NORTHWEST REGIONAL ENERGY PLAN

2024 – 20__

Adopted by the Board of Regional Commissioners: (Insert date here), 2024

Effective: (Insert data here), 2024

NRPC Northwest Regional Planning Commission

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I. EXECUTIVE SUMMARY

The Northwest Regional Energy Plan began as a pilot project funded by the Vermont Department of Public Service in 2017. The intent of the project was to complete in-depth energy planning at the regional level while achieving state and regional energy goals—most notably, the goal to have renewable energy sources meet 90% of the state's total energy needs by 2050 (CAP Mitigation Scenario). This in-depth regional energy planning is needed to address three key issues: energy security, environmental protection, and economic needs and opportunities.

Specific goals to be achieved by this plan include the following:

- Collaboration with Vermont Energy Investment Corporation (VEIC) to create a regional energy model that identifies targets for energy conservation and renewable energy generation
- Creation of specific strategies to help the region achieve state energy goals
- Creation of regional maps prioritizing locations for the development of future renewable generation facilities in the region

The region's energy supply and consumption are analyzed in Section IV to establish baseline energy use. The use of space heating energy, transportation energy, and electricity in the region is specifically examined.

The energy element of NRPC's regional plan consists of the energy chapter of the Northwest Regional Plan and this Northwest Regional Energy Plan. While the energy chapter is a high-level overview of NRPC's energy goals and policies, the energy plan takes a comprehensive and detailed look at the region's energy context. This regional energy plan meets the standards required for an enhanced energy plan and therefore gives NRPC increased deference in Act 248 proceedings. The requirements for enhanced energy plans can be found in Appendix I. Since the development of NRPC's regional energy plan, there have been several statewide planning efforts that will inform NRPC's future energy planning. In 2020, the Legislature passed the Global Warming Solutions Act, which sets specific required emissions targets for the state. The Climate Action Plan (CAP), written in 2021 by Vermont's Climate Council, sets out pathways to achieve these emission targets, as well as addressing how to ensure an equitable transition and climate resilience. In 2022, the state updated its Comprehensive Energy Plan (CEP). The CEP included an increased focus on ensuring an equitable climate change transition and three updated sector goals for thermal, transportation and electric sectors.

NRPC's updated Energy Plan, adopted in 2024, further addresses these new statewide planning efforts and new regional considerations including a focus on an equitable energy transition for all residents.

The NRPC worked with VEIC to create targets for energy conservation and renewable energy generation that align with state energy goals while taking into account regional factors. The energy saved via conservation and improved efficiency is targeted to equal approximately 3.5 trillion BTUs by 2050. Conservation and improved efficiency are planned through a variety of means including increased use of efficient materials during construction and weatherization of existing structures, installation of efficient technologies, and electrification of previously fossil fuel powered technologies. Most prominently, improved efficiency is targeted through the use of electric vehicles for transportation and electric heat pumps for space heating. The resulting increase in regional electricity demand means that electricity generation in the region will also need to increase.

Goals, strategies, and implementation steps are established in Section VI to guide the Northwest region to achieve the energy conservation and renewable energy generation targets created in Section V. Goals, strategies, and implementation steps have been specifically identified for the following categories: electricity conservation, thermal efficiency, and transportation. Electricity conservation, thermal efficiency and transportation are the types of energy conservation that the Northwest Region focuses upon in this section. Achievement of the goals set by NRPC will require the cooperation of regional partners, businesses, and the efforts of individual citizens.

A substantial part of the Northwest Region's effort to set renewable electricity generations goals involves the creation of regional energy generation maps as shown in Appendix C. The regional energy generation maps are meant to guide the development of new solar, wind, hydro, and biomass energy generation facilities in the Northwest region. The NRPC Regional Energy and Climate Committee was actively involved in this effort. The maps inform and help guide the siting of new renewable energy generation facilities in the region. The maps provide a macro-scale look at different factors that impact the siting of renewable generation facilities including generation potential. The objective of the NRPC Regional Energy Committee was to allow for sufficient
renewable electricity generation in the region while avoiding undue adverse impacts upon known and possible constraints (these resources are specifically identified in Appendix B).

Section VII assesses the feasibility of meeting regional goals and outlines challenges to implementation. Regional energy generation goals are attainable while still allowing for the protection of known and possible constraints. The identified conservation goals and strategies may be more difficult for the NRPC to implement given that implementation is heavily reliant on the choices and financial means of individual consumers in the region. The thermal efficiency goals and strategies are similar. While NRPC, cannot accomplish the goals and implement the strategies in the plan alone, it can aid the efforts of other organizations to increase conservation and thermal efficiency in the region as well as increase volunteer capacity, outreach, and community engagement.

Achieving transportation-related energy goals is more straightforward. One of NRPC's core functions is coordinating transportation planning for the region and this makes NRPC well suited to achieving goals and implementing strategies for transportation. Progress on transportation-related implementation actions will be prioritized.

There are several challenges to successful plan implementation, and overcoming these challenges to implementation will likely mean bearing both economic and environmental costs. The equity issues related to who will bear those costs is of continuing concern to NRPC, and are addressed in depth in Section III.

Appendix A contains the full results of NRPC's collaboration with VEIC to set regional targets for energy conservation and renewable generation. Appendix B contains a list of the known and possible constraints identified by the NRPC Regional Energy Committee that were used to create the regional energy generation maps. Appendix C contains the regional generation maps to be used in regulatory proceedings (Section 248). Appendix D summarizes the planning approach and process used to create this plan. Appendix E contains a list of acronyms and phrases used throughout the plan. Appendix F is a summary of existing renewable generation facilities in the Northwest Region (by municipality). Appendix G includes a summary of municipal energy analysis and targets.

