 4.903B. It is to be submitted to the Public Service Board and the Department of Public Service no later than 30 days after the end of the calendar year.

Electricity Outage Report -- PSB Rule 4.900

Name of company	Jacksonville
Calendar year report covers	2017
Contact person	Ken Couture (GMP)
Phone number	(802) 655-8780
Number of customers	713

System average interruption frequency index (SAIFI) =	**0.86**
Customers Out / Customers Served	
Customer average interruption duration index (CAIDI) =	**3.82**
Customer Hours Out / Customers Out	

	Outage cause	Number of Outages	Total customer hours out
1	**Trees**	11	2,199
2	**Weather**	7	22
3	**Company initiated outage**	2	8
4	**Equipment failure**	9	74
5	**Operator error**	0	0
6	**Accidents**	1	41
7	**Animals**	4	4
8	**Power supplier**	0	0
9	**Non-utility power supplier**	0	0
10	**Other**	0	0
11	**Unknown**	1	4
	Total	35	2,351

		Jacksonville		
Revised Calculation - Removed Power Supplier Outage of 11/26/18				
This report is pursuant to PUC Rule 4.903B. It is to be submitted to the Public Service Board and				
the Department of Public Service no later than 30 days after the end of the calendar year.				
Electricity Outage Report -- PUC Rule 4.900				
	Name of company	Jacksonville		
	Calendar year report covers	2018		
	Contact person	Ken Couture (GMP)		
	Phone number	(802) 655-8780		
	Number of customers	717		
	System average interruption frequency index (SAIFI) =			**3.00**
	Customers Out / Customers Served			
	Customer average interruption duration index (CAIDI) =			**1.35**
	Customer Hours Out / Customers Out			
	Outage cause	**Number of Outages**	**Total customer hours out**	
1	**Trees**	14	326	
2	**Weather**	4	236	
3	**Company initiated outage**	0	0	
4	**Equipment failure**	5	8	
5	**Operator error**	0	0	
6	**Accidents**	0	0	
7	**Animals**	8	12	
8	**Power supplier**	2	1,677	
9	**Non-utility power supplier**	0	0	
10	**Other**	0	0	
11	**Unknown**	7	653	
	Total	40	2,913	

Appendix E: Inverter Source Requirements

Inverter Source Requirement Document of ISO New England (ISO-NE)

This Source Requirement Document applies to inverters associated with specific types of generation for projects that have applied for interconnection after specific dates. These details will be described in separate document(s). This document was developed with the help of the Massachusetts Technical Standards Review Group and is consistent with the pending revision of the IEEE 1547 Standard for Interconnection and Interoperability of Distributed Resources with Associated Electrical Power Systems Interfaces. All applicable inverter-based applications <u>shall</u>:

- be certified per the requirements of UL 1741 SA as a grid support utility interactive inverter
- have the voltage and frequency trip settings
- have the abnormal performance capabilities (ride-through)
- comply with other grid support utility interactive inverter functions statuses

These specifications are detailed below and are consistent with the amended IEEE Std 1547a-2014.

1. **Certification per UL 1741 SA as grid support utility interactive inverters**

   In the interim period while IEEE P1547.1 is not yet revised and published, certification of all inverter- based applications:

   a. <u>shall</u> be compliant with only those parts of Clause 6 (Response to Area EPS abnormal conditions) of IEEE Std 1547-2018 (2nd ed.)1 that can be certified per the type test requirements of
   UL 1741 SA (September 2016). IEEE Std 1547-2018 (2nd ed.) in combination with this document

   replaces other Source Requirements Documents (SRDs), as applicable;

   b. <u>may</u> be sufficiently achieved by certifying inverters as grid support utility interactive inverters per the requirements of UL 1741 SA (September 2016) with either CA Rule 21 or Hawai'ian Rule 14H as the SRD. Such inverters are deemed capable of meeting the requirements of this document.

2. **Voltage and frequency trip settings for inverter based applications**

   Applications shall have the voltage and frequency trip points specified in Tables I and II below.

3. Abnormal performance capability (ride-through) requirements for inverter based applications

The inverters shall have the ride-through capability per abnormal performance category II of IEEE Std 1547-2018 (2nd ed.) as quoted in Tables III and IV.

The following additional performance requirements shall apply for all inverters:

a. In the Permissive Operation region above 0.5 p.u., inverters shall ride-through in Mandatory Operation mode, and
b. In the Permissive Operation region below 0.5 p.u., inverters shall ride-through in Momentary Cessation mode.

1

7.3 as a proxy, subject to minor

editorial changes.

Consistent with IEEE Std 1547-2018 (2nd ed.) the following shall apply:

a. DER tripping requirements specified in this SRD shall take precedence over the abnormal performance capability (ride-through) requirements in this section, subject to the following:
    1. Where the prescribed trip duration settings for the respective voltage or frequency magnitude are set at least 160 ms or 1% of the prescribed tripping time, whichever is greater, beyond the prescribed ride-through duration, the DER shall comply with the ride-through requirements specified in this section prior to tripping.
    2. In all other cases, the ride-through requirements shall apply until 160 ms or 1% of the prescribed tripping time, whichever is greater, prior to the prescribed tripping time.
b. DER ride-through requirements specified in this section shall take precedence over all other requirements within this SRD with the exception of tripping requirements listed in item a. above. Ride-through may be terminated by the detection of an unintentional island. However, false detection of an unintentional island that does not actually exist shall not justify non- compliance with ride-through requirements. Conversely, ride-through requirements specified in this section shall not inhibit the islanding detection performance where a valid unintentional islanding condition exists.

4. Other grid support utility interactive inverter functions statuses

Other functions required by UL 1741 SA shall comply with the requirements specified in Table V. For functions not activated by default, the inverter is compliant if tested to the manufacturers stated capability.

5. Definitions

The following definitions which are consistent with IEEE Std 1547-2018 (2nd ed.) and UL 1741 SA shall apply:

cease to energize: Cessation of active power delivery under steady state and transient conditions and limitation of reactive power exchange. This may lead to momentary cessation or trip.

clearing time: The time between the start of an abnormal condition and the DER ceasing to energize the utility's distribution circuit(s) to which it is connected. It is the sum of the detection time, any adjustable time delay, the operating time plus arcing time for any interposing devices (if used), and the operating time plus arcing time for the interrupting device (used to interconnect the DER with the utility's distribution circuit).

continuous operation: Exchange of current between the DER and an EPS within prescribed behavior while connected to the utility's distribution system and while the applicable voltage and the system frequency is within specified parameters.

mandatory operation: Required continuance of active current and reactive current exchange of DER with utility's distribution system as prescribed, notwithstanding disturbances of the utility's distribution system voltage or frequency having magnitude and duration severity within defined limits.

momentary cessation: Temporarily cease to energize the utility's distribution system while connected to the utility's distribution system, in response to a disturbance of the applicable voltages or the system frequency, with the capability of immediate restore output of operation when the applicable voltages and the system frequency return to within defined ranges.

permissive operation: operating mode where the DER performs ride-through either in mandatory operation or in momentary cessation, in response to a disturbance of the applicable voltages or the system frequency.

February 6, 2018
Page 3

ISO-NE PUBLIC **Table I: Inverters' Voltage Trip Settings**

Shall Trip – IEEE Std 1547-2018 (2nd ed.) Category II					
Shall Trip Function	**Required Settings**		**Comparison to IEEE Std 1547-2018 (2nd ed.) default settings and ranges of allowable settings for Category II**		
	Voltage (p.u. of nominal voltage)	**Clearing Time(s)**	**Voltage**	**Clearing Time(s)**	**Within ranges of allowable settings?**
OV2	1.20	0.16	Identical	Identical	Yes
OV1	1.10	2.0	Identical	Identical	Yes
UV1	0.88	2.0	Higher (default is 0.70 p.u.)	Much shorter (default is 10 s)	Yes
UV2	0.50	1.1	Slightly higher (default is 0.45 p.u.)	Much longer (default is 0.16 s)	Yes

Table II: Inverters' Frequency Trip Settings

Shall Trip Function	Required Settings		Comparison to IEEE Std 1547-2018 (2nd ed.) default settings and ranges of allowable		
	Frequency (Hz)	Clearing Time(s)	Frequency	Clearing Time(s)	Within ranges of allowable settings?
OF2	62.0	0.16	Identical	Identical	Yes
OF1	61.2	300.0	Identical	Identical	Yes
UF1	58.5	300.0	Identical	Identical	Yes
UF2	56.5	0.16	Identical	Identical	Yes

Table III: Inverters' Voltage Ride-through Capability and Operational Requirements

Voltage Range (p.u.)	Operating Mode/ Response	Minimum Ride-through Time(s) (design criteria)	Maximum Response Time(s) (design criteria)	Comparison to IEEE Std 1547-2018
V > 1.20	Cease to Energize	N/A	0.16	Identical
1.175 < V ≤ 1.20	Permissive Operation	0.2	N/A	Identical
1.15 < V ≤ 1.175	Permissive Operation	0.5	N/A	Identical
1.10 < V ≤ 1.15	Permissive Operation	1	N/A	Identical
0.88 ≤ V ≤ 1.10	Continuous Operation	infinite	N/A	Identical
0.65 ≤ V < 0.88	Mandatory Operation	Linear slope of 8.7 s/1 p.u. voltage starting at 3 s @ 0.65 p.u.: T = 3 s + 8.7 s (V − 0.65	N/A	Identical
0.45 ≤ V < 0.65	Permissive Operation [a,b]	0.32	N/A	See footnotes a & b
0.30 ≤ V < 0.45	Permissive Operation [b]	0.16	N/A	See footnote b
V < 0.30	Cease to Energize	N/A	0.16	Identical

The following additional operational requirements shall apply for all inverters:

a. In the Permissive Operation region above 0.5 p.u., inverters shall ride-through in Mandatory Operation mode, and
b. In the Permissive Operation region below 0.5 p.u., inverters shall ride-through in Momentary Cessation mode with a maximum response time of 0.083 seconds.

February 6, 2018
Page 4

ISO-NE PUBLICebruary 6, 2018
Page 5

ISO-NE PUBLIC

Table IV: Inverters' Frequency Ride-through Capability

Frequency Range (Hz)	Operating Mode	Minimum Time(s) (design criteria)	Comparison to IEEE Std 1547-2018 (2nd ed.)
f > 62.0	No ride-through requirements apply to this range		Identical
61.2 < f ≤ 61.8	Mandatory Operation	299	Identical
58.8 ≤ f ≤ 61.2	Continuous Operation	Infinite	Identical
57.0 ≤ f < 58.8	Mandatory Operation	299	Identical
f < 57.0	No ride-through requirements apply to this range		Identical

Table V: Grid Support Utility Interactive Inverter Functions Status

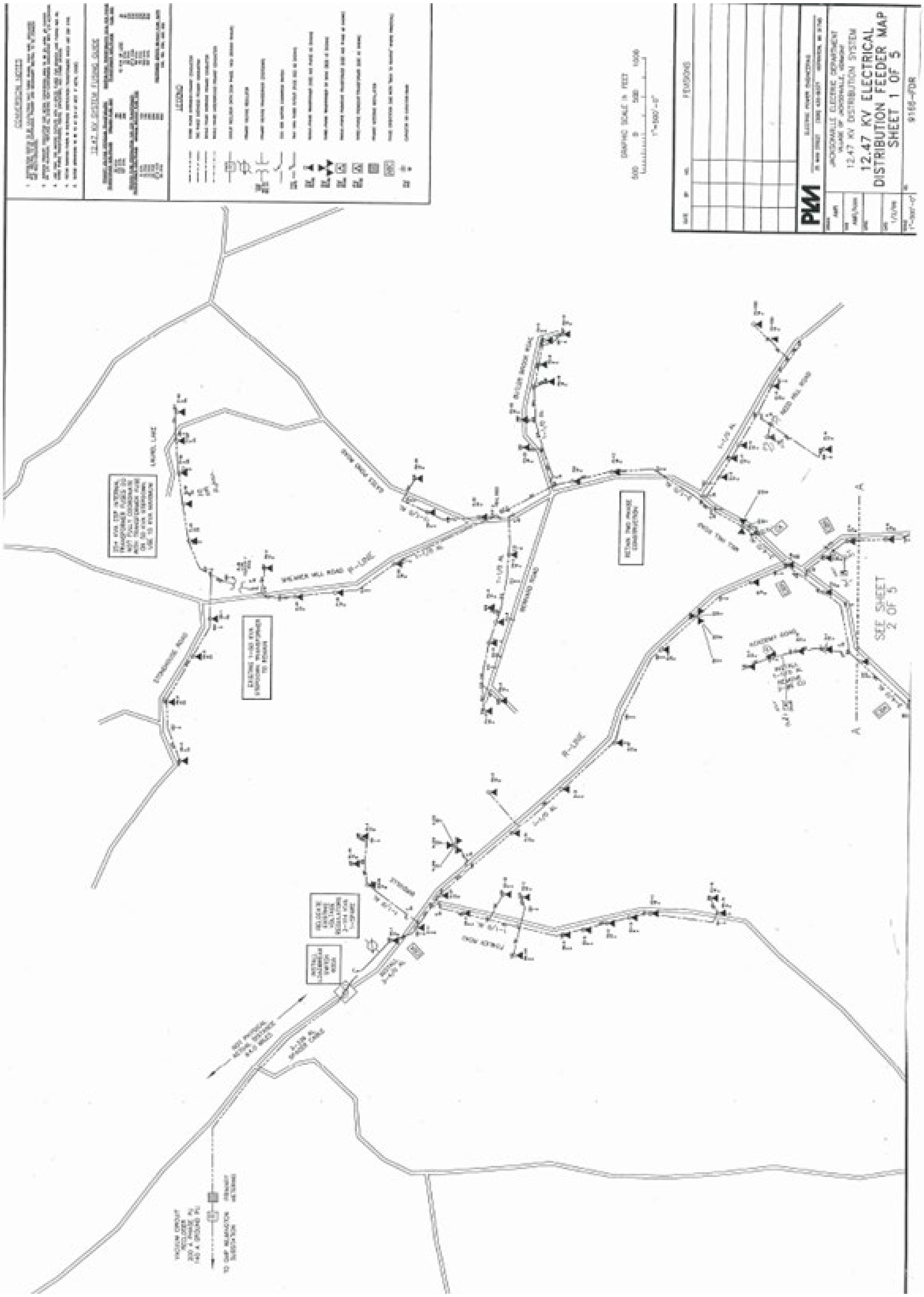
Function	Default Activation State
SPF, Specified Power Factor	**OFF[2]**
Q(V), Volt-Var Function with Watt	**OFF**
SS, Soft-Start Ramp Rate	**ON** **Default value: 2% of maximum current**
FW, Freq-Watt Function OFF	**OFF**

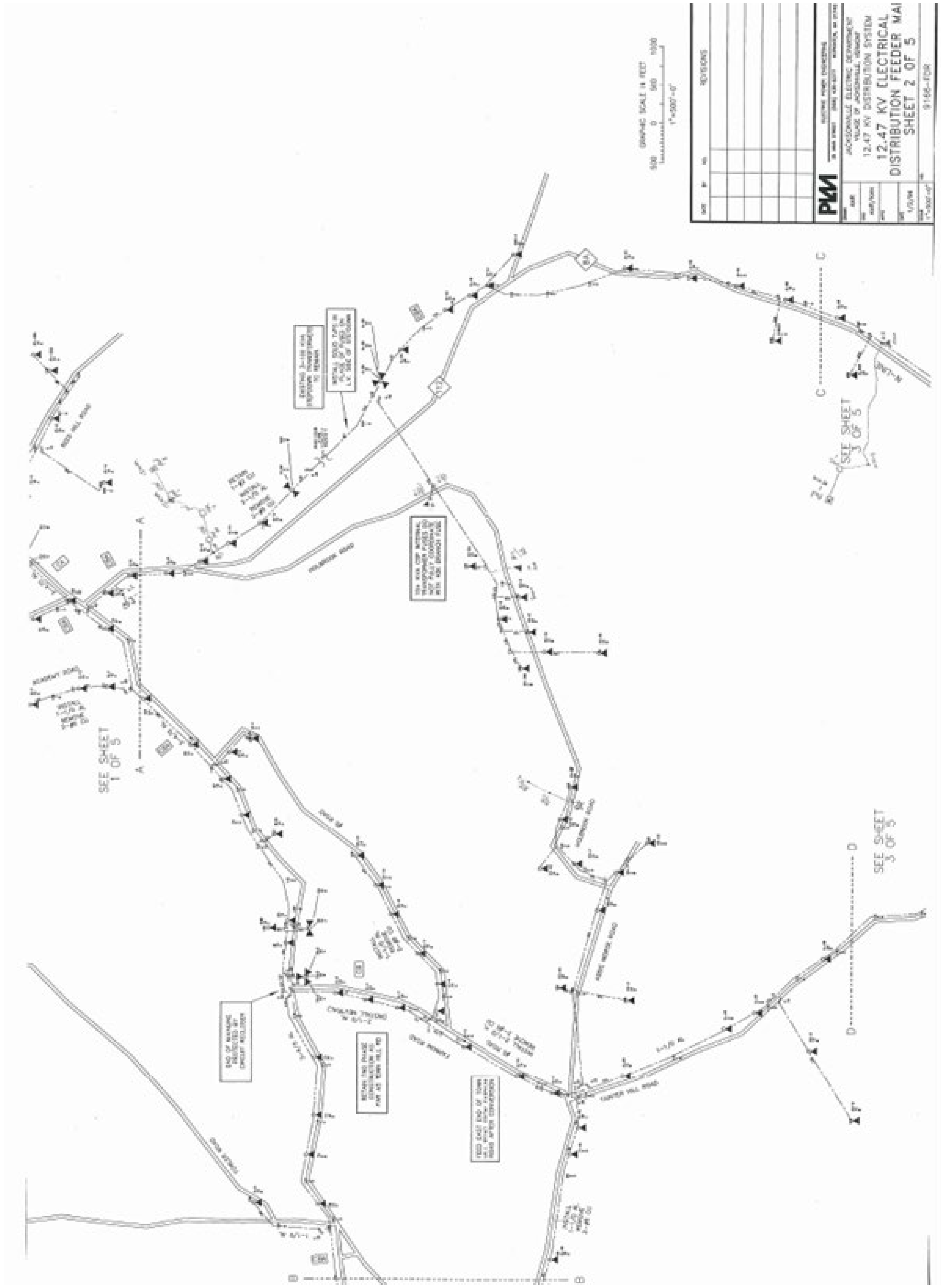
2

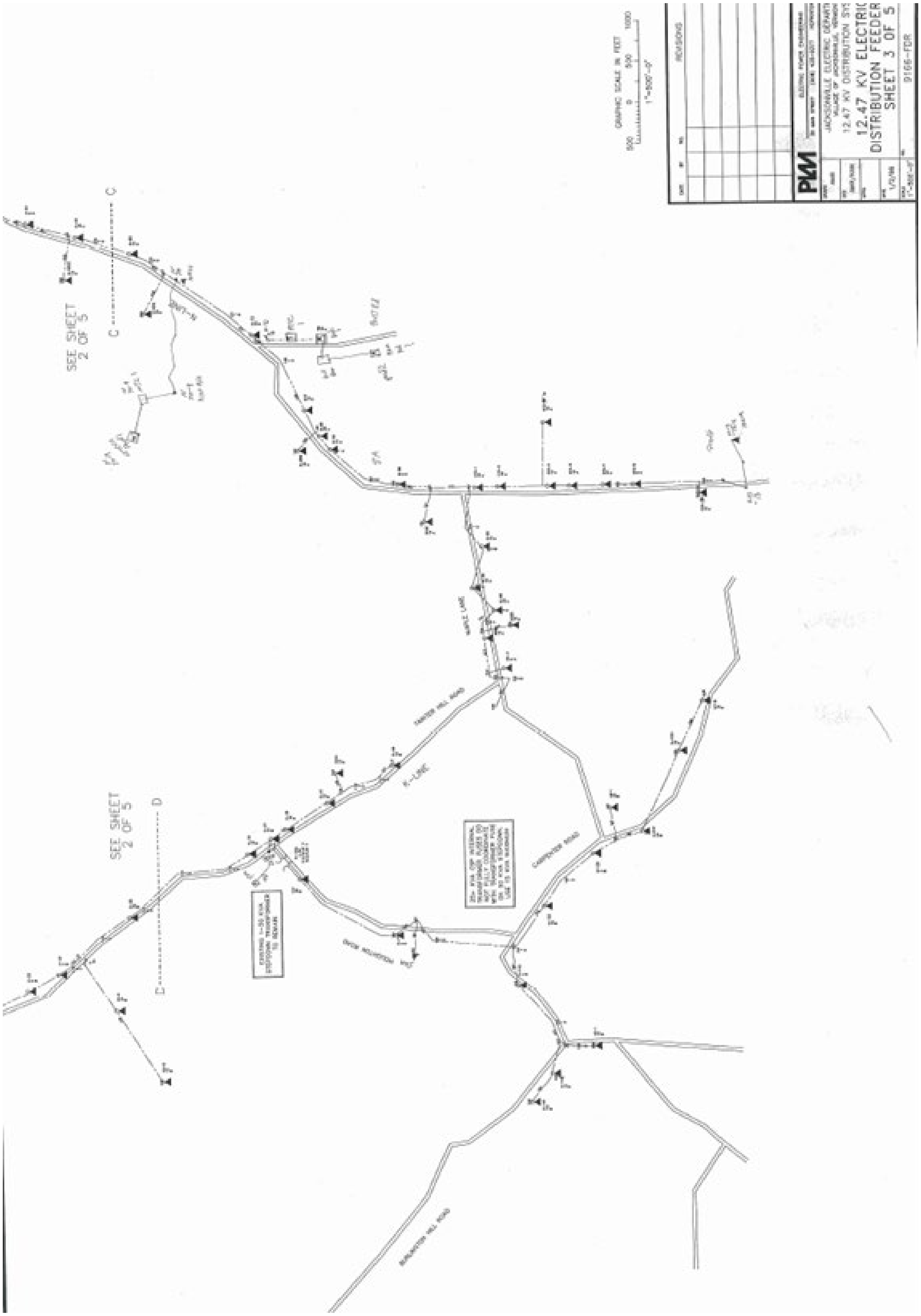
with unity PF.

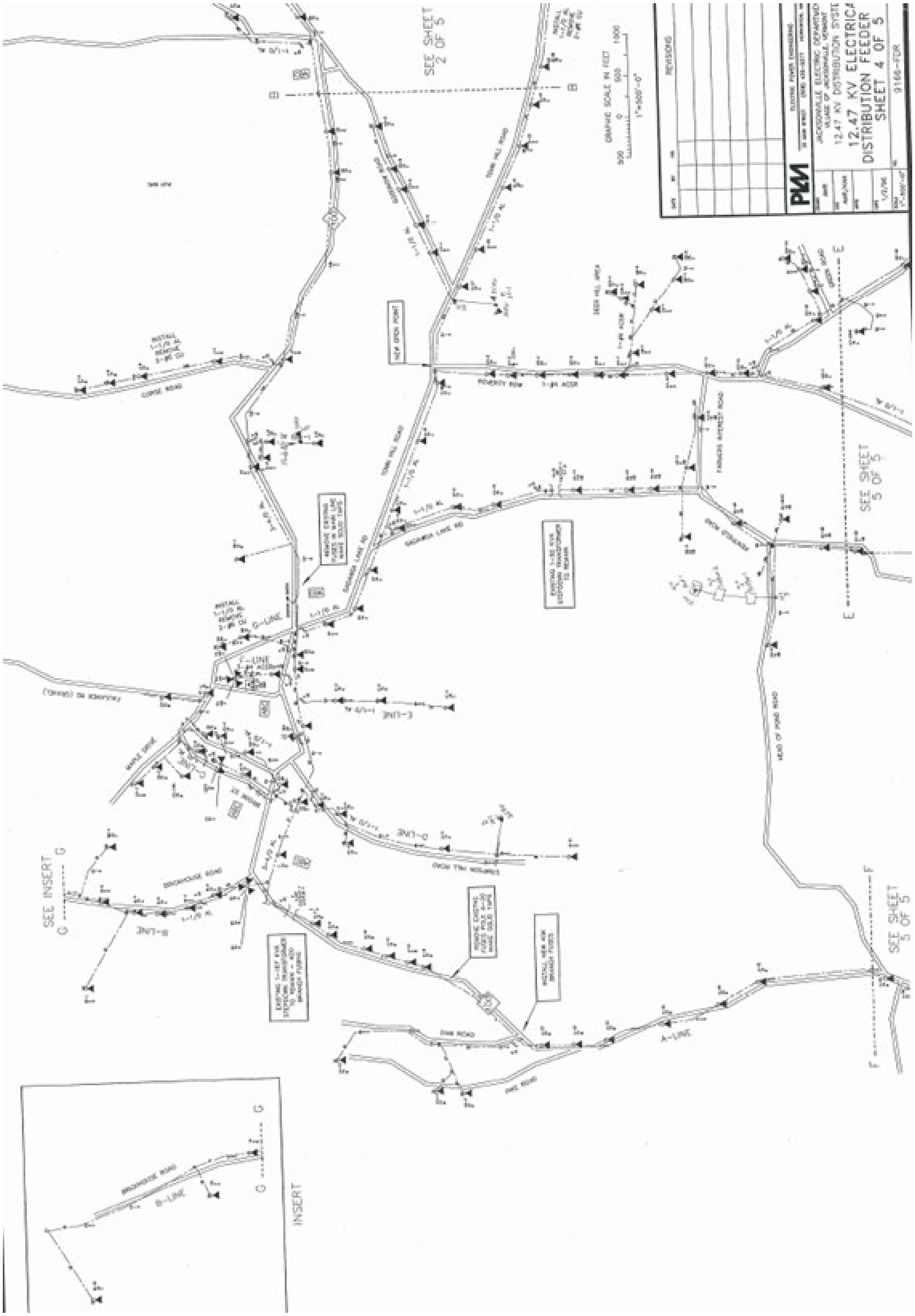
Appendix F: One-Line Diagrams

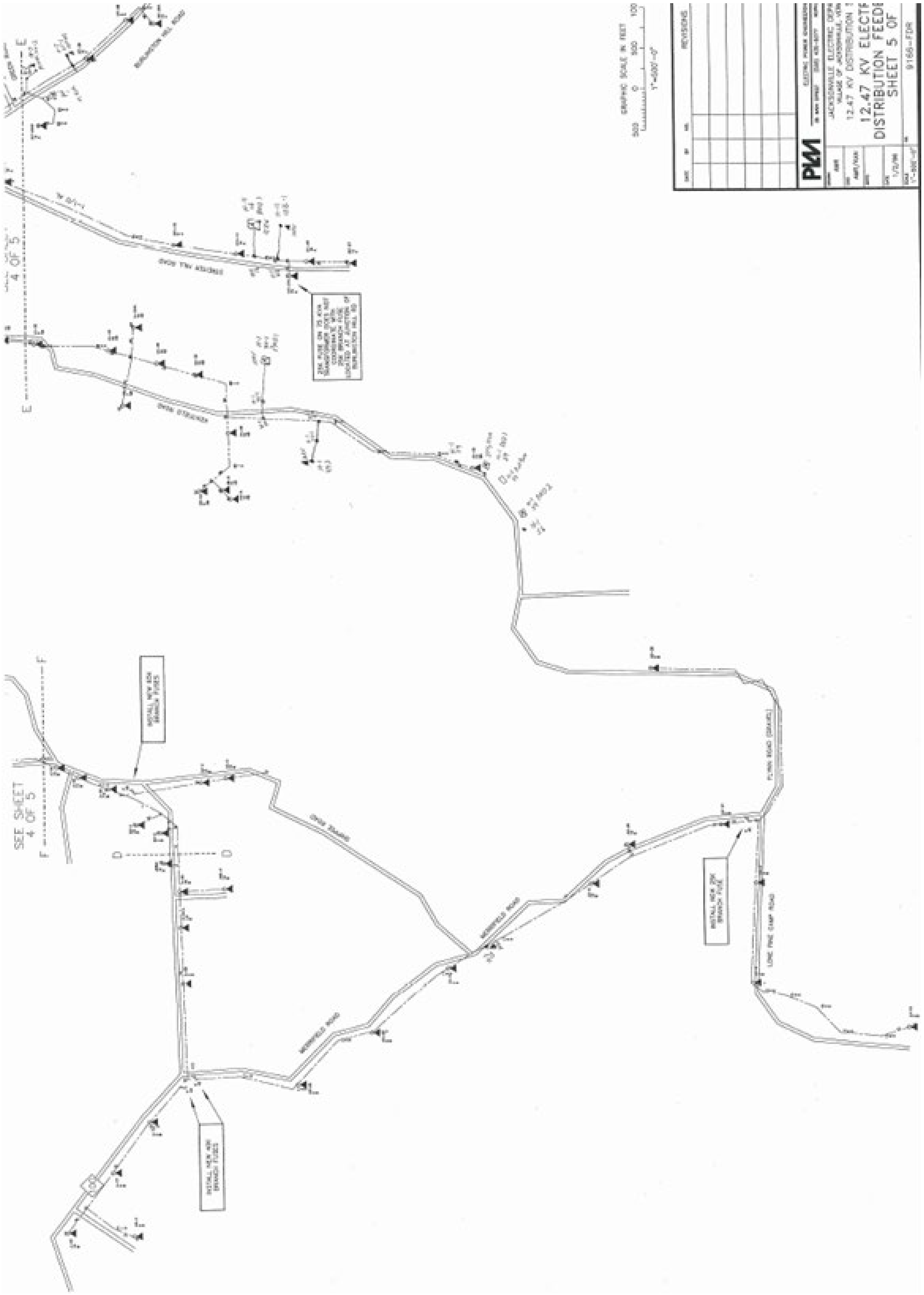
Figure 22: JEC One-Line Diagrams


12.47 KV ELECTRICAL
DISTRIBUTION FEEDER MAP
SHEET 1 OF 5
SEE SHEET
2 OF 5


REVISIONS
12.47 KV ELECTRICAL
DISTRIBUTION FEEDER MAI
SHEET 2 OF 5
SEE SHEET 3 OF 5
SEE SHEET 1 OF 5
SEE SHEET 3 OF 5


12.47 KV ELECTRIC
DISTRIBUTION FEEDER
SHEET 3 OF 5
SEE SHEET 2 OF 5
SEE SHEET 2 OF 5
K-LINE


SEE SHEET 2 OF 5
SHEET 4 OF 5
SEE SHEET 5 OF 5
SEE INSERT G
INSERT
G-LINE
F-LINE
E-LINE
D-LINE
B-LINE
A-LINE


SEE SHEET
4 OF 5

Glossary

ACP	Alternative Compliance Payment
ACSR	Aluminum conductor steel-reinforced
APPA	American Public Power Association
CAGR	Compound Annual Growth Rate
CAIDI	Customer Average Interruption Duration Index
CC	Combined Cycle (Power Plant)
CCHP	Cold Climate Heat Pump
CEDF	Clean Energy Development Fund
CEP	Comprehensive Energy Plan
DER	Distributed Energy Resource
DPS	Department of Public Service or "Department"
EIA	Energy Information Administration
ET	Energy Transformation (Tier III)
EV	Electric Vehicle
EVT	Efficiency Vermont
GMP	Green Mountain Power
HPWH	Heat Pump Water Heater
IRP	Integrated Resource Plan
ISO-NE	ISO New England (New England's Independent System Operator)
JEC	Village of Jacksonville Electric Company
kV	Kilovolt
kVA	Kilovolt Amperes
MAPE	Mean Absolute Percent Error
ME II	Maine Class II (RECs)
MVA	Megavolt Ampere
MW	Megawatt
MWH	Megawatt-hour
NYPA	New York Power Authority
PFP	Pay for Performance
PUC	Public Utility Commission
PPA	Power Purchase Agreement
R^2	R-squared
RES	Renewable Energy Standard
RTLO	Real-Time Load Obligation
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Acquisition
SRD	Source Requirement Document
TIER I	Total Renewable Energy (Tier I)
TIER II	Distributed Renewable Energy (Tier II)
TIER III	Energy Transformation (Tier III)
TOU	Time-Of-Use (Rate)
VELCO	Vermont Electric Power Company
VEPPI	Vermont Electric Power Producers, Inc.
VFD	Variable Frequency Drive
VSPC	Vermont System Planning Committee
WRC	Windham Regional Commission

Windham Regional Energy Plan

Adopted April 24th, 2018

Windham Regional Commission
139 Main Street, Suite 505
Brattleboro, VT 05301
(802) 257-4547
www.windhamregional.org

TABLE OF CONTENTS

PART I: CONTEXT / INTRODUCTION

PART II: CURRENT ENERGY USE

PART III: FUTURE ENERGY USE & TARGETS

PART IV: ADAPTATION & STRATEGIES

PART V: APPENDIX

PART I

Context / Introduction

WINDHAM REGIONAL ENERGY PLANNING

The Windham Region, which is composed of the 23 towns of Windham County, Readsboro, Searsburg and Winhall in Bennington County, and Weston in Windsor County, has a long history of engagement in energy generation and the promotion of energy efficiency through land use policy and other means. The Windham Regional Commission (WRC) was instrumental in the creation of Act 250 in response to unhindered development associated with resort development in the 1960s and early 1970s, and was an early advocate for what we would today call "smart growth" planning.[1] An early energy policy issue for the Commission was the construction of the Vermont Yankee Nuclear Power Station. The state's first major utility-scale wind-power development was constructed in Searsburg. All of our major river systems are or once were dammed for the purpose of hydropower generation (the Deerfield and Connecticut have major operating hydropower facilities; the West River once had a hydropower dam in the vicinity of West Dummerston but is now only generating power through two hydropower retrofits at Ball Mountain and Townshend flood control dams). Since the 1990s the Windham Regional Plan has had a major greenhouse gas emission reduction and renewable energy transition focus. To support this focus energy has been incorporated as a thread throughout all sections and topics of the plan. We emphasize compact settlement patterns, speak to opportunities to reduce energy consumed through transportation, recognize the critical role of weatherization and thermal efficiency, and encourage the transition from carbon-based fuels to renewable energy sources.

The Vermont Comprehensive Energy Plan (CEP) aims to have 90% of all energy consumed to be sourced from renewable resources by 2050. With high goals set for conservation, energy efficiency, and renewable energy generation, the state looks to become more energy independent, secure, and green. In 2016, Act 174 was passed which tasked Regional Planning Commissions to generate Regional Energy Plans, which would facilitate the implementation of the CEP's 90% by 2050 goal (or, the "90x50 Goal"). Three pilot regions completed their draft plans in 2016: Bennington County Regional Commission, Two Rivers-Ottauquechee Regional Commission, and Northwest Regional Planning Commission. Concurrently, the Department of Public Service created standards by which to review the Regional Plans for Compliance with Act 174. With technical support from the Department of Public Service, Vermont Energy Investment Corporation, the Energy Action Network, and these three pilot RPCs, the remaining eight RPC's developed their Regional Energy Plans.

---

1 The WRC celebrated its 50th anniversary in 2015. The archive of our yearlong commemoration is available here, and includes discussion of our role in Vermont land use planning and Vermont Yankee: http://windhamregional.org/anniversary. The 50th anniversary booklet can be downloaded here: http://windhamregional.org/images/docs/publications/WRC_Celebrating_50_Years.pdf.

The Plans explore the respective regions' energy needs by analyzing current energy use, projected use from 2014 to 2050, identifying target consumption and conservation goals for the years leading up to 2050, and identifying where energy generation has potential within the Region. The data (which will be explored in depth in part II) were gathered from the U.S. Census Bureau, the U.S. Energy Information Administration, Vermont Agency of Transportation, Department of Labor, and Efficiency Vermont. The model used to generate target consumption data was produced by the Long-range Energy Alternative Planning System model. The plans explore energy broken out into three sectors: electrical, transportation, and thermal (hereafter referred to as "heat").

The Windham Regional Energy Plan melds land use and energy planning into comprehensive energy planning by first discussing the Region's energy needs and identifying targets for the future which align with the State's 90x50 Goal. It next identifies pathways, policies, and implementation steps to reach these targets. Finally, it presents policies to guide renewable energy generation and maps which illustrate energy generation potential and constraints. The WRC solicited input from the public, municipalities, commissioners, and professionals in a series of workshops, presentations, and public meetings to ensure the plan was reflective of the Region.

KEY ISSUES AND GOALS

For the purposes of this plan, energy is defined as usable power that is derived from fuel sources such as transportation fuel, heating fuel, and electricity generation. Vermonters use a variety of fuel sources to meet their energy needs, all of which present societal and environmental trade-offs, some of which are realized locally and others which have global implications and even present existential threats. Most of that energy is imported, and much of it is carbon-based. All of the petroleum that is used for transportation and space heating, for example, is imported from outside the state, and much of that from outside the United States. Most of Vermont's hydroelectric power is imported from Canada. The only fuels that are not imported to Vermont are locally grown wood used for heating, and locally produced wind, hydroelectric, and solar power.

Energy Security

The energy mix in Vermont currently depends heavily on imported fuels. Fossil fuels account for over 75% of the energy mix as transportation and heating both currently rely on this fuel. Imported electricity generated from Hydro Quebec accounts for roughly 25% of the State's electricity load. With the state's dependence on these non-local resources, dollars are funneled directly out of the local economy. From an environmental perspective, petroleum and other hydrocarbon-dependent energy is a significant cause of localized environmental damage where those fuels are produced and refined, and the emissions from their use is responsible for human-induced climate change, related climate-change disasters, and ecological degradation. Any efforts to reduce the use of non-renewable energy and shift to more environmentally sound energy sources will benefit the State and Region's environment.

Figure 1 on the following page is excerpted from the 2016 Vermont Comprehensive Energy Plan, and illustrates the transition needed to be taken across the state in fuel source to end use. Though Vermont's energy transformation may take years to implement, it has the potential to enhance the vitality of the state and local economy by reducing money spent on fuels pumped, mined, or generated elsewhere, improve our health through reduced emissions and increased bicycle and pedestrian mobility options, and improve the quality of our local and global environment through reduced greenhouse gas emissions. This robust energy

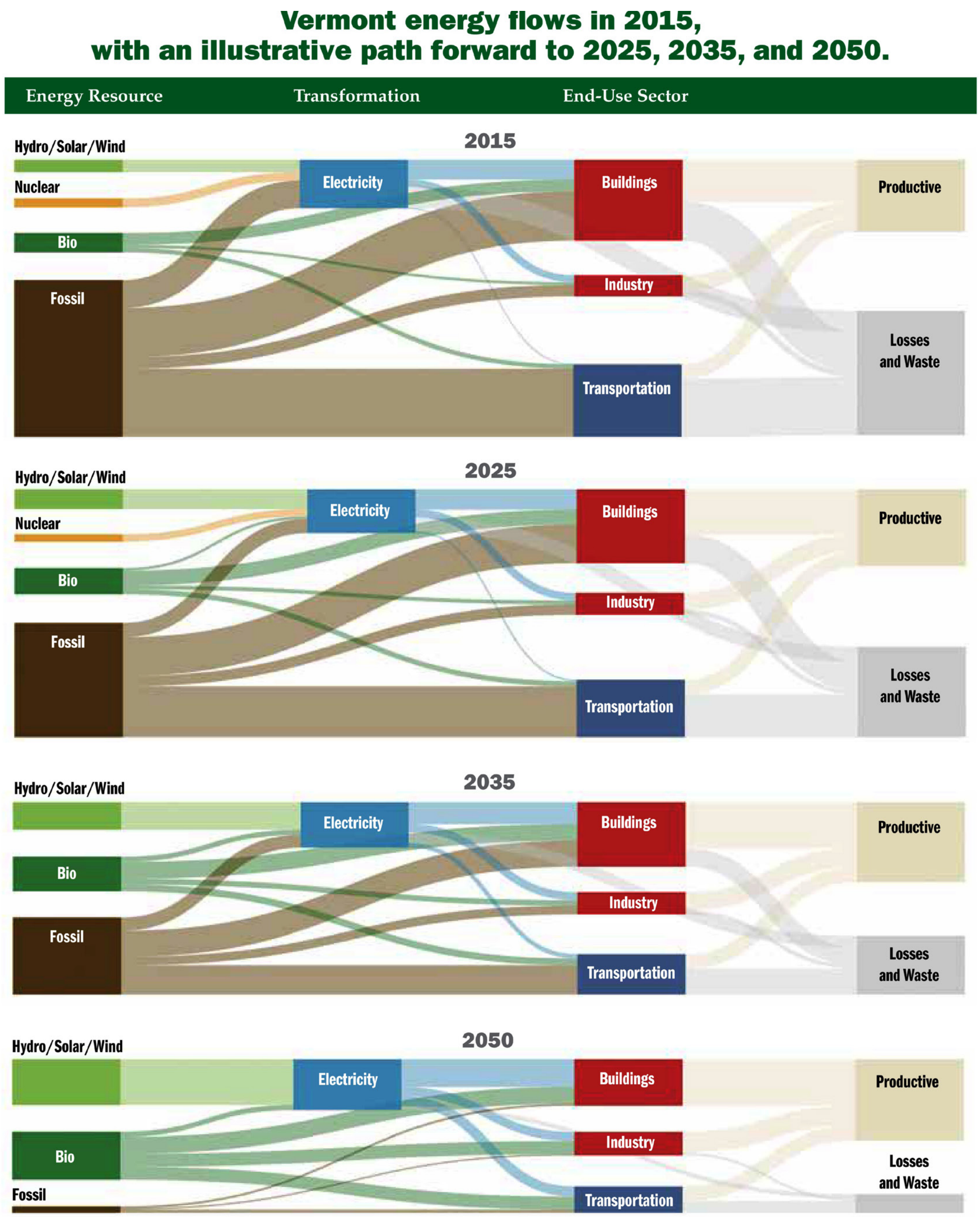


Figure 1: State energy use fuel source to end use from 2015-2050, extracted from the Vermont 2016 Comprehensive Energy Plan.

plan is a tool to advance the economic and environmental well-being of the Region, thereby improving the quality of life for its residents. Pursuing the energy goals will reduce the Region's vulnerability to energy-related economic pressures and, in the long term, climate change-related natural disasters, and promote long-term community resiliency in a variety of contexts.

There is a trend toward factoring the "societal costs" into the price of energy; society pays for health costs associated with pollution, environmental clean-up, military protection of energy sources, and the continued failure of the Federal government to address the disposal of radioactive wastes. And in the long term, communities who depend on fossil fuels are vulnerable to risks associated with their price and production volatility.

These challenges may significantly increase the cost of conventional energy sources within the next 10 to 20 years. As a result, both the Windham Region and the State of Vermont seek to promote and develop reliable energy resources, as well as energy conservation practices, to hedge against the increasing volatility of hydrocarbon prices, and to reduce the environmental impact of our energy use. The role of clean, alternative energy sources will be expanded and supported.

CURRENT WINDHAM REGION ENERGY GOALS OVERVIEW

A reliable and affordable supply of energy is critical to our society and to our way of life. While energy issues are often national or global in reach, local land use decisions have a direct, lasting impact on the energy requirements needed to sustain the function of development. The Windham Region can lead by example by increasing the efficiency of its energy-dependent systems, identifying critical areas of improvement, and supporting local energy options that benefit its communities. The Windham Region actively supports partnerships, strategies, and state and federal legislation that will ensure the affordable and reliable production and delivery of energy to the area, in conformance with regional goals and objectives. It is our intent to work with the State, utility providers, our member towns, and neighboring regions to plan for energy demand and future shifts in primary energy sources.

The following set of regional goals has withstood the test of time for relevance and importance to the Windham Region. These goals evolved from prior plans and they continue to be the subject of ongoing dialogue between the WRC and its member towns. They correspond generally to the State's planning goals, and they guide the development of our regional energy plan policies.

- To plan development in order to maintain the Region 's land use and historic settlement pattern of compact villages and urban centers separated by rural countryside;
- To encourage the availability of a reliable, sufficient, and economical energy supply, to support energy conservation and efficiency, to encourage the development of appropriately scaled and sited energy generation resources, and to facilitate conversations between towns where different interests exist;
- To provide for safe, convenient, economical, and energy efficient transportation systems including options such as public transit and paths for pedestrians and bicyclists, where appropriate;
- To provide a vital and diverse economy with rewarding job opportunities and high environmental standards for the Region 's citizens;
- To encourage and strengthen agricultural and forest enterprises;
- To maintain and improve the quality of air, water, wildlife, and land resources in the Region ;
- To identify, protect, and preserve regionally important natural and historic features of the Vermont landscape;
- To provide for thoughtful and efficient use of the Region 's natural resources, including the prevention of surface water and groundwater pollution, the protection of fragile natural habitats and endangered or threatened species, the avoidance of agricultural and other land-use practices

that lead to soil erosion, the management of woodlands on a sustainable basis, and the sensitive treatment of scenic resources. Mineral extraction should have minimal adverse effects on aesthetics, water quality, air quality, and special community resources (such as historic sites, recreation, or scenic areas), and effective site rehabilitation plans should be provided and implemented;

- To plan for, and to educate the public about, natural and other hazards in the Region, the prevention and mitigation of these hazards, and for preparedness, response, recovery, and resilience;
- To educate the public about the inherent risk to life and property associated with development within river and stream corridors, including fluvial erosion hazard areas, and to continue to develop actions and policies that prevent and mitigate these risks wherever possible;
- To promote the development of housing suitable to the needs of the Region and to ensure the availability of safe and affordable housing for all citizens;
- To broaden access to education and training for all citizens;
- To maintain and enhance recreational opportunities for both residents and visitors in keeping with the carrying capacity of natural resources and public facilities;
- To plan for, finance, and provide an efficient system of public facilities and services (such as schools, water and wastewater facilities, highways and bridges) to meet future local, regional, and state needs; and
- To support affordable access to high-quality health care services for all citizens.

The following action steps are adopted steps specific to energy within the Windham Regional Plan:

- Energy conditions are rapidly changing in Vermont, in part due to volatile energy prices, new technologies, and the 2014 closure of Vermont Yankee Nuclear Power Station. The State has adopted aggressive goals to create a renewable energy future including the CEP's 90x50 Goal. During the 2011-2012 legislative session, the State of Vermont amended the Sustainably Priced Energy Economic Development (SPEED) goal (adopted in 2005) with the Total Renewable Energy Goal, which states that starting in 2017, 55 percent of each retail electric utility's annual sales must be met by renewable sources, increasing by 4 percent every third year until 2032, when 75 percent of sales must be met by renewables (see Act 170). **The WRC will support state energy goals provided they comport with the provisions contained within this plan, including the protection of significant natural and cultural resources and human health and welfare.**

- Energy conservation and energy efficiency are among the best energy investments, providing opportunities for significant reductions in energy use and costs.[2,3] While there are social and ecological impacts associated with all energy production, energy conservation and energy efficiency help reduce these impacts by reducing demand. Lowering demand makes energy more affordable

2 "Energy efficiency" - Using less energy to perform the same functions and tasks. This applies to measures such as the use of new technologies (e.g., LED lights, more energy-efficient appliances) that use energy more efficiently and reduce waste.

3 "Energy conservation" - Reducing energy use. This applies to measures such as building weatherization and changes in personal habits (e.g., turning off lights, driving less) that reduce the amount of energy consumed.

for all by reducing infrastructure requirements. Reducing energy demand reduces the impacts associated with all forms of energy, both renewable and non-renewable. In October 2011, the State of Vermont adopted Residential Building Energy Standards (RBES) and Commercial Building Energy Standards (CBES), which establish a minimum standard of energy efficiency for nearly all new residential construction, including building additions, renovations, and repairs statewide. Meanwhile, utility companies are actively installing Smart Grid technology, which allows consumers to monitor and to make more informed choices about their daily energy use. **The WRC supports improved energy conservation and efficiency strategies as a preferred alternative to the construction of new energy generation and transmission capacity.**

- Energy conservation and efficiency should be a primary consideration in all development projects, with a primary land use goal of locating significant projects adjacent to or within existing developed areas. Scattered development increases the need for vehicular traffic, requires further extension of public infrastructure and utilities, and consumes a higher percentage of open space, all of which increases the overall energy demand of the project. There is also a direct relationship between development patterns and the subsequent transportation energy needed to sustain that development, which is especially significant in this State where the greatest end-use consumption of energy occurs in the transportation sector. **The WRC will encourage development in the Region that meets the highest State and regional standards and exhibits best practices in terms of energy conservation and energy efficiency.**

- The cost of energy in Vermont, across all sectors, is the third highest in the nation, averaging $27.77 per million BTU.[4] Only Hawaii and Connecticut have higher average costs.[5] The high cost of energy in the state and in the Region means that residents and businesses are paying more for the energy they use relative to the surrounding States and the country on a per-unit basis. This is partly due to the fact that natural gas prices nationwide have fallen to historic lows, allowing many residents and businesses across the country to take advantage of this economically priced fuel source. However, there is no natural gas pipeline currently serving the Windham Region, and delivery of compressed natural gas is only available to industrial users. In order to remain economically competitive, the Region will need to look for diverse options to reduce energy costs. **The WRC will continue to provide educational materials and workshops to inform towns, businesses, and residents how to reduce their overall energy costs, and will support development of energy facilities and sources that will provide competitively priced energy to the Region.**

- Dependence on both external sources of energy and large-scale infrastructure places the Region in a vulnerable position with regard to energy security. While it is acknowledged that these sources are integral parts of a much larger and complex energy system, it is prudent for the Region to consider options to increase energy security and stability during times of shortages and outages. **The WRC will support diversification of energy sources in the Region, redundancy of systems to support critical functions in times of supply interruptions as well as net-metering, off-grid, and community-scaled, distributed generation projects to enhance self-sufficiency and**

---

4 A BTU is the amount of heat required to raise the temperature of 1 pound (0.454 kg) of liquid water by 1.0 °F (0.56 °C) at a constant pressure of one atmosphere. It is the common unit used to compare energy use across the various types of energy sectors (heat, electricity, etc).

5 U.S. Energy Information Administration, 2011 Estimates, http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_fuel/html/fuel_te.html&sid=VT.

resiliency.

- The combustion of carbon-based fuels releases greenhouse gas (GHG) emissions into the atmosphere contributing to alteration of the climate. The region's current energy demand relies heavily upon fuel combustion. Energy consumed for transportation, space heating, and electricity generation accounts for more than 80 percent of Vermont's annual statewide GHG emissions. Increases in energy conservation and efficiency in the region, coupled with a greater reliance on low GHG-emitting energy sources and renewable energy, will help reduce overall GHG emissions. **The WRC will encourage a shift away from GHG-intensive energy sources and towards socially and ecologically sensitive energy sources that have zero or low GHG emissions.**

- Methane is both a valuable renewable energy source as well as a potent GHG that is 21 times stronger than carbon dioxide when released directly into the atmosphere. In this region, methane is primarily a by-product of the livestock industry, particularly from dairies. Methane digesters have been developed to burn methane to create useful electricity. **The WRC will encourage the deployment of methane digesters.**

- Renewable energy is generally defined as any energy resource that is naturally regenerated over a human timescale, including sources derived directly from the sun (such as thermal, photochemical, and photoelectric), indirectly from the sun (such as wind, hydropower, and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy). The "renewable" characteristic of these energy resources means that they are not as vulnerable to supply disruptions and the increasing costs and volatility associated with a finite fuel source like fossil fuels. Although all energy sources create negative environmental impacts, renewable energy technologies are comparatively clean sources of energy that can have a much lower environmental impact than conventional energy technologies. **The WRC will support the development and use of renewable energy resources that enhance energy system capacity and security, promote cleaner, more affordable energy technologies, increase the energy options available locally, and avoid undue adverse impacts of energy development on the local community and environment.**

- Every energy facility, including renewable energy systems, has varying social, economic, and environmental implications, some of which may impact the greater community. As with any development project, there are a variety of public perspectives and values leading to differences in opinion regarding how the Region is best served. In some cases, concerns have been raised regarding location suitability and installation practices of energy generation. **The WRC will encourage developers to use sound siting practices when installing energy facilities, support opportunities for public participation, and will facilitate inter-town conversations**

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.

where differences exist. The WRC expects projects to comport with the vision and intent articulated in this plan and those of municipalities.

The Windham Regional Plan also incorporates the Windham Regional Transportation Plan that was adopted in 2013. The Transportation Plan also speaks to energy consumption, protection and improvement of air quality, and reduction of greenhouse gas emissions. The following is excerpted from the Transportation Plan (page 13):

The transportation sector's contribution to GHG emissions must also be considered when evaluating air quality because of climate change concerns. In 2015, the transportation sector accounted for 54.6% of Vermont's GHG emissions. Suggested measures for reducing mobile source emissions have been recommended by the Federal Highway Administration (FHWA) and are included in the Regional Transportation Plan, Chapter 2: *Energy and Air Quality*. Among the suggested improvements, the most relevant to this Region are the following:

- Improved public transit;
- Park and ride/fringe parking;
- Ride-sharing programs;
- Pedestrian and bicycle facilities;
- Programs to promote non-automobile travel to major activity centers such as shopping centers, special events, and other centers of vehicle activity; and,
- Programs for new construction and major reconstruction of paths or areas solely for use of pedestrian or other non-motorized means of transportation.

The Regional Transportation Plan included the following energy-related policies:

- Support emissions standards that reduce regionally generated air pollutants from transportation-related activities.
- Promote alternative fuel vehicles and the infrastructure necessary to fuel those vehicles.
- Require all development projects to incorporate elements that reduce reliance on single occupant vehicles, such as providing access to public transit, installing pedestrian and bicycle network links, or providing access to ride-sharing programs.
- Support efforts to minimize energy consumption, especially non-renewable energy resources, and explore expanded use of alternative fuels.
- Integrate traffic designs in designated downtowns and village centers that limit idling and calm traffic.

The Windham Region has a strong history of generating energy and supporting renewable energy, conservation and efficiency, and reducing greenhouse gas emissions through adopting policies and goals encouraging these on a regional level. This comprehensive energy plan applies these goals to the data of current use and projected use and explores the implementable steps to achieve the state goal of 90% renewable energy by 2050. In this plan, energy is divided into three sectors: electricity, transportation, and heating. Each chapter discusses the three sectors in the contexts of Current Energy Use (Part II), Future Energy Use & Targets (Part III), and Adaptation & Strategies to achieve those targets (Part IV).

PART II

Current Energy Use

BACKGROUND

Too often we as a society take for granted how energy is used and to what ends until an event occurs that impacts supply, availability, access, and price. Sometimes these events are highly visible and reported, such as armed conflict, an energy cartel agreement, an oil spill, gas explosion, mine collapse, or radioactive leak. Other events such as changes in exploration technology, market structure and competition, global demand and supply, or regional supply chains, are less apparent.

The local, regional, and global environmental effects associated with energy exploration, development, refining and production, transportation, transmission and distribution, and end-user consumption are similarly at times obvious and at other times subtle. Climate change is perhaps the most insidious of these effects, even though its existence and human cause are increasingly affirmed.[6] Understanding what energy is used in the Region, how that energy is used, where it comes from, and what it costs establishes a baseline understanding of our energy present and what changes will be necessary for the Windham Region to achieve its desired energy future.

ENERGY CONSUMPTION AND DEMAND

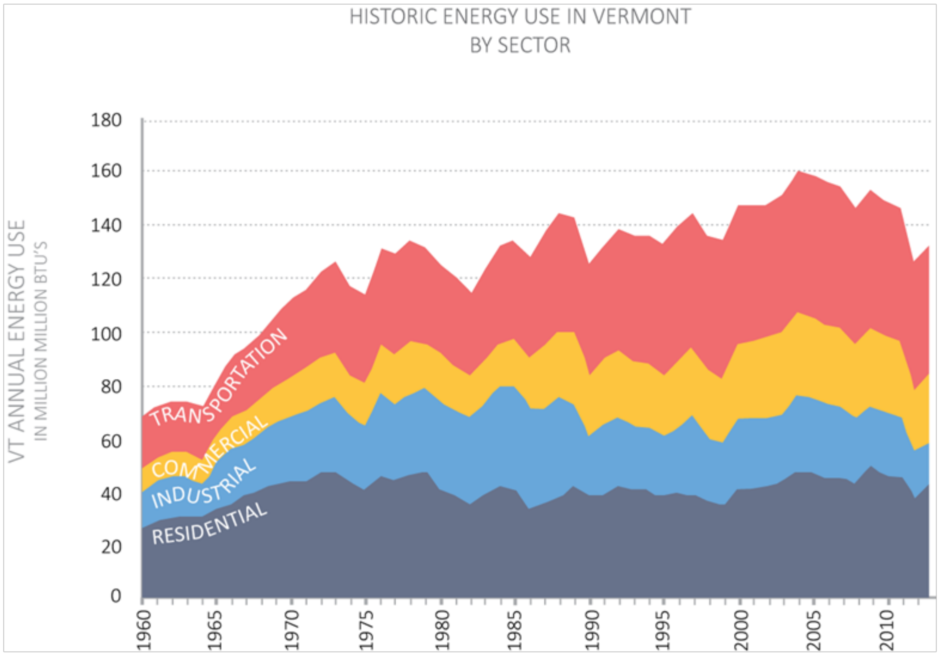


Figure 2: Historic energy use in Vermont, by sector.

This chapter explores current energy usages along with the amounts used in total units. The numbers presented are the most accurate estimates available based on current information sourced from the American Community Survey, the U.S. Department of Labor, the Vermont Agency of Transportation, Efficiency Vermont, and the U.S. Energy Information Administration. The discussion of this data provides the context for this energy plan; it is the starting point from which the Region will plan to achieve the goal set out in the Vermont

6 U.S. Global Change Research Program Fourth National Climate Assessment, 2017 Volume 1. https://science2017.globalchange.gov/.

Comprehensive Energy Plan (CEP) of 90% renewable by 2050 (90x50 Goal).

GROWTH AND ENERGY USE

Over the last 80 or so years, both the State of Vermont and Windham Region have drawn energy from multiple sources, primarily gasoline, liquid petroleum gas, and wood. Overall consumption throughout the 20th century increased dramatically, with some decline around the advent of the "Great Recession" of 2008 (see Figure 2). Energy consumption has generally tracked with population.

While still a rural state, Vermont's population and economy are not as agrarian as they were at the turn of the last century. 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

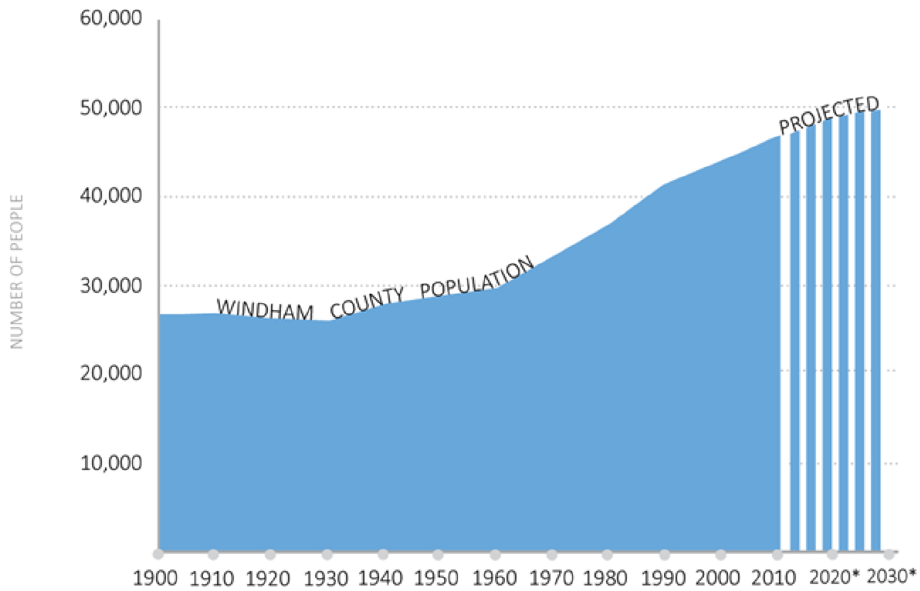


Figure 3: Windham County population, both measured and projected.

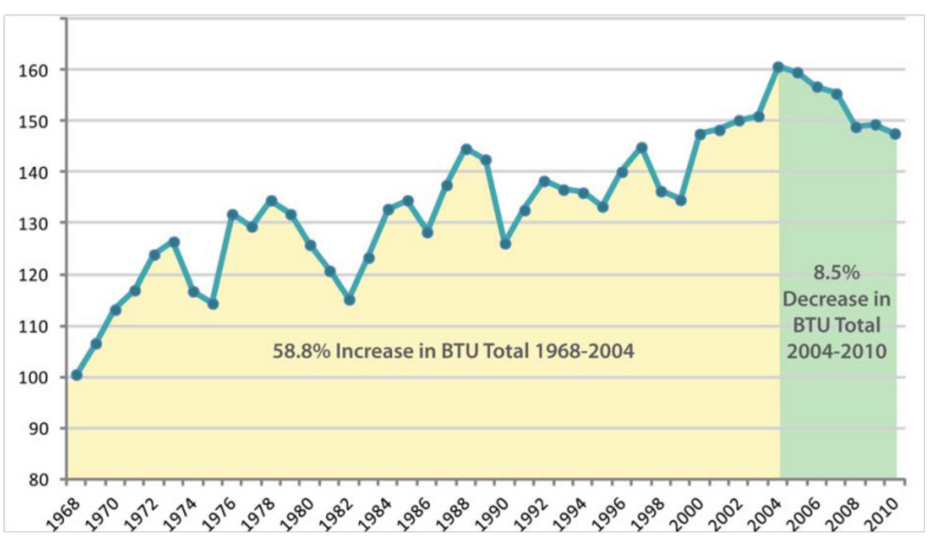


Figure 4: Total end-use energy consumption estimates in Vermont, 1960-2010.
Source: U.S. Energy Information Administration, http://www.eia.gov/states/seds/data.cfm.

led to a boom in population growth through the 2000 Census. Figure 3 below shows Windham County's population, along with a projection of what the population is expected to be in the coming decades.

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. Figure 4 below illustrates the trending relationship between Vermont real GDP growth and the total consumption of energy (in Btu or British Thermal Units). This figure also demonstrates how energy consumption responded to the Great Recession, noted by the clear dip in energy consumption in 2008. Overall energy demand in Vermont has grown from 135.4 trillion Btu in 1990 to its peak of 158.1 trillion Btu in 2009, a 17 percent increase. Since 2009, the demand has decreased to 132.0 Btu in 2015 bringing it back to near 1990 levels.

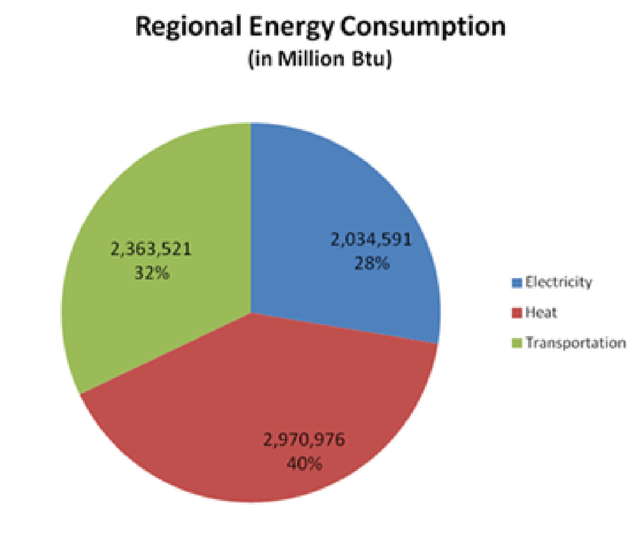
REGIONAL ENERGY USE & EXPENDITURES

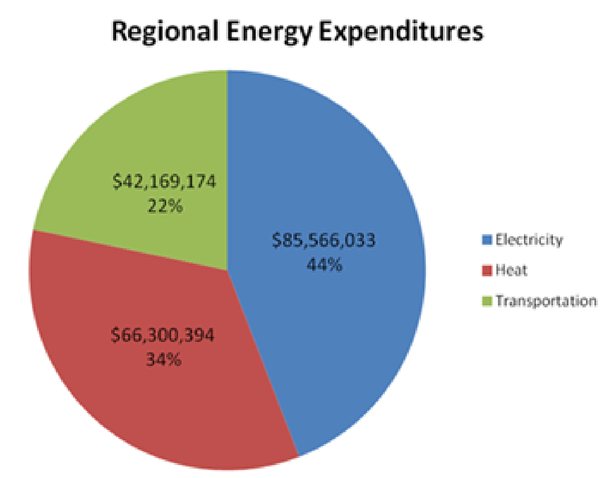
In total, the Region consumes annually 7,369,088 million Btu across the electricity, heating, and transportation energy sectors (Figure 5). This computes to an annual energy cost for the Region of $194,000,000 (Figure 6). With each of the three sectors depending heavily of fossil fuels for the main source of fuel, a majority of these dollars leave the state and local economy. Each sector is discussed in greater detail below. For an overview of energy use by town, see Appendix D on page 72.

ELECTRICITY SECTOR

Electricity usage has increased slightly since 2014, as is portrayed in Figure 7 on the following page. Efficiency Vermont compiled usage from distributors. In 2016, the total amount of electricity used in the Windham Region was 503,562,372 kilo-watt hours (kWh); 296,945,653 kWh for commercial and industrial use (C&I), and 206,616,719 kWh for residential use (RES).[7]

In 2014, 73% of the Region's electricity needs was sourced by renewable energy, including renewable energy imported from beyond the State's boundaries. Note that this refers to electricity only, and does not does not include heat or transportation energy demand, which have much lower rates of renewable energy use due to reliance upon petroleum-based products.[8]





Figures 5 and 6: Total estimated energy consumption and expenditures in the Windham Region, per sector.

7 The estimated electricity consumption data shown in Figures 5 and 6 was calculated based on reasonable regional averages for electricity consumption per Windham Region municipality. Figure 7 shows a relatively slight difference in electricity consumption, since it is measured from meter data, compiled and delivered to RPCs from Efficiency Vermont.

8 Source: Vermont Community Energy Dashboard data for the Windham Region, http://www.vtenergydashboard.org/my-community/windham-regional-commission/progress

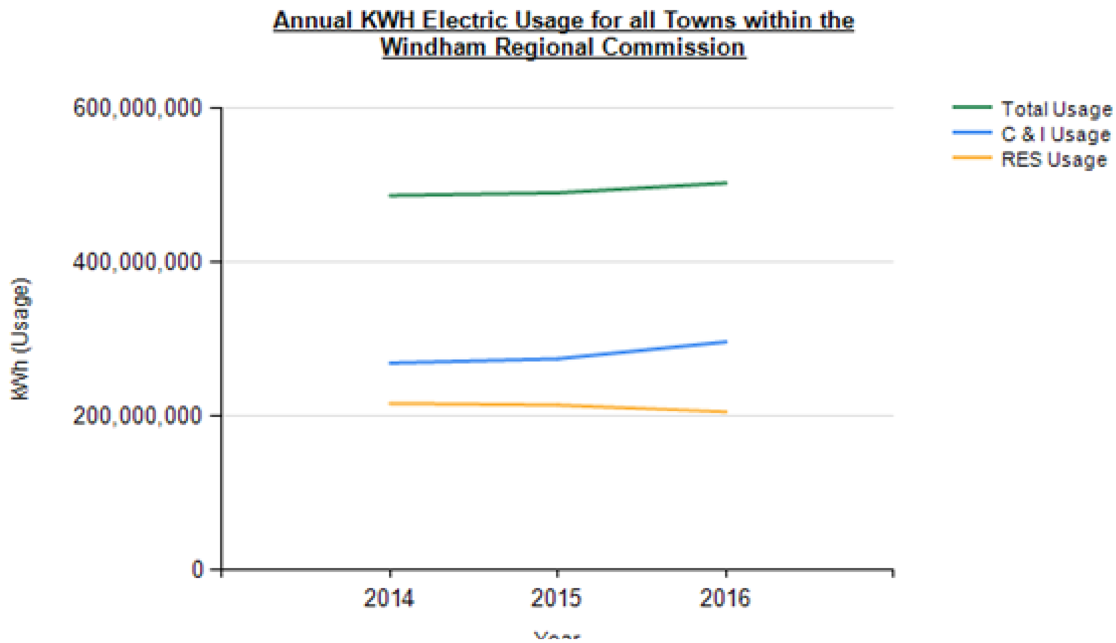


Figure 7: Measured electricity consumption in the Windham Region, 2014-2016. Data from Efficiency Vermont.

TRANSPORTATION SECTOR

As Vermont is a rural state, dependency upon single-occupancy, petroleum-powered vehicles is not only a social norm, but a necessity in many cases. The dispersed settlement patterns of the Windham Region and the State encourage car usage by the long distances between destinations. In Windham County, the average travel time to work from 2011 to 2015 was 21.5 minutes.[9] Most of these trips are by single occupant vehicles. Figure 8 shows the State's overall petroleum consumption since 1960. Transportation consumes a large portion of the total petroleum used, and has steadily increased since the 1960s, though the trend is now leveling off.

SYSTEM ENERGY LOSS

It is important to acknowledge the losses incurred from energy generation to distribution. As described by the EIA, these losses are "incurred in the generation, transmission, and distribution of electricity plus plant use and unaccounted for electrical system energy losses." According to the EIA, the estimated transmission and distribution losses in Vermont were 4.92 percent in 2010.

In the Windham Region, transportation accounts for 35% of the total energy use. The leading fuel for transportation is gasoline followed by distillate fuel. Because transportation-related energy use is mainly determined by the individual vehicle miles traveled by residents and visitors to Vermont, 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.

To estimate the total amount spent on transportation-related energy consumption in the Region, we began with an estimation of the number of vehicles per household. Based on number of households in the region, it is estimated that the Windham Region has a total number of 34,800 vehicles. Based on VTrans

9 Regional Transportation Plan, 2013: http://windhamregional.org/images/docs/trans-plan/2013_WR%20Transportation%20Plan_complete.pdf.

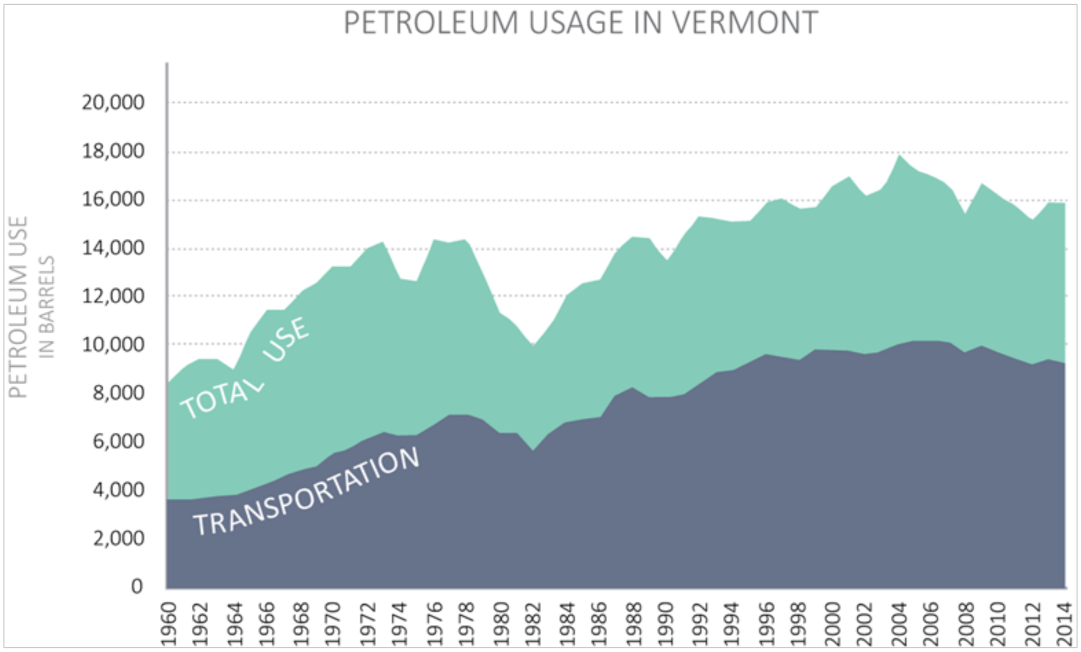


Figure 8: Petroleum consumption in Vermont, total and by transportation sector.

average miles traveled per vehicle in the State, these cars drive 395,327,000 miles total in a year, consuming 17,999,000 gallons of fossil fuel (both gasoline and diesel). This yields an estimated total of $42,169,000 spent on transportation-related fuels. Electric vehicles make up a fraction of the fleet in the Region with an approximate number of between one 100 and 200 vehicles (see Figure 9).

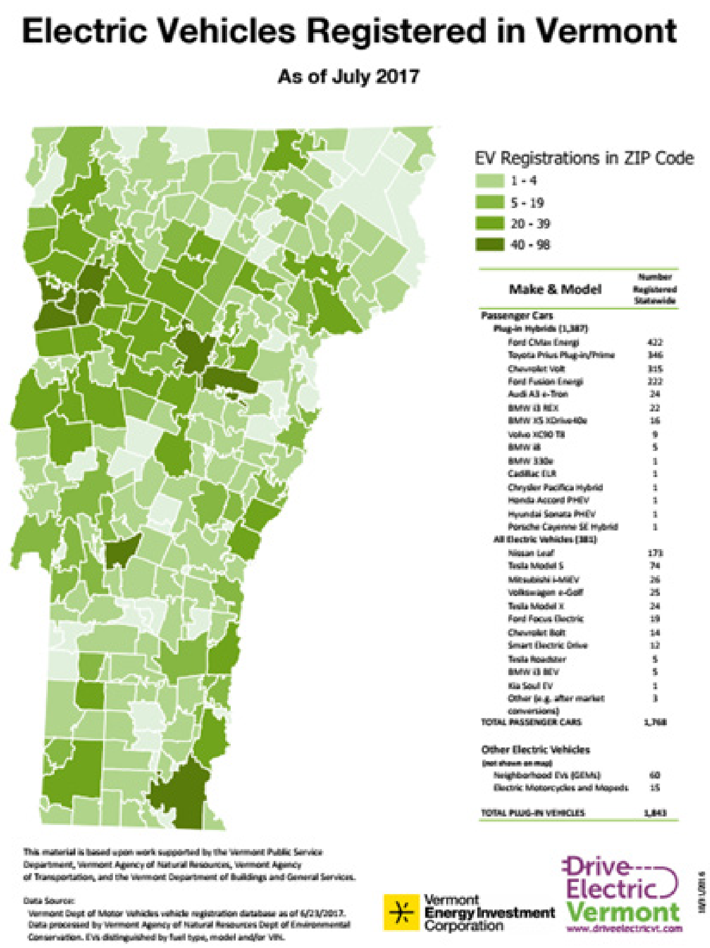
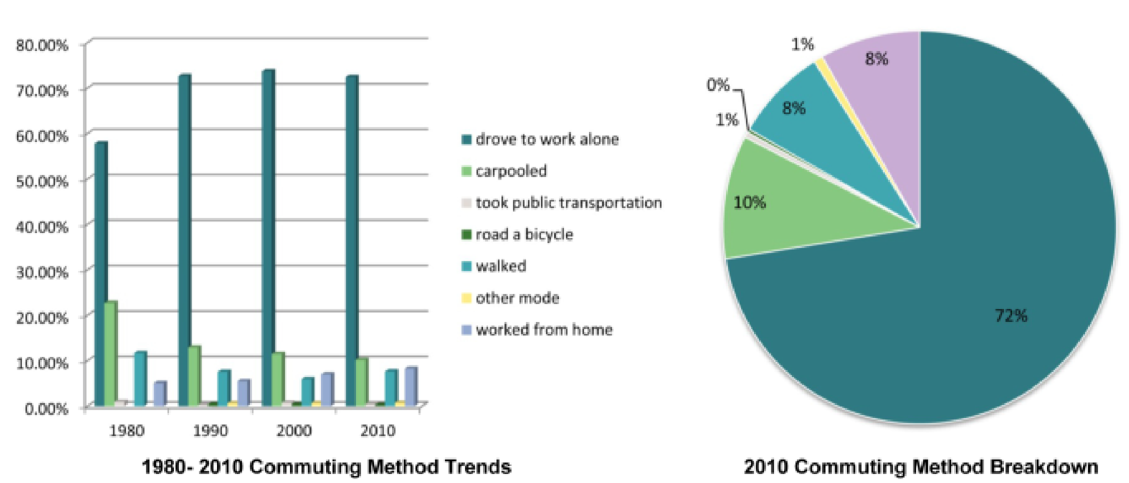


Figure 9: Number of electric vehicles registered by zip code in Vermont.

Factors Contributing to Transportation Energy Consumption

Fuel efficiency has increased over time. The federal fuel efficiency standards of 2011 require a 35.5 mpg average for the U.S. auto industry by 2016. The majority of the vehicle fleet in Vermont fell within the 21-30 mpg efficiency range based on the vehicles registered in 2010. Less than 10% of the fleet fell within the 31-40 mpg range. In theory, newer, more efficient vehicles should improve the overall miles per gallon rate of both the Windham Region and Vermont vehicle fleet. However, the recent general decline in gasoline prices may encourage drivers to purchase less-efficient and larger vehicles, or defer the replacement of older, less-efficient vehicles with newer, more-efficient vehicles. For a full discussion of fuel efficiencies across the State and within the Region, see the Windham Regional Transportation Plan.



2010 Census, U.S. Census Bureau
http://www.census.gov/

Figure 10: Commuting methods of the Windham Region.

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 market, schools, and work tend to be only possible with the use of an automobile (see Figure 10).

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. Figure 11 exemplifies this by illustrating the commuting links between residences and major employment centers. Concentration of retail in pedestrian-unfriendly, auto-dependent strips also contributes to single-trip automobile use.

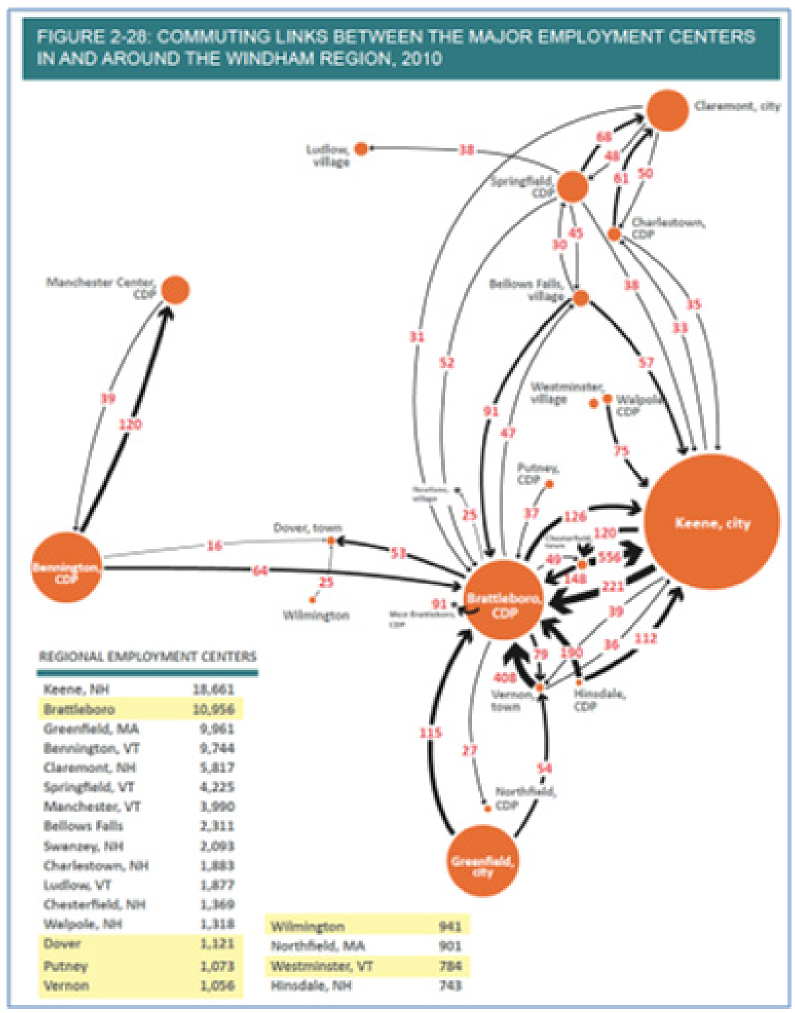


Figure 11: Commuting links between the major employment centers in and around the Windham Region, 2013.

HEAT/THERMAL SECTOR

Energy consumed for heating is estimated based upon the average square footage of residential and commercial spaces by fuel type. This was calculated using data from American Community Survey and the 2011 American Housing Survey. The Region spends approximately $25,256,000 on commercial and $49,770,500 on residential heating (these figures were found by using an average rate of $22.32 spent per million Btu each year, based on the 2016 Vermont Fuel Price Report).

To account for the different building types and their respective uses, the following estimates divide thermal energy consumption into residential and commercial uses (industrial building thermal demand is not included, as the data is not available and highly variable). Figure 12 illustrates this energy consumption by fuel type. The Region depends heavily on fuel oil and kerosene with this fuel source supplying over 50% of residential heating needs. As the majority of the fuel types are not locally produced (fossil fuel sourced), the funds going to this supply are funneled directly out of both the State and Region.

Wood products fuel over a quarter of the residential heating needs for the Region. The Windham Region has an abundance of forest resources. A study completed by Innovative Natural Resources Solutions (INRS) revealed Windham County has the largest 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.[10] With this abundant resource, the Region has the ability to support a significantly higher percentage of the heating needs with advanced wood heating options while supporting an important local economy if wood fuel processing and distribution can be developed at an economical scale (discussed further in Part IV: Adaptation & Strategies of this Plan, on page 40).

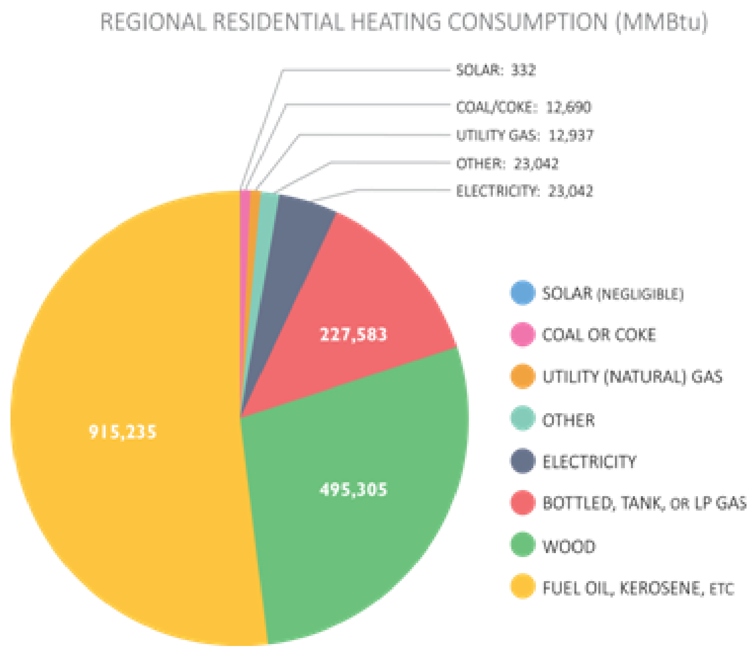


Figure 12: Residential fuel sources for the Windham Region.

Residential Buildings

For residential buildings, it was assumed that the average annual heating load of area residences is 110 million Btu, for both space and water heating (the Vermont state average). With 20,275 primary housing units in the Region (see Table 1 on the following page), this calculates to an estimated 2,230,250 MMBtu annual total heat consumption.

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

Total housing units	32,638	100.0%
Occupied housing units	20,275	62.1%
Vacant housing units	12,363	37.9%
For rent	615	1.9%
Rented, not occupied	43	0.1%
For sale only	309	0.9%
Sold, not occupied	23	0.1%
For seasonal, recreational, or occasional use	10,916	33.4%
All other vacancies	457	1.4%

Table 1: Windham Region housing tenure status, 2010.

In the Windham Region, there is a high percentage of seasonal homes at 33.4% of the total housing stock (Table 1). Consistent with the assumptions informing the energy model projections from the state (created by the LEAP, or Long-Range Energy Alternatives Planning model assumptions discussed in Appendix A), it can be assumed that seasonal homes only use about 15% of the energy of a primary home, due to more occasional use and presumed higher energy efficiency as they are assumed to be of more recent construction or renovation. As such, seasonal homes in the Region are estimated to consume about 180,114 MMBtu annually, and therefore spend about $4,019,500 on heating.

Commercial Establishments

For commercial establishments, it can be estimated that the total heating load is about 725 MMBtu each year per establishment (the estimated commercial heating demand per municipality will vary depending on the types of commercial establishments in the area, but this State average can be used as a regional approximation). With 1,509 commercial establishments in the Region, there is an estimated thermal energy demand of 1,094,025 MMBtu annually. Together these businesses pay an estimated $24,414,000 each year total in heating expenses.[11]

11 Based on Windham County averages for fuel types consumed overall, and costs per fuel type from the 2016 Vermont Fuel Price Report. http://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Fuel_Price_Report/2016/June%202016%20Fuel%20Price%20Report.pdf.

PART III

Future Energy Use & Targets

LEAP MODEL OUTPUT DISCUSSION

The State and its regions are faced with the challenge of how to contribute to the achievement of that goal outlined in the Comprehensive Energy Plan of 90% renewable energy by 2050 (referred to as "90x50"). In order to effectively plan for the renewable future, modeling the Region's use and future use provides a baseline from which to plan. This chapter studies the current energy consumption patterns of the Windham Region, which will provide the context for the large gains necessary in energy conservation and efficiency, as well as renewable energy generation, to meet the stated goal.

The Long-Range Energy Alternative Planning-System (LEAP) is a model the Vermont Energy Investment Corporation (VEIC) used to identify pathways to achieve the 90x50 goal. VEIC was retained by the Vermont Department of Public Service to model scenarios for those pathways for use by the state, the regional planning commissions, and municipalities. The model is driven by assumptions discussed in the Total Energy Study (TES)[12] using their TREES scenario (Total Renewable Energy Efficiency Standard). The TREES Scenario accounted for policies requiring energy distributors to source an escalating percentage of their supply from renewable resources over time. The LEAP model was run with two scenarios to illustrate the pathways to 2050. The first is the "Reference Scenario," which assumes business as usual not accounting for current state policy and goals, on reducing greenhouse gas emissions and renewable energy consumption. The second is the "90x2050 VEIC Scenario," which illustrates the changes needed in consumption from 2015 to 2050 in order to achieve the 90x50 goal. For more discussion on the LEAP model assumptions, see Appendix F: VEIC's entire LEAP model discussion, on page 108.

At the state and regional levels, energy demand is depicted as decreasing substantially by the year 2050. Figure 13 on the following page illustrates total state consumption by the sectors: residential, commercial, industrial, and transportation (note these are different sectors than the three sectors this plan studies: electric, transportation, and heating). The Reference Scenario is the upper curve of the gray barred area. This space illustrates the difference between the energy consumption of the Reference Scenario versus 90x2050 VEIC Scenario. Much of this difference is accounted for by 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.

The Windham Region's energy consumption by fuel type over time, as per the LEAP model, is depicted in Figure 14. 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 energy efficiency technology across all sectors.

---

12 The Total Energy Study can be found in full here: http://publicservice.vermont.gov/publications-resources/publications/total_energy_study.

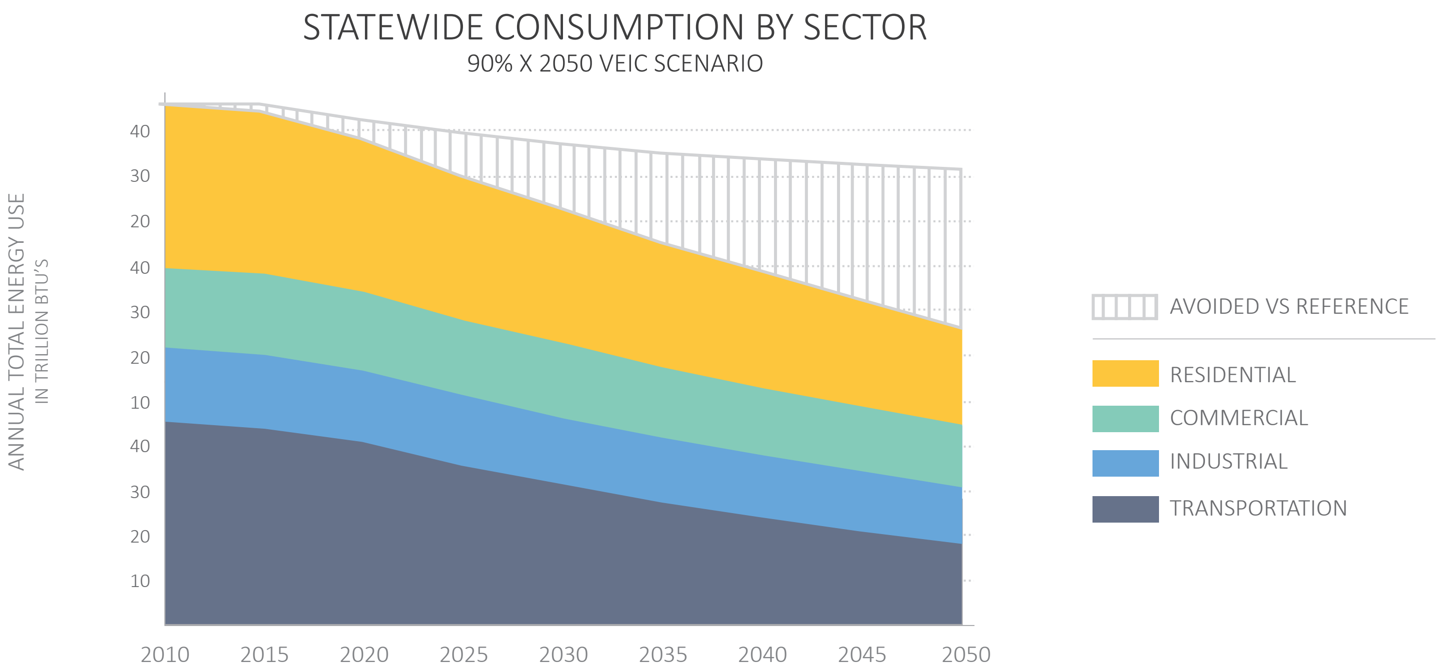


Figure 13: Statewide energy consumption by sector, 90% x 2050 VEIC scenario compared to the reference scenario.

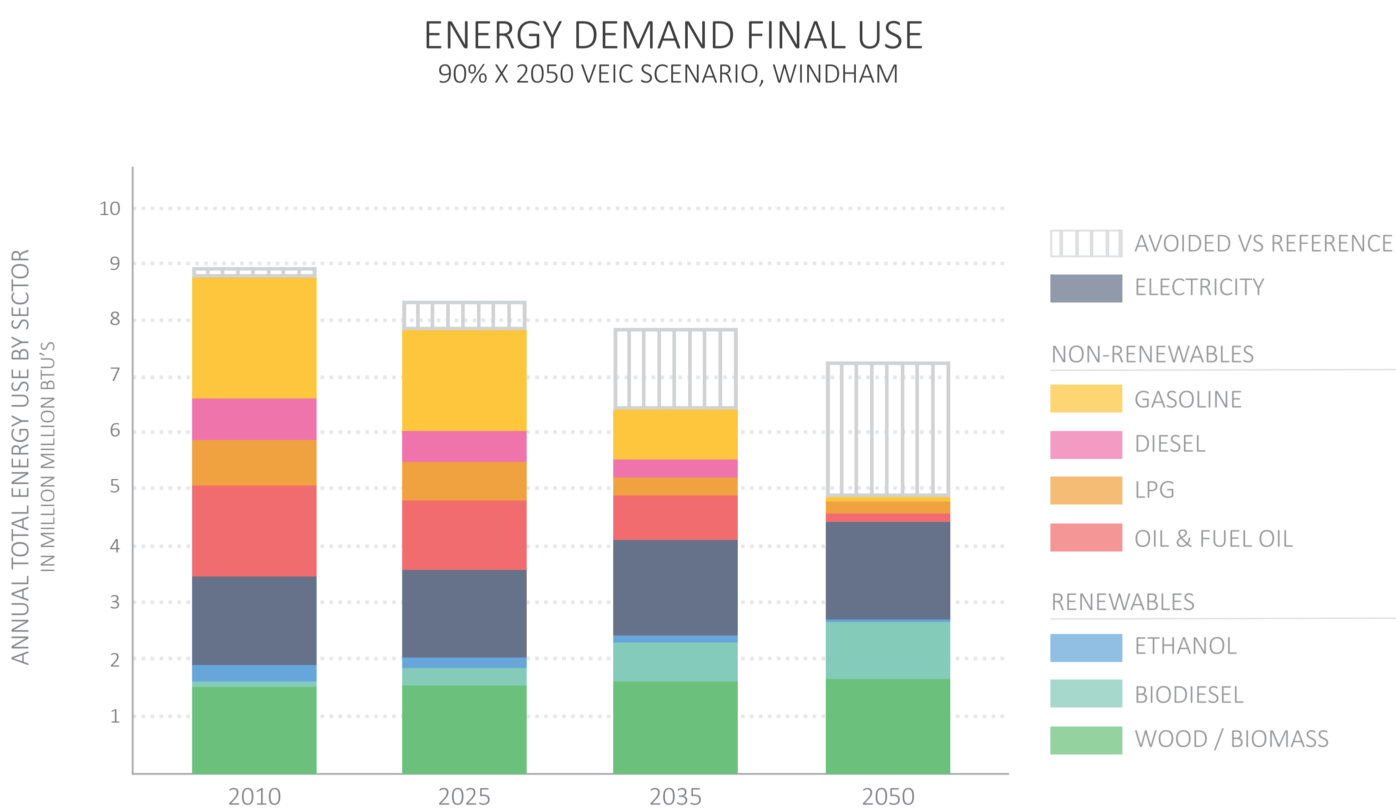


Figure 14: Regional energy consumption by fuel, LEAP scenario.