SECTION II

II. INTRODUCTION

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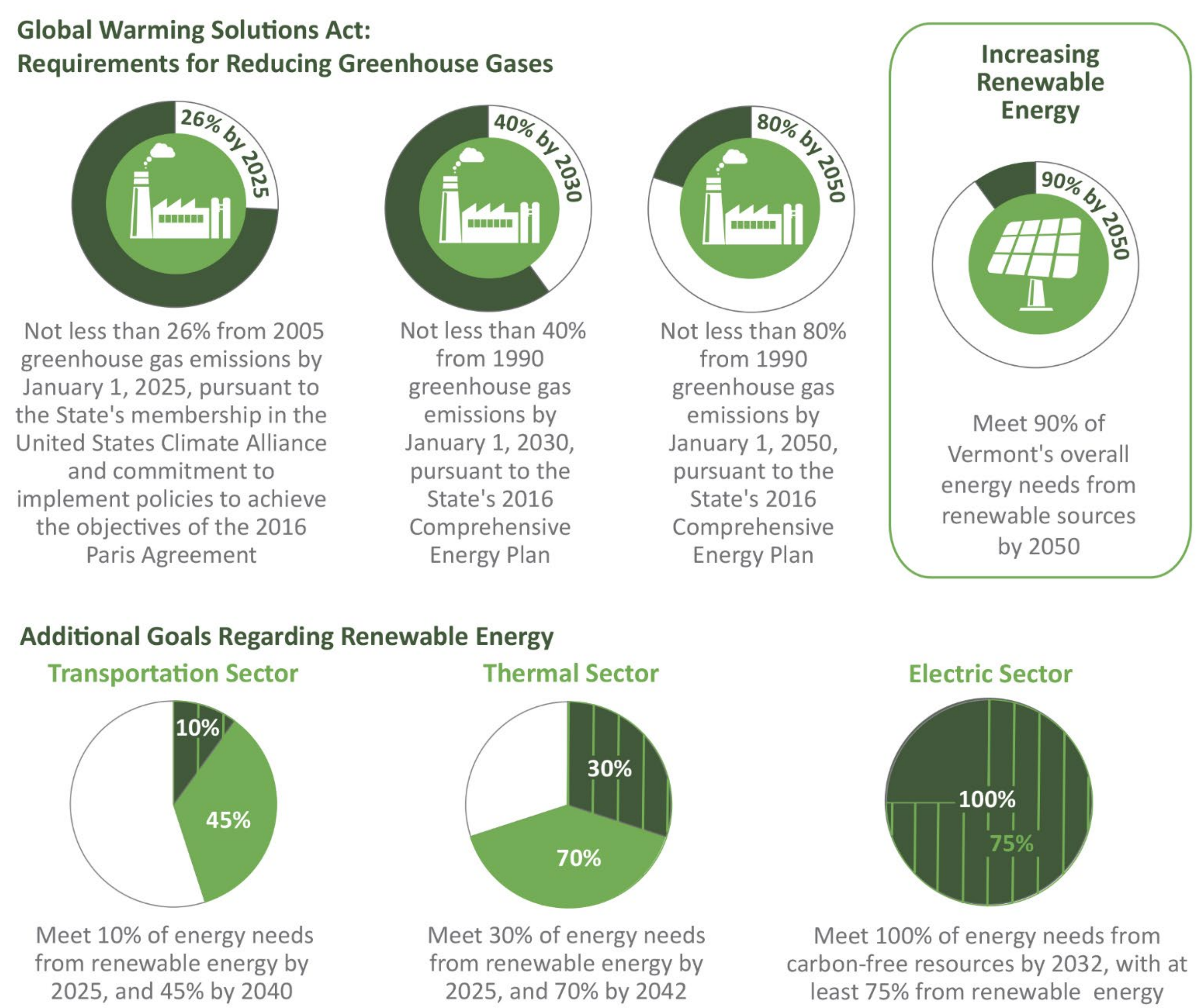
ECONOMIC NEEDS AND OPPORTUNITIES

II. INTRODUCTION

A. BACKGROUND AND VERMONT STATE ENERGY GOALS

In 2017, NRPC completed the Northwest Regional Energy Plan, a pilot project funded via the Vermont Department of Public Service. The intent of the project was to complete in-depth energy planning at the regional level while achieving state and regional energy goals- most notably, the goal to have renewable energy sources meet 90% of the state's total energy needs by 2050 (commonly referred to as 90 x 50). The energy element of this regional plan consists of the energy chapter of the Northwest Regional Plan and this Northwest Regional Energy Plan. While the energy chapter is a high-level overview of NRPC's energy goals and policies, the energy plan takes a comprehensive and detailed look at the region's energy context. This regional energy plan meets the standards required for an enhanced energy plan and therefore gives NRPC increased deference in Act 248 proceedings. The requirements for enhanced energy plans can be found in Appendix I. Since the development of NRPC's regional energy plan, there have been several statewide planning efforts that will inform NRPC's future energy planning. In 2020, the Legislature passed the Global Warming Solutions Act, which sets specific required emissions targets for the state. The Climate Action Plan (CAP), written in 2021 by

FIGURE 2.1 STATE ENERGY AND GREENHOUSE GAS EMISSION GOALS



Vermont's Climate Council, sets out pathways to achieve these emission targets, as well as addressing how to ensure an equitable transition and ensuring climate resilience. In 2022, the state updated its Comprehensive Energy Plan (CEP). The CEP included an increased focus on ensuring an equitable climate change transition and three updated sector goals for thermal, transportation and electric sectors.

NRPC's updated Energy Plan, adopted in 2023, further addresses these new statewide planning efforts and new regional considerations including a focus on equity and a just energy transition for all residents.

The State of Vermont has adopted several ambitious energy goals. The Vermont Comprehensive Energy Plan, developed by the Department of Public Service, calls for the state to meet 90% of its total energy needs through renewable energy sources by 2050 (90 x 50 scenario). State statute also contains several goals pertaining to greenhouse gas emissions, energy generation, and energy efficiency (Figure 2.1).

Additional energy goals have also been set for Vermont's public utilities for renewable energy generation, distributed generation, and fossil fuel use through Act 56 (the Vermont Renewable Energy Standard).[1] It is important that these goals be kept in mind while reading and using this document. The goals and strategies in this plan will provide a path to achieving regional and state energy goals.

B. PURPOSE OF THE PLAN

The NRPC has identified regional goals and strategies for energy conservation and renewable energy generation that will support the attainment of Vermont's energy goals. NRPC has also identified specific implementation strategies appropriate to the region to accomplish these goals. Goals and strategies for municipalities, organizations, and individuals have been included in order to encourage sustainable changes across the entire region in all facets of our community.