LEAP Model: Electricity

The electricity sector is where much of the change will occur over time. Despite the near flat rate of electric energy consumption over time depicted in Figure 14, the model assumes electrification of the light duty vehicle fleet (passenger vehicles) will call for a dramatic increase in electricity, along with an assumed electrification of heating and cooling systems. The model also assumes increased efficiency of these technologies over time. In the year 2050, electricity is assumed to be the primary source of fuel for the Region, accounting for almost half of the total fuel consumed.

LEAP Model: Transportation

Transportation currently accounts for approximately a third of the Windham Region's energy consumption. To achieve the goal of 90 x 50, the transportation sector will need to radically transform its fleet efficiency and fuel sources. The model assumes consumption of fuels by the light duty vehicle fleet will drop by 80% from today's estimates and the makeup of the energy mix will change from predominantly gasoline to electricity. Figure 15 below illustrates the change over time in the transportation sector. The LEAP model separated light duty vehicles and heavy duty vehicles and applied separate fuel switching assumptions in the data. The notable increase in biodiesel is driven by the assumption that the heavy duty fleet will convert from diesel to biodiesel, though biodiesel consumption in light duty vehicles is expected to rise as well.

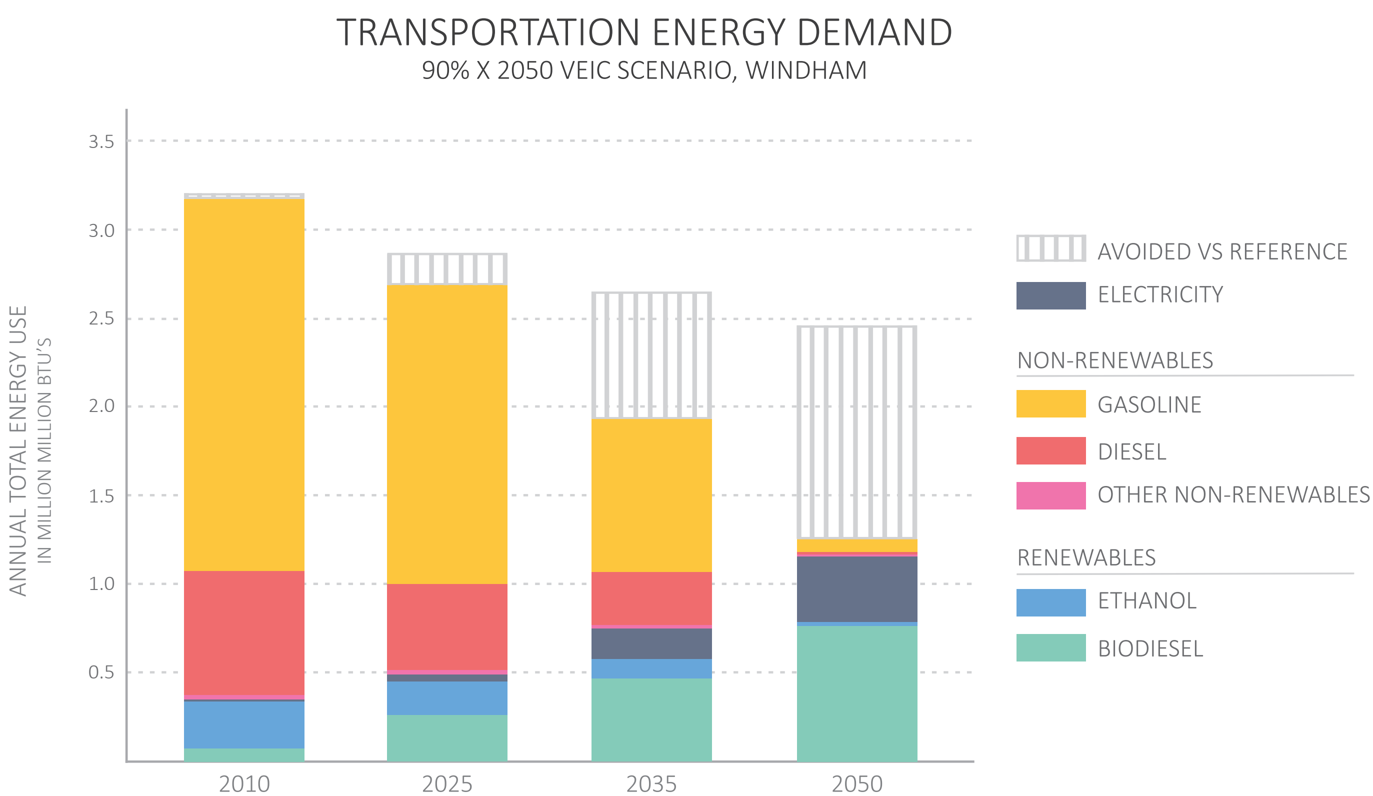


Figure 15: Regional transportation energy consumption by fuel, LEAP scenario.

LEAP Model: Heating

Today, the heating sector consumes approximately one third of the energy in the region. Over 41 million dollars are spent on meeting home heating needs within the Windham Region. The LEAP model shows a dramatic decrease in home heating consumption between 2015 and 2050. In Figure 16 below, the Reference Scenario is accounted for on the upper limit of the lined bar. Comparing the Reference Scenario to the 90 x 2050 VEIC Scenario, both assume decreased consumption over time. The decrease in consumption reflects the Total Energy Study's assumptions that underlie the Reference Scenario accounting for more houses heating with heat pump technology and wood pellet systems. They also account for assumed technological advances in the efficiency of the heat pumps and increased weatherization and building envelope efficiency work. Collectively these assumptions account for the negative trend in the Reference Scenario graph in Figure 16.

Underlying the negative trend in the data for the 90 x 2050 VEIC Scenario are many of the same assumptions. In Figure 16, a notable trend in the graph is that almost none of the fuels seem to increase in volume by 2050. Some, such as wood pellets and cord wood, decrease. This is where efficiency plays into the equation. 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 (houses) overall.

Second Homes Heating Demand

Approximately one third of the housing stock in the Windham Region is second homes[13] (see Table 1 on page 20 of this Plan). The model accounts for second home energy consumption by assuming that these homes use 15% of the heating fuel used by a single family home.

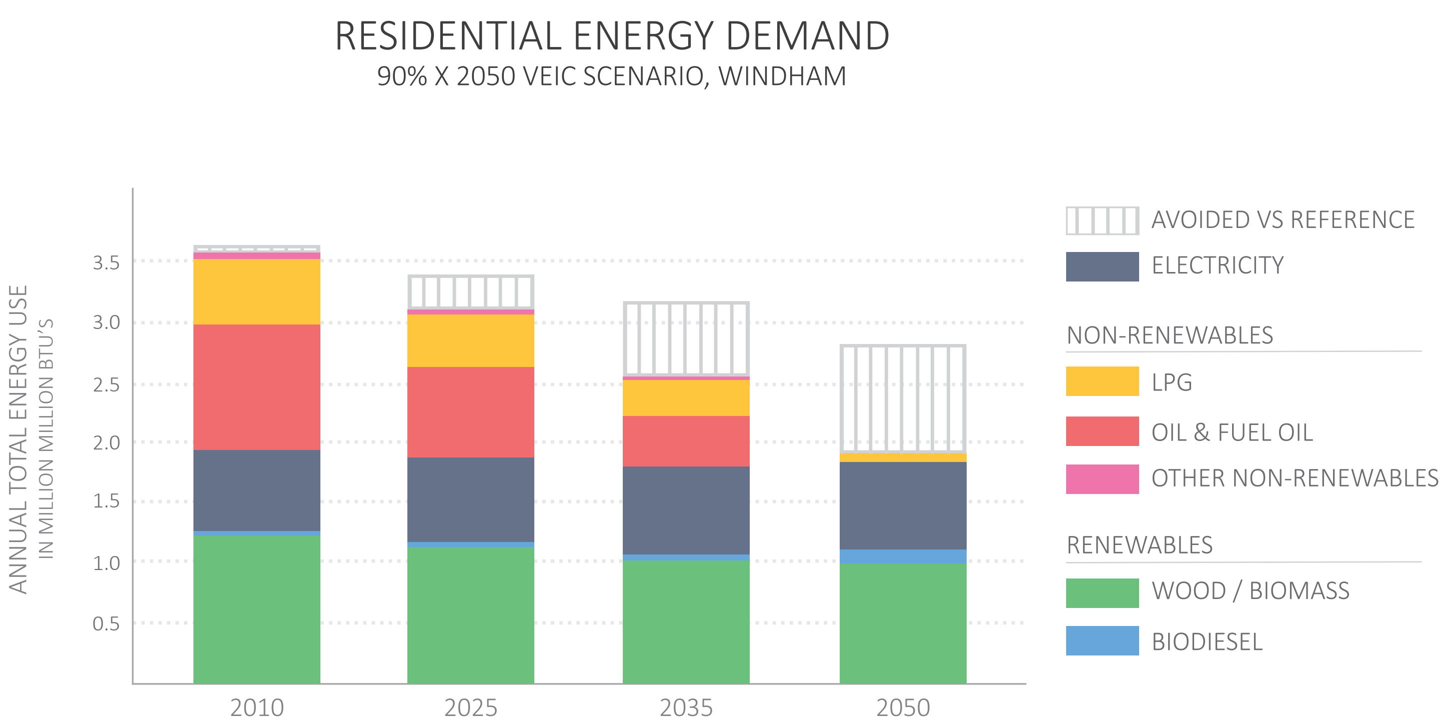


Figure 16: Regional residential heat energy consumption by fuel. LEAP scenario.

13 Windham Regional Plan, 2014.

LEAP Model: Commercial and Industrial

The model assumes that the least amount of change in energy consumption and fuel mix is within the commercial and industrial sectors. This is due to 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 Reference Scenario and with the 90 x 2050 Scenario. There are, however, two noticeable trend assumptions underlying the fuel mix ratio: that electricity consumption decreases substantially over time, and

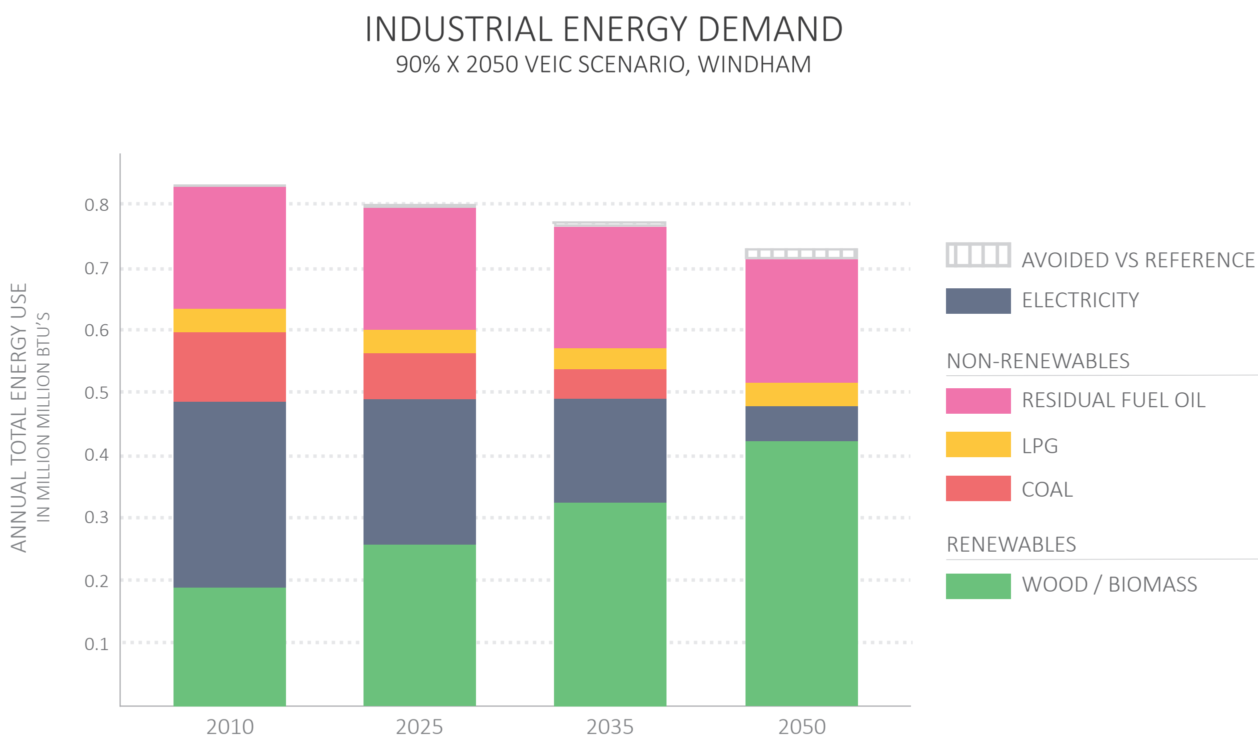


Figure 17: Regional industrial consumption by fuel, LEAP scenario.

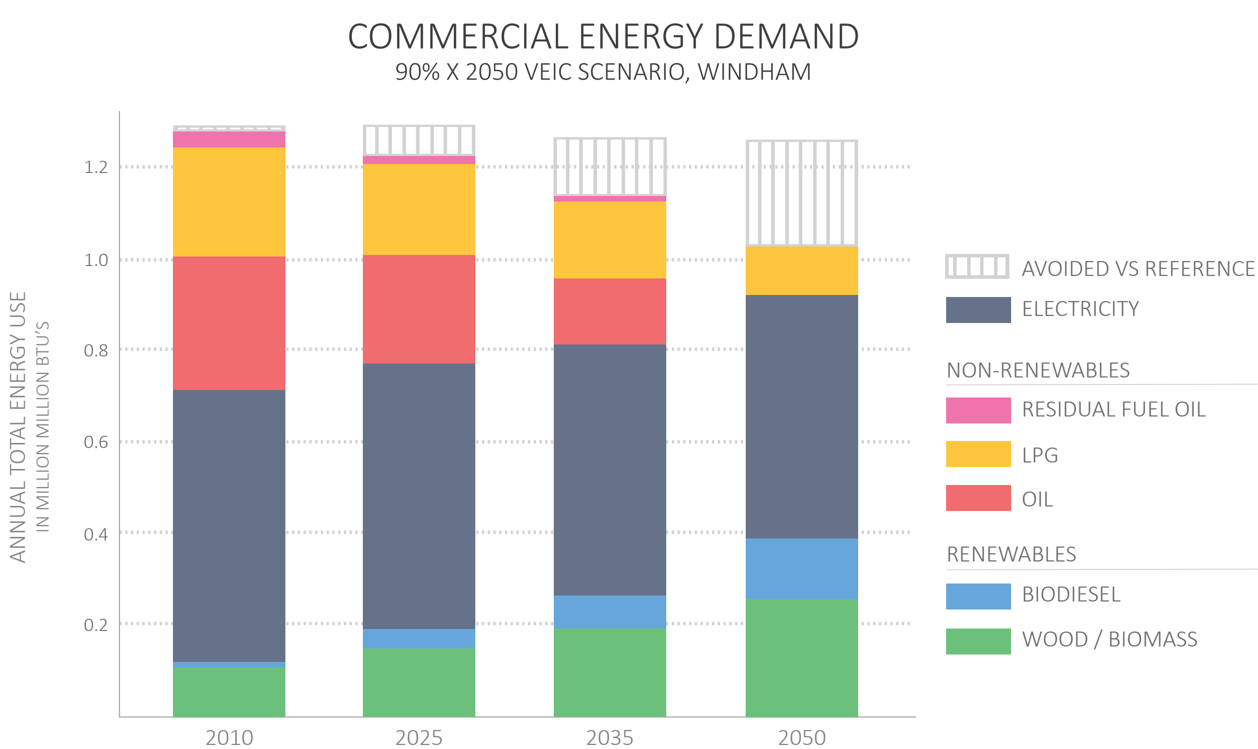


Figure 18: Regional commercial consumption by fuel, LEAP scenario.

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 derived directly from the Total Energy Study.[14]

Commercial Energy Demand portrayed in Figure 18 also varies little between the Reference and 90x2050 Scenarios. However, the 90 x 2050 scenario does assume that residual fuel oil and oil are replaced by an increase in wood chips and biodiesel, and that overall energy consumption decreases by 20%. The sector itself is assumed to grow over time, accounting for only a moderate decline in total energy consumption.

REGIONAL TARGETS

The previously discussed LEAP projections and following targets illustrate one possible pathway to meet the 90x50 state goal. Though the actual pathway is likely to divert from what is depicted in the above graphs, the model allows for the Region to plan for the upcoming years with targets in conservation and efficiency and energy generation. Because the model and underlying assumptions are being used statewide by all regional planning commissions, each regional energy plan is being built upon a common understanding intended to both meet the goals of the current CEP and inform future iterations of the CEP.

CONSERVATION AND EFFICIENCY TARGETS ACROSS THE SECTORS

The following discussion references specific data for energy efficiency and fuel conversion targets, developed for the Windham Region by the aforementioned LEAP model. Specific charts outlining the weatherization goals, fuel switching for the portion of biofuels in biofuel-blend fuels, the percentage of residences using biofuels, the percentage of residences using wood, the percentage of residences using heat pumps, and the percentage of residences using fossil fuels per benchmark year can be found in Appendix E: Regional Efficiency and Fuel Switching Targets, on page 104.

Thermal/Heating Targets

As discussed in the Current Energy Use section, the heating sector accounts for a large portion of the Region's energy consumption budget. For the 90x50 goal to be attainable, efficiency must be actively pursued. Based on the outputs of the LEAP model and calculation guidance from the Department of Public Service, the Windham Region has ambitious goals in weatherization and switching to renewable heating fuels. Using the LEAP model projected population growth of 0.34%, very little increase to the housing stock is assumed.

The weatherization process upgrades building envelopes to become more energy efficient so as to retain interior temperatures rather than leak heated or cooled/conditioned air through leaking roofs, doors, windows, as well as walls. Much of the housing stock in the Region does not meet a high standard of efficiency because of its age. Out of the residential buildings that are primary residences, the targets for weatherization span from 24% by 2025 to 94% by 2050 (see Table 1, page 104). This equates to 19,254 of primary residences weatherized by 2050. As approximately a third of the housing stock is "vacant housing units" this number will be just under 67% of the total housing in the Region. We will note here that the funding and necessary organizational partnerships to make this target possible do not yet exist, though

14 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, the Region will see an increase in use of natural gas.

programs such as the NeighborWorks Heat Squad do provide a model.[15]

The targets for the weatherization of commercial buildings are comparatively low in percentage of total buildings weatherized. In 2025, 4% of buildings are targeted to be weatherized and that percentage climbs to 12% in 2050 (Table 2). These targets represent a higher number of actual buildings, as the number of commercial buildings is anticipated to grow by 17% by 2050.

Though weatherization has a significant impact on building and fuel use efficiency, the fuel types used in these buildings will need to switch to more renewable sources in order to meet our goals. The LEAP scenarios discussed in the beginning of this chapter illustrate the extent to which the fuel sources in these buildings are anticipated to shift. The targets for residential buildings and commercial buildings are analyzed separately because of the significant difference in both building use and architectural style.

For residential fuel switching targets (to a higher percentage of renewable fuels), there is a decrease in the total percentage of homes heated with biofuel blend over time (from 40% in 2025 to 6% in 2050) despite the portion of biofuels in biofuel blend increasing from 4% to 100% in those years (Tables 3 and 4 respectively, page 104). With the same assumptions, the percentage of residences heated by wood remains relatively level, increasing by only 2 percentage points (from 55% to 57%, Table 5).

Homes targeted to heat exclusively with heat pumps reaches 64% by 2050 (Table 6). In order for heat pumps to work efficiently, the building envelope must be entirely upgraded. With this high percentage of residences heating with heat pumps, the ambitious targets for weatherization are necessary, even if the means and funding by which to achieve these targets are not readily apparent. With these fuel switching targets, the percentage of residences using fossil fuels for heating and cooling falls to 4% by year 2050 (Table 7).

Similar to weatherization, the commercial fuel switching targets are less ambitious than those for residences. With commercial heating and cooling, biofuel blend is used as a transition fuel starting with high use percentages, then tapering off by 2050 (Table 8). The percentage of buildings converting to heat pumps exclusively mirrors the weatherization targets with the 2050 target amounting to only 12% (Table 11). More commercial buildings will be converting to wood to meet their thermal needs (Table 10), and the overall percentage of commercial buildings using fossil fuels for heat is targeted to drop from 17% in 2025 to 8% in 2050 (Table 12).

Transportation Targets

LEAP assumes the light duty vehicle fleet (passenger vehicles) will transform substantially by 2050. By 2050 the Region's fleet is targeted to be 76% electric, and 8% fueled by biofuel-blend. With light duty vehicles (LDV) as was with commercial heating, the transition fuel is biofuel blend. By 2025, 90% of LDV are targeted to be fueled by this blend (Table 15). As the benchmark years progress, that percentage tapers off to only 8% by 2050, despite the concentration of biofuels within that blend rising from 11% to 52% by the same year (Table 14).

The WRC does not consider ethanol to be a truly renewable source of energy because of the amount of non-renewable materials currently consumed by its production, though it is considered as such within the LEAP assumptions. In the LEAP Model assumptions, the heavy duty vehicle fleet is assumed to switch almost entirely from diesel to biodiesel by 2050.

15 For more information about the NeighborWorks Heat Squad see https://heatsquad.org/.

Electricity Targets

In these targets, electricity cannot be neatly separated out as its own category. For instance, transportation and heating rely heavily on an increase in electricity as a fuel source. The targets within these sectors focus on the savings from energy efficiency in appliances and equipment. Based on an average savings per residence, the Region has ambitious targets to meet with 96% of residences upgrading their electric appliances and equipment by 2050 (Table 16). This equates to a total regional savings of 98,000 MWh of electricity. This mirrors the weatherization targets previously discussed. We note that these goals in efficiencies are incredibly ambitious. The funding and programs to support this level of efficiency upgrades are not robust enough at this time. Organizations like Efficiency Vermont work towards these targets; however, more support will be necessary to reach these targets.

ENERGY GENERATION TARGETS

The Windham Region has long been home to energy projects. European settlement of the state was largely organized around the ability to harness water power for industry. Hydropower was developed in the early 1900s on the Connecticut and Deerfield Rivers. The 620-megawatt Vermont Yankee Nuclear Power Station located in Vernon began operation in 1972 and ceased operation in 2014. This plant was a significant source of earned income and employment for the Region and is now the focus of decommissioning, site restoration, and spent fuel and high-level nuclear waste storage discussions.

The Region is now a leader in diverse renewable energy generation, with:

- 531 solar sites generating 11,071,442 kWh,
- 13 installed and active wind sites generating 128,773 kWh (several more sites are permitted and currently under construction– discussed below),
- 2 anaerobic digesters generating 2,706,840 kWh,
- 1 landfill site generating 3,679,200 kWh, and
- major hydropower facilities on the Connecticut and Deerfield Rivers (and smaller facilities elsewhere), produce 549,405,000 kWh.

The Windham Region currently has 36.06 mega-watt (MW) capacity of permitted wind projects, and 15.70 MW of installed solar capacity. This includes a number of large-scale projects permitted and being developed in the area, notably the Deerfield Wind Project (at 30 MW capacity). The Region currently generates 566,991,255 kWh of electricity. To see energy generation data by municipality, see Appendix D: Energy Data for Windham Region Municipalities, page 72. In order to achieve the 90x50 goal, a targeted total for the Region is 58,493MWh, or 45 MW capacity needed in new renewable energy generation. This generation target can be met with a variety of different technologies, though solar and wind generation have the highest capacity in both the Region and State. Although local energy generation siting concerns are real and are addressed below, the environmental impacts of obtaining electricity from wind turbines on a Vermont ridgeline or from solar panels along a Vermont roadway should be considered in the context of the impacts of strip mining, wholesale removal of mountains, hydraulic fracturing, nuclear waste, oil spills, and devastating climate impacts.

However, as will be discussed below, the Windham Regional Commission is adopting a policy that restricts additional utility-scale wind energy generation in Resource Lands (see land use policy definition on page 34), and that the new capacity be developed through primarily solar generation and appropriately scaled biomass generation (digesters and combined heat-power generators as well as wood fuel production), small hydro (run-of-river facilities on existing safe and stable dams), and residential- or community-serving (owned by municipality with generated credits allocated to community buildings) wind.

Generation Capacity and Regional Resources

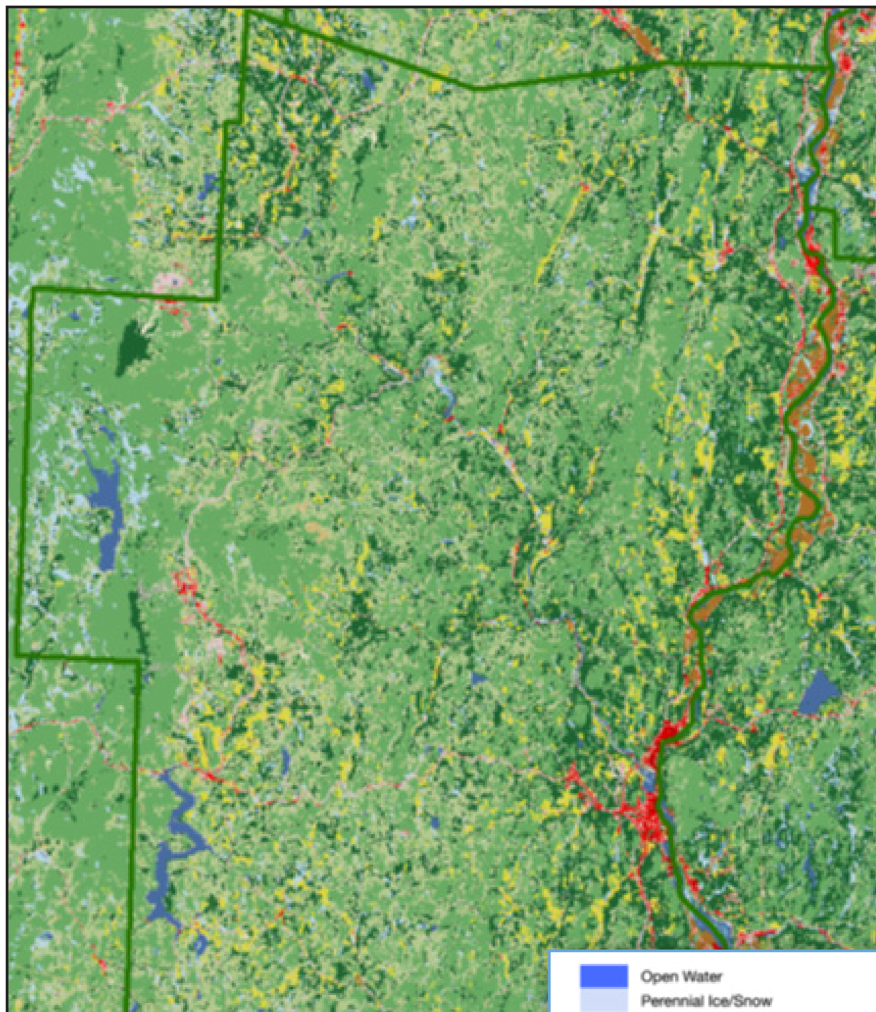
Table 2 below shows the calculated statewide capacity of new renewable energy technologies aside from wind and solar. The table represents the capacity of new units (not yet installed or permitted) across the state and highlights the megawatt hours the technologies are capable of producing, given the average installation size. As our Region has a goal of 45 MW of new renewable energy to generate, these technologies will likely be only a limited portion of the renewable energy portfolio by 2050.

Farm Digesters:	20 to 25 MW	capable of producing:	125,000 to 150,000 MWh per year
Food Digesters:	2 to 5 MW	capable of producing:	5,000 to 25,000 MWh per year
Small Hydro:	100 to 200 MW	capable of producing:	400,000 to 900,000 MWh per year
Biomass:	100 to 200 MW	capable of producing:	600,000 to 125,000 MWh per year

Table 2: Average capacity of renewable energy technologies, statewide.

BIOMASS ENERGY

Biomass along with farm and food digesters are different from the other renewable energy generation technologies as the generation capacity is not inextricably linked to the site. Biomass resource is harvested from a location, and then transported to a generation facility.



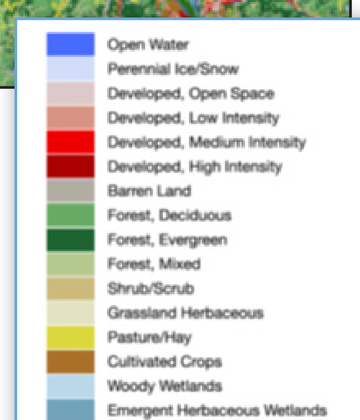


Figure 19: Windham County land cover and forest resources, produced by INRS.

Approximately 516,000 acres (86%) of the Windham Region is forested (see Figure 19). The area'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 forestry operations and Federal, State, and local governments sharing the rest.

The Region is already working on becoming a hub for biomass by tapping into this abundant resource and applying it to the heating sector. The Windham Wood Heat project, funded through the Clean Energy Development Fund, is working with schools, municipalities, and public-serving institutions to convert to advanced wood heating while supporting the local market. The Region will be funneling much of the resource into heat rather than electricity generation though co-generation facilities have begun to contribute to the generation targets. We will continue to work with the forest industry in the area to develop pellet and chip production to reduce dependence upon wood-based fuel brought in from beyond the Region.

Biomass energy generation does produce particulate matter and carbon dioxide emissions. With the advancement of the modern wood heating technologies, both have been substantially addressed as the fuels are burned with high efficiency and smokestacks are designed to address air quality concerns. As it is a combustion fuel, however, the particulate matter is still being addressed and studied. In a study recently conducted for the Northern Forest Center, greenhouse gas emissions were found to be reduced by more than half compared to fossil fuels.[16] This study analyzed the emissions with a life cycle analysis, taking into account new tree growth.

LANDFILL GAS, METHANE DIGESTERS, AND FOOD WASTE DIGESTERS

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 (GMP). The project generates approximately four million kilowatt hours annually.

Methane is also emitted from volatile solids andanimal 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. As of 2017, there are two methane digester facilities in the Windham Region at Westminster Farms, Inc., and the Brattleboro Wastewater Treatment Plant. Pursuant of Act 148, diverting organics from the waste stream, food waste digesters will become more prominent in the energy mix. A feasibility study is being completed for a food waste digester to be sited at the Windham Solid Waste District, which would address the challenge of diverting that waste food on a regional scale.

Green Mountain Power's (GMP) Cow Power™ program has been a deciding factor in a number of farm methane installations in the state. For every kilowatt hour requested by customers and provided by a Vermont farm, GMP will pay the farmer the market price for energy plus the GMP Cow Power™ charge of 4 cents for the environmental benefits of the energy.

HYDROPOWER

It is estimated that following Vermont Yankee's 2014 closure, hydroelectric power accounted for approximately 10.8% of the total energy consumed in Vermont in 2016, equivalent to an estimated 27% share of all renewable energy consumed that same year. As of 2017, the Windham Region had approximately 126 MW of installed hydroelectric capacity, ranking second in the State for installed capacity.[17]

16 Northern Forest Center, *Greenhouse Gas Emissions of Wood Pellet Heat in the Northern Forest.* https://northernforest.org/programs/modern-wood-heat/wood-pellet-greenhouse-gas-emissions-study.
17 Community Energy Dashboard, Statistics for the Windham Region. http://www.vtenergydashboard.org/my-community/windham-regional-commission/statistics.

The major supplier of hydropower for Vermont is Hydro Québec (HQ), a Canadian company. The Public Service Board approved the previous HQ contract in 1990; a 30-year agreement between a group of eight Vermont utilities, known as the Vermont Joint Owners (VJO) to purchase long-term base-load power from HQ and to make it available at wholesale to the rest of Vermont's utilities. 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.[18]

Vermont has 46 utility-owned hydro sites and approximately 35 independently owned hydro sites. In the Windham Region, Great River Hydro (formerly TransCanada) operates hydroelectric stations and associated storage reservoirs and dams on the Connecticut and Deerfield Rivers.[19] 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 32.4 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. Smaller, privately owned facilities also exist around the Region. Two small generators have been installed at the Ball Mountain and Townshend U.S. Army Corps of Engineers flood control dams.

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 their facilities. For some hydro facilities, this has resulted in a 10-20% loss of energy production.[20]

The current licenses for each of the Wilder, Bellows Falls, and the Vernon Hydroelectric Projects (Great River Hydro) and the Turners Falls Hydroelectric Project and Northfield Mountain Pumped Storage Project (FirstLight) are set to expire in April 2018. All projects utilize water from the Connecticut River to generate hydroelectric power. The licenses were issued by the FERC for terms of 30-50 years, and Great River Hydro and FirstLight are seeking re-licensing for these dams using FERC's Integrated Licensing Process (ILP).

According to assessments completed by the State, it is clear that the best hydro-power 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. The Agency of Natural Resources (ANR) has recently approved sites with generation capability as low as 15 kW.[21]

---

19 Transcanada, *Connecticut River and Deerfield River Hydro Facilities.* http://www.transcanada-relicensing.com/wp-content/uploads/2012/10/HydroFacilities1.pdf.

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

21 Vermont Department of Public Service, *Comprehensive Energy Plan 2011.* http://publicservice.vermont.gov/publications/energy_plan.

According to 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.
- 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 ENERGY

Solar has become prominent throughout the Windham Region, with at least 709 installed sites totaling to 9,491.7 kW capacity (the Windham Region ranks fifth in the state for this installed capacity). As discussed above and illustrated in Table 2 (page 29), the capacity for energy generation through sources other than wind and solar are limited. Therefore, the bulk of the generation targets will need to be met by wind or solar as their generation capacity is much greater. As discussed in greater detail below in the Renewable Energy Generation Policy section (page 35), and due to the political climate and local concerns with the impacts of wind turbines, solar energy generation will be the leading energy source to meet the generation targets. This will equal a total of 362,943 MWh, with only 58,493 MWh of that being new installations. Using the methodology outlined by the Bennington County Regional Commission detailed in the 2016 Bennington County Regional Energy Plan, 45% of this capacity can be met with rooftop solar alone, thus preventing any adverse impacts on land-based natural resources (this is based on conservative estimates of commercial and residential rooftop availability).

To meet the Region's generation targets, adequate acreage for solar energy arrays must be planned for. It is estimated that per megawatt of capacity, an eight-acre footprint is needed. This equals 360 acres of new installation acreage, if none of the generation is met by rooftop solar. As no site is perfect (irregular lot shapes, landowner preferences, slopes and azimuth, and adjacent shading), a footprint rate of 60 acres per megawatt is used as the contingency estimate for planning purposes (this figure was created by the VT Department of Public Service, and is based on statewide averages for installation sizes and generation capacity). Therefore, order to prudently reach the generation target, 2,700 acres should be identified as having potential for solar development.

Vermont Center for Geographic Information (VCGI) developed the raw data for Vermont's regional planning commissions to analyze in GIS the land in the respective regions where renewable energy generation would be possible. Two layers of constraints, "known" and "possible," were layered onto the raw solar data (where the sun shines) to portray where energy generation may be possible (see Appendix C: Regional Energy Planning Maps, page 66).

It is crucial to note that these maps developed by the Windham Regional Commission are not energy generation siting maps. They are planning tools for analyzing the generation possibilities in the Region. The WRC did not add any Region-specific constraints beyond those specified in Act 174. Municipalities can add their own local constraints to municipal maps associated with their enhanced energy elements. In a GIS analysis of the Region, given slope and sun exposure, there are 37,043 acres of prime solar land where there is solar generation potential.

While there is 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 that roof-mounted systems, and generally are sited on undeveloped or agricultural land. More recently, there have been concerns about large utility-scale installations being built on land zoned as industrial or commercial use. This is a legitimate concern in the Windham Region, as geography significantly limits the availability of land that is appropriate for such intensive use. This plan defers to the towns to identify preferred sites for solar generation on a local level.

Solar systems are generally benign once installed; however, the Region has relatively little prime agricultural soil. Installations covering large acreage should provide mitigation in the form of retained agricultural soils on site, or conserved agricultural land of equal value elsewhere in the Region. Rooftop array 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 codes.

WIND ENERGY

The Windham Region has 36.06 megawatts (MW) of permitted and/or installed capacity in wind development with the Deerfield Wind Development in Readsboro and Searsburg attributing 30 MW to that total. The GIS analysis of the Windham Region for wind shows there are 40,726 acres of prime land in the Region. This equates to 10,181.5 MW of capacity using the assumption of 4 acres per MW capacity. The generation target equates to 19 MW of installed capacity. Wind energy generation has several advantages over solar. Wind turbines have a more significant amount of "up-time" in terms of generated energy because they have the potential to operate 24 hours a day. Additionally, they are able to produce energy during the winter, when sunlight is less available for solar production. But, because of the need for constant wind speed, commercial-scale wind energy generation facilities generally require areas with elevated topography (where wind speeds are generally higher). Given the topography of the Region, however, much of the wind energy generation potential falls within designated Resource Lands (see Box 1 on the following page for Resource Lands policy definition).

Energy generated from 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 and 3,300 feet, locations in Vermont that tend to have sensitive, thin soils and steep slopes. The windiest areas in the Region are most often on the higher-elevation ridgelines that are sensitive habitats for plants and wildlife, and are the source of the area'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

BOX 1: WRC DEFINITION OF
"RESOURCE LANDS"

- Strongly discourage all development in Resource Lands for purposes other than forestry and agriculture. Any development proposed within critical resource areas shall provide evidence as to why the development cannot be avoided, and shall provide mitigation for natural resources impacted by the development.

- Resource Lands are dominated by lands requiring special protection or consideration due to their uniqueness, irreplaceable or fragile nature, or important ecological function. As a subcategory of Resource Lands, this plan recognizes critical resource areas as key sites that are particularly sensitive and should be given maximum protection.

- Use open space plans and resource protection techniques to protect agriculture, forest, mineral, and Resource Lands from development and fragmentation. Encourage town open space planning and help coordinate those planning efforts through the development of a regional Open Space Plan.

- Resource lands require special protection or consideration due to their uniqueness, irreplaceable or fragile nature, or important ecological function. Resource lands include lands over 2,500 feet in elevation, identified bear travel corridors, areas hosting significant plants, animals, and ecological communities as designated by Vermont's Nongame and Natural Heritage Program, or by federally identified endangered and threatened species, unique and fragile natural areas, riparian areas and their buffers, wetlands, floodplains, shore lands, steep slopes over 25%, and finally, scenic corridors or vistas as identified in town plans. Resource Lands should be preserved and protected to the greatest extent possible. Any development or land use in these areas should be designed to have a minimal impact on natural resources and should include effective mitigation measures that will protect natural resource values. The most appropriate uses for Resource Lands are conservation and management of natural resources and limited, low impact, very low-density rural uses.

fragmentation, erosion, pollution from facility maintenance, turbine noise, and visual flicker.

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 may have generation capacity. 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 renewable energy generation from all sources–solar, wind, hydropower, biomass–is essential. The evolution of storage options may make coordination and integration of renewable energy generation and transmission easier.

RENEWABLE ENERGY GENERATION POLICY

For the development of an Act 174-compliant regional energy plan, the most challenging policy considerations for the Commission are the appropriate mix of renewable energy generation sources to meet the state's 90% renewable energy target by 2050, and the siting of those renewable energy generation facilities. The renewable energy generation target established for the Windham Region is approximately 58,500 megawatt hours.

To meet this energy generation target, this plan supports the development of well-sited renewable energy generation, referring to municipalities to identify specific preferred locations. "Well-sited" encourages the development of energy generation that is compatible with our regional plan land use policies. This would not preclude the development of all wind projects. Community-serving developments (i.e., energy generation scaled to offset a defined community such as a village or town's electrical needs, and which is developed as part of a town energy plan by and for the town or defined area within the town) that is supported by towns could be appropriate, as could residential-scale wind (i.e., a project that would serve an individual residence or business).

Preferred Siting Policy

This plan does not restrict energy development within the Region unless the proposed development is utility-scale in Resource Lands (discussed below). For solar generation, the WRC encourages its member towns to pro-actively identify locally preferred sites within their municipalities.

The state defines preferred sites as a new or existing structure whose primary use is not the generation of electricity or providing support for the placement of equipment that generates electricity; a parking lot canopy over a paved parking lot, provided that the location remains in use as a parking lot; a tract previously developed for a use other than siting a plant, land certified by the Secretary of Natural Resources to be a brownfield site as defined under 10 V.S.A. § 6642; a sanitary landfill as defined in 10 V.S.A. § 6602, provided that the Secretary of Natural Resources certifies that the land constitutes such a landfill and is suitable for the development of the plant; the disturbed portion of a gravel pit, quarry, or similar site for the extraction of a mineral resource.

ENERGY GENERATION POTENTIAL AND WRC LAND USE POLICY

Below are maps that identify where wind and energy generation potential are strongest within the Region. These same maps are provided as attachments, as is a description of what these maps represent and what they do not, in Appendix D on page 72. When these maps are compared to the Proposed Land Use Map of the Windham Regional Plan, the majority of the prime and secondary wind and solar resources fall within areas identified as Resource Lands or Productive Rural Lands.

Discussion of the Experience with Utility-Scale Wind and Solar to Date

Within the Windham Region there has been some site- and project-specific concern with large solar projects. But as a category, utility-scale ridgetop wind energy has been the focus of the most vigorous debate and division. Support for or opposition to utility-scale wind is not uniform within the Region. There seems to be general official town support for, or limited opposition to, utility-scale wind in Readsboro and Searsburg. The recently proposed utility-scale wind development in the towns of Grafton and Windham has been divisive. Windham has taken a clear stance against wind in its town plan. The Grafton plan takes no strong stance one way or the other. Both Grafton and Windham held special votes on the proposed Iberdrola project that would generate approximately 70 MW of electricity. In Grafton the wind project was rejected by a vote of 235 to 158. In Windham, voters rejected the project 181 to 101. Both towns reported voter turnout of greater than 75%. The recent Townshend Planning Commission hearing of their draft Town Plan includes language similar to that in the Windham Town Plan in opposition to wind. These are the more recent developments and debates about which we have knowledge. Overall, we are not aware of towns in the Region that have expressed significant support for utility-scale wind power generation within their respective borders, either as a matter of plan policy or as a formal town position, that has been communicated to the WRC.

As a matter of public opinion and town policy, utility-scale solar power generation has been less controversial. There has been opposition to specific projects where major solar development has been

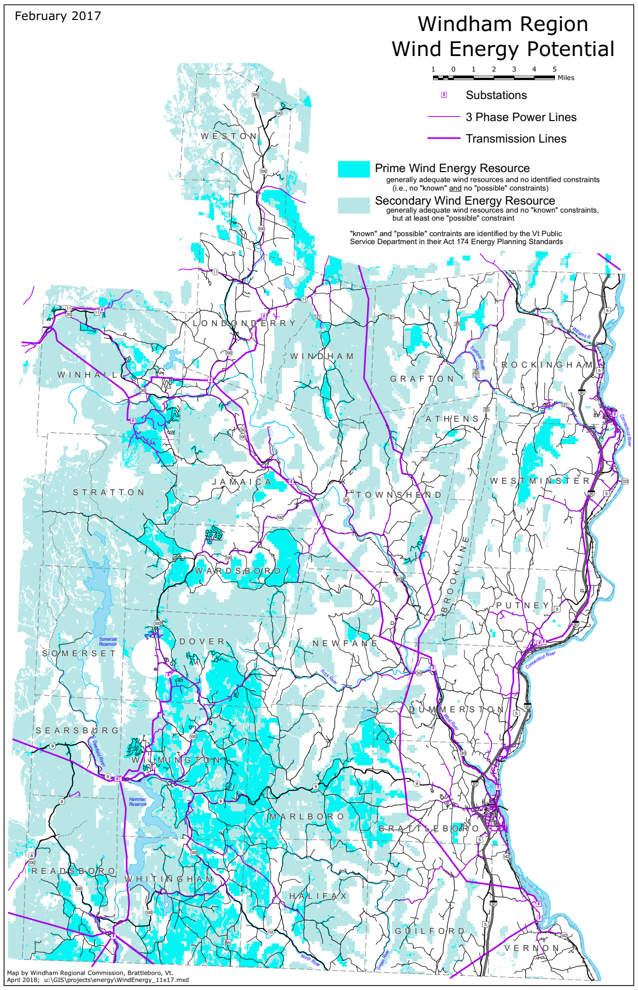


Figure 20: Modeled wind energy potential in the Windham Region.

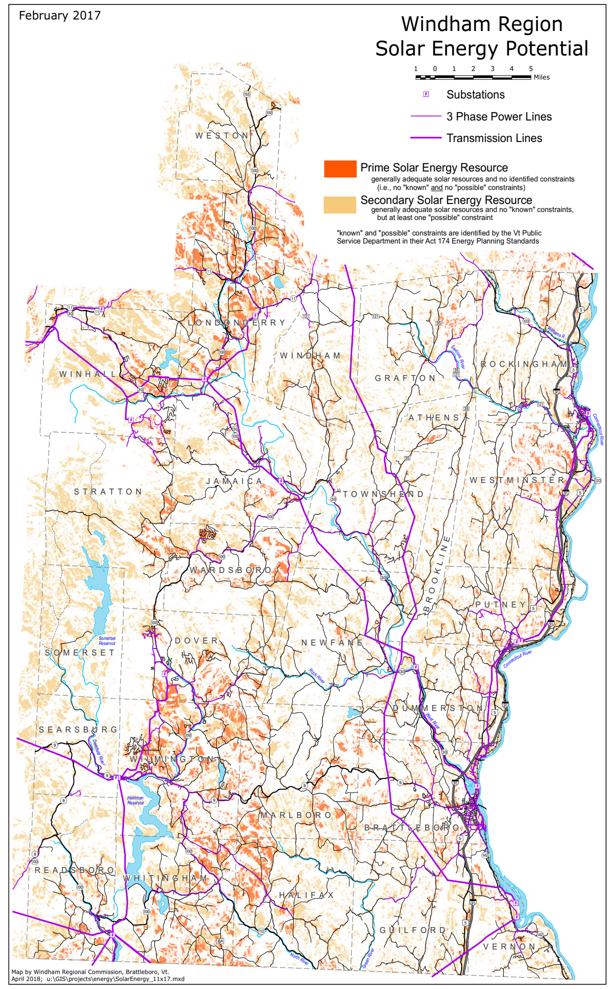


Figure 21: Modeled solar energy potential in the Windham Region.

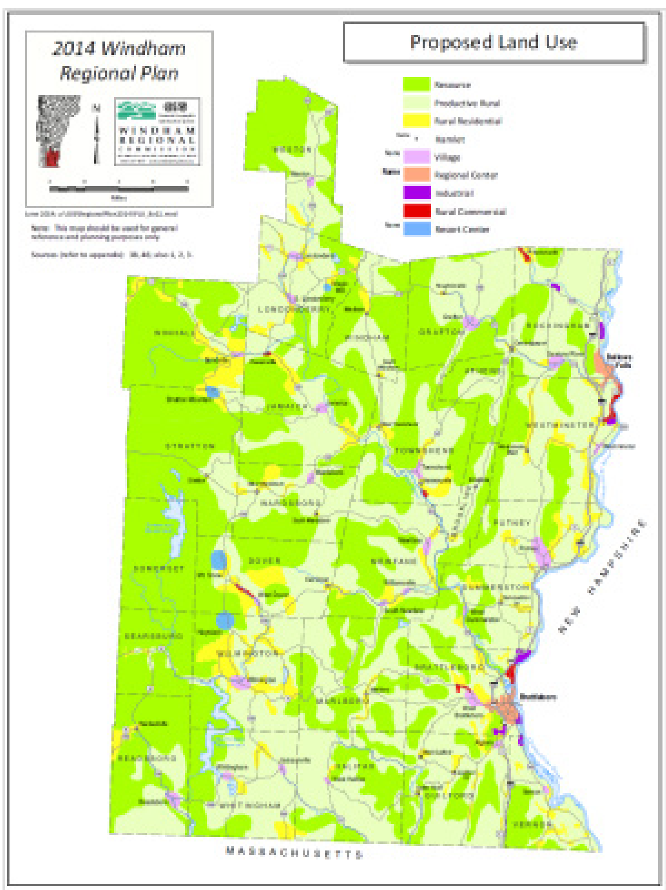


Figure 22: Proposed land use map of the Windham Region, taken from the 2014 Regional Plan.

proposed for and/or built on lands designated for industrial or other commercial development. In these cases land designated as such was limited not only as a matter of policy, but also as a matter of local geography. Solar was felt to be inappropriate as it does not generate jobs or contribute to the tax base as much as commercial or industrial development would. In other cases concern has related to solar installations proposed or built in very close proximity to existing residential development with limited or no screening, impacts to local viewsheds, and proposed development in a mapped floodplain. The WRC Project Review Committee has typically agreed with the town concerns in these cases.

UTILITY-SCALE GENERATION POLICY

Based on the discussion, comments, and engagement thus far in our Act 174 regional energy planning process, experience with the aforementioned projects and project proposals, and what we know about town policy positions, the WRC is adopting the following overarching policy positions regarding renewable energy siting.

As a matter of policy, utility-scale energy generation projects are considered regionally significant, and therefore are subject to the review of the WRC Project Review Committee.

Utility-Scale Wind

The question of the appropriateness of utility-scale wind has been particularly contentious within and among some towns in the Region. Appropriateness in the context of this regional discussion relates to the compatibility of energy generation with the land use goals, objectives, and policies contained in the 2014 Windham Regional Plan, as well as compatibility with adjacent and near-adjacent land uses.

- Most areas within the Region that are identified as being a prime or secondary wind resource fall within Resource Lands identified on the Proposed Land Use map of the Windham Regional Plan. Given the nature of utility-scale wind development, which involves considerable blasting, road building, and other permanent alterations of the landscape and surface hydrology, it is deemed to be incompatible within Resource Lands.

The WRC will revisit its policy position on utility-scale wind when the Regional Plan is next revised (after this revision) to determine if new wind technologies could mitigate problems that currently make it incompatible with land use policies.

Additionally, the WRC recognizes the need to update the Proposed Land Use map as it currently appears in the 2014 Regional Plan. In consultation with its member towns, the WRC will prioritize the update of the Proposed Land Use map and policies with the next update of the Windham Regional Plan.

SCALE DEFINITIONS

Utility-Scale Wind: Turbines with hub heights above 70 meters.

Utility-Scale Solar: Equal to or greater than 500 kW capacity

Utility-Scale Solar

Concern over the appropriateness of solar energy generation installations has generally been site-specific.

- While utility-scale solar may require clearing, its operation is virtually silent and its development impacts are decidedly less permanent. Once constructed, solar may create visual impacts but it does not have the noise, vibration, flicker, or ice-throwing concerns associated with large wind turbines. Solar would also seem to be more easily adaptable to changes in panel technology. In short, solar is a more compatible land use within the context of our overall land use policies and their intent

• Utility-scale solar development should be precluded from Resource Lands unless it can be demonstrated that the development of such would provide beneficial habitat diversity. This would be similar in approach to other strategic clearings created by the U.S. Forest Service or non-governmental organizations (i.e., Ruffed Grouse Society) for upland birds or other species. Such developments should be no greater than 2 acres in size. There may exist some already impacted areas within Resource Lands boundaries that may be suitable for utility-scale solar power development because of their close proximity to existing power lines. These areas would include former quarries and power line corridors themselves where the agricultural and forestry value of the land has already been compromised. In these circumstances, encroachment into non-impacted lands for access roads and other accessory uses shall be avoided or minimized.

• Utility-scale solar development in land use designations other than Resource Lands would be limited only by regional plan policies that apply to all other types of development of lands that fall within this designation. Screening should make use of native trees and shrubs that provide habitat and forage for wildlife. In cases where the area around the panel installations will not be grazed by livestock or otherwise used for agricultural production, solar developments should be planted in native perennials that have a high forage value for native pollinators,[22,23] birds[24] and mammals. In addition to providing habitat, this approach will contribute to the continued building of soils.

• Towns that wish to preclude utility-scale solar development on lands designated by their plans as commercial or industrial, or defined as aesthetically valuable (e.g., scenic corridors or viewsheds), are encouraged to establish policies to that effect, and should direct solar development to lands deemed appropriate as a matter of town policy.

• Utility-scale solar developments should have an escrowed decommissioning fund to ensure they are decommissioned after they permanently cease operation.

Other Energy Generators

• Other types of renewable energy development, such as methane digesters or properly scaled and sited biomass-based generation, specifically combined heat and power projects such as that recently proposed by Allard Lumber for which the WRC awarded a grant, could be appropriate. There may be additional hydropower opportunities as well, but these would likely be small, run-of-river installations that make use of existing dams with sound and viable structural integrity.

---

22 The Gund Institute and Energy Action Network, *Using Solar Arrays to Promote Pollinators*. http://eanvt.org/wp-content/uploads/2017/04/Pollinator-Friendly-Solar-Summary-03-30-17.pdf.

23 Bee Culture, *Can Solar Sites Help Save Bees?* http://www.beeculture.com/can-solar-sites-help-save-bees/.

24 The Audubon Society, *Can Solar Panels Make Good Habitat?* http://www.audubon.org/news/can-solar-plants-make-good-bird-habitat.

PART IV

Adaptation & Strategies

WINDHAM REGION ADAPTATION STRATEGIES AND PATHWAYS

Regional energy planning is both relevant and important. While many energy issues are national or global in reach, land use decisions and the way in which the Region develops has a direct and lasting impact on the types of energy needed and the amount of energy input necessary to sustain the function of that development. The Windham Region can lead by example by increasing the efficiency of the Region's energy dependent systems, analyzing its current energy usage, looking for critical areas of improvement, and supporting local energy options that benefit its communities. A reliable supply of energy is critical to our society and way of life.

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

1. *Greater diversification of energy sources*, in order to reduce dependency on foreign sources and to increase stability in the event of supply interruptions or cost fluctuations;

2. *Reduced environmental impacts*, especially regarding greenhouse gas emissions, other air quality impacts, and subsequent impacts on water quality and other natural resources;[25]

3. *Increased conservation and efficiency* in all energy uses in order to reduce costs and environmental impacts, and to reduce the area's vulnerability to energy disruptions;

4. *Ongoing public education* regarding the Region's energy future and what individuals and towns can do to influence it; and

5. *Enhanced local self-sufficiency* in all public policy areas so that the Region's quality of life will be resilient to potential supply disruptions or significant cost increases.

INTRODUCTION

Energy has become a global commodity and, as we have learned from human-induced climate change, the combustion of hydrocarbons strongly linked with energy consumption has the capacity to alter the planet in profound and potentially irreversible ways. But energy issues can also be on a local scale, and have both positive and negative impacts depending upon how it is explored, developed, transported, and used. State and local governments, businesses, and individuals can best prepare for the future by taking action to diversify energy sources, to improve the efficiency of energy use, to stimulate the use of renewable energy resources, and to implement land use strategies that foster and support sustainable energy.

---

25 Some impacts originate elsewhere, such as acidification and mercury deposition in surface waters from electric power plants to the west of New England, and some locally, such as air impacts of carbon monoxide and soot from gasoline and diesel engines and the inefficient combustion of wood.

Vermont's Comprehensive Energy Plan (CEP) lays out an ambitious task for the state: to source 90% of its energy from renewable resources by 2050 (90x50). In order to attain that goal, Vermont and its regions are faced with a considerable challenge; in order for this goal to be practical, every conservation measure must be considered (see Appendix E: Regional Efficiency and Fuel Switching Targets, page 104). Future iterations of the CEP are to be informed by regional plans and the experience associated with their implementation. The development of policies, the regulatory and non-regulatory implementation of those policies, and candid, unvarnished assessments of the effectiveness of the policies and their implementation at all levels of government will be essential going forward.

There are a series of intermediate goals which being met, work towards the end goal of 90x50:

- Greenhouse gas reduction goals of 50% from 1990 levels by 2028 and 75% by 2050.
- 25% of energy supplied by renewable resources by 2025 (25 x 25).
- Building efficiency of 25% of homes (80,000 units) by 2020.

These progressive goals require more than the siting of renewable energy generation to accomplish. With an assumed increase in population and growth in commercial and industrial sectors, decreasing our total energy consumption to two thirds the consumption of 2015 by 2050 will require substantial shifts across all sectors (transportation, heating, and electricity). Regional planning commissions, as well as municipalities, need to identify what changes they can directly effect, and what changes are primarily aspirational and will require effective advocacy at the household, business, and institutional levels as well as in the realm of local, state, federal, and international policy and policy administration. For instance, regional planning commissions have no final permitting or decision-making authority with regard to the implementation of their policies, but they must be strong advocates for those policies in permitting processes as well as in legislative and policy promulgation discussions.

The Comprehensive Energy Plan lays out a series of strategies to reduce overall energy consumption across the state (see Appendix A: Example Policies from the Department of Public Service, page 52). To have this plan applicable to the Windham Region specifically, the Windham Regional Commission gathered its town-appointed Commissioners, stakeholders from professional fields, volunteer organizations, town committee members, and managers and administrators to discuss and explore energy saving measures in our Region in three broad policy areas: land use, transportation, and conservation and efficiency (Appendix B: Adopted Windham Regional Goals and Policies, page 55). These three policy areas are drivers and indicators of energy consumption and bring the conversation to a more comprehensive perspective than focusing solely on technologies.

The challenges the Windham Region faces with energy consumption relate to each policy area and sector of energy. Because of the rural nature of Vermont and the Windham Region, efficiency in transportation is a seemingly insurmountable obstacle. Personal vehicles have expanded the range of what is considered local. Land use patterns, though traditionally more centered on compact settlements leaving the rest of the land to agriculture, have developed into more dispersed, linear patterns. Some choose to live beyond the "compact settlements" of our downtowns and villages because of preferences related to living in the countryside. But a major challenge we face when it comes to concentrating development in and around these compact settlements is the absence, in many cases, of municipal or community water and wastewater infrastructure to support that settlement pattern. Indeed, in many villages the small lot sizes and septic system "shadows" would preclude the development of any additional dwelling units, as well as the modification or expansion of commercial operations. Conservation and efficiency face challenges in technological advances, affordability, and education. Through the stakeholder discussions, strategies to address these challenges were discovered and resulted in a wealth of innovative ideas and implementable action steps (listed in the "Implementation Steps" section below, page 48).

ENERGY EFFICIENCY AND CONSERVATION STRATEGIES

Introduction

In discussing strategies for the Region, several themes recurred across all the policy areas (land use, transportation, and conservation and efficiency). These recurring themes are important as they can inform broad-brush policies which could target large impact change across the sectors. These cross-sectional themes are as follows:

- The positive correlation between low density settlements and increased energy consumption.
- The regional infrastructural limitations to compact settlements.
- The role zoning could have on restricting impacts across the sectors.
- The need for increased dependency on shared transportation.
- The need for advances in efficiency technologies to meet the demand and affordability of the Region.
- The importance of education and knowledge sharing while moving towards the long-term goals.

Policies which reflect these needs and target these challenges will have the greatest impact on lowering overall energy consumption as they touch on all of the sectors. We recognize that while the WRC has a policy, leadership, and advocacy role to play associated with each of these themes, it is at the town and state permitting levels where the final decisions get made.

Education was the theme which came up consistently and held the most importance among the stakeholders. As the 90x50 is a long-term goal with challenges and opportunities across all sectors, it is important to share strategies and success stories across the Region between professionals, town officials, and volunteers and also equally (if not more so) as important to include schools and students. Not only will this instill the knowledge of the importance of becoming more energy independent, but the students and schools act as another means of information dispersal by becoming vectors from their hubs (the schools) into their homes and communities.

Each subject area had themes, policies, and implementation steps towards reducing energy consumption in innovative ways. Below, each subject area is highlighted with solutions and strategies discussed. The implementation steps, policies, and action steps are compiled into one list following this strategy discussion section.

LAND USE STRATEGIES

Land use is an important driver and indicator of energy consumption. The two are inextricably related; therefore addressing challenges in land use can result in lowering energy consumption. From beginning the discussion on a broader scale, it's important to explore the question "how do we interact with the land and what impacts or implications does that have?" This section addresses this question through discussion on settlement patterns, community design, zoning, natural habitat health, and the food and agriculture sectors.

As discussed briefly above, dispersed settlement patterns typically result in higher energy consumption, especially when mobility is dependent upon driving. This is due to the lack of efficiency in space, inability for efficient heating distribution, increased energy input to deliver essential services to businesses and residents, and a lack of shared modes of transportation. For future development, a policy of the Region is to encourage infill and compact growth ("smart growth"). However, it is important to note the juxtaposition of stressing a need for compact settlement patterns while being prohibitively limited in municipal facilities for water and sewer. In acknowledgment of this challenge, the stakeholders discussed living machines to treat gray water, constructed wetlands, composting toilets, and nutrient recapturing programs as alternate strategies to this challenge while citing work already being done in the Region by organizations such as the Rich Earth Institute.

Municipal infrastructure was not the only challenge to compact settlement discussed. Discussants felt there is a pervasive ideology amongst Vermont residents to prefer living in isolation, off the land, or secluded from the bustle of society. How can compact settlement patterns become more attractive for residents (and second home owners)? The opportunity lies in design and downtown revitalization. With settlements and downtowns that have thriving mixed use buildings, residents have to travel less to reach amenities (targeting transportation consumption) and also reap the benefits from strong communities while leaving space outside the centers for agriculture, open space, forestry, diverse habitats, and recreation. These communities, in order to cater to those pursuing a more classically rural lifestyle, also pose an opportunity for innovative design of space. With the designed sense of space mirroring that which one would achieve in a more isolated area but with immediate access to amenities and community, compact settlements have the ability to be attractive.

It is a noted trend that the population gravitating to more rural living is reversing as millennials, and increasingly retirees, are choosing to live in closer proximity to amenities. With this general movement, implementing compact settlements may become more achievable over time especially with thriving, mixed use centers.

Zoning is a powerful land use tool that can be employed by towns. Zoning is the regulatory tool by which towns can directly implement their plan policies. In the absence of zoning, towns must rely on the decisions of District Environmental Commissions for projects which fall within the purview of Act 250 (land use) and Section 248 (energy). Strategies for decreasing energy consumption using zoning include: zoning development for more compact settlements and zoning regulations on buildings that enforce a standard of energy efficiency (LED light bulbs, weatherization, passive solar, low flow, composting, and/or urine diverting toilets, etc.).

Though these strategies have thus far targeted reducing the Region's overall energy consumption, it is important to explore how an increased amount of renewable energy generation within the Region will impact the natural communities. Can renewable energy generation sites encourage a diverse range of habitats? Windham Region, though rich in its forestry resources with 86% of the land forested, is lacking in a diversity of habitats. Though generally viewed as a limiting factor to habitat encouragement now, solar fields could serve as a tool in addressing this need. Encouraging biodiversity within the natural communities of solar fields can support a variety of species and ecosystems, while also fostering the health of the soil, thus bringing an added benefit of increased carbon sequestration. This stacking of the land function encourages efficiency in land use as well as the general health of the land. Solar installations also have the potential to provide farmers with a means by which to generate ongoing income from land that is better suited to not being cropped or grazed, an approach that would combine solar generation

THE RICH EARTH INSTITUTE

Rich Earth Institute engages in research, education, and technological innovation to advance the use of human waste as a resource in order to conserve water, prevent pollution, and sustain soil fertility.

We can support these kinds of local, progressive initiatives to innovate new methods of systemically addressing the materials we use, our energy demand, and how we handle our waste. Collaboration between regional partners, like the WRC and the Rich Earth Institute, can be a model for how regional planners utilize local expertise and knowledge to generate regionally appropriate and novel energy solutions.

with habitat and soil conservation and regeneration benefits of programs such as the Conservation Reserve or Wildlife Habitat Improvement programs.

A large portion of energy consumption can be attributed to the food sector. Although not broken out specifically in the current use data discussion, the food system in the United States and Vermont is remarkably energy dependent. The food system depends on high energy inputs from fertilizers, from fuel to run machinery, to energy to process and package the products, to transportation to ship the food from place to place often from far-flung locations. Though Vermont is ahead of the curve in comparison with other areas in the country, seasonality and financial challenges have become roadblocks to local food production and consumption. The stakeholders identified these two areas of agriculture to focus on to support increased efficiencies in the food system.

With Vermont's distinct seasons, agriculture production is generally confined to nature's timeline. Season extension means the lengthening of that constrained timeline by using technologies like greenhouses to extend the season, beginning earlier in the spring and extending later into the fall. By increasing the land's ability to produce longer, the Region would be able to glean more local food for a greater portion of the year, thereby decreasing food miles for imported products.

Agriculture in the Region has been shifting over the years. Following a statewide trend, the number of dairy farms has significantly decreased and, more recently, the farms have transitioned to smaller diversified agriculture. Stakeholders identified local agriculture as key to addressing inefficiencies in the food sector, as it supports the local economy as well as reducing energy inputs into product transportation. Local agriculture takes the market support off of globally sourced products and funnels it into farms within a certain radius. Putting an emphasis on more locally produced food and consumption dramatically cuts the fuel input used to transport the product from production to the plate. The Farm to Plate Initiative in Vermont focuses on planning for and supporting this connection. We also recognize, however, that local producers are somewhat dependent upon sales beyond the local region. The goal should be a food system that is more energy efficient in all aspects, and which promotes stewardship of the land and a decent living for all of those who work it.

VERMONT'S LOCAL FOOD MOVEMENT

Farm to Plate is Vermont's food system plan being implemented statewide to increase economic development and jobs in the farm and food sector, and improve access to healthy local food for all Vermonters.

Additionally, more local projects, like Windham Region-based **Food Connects**, can provide the area with food supply solutions that are unique and appropriate for the Region. Food Connects is a local food hub that is working to re-envision our food system. They provide the connection between local farms and area schools, hospitals, restaurants, workplaces, and elder care centers, thus making local food accessible to a diversity of populations.

Organizations and initiatives like these aim to improve the quality of life of our community via healthy food, but they also reduce our overall energy demand by supporting local and often organic farms.

TRANSPORTATION STRATEGIES

Transportation, closely tied to land use, is a challenge rural communities face with energy consumption. The Windham Region is not unique in having a rural development pattern in which personal transportation is regarded as a necessity. There is a lack of capacity for practical and dependable shared transportation: seasonal changes pose challenges to all types of transportation, the majority of roads are designed for automobiles exclusively, broadband internet access is not reliable in many areas eliminating the possibility of telecommuting (which would still not resolve demand for other non-work related trips), and the convenience of controlling one's own commuting schedule and other travel demands is highly valued.

The Windham Region spends approximately $57 million on fuel alone and as the vast majority of the fleet is powered conventionally, these funds are getting channeled directly out of the Region and State. In order to achieve the 90x50 goal, the light duty fleet is assumed to convert to electric vehicles while, simultaneously, a decrease in single occupancy vehicles is necessary. This plan recognizes the financial barrier in the assumption to convert the fleet to electricity. As electric vehicles have become increasingly more affordable with increased demand, the state assumes the continuation of the trajectory to make the conversion more viable.

As discussed in the land use portion above, Vermont's as well as Windham Region's settlement patterns are low density and dispersed. Of the 27 towns, there are two regional centers within the Region drawing most of the local traffic within their spheres of influence due to the amenities available there. With few hubs of population confluence, public transportation efficacy is challenged. Though the Region does have several bus services and a train, the schedules are restrictive and not all communities have access to them, leaving them underutilized.

Reducing the rate of growth in energy consumption for transportation, our primary energy use, will also have positive economic and environmental effects. The relationship between the use of transportation resources on one hand, and land use decisions and subsequent development patterns on the other, are undeniable, yet trends over time have tended toward less efficiency. Sprawl, discussed in the Land Use section of this plan, is scattered development that increases traffic, increases pressure on local resources, and consumes open space, turning farms and forests into rural subdivisions that serve cars better than people. The automobile-based American culture has made this possible. To the extent that society has continued to allow and, in some cases, even encourage sprawling development, society is forcing itself and future generations to spend more money and consume more energy for automobile transportation than would otherwise be necessary. Conservation and efficiency measures may present the greatest—and closest to home—new energy "sources," and interact with transportation policies in many ways, including:

- the extent to which people drive private motor vehicles instead of using public transportation or walking or cycling;
- the extent to which people design and develop communities to favor automobiles over other modes of transportation; and
- the extent to which people choose energy-efficient vehicles when driving.

Though addressing these challenges is a daunting task, several strategies are applicable. Working in tandem off the land use policies and strategies above, an increased emphasis on compact settlement patterns and thriving, mixed use downtowns, transportation energy use can decrease substantially because of the opportunities for public transportation, shared transportation options, and walk-ability. But we must also recognize the development that has already occurred, as well as the fact that residential (primary residences) and commercial development has been relatively static in the Region for nearly two decades. As there are 27 towns and existing settlement patterns will continue to be relevant in the years to come, the Region can increase the number of park and rides or satellite parking lots with access to public transportation, car share, bike share, and other shared modes of transportation.

Electric Vehicles

As single occupancy vehicles will continue as a necessity for a portion of the population, creating incentives and encouraging that population to invest in electric vehicles (EVs) is paramount. This can be accomplished by increasing access to charging stations (as the demand for EVs increases with the lowering prices, the market will respond by introducing more charging opportunities) and offering free parking for charging EVs.

Alternative Transportation

Alternative transportation options such as shared transportation (carpooling, public transportation, car share) or active transportation (walking and biking) will becoming increasingly relied upon. These two types of transportation face challenges in today's infrastructure and transportation system which accommodate primarily single occupancy vehicles. These challenges can be addressed by planning for and designing infrastructure which supports these modes.

Shared transportation is a broad term covering carpooling, collectively owned vehicles, car share organizations, bike shares, and others. The website Go! Vermont supports carpooling by providing matches for individuals with similar schedules and destinations. The website is Vermont's agency of Transportation's official site for distributing information on alternative transportation. Boosting the user base, visibility, and accessibility of this site will encourage people to engage in shared transportation. By having shared transportation available and reliable, the commuting population has the option to not invest in a personal vehicle.

> From the website:
>
> "Go Vermont is a resource for Vermonters who want to reduce the cost and environmental impact of driving. We offer free carpool matching and vanpool services, and statewide bus routes, as well as free Go! Vermont resources to help you promote more efficient travel."

Active transportation is one of the easiest ways to reduce energy consumption in the transportation sector. With the only fuel input being human force, the means of transportation is the most fuel efficient, clean, and renewable. The challenge to this mode of transportation is safety concerns. The road systems have traditionally been designed for automobiles rather than alternative transportation modes. By designing complete streets[26] in congested areas and creating bike path and sidewalk connectivity,[27] the safety of these modes of transportation are substantially increased.

Along with increasing the safety of active transportation in planning and design, increasing access to these modes of transportation is critical. Programs like bike shares, rebates for electric assist bikes, and tax deductions for purchasing electric bikes all encourage the use of these modes of transportation.

Seasonality is often viewed as a prohibitive factor to successful alternative transportation. Thriving biking and walking cultures in other areas of the world, however, prove that the true prohibitive factors are the access people have to necessary equipment and the safety and security they feel in using it. By bolstering the strategies already available to our Region, alternative transportation is more of a possibility than commonly viewed. Workplaces can encourage their employees to partake in alternative transportation by having showers available, bargain rates with public transit for employees, bike racks or storage space, and flexible hours, among others.

Another challenge that the transportation sector faces is tourism. The Vermont economy and the economy of the Windham Region depend heavily upon dollars that come in from out of state due to tourists. Although their vehicle miles traveled are not accounted for in the fuel consumption which the

---

26 "Complete Streets: Complete Streets are streets for everyone. They are designed and operated to enable safe access for all users. Pedestrians, bicyclists, motorists, and public transportation users of all ages and abilities are able to safely move along and across a complete street. Complete Streets make it easy to cross the street, walk to shops, and bicycle to work. They allow buses to run on time and make it safe for people to walk to and from train stations." – National Complete Streets Coalition.

27 Bike path and sidewalk connectivity refer to the continuity of bike paths and sidewalks in a transportation corridor. Generally, as bike paths and sidewalks have been added to the road system, the lanes are often not continuous due to the original design of the road.

current use and projected use data were calculated from, it is important to recognize the large contribution the consumption has. The Region has the opportunity to incorporate alternative transportation into part of Vermont's draw, while also considering that many tourism-related businesses are dependent upon the tourism via car model. The evolution of transportation and mobility with energy in mind will require adaptations. With artisanal beer and cheese tours and Vermont's beautiful scenery already drawing flocks of tourists, combining them with bike tours and the Region's flourishing alternative transportation systems offers great potential.

BUILDING EFFICIENCY

Conservation and efficiency are broad topics touching most subject areas, and can be applied to both the land use and transportation sectors. Where these topics intersect, they are discussed in greater detail above. Energy conservation and energy efficiency in buildings remain prime areas for investment to realize significant savings in energy use. The Region should lead by example to increase energy efficiency and to reduce overall energy consumption. Energy efficiency and conservation should be a primary consideration in all development projects, especially with regard to:

- designing and building housing and commercial structures to capture passive heat and light and to use energy more efficiently and conserve it more effectively;
- fostering the development of local and renewable energy sources;
- encouraging federal and state polices that support more local and distributed electricity generation; and
- accepting local and state regulations that would encourage more energy-efficient land use patterns, or that would require more aggressive and longer-range energy planning.

One on the sectors the Regional Energy Plan focuses on is thermal, or heat. Building and zoning codes are tools which can encourage and enforce conservation in buildings. There are many technologies currently circulating which can be applied to new and old buildings to boost their performance.

Heating and cooling systems demand approximately one third of the Region's energy consumption. Much of this climate control is fueled by fossil fuels; however, there are reliable alternatives. Heat pumps which exchange both hot and cold air are powered by electricity. Because the Region is rich with lumber resources, advanced wood heating systems offer both the ability to efficiently heat buildings with renewable energy, but also strengthen the local wood industry while bolstering the economy. With clustered development, district heating is an efficient and effective way to heat multiple buildings. For passive cooling, trees can be strategically planted to block direct sun.

To encourage efficiency in buildings, methods like zoning and fee alleviation are powerful tools. Zoning, in this case, would require design for passive solar heating, low-flow toilets, LED lighting fixtures, among other technologies. As an incentive tool, fees which otherwise would be applied to new structures could be omitted if those structures are net zero.[28]

Though not yet developed to its full capacity, 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 micro-grids. With increased distributive generation, storage and micro-grids bring resilience to communities across both the Region and the State of Vermont.

28 Net zero buildings generate enough renewable energy annually to meet the consumption needs of the building.

IMPLEMENTATION STEPS

Conservation and efficiency are the drivers to achieving the 90x50 goal. In land use, transportation, and heating, action steps and implementable policies will bring about the conservation needed to reach the 90x50 goal.

Below are listed implementation steps, gleaned from the stakeholder discussions in the Windham Region, and distilled from the previous discussion in this section. Appendix A (on page 52) also contains sample policy statements generated by the Vermont Department of Public Service, which are considered applicable to the Windham Region.

1. Promote recognition of and activity with NeighborWorks and Heat Squad activity for Eastern Vermont as technical support for weatherization.

2. Promote programs which support a regional push to perform energy audits for all public buildings.

3. Wave building permit fees for new homes designed for net-zero buildings.

4. Increase education on conservation and efficiency by incorporating the topics into school curricula, including tours of efficient buildings, hands-on conservation projects, and involvement in school building energy conservation measures.

5. Organize regular region-wide knowledge sharing forums where organizations, towns, and individuals can bring strategies, innovations, and information about conservation and efficiency.

6. Prioritize both new construction and buildings as well as old boilers in need of upgrade to convert to renewable heating.

7. Incorporate complete street design into transportation plans.

8. Increase park and rides/satellite parking lots with access to car shares, bike shares, and public transportation.

9. Decrease downtown parking.

10. Increase and improve public transit and amenities.

11. Encourage development by smart growth principle guidelines.

12. Promote the Go!Vermont app as a centralized online space for organizing carpooling.

13. Wave registration fees for electric vehicles.

14. Free parking for EVs at charging stations.

15. Support a carbon tax.

16. Revitalize village downtowns to reduce the need for longer commutes for amenities and work.

17. Incorporate the cost of greenhouse gas emission into product pricing.

18. Establish cover cropping as required agricultural practice (RAP).

19. Conduct regional study (followed by implementation) of where best to add satellite parking lots to bring accessibility of public transportation and shared transportation to the majority of towns.

20. Encourage low-grade lumber industry by increasing local market in modern wood heat.

PART V

Appendix

CONTENTS

APPENDIX A:

Example Policies from Department of Public Service

Below are listed example policies generated by the Department of Public Service. They may or may not prove to fit well with the Windham Region context.

- Coordinate with and promote Energy Efficiency Utility (EEU) programs and the state Weatherization Assistance Program for low-income households and encourage residents to participate.
- Co-sponsor and organize weatherization workshops for homes and businesses with EEUs.
- Identify available electric, natural gas, and deliverable fuel (oil, propane) Energy Efficiency Utility program resources and make web links available on municipal/regional websites.
    - Electric EEU – Efficiency Vermont (statewide) and City of Burlington Electric Department (funded through the electric energy efficiency charge)
    - Natural Gas EEU – Vermont Gas Systems (funded through the natural gas energy efficiency charge)
    - Unregulated Fuels – Thermal Energy and Process Fuel programs
- Work with partner organizations and EEUs to offer workshops and educational opportunities to businesses on efficiency in new construction, retrofits, and conservation practices.
- Identify large energy usage customers (including large businesses, manufacturing facilities, and schools) as a target audience and encourage participation in commercial and industrial EEU programs.
- Facilitate a workshop and/or conduct building walk-throughs for owners of rental housing (including farm labor housing) to encourage implementation of energy efficiency.
- Encourage residents to hire Efficiency Excellence Network (EEN) contractors when completing energy efficiency projects by including links to the EEN on municipal/regional websites.
- Facilitate strategic tree planting to maximize energy benefits.

Promoting Energy Efficient Buildings

- Promote the use of Vermont's residential building energy label/score.
- Promote the use of the residential and commercial building energy standards by distributing code information to permit applicants and ensuring code compliance.
- Promote benchmarking (using the free EPA Portfolio Manager tool and/or with assistance from the EEUs) for commercial buildings.
- Include policies that promote or require residential projects to follow the residential stretch energy code.
- Include policies that require commercial Act 250 projects to follow commercial stretch energy guidelines.

- Promote the construction of net-zero ready buildings by including a discussion of such buildings in the plan and identifying educational opportunities as an implementation action.
- Promote the use of landscaping for energy efficiency.
- Promote the use of cold climate heat pumps with education/presentations in coordination with the EEUs/electric utilities.
- Support the use of ground-source heat pump heating and cooling systems for new construction.
- Identify potential locations for wood-fired district heating. For example, locations with a high concentration of buildings (two or more buildings) with space for a central heat plant and/or where there is a large building that could be an anchor for an district heating system that also supplies heat to neighboring buildings.
- Provide examples of model ordinances related to district heating projects that require access to town and/or state rights-of-way.
- Provide examples of municipal-owned district heating systems including sample documents needed for setting up a district heating service.
- Identify managed forest lands closest to the identified potential district heat locations that could supply wood chips to the project
- Identify regional/town businesses that make, sell, and/or transport wood chips and/or wood pellets that could be used in a district heat system.
- Encourage, promote, and incentivize advanced wood heating by: supporting the conversion of existing fossil fuel heating systems to wood; encouraging local manufacturing of advanced wood heat technology; supporting development of wood fuel delivery infrastructure; supporting development of sustainable forestry and procurement services; expanding wood fuel processing facilities, encouraging bulk wood pellet delivery systems; and providing training and education on the benefits of heating with efficient, clean wood energy systems.
- Promote wood stove change-out programs that take older non-EPA certified stoves out of service and replace them with more efficient and lower emitting cord and pellet stoves.
- Encourage new construction to install advanced wood heating equipment.
- Participate in education campaigns to provide best practices on cordwood and wood pellet selection, storage, and combustion to promote the most efficient, clean, and cost-effective use of wood heating technology while protecting human and environmental health.
- Identify any businesses that have a year-round need for process heat. Encourage these businesses to look into wood-fired combined heat and power
- Regions should encourage the development of the biomethane sector by supporting proposals for appropriately sited, cost-effective biomethane production facilities and related infrastructure.
- Identify potential producers of food and farm waste (farms, food processors, restaurants/schools/institutions with food waste) that could potentially host a farm or food waste digester.

Promoting Consumer Awareness of the Benefits of and Access to EVs and Alternative-Fuel Vehicles

- Work with local employers and nonprofit partners such as the Vermont Energy and Climate Action

Network and Vermont League of Cities and Towns to encourage broader implementation of EV incentives, such as free or reduced parking costs for EV and fuel-efficient vehicle owners and preferential access to parking spaces limited in supply.

- Promote the Drive Electric Vermont webpage, which connects users to financial incentives, dealers, and recharging stations for EVs.
- Contact local vehicle dealers to encourage them to offer EV and fuel-efficient vehicles by both sale and lease. Encourage local media and chambers of commerce to provide positive visibility for supplying EVs.
- Partner with Drive Electric Vermont, nonprofit organizations, vehicle dealers, and/or state agencies to organize high-visibility events where people can see and test drive EVs, such as county fairs, energy fairs, and summer festivals. Events should also leverage local newspaper and public access coverage to showcase local residents and organizations that are helping to propel the transition to EVs.
- Encourage major employers in the community that operate private fleets (for example garbage collection, public transit, colleges and universities, or milk transportation) to switch some of their vehicles to electric or biodiesel-fueled vehicles. Help build awareness of related grant opportunities.
- Host a "show and tell" day featuring different kinds of EVs and giving people interested in purchasing them an opportunity to talk with fellow community members who own them.

Deploying EV Infrastructure at Workplaces and Key Public Locations

- Assess current access to public and workplace charging (to the extent known) in the community or region and identify strategic locations in busy areas (large employers or areas of high visitation in downtowns) where charging stations should be added or expanded.
- Regions should partner with Drive Electric Vermont, the Vermont Clean Cities Coalition, and other organizations to promote the expansion of workplace charging, in particular by continuing funding for incentives that help employers cover the costs of installing charging stations.
- Regions should encourage the electric utility operating in their service area to invest in charging infrastructure and to build awareness of charging opportunities as part of their strategy for complying with the state's Renewable Energy Portfolio Standard
- Regions should promote and seek grants to fund the installation of DC fast-charging infrastructure at strategic locations along major travel corridors and in transit hubs such as park-and-ride locations.
- Plan, advocate for, and consider requiring the installation of Electric Vehicle charging infrastructure as part of new or redevelopment, especially for developments subject to Act 250.
- Support the development of additional refueling stations for alternative fuels for both private and public transportation fleets by sharing station development costs between public and private interests.
- Work with the Clean Cities Coalition to encourage large fleets to switch to natural gas use where biodiesel is impractical, in areas of the state where natural gas is available. Encourage the use of renewable natural gas through Vermont Gas's forthcoming renewable natural gas green pricing program.
- Public and private stakeholders should continue to develop a sustainable biofuels industry in Vermont to enable the production and use of biofuels for transportation, agricultural, and thermal applications.

APPENDIX B:

Adopted Windham Regional Goals and Policies

Below are the adopted policies from the Windham Regional Plan and the Windham Regional Transportation plan. The full Windham Regional Plan can be accessed here and the Transportation Plan accessed here.

TRANSPORTATION

Land Use Policies

1. Weigh the secondary growth effects that often result from transportation infrastructure improvements and determine if the benefits of the improvements outweigh the costs to existing historical, cultural, and environmental assets.
2. Minimize functional conflicts and require that developers be responsible for relieving new traffic impacts generated by their developments.
3. Avoid strip development and minimize the negative effects of existing strip development.
4. Preserve village character through appropriate design and scale of commercial, industrial, residential, and transportation infrastructure and community structures and uses.
5. Preserve and create Right-of-Ways for future transportation linkages between communities, neighborhood services, and other destinations.
6. Avoid extension of roads into and through Resource Lands.

Energy Policies

7. Support emissions standards that reduce regionally generated air pollutants from transportation related activities.
8. Promote the reduction of vehicle miles traveled in Vermont through public education, expanded public transit infrastructure, rideshare programs, and park and ride facilities.
9. Promote alternative fuel vehicles and the infrastructure necessary to fuel those vehicles.
10. Require all development projects to incorporate elements that reduce reliance on single occupancy vehicles, such as providing access to public transit, installing pedestrian and bicycle network links, or providing access to ride-sharing programs.
11. Support efforts to minimize energy consumption, especially non-renewable energy resources, and explore expanded use of alternative fuels.
12. Integrate traffic designs in designated downtowns and village centers that limit idling and calm traffic.

Freight Policies

13. Maintain, improve, and expand passenger and freight rail services.
14. Encourage businesses and industries with high freight demands to locate within the rail corridor, improving mobility of goods by rail.

Public Transportation

15. Implement an integrated, multi-modal transportation system in the urban centers, providing

connections between rail, air, bus, car, bike, and pedestrian.

16. Integrate the use of energy-efficient and alternative modes of transportation into community plans and development.
17. Establish effective and efficient public transit services to meet the needs of transit dependent populations and to better serve the general public.
18. Establish a safe and convenient regional system of park and ride lots to encourage ride-sharing.
19. Include transit oriented development in any proposed project.
20. Incorporate public transportation into planned transportation improvements for resort centers.
21. Create new and expand existing public transit services to fulfill intercity and intra-regional demand.

Active Transportation

22. Incorporate ADA regulations and guidelines into all pedestrian projects.
23. Require provision of appropriate pedestrian and bicycle facilities in new development projects.
24. Review and accommodate for non-motorized transportation, such as bicycle lanes, wider shoulders and sidewalks in roadway and bridge projects.
25. Preserve and encourage creation of Rights-of-Way for future linkages between communities, neighborhoods services, and other destinations.

LAND USE

1. Direct new growth, such as jobs, housing, commerce, public infrastructure, industry, community facilities, into appropriate development types (regional centers, commercial/industrial areas, rural commercial, resort centers, and villages). New growth should give attention to the type and scale of the existing form, in order to keep these centers culturally, socially, and economically viable. Infill development and "brownfield" redevelopment are encouraged in these areas.
2. Utilize strategies that increase the energy efficiency of new and existing development. All major projects reviewed under Act 250 shall provide evidence demonstrating how the development is energy efficient from a regional land use perspective, including projected transportation, heating, and electricity needs.
3. Preserve the historic and architectural character of the Region. Support the reuse and repurposing of viable existing structures to retain historic development patterns, densities, and character in the Region, especially within regional centers, villages, and hamlets.
4. Consider current and future housing requirements when evaluating business development and expansion projects. Encourage measures that will establish and maintain an adequate housing stock for area workers that satisfy a diversity of needs and income levels.
5. Develop master plans for the transformation of existing rural commercial areas, as identified on the Proposed Land Use Map, into areas serving a mix of uses, offering diversified transportation options and planned infill locations, while also conforming to traditional historic development patterns.
6. Where strip development has already occurred beyond villages and growth centers, promote redevelopment that reflects the historic development patterns of existing hamlets and villages. Strip development in known floodplains and fluvial erosion hazard areas that has experienced past damage should be considered for floodplain restoration and hazard mitigation opportunities.
7. Concentrate ski resort expansion and secondary growth to minimize the trend toward dispersed/sprawl development. All ski resort development shall be reviewed and approved as part of a development master plan before any individual development projects are approved in order to assess cumulative impacts of the potential growth of the development.
8. Plan for and develop public infrastructure, including water and sewer systems, that promotes and enables greater densities in development centers, including regional centers, villages, resort centers,

commercial/industrial sites, and growth areas as identified by town plans.
9. Develop and expand hamlets in a form that maintains traditional density and residential settlement pattern within the Windham Region. Encourage towns to enable this pattern of development in town land use regulations.
10. Provide guidance and training on regulatory and non-regulatory tools for open space and resource protection available to towns for use in town plans and regulations. Encourage implementation of tools such as conservation subdivision, clustered development, and variable lot size in all subdivision development, and especially within rural residential and productive rural lands.
11. Use open space plans and resource protection techniques to protect agriculture, forest, mineral, and Resource Lands from development and fragmentation. Encourage town open space planning and help coordinate those planning efforts through the development of a regional Open Space Plan.
12. Require all major projects reviewed under Act 250 to mitigate any loss of prime agricultural and/or forest land as a result of the development.
13. Promote critical resource areas by educating towns and the public on the importance of preserving exceptional natural resources. Preserve critical resource areas by identifying key sites and by assisting towns in incorporating provisions in their town plans and land use regulations to protect them (and, as appropriate, restore them).
14. Strongly discourage all development in Resource Lands for purposes other than forestry and agriculture. Any development proposed within critical resource areas shall provide evidence as to why the development cannot be avoided, and shall provide mitigation for natural resources impacted by the development.
15. Require that the benefits of any mitigation occurring as a result of a proposed development within the Windham Region be directed to the Windham Region.

Energy

1. 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 GHG emissions.
2. Work with the State, utility companies, and other energy suppliers to create a regional energy profile as a foundation for planning to meet future regional energy needs and to provide guidance on energy development in our member towns.
3. Support the State in achieving its Total Renewable Energy and Comprehensive Energy Plan goals through avenues that maintain an adequate, reliable, and economical energy supply without causing undue adverse impacts to humans and the environment.
4. Support cost-effective energy efficiency and energy conservation measures, and programs such as Efficiency Vermont to help reduce energy costs in the region.
5. Support incorporation of high-efficiency energy systems, sized appropriately to the energy need, and located in close proximity to the user base.
6. Support the advancement of Smart Grid technology to allow businesses and residents to make informed choices about their energy usage and expenditures by monitoring when they are using energy, how much they are using, and how much it costs.
7. Require that new development and renovations, at minimum, meet State commercial and residential energy building codes. Encourage development to utilize strategies to increase energy efficiency, including consideration of transportation energy use, on-site generation and heating systems, and reuse/repurposing of existing structures.
8. Provide and distribute educational information on:
    a. Energy conservation techniques;

b. Energy-efficient products and weatherization programs;
c. Available energy options and their respective impacts and costs; and
d. Opportunities for energy diversification and locally based energy sources.

9. Encourage an economically competitive energy supply through increased operation efficiencies, technology upgrades, and availability of low-cost fuels, including natural gas.

10. Balance improved efficiency and conservation measures with the need for new generation and transmission infrastructure to ensure adequate future energy supplies. Support requirements that utilities improve the efficiency of procedures and infrastructure and assist customers to conserve energy and reduce costs.

11. Support the continued availability and use of net metering electrical systems, including both individual and group net metering installations.

12. Encourage a shift toward zero and low-GHG emission energy sources, including the capture of methane gas and its conversion to useful energy.

13. Require sustainable sources and practices for all biomass and biofuel projects to ensure that projects create a net reduction in GHG emissions, protect the working landscape, capture and reuse waste heat, and follow verifiable stewardship practices.

14. Support sound energy facility siting practices by ensuring that new developments give adequate attention to facility siting requirements, development constraints, natural resource protection, and land use compatibility.

15. With regard to all energy generation, transmission, and distribution projects:
a. Adhere to a high environmental standard that includes avoiding negative environmental impacts to the extent possible and adequately minimizing and mitigating those that cannot be avoided;
b. Conduct thorough and proper studies and analyses of all anticipated socioeconomic and environmental impacts, both positive and negative;
c. Adequately address all areas of concern regarding proposed developments; and
d. Effectively and adequately address all issues related to facility operation and reliability.

16. Facilitate public participation as an integral part of the decision-making process for siting, evaluating, and relicensing energy generation, transmission, and distribution facilities and for electric utility deregulation.

17. Facilitate inter-town conversations about appropriately scaled and sited generation sources, which include consideration of the wishes of residents regarding the meaning of "appropriate" as expressed in their town plans. The WRC recognizes that host towns and abutting towns may have different goals in this area, and will use its best efforts to gain consensus and/or cooperation among them.

REGIONAL ECONOMY

1. Work with BDCC and other organizations to attract and retain youth in the Region by identifying and addressing barriers to their settling here, by providing targeted educational and skill training opportunities, and by creating meaningful career options with livable wages.

2. Promote activities and development that contribute to a strong and diverse economy, providing satisfying and rewarding job opportunities for citizens in all parts of the Region and supporting a strong municipal tax base, while maintaining environmental standards and promoting environmental justice.

3. Generate a variety of stable, year-round jobs with wages and other compensation that provide a livable income, and that include skills training programs and other benefits that contribute to the personal development and quality of life for all workers, particularly in areas with high unemployment or high numbers of workers earning less than a livable wage.

4. Utilize existing financial, physical, and technical resources to facilitate economic development, including the creative use and revitalization of suitable existing space for manufacturing and industrial activities, commerce, housing, and the arts.

5. Develop and assist the growth of small businesses including home businesses and entrepreneurial ventures that help preserve and revitalize communities.
6. Support educational programs in technical and trade skills, as well as basic skills such as math and communications, in order to improve the value of opportunities for the Region's workforce, both entry-level and advanced.
7. Support the transition of Vermont Yankee employees into new jobs and industries through the development of specific job re-training programs, and entrepreneurial support strategies.
8. Encourage development of land-based industries, focusing on the production, distribution, and marketing of agricultural and forestry products and programs from within the Region in a manner that maximizes the sustainable use of these resources, minimizes and repurposes waste, and promotes the economic, physical, and environmental well-being of our communities and their residents.
9. Promote the economy through tourism activities that emphasize the character of the Region itself: its beauty, culture, history, wildlife, and outdoor recreation.
10. Support the arts and culture industry by encouraging increased use of community resources, improved cultural opportunities for all residents, and enhanced year-round tourism.