In 2017, NRPC collaborated with Vermont Energy Investment Corporation (VEIC) to create a regional energy model to identify targets for energy conservation and renewable energy generation. VEIC used the Long-range Energy Alternatives Planning (LEAP) modeling system to create a statewide model as well as regional models for the regional planning commissions (RPCs). This model was updated by the Department of Public Service in 2023. The models provide one possible scenario of accomplishing the state's goal of meeting 90% of total energy demand through renewable energy resources by 2050 and analyze the potential energy demand within the region. They also look at regional energy generation needs. Specific information about the models and their results can be found in Section V.

The modeling work completed by VEIC provided a framework for two other tasks completed by NRPC:

- Creation of specific strategies to help the region achieve state energy goals
- Creation of regional maps prioritizing locations for the development of future renewable generation facilities in the region

Regional strategies are outlined in Section VI. The regional energy maps as well as information regarding the process by which the maps were developed are located in Section VI, Appendix B, and Appendix C.

While reading this document, it is also important to keep in mind what the Regional Energy Plan will not do. Much like the Vermont Comprehensive Energy Plan, the Regional Energy Plan does not intend to directly address every specific energy-related issue within the region, and it does not discuss or provide recommendations regarding specific renewable energy generation projects that have been proposed in the region. Although it provides a prospective vision of the mix of renewables that may be developed in the

[1] Act 56: Vermont Renewable Energy Standard (http://legislature.vermont.gov/bill/status/2016/h.40)

region to attain state goals, the Regional Energy Plan does not specify the mix of renewable energy generation facilities that will actually be built or contracted by utilities serving the Northwest region. In addition, the plan does not provide specific information about the costs of implementing the plan or the costs of failing to implement the plan.

The energy landscape in Vermont has rapidly changed over the past 10 years. This has been driven by climate change, policy changes, materials cost reductions, and quickly evolving technologies. The NRPC anticipates that methods of generating, distributing, and conserving energy will continue to evolve over the next 30 to 40 years. This plan should be revisited and revised—perhaps more frequently than other regional plans adopted by NRPC—to account for changes in federal and state policy as well as regulatory frameworks, and for changes in environmental conditions due to climate change.

NRPC will continue to incorporate the strategies identified in this plan into the Northwest Regional Plan during future updates.

C. KEY CONSIDERATIONS

While it is important to understand the energy goals established by the legislature, it is more important to understand the reasons why the goals were established. The "why" behind this plan can be explained by looking at three different motivations that are important both regionally and statewide: energy security, environmental protection, and economic needs and opportunities. As climate change continues to change our world, NRPC hopes to prepare its communities, businesses, residents, and infrastructure for the transition.

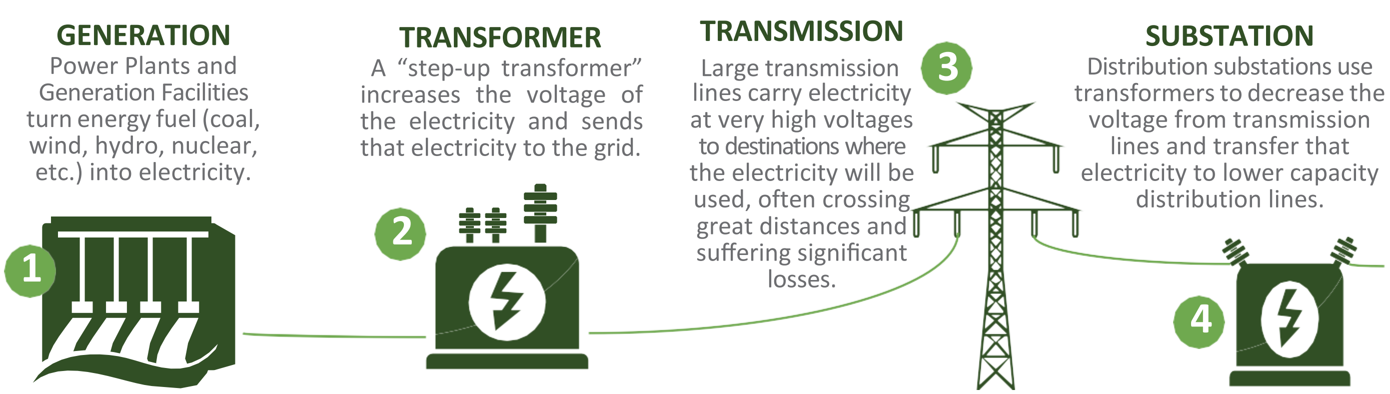
ENERGY SECURITY

Vermont and the Northwest region are reliant upon other states and countries for a large portion of their energy needs. To address this issue, a state statute (10 V.S.A. 580(a)) has set a goal that by 2025, 25% of the energy consumed within the state will also be produced in the state by renewable generation.

Transportation energy is a clear example of the potential threats to both state and regional energy security. Vermont imports all of the gasoline and diesel fuels that are required to operate passenger and heavy vehicles in the state. While there are varying opinions about "peak oil," there is no debate that fossil fuels are a finite resource. The continuing reliance on a finite resource combined with the volatility of the fossil fuel market will result in increasing transportation costs with potentially far-reaching implications.

FIGURE 2.2 UNDERSTANDING THE GRID

The major components in the US electrical generation and distribution grid are enumerated and described in the diagram below (continued on the following page)



Reliance on external fuel sources for transportation isn't the only example of a potential threat to energy security, the source of electrical energy is also a concern. Vermont currently obtains much of its electricity from hydroelectric facilities located out of state, primarily Quebec. Although these sources of electricity currently provide the region with low-cost, renewable generation, the prospective construction of high-capacity transmission lines from Quebec to southern New England may create increased competition for electricity between Vermont and other, faster-growing states that are seeking electricity from renewable sources. Increased competition could increase cost. Maintaining or decreasing reliance on electricity from sources located outside Vermont will certainly make both the state and the region more energy secure, especially as electricity demand is anticipated to almost double by 2050 (see Section IV).

It is possible to have a state and a region that are less reliant on others for their energy needs. By utilizing the resources that exist inside both the state and the region, long-term security concerns about energy supply and energy costs can be alleviated.