NATURAL RESOURCES

Forest Resources

1. Maintain a high-value, forested landscape in the Region composed of large, contiguous parcels by supporting programs such as Use Value Appraisal and encouraging the use of conservation subdivision models, conservation easements, and purchase and ownership of lands for conservation purposes by land trusts, state and local government, or other similar organizations.
2. Support the harvest and use of lower grade timber to ensure full use of the forest resource and help protect the Region from the threat of wildfire destruction.
3. Encourage public, industrial, and private landowners to maintain and enhance forest resources on their lands, and to follow sustainable forest management practices that provide habitat for diverse natural species, avoid high grading of timberlands, and follow Acceptable Management Practices.
4. Support the management and eventual eradication of invasive species in the Region through activities such as provision of education materials, sponsorship of workshops on best management practices, encouraging the involvement of community organizations, and requiring the eradication or mitigation of invasive species as a condition on permits for development where the introduction or spread of invasive species is likely.
5. Maintain the Vermont tradition of public access to forested lands by encouraging preservation of historic access points and promoting public access connections in development proposals.
6. Continue to support the Vermont Use Value Appraisal (Current Use) Program—a program critical to the forest resource in the region—on a fully funded basis.
7. Support organizations and educational programs that teach or demonstrate sustainable forestry and Acceptable Management Practices, to facilitate understanding and appreciation of the environmental, economic, and recreational benefits offered by the Region's forest resource.

Surface Waters

8. Maintain and restore the chemical, biological, and physical quality of the Region's surface water per the objective in State water regulations.
9. Maintain undisturbed buffers of vegetation along watercourses, lakes, ponds, wetlands, and vernal pools consistent with State regulations and the highest precedent established by the District Environmental Commission and State Environmental Court in order to protect shorelines, provide shading to prevent

undue increase in stream temperatures, to minimize effects of erosion, sedimentation and other sources of pollution, and to maintain scenic, recreational, and habitat values.

10. Evaluate the licensing or re-licensing of hydroelectric power generating facilities on a case by case basis in a manner that supports other provisions of this plan.

11. Maintain any designated Class I wetlands in their natural condition. Ensure that any permitted alterations to Class II and Class III wetlands do not significantly diminish their functional, ecological, or aesthetic values. All projects of regional importance shall provide evidence that onsite wetlands have been field checked and verified by an environmental official or State agency representative.

12. Evaluate inter-basin transfers of water on a case by case basis and require project proposals to demonstrate that the water quality in both the sending and receiving basins will not be significantly lowered, that the water table and stream flow in the sending basin will not be detrimentally lowered, and that peak flows in the receiving basin will not be detrimentally increased. For purposes of this policy, a basin is the drainage area of a watercourse that is at least 1,000 acres in area.

13. Encourage towns and community organizations to identify critical resource areas in the Region and support efforts to protect these exceptional natural resources.

14. Support surface water classification and management strategies which are consistent with the municipal and regional land use planning objectives for the affected watershed, and which will effectively maintain or improve existing water quality.

15. Maintain water flows in streams at levels that support a full range of in stream uses and values.

16. Require flood hazard and/or fluvial erosion hazard mitigation for development proposals in the floodway, floodplain, or fluvial erosion hazard zone.

17. Support State regulations and programs to protect surface waters from run-off and sedimentation caused by agriculture, forestry, recreation, and development activities through the use of tools such as: Acceptable Agricultural Practices (AAPs), Acceptable Management Practices (AMPs) for forestry, and Best Management Practices (BMPs) for erosion control.

Groundwater

18. Avoid contamination of groundwater from the drilling of wells through the use of proper drilling technology and appropriate well placement.

19. Require small-quantity generators of hazardous waste to have storage and disposal plans demonstrating that water contamination risks have been minimized. Support efforts to make appropriate disposal of small-quantities of hazardous waste convenient and effective in the region.

20. Support the Department of Environmental Conservation Water Supply Division in regulating and monitoring water withdrawal from underground sources to ensure that aquifers and surface waters are not significantly depleted, and that water is properly allocated. Promulgation of specific laws and regulations to control water withdrawal and to ensure minimum flows is encouraged.

Soils and Topography

21. Require developers to take special precautions on slopes to avoid environmental damage, including negative consequences associated with erosion and landslides.

    a. Minimize areas of earth disturbance, grading, and vegetation clearing on slopes over 15%;

    b. Design development on slopes over 15% such that it minimizes the potential impacts of slides and earthquakes; and

    c. Avoid development (other than appropriately designed recreational trails and ski lifts) in areas with slopes exceeding 25% or above 2,500 feet in elevation.

22. Require detailed site studies to determine suitability for development where steep slopes occur with shallow soils. Ensure that all development proposals on such soils provide and conform to a site drainage

plan and an erosion control plan for construction phases of the development.

23. Avoid development on wet soils, mucks, clays, silts, and other unstable soils that offer poor support for foundations or footings or that are subject to slippage.

24. Ensure that gravel extraction does not have negative impact on groundwater, surface waters, recreation sites, scenic areas, and special community resources. Future access to gravel resources should be considered in development proposals. Best practices are to be used to minimize dust, noise, and other degradation of air quality.

25. Ensure that effective site rehabilitation plans are provided and implemented for new development projects.

Natural Areas, Fragile Areas, and Wildlife Resources

26. Protect Natural Areas, Fragile Areas, wildlife corridors, and important plant and animal habitats.

27. Protect Natural and Fragile Areas from development. When development is proposed near a natural or fragile area a buffer strip, designed in consultation with the appropriate state agency, must be designated and maintained between the development and any natural or fragile area.

28. Support state, federal, and private acquisition of land and/or conservation easements to protect and connect important wildlife habitats and to encourage designation of State Natural and Fragile Areas.

29. Support local, regional, state and federal programs and incentives that encourage private and public landowners to recognize the economic importance of protecting, maintaining, and enhancing fish and wildlife habitats and ecosystems.

Air Quality

30. Require that development activities meet state and federal standards for air quality and noise.

Scenic Resources

31. Encourage towns to identify their scenic resources and support efforts for their enhancement and maintenance.

32. Encourage donation of scenic easements to public agencies or to private conservation organizations.

33. Require that the scale, siting, design, and management of new development maintains or enhances the landscape and protects high-quality scenic landscapes and scenic corridors as identified by town plans.

34. Minimize visual impacts of high-elevation or ridgeline structures through co-location, design, siting, and color choice. Design and site high-elevation tower structures so that they do not require nighttime illumination.

35. Require illumination of structures and exterior areas only at levels necessary to ensure safety and security of persons and property. Require arrangement of all exterior lighting so that the light source (lamp) is not directly visible from public roads, adjacent residences, or distant vantage points. Require shielding of exterior lighting so that the light does not project above the lamp. Discourage exterior area illumination of regionally prominent physical features and landscapes.

36. Plan new or improve existing roads so that they maintain or enhance scenic resources.

37. Screen new development from I-91 and other scenic roads and rivers, as identified by town plans, to the greatest extent practicable using vernacular perimeter plantings of hedges, hedgerows, and street trees.

Housing

1. Promote a diversity of housing stock within the Region offering safe, adequate, accessible, and affordable housing to meet the needs of all residents across the entire income spectrum and increase opportunities for owner-occupied housing.

2. Develop housing in a manner that maintains the historic settlement pattern of compact village and urban centers separated by rural countryside, and that has minimal impact on natural resources, open space, floodplains, fluvial erosion hazard zones, and important agricultural and forest lands.
3. Implement innovative planning, design, and construction techniques that minimize the long term cost and energy consumption of housing, including locating housing convenient to community centers, in proximity to transportation centers, in a compact development arrangement, and employing energy efficient construction techniques.
4. Promote and facilitate the design and retrofit of life safety and accessibility improvements in housing units.
5. Assist the coordination between public and private agencies involved in planning and financing of affordable housing, including alternative mechanisms such as land trusts, cooperative housing, limited equity cooperatives, and others.
6. Ensure that publicly funded projects do not revert to market-driven housing through support of Vermont Housing and Conservation Board (VHCB) covenants that restrict resale to eligible households, VHCB Mortgage Deeds, and Windham and Windsor Housing Trust (WWHT) agreements that restrict resale prices.
7. Support rehabilitation and maintenance of existing affordable housing stock.
8. Support affordable housing projects and encourage waiving of fees, tax credits and property tax abatement, and assistance with public grants and other sources of funding.
9. Facilitate opportunities for housing that is affordable to the Region's workforce. All Major Act 250 applications for development that will create 50 new full time equivalent positions shall provide evidence that there is existing available and affordable housing stock for the new employees within a thirty mile commuter shed. If housing that meets this requirement is not available, the development shall include affordable housing within the project or a mitigation payment to be used for affordable housing in the Windham Region.

EDUCATIONAL, CULTURAL, & RECREATIONAL RESOURCES

Educational System

1. Increase the availability, affordability, and accessibility of childcare.
2. Encourage school construction and renovation projects in existing developed areas such as downtowns and village centers in order to take advantage of existing infrastructure, encourage walking and bicycling to school where appropriate, and to enhance revitalization of communities.
3. Encourage and contribute to the ongoing debate about sources and efficiencies of educational funding.
4. Support efforts of libraries to provide materials, technology and facilities for independent learning and development of lifelong education.
5. Increase offerings for workforce training and adult education programs in the Region, and help coordinate partnerships to ensure these programs are well-suited to both the self-employed and employer needs of the Region.
6. Facilitate increased opportunities for public and private cooperation in offering vocational and basic competency training to employees and future employees of area businesses and industry.

Media Resources

7. Support greater penetration of public access, educational, and government programming (PEG) through new PEG group formation and regional agreements. Encourage cable companies and other video programming service providers to support PEG operating and capital budgets. Encourage cable television companies to provide coverage of regular town meetings and other important local events as part of their cable franchise agreements.

8. Support increased access to information about local events in user-friendly electronic formats.

9. Encourage increased access for residents to state and local public meetings and hearings through Vermont Interactive Television, PEG channels, and other electronic means.

Cultural and Historic Resources

10. Foster and encourage a vibrant local arts/cultural community through assistance and support for local arts friendly facilities, organizations, education, art marketing, and distribution efforts.

11. Support organizational and communication networks serving the Region to promote the enhancement of cultural opportunities.

12. Protect places of outstanding educational, aesthetic, archeological, or historical value by discouraging development that would adversely affect these cultural resources, including their destruction or alteration, alteration of surroundings, or the introduction of non-harmonious visual or audible elements. Require mitigation of negative impacts in projects that create unavoidable conflicts.

13. Encourage preservation of significant historic sites or structures through support of ownership, protective easements, and/or other regulatory options.

14. Support rehabilitation and adaptive reuse of significant historic sites and structures.

15. Support local, regional, and State nonprofit historic preservation trusts.

Recreation

16. Provide varied and accessible opportunities for outdoor recreation.

17. Facilitate the orderly development of needed public and private recreational facilities.

18. Recognize the recreational potential of watercourses and shorelines and encourage provision of facilities for sustainable water-oriented day use that does not impair the resource or related habitat.

19. Protect existing trail corridors and encourage use of abandoned railroad beds, Class 4 roads, and other public rights-of-way for future trail development and public access.

20. Encourage federal, state, and local acquisition of land and facilities well-suited for outdoor recreation, provided that adequate financial and management arrangements are made with the involved local governments.

21. Support United States Forest Service acquisition, other than by eminent domain, of private in-holdings within and selected lands adjacent to the Green Mountain National Forest, and adjacent to the Conti Natural Wildlife Area, provided that adequate payments in lieu of taxes are made to the affected local governments by the U.S. Forest Service.

22. Increase public opportunities for multiple-use recreation and for public access to recreation lands. Ensure provision of separate areas or facilities for conflicting uses of recreational resources when such conflicts create safety hazards or significantly impair the use or enjoyment of the resource.

UTILITIES, FACILITIES, AND TECHNOLOGY

1. Maximize water conservation when planning for development through mechanisms such as low-flow fixtures, water-efficient technologies, and, where appropriate, computerized control systems in order to limit demands on public water supplies.

2. Assist towns and the Agency of Natural Resources (ANR) to develop and disseminate educational material explaining how to reduce hazardous elements and compounds that pose a risk of release to water and soil resources.

3. Support the acquisition of future public and quasi-public utility sites, properties, or interests, and assist towns with identifying these sites for future development

Public and Private water supplies

4. Develop or extend municipal water mains to only those areas where future development is appropriate, including regional centers, villages, resort centers, commercial/industrial locations as identified

by town plans, or in areas where extension is required for public health purposes.

5. Review land development within existing or planned wellhead protection areas to ensure that it will not pose a threat of contamination to public water supplies.

6. Minimize erosion and runoff to protect public and private water supplies by maintaining town roads consistent with Best Management Practices for erosion control.

7. Encourage testing of private water supplies for total coliform bacteria annually, and inorganic compounds and alpha radiation at five-year intervals to protect public health.

Wastewater Treatment

8. Support environmentally sound and affordable wastewater treatment, including research regarding the viability of alternative on-site management systems such as composting toilets and gray water recycling.

9. Educate town representatives and the public about the importance of adequately investing in the maintenance of existing public wastewater infrastructure and, where appropriate, the construction of new systems to protect public health.

10. Plan development so as to manage wastewater effectively and to maintain surface and groundwater quality.

11. Support development of new wastewater treatment facilities in areas where future growth is appropriate, including regional centers, villages, resort centers, commercial/industrial locations, and growth centers as identified by town plans, and in areas where extension is required for public health purposes.

12. Encourage installation of community wastewater treatment systems in villages, hamlets, and in clustered housing developments, and ensure that agreements for those facilities adequately provide for ongoing maintenance and oversight.

13. Work with municipalities to improve outreach to on-site sewage disposal system owners through provision of guidance material explaining how to properly maintain their systems. Support development of model pumping ordinance language.

14. Support programs to assist with the replacement of failed on-site sewage disposal systems.

Solid Waste Management

15. Support regulations that govern the safe disposal of all wastes, including hazardous wastes. Encourage all towns to support and participate in regional or state sponsored household hazardous waste collection programs.

16. Support federal, state, and local actions that reduce the volume and toxicity of solid waste in the Windham Region, including implementation of Act 148.

17. Work with solid waste entities and towns to plan for waste disposal needs, including regulations under Act 148, through the establishment of recycling, composting, waste reduction and reuse, and general waste management programs, while addressing public health, environmental quality, and impacts on adjacent and nearby land uses.

18. Support the assessment of waste disposal fees that accurately and fairly charge disposal costs to the waste generators.

19. Work with the District Environmental Commission to satisfy waste management requirements in Act 250 land use permit applications, as appropriate.

Radioactive Waste

20. Ensure the safe and effective storage, transportation, and disposal of low level radioactive waste (LLRW).

21. Work to assure that standards proposed for a LLRW storage site in Vermont are at least as stringent as those applied to any alternative site.

22. Minimize the generation of LLRW and high level radioactive waste (HLRW).

23. Support increased local and regional public involvement regarding all spent nuclear fuel permitting and licensing decisions.

Emergency Planning

24. Build disaster resistant and resilient communities by promoting sound land use planning that accounts for known hazards.
25. Encourage towns and the State of Vermont to continue to improve and adopt road, bridge and culvert codes and standards.
26. Encourage towns to require that all new public and private roads and driveways are properly constructed so that they do not contribute to the damage of town roads from stormwater.
27. Support a regional effort to develop a hazard plan for each town according to FEMA guidelines that stresses disaster mitigation and post-disaster resiliency through coordinated efforts.
28. Encourage towns to adopt and implement flood and fluvial erosion hazard area regulations.
29. Encourage the development and improvement of emergency evacuation plans and local emergency operations plans.
30. Encourage the inclusion of provisions for pets and livestock in town disaster plans.
31. Explore efforts to develop a regional emergency response plan that includes surrounding areas in Vermont, New Hampshire, and Massachusetts.

Emergency Response

32. Provide timely and effective emergency services to all persons regardless of their ability to pay.
33. Provide fire hydrants or other water sources in proposed developments so that firefighting personnel can adequately serve all structures.
34. Design and build new roads so that emergency vehicles can readily maneuver and access all proposed structures.
35. Ensure that the additional emergency service personnel, facilities, and equipment needed to effectively service new development are available to avoid placing undue demands on existing resources.
36. Support the development and installation of an additional or improved emergency communications infrastructure, systems, and procedures.

Communications Infrastructure

37. Promote universal access to broadband telecommunications and information services that are competitive in availability and cost.
38. Encourage reduced rates on advanced telecommunications services, equipment, and user training for libraries, educational, and health care facilities. Support local access to diverse life-long distance learning opportunities and to low-cost public-use computers for internet access.
39. Encourage modernization and expansion of transmission and receiving equipment at existing transmission and receiving stations, including co-location of radio communications.
40. Encourage siting, design, and access to communications towers and structures to provide quality transmission and to minimize negative impacts on natural and scenic resources.
41. Require that communications towers and structures be set back from property lines and public rights of way, such that the tower or structure will not cross the aforementioned lines or rights of way in the event of a collapse.

Human Services

42. Support the development of appropriate facilities to provide for childcare, eldercare, and care for persons with disabilities in the region.
43. Assist the coordination of community service organizations to avoid duplication of effort, as is feasible and appropriate.

APPENDIX C: WINDHAM REGIONAL ENERGY MAPS

Maps for Energy Planning
Windham Regional Commission

WRC has used GIS data layers supplied by the State of Vermont (specifically, the Vermont Center for Geographic Information) to create regional maps for our energy planning efforts, and the efforts of others, including towns. These data layers—both existing layers and those newly created through a GIS analysis—are specified by the Vermont Department of Public Service (DPS) in the Act 174 Mapping Standards.

Why were these maps created?

DPS provides the following guidance in their standards.
"The Mapping standards lay out a sequence of steps for planners to examine existing renewable resources and to identify potential (and preferred) areas for renewable energy development, and to identify likely unsuitable areas for development, by layering constraint map layers on to raw energy resource potential map layers. The maps should help regions visualize and calculate the potential generation from potential areas, and compare it with the 2025, 2035, and 2050 targets from the Analysis and Targets standards to get a sense of the scale and scope of generation that could be produced within the Region to meet the region's needs. DPS will provide additional guidance to accompany the standards that fleshes out the steps, layers, and standards more fully."

What these maps are:

These maps can help Regional Planning Commissions and towns "examine existing renewable resources," and are one tool to be used to "identify potential (and preferred) areas for renewable energy development, and to identify likely unsuitable areas for development."
You can think of these maps as similar to ones used in creating a land use plan. We might do a suitability analysis to find potential locations for residential development using state-level data sets. The resulting development potential map would be similar to these energy maps—it informs us about the land and its resources and its limitations, but would not be the final land use or zoning map; these are created by using the development potential map in conjunction with other information to decide which areas of town are actually preferred for development.

What these maps are not:

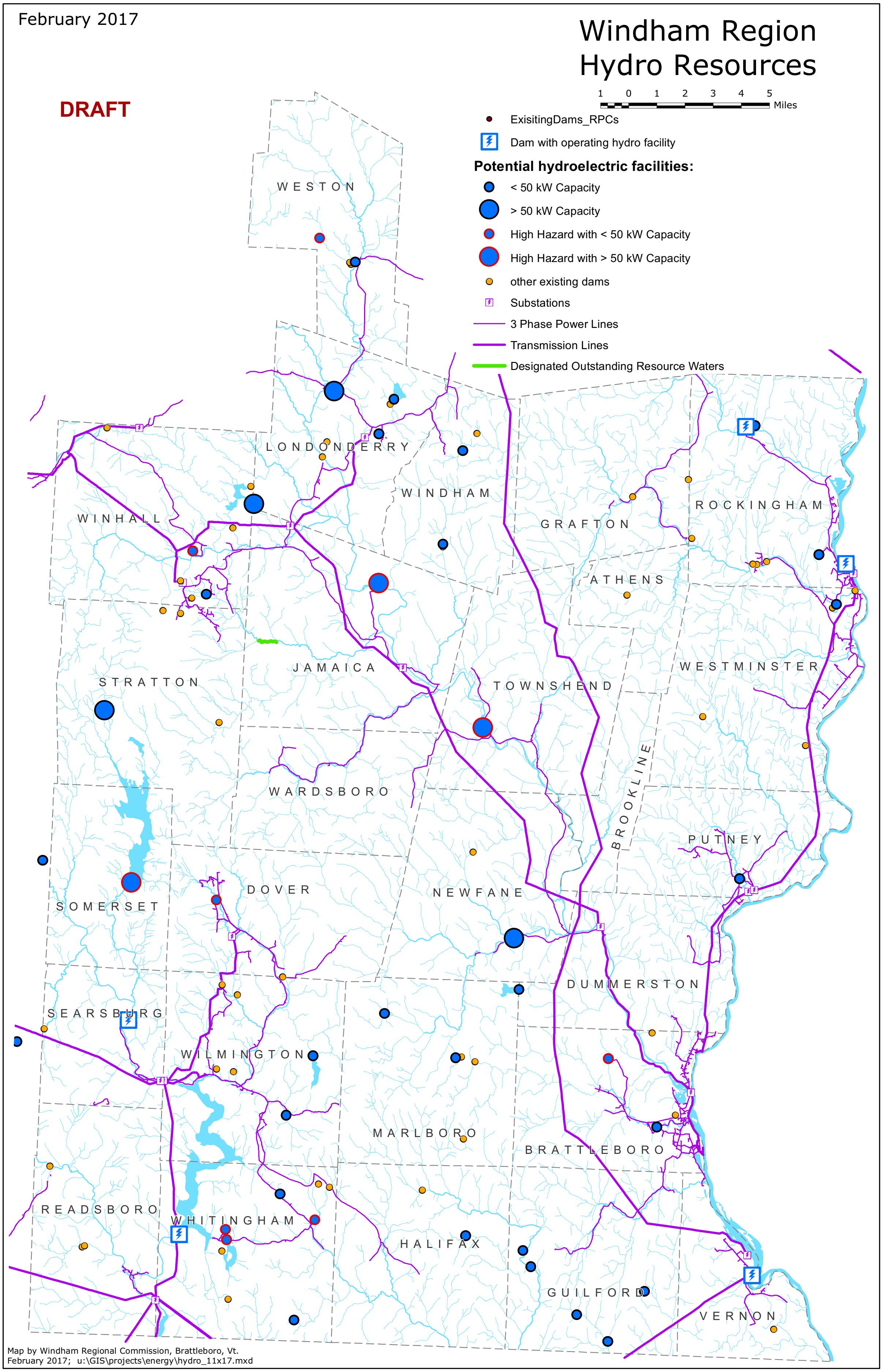
These maps are not a statement of where renewable energy development should occur and should not (or could not) occur. They are not siting maps. While they may identify potential areas for renewable energy development, they do not identify preferred areas for development (but again, they are a tool to help towns, RPCs, and others identify preferred areas).

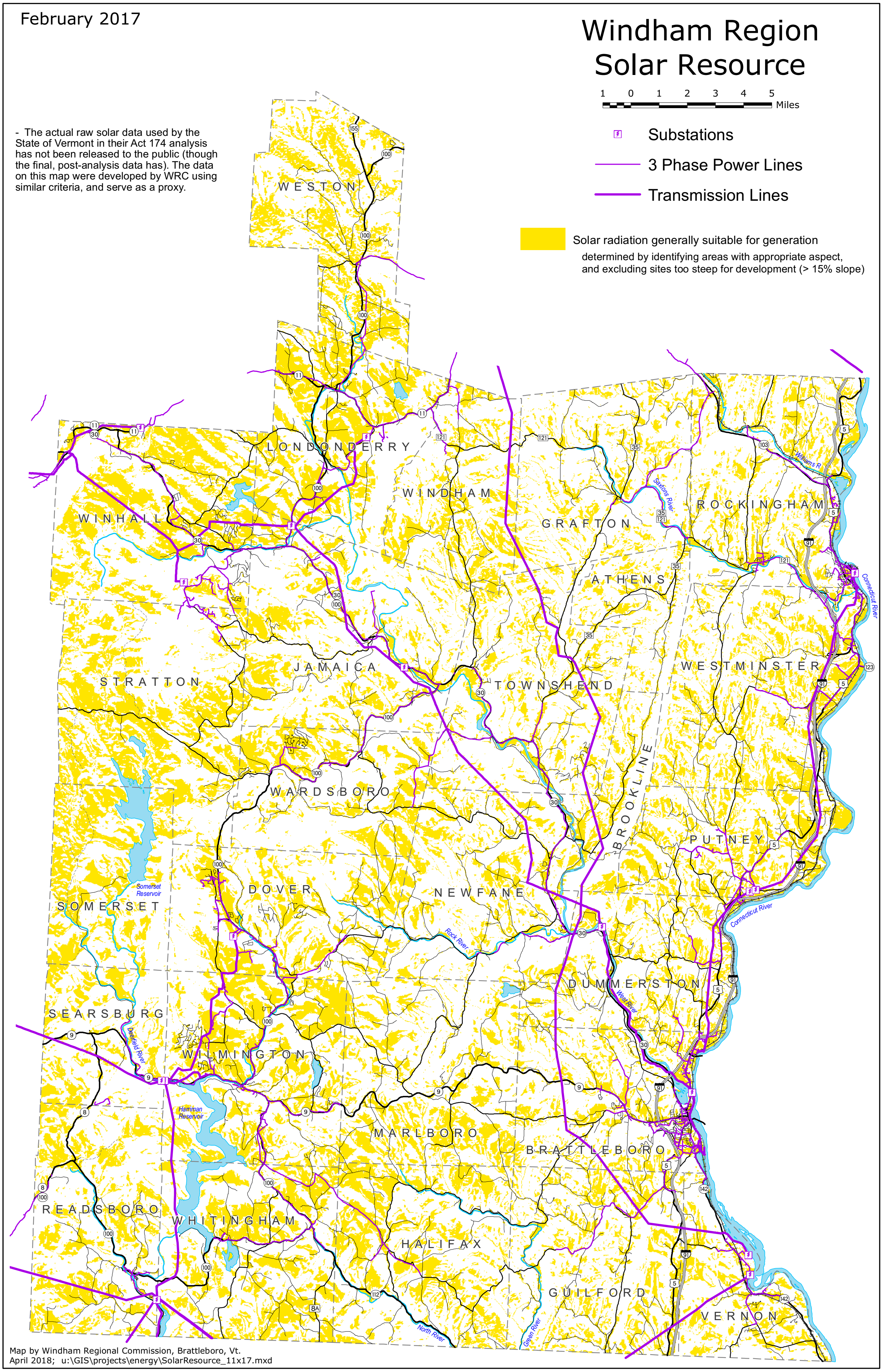
How should these maps be used?

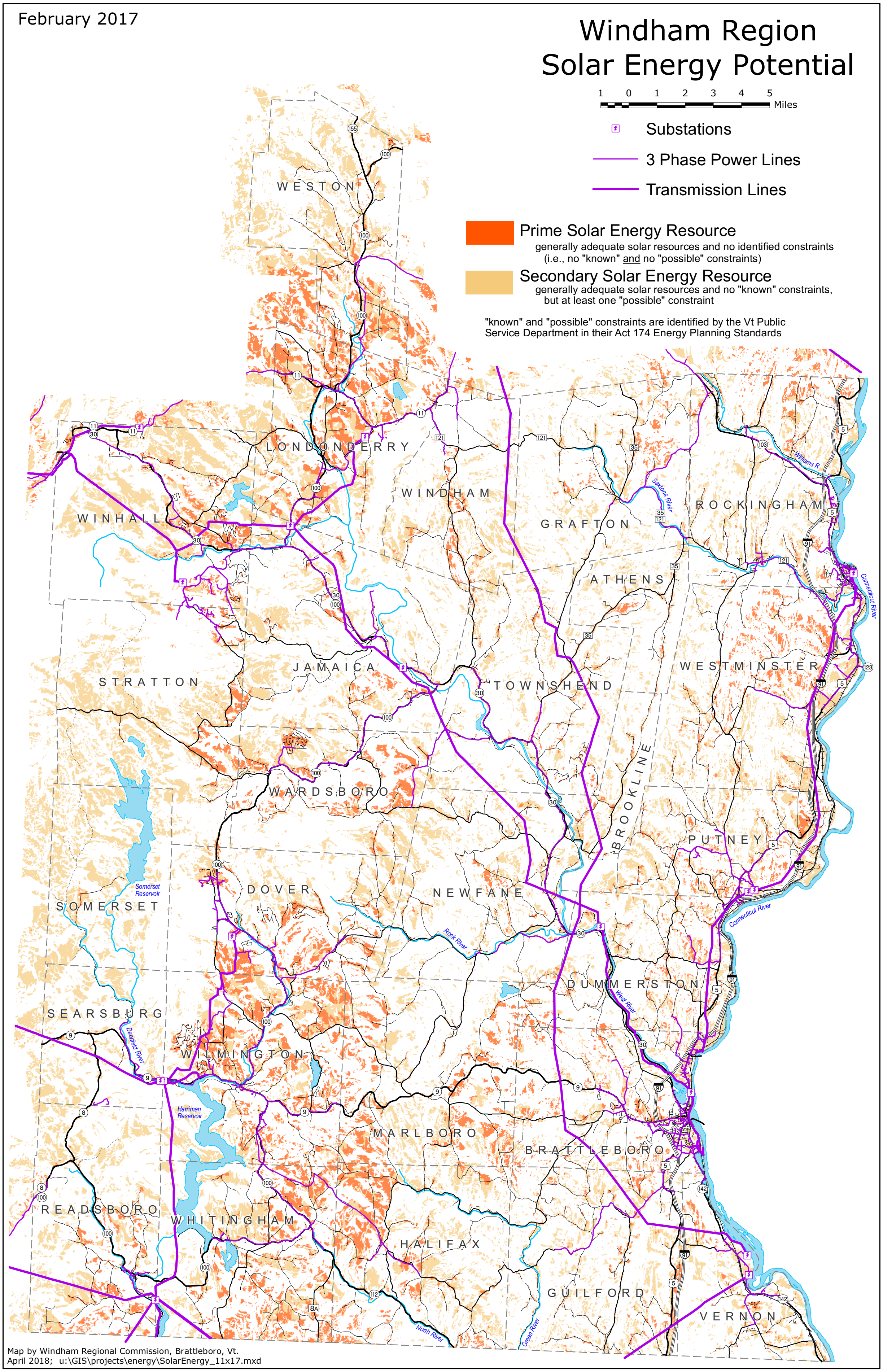
These maps, and additional maps that will be created as part of this process, should be used by towns, RPCs, and others as one tool to gain an understanding of the raw resources (wind speeds and solar radiation) necessary for renewable energy development, and those natural and regulatory limitations (the "known" and "possible" constraints specified in the Act 174 standards), that may impact development. Other tools would be verifying this information through direct knowledge or site review. Certainly there are limitations to development in addition to those specified in the standard; the Act 174 energy planning process allows for towns and RPCs to identify their own constraints. These local and regional constraints can be incorporated into subsequent mapping just as towns and regions do at present when developing their proposed land use maps as components of their respective plans

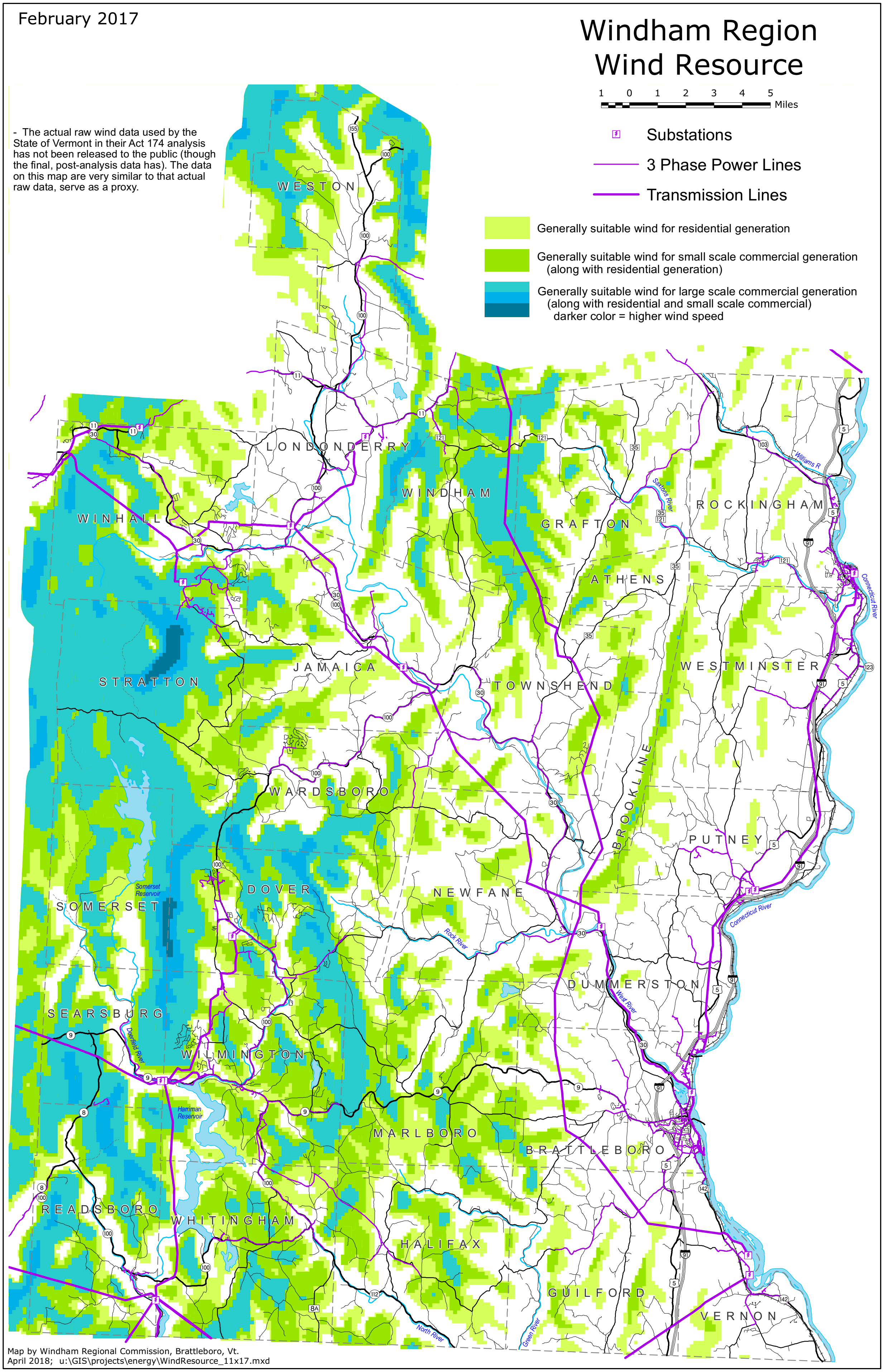
Want further information?

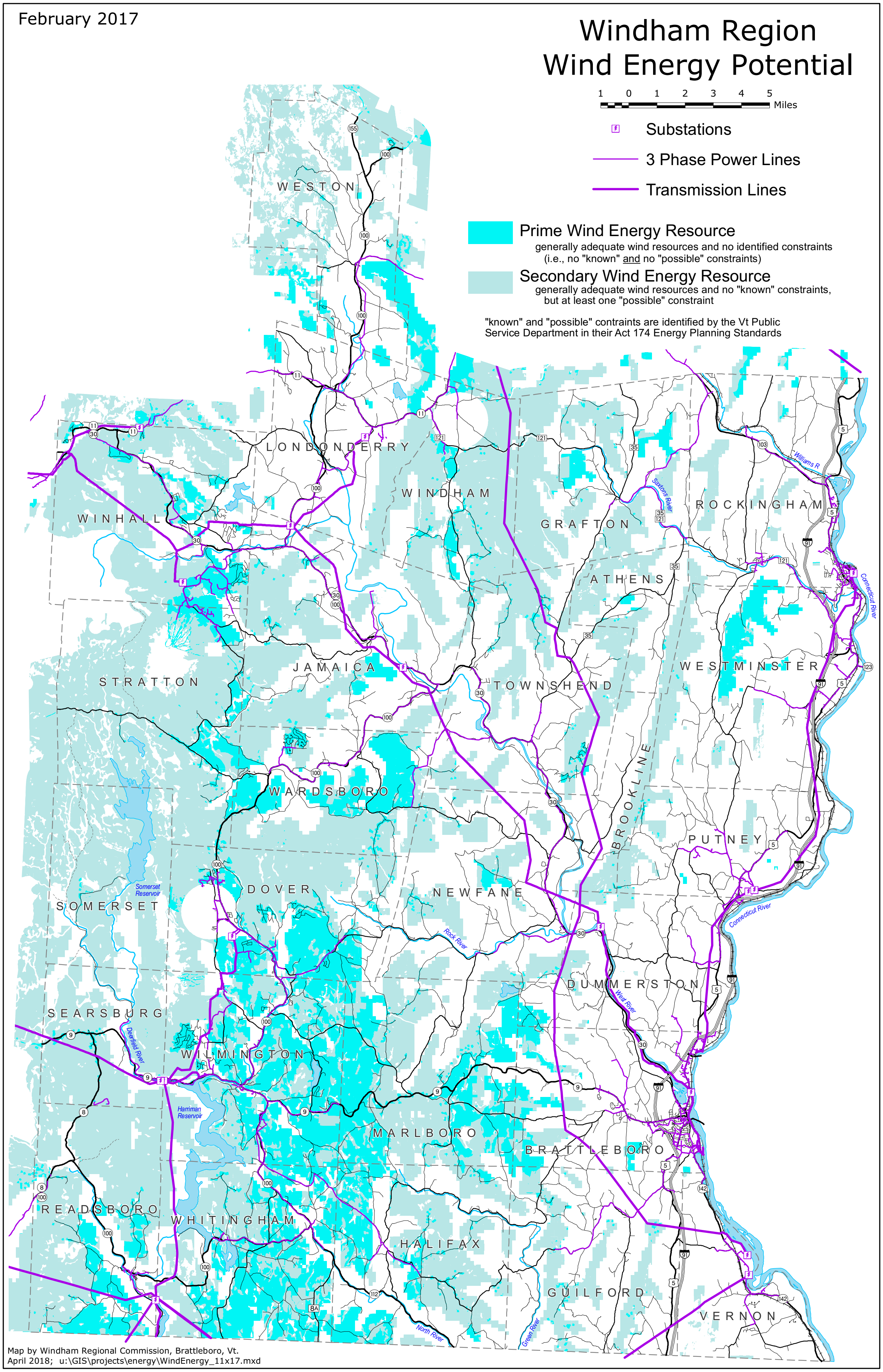
The Energy Atlas on the Vermont Energy Dashboard, http://www.vtenergydashboard.org/, has many of the data layers used in these maps available in an interactive mapping environment. This means you can view the data at various scales, and discover details on where specific constraints lie. For towns that are embarking in their energy planning process, WRC can also produce custom maps showing more detail and added information. WRC can also answer questions about where specific constraints lie.


February 2017
Windham Region
Hydro Resources
DRAFT
1 0 1 2 3 4 5
Miles
ExisitingDams_RPCs
Dam with operating hydro facility
Potential hydroelectric facilities:
< 50 kW Capacity
> 50 kW Capacity
High Hazard with < 50 kW Capacity
High Hazard with > 50 kW Capacity
other existing dams
Substations
3 Phase Power Lines
Transmission Lines
Designated Outstanding Resource Waters
WESTON
LONDONDERRY
WINHALL
WINDHAM
GRAFTON
ROCKINGHAM
ATHENS
JAMAICA
STRATTON
TOWNSHEND
WESTMINSTER
WARDSBORO
BROOKLINE
PUTNEY
DOVER
SOMERSET
NEWFANE
DUMMERSTON
SEARSBURG
WILMINGTON
MARLBORO
BRATTLEBORO
READSBORO
WHITINGHAM
HALIFAX
GUILFORD
VERNON
Map by Windham Regional Commission, Brattleboro, Vt.
February 2017; u:\GIS\projects\energy\hydro_11x17.mxd


February 2017
Windham Region
Solar Resource
1 0 1 2 3 4 5
Miles
Substations
3 Phase Power Lines
Transmission Lines
Solar radiation generally suitable for generation
determined by identifying areas with appropriate aspect, and excluding sites too steep for development (> 15% slope)
- The actual raw solar data used by the State of Vermont in their Act 174 analysis has not been released to the public (though the final, post-analysis data has). The data on this map were developed by WRC using similar criteria, and serve as a proxy.
WESTON
LONDONDERRY
WINDHAM
WINHALL
GRAFTON
ROCKINGHAM
ATHENS
STRATTON
JAMAICA
TOWNSHEND
WESTMINSTER
WARDSBORO
BROOKLINE
PUTNEY
DOVER
NEWFANE
SOMERSET
DUMMERSTON
SEARSBURG
WILMINGTON
MARLBORO
BRATTLEBORO
READSBORO
WHITINGHAM
HALIFAX
GUILFORD
VERNON
Somerset Reservoir
Harriman Reservoir
Connecticut River
Rock River
West River
Deerfield River
North River
Green River
Saxtons River
Williams R
Map by Windham Regional Commission, Brattleboro, Vt.
April 2018; u:\GIS\projects\energy\SolarResource_11x17.mxd


February 2017
Windham Region
Solar Energy Potential
1 0 1 2 3 4 5
Miles
Substations
3 Phase Power Lines
Transmission Lines
Prime Solar Energy Resource
generally adequate solar resources and no identified constraints
(i.e., no "known" and no "possible" constraints)
Secondary Solar Energy Resource
generally adequate solar resources and no "known" constraints,
but at least one "possible" constraint
"known" and "possible" constraints are identified by the Vt Public
Service Department in their Act 174 Energy Planning Standards
WESTON
LONDONDERRY
WINDHAM
WINHALL
GRAFTON
ROCKINGHAM
ATHENS
JAMAICA
STRATTON
TOWNSHEND
WESTMINSTER
WARDSBORO
BROOKLINE
PUTNEY
DOVER
NEWFANE
SOMERSET
Somerset Reservoir
DUMMERSTON
SEARSBURG
WILMINGTON
MARLBORO
BRATTLEBORO
READSBORO
WHITINGHAM
HALIFAX
GUILFORD
VERNON
Harriman Reservoir
Deerfield River
Rock River
West River
Saxtons River
Williams R
Connecticut River
North River
Green River
Map by Windham Regional Commission, Brattleboro, Vt.
April 2018; u:\GIS\projects\energy\SolarEnergy_11x17.mxd


February 2017
Windham Region
Wind Resource
1 0 1 2 3 4 5
Miles
Substations
3 Phase Power Lines
Transmission Lines
Generally suitable wind for residential generation
Generally suitable wind for small scale commercial generation (along with residential generation)
Generally suitable wind for large scale commercial generation (along with residential and small scale commercial) darker color = higher wind speed
- The actual raw wind data used by the State of Vermont in their Act 174 analysis has not been released to the public (though the final, post-analysis data has). The data on this map are very similar to that actual raw data, serve as a proxy.
WESTON
LONDONDERRY
WINDHAM
GRAFTON
ROCKINGHAM
WINHALL
ATHENS
STRATTON
JAMAICA
TOWNSHEND
WESTMINSTER
BROOKLINE
WARDSBORO
PUTNEY
DOVER
NEWFANE
SOMERSET
DUMMERSTON
SEARSBURG
WILMINGTON
MARLBORO
BRATTLEBORO
READSBORO
WHITINGHAM
HALIFAX
GUILFORD
VERNON
Somerset Reservoir
Harriman Reservoir
Connecticut River
Williams R
Saxtons River
Rock River
West River
Deerfield River
North River
Green River
Map by Windham Regional Commission, Brattleboro, Vt.
April 2018; u:\GIS\projects\energy\WindResource_11x17.mxd

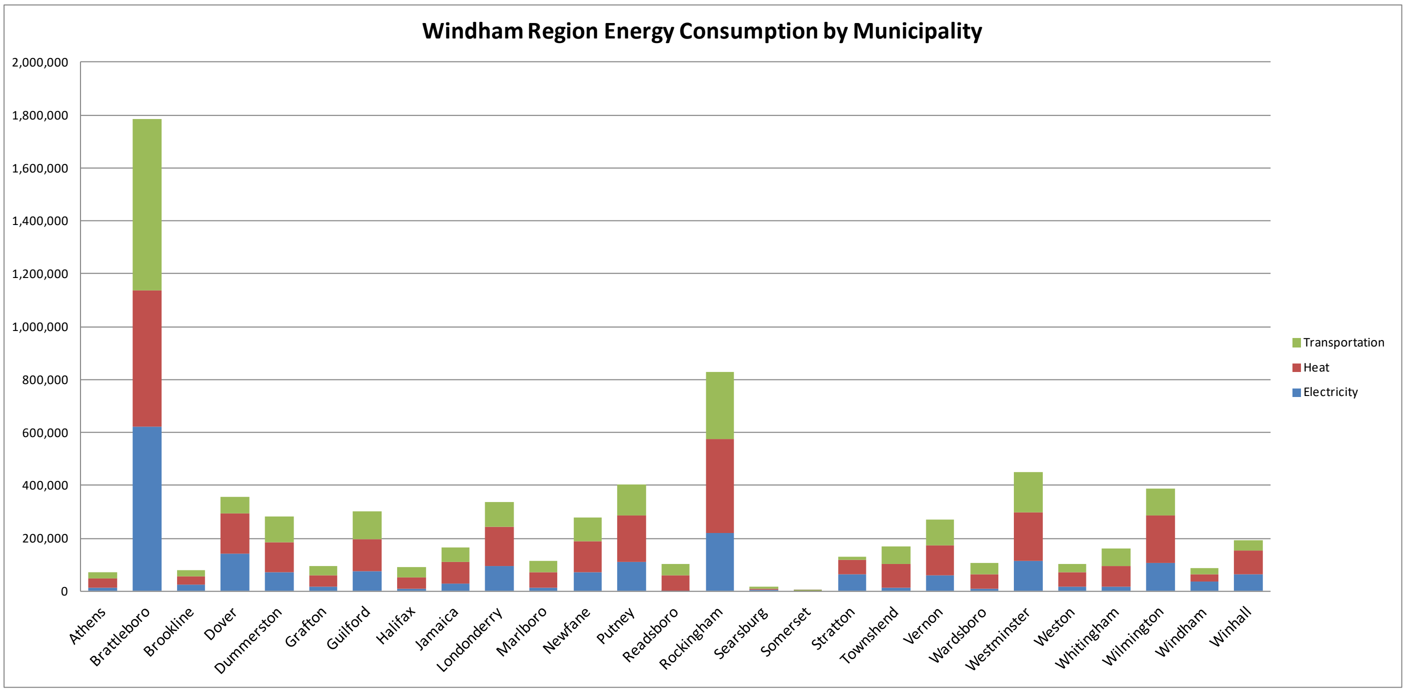

February 2017
Windham Region
Wind Energy Potential
1 0 1 2 3 4 5 Miles
Substations
3 Phase Power Lines
Transmission Lines
Prime Wind Energy Resource
generally adequate wind resources and no identified constraints
(i.e., no "known" and no "possible" constraints)
Secondary Wind Energy Resource
generally adequate wind resources and no "known" constraints,
but at least one "possible" constraint
"known" and "possible" contraints are identified by the Vt Public
Service Department in their Act 174 Energy Planning Standards
WESTON
LONDONDERRY
WINDHAM
GRAFTON
ROCKINGHAM
WINHALL
ATHENS
JAMAICA
TOWNSHEND
WESTMINSTER
STRATTON
WARDSBORO
BROOKLINE
PUTNEY
DOVER
NEWFANE
SOMERSET
DUMMERSTON
SEARSBURG
WILMINGTON
MARLBORO
BRATTLEBORO
READSBORO
WHITINGHAM
HALIFAX
GUILFORD
VERNON
Somerset Reservoir
Harriman Reservoir
Williams R
Saxtons River
Connecticut River
Rock River
West River
Deerfield River
North River
Green River
Map by Windham Regional Commission, Brattleboro, Vt.
April 2018; u:\GIS\projects\energy\WindEnergy_11x17.mxd

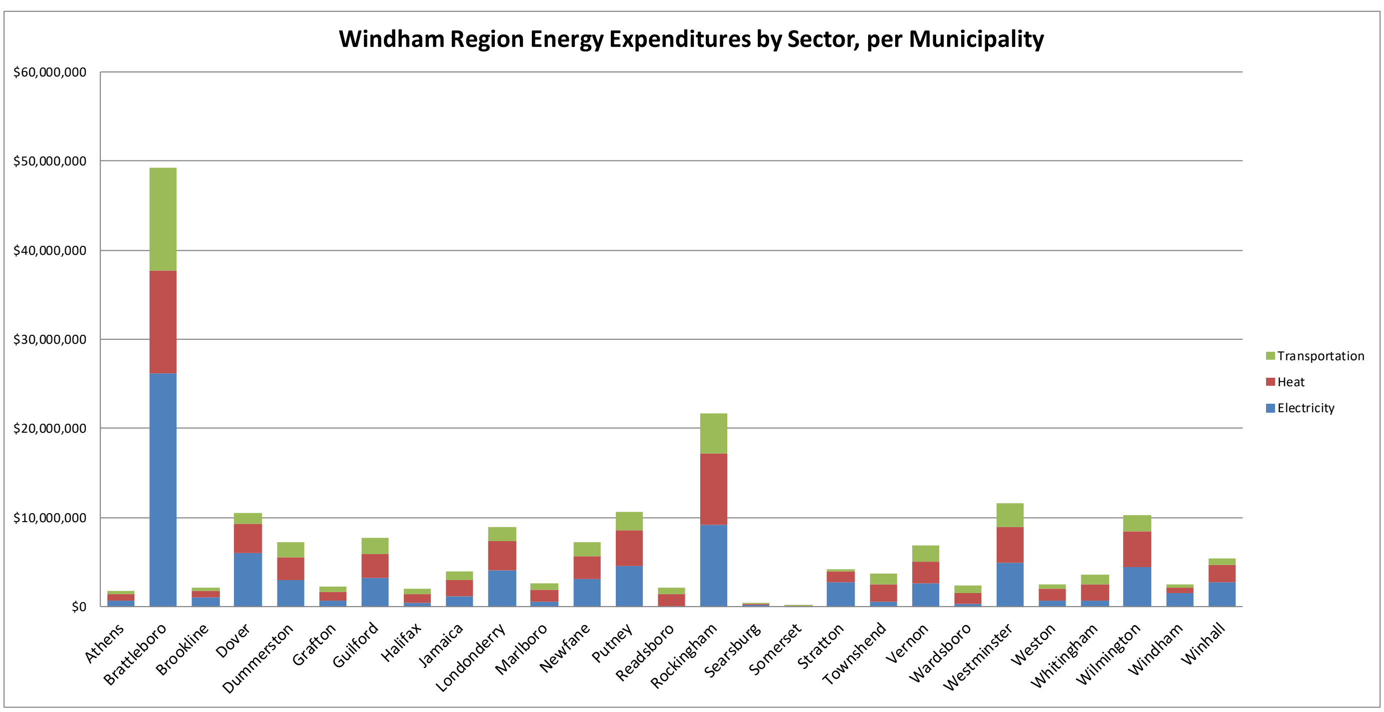
APPENDIX D: ENERGY DATA FOR WINDHAM REGIONAL MUNICIPALITIES

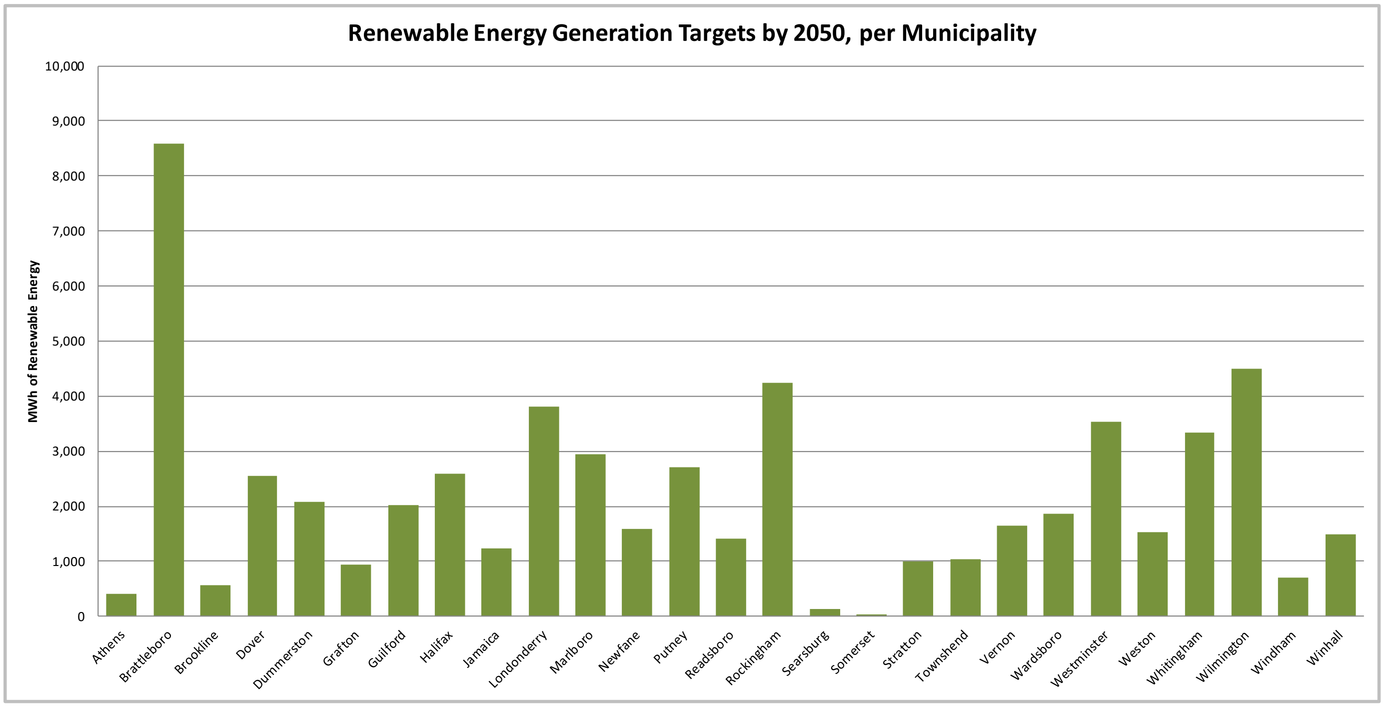
SUMMARY MUNICIPAL DATA, TOWN COMPARISONS

The three graphs presented on these two pages show the comparative energy data (current energy use, total energy expenditures, and renewable energy generation targets) for Windham Region towns.