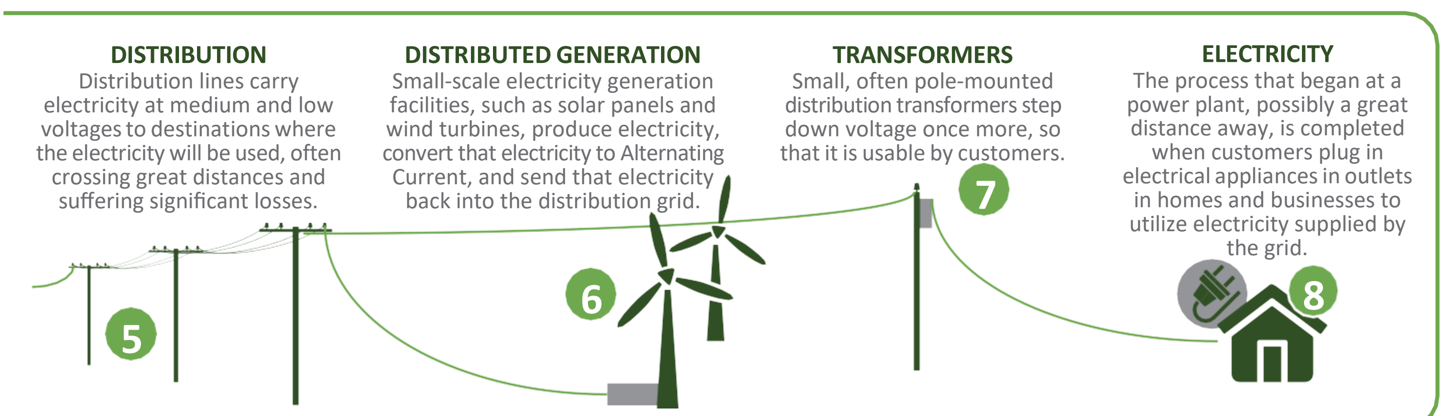
ENVIRONMENTAL PROTECTION

Human energy needs over the past few centuries have had confirmed negative impacts upon environmental quality worldwide—primarily due to fossil fuel use. And while these effects have often seemed intangible in the past, Vermonters are becoming well acquainted with the influence of climate change.

The changing composition of the state and region's forest may have a real impact on the future of the sugaring industry. This is an issue of immense importance in the Northwest region, the highest-producing maple syrup region in the state. Pollution from coal-burning power plants in the Midwest continues to cause acid rain, which also threatens forests. In addition, higher temperatures threaten the future of the ski industry in Vermont as well as the industries that support skiing and tourism. Forest fires in surrounding states and provinces damage air quality and pose a threat to Vermont's forests. More frequent and substantial precipitation threatens public infrastructure—bridges, culverts, etc.—and financially burdens local governments' ability to pay for repair or replacement. Climate change alone has provided more than an adequate basis for seeking alternative, renewable fuel sources and striving to achieve the CAP Mitigation Scenario.

ECONOMIC NEEDS AND OPPORTUNITIES

Energy costs have historically increased in both the state and the region. As fossil fuels have become more difficult to obtain, the costs to extract and bring fuels to market have also risen and these additional costs have been passed on to the consumer. In the long term, this trend could potentially have devastating consequences on Vermont and the region. In April 2017, NRPC estimated that regional residents spend approximately $96 million a year on gasoline for transportation (not including local businesses' expenses). While some of this money may be retained by local distributors, much of the money spent on gasoline leaves the state, the region, and sometimes the country. A similar scenario exists for other fossil fuel–dependent activities. The ability to



retain even a fraction of the money spent each year on fossil fuel–related expenses in the region would mean a tremendous financial gain for regional residents and businesses.

Prices of other energy sources have also historically risen, including electricity. However, programs like net metering have provided Vermonters with the ability to produce their own electricity and “zero-out” their own costs, eventually delivering cost savings to those individuals. Electricity also provides more cost stability and community control than fossil fuels.

It should also be noted that the industries that support small-scale solar, heat pumps, and other “clean energy” technologies—installers, distribution, sales, etc.—have created jobs in the state. “Clean energy”–related business establishments employ 18,156 in-state workers, according to the Public Service Department’s Vermont Clean Energy – 2023 Industry Report.

NRPC understands that achieving the goals established by the state legislature and the Comprehensive Energy Plan will require significant change in the Northwest region. These changes will affect local governments, institutions, businesses, and individuals. Some of the changes may have economic costs, especially in the short term. NRPC aspires to have the economic impacts from energy-related decisions in the region— both pro and con—spread as equally as possible across the region’s residents and municipalities. Ensuring this will take specific care and focus on equitable practices and impacts (Section VI). The commission also hopes to ensure the continued viability of the public utilities serving the region, including municipal utilities. This plan broadly addresses the potential economic impacts of energy transformation on the region over the next 35 years, but it does not delve into the specific accounting costs of enacting this plan (or the costs of inaction). This plan remains focused on accomplishing goals that will positively affect the long-term environmental and economic sustainability of the Northwest region.

SECTION III

III. EQUITY

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Defining equity is important for this plan and NRPC's continued work.

1. Distributive equity recognizes disparities in the allocation of resources, health outcomes, the inequities in living conditions and lack of political power place frontline / impacted communities.
2. Procedural equity includes equitable planning and implementation that requires communities have a meaningful opportunity to participate.
3. Contextual equity ensures that mitigation and adaption strategies consider that low-income communities, black communities, indigenous communities and people of color, and people with disabilities, historically marginalized people, are often more vulnerable to climate change.
4. Corrective equity ensures that mitigation and adaptation strategies provide communities with clear processes to hold the state accountable to its commitments to pursue equity.

A. NRPC'S EQUITY WORK

NRPC has and will continue to broaden its consideration of equity in its planning and implementation work. In 2021, NRPC contracted with a consultant to:

- Improve the ability to respond effectively and respectfully to complex social, economic, and political issues that impact the community.
- Improve the decision-making processes to ensure that decisions are fair and balanced.
- Create and support the development of a more inclusive workspace and external community culture.

Early in 2022, the NRPC Board of Commissioners adopted a statement of inclusion to help guide our work. This statement was modified from the Municipal Declaration of Inclusion, which was first adopted in Vermont by the town of Franklin. The NRPC Board of Commissioners has identified ways to implement the statement of inclusion and tasked each of its committees to identify how to consider equity and inclusion within their work. These themes and ideas have been incorporated into this plan and will be considered further in the implementation of this plan. NRPC will continue to partner with regional organizations to ensure regional projects and programs support improved access to opportunity for all people in the region.

This plan's Guiding Principles for a Just Transition are adapted from those developed as part of the Vermont Climate Action Plan. They are meant to create practices and systems that ensure equity in all energy work undertaken by NRPC.

1. Ensuring *Inclusive, Transparent, and Innovative* Engagement in the development of the plan and associated policies and program.
2. Creating *Accountable and Restorative* recommendations that recognize inequality and seek to resolve them using clearly identified strategies.
3. *Moving at The Speed of Trust* where candor and honesty are recognized as essential for public trust and preparing residents for the transition to a sustainable climate future.
4. *Incorporating Solidarity* to create inclusionary spaces for all traditions and cultures, particularly for Indigenous communities, recognizing them as integral to a healthy and vibrant Vermont.
5. *Prioritizing The Most Impacted First* through recommendations that address the needs of impacted and frontline communities first, providing the greatest benefits of transitions to these communities.
6. Developing *Supports for Workers, Families, and Communities* that consider and plan for potential impacts on workers, families and their communities based on the implementation of NRPC's Comprehensive Energy Plan and the green transition in our region.

B. EQUITY MAPPING TOOLS

It is important for NRPC to understand areas of vulnerability within the region so that planning efforts can keep overburdened areas from becoming even more so and can strategically prioritize efforts that positively affect some populations more. Several mapping and analytical tools have been developed by state and federal agencies that aim to identify areas of vulnerability and weakness in communities. Vulnerable communities are understood to be those that are less able to respond to the impacts of a certain hardship—this could be exposure to chemical contaminants, limited access to housing, health care or food, or responding to higher temperatures and increased flooding. As climate change exacerbates many existing dangers including food insecurity, natural disasters, and extreme temperatures, addressing and investigating equity in NRPC's work and in our communities is more important than ever.

Climate and Economic Justice Screening Tool: Two census tracts in the Northwest region have been highlighted as disadvantaged in this analysis, by meeting the associated socioeconomic thresholds.

- Richford and Montgomery have been identified as disadvantaged in areas of energy, health, and transportation. Specifically, energy costs, asthma rates, and transportation costs are all in the top 10% nationwide.
- The western half of St. Albans City has also been identified as disadvantaged in three areas: health, housing, and water and wastewater. This part of the city ranks in the lowest 10% nationwide for low life expectancy and leaking underground storage tanks within 1,500 feet of homes.

Social Vulnerability Index: In this tool, indicators that are over the 90th percentile statewide are flagged, indicating higher vulnerability when considering community health. It should be noted that some of the data from the Northwest region have high relative standard errors due to its relatively low population density, meaning the results may not be as accurate as desired. Regardless, it can provide context for further energy and equity work.

Heat Illness Vulnerability Index: The Heat Illness Vulnerability Index is a composite of six indicators. In the Northwest region, the index identifies St. Albans Town and St. Albans City as more vulnerable overall to heat illness than the rest of the state. EPA Environmental Justice (EJ) Screen: The EPA EJ Screen includes six environmental indicators that focus on air and air pollutants; four are areas of concern in the region. The particulate matter 2.5 and ozone indicators had the farthest ranging areas of concern for the region, with 11 census groups falling within the 90th to 100th percentile within the state. In Northwest Vermont, traffic proximity is only an issue in St. Albans, and similarly, the diesel particulate matter index indicated higher percentiles in St. Albans City and Swanton. Although there are no superfund sites in Northwest Vermont, the block groups surrounding St. Albans City, including ones in St. Albans Town and Swanton, are located near facilities that have highly toxic substances. St. Albans City is noted as an area with a high percentile for the environmental indicator of underground storage tanks (USTs) and leaking USTs.

SECTION IV

IV. REGIONAL ENERGY SUPPLY AND CONSUMPTION

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To understand what strategies the region needs to implement to achieve state energy goals, it is important to understand the region's current energy supply and energy consumption. Using federal, state, and regional data, the NRPC has estimated regional energy consumption for space heating, transportation, and electric uses. The regional energy supply for heating and transportation has also been estimated. Regional information regarding electricity supply has been compiled using data available from public utilities servicing the Northwest region.

Where possible, space heating, transportation, and electric uses have been broken down into subsectors (residential, commercial, industrial, institutional) to provide a more refined understanding of the data. All energy data in this section is expressed in British thermal units (BTUs) (Figure 4.1). The data in this section provides some context for the changes that will need to occur in the future to achieve state and regional energy goals.

A. SPACE HEATING

RESIDENTIAL HEATING SOURCES

Estimates for residential space heating fuel use by household are available from the American Community Survey (ACS). The primary heating sources in the region are fuel oil (including kerosene), electricity, liquid propane (LP), utility gas (such as natural gas), and wood (cord wood & pellets). Utility gas is available in the region, but only in western Franklin County and in the vicinity of Enosburg Falls (see Appendix C for map of service area). Fuel oil is the most common residential heating source in the region (37%), followed by utility gas (23%) and propane (17%). Use of utility natural gas and propane has increased somewhat since 2013.

The use of electrical heat pumps has increased significantly from 2013 to 2021, although it still represents a small number of total households. Approximately 10 times as many households have installed heat pumps in 2021 than had installed heat pumps in 2016.

Based on NRPC's estimates, the region currently uses approximately 2.25 trillion BTUs to heat residential units each year. Despite increased use of heat pumps, increased efficiency of new heating systems and increased weatherization, total thermal energy use has increased slightly since 2013, likely due to increased population in the region.

FIGURE 4.1 BRITISH THERMAL UNITS (BTUs)

British thermal units (BTUs) are the standard of measurement used in this plan. Using BTUs allows for comparisons between different types of energy inputs (e.g., electricity vs. cord wood). Here are some example conversions:

Common Measurement	BTU
1 gallon of gasoline	120,404
1 gallon of diesel fuel	137,571
1 gallon of heating oil	137,571
1 gallon of liquid propane	84,738
1 cord of wood	20,000,000
1 kWh of electricity	3,412

FIGURE 4.2 AMERICAN COMMUNITY SURVEY (ACS)

Much of the information used in this section is derived from the American Community Survey (ACS), which is conducted by the U.S. Census Bureau. This is because the U.S. Census no longer collects a considerable amount of data that it previously compiled.