The following pages (76-102) in this Appendix provide a more detailed break down of each of the 27 Windham Regional Commission member municipalities, along with relevant census data.







ENERGY DATA AND CALCULATIONS METHODOLOGY

The following data sources were used and energy calculation methods were developed with the guidance from State Act 174 energy planning partners, (the VT Department of Public Service, the Bennington Regional Planning Commission, and the Northwest Regional Planning Commission). The Windham Regional Commission adapted some of this energy use calculation guidance so that it might be the most relevant and appropriate for the Windham Region.

However, the following calculations and methods were never intended to provide exact figures for municipal energy use across the sectors, or precise efficiency and conservation goals. Rather, they are estimates only, and are meant to inform those in energy planning or municipal decision-making. As it is nearly impossible to provide exact quantities of kilowatt hours, gallons of fuel, cords of wood, and Btus consumed across the three sectors in a town or region, this data only a starting point that enables us to have an informed planning process.

Home Heating Estimates

1. Retrieve Fuel Type Data from U.S. Census Bureau's American FactFinder website. To locate specific sets of data, use the "Guided Search" feature on the American FactFinder data portal, and navigate to a specific data set per municipality. Note there is data for both owner-occupied and renter-occupied residences.

The following page has an example chart, with sample data derived from the American FactFinder website.

EXAMPLE: Anytown, VT

Total	1,110 Households (HHs)
Owner Occupied:	780 HHs
Utility gas	0
Bottled, tank, or LP gas	57
Electricity	0
Fuel oil, kerosene, etc.	521
Coal or coke	4
Wood	181
Solar Energy	0
Other fuel	17
No fuel used	0
Renter Occupied:	330 HHs
Utility gas	0
Bottled, tank, or LP gas	47
Electricity	7
Fuel oil, kerosene, etc.	254
Coal or coke	0
Wood	22
Solar energy	0
Other fuel	0
No fuel used	0

2. Retrieve Household Size Data from American FactFinder, and generate approximate square footage by household type.
To do so, find the average number of people per household, then use a national rate of square feet per person. The national square feet per person medians are taken from the 2011 American Housing Survey for the United States, published in 2013 by the U.S. Census Bureau.

	Avg. ppl per HH	Ntnl. median sqft per person	Total HHs	Total estimated square ft
Owner	2.24	800	780	= 1,395,968
Renter	1.99	500	330	= 328,350

3. Calculate Square Footage Heated by Fuel Type to estimate the amount of space being heated by each fuel.

4. Calculate Energy Required for Heating with an assumed heating rate of 60,000 Btus per sqft of housing in VT.
Assumed heating rate is a cautious estimate, assuming generally low residential energy efficiency, and is based on a combination of federal and online sources. It is possible to use a lower (more efficient) rate closer to 50,000 Btus per household.

5. Calculate Quantities of Fuel Consumed with assumed rates of energy per unit of each fuel type. Fuel efficiencies, based on several federal and additional sources. See Table A below.

6. Calculate Cost of Fuel Consumed with assumed prices for each of the fuel types. Prices for fuel inputs fluctuate often, so prices used here are estimates that can be adjusted over time. These were the rates used, and cited, in the 2016 Bennington Regional Energy Plan. See Table B below.

1 Gallon Propane	= 91,000 BTUs
1 kWh Electricity	= 3,414 BTUs
1 Gallon Heating Oil	= 140,000 BTUs
1 Pound Coal	= 11,560 BTUs
1 Pound Wood Pellets	= 8,750 BTUs

Table A: Btus per unit fuel

Propane	= $3.45/Gallon
Electricity	= $0.1471/kWh
Heating Oil	= $2.75/Gallon
Coal	= $0.16/Pound
Wood Pellets	= $0.16875/Pound

Table B: Fuel cost

Commercial Heating Estimates

1. Find the number of commercial establishments in the area. Visit the Covered Employment and Wages data site on the VT Department of Labor's website, where searches can be made by county or town.

2. Estimate the average annual heating load of commercial establishments in the area, in millions of Btu (space and water heating loads combined). For the state as a whole, the average is in the range of 700 MMMBtu to 750 MMMBtu per year per establishment, but the average for any given area is very likely to be significantly higher or lower, as the mix of businesses from region to region is highly variable. The VT Department of Public Service (DPS) has provided RPCs with a method to estimate the heating load for businesses in an area, given the business type and determined by the NAICS code.

Transportation Fuel Use Estimates

1. Estimate the number of light duty vehicles (LDVs), based on number of housing units per municipality and the VT state averages for counts of vehicles associated with area housing units. Both figures can be found via the US Census Bureau's American FactFinder.

2. Calculate gallons of gas consumed, based on

(a) the average annual number of miles traveled by an LDV in the area. For the State as a whole, total vehicle miles traveled per registered vehicle was around 12,500. The vast majority of LDV in Vermont can safely be assumed to drive between 9,000 and 15,000 miles annually.

(b) the average fuel economy of fossil fuel burning LDV fleet in the area, in miles per gallon (MPG). Statewide, the average fuel economy of all registered vehicles is around 22 MPG.

Therefore: (# miles/year) ÷ 22 MPG (DPS Guidance) = # gallons

3. Find gasoline expenditures, based on the rate of $2.3428/gallon (average price per gallon of retail petroleum products, based on January 2016 Vermont Fuel Price Report).

4. Estimate the energy consumption of LDVs, in Btu, by using the average number of Btu in a gallon of fossil fuel (121,259), computed as a weighted average of the individual heat contents of gasoline (95%) and diesel (5%).

Electricity Use Estimates

1. From Efficiency Vermont, measured metered consumption data delivered to all RPCs for these planning purposes, per municipality.

2. This electricity consumption data was divided into Residential and Commercial/Industrial use categories.

3. This information was updated by Efficiency Vermont in July 2017 and distributed to all RPCs. If you'd like to see your town's electricity data, contact a Windham Regional Commission Staff Planner.

ATHENS

POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **378**

Total households *(2014)*: **231**

Total businesses *(2015)*: **5**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **311**

Estimated miles traveled annually: **3,529,184**

Estimated gallons of fuel used: **160,686**

Estimated total transportation costs: **$376,455**

Heating

Total estimated residential heating use: **19,910 MMBtu**

Total heating cost of primary residences: **$377,839**

Total estimated commercial heating use: **476 MMBtu**

Total heating energy use: **33,991 MMBtu**

Estimated total heating cost: **$758,546**

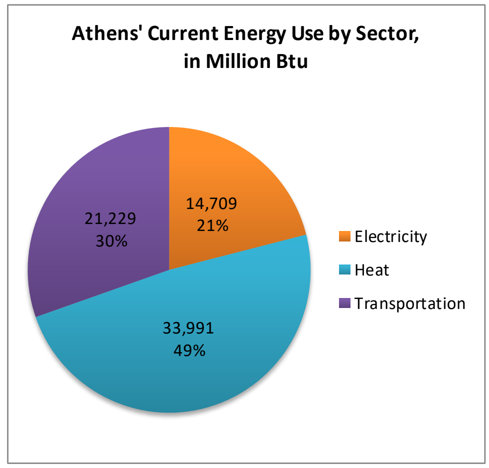
Electricity

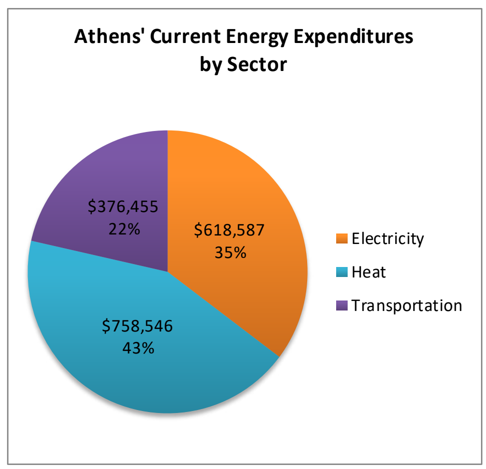
Residential usage *(2016, KWh)*: **1,492,469**

Commericial/Industrial usage *(2016, KWh)*: **63,942**

Total electricity usage *(2016, KWh)*: **1,556,411**

Estimated total electricity cost: **$618,587**





ENERGY GENERATION TARGET

For the 90x50 State goal, target renewable energy generation by 2050: **415 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Athens *(2016)*: **246 MWh**

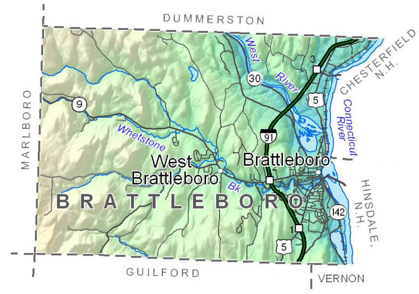
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **3**

...in 2015: **3**

...in 2016: **5**

BRATTLEBORO



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **11,841**

Total households *(2014)*: **5,998**

Total businesses *(2015)*: **715**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **9,550**

Estimated miles traveled annually: **108,449,278**

Estimated gallons of fuel used: **4,937,760**

Estimated total transportation costs: **$11,568,185**

Heating

Total estimated residential heating use: **611,820 MMBtu**

Total heating cost of primary residences: **$11,866,198**

Total estimated commercial heating use: **495,344**

MMBtu

Total heating energy use: **1,114,072 MMBtu**

Estimated total heating cost: **$24,861,659**

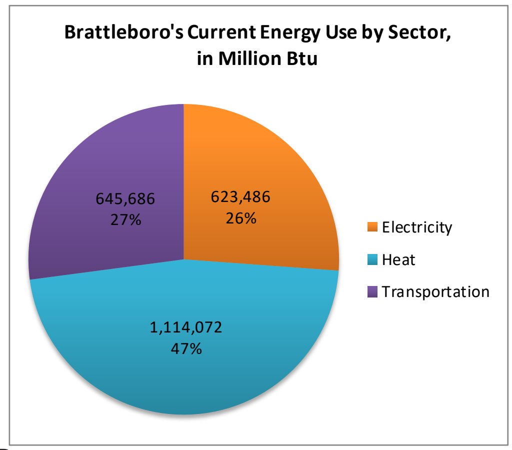
Electricity

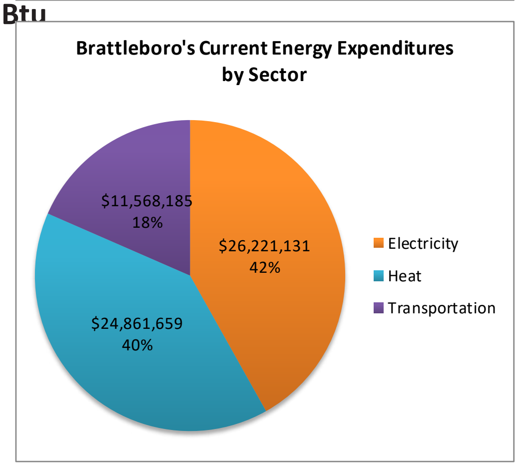
Residential usage *(2016, KWh)*: **31,684,922**

Commericial/Industrial usage *(2016, KWh)*: **132,214,258**

Total electricity usage *(2016, KWh)*: **163,899,179**

Estimated total electricity cost: **$26,221,131**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **8,578 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Brattleboro *(2016)*: **12,750 MWh**

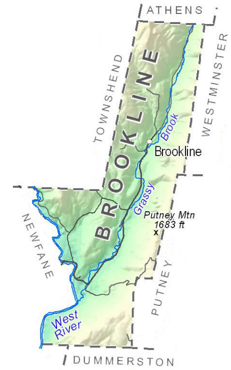
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **108**

...in 2015: **154**

...in 2016: **177**

BROOKLINE



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **646**

Total households *(2014)*: **294**

Total businesses *(2015)*: **10**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **354**

Estimated miles traveled annually: **4,016,640**

Estimated gallons of fuel used: **182,880**

Estimated total transportation costs: **$428,451**

Heating

Total estimated residential heating use: **24,117 MMBtu**

Total heating cost of primary residences: **$467,779**

Total estimated commercial heating use: **5,810 MMBtu**

Total heating energy use: **29,927 MMBtu**

Estimated total heating cost: **$667,838**

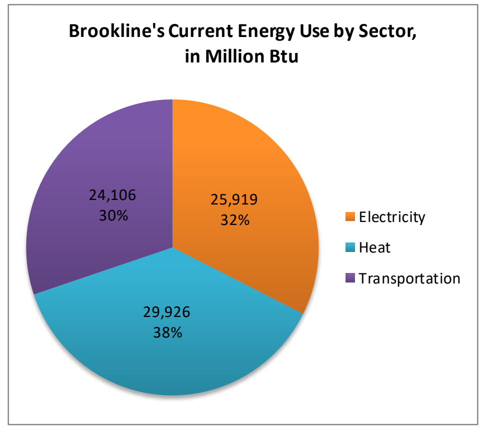
Electricity

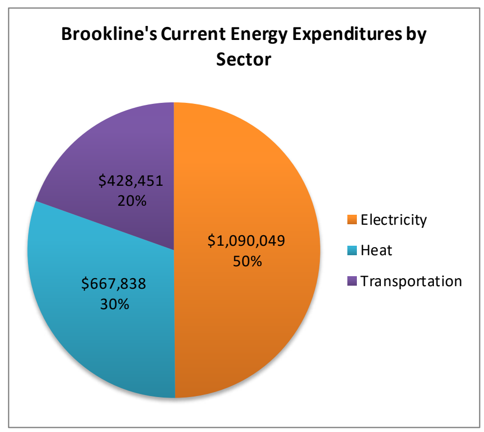
Residential usage *(2016, KWh)*: **1,930,959**

Commericial/Industrial usage *(2016, KWh)*: **126,853**

Total electricity usage *(2016, KWh)*: **2,057,812**

Estimated total electricity cost: **$1,090,049**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **564 MWh***

**In addition to the renewable energy currently being generated*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Brookline *(2016)*: **53 MWh**

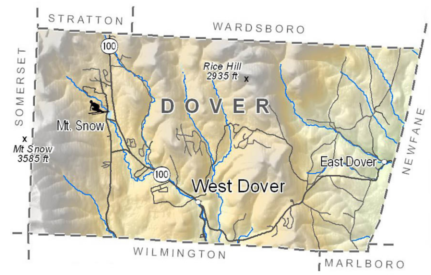
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **11**

...in 2015: **18**

...in 2016: **18**

DOVER



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **1,337**

Total households *(2014)*: **3,054**

Total businesses *(2015)*: **109**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **922**

Estimated miles traveled annually: **10,470,561**

Estimated gallons of fuel used: **476,731**

Estimated total transportation costs: **$1,116,885**

Heating

Total estimated residential heating use: **99,435 MMBtu**

Total heating cost of primary residences: **$1,430,457**

Total estimated commercial heating use: **51,899** **MMBt**

Total heating energy use: **151,333 MMBtu**

Estimated total heating cost: **$3,377,157**

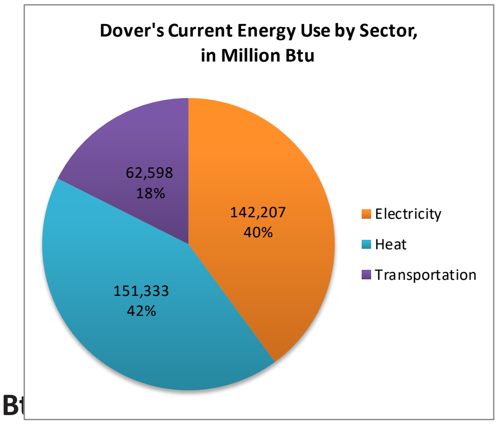
Electricity

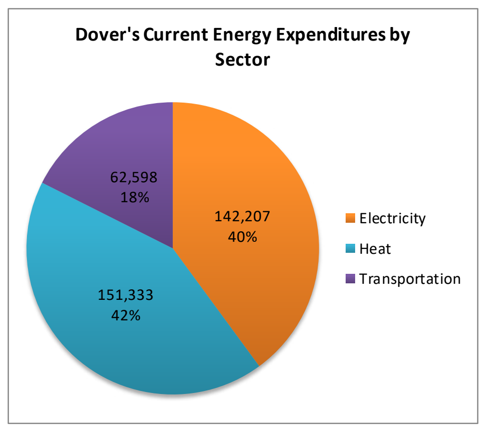
Residential usage *(2016, KWh)*: **18,804,809**

Commericial/Industrial usage *(2016, KWh)*: **21,788,013**

Total electricity usage *(2016, KWh)*: **40,592,822**

Estimated total electricity cost: **$5,980,609**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **2,545 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Dover *(2016)*: **938 MWh**

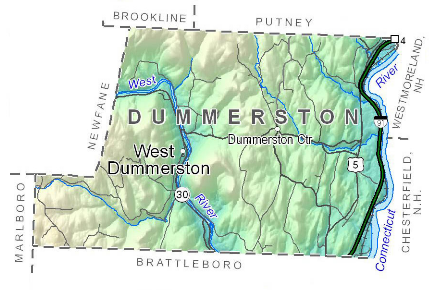
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **17**

...in 2015: **41**

...in 2016: **43**

DUMMERSTON



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **1,939**

Total households *(2014)*: **950**

Total businesses *(2015)*: **53**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **1,413**

Estimated miles traveled annually: **16,047,061**

Estimated gallons of fuel used: **730,632**

Estimated total transportation costs: **$1,711,725**

Heating

Total estimated residential heating use: **90,530 MMBtu**

Total heating cost of primary residences: **$1,834,779**

Total estimated commercial heating use: **20,662**

Total heating energy use: **113,222 MMBtu**

Estimated total heating cost: **$2,526,656**

Electricity

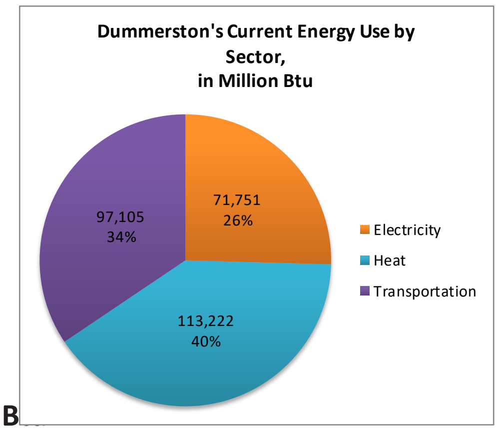
Residential usage *(2016, KWh)*: **6,603,873**

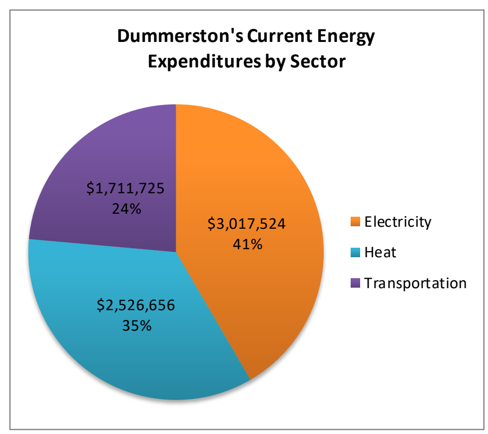
Commericial/Industrial usage *(2016, KWh)*: **3,280,041**

Total electricity usage *(2016, KWh)*: **9,883,915**

Estimated total electricity cost: **$3,017,524**

MMB


Dummerston's Current Energy Use by Sector, in Million Btu


Dummerston's Current Energy Expenditures by Sector

ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **2,070 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Dummerston *(2016)*: **1,497 MWh**

Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **14**

...in 2015: **32**

...in 2016: **31**

GRAFTON

POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **669**

Total households *(2014)*: **486**

Total businesses *(2015)*: **25**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **537**

Estimated miles traveled annually: **6,102,953**

Estimated gallons of fuel used: **277,871**

Estimated total transportation costs: **$650,996**

Heating

Total estimated residential heating use: **34,430 MMBtu**

Total heating cost of primary residences: **$656,776**

Total estimated commercial heating use: **7,233 MMBtu**

Total heating energy use: **44,568 MMBtu**

Estimated total heating cost: **$994,584**

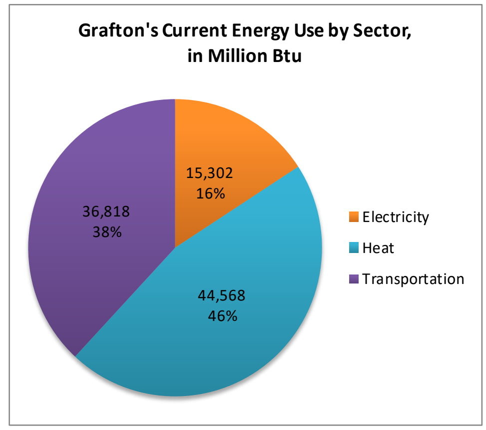
Electricity

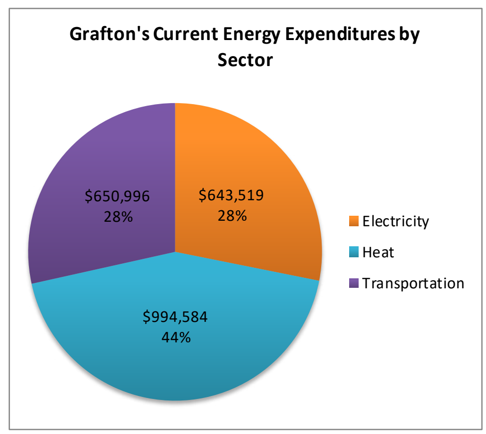
Residential usage *(2016, KWh)*: **3,560,066**

Commericial/Industrial usage *(2016, KWh)*: **1,433,839**

Total electricity usage *(2016, KWh)*: **4,993,905**

Estimated total electricity cost: **$643,519**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **949 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Grafton *(2016, Mwh)*: **85 MWh**

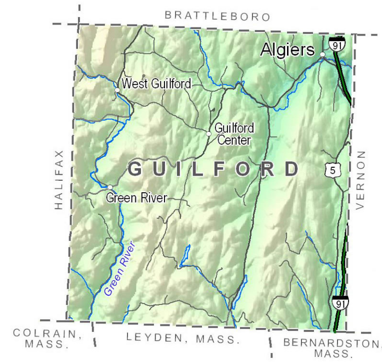
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **7**

...in 2015: **27**

...in 2016: **28**

GUILFORD



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **2,093**

Total households *(2014)*: **1,038**

Total businesses *(2015)*: **49**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **1,549**

Estimated miles traveled annually: **17,587,423**

Estimated gallons of fuel used: **800,766**

Estimated total transportation costs: **$1,876,034**

Heating

Total estimated residential heating use: **99,220 MMBtu**

Total heating cost of primary residences: **$1,967,000**

Total estimated commercial heating use: **16,379** **MMBt**

Total heating energy use: **117,823 MMBtu**

Estimated total heating cost: **$2,629,346**

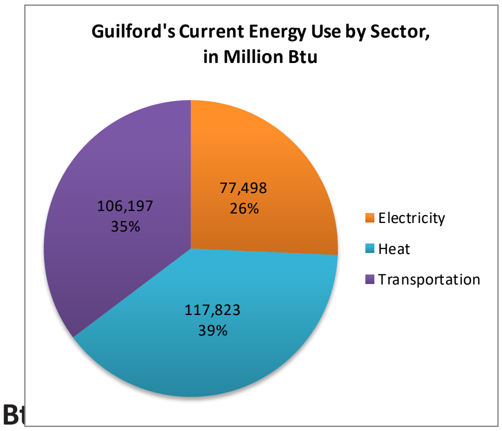
Electricity

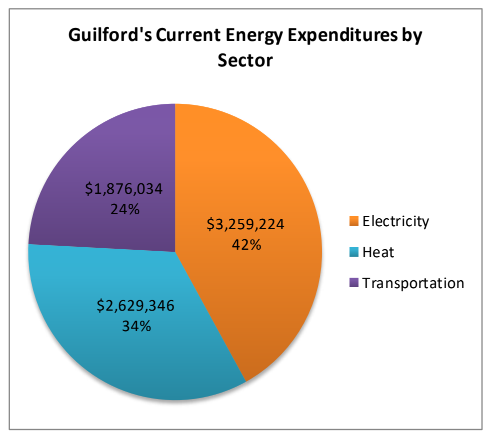
Residential usage *(2016, KWh)*: **7,363,932**

Commericial/Industrial usage *(2016, KWh)*: **1,161,469**

Total electricity usage *(2016, KWh)*: **8,525,400**

Estimated total electricity cost: **$3,259,224**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **2,050 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Guilford *(2016)*: **805 MWh**

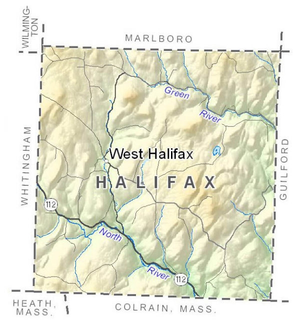
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **14**

...in 2015: **19**

...in 2016: **42**

HALIFAX



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **772**

Total households *(2014)*: **542**

Total businesses *(2015)*: **14**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **567**

Estimated miles traveled annually: **6,434,423**

Estimated gallons of fuel used: **292,963**

Estimated total transportation costs: **$686,354**

Heating

Total estimated residential heating use: **36,300 MMBtu**

Total heating cost of primary residences: **$815,380**

Total estimated commercial heating use: **4,032 MMBtu**

Total heating energy use: **43,813 MMBtu**

Estimated total heating cost: **$977,726**

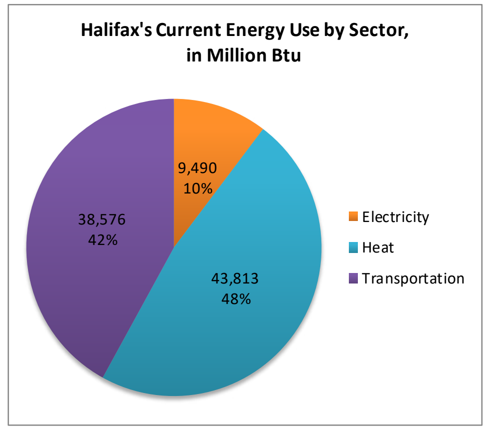
Electricity

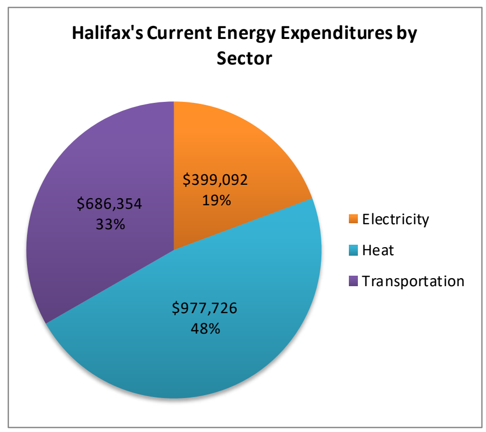
Residential usage *(2016, KWh)*: **2,930,554**

Commericial/Industrial usage *(2016, KWh)*: **267,034**

Total electricity usage *(2016, KWh)*: **3,197,588**

Estimated total electricity cost: **$399,092**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **2,597 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Halifax *(2016)*: **119 MWh**

Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **7**

...in 2015: **13**

...in 2016: **14**

JAMAICA

POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **914**

Total households *(2014)*: **1,055**

Total businesses *(2015)*: **34**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **790**

Estimated miles traveled annually: **8,969,196**

Estimated gallons of fuel used: **408,373**

Estimated total transportation costs: **$956,736**

Heating

Total estimated residential heating use: **50,600 MMBtu**

Total heating cost of primary residences: **$1,055,212**

Total estimated commercial heating use: **21,500 MMB**

Total heating energy use: **81,760 MMBtu**

Estimated total heating cost: **$1,824,553**

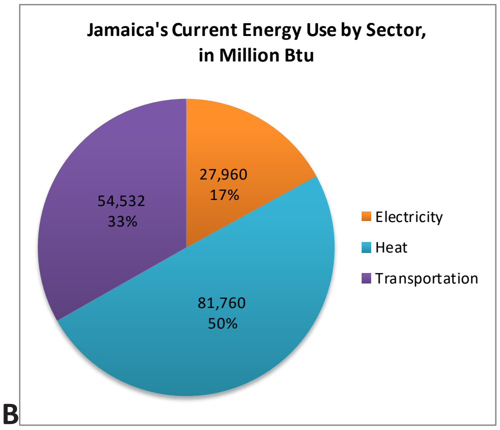
Electricity

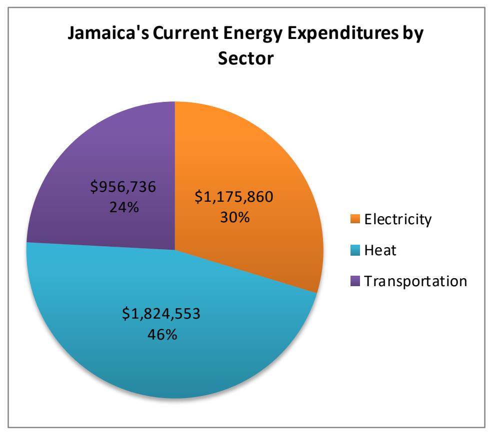
Residential usage *(2016, KWh)*: **6,656,277**

Commericial/Industrial usage *(2016, KWh)*: **1,120,056**

Total electricity usage *(2016, KWh)*: **7,776,333**

Estimated total electricity cost: **$1,175,860**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **1,231 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Jamaica *(2016)*: **75 MWh**

Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **14**

...in 2015: **29**

...in 2016: **50**

LONDONDERRY

POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **1,580**

Total households *(2014)*: **1,476**

Total businesses *(2015)*: **105**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **1,356**

Estimated miles traveled annually: **15,403,619**

Estimated gallons of fuel used: **701,336**

Estimated total transportation costs: **$1,643,090**

Heating

Total estimated residential heating use: **86,900 MMBtu**

Total heating cost of primary residences: **$2,022,626**

Total estimated commercial heating use: **48,775** **MMB**

Total heating energy use: **146,779 MMBtu**

Estimated total heating cost: **$3,275,521**

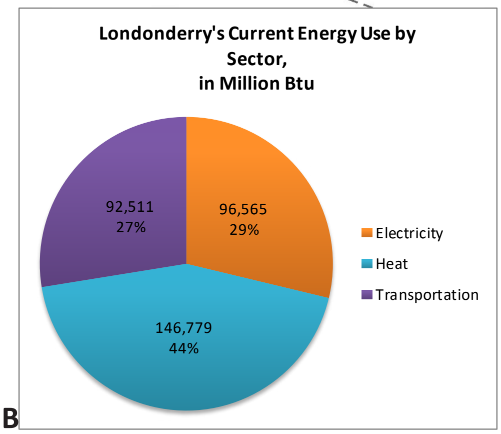
Electricity

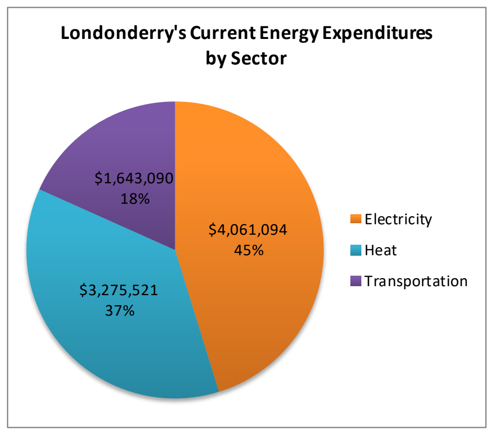
Residential usage *(2016, KWh)*: **19,542,198**

Commericial/Industrial usage *(2016, KWh)*: **38,320,488**

Total electricity usage *(2016, KWh)*: **57,862,686**

Estimated total electricity cost: **$4,061,094**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **3,807 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Londonderry *(2016)*: **285 MWh**

Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **37**

...in 2015: **75**

...in 2016: **55**

MARLBORO

POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **1,164**

Total households *(2014)*: **526**

Total businesses *(2015)*: **27**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **649**

Estimated miles traveled annually: **7,370,339**

Estimated gallons of fuel used: **335,576**

Estimated total transportation costs: **$786,187**

Heating

Total estimated residential heating use: **41,580 MMBtu**

Total heating cost of primary residences: **$851,612**

Total estimated commercial heating use: **15,821** **MMBt**

Total heating energy use: **59,827 MMBtu**

Estimated total heating cost: **$1,335,095**

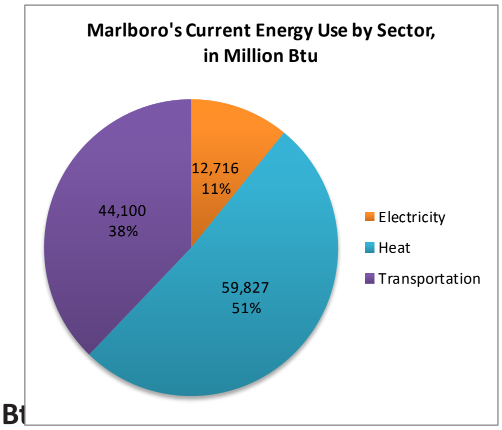
Electricity

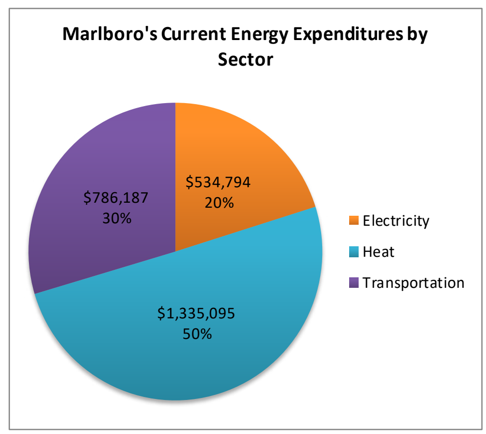
Residential usage *(2016, KWh)*: **2,758,975**

Commericial/Industrial usage *(2016, KWh)*: **1,160,788**

Total electricity usage *(2016, KWh)*: **3,919,763**

Estimated total electricity cost: **$534,794**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **2,943 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Marlboro *(2016)*: **196 MWh**

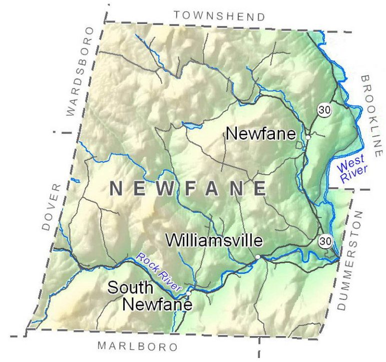
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **17**

...in 2015: **20**

...in 2016: **32**

NEWFANE



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **1,808**

Total households *(2014)*: **1,090**

Total businesses *(2015)*: **48**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **1,324**

Estimated miles traveled annually: **15,033,152**

Estimated gallons of fuel used: **684,468**

Estimated total transportation costs: **$1,603,573**

Heating

Total estimated residential heating use: **84,810 MMBtu**

Total heating cost of primary residences: **$1,786,067**

Total estimated commercial heating use: **25,409** **MMBt**

Total heating energy use: **115,415 MMBtu**

Estimated total heating cost: **$2,575,600**

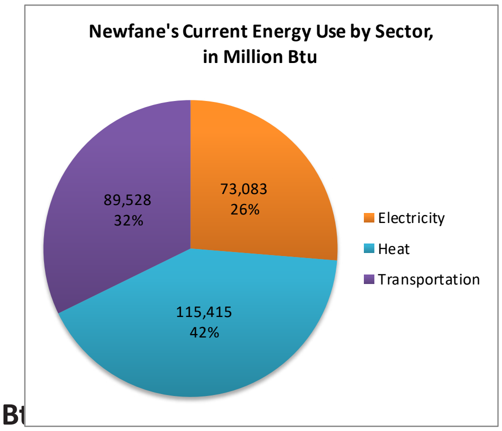
Electricity

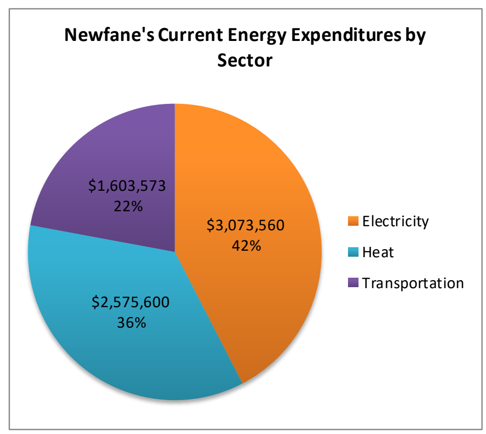
Residential usage *(2016, KWh)*: **6,335,242**

Commericial/Industrial usage *(2016, KWh)*: **1,534,686**

Total electricity usage *(2016, KWh)*: **7,869,928**

Estimated total electricity cost: **$3,073,560**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **1,589 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Newfane *(2016)*: **127 MWh**

Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

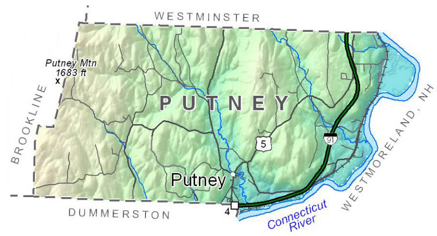
...in 2014: **29**

...in 2015: **34**

...in 2016: **40**

PUTNEY

POPULATION, HOUSEHOLDS, & BUSINESSES



Total population *(2014)*: **2,687**

Total households *(2014)*: **1,146**

Total businesses *(2015)*: **103**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **1,719**

Estimated miles traveled annually: **19,517,750**

Estimated gallons of fuel used: **888,655**

Estimated total transportation costs: **$2,081,940**

Heating

Total estimated residential heating use: **110,110** **MMBt**

Total heating cost of primary residences: **$1,962,500**

Total estimated commercial heating use: **63,392** **MMBt**

Total heating energy use: **116,197 MMBtu**

Estimated total heating cost: **$3,926,948**

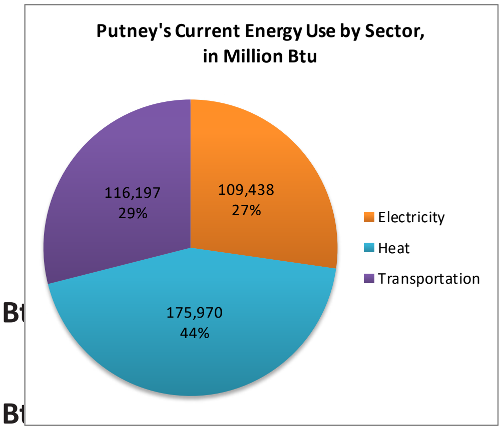
Electricity

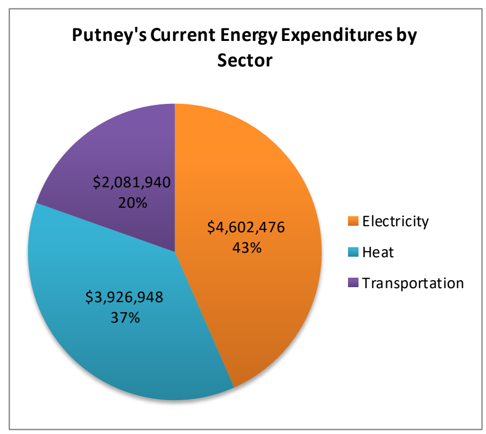
Residential usage *(2016, KWh)*: **8,016,125**

Commericial/Industrial usage *(2016, KWh)*: **27,393,657**

Total electricity usage *(2016, KWh)*: **35,409,782**

Estimated total electricity cost: $**4,602,476**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **2,701 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Putney *(2016)*: **1,808 MWh**

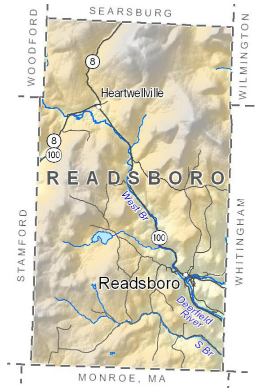
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **34**

...in 2015: **59**

...in 2016: **59**

READSBORO



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **763**

Total households *(2014)*: **496**

Total businesses *(2015)*: **21**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **577**

Estimated miles traveled annually: **6,551,413**

Estimated gallons of fuel used: **298,290**

Estimated total transportation costs: **$698,833**

Heating

Total estimated residential heating use: **36,960 MMBtu**

Total heating cost of primary residences: **$832,085**

Total estimated commercial heating use: **19,505** **MMBt**

Total heating energy use: **59,074 MMBtu**

Estimated total heating cost: **$1,318,291**

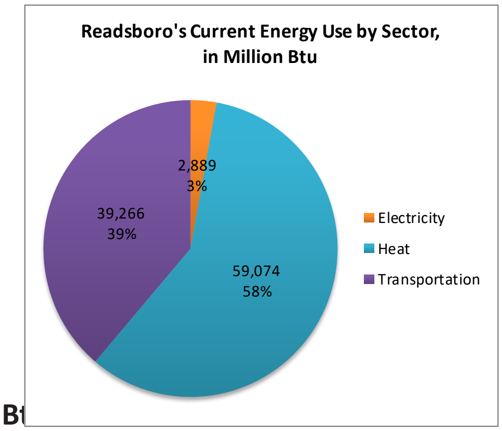
Electricity

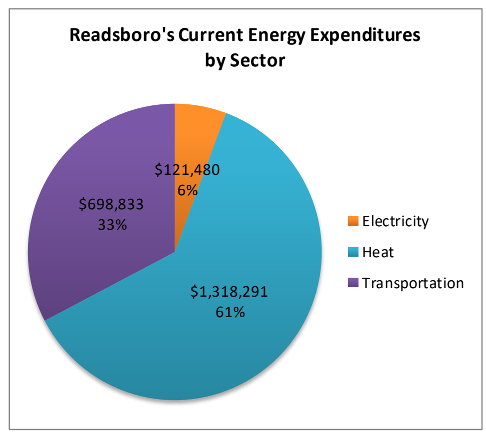
Residential usage *(2016, KWh)*: **2,690,837**

Commericial/Industrial usage *(2016, KWh)*: **547,800**

Total electricity usage *(2016, KWh)*: **3,238,636**

Estimated total electricity cost: **$121,480**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **1,410 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Readsboro *(2016)*: **41 MWh**

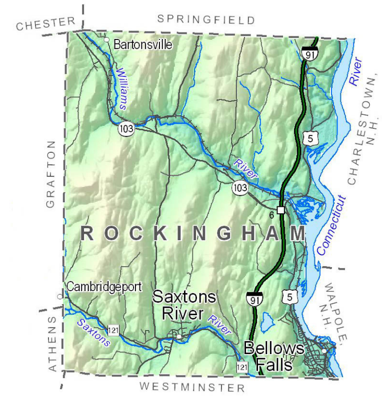
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **9**

...in 2015: **18**

...in 2016: **24**

ROCKINGHAM



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **5,165**

Total households *(2014)*: **2,551**

Total businesses *(2015)*: **190**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **3,772**

Estimated miles traveled annually: **42,837,660**

Estimated gallons of fuel used: **1,950,424**

Estimated total transportation costs: **$4,569,454**

Heating

Total estimated residential heating use: **241,670 MMBtu**

Total heating cost of primary residences: **$4,278,978**

Total estimated commercial heating use: **108,110**

Total heating energy use: **355,681 MMBtu**

Estimated total heating cost: **$7,937,390**

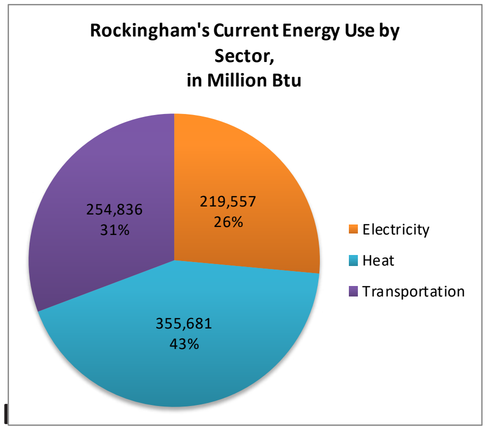
Electricity

Residential usage *(2016, KWh)*: **15,291,948**

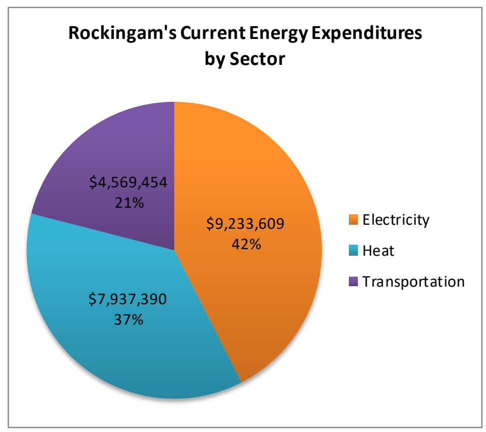
Commericial/Industrial usage *(2016, KWh)*: **17,700,515**

Total electricity usage *(2016, KWh)*: **32,992,463**

Estimated total electricity cost: **$9,233,609**



MMI



ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **4,239 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Rockingham *(2016, Mwh)*: **185,148 MWh**

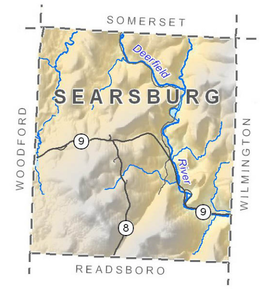
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **31**

...in 2015: **65**

...in 2016: **91**

SEARSBURG



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **89**

Total households *(2014)*: **93**

Total businesses *(2015)*: **5**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **76**

Estimated miles traveled annually: **857,923**

Estimated gallons of fuel used: **39,062**

Estimated total transportation costs: **$91,514**

Heating

Total estimated residential heating use: **4,840 MMBtu**

Total heating cost of primary residences: **$156,120**

Total estimated commercial heating use: **961 MMBtu**

Total heating energy use: **5,920 MMBtu**

Estimated total heating cost: **$132,102**

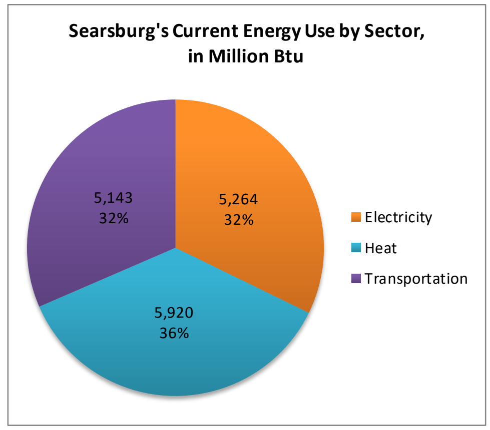
Electricity

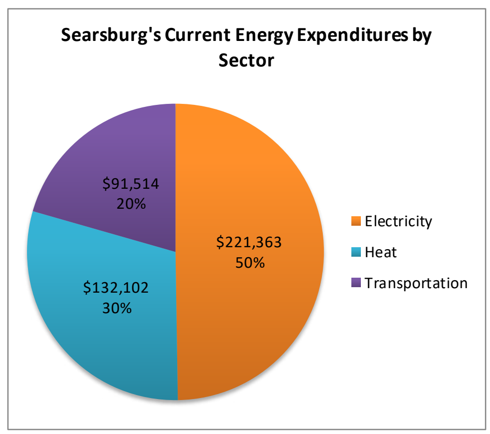
Residential usage *(2016, KWh)*: **479,067**

Commericial/Industrial usage *(2016, KWh)*: **160,334**

Total electricity usage *(2016, KWh)*: **639,401**

Estimated total electricity cost: **$221,363**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **134 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Searsburg *(2016, Mwh)*: **33,200 MWh**

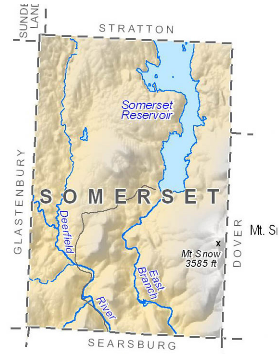
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **12**

...in 2015: **27**

...in 2016: **15**

SOMERSET



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **8**

Total households *(2014)*: **21**

Total businesses *(2015)*: **0**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **5**

Estimated miles traveled annually: **11,356**

Estimated gallons of fuel used: **2,663**

Estimated total transportation costs: **$6,240**

Heating

Total estimated residential heating use: **634 MMBtu**

Total heating cost of primary residences: **$6,219**

Total estimated commercial heating use: **0 MMBtu**

Total heating energy use: **634 MMBtu**

Estimated total heating cost: **$14,150**

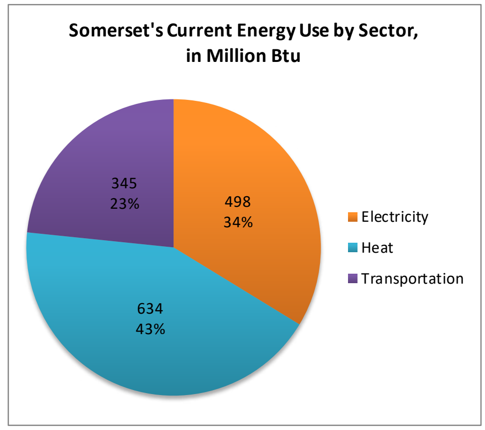
Electricity

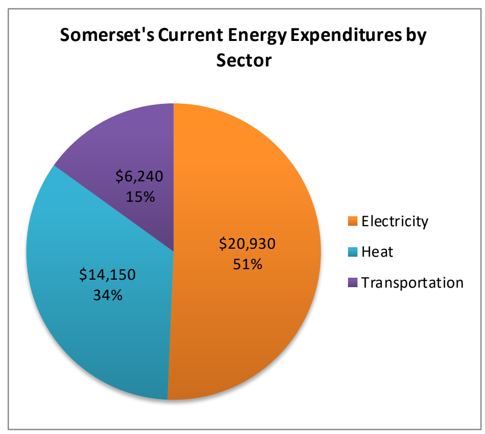
Residential usage *(2016, KWh)*: **145,856**

Commericial/Industrial usage *(2016, KWh)*: **(no data)**

Total electricity usage *(2016, KWh)*: **145,856**

Estimated total electricity cost: **$20,930**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **0 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Somerset *(2016, Mwh)*: **0**

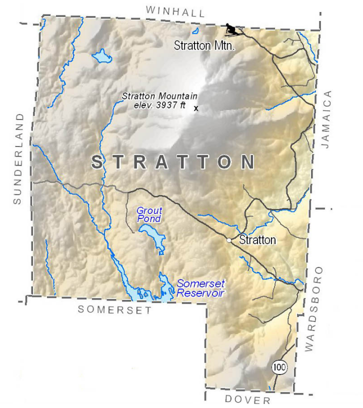
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **0**

...in 2015: **0**

...in 2016: **0**

STRATTON



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **224**

Total households *(2014)*: **1,447**

Total businesses *(2015)*: **25**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **168**

Estimated miles traveled annually: **1,910,829**

Estimated gallons of fuel used: **87,001**

Estimated total transportation costs: **$203,826**

Heating

Total estimated residential heating use: **32,263 MMBtu**

Total heating cost of primary residences: **$268,406**

Total estimated commercial heating use: **22,276**

MMBt

Total heating energy use: **54,539 MMBtu**

Estimated total heating cost: **$1,217,094**

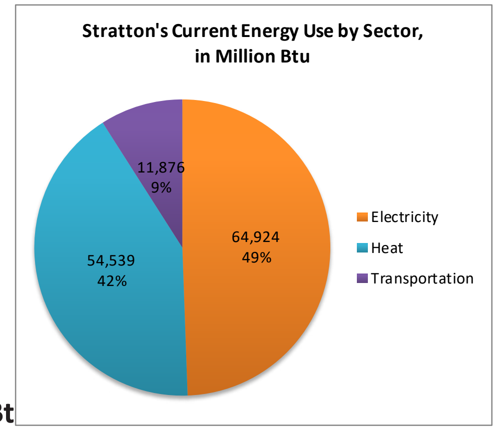
Electricity

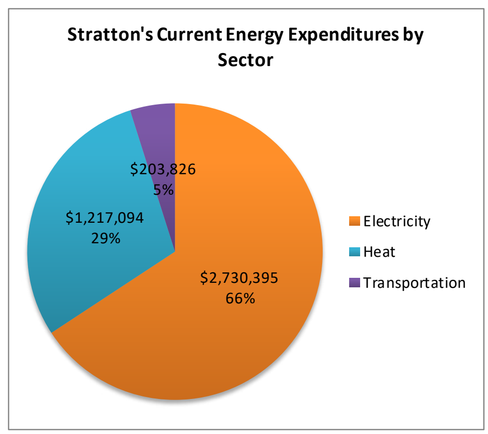
Residential usage *(2016, KWh)*: **(no data)**

Commericial/Industrial usage *(2016, KWh)*: **(no data)**

Total electricity usage *(2016, KWh)*: **19,027,141**

Estimated total electricity cost: **$2,730,395**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **1,000 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Stratton *(2016)*: **11 MWh**

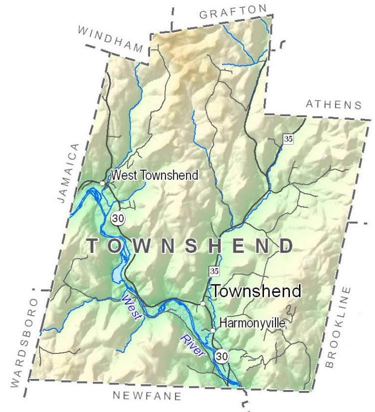
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **3**

...in 2015: **4**

...in 2016: **17**

TOWNSHEND



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **1,022**

Total households *(2014)*: **784**

Total businesses *(2015)*: **44**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **986**

Estimated miles traveled annually: **11,191,997**

Estimated gallons of fuel used: **509,578**

Estimated total transportation costs: **$1,193,840**

Heating

Total estimated residential heating use: **63,140 MMBtu**

Total heating cost of primary residences: **$1,287,229**

Total estimated commercial heating use: **20,667** **MMBt**

Total heating energy use: **87,310 MMBtu**

Estimated total heating cost: **$1,948,405**

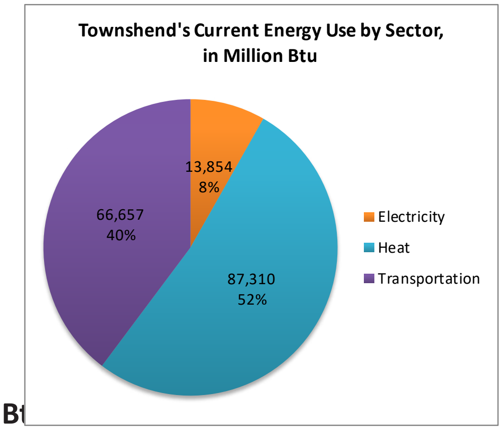
Electricity

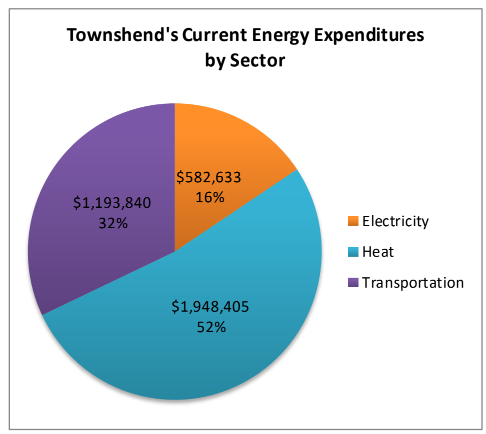
Residential usage *(2016, KWh)*: **4,727,401**

Commericial/Industrial usage *(2016, KWh)*: **3,594,982**

Total electricity usage *(2016, KWh)*: **8,322,384**

Estimated total electricity cost: **$582,633**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **1,043 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Townshend *(2016, Mwh)*: **471 MWh**

Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **19**

...in 2015: **31**

...in 2016: **57**

VERNON

POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **2,055**

Total households *(2014)*: **924**

Total businesses *(2015)*: **55**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **1,485**

Estimated miles traveled annually: **16,865,988**

Estimated gallons of fuel used: **767,918**

Estimated total transportation costs: **$1,799,079**

Heating

Total estimated residential heating use: **95,150 MMBtu**

Total heating cost of primary residences: **$1,866,665**

Total estimated commercial heating use: **14,258** **MMBt**

Total heating energy use: **110,319 MMBtu**

Estimated total heating cost: **$2,461,883**

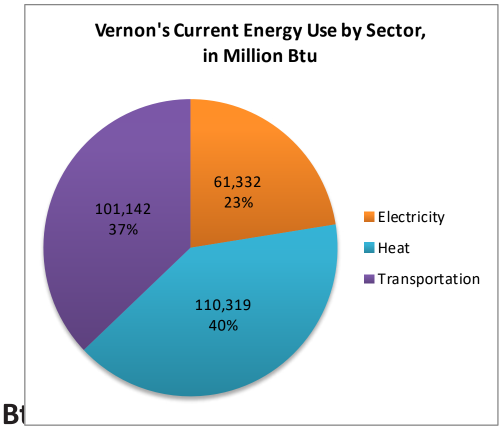
Electricity

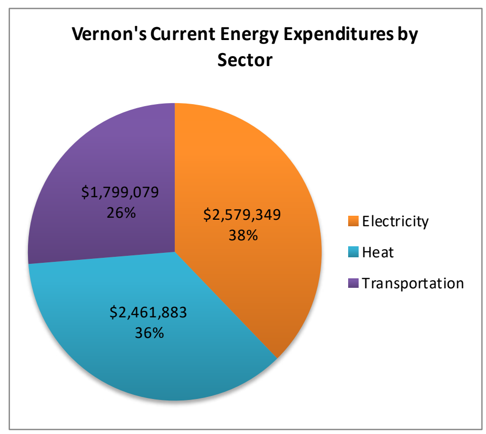
Residential usage *(2016, KWh)*: **7,544,778**

Commercial/Industrial usage *(2016, KWh)*: **20,534,190**

Total electricity usage *(2016, KWh)*: **28,078,968**

Estimated total electricity cost: **$2,579,349**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **1,654 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Vernon *(2016, Mwh)*: **184,200 MWh**

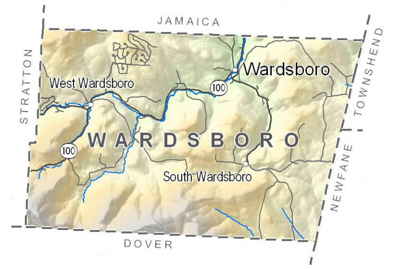
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **14**

...in 2015: **37**

...in 2016: **39**

WARDSBORO



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **704**

Total households *(2014)*: **849**

Total businesses *(2015)*: **28**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **642**

Estimated miles traveled annually: **11,356**

Estimated gallons of fuel used: **332,025**

Estimated total transportation costs: **$777,868**

Heating

Total estimated residential heating use: **41,140 MMBtu**

Total heating cost of primary residences: **$1,003,987**

Total estimated commercial heating use: **6,740 MMBtu**

Total heating energy use: **55,734 MMBtu**

Estimated total heating cost: **$1,243,767**

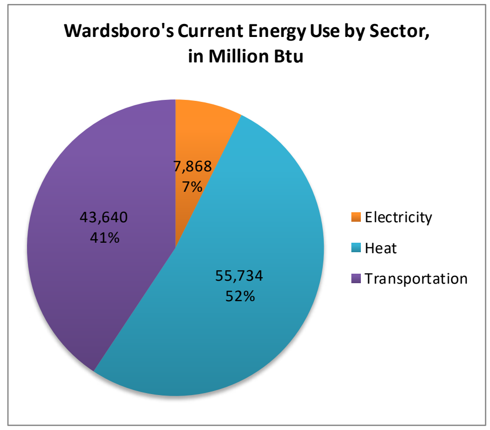
Electricity

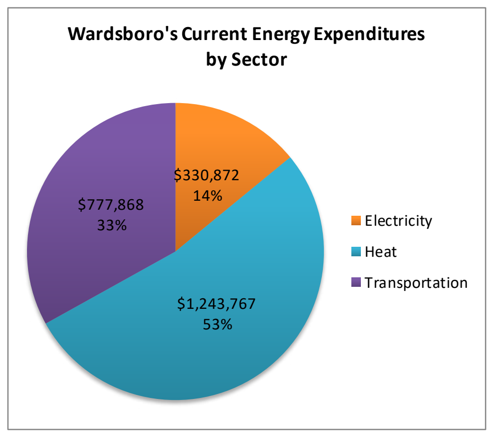
Residential usage *(2016, KWh)*: **4,582,220**

Commericial/Industrial usage *(2016, KWh)*: **598,626**

Total electricity usage *(2016, KWh)*: **5,180,846**

Estimated total electricity cost: **$330,872**





ENERGY GENERATION TARGETS

For the 90% x 50 State goal, target renewable energy generation by 2050: **1,864 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Wardsboro *(2016)*: **23 MWh**

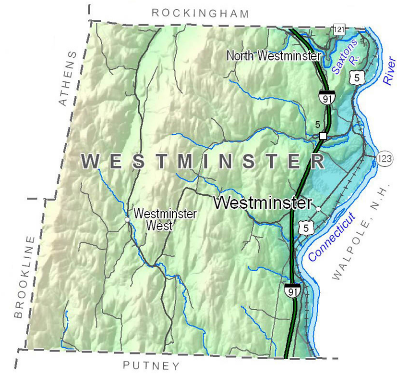
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **9**

...in 2015: **21**

...in 2016: **28**

WESTMINSTER



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **3,127**

Total households *(2014)*: **1,466**

Total businesses *(2015)*: **79**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **2,229**

Estimated miles traveled annually: **25,308,731**

Estimated gallons of fuel used: **1,152,322**

Estimated total transportation costs: **$2,699,659**

Heating

Total estimated residential heating use: **142,780** **MMB**

Total heating cost of primary residences: **$2,973,189**

Total estimated commercial heating use: **36,729** **MMB**

Total heating energy use: **182,156 MMBtu**

Estimated total heating cost: **$4,065,002**

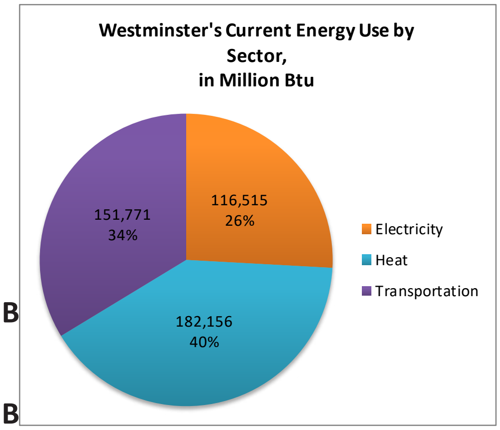
Electricity

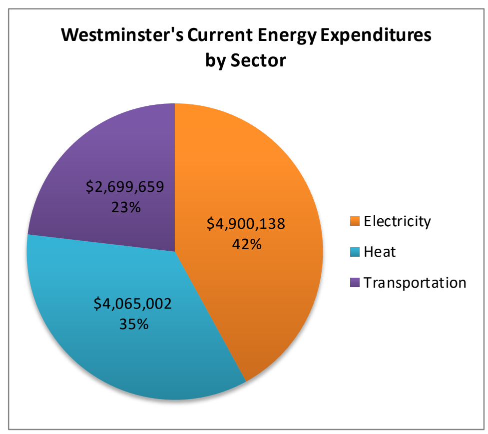
Residential usage *(2016, KWh)*: **10,138,254**

Commericial/Industrial usage *(2016, KWh)*: **5,348,487**

Total electricity usage *(2016, KWh)*: **15,486,741**

Estimated total electricity cost: **$4,900,138**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **3,544 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Westminster *(2016)*: **3,544 MWh**

Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **33**

...in 2015: **42**

...in 2016: **54**

WESTON

POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **571**

Total households *(2014)*: **565**

Total businesses *(2015)*: **36**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **450**

Estimated miles traveled annually: **5,108,542**

Estimated gallons of fuel used: **232,595**

Estimated total transportation costs: **$544,923**

Heating

Total estimated residential heating use: **28,820 MMBtu**

Total heating cost of primary residences: **$657,762**

Total estimated commercial heating use: **21,995** **MMBt**

Total heating energy use: **55,890 MMBtu**

Estimated total heating cost: **$1,247,242**

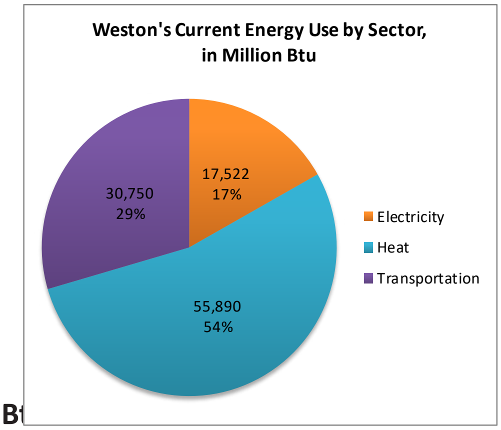
Electricity

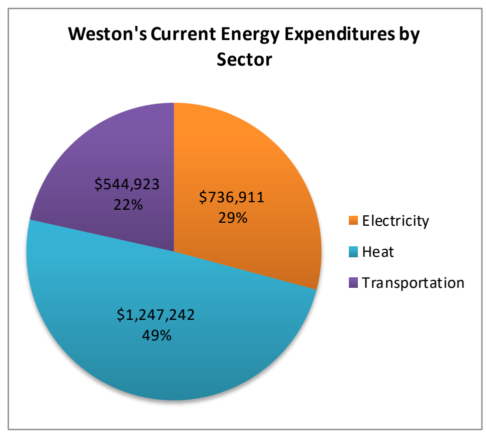
Residential usage *(2016, KWh)*: **3,633,989**

Commericial/Industrial usage *(2016, KWh)*: **1,299,194**

Total electricity usage *(2016, KWh)*: **4,933,184**

Estimated total electricity cost: **$736,911**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **1,524 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Weston *(2016)*: **119 MWh**

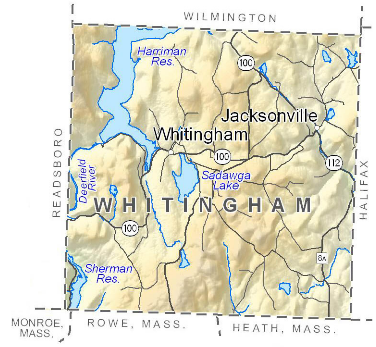
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **16**

...in 2015: **29**

...in 2016: **30**

WHITINGHAM



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **1,299**

Total households *(2014)*: **918**

Total businesses *(2015)*: **36**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **986**

Estimated miles traveled annually: **11,191,997**

Estimated gallons of fuel used: **509,578**

Estimated total transportation costs: **$1,193,840**

Heating

Total estimated residential heating use: **63,140 MMBtu**

Total heating cost of primary residences: **$1,396,601**

Total estimated commercial heating use: **10,797 MMBt**

Total heating energy use: **79,500 MMBtu**

Estimated total heating cost: **$1,774,116**

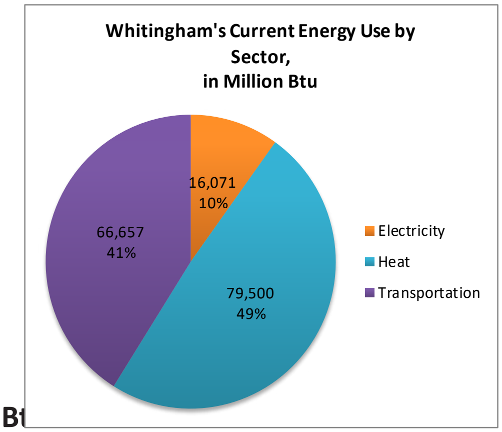
Electricity

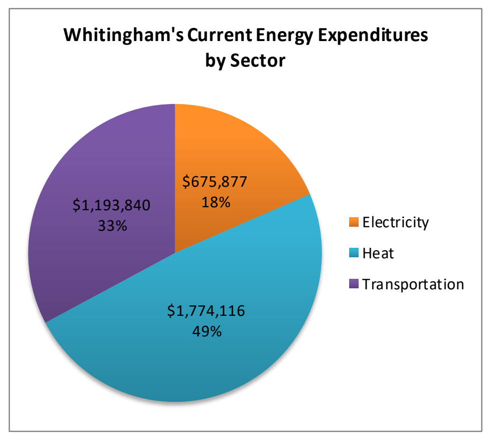
Residential usage *(2016, KWh)*: **1,717,234**

Commericial/Industrial usage *(2016, KWh)*: **5,319,272**

Total electricity usage *(2016, KWh)*: **7,036,506**

Estimated total electricity cost: **$675,877**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **3,330 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Whitingham *(2016)*: **198,082 MWh**

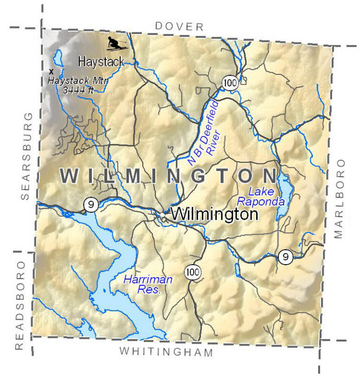
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **13**

...in 2015: **22**

...in 2016: **30**

WILMINGTON



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **2,067**

Total households *(2014)*: **2,493**

Total businesses *(2015)*: **124**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **1,487**

Estimated miles traveled annually: **16,885,486**

Estimated gallons of fuel used: **768,806**

Estimated total transportation costs: **$1,801,159**

Heating

Total estimated residential heating use: **95,260 MMBtu**

Total heating cost of primary residences: **$2,138,839**

Total estimated commercial heating use: **59,094** **MMBt**

Total heating energy use: **180,891 MMBtu**

Estimated total heating cost: **$4,036,771**

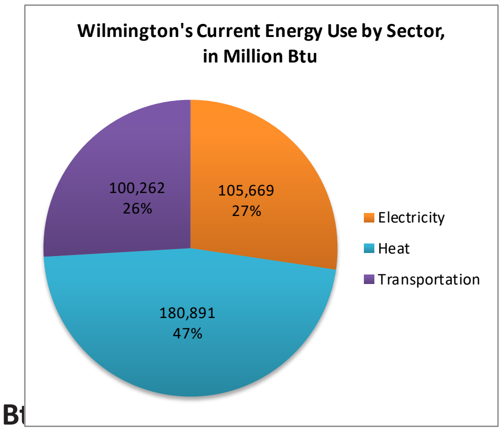
Electricity

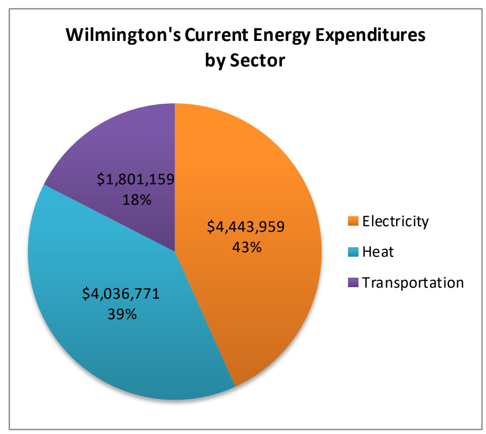
Residential usage *(2016, KWh)*: **17,511,342**

Commericial/Industrial usage *(2016, KWh)*: **12,786,251**

Total electricity usage *(2016, KWh)*: **30,297,593**

Estimated total electricity cost: **$4,443,959**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **4,504 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Wilmington *(2016)*: **197 MWh**

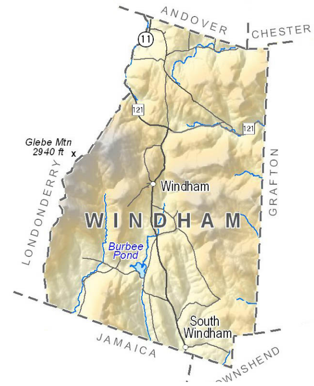
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **21**

...in 2015: **34**

...in 2016: **37**

WINDHAM



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **359**

Total households *(2014)*: **396**

Total businesses *(2015)*: **14**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **321**

Estimated miles traveled annually: **3,646,173**

Estimated gallons of fuel used: **166,012**

Estimated total transportation costs: **$388,934**

Heating

Total estimated residential heating use: **20,570 MMBtu**

Total heating cost of primary residences: **$468,476**

Total estimated commercial heating use: **2,984 MMBtu**

Total heating energy use: **27,033 MMBtu**

Estimated total heating cost: **$603,278**

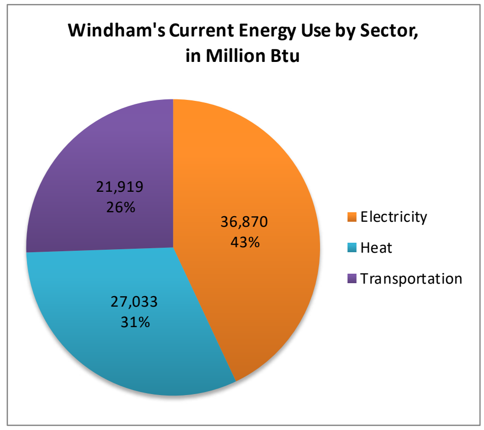
Electricity

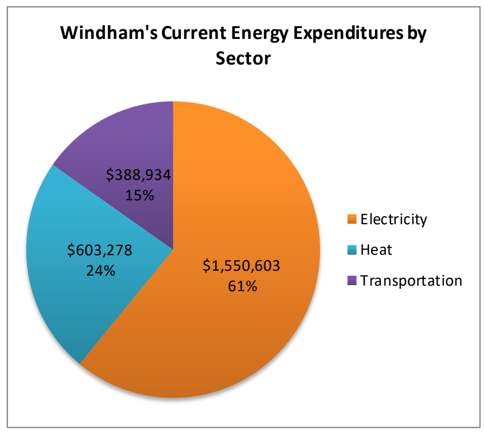
Residential usage *(2016, KWh)*: **2,250,160**

Commericial/Industrial usage *(2016, KWh)*: **198,325**

Total electricity usage *(2016, KWh)*: **2,448,485**

Estimated total electricity cost: **$1,550,603**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **695 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Windham *(2016)*: **53 MWh**

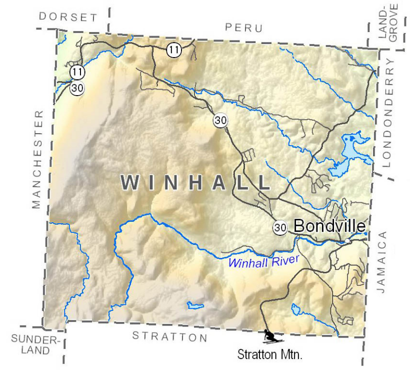
Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **8**

...in 2015: **15**

...in 2016: **19**

WINHALL



POPULATION, HOUSEHOLDS, & BUSINESSES

Total population *(2014)*: **537**

Total households *(2014)*: **1,749**

Total businesses *(2015)*: **54**

CURRENT ENERGY USE & EXPENDITURES

Transportation

Number of vehicles *(2014)*: **589**

Estimated miles traveled annually: **6,687,900**

Estimated gallons of fuel used: **304,504**

Estimated total transportation costs: **$713,392**

Heating

Total estimated residential heating use: **37,730 MMBtu**

Total heating cost of primary residences: **$900,372**

Total estimated commercial heating use: **26,022** **MMBt**

Total heating energy use: **86,390 MMBtu**

Estimated total heating cost: **$1,927,891**

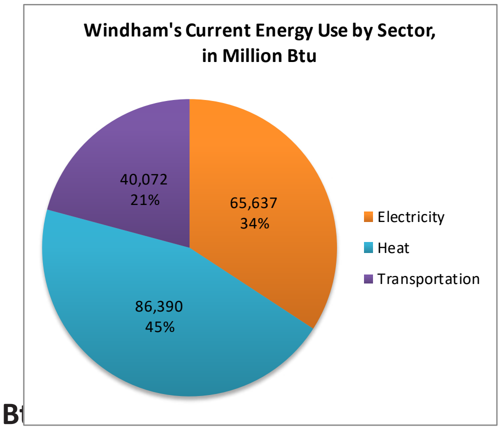
Electricity

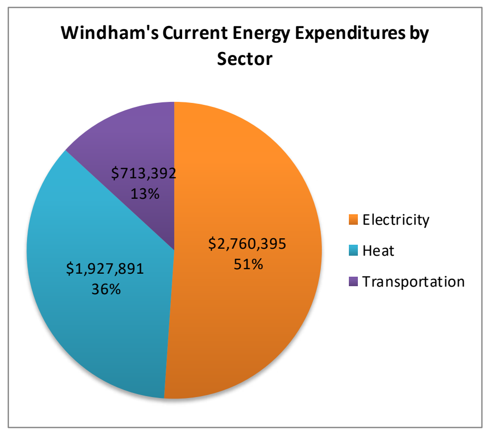
Residential usage *(2016, KWh)*: **14,762,991**

Commericial/Industrial usage *(2016, KWh)*: **2,594,592**

Total electricity usage *(2016, KWh)*: **17,357,583**

Estimated total electricity cost: **$2,760,395**





ENERGY GENERATION TARGETS

For the 90x50 State goal, target renewable energy generation by 2050: **1,499 MWh***

**In addition to the renewable energy currently being generated.*

EXISTING GENERATION & CONSERVATION PROJECTS

Existing renewable energy generation in Winhall *(2016)*: **85 MWh**

Total residential energy conservation projects (includes Home Performance with ENERGY STAR® projects)...

...in 2014: **15**

...in 2015: **31**

...in 2016: **45**

APPENDIX E: WINDHAM REGION EFFICIENCY & FUEL SWITCHING TARGETS

WEATHERIZATION EFFICIENCY TARGETS FOR BUILDINGS

Table 1: Efficiency targets for residential buildings

Percent of residential buildings to be weatherized	LEAP benchmark year
24%	2025
46%	2035
94%	2050

Table 2: Efficiency targets for commercial buildings

Percent of commercial buildings to be weatherized	LEAP benchmark year
4%	2025
7%	2035
12%	2050

RESIDENTIAL FUEL SWITCHING TARGETS

Table 3: Biofuel composition in residential fuels

Percent of biofuels in biofuel-blend heating fuels	LEAP benchmark year
4%	2025
10%	2035
100%	2050

Table 4: Residences using biofuels

Percent of homes using biofuel-blend heating fuel	LEAP benchmark year
40%	2025
27%	2035
6%	2050

Table 5: Residences using wood fuel

Percent of homes using wood-based heating fuel	LEAP benchmark year
55%	2025
53%	2035
57%	2050

Table 6: Residences using electric heat pumps

Percent of homes switching exclusively to heat pumps (electrification)	LEAP benchmark year
18%	2025
39%	2035
64%	2050

Table 7: Residences using non-renewable fuels

Percent of fossil fuel use in residential heating	LEAP benchmark year
19%	2025
14%	2035
4%	2050

COMMERCIAL FUEL SWITCHING TARGETS

Table 8: Biofuel composition in commercial fuels

Percent of biofuels in biofuel-blend heating fuels	LEAP benchmark year
13%	2025
31%	2035
99%	2050

Table 9: Commercial establishments using biofuels

Percent of businesses using biofuel-blend heating fuel	LEAP benchmark year
26%	2025
19%	2035
10%	2050

Table 10: Commercial establishments using wood fuel

Percent of businesses using wood-based heating fuel	LEAP benchmark year
13%	2025
15%	2035
20%	2050

Table 11: Commercial establishments using electric heat pumps

Percent of businesses switching exclusively to heat pumps (electrification)	LEAP benchmark year
5%	2025
9%	2035
12%	2050

Table 12: Commercial establishments using non-renewable fuels

Percent of fossil fuel use in commercial heating	LEAP benchmark year
17%	2025
13%	2035
8%	2050

TRANSPORTATION FUEL SWITCHING TARGETS

The LEAP model assumes the light duty vehicle fleet (passenger vehicles) will transform substantially by 2050. By 2050 the Region's fleet is targeted to be fueled by 76% electric and 8% biofuel-blend.

Table 13: Electric car conversion

Percent of vehicle fleet to be converted to electric	LEAP benchmark year
5%	2025
37%	2035
76%	2050

Table 14: Biofuel composition in light duty vehicle fuel

Percent of biofuels in biofuel blend	LEAP benchmark year
11%	2025
14%	2035
52%	2050

Table 15: Biofuel car conversion

Percent of vehicles fueled by biofuel blend	LEAP benchmark year
90%	2025
50%	2035
8%	2050

ELECTRICAL EFFICIENCY TARGETS

Table 16: Targeted number of homes with electrical efficiency projects

Residences to be upgraded with electricity efficiencies	Total electricity saved from improvements in area residential equipment efficiency, in kWh	LEAP benchmark year
7,885 (39%)	41,000,000	2025
12,885 (63%)	67,000,000	2035
18,845 (96%)	98,000,000	2050

APPENDIX F: WINDHAM REGION LEAP SYSTEM MODELING

Vermont Energy Investment Corporation

Powered by SunShot U.S. Department of Energy

Summary Results and Methodology

Introduction

This document supplements the regional energy plans created by each Regional Planning Commission (RPC). It was developed by Vermont Energy Investment Corporation (VEIC) as documentation to modeling work performed for the RPCs. An award from the Department of Energy's SunShot Solar Market Pathways program funded the creation of a detailed statewide total energy supply and demand model. The VEIC team used the statewide energy model as a foundation for the region-specific modeling efforts. More detailed methodology is included at the end of this report.

Statewide Approach

Historic information was primarily drawn from the Public Service Department's Utility Facts 2013[1] and EIA data. Projections came from the Total Energy Study (TES)[2], the utilities' Committed Supply[3], and stakeholder input.

Demand Drivers

Each sector has a unit that is used to measure activity in the sector. That unit is the "demand driver" because in the model it is multiplied by the energy intensity of the activity to calculate energy demand.

The population change for each region is calculated from town data in Vermont Population Projections 2010-2030[4]. Growth rates are assumed constant through 2050.

RPC	Annual Growth
Addison	0.00%
Bennington	0.02%
Central VT	0.12%
Chittenden	0.48%
Lamoille	1.46%
Northwest	0.87%
NVDA	0.21%
Rutland	-0.27%
Southern Windsor	0.24%
Two Rivers	0.29%
Windham	0.34%

[1] Vermont Public Service Department, Utility Facts 2013. http://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Utility_Facts/Utility%20Facts%202013.pdf

[2] Vermont Public Service Department, Total Energy Study: Final Report on a Total Energy Approach to Meeting the State's Greenhouse Gas and Renewable Energy Goals. December 8, 2014. http://publicservice.vermont.gov/sites/psd/files/Pubs_Plans_Reports/TES/TES%20FINAL%20Report%2020141208.pdf.

[3] Vermont Public Service Department provided the data behind the graph on the bottom half of page E.7 in Utility Facts 2013. It is compiled from utility Integrated Resource Plans.

[4] Jones, Ken, and Lilly Schwarz, Vermont Population Projections-2010-2030, August, 2013. http://dail.vermont.gov/dail-publications/publications-general-reports/vt-population-projections-2010-2030.

People per house are assumed to decrease from 2.4 in 2010 to 2.17 in 2050. This gives the number of households, the basic unit and demand driver in the model for residential energy consumption.

Projected change in the energy demand from the commercial sector was based on commercial sector data in the TES. The demand driver for the commercial sector is commercial building square feet which grow almost 17% from 2010 to 2050.

The team entered total industrial consumption by fuel from the TES directly into the model. It grows from 1.1 TBtu in 2010 to 1.4 TBtu in 2050.

Transportation energy use is based on projections of vehicle miles traveled (VMT). VMT peaked in 2006 and has since declined slightly.[5] Given this, and Vermont's efforts to concentrate development and to support alternatives to single occupant vehicles, VMT per capita is assumed to remain flat at 12,000.

The regional models use two scenarios. The **reference scenario** assumes a continuation of today's energy use patterns, but does not reflect the Vermont's renewable portfolio standard or renewable energy or greenhouse gas emissions goals. The main changes over time in the reference scenario are more fuel efficient cars because of CAFE standards and the expansion of natural gas infrastructure. The **90% x 2050 $_{\mathbf{VEIC}}$ scenario** is designed to achieve the goal of meeting 90% of Vermont's total energy demand with renewable sources. It is adapted from the TES TREES Local scenarios. It is a hybrid of the high and low biofuel cost scenarios, with biodiesel or renewable diesel replacing petroleum diesel in heavy duty vehicles and electricity replacing gasoline in light duty vehicles. Despite a growing population and economy, energy use declines because of efficiency and electrification. Electrification of heating and transportation has a large effect on the total demand because the electric end uses are three to four times more efficient than the combustion versions they replace.

Regionalization Approach

The demand in the statewide model was broken into the state's planning regions. Residential demand was distributed according to housing units using data from the American Community Survey. Commercial and industrial demand was allocated to the regions by service-providing and goods-producing NAICS codes respectively. Fuel use in these sectors was allocated based on existing natural gas infrastructure. In the commercial sector, it was assumed that commercial fuel use per employee has the same average energy intensity across the state. All commercial natural gas use was allocated to the regions currently served by natural gas infrastructure, and the rest of the fuel was allocated to create equal consumption by employee.

[5] Jonathan Dowds et al., "Vermont Transportation Energy Profile," October 2015. http://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/Vermont%20Transportation%20Energy%20Profile%202015.pdf.

The industrial sector was assumed to be more diverse in its energy consumption. In the industrial sector, natural gas was allocated among the regions currently served by natural gas based on the number of industrial employees in each region. Other non-electric fuels were distributed among regions without access to natural gas, as it was assumed that other non-electric fuels were primarily used for combustion purposes, and that purpose could likely be served more cheaply with gas. Transportation demand was primarily regionalized through population. The passenger rail sector of transportation demand was regionalized using Amtrak boarding and alighting data to create percentages of rail miles activity by region.[6] The freight rail sector of transportation was regionalized using the following approach: in regions with freight rail infrastructure, activity level was regionalized by share of employees in goods-producing NAICS code sectors. Regions without freight rail infrastructure were determined using a Vermont Rail System map and then assigned an activity level of zero.[7] A weighting factor was applied to regions with freight rail infrastructure to bring the total activity level back up to the calculated statewide total of freight rail short-ton miles in Vermont. Each region's share of state activity and energy use is held constant throughout the analysis period as a simplifying assumption.