The main difference between the ACS and the U.S. Census is that the ACS is based on surveys of random households within a community during a five-year period (e.g., 2009–2013). It is not a "count" like the census. The ACS is collected via mail.

According to the U.S. Census Bureau, approximately 295,000 surveys are mailed per month to randomly selected addresses in the United States. Follow-up phone calls or personal visits by U.S. Census workers are made to households that do not respond to the mailed survey.

Since the Northwest region has a relatively small population, and since the ACS is a survey and not a census, regional data from the ACS has a margin of error. This should be kept in mind while reading this report. Regardless, the ACS is the best available source for a variety of data points used in this plan.

More information about the ACS can be found at www.census.gov/acs/www/.

Figure 4.3 shows estimated residential heating use and costs.[2] Regional households who use propane or fuel oil spend more on energy than those using natural gas, wood or electric heat pumps. Wood costs may be lower than projected, as many residents in the region use cord wood harvested on their property and may not actually pay for wood. Cost information may vary considerably year to year based on global and regional fuel market price, particularly for unregulated fuels such as fuel oil and propane. While electricity has lower average costs than fuel oil and propane, the initial investment in transitioning to this heating source can be cost-prohibitive for many households.

FIGURE 4.3 REGIONAL RESIDENTIAL THERMAL ENERGY USE - 2021

Fuel Source	Regional Households (ACS 2016-2021)	% of Households	BTU (in billions)	Change Since 2013	% of the Total Costs
Natural Gas	5,082	23%	561.22	29%	13%
Propane	3,774	17%	440.72	21%	26%
Electricity	1,123	5%	108.69	168%	4%
Fuel Oil	8,216	37%	946.72	-14%	44%
Coal	14	0%	1.78	6%	n/a
Wood	3,273	15%	404.13	-16%	13%
Solar	62	0%	7.87	-	n/a
Other	427	2%	46.53	-2%	n/a
No Fuel	40	0%	3.63	-24%	n/a
Total	**22,011**	**100%**	**2,521.28**	**2%**	**100%**

***Source:** Vermont Comprehensive Energy Plan*

There are approximately 22,011 households in the region. Roughly 80% of regional households are owner-occupied households, and 20% are renter-occupied households. It is important to note that renter-occupied households often have little to no control over the heating source used in their housing unit because renters cannot lawfully change their heating source. In addition, landlords often have little incentive to upgrade to more efficient heating sources when the tenant is paying for heat.

COMMERCIAL, INDUSTRIAL, AND INSTITUTIONAL HEATING SOURCES

Estimating space heating sources and costs for non-residential structures is more difficult than for residential structures given the lack of available information about structure square footage. There isn't enough existing data to provide an accurate estimate regarding heating sources and costs for non-residential uses in the state and the region.

Statewide, roughly 40% of all thermal energy consumption is from industrial and commercial sources (2021 CEP). If this trend is similar for the Northwest Region, regional thermal energy use for commercial and industrial uses may be around 1680.85 billion BTUs. However, this data should not be assumed to be accurate due to lack of region-specific information. There is no regional or statewide breakdown of source of thermal energy for commercial, industrial and institutional uses.

[2]Unit costs were calculated as follows: Estimated fuel costs from the 2021 Vermont CEP. Wood heating cost is the average of costs for pellet boilers & wood stoves. Electrical costs are assumed to be from heat pumps.

WEATHERIZATION

Weatherization of existing structures is critical to reduce thermal energy use and increase the efficacy of cold climate heat pumps. According to data from Efficiency Vermont (EVT), an average of 35 residential units per year were weatherized between 2016-2021, this is a 36% increase compared to the average yearly weatherization in 2011-2015.
However, this is far below the previous plan's goal of weatherizing 5,400 residential units by 2020.

Weatherization of existing structures in the region may be completed by various parties: individual homeowners, businesspersons, or institutions. Several public and private organizations in the region can help residential, commercial, and industrial customers weatherize their structures.

Data from public organizations regarding their weatherization efforts in the region is available. The Champlain Valley Office of Economic Opportunity (CVOEO), Efficiency Vermont, and VGS, formerly Vermont Gas Systems, are three prominent organizations operating within the region that provide weatherization-related services to individuals and businesses. Many private businesses also specialize in helping individuals and businesses weatherize. NRPC has chosen to highlight these three organizations because they are public utilities and/or provide services that are publicly funded.

Champlain Valley Office of Economic Opportunity

The Champlain Valley Office of Economic Opportunity (CVOEO) is the state-appointed community action agency serving the Northwest region. The organization administers a variety of programs focused on combating poverty and enabling individuals to reach self-sufficiency. One program operated by CVOEO is the low-income weatherization program in the region. This program is available to homeowners and renters that make less than 80% of the average income in Chittenden, Franklin Grand Isle counties (between $64,792-
$122,179 depending on household size). CVOEO prioritizes serving households with the greatest need. Many of the program's grantees are also eligible for other state programs focused on making heating more affordable, including the Fuel Assistance Program.

VGS

VGS is the natural gas utility serving the region. The organization offers several weatherization programs to its customers. Specific programs for residential customers, both renters and homeowners, include the Retrofit Program and the New Construction Program. Each program allows the customer to install significant building improvements to increase thermal efficiency. The Retrofit Program includes a free energy audit and low-interest financing options. VGS also provides comparable programs to its commercial customers. The most popular program for both residential and commercial customers provide rebates or other financial incentives to install high-efficiency equipment such as furnaces and water heaters.

Efficiency Vermont

Efficiency Vermont is the statewide Energy Efficiency Utility (EEU) appointed by the Public Service Board. It manages a broad array of programs that are focused on conservation efforts through providing education, services, and incentives to Vermont homeowners and businesses. This includes providing financing and technical support to homeowners and businesses seeking to complete energy-saving improvements and administering rebate programs for a variety of appliances and equipment.