Results

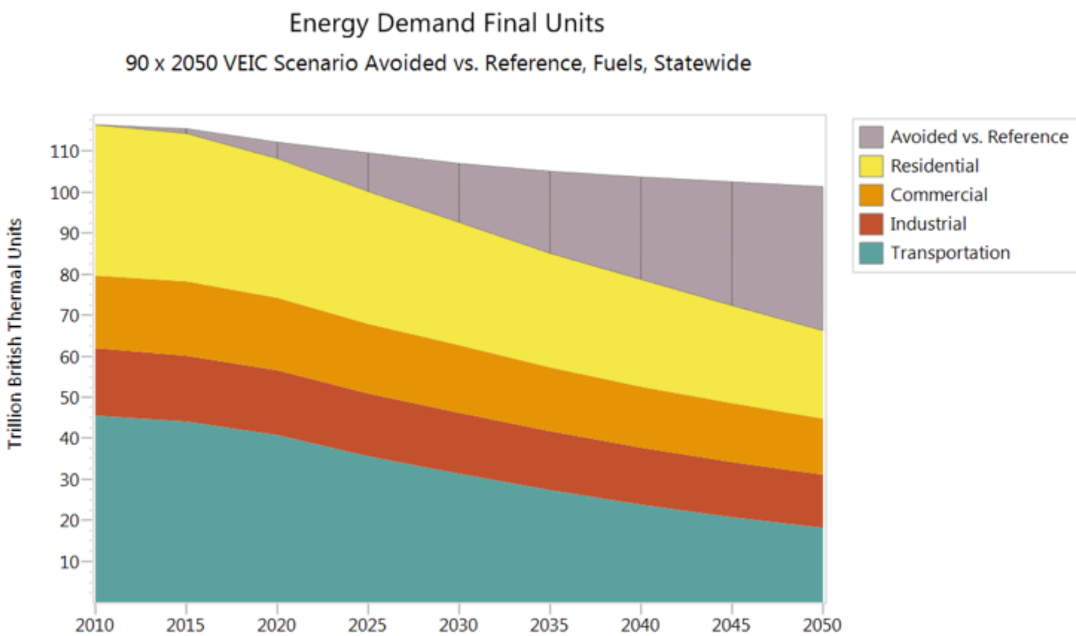
The numbers below show the results of the scenarios in "final units," sometimes referred to as "site" energy. This is the energy households and businesses see on their bills and pay for. Energy analysis is sometimes done at the "source" level, which accounts for inefficiency in power plants and losses from transmission and distribution power lines. The model accounts for those losses when calculating supply, but all results provided here are on the demand side, so do not show them.

The graphs below show the more efficient 90% x 2050 $_{\text{VEIC}}$ scenario, which is one path to reduce demand enough to make 90% renewable supply possible. This scenario makes use of wood energy, but there is more growth in electric heating and transportation to lower total energy demand. Where the graphs show "Avoided vs. Reference," that is the portion of energy that we do not need to provide because of the efficiency in this scenario compared to the less efficient Reference scenario.

---

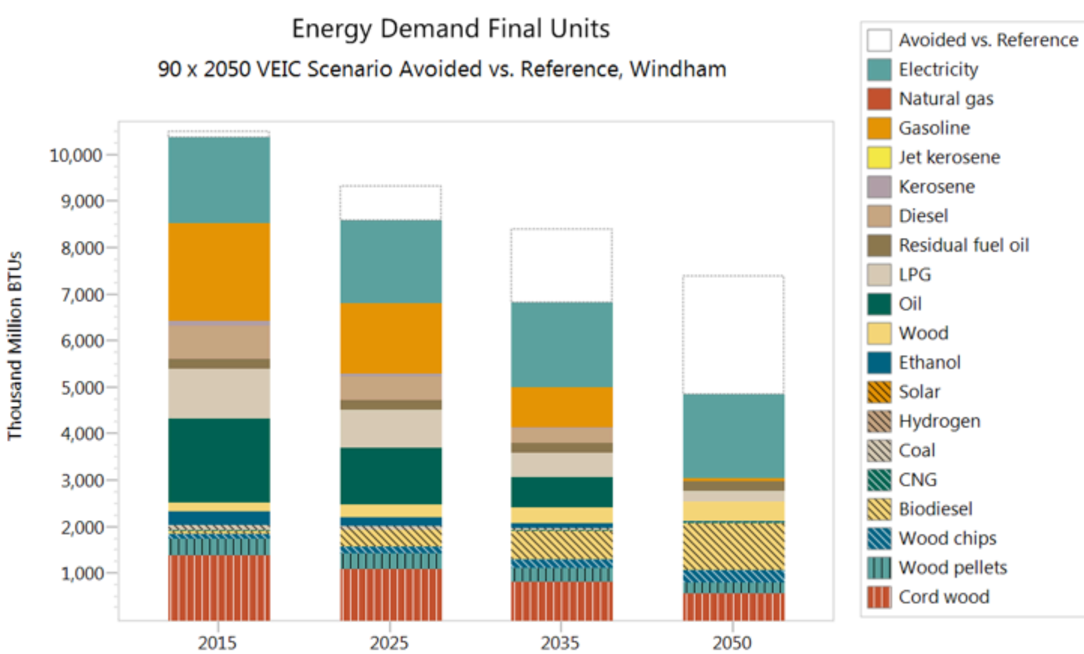
[6] National Association of Railroad Passengers, "*Fact Sheet: Amtrak in Vermont,*" 2016. https://www.narprail.org/site/assets/files/1038/states_2015.pdf.
[7] Streamlined Design, "*Green Mountain Railroad Map*" (Vermont Rail System, 2014). http://www.vermontrailway.com/maps/regional_map.html.

STATEWIDE TOTAL ENERGY CONSUMPTION



I NARIO
(

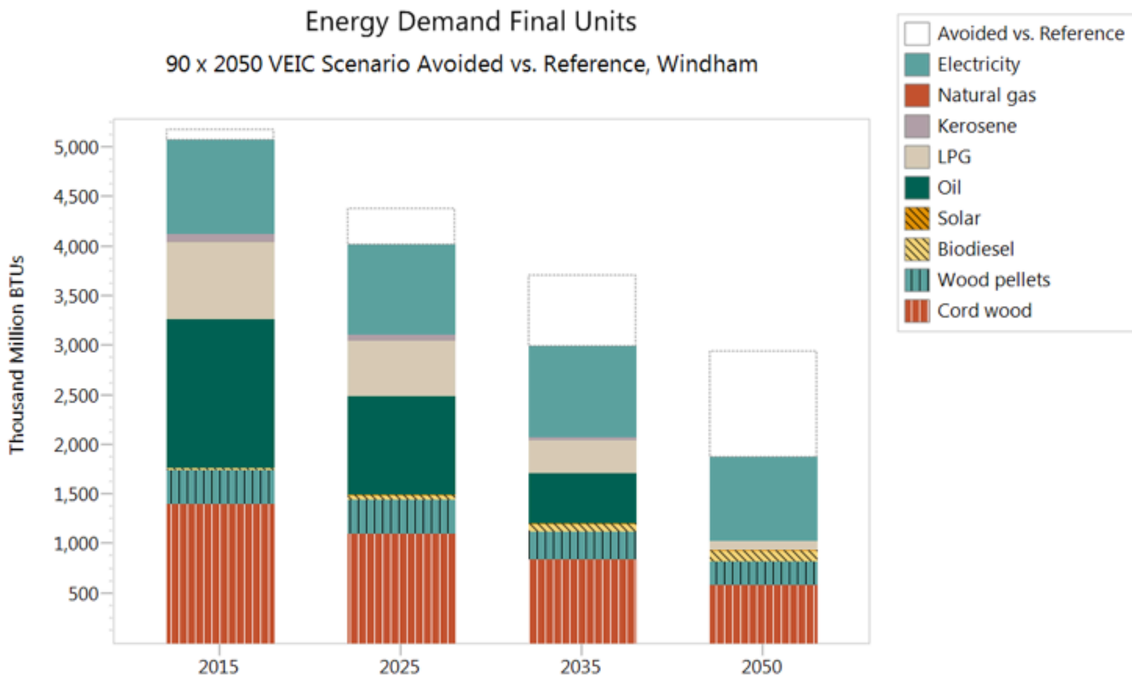
REGIONAL TOTAL ENERGY CONSUMPTION



Vermont Energy Investment Corporation

Powered by SunShot U.S. Department of Energy

REGIONAL ENERGY CONSUMPTION BY SECTOR



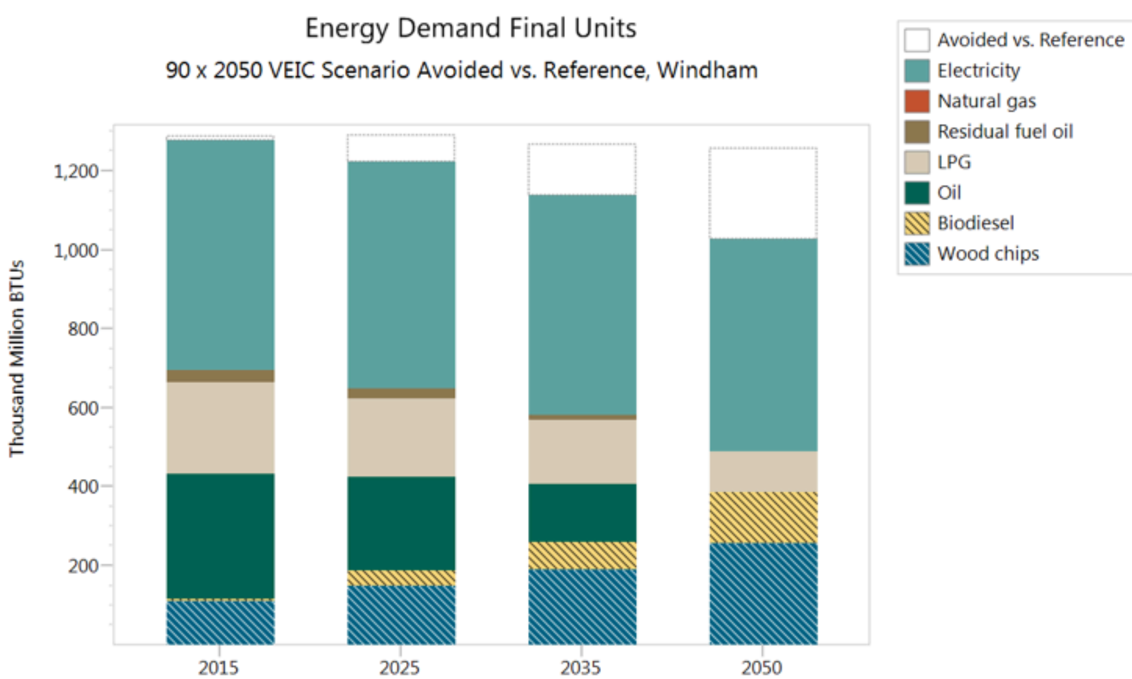


FIGURE 4 - REGIONAL COMMERCIAL ENERGY CONSUMPTION BY FUEL.

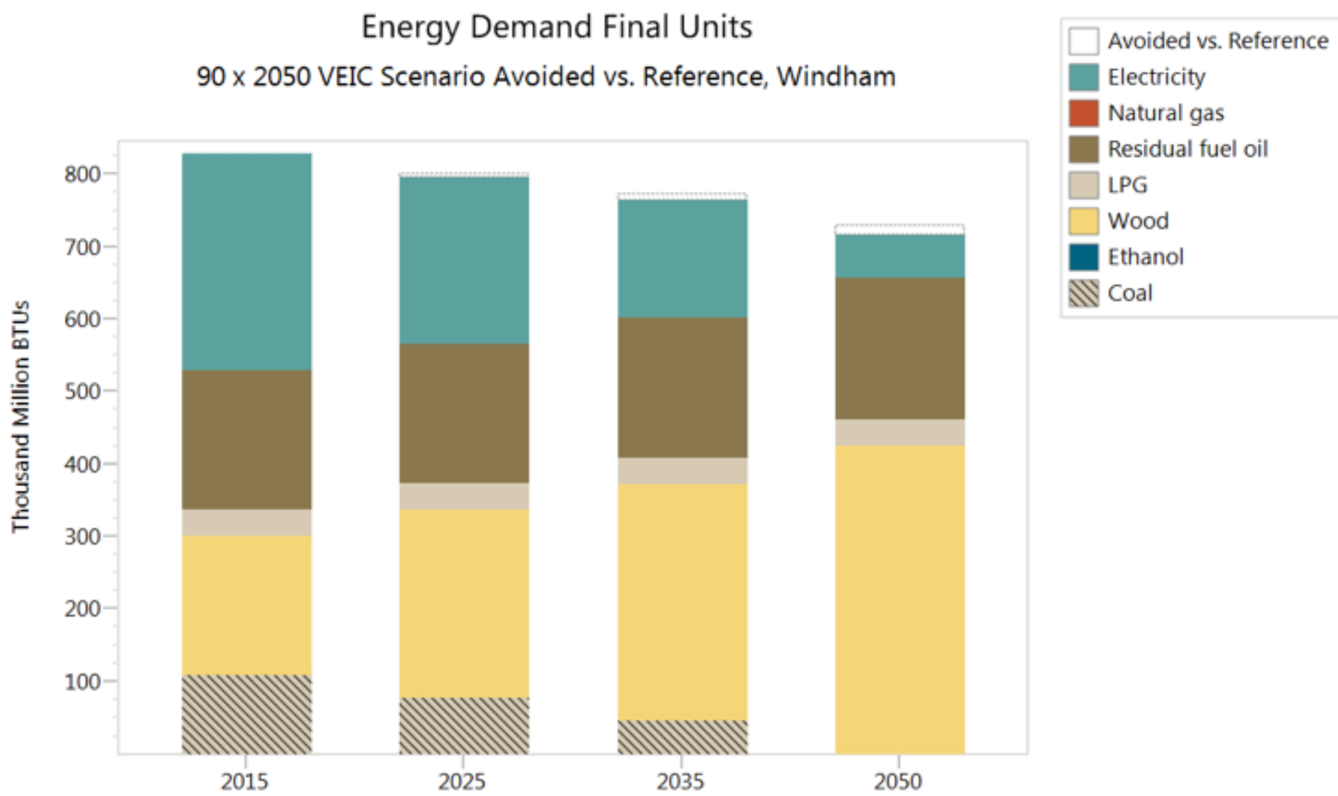


FIGURE 5 - REGIONAL INDUSTRIAL ENERGY CONSUMPTION BY FUEL.

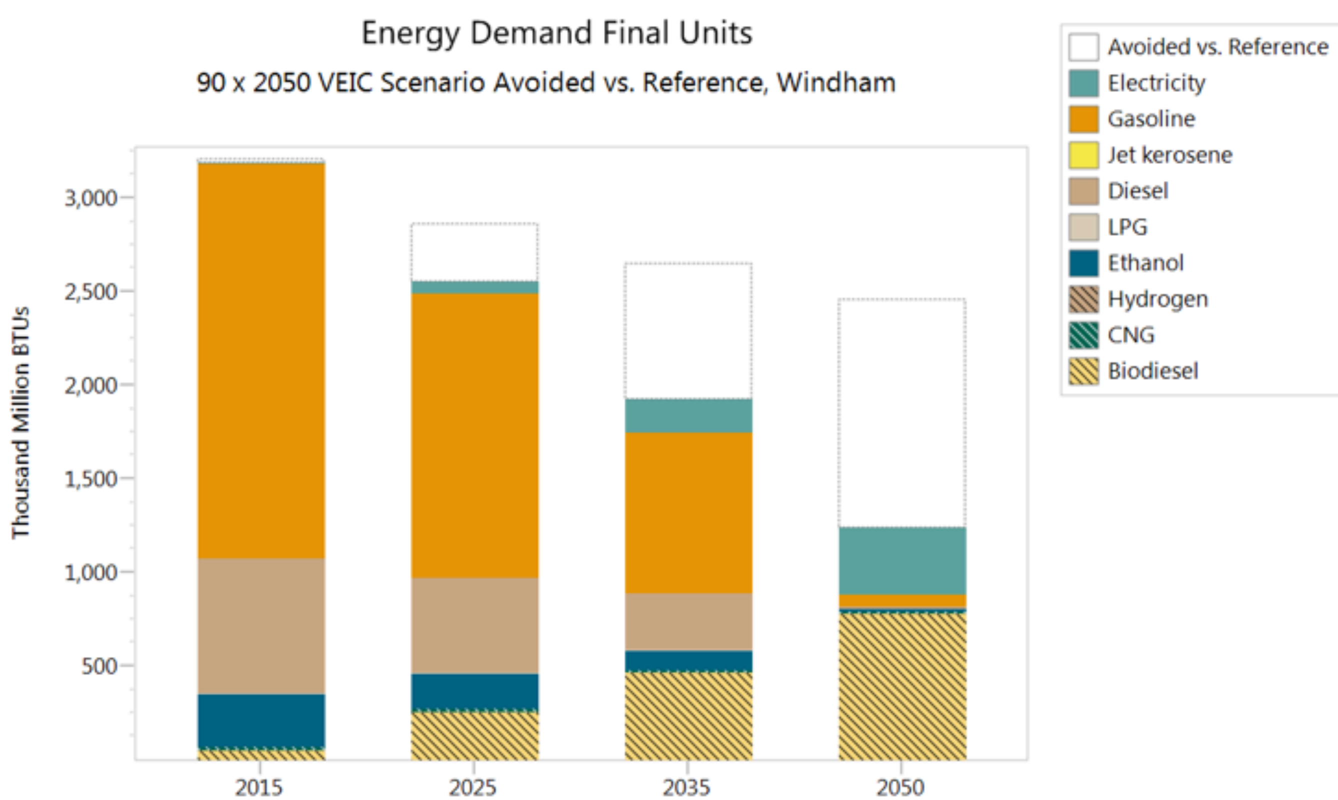


FIGURE 6 - REGIONAL TRANSPORTATION ENERGY CONSUMPTION BY FUEL.

Detailed Sources and Assumptions

Residential

The TES provides total fuels used by sector. We used a combination of industry data and professional judgment to determine demand inputs at a sufficiently fine level of detail to allow for analysis at many levels, including end use (heating, water heating, appliances, etc.), device (boiler, furnace, heat pump) or home-type (single family, multi-family, seasonal, mobile). Assumptions for each are detailed below. All assumptions for residential demand are at a per-home level.

Space Heating

The team determined per home consumption by fuel type and home type. EIA data on Vermont home heating provides the percent share of homes using each type of fuel. 2009 Residential energy consumption survey (RECS) data provided information on heating fuels used by mobile homes. Current heat pumps consumption estimates were found in a 2013 report prepared for Green Mountain Power by Steve LeTendre entitled Hyper Efficient Devices: Assessing the Fuel Displacement Potential in Vermont of Plug-In Vehicles and Heat Pump Technology. Future projections of heat pump efficiency were provided by Efficiency Vermont Efficient Products and Heat Pump program experts.

Additional information came from the following data sources:

- 2010 Housing Needs Assessment [8]
- EIA Vermont State Energy Profile[9]
- 2007-2008 VT Residential Fuel Assessment[10]
- EIA Adjusted Distillate Fuel Oil and Kerosene Sales by End Use[11]

The analyst team made the following assumptions for each home type:

- Multi-family units use 60% of the heating fuel used by single family homes, on average, due to assumed reduced size of multi-family units compared to single-family units. Additionally, where natural gas is available, the team assumed a slightly higher percentage of multi-family homes use natural gas as compared to single family homes, given the high number of multi-family units located in the Burlington area, which is served by the natural gas pipeline. The team also assumed that few multi-family homes rely on cordwood as a primary heating source.

---

[8] Vermont Housing and Finance Agency, "2010 Vermont Housing Needs Assessment," December 2009. http://www.vtaffordablehousing.org/documents/resources/623_1.8_Appendix_6_2010_Vermont_Housing_Needs_Assessment.pdf.

[9] U.S. Energy Information Administration, "Vermont Energy Consumption Estimates", 2004. https://www.eia.gov/state/print.cfm?sid=VT

[10] Frederick P. Vermont Residential Fuel Assessment: for the 2007-2008 heating season. Vermont Department of Forest, Parks and Recreation. 2011.

[11] U.S. Energy Information Administration, "Adjusted Distillate Fuel Oil and Kerosene Sales by End Use," December 2015. https://www.eia.gov/dnav/pet/pet_cons_821usea_dcu_nus_a.htm.

- Unoccupied/Seasonal Units: On average, seasonal or unoccupied homes were expected to use 10% of the heating fuel used by single family homes. For cord wood, we expected unoccupied or seasonal homes to use 5% of heating fuel, assuming any seasonal or unoccupied home dependent on cord wood are small in number and may typically be homes unoccupied for most of the winter months (deer camps, summer camps, etc.)
- Mobile homes—we had great mobile home data from 2009 RECS. As heat pumps were not widely deployed in mobile homes in 2009 and did not appear in the RECs data, we applied the ratio of oil consumed between single family homes and mobile homes to estimated single family heat pump use to estimate mobile home heat pump use.
- The reference scenario heating demand projections were developed in line with the TES reference scenario. This included the following: assumed an increase in the number of homes using natural gas, increase in the number of homes using heat pumps as a primary heating source (up to 37% in some home types), an increase in home heated with wood pellets, and drastic decline in homes heating with heating oil. Heating system efficiency and shell efficiency were modeled together and, together, were estimated to increase 5-10% depending on the fuel type. However, heat pumps are expected to continue to rapidly increase in efficiency (becoming 45% more efficient, when combined with shell upgrades, by 2050). We also reflect some trends increasing home sizes.
- In the 90% x 2050 $_{\text{VEIC}}$ scenario, scenario heating demand projections were developed in line with the TES TREES Local scenarios, a hybrid of the high and low biofuel cost scenarios. This included the following: assumed increase in the number of homes using heat pumps as a primary heating source (up to 70% in some home types), an increase in home heated with wood pellets, a drastic decline in homes heating with heating oil and propane, and moderate decline in home heating with natural gas. Heating system efficiency and shell efficiency were modeled together and were estimated to increase 10%-20% depending on the fuel type. However, heat pumps are expected to continue to rapidly increase in efficiency (becoming 50% more efficient, when combined with shell upgrades by 2050). We also reflect some trends increasing home sizes.

Lighting

Lighting efficiency predictions were estimated by Efficiency Vermont products experts.

Water Heating

Water heating estimates were derived from the Efficiency Vermont Technical Reference Manual. [12]

Appliances and Other Household Energy Use:

EnergyStar appliance estimates and the Efficiency Vermont Electric Usage Chart[13] provided estimates for appliance and other extraneous household energy uses.

---

[12] Efficiency Vermont, "*Technical Reference User Manual (TRM): Measure Savings Algorithms and Cost Assumptions*, No. 2014-87," March 2015. http://psb.vermont.gov/sites/psb/files/docketsandprojects/electric/majorpendingproceedings/TRM%20User%20Manual%20No.%202015-87C.pdf.

[13] Efficiency Vermont, "*Electric Usage Chart Tool,*" https://www.efficiencyvermont.com/tips-tools/tools/electric-usage-chart-tool.

Using the sources and assumptions listed above, the team created a model that aligned with the residential fuel consumption values in the TES.

Commercial

Commercial energy use estimates are entered in to the model as energy consumed per square foot of commercial space, on average. This was calculated using data from the TES.

Industrial

Industrial use was entered directly from the results of the TES data.

Transportation

The transportation branch focused on aligning with values from the Total Energy Study (TES) Framework for Analysis of Climate-Energy-Technology Systems (FACETS) data in the transportation sector in the Business as Usual (BAU) scenario. The VEIC 90% x 2050 scenario was predominantly aligned with a blend of the Total Renewable Energy and Efficiency Standard (TREES) Local High and Low Bio scenarios in the transportation sector of FACETS data. There were slight deviations from the FACETS data, which are discussed in further detail below.

Light Duty Vehicles

Light Duty Vehicle (LDV) efficiency is based on a number of assumptions: gasoline and ethanol efficiency were derived from the Vermont Transportation Energy Profile.[14] Diesel LDV efficiency was obtained from underlying transportation data used in the Business as Usual scenario for the Total Energy Study, which is referred to as TES Transportation Data below. Biodiesel LDV efficiency was assumed to be 10% less efficient than LDV diesel efficiency.[15] Electric vehicle (EV) efficiency was derived from an Excel worksheet from Drive Electric Vermont. The worksheet calculated EV efficiency using the number of registered EVs in Vermont, EV efficiency associated with each model type, percentage driven in electric mode by model type (if a plug-in hybrid vehicle), and the Vermont average annual vehicle miles traveled. LDV electric vehicle efficiency was assumed to increase at a rate of .6%. This was a calculated weighted average of 100-mile electric vehicles, 200-mile electric vehicles, plug-in 10 gasoline hybrid and plug-in 40 gasoline hybrid vehicles from the Energy Information Administration Annual Energy Outlook.[16]

---

[14] Jonathan Dowds et al., "*Vermont Transportation Energy Profile*," October 2015. http://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/Vermont%20Transportation%20Energy%20Profile%202015.pdf.

[15] U.S. Environmental Protection Agency: Office of Transportation & Air Quality, "*Biodiesel*," Www.fueleconomy.gov, accessed August 19, 2016. https://www.fueleconomy.gov/feg/biodiesel.shtml.

[16] U.S. Energy Information Administration, "*Light-Duty Vehicle Miles per Gallon by Technology Type,*" Annual Energy Outlook 2015. 2015, https://www.eia.gov/forecasts/aeo/data/browser/#/?id=50-AEO2016&cases=ref2016~ref_no_cpp&sourcekey=0.

Miles per LDV was calculated using the following assumptions: data from the Vermont Agency of Transportation provided values for statewide vehicles per capita and annual miles traveled.[17] The total number of LDVs in Vermont was sourced TES Transportation Data. The calculated LDV miles per capita was multiplied by the population of Vermont and divided by the number of LDVs to calculate miles per LDV.

The number of EVs were sourced directly from Drive Electric Vermont, which provided a worksheet of actual EV registrations by make and model. This worksheet was used to calculate an estimate of the number of electric vehicles using the percentage driven in electric mode by vehicle type to devalue the count of plug-in hybrid vehicles. Drive Electric Vermont also provided the number of EVs in the 90% x 2050 $_{\text{VEIC}}$ scenario.

Heavy Duty Vehicles

Similar to the LDV vehicle efficiency methods above, HDV efficiency values contained a variety of assumptions from different sources. A weighted average of HDV diesel efficiency was calculated using registration and fuel economy values from the Transportation Energy Data Book.[18] The vehicle efficiency values for diesel and compressed natural gas (CNG) were all assumed to be equal.[19] Diesel efficiency was reduced by 10% to represent biodiesel efficiency.[20] Propane efficiency was calculated using a weighted average from the Energy Information Administration Annual Energy Outlook table for Freight Transportation Energy Use.[21]

In the 90% x 2050 $_{\text{VEIC}}$ scenario, it was assumed HDVs will switch entirely from diesel to biodiesel or renewable diesel by 2050. This assumption is backed by recent advances with biofuel. Cities such as Oakland and San Francisco are integrating a relatively new product called renewable diesel into their municipal fleets that does not gel in colder temperatures and has a much lower overall emissions factor.[22] Historically, gelling in cold temperatures has prevented higher percentages of plant-based diesel replacement products.

Although there has been some progress toward electrifying HDVs, the VEIC 90% x 2050 scenario does not include electric HDVs. An electric transit bus toured the area and gave employees of BED, GMTA, and VEIC a nearly silent ride around Burlington. The bus is able to fast charge using an immense amount of power that few places on the grid can currently support. The California Air Resources Board indicated

---

[17] Jonathan Dowds et al., "Vermont Transportation Energy Profile."
[18] Ibid.
[19] "Natural Gas Fuel Basics," Alternative Fuels Data Center, accessed August 19, 2016. http://www.afdc.energy.gov/fuels/natural_gas_basics.html.
[20] U.S. Environmental Protection Agency: Office of Transportation & Air Quality, "Biodiesel."
[21] U.S. Energy Information Administration (EIA), "Freight Transportation Energy Use, Reference Case," Annual Energy Outlook 2015, 2015. http://www.eia.gov/forecasts/aeo/data/browser/#/?id=58-AEO2015&region=0-0&cases=ref2015&start=2012&end=2040&f=A&linechart=ref2015-d021915a.6-58-AEO2015&sourcekey=0.
[22] Oregon Department of Transportation and U.S. Department of Transportation Federal Highway Administration, "Primer on Renewable Diesel," accessed August 29, 2016. http://altfueltoolkit.org/wp-content/uploads/2004/05/Renewable-Diesel-Fact-Sheet.pdf.

a very limited number of electric HDVs are in use within the state.[23] Anecdotally, Tesla communicated it is working on developing an electric semi-tractor that will reduce the costs of freight transport.[24]

The total number of HDVs was calculated using the difference between the total number of HDVs and LDVs in 2010 in the Vermont Transportation Energy Profile and the total number of LDVs from TES Transportation Data.[25] HDV miles per capita was calculated using the ratio of total HDV miles traveled from the 2012 Transportation Energy Data Book and the 2012 American Community Survey U.S. population estimate.[26,27] The total number of HDVs and HDV miles per capita were combined with the population assumptions outlined above to calculate miles per HDV.

Rail

The rail sector of the transportation branch consists of two types: freight and passenger. Currently in Vermont, freight and passenger rail use diesel fuel.[28,29] The energy intensity (Btu/short ton-mile) of freight rail was obtained from the U.S. Department of Transportation Bureau of Transportation Statistics.[30] A 10-year average energy intensity of passenger rail (Btu/passenger mile) was also obtained from the U.S. Department of Transportation Bureau of Transportation Statistics.[31] Passenger miles were calculated using two sets of information. First, distance between Vermont Amtrak stations and the appropriate Vermont border location were estimated using Google Maps data. Second, 2013 passenger data was obtained from the National Association of Railroad Passengers.[32] Combined, these two components created total Vermont passenger miles. We used a compound growth rate of 3% for forecast future passenger rail demand in the 90% x 2050 $_{\text{VEIC}}$ scenario, consistent with the historical growth rates of rail

---

[23] California Environmental Protection Agency Air Resources Board, "Draft Technology Assessment: Medium- and Heavy-Duty Battery Electric Trucks and Buses," October 2015. https://www.arb.ca.gov/msprog/tech/techreport/bev_tech_report.pdf.
[24] Elon Musk, "Master Plan, Part Deux," Tesla, July 20, 2016. https://www.tesla.com/blog/master-plan-part-deux.
25 Jonathan Dowds et al., "*Vermont Transportation Energy Profile.*"
[26] "Transportation Energy Data Book: Edition 33" (Oak Ridge National Laboratory, n.d.), accessed August 18, 2016.
[27] U. S. Census Bureau, "Total Population, Universe: Total Population, 2012 American Community Survey 1-Year Estimates," American Fact Finder, 2012. http://factfinder.census.gov/bkmk/table/1.0/en/ACS/12_1YR/B01003/0100000US.
[28] US Energy Information Administration (EIA), "*Freight Transportation Energy Use, Reference Case.*"
[29] Vermont Agency of Transportation Operations Division - Rail Section, "Passenger Rail Equipment Options for the Amtrak Vermonter and Ethan Allen Express: A Report to the Vermont Legislature," January 2010. http://www.leg.state.vt.us/reports/2010ExternalReports/253921.pdf.
[30] U.S. Department of Transportation: Office of the Assistant Secretary for Research and Technology Bureau of Transportation Statistics, "Table 4-25: Energy Intensity of Class I Railroad Freight Service," accessed August 26, 2016. http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_25.html.
[31] U.S. Department of Transportation: Office of the Assistant Secretary for Research and Technology Bureau of Transportation Statistics, "Table 4-26: Energy Intensity of Amtrak Services," accessed August 26, 2016. http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_26.html.
[32] National Association of Railroad Passengers, "*Fact Sheet: Amtrak in Vermont,*" 2016. https://www.narprail.org/site/assets/files/1038/states_2015.pdf.

passenger miles in Vermont.[33] Passenger rail is assumed to completely transform to electric locomotion. Freight rail is assumed to transform to biodiesel or renewable diesel.

Air

The total energy of air sector used appropriate FACETS data values directly. The air sector is expected to continue using Jet Fuel in both scenarios.

[33] Joseph Barr, AICP et al., "*Vermont State Rail Plan: Regional Passenger Rail Forecasts.*"

Vermont Public Power Supply Authority
Putting the Public in Power.
www.vppsa.com
P.O. Box 126 • 5195 Waterbury-Stowe Rd. • Waterbury Center, VT 05677 • 802.244.7678 • Fax: 802.244.6889

Vermont Public Power Supply Authority
2020 Tier 3 Annual Plan

In accordance with the Public Utility Commission's ("PUC") *Final Order in Docket 8550*, Vermont Public Power Supply Authority ("VPPSA") is filing this Annual Plan describing its proposed 2020 Energy Transformation programs. Vermont's Renewable Energy Standard ("RES"), enacted through Act 56 in 2015, requires electric distribution utilities to either generate fossil fuel savings by encouraging Energy Transformation ("Tier 3") projects or purchase additional Renewable Energy Credits ("RECs") from small, distributed renewable generators ("Tier 2").

VPPSA's Requirement

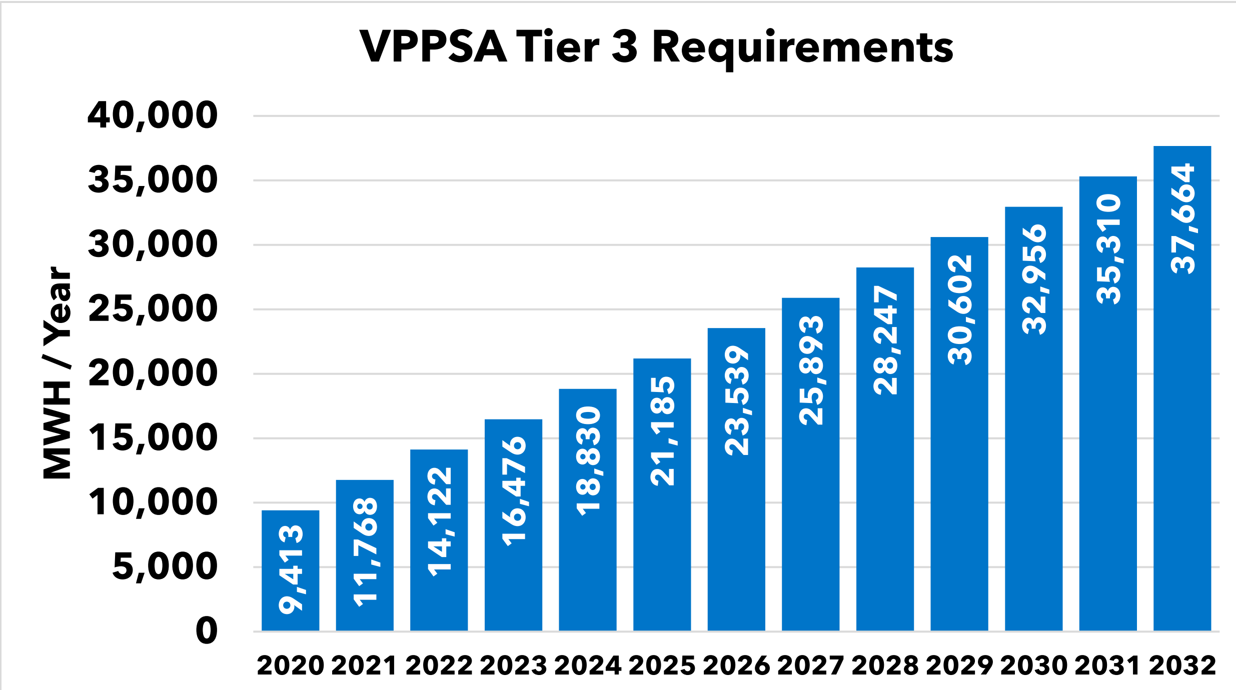
Utilities' Tier 3 requirements are established by 30 V.S.A. § 8005(a)(3)(B), which states that "in the case of a provider that is a municipal electric utility serving not more than 6,000 customers, the required amount shall be two percent of the provider's annual retail sales beginning on January 1, 2019.[1]"

Under 30 V.S.A. § 8004 (e) "[i]n the case of members of the Vermont Public Power Supply Authority, the requirements of this chapter may be met in the aggregate." The 11 VPPSA member utilities plan to meet Tier 3 requirements in aggregate. In 2020, VPPSA's aggregate requirement is estimated to be 9,413 MWh equivalent in savings, representing 2.67% of annual retail sales.

VPPSA Members:
- **Barton Village**
- **The Village of Enosburg Falls**
- **Hardwick Electric Department**
- **Village of Jacksonville**
- **Village of Johnson**
- **Ludlow Electric Light Department**
- **Lyndonville Electric Department**
- **Morrisville Water & Light**
- **Northfield Electric Department**
- **Village of Orleans**
- **Swanton Village**

[1] 30 V.S.A. § 8005(a)(3)(B)

Tier 3 requirements increase by .67% annually. The below chart represents VPPSA's projected annual MWh equivalent in savings through 2032.



Summary of 2019 Projects

VPPSA expects to meet its 2019 Tier 3 requirements of 7,059 MWh through a combination of prescriptive and custom measures and through employing excess Tier 2 RECs as needed.

Prescriptive measures included post-purchase rebates for:

1. Cold Climate Heat Pumps
2. Heat Pump Water Heaters
3. Electric and Plug-In Hybrid Vehicles

Of the three prescriptive measures, we found cold climate heat pumps to be the most successful. We additionally found that custom measures, while providing a greater return in MWh savings at a lower cost, tend to have a longer ramp-up time. We identified and began working on multiple custom measures in 2019, but completion will likely not take place until a later date. Because the pricing of Tier 2 RECs was lower than the cost of implementing Tier 3 programs, purchasing excess Tier 2 was an effective strategy for keeping the Tier 3 compliance cost low. However, to accommodate the changing REC market prices, we have preemptively employed a Tier 3 marketing strategy to raise customer awareness around Energy Transformation Projects and increase uptake in the coming years.

2020 Program Overview

VPPSA proposes employing a similar strategy to meet the 2020 Tier 3 requirements while mitigating costs that could put upward pressure on rates. This includes a combination of prescriptive and custom measures and use of excess Tier 2 RECs.

Prescriptive Measures

VPPSA intends to expand its prescriptive measures offerings. Savings are estimated using measure characterizations created by the Tier 3 TAG. VPPSA's budget and estimated savings for prescriptive Tier 3 Programs is summarized below.

Cold Climate Heat Pumps

VPPSA will continue to offer customer rebates for the purchase of cold climate heat pumps ("CCHP".) In 2020 the rebate amount will be increased to $400. For customers that can demonstrate a defined level of building performance, the CCHP rebate will be increased to $500. The additional incentive serves to highlight the importance of overall building performance. In order to be eligible for the higher incentive amount, customers will need to demonstrate that their homes were weatherized according to a list of standards developed and circulated by the Department of Public Service ("DPS") during the CCHP measure characterization by the TAG.

Heat Pump Water Heaters

VPPSA will provide rebates to customers that install heat pump water heaters ("HPWH") to replace fossil-fuel fired water heaters. In 2019, our incentives were provided in conjunction with Efficiency Vermont ("EVT"). VPPSA and EVT are currently negotiating a Memorandum of Understanding to implement the 2020 program and define the "savings split" between VPPSA utilities and EVT.

Electric Vehicles and Plug-In Hybrids

Despite lower operating and maintenance costs associated with electric vehicles ("EVs") and plug-in hybrid electric vehicles ("PHEVs"), the upfront cost continues to be a major barrier to greater EV penetration in the state. EVs and PHEVs remain a relatively low percentage of overall vehicle sales in the state. According to Drive Electric Vermont, the number of plug-in vehicles (EVs and PHEVs) in the state increased by 676 vehicles, or 26%, over the past year. These vehicles comprised 4.1% of new passenger vehicle registrations over the past quarter. Nonetheless, there were only 3,288 plug-in vehicles registered in Vermont as of July 2019.

VPPSA is working to raise awareness of the benefits of plug-in vehicles and help alleviate the financial barriers to EV and PHEV adoption. VPPSA will continue to offer customer rebates for the purchase or lease of EVs and PHEVs and raise the rebate levels in 2020. The customer incentive for purchasing or leasing a new electric vehicle will be $1000 and the customer incentive for purchasing or leasing a new plug-in hybrid electric vehicle will be $500. Low-income customers[2] will receive an additional $400 towards the purchase or lease of an EV or PHEV.

To further expand on this program, VPPSA is adding incentives for purchasing used EVs and PHEVs. The customer incentive will be $500 for the purchase of a used EV and $250 for the purchase of a used PHEV. We are also adding a $500 incentive for the purchase of a Level 2 Charger.

Forklifts

Several industrial customers in VPPSA Members' territories utilize forklifts in their operations. Because the potential fossil fuel savings from converting diesel forklifts to those powered by electricity is significant VPPSA will actively work with these customers to determine whether a conversion is feasible. We are adding a rebate incentive of $800.

Golf Carts

VPPSA has identified opportunities to switch golf carts from fossil fuel to battery powered. We are adding a rebate incentive of $50.

Lawn Mowers

VPPSA will be adding both commercial and residential lawn mower incentives. A rebate of $25 for a residential lawn mower and $1,000 for a commercial lawn mower will be available in 2020.

E-Bikes

Utility customers have expressed interest in e-bikes, which has led VPPSA to add a rebate incentive of $100 for the purchase of a new e-bike.

---

[2] According to the PUC's *Order Implementing the Renewable Energy Standard* dated 6/28/2016, "A low-income customer shall be defined as a customer whose household income is at or below 80% of Vermont statewide median income.

Measure	Savings/Unit (MWh)	Incentive Amount	Admin Cost	Total Cost	Volume	Cost/MWh	Credit (MWh)	Budget
EV	29.50	$1,000	$414	$1,414	20	$47.92	590	$28,275
PHEV	23.08	$500	$324	$824	20	$35.69	462	$16,474
EV (Low Income)	29.50	$1,400	$414	$1,814	5	$61.48	148	$9,069
PHEV (Low Income)	23.08	$900	$324	$1,224	5	$53.02	115	$6,119
EV (Used)	14.75	$500	$207	$707	4	$47.92	59	$2,828
PHEV (Used)	11.54	$250	$162	$412	4	$35.69	46	$1,647
Level 2 Charger	15.27	$500	$214	$714	4	$46.77	61	$2,857
CCHP	13.57	$400	$190	$590	42	$43.50	570	$24,794
CCHP (Weatherized)	16.96	$500	$238	$738	8	$43.51	136	$5,903
HPWH	12.50	$650	$175	$825	10	$66.03	125	$8,253
Level 2 Charger	15.27	$500	$214	$714	4	$46.77	61	$2,857
Forklift	72.96	$800	$1,023	$1,823	5	$24.99	365	$9,117
Golf Cart	2.6	$50	$36	$86	25	$33.26	65	$2,162
Lawn Mower (Residential)	1.24	$25	$17	$42	20	$34.19	25	$848
Lawn Mower (Commercial)	52.35	$1,000	$734	$1,734	2	$33.13	105	$3,469
E-Bike	5.2	$100	$73	$173	10	$33.11	52	$1,735
TOTAL					**184**	**$42.27**	**2923**	**$123,549**

Custom Measures

Commercial and industrial ("C&I") customers will be served on an individual, custom basis in 2020. VPPSA continues to explore cost-effective Tier 3 custom projects, including converting utility customers from diesel generators to electric service. In addition, C&I customers that have potential Tier 3 projects are being identified by Efficiency Vermont through a joint arrangement with VPPSA to ensure that these customers receive comprehensive efficiency services. To date, opportunities have been identified at ski resorts, a furniture maker, a quarry, and a candy manufacturer. Due to the long ramp-up time expected for these projects, completion will likely take place after 2020. The Tier 3 savings would be claimed in the year the project is completed. VPPSA will continue to work with the DPS on custom projects to ensure savings claims are valid and able to be evaluated.

Tier 2 RECs

To the extent that there is a shortfall in savings from the prescriptive and custom measures, VPPSA will purchase Tier 2 RECs when prices are low as a hedge against a shortfall in savings from Tier 3 programs. To the extent that Tier 2 RECs are less expensive than implementing Tier 3 programs, VPPSA will exercise this strategy to benefit its members. For VPPSA members that own Tier 2 eligible generating resources, Tier 2 RECs may be the primary strategy for Tier 3 compliance.

Should REC prices increase, VPPSA will reevaluate its incentive levels and potentially increase the rebate value. In that situation, VPPSA would re-file its annual Tier 3 planning document.

Demand Management

Over the long-term, Tier 3 programs have the potential to significantly increase loads for Vermont utilities. Through ongoing distribution planning efforts, the VPPSA members have identified that their systems remain robust, and the expected growth in annual and local peak demand associated with proposed measures can generally be sustained if monitored and deployed carefully.

VPPSA has established a partnership with Virtual Peaker, allowing us to assist our members in demand-response programming. In 2020, VPPSA will be piloting the following demand-response programs to keep peak load and the cost of electricity at a minimum:

1. Internal utility behavioral demand-response program to strategically maximize load-reducing generation
2. Active demand-response programs to control electric devices including CCHPs, HPWHs, and Level 2 chargers

VPPSA is also exploring partnerships outside of Virtual Peaker to best deploy demand-response programming.

Equitable Opportunity

The Tier 3 incentives described above will be available to all VPPSA member utility customers. The ability to bring financial benefits to all customers, rather than just participating customers, makes electrification an attractive Tier 3 option from an equity perspective. If additional kWh can be procured at costs at or below the costs embedded in a utility's rates, increasing the number of kWh delivered through the utility's system allows the fixed costs of operating the utility to be recovered over a larger number of units, driving the per kWh rate down.

VPPSA's analysis shows that the incentive dollars paid to customers in rebates for electrification measures are expected to be recovered through increased sales over the life of the measures, making these programs revenue neutral or, more likely, economically beneficial for non-participating ratepayers.

Partnership, Collaboration, and Marketing

VPPSA plans to continue actively working with both public and private partners to best execute our Tier 3 plan in the most cost-effective way.

VPPSA is participating in administering the VTrans electric vehicle incentive. The VTrans incentive is offered on the sale of any vehicle registered in Vermont. The value of the VTrans incentive is dependent upon the owner's household income level. Participating car dealers will sell the vehicle at a price reduced by the statewide incentive. The dealer will then submit the customer's information and vehicle details to VPPSA. VPPSA will batch the incentives on a monthly basis and send the information to VTrans with a summary report and invoice. VTrans will pay VPPSA for the state incentive, which VPPSA will then remit to the dealer. We anticipate that stacked incentives and collaboration with car dealers will help to increase participation in VPPSA's electric vehicle rebate program.

VPPSA and EVT are working together to define how the two entities can provide holistic efficiency services to residential, commercial, and industrial customers. In many cases, this partnership involves VPPSA providing incentives for electrification measures, which can provide benefits to all VPPSA utility customers, while EVT provides incentives for thermal and electric efficiency measures.

VPPSA and EVT are also working closely on the Energy Savings Account pilot, which involves Ethan Allen and the Village of Orleans. This pilot allows Ethan Allen to engage in electrical efficiency measures and helps to identify opportunities for strategic energy transformation projects.

Two VPPSA member utility areas have been selected for EVT's 2020 Targeted Communities. The Village of Johnson and the Village of Orleans will both receive enhanced services from EVT for efficiency. This is yet another opportunity to explore strategic electrification for customers while reducing overall energy burden. The 2020 Targeted Communities effort is designed to have the greatest impact on low-income households.

VPPSA is taking on a greater role in utility customer interaction. Historically, the individual VPPSA member utilities were responsible for customer outreach. With the addition of Tier 3 projects, VPPSA will educate utility customers on the available incentives through use of the following:

- VPPSA website
- VPPSA member utility websites
- Social media
- Front Porch Forum
- Collaborative events and workshops
- Car dealer outreach
- EVT contractor and distributor outreach