CVOEO and Efficiency Vermont have recognized that occasionally their efforts may duplicate, especially with regard to weatherizing multi-family housing because property owners may be eligible for programs through each organization. There may also be some overlap with VGS programs. However, this circumstance is the exception, not the rule. The above cited data from Efficiency Vermont excludes projects completed that overlap VGS or CVOEO programs.

B. TRANSPORTATION

Transportation contributes a considerable amount to the region's total energy use. This is due to several factors: reliance upon the automobile for transportation, land use patterns, and fuel costs.

AUTOMOBILE RELIANCE

Data regarding vehicle use and vehicle miles traveled is available from both state and federal sources, and it provides a clear picture of auto reliance in the state and the region (Figure 4.4).

FIGURE 4.4 GAS VEHICLE ENERGY USE

	2013	2021
Est. # of Gas Vehicles	42,471	39,564
Average Miles Traveled (Vermont)	11,356	12,274
Transportation BTUs (Thousand MMBTU)	3,121	3,029
Gasoline Cost	$59,883,119	$95,863,654

***Source:** US Census 2016-2021 ACS, 2021 VTrans Vermont Transportation Energy Profile*

From 2013-2021, estimated gasoline energy usage is down 2.9%. This is largely due to fewer gasoline vehicles estimated to be on the road, as well as a small increase in average vehicle fuel efficiency. However, average miles traveled is increasing in the state, which reduces fuel savings. This data is also likely impacted by COVID-19 and the prevalence of work from home arrangements during and after the pandemic.

ELECTRIC VEHICLES

Electric vehicles use energy more efficiently than gas powered vehicles and allow for the use of renewable energy to power our vehicles. From 2013-2021, the region has made significant progress in increasing the number of electric vehicles. While the total increase has been large, electric vehicles still make up just 2% of all vehicles in the region, so impacts to total gasoline energy use have been limited. As electric vehicles grow in popularity, so does the range of prices, mileage ranges, and sizes of electric vehicles on the market. The more electric vehicles replace gas vehicles in Vermont, the lower the carbon emissions from transportation and this will help to achieve state and regional energy goals. Incentives and advancements in technologies are aimed at increasing the rate of adoption for electric vehicles.

FIGURE 4.5 ELECTRIC VEHICLE TOTAL REGISTRATIONS

	2013	2021	% Change
Battery Electric Vehicle	5	316	6,220%
Plug-In Hybrid Vehicle	6	536	8,833%
Total	**11**	**852**	**7,645%**

***Source:** Efficiency Vermont, Electric Vehicle Registrations from Vermont DMV*

Consistent with the statewide trend of increased vehicle miles traveled, fewer regional commuters appear to be carpooling than in 2013 but work from home has increased.
Data for other modes of transit is difficult to interpret due to the margin of error. Public health measures encouraged during the COVID-19 pandemic from 2020-2022 may explain the reduction in carpooling and increase in work from home.

FIGURE 4.6 COMMUTER CHARACTERISTICS

	2013	2021	% Change
Car, alone	77.3%	79.8%	3.2%
Carpooling	12.8%	9.0%	-30.1%
Public Transit*	0.5%	0.0%	-92.8%
Walking & Biking	3.0%	1.8%	-38.5%
Work from Home	5.3%	8.7%	64.1%
Other	0.8%	0.6%	-32.2%

***Source:** US Census American Community Survey*
**Likely impacted by COVID-19*

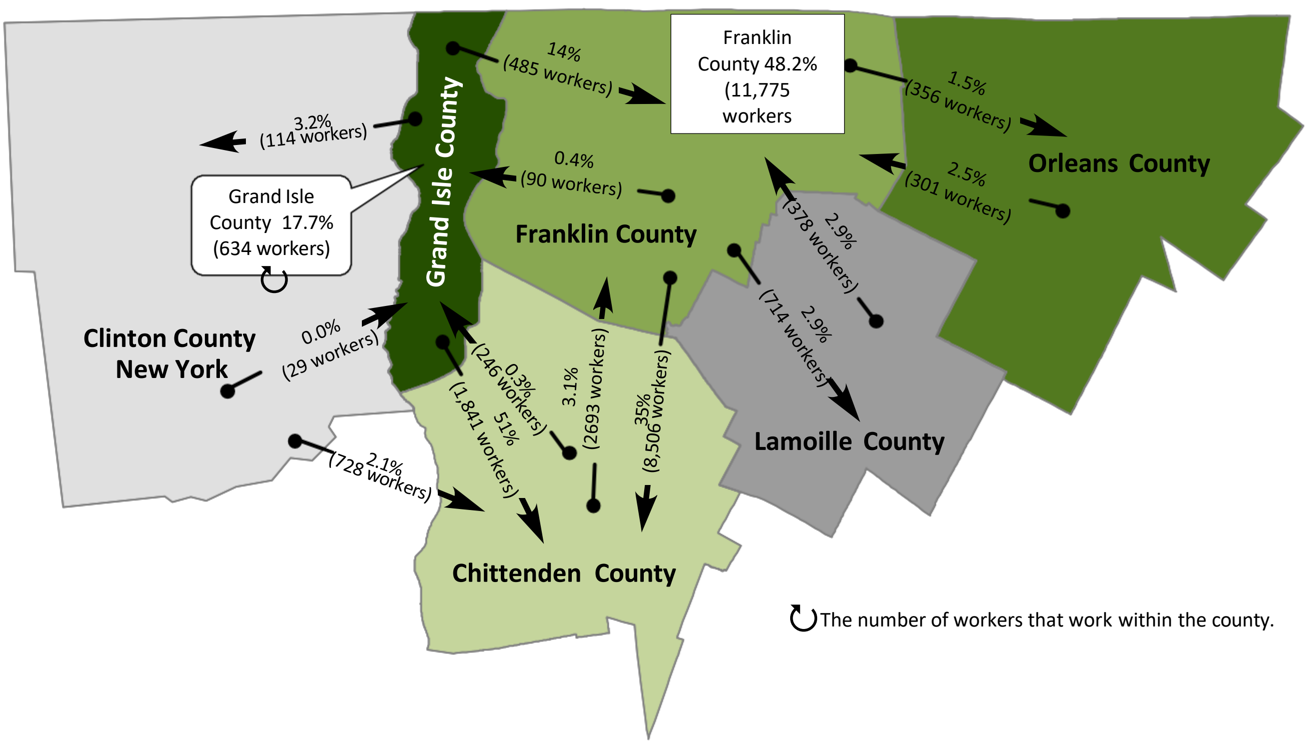
LAND USE PATTERNS

The transportation choices made by regional residents are influenced significantly by regional land use patterns. Land use in the region has historically been characterized as compact development (downtowns and villages) surrounded by working landscape (agriculture and forestry). This model of development is still supported by the Northwest Regional Plan because it promotes concentrated economic development, walkability, and viability of public transportation, and it limits threats to the region's working landscape. It also decreases transportation costs.

With the development of the Interstate Highway System, land use patterns in the region began to change. Access to less expensive rural land and cheap fuel as well as the region's proximity to Chittenden County, the economic center of Vermont, have altered the way the region has developed over the past 60 years. The result is the loss of working landscape in the region (notably agricultural lands), increased commute times, and increased vehicle miles travelled (VMT). The highway system has also contributed negatively to environmental quality and greenhouse gas emissions and has led to changed commuting patterns (Figure 4.7).

FIGURE 4.7 REGIONAL COMMUTING PATTERNS

- Roughly 35% of workers who reside in Franklin County commute to Chittenden County for work. About 50% of workers commute within Franklin County.
- Approximately 75% of Grand Isle County workers commute to jobs outside the county, including a total of 51% of all workers who commute to Chittenden County.



Source: *US Census – Longitudinal Employer-Household Dynamics On The Map tool (2019)*

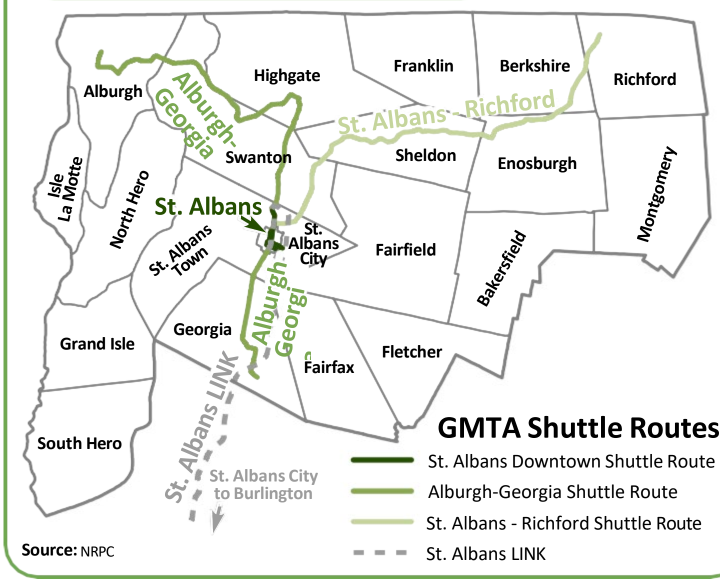
FUEL USE

Current land use and commuting patterns have led to heightened transportation costs for individuals and a comprehensive reliance on increasingly expensive fossil fuels. Transportation fuel use and costs for individuals in the region can be estimated using data from the ACS and VTrans. Using the average fuel cost in 2023, individuals in the region spend approximately $95 million per year in transportation fuel costs. This figure is even higher when vehicles owned by regional businesses are considered. In addition, much of this money leaves the local economy.

PUBLIC TRANSIT

As previously noted, few regional residents use public transportation during their commute to work. However, public transit will be a key component to reducing transportation costs and meeting state and regional energy goals.

FIGURE 4.8 GMT SHUTTLE ROUTES



Green Mountain Transit (GMT) provides public transportation to the Northwest region and operates four routes in the region: the Alburgh–Georgia Shuttle, the St. Albans–Richford Shuttle, the St. Albans Downtown Shuttle, and the St. Albans LINK which provides access to Burlington (Figure 4.8). The former two routes terminate in two of the region's industrial parks. However, most of Grand Isle County and eastern Franklin County are without public transportation services. GMT also provides special transportation services to residents with disabilities and those over 65 years old. In addition, GMT serves as the fiscal agent for its partner agency, Champlain Islanders Developing Essential Resources (C.I.D.E.R.), which provides transportation to residents with disabilities and those over 65 years old in Grand Isle County. All buses in the region currently run on gasoline.

Amtrak serves St. Albans City via the Vermonter Line. According to Amtrak, in 2022, there was 3,621 riders from the St. Albans stop. Rail trips from the St. Albans station decreased somewhat compared to 2016. There is no commuter rail service within the region.

The financial costs and environmental impact of moving goods in and through the region are substantial. Currently, trucks move approximately 84% of goods by weight statewide, according to the 2021 Vermont Freight Plan. St. Albans is home to a private railyard owned by New England Central Railroad. Information about freight capacity and current traffic through the railyard is private and unavailable. Information about freight capacity and current traffic through the railyard is private and unavailable. While rail is an efficient and less carbon intensive way to transport goods, any plans to expand railroads must consider the economic, social, and environmental value of the rail trails that currently inhabit many rail beds.

C. ELECTRICITY

ELECTRICITY USE

According to Efficiency Vermont, 504,569,387 kwH of electricity were used in the region in 2021, representing roughly 10% of the state's energy use. Residential energy use has increased roughly 10% since 2013, while commercial and industrial use has stayed relatively consistent.

FIGURE 4.9 ELECTRICAL ENERGY USE (in Billions BTUs)

	2013	2021	% Change
Residential	664.0681448	730.384048	10.0%
Commercial & Industrial	983.145859	991.27734	0.8%

Source: *Efficiency Vermont*

As discussed in the next section, electricity use must continue to grow through 2050 in order to meet the CAP Mitigation Scenario. It is difficult to interpret how much of current increases in electricity use are the result of electrification efforts.

REGIONAL ELECTRICITY GENERATION

As of 2023, the Northwest region had the capacity to generate 91 MW of electricity through hydro, wind, solar, and biomass technologies, and it had 131 MW of total generation capacity from all sources, according to data available from the Community Energy Dashboard & the Vermont Distributed Generation Survey. The 91 MW of renewable generation in the region is a "raw" number that does not take "capacity factors, renewable energy credits sold, or ownership of the systems" into consideration.

Hydro

The region has four dams with a total generation capacity of approximately 43.5 MW of electricity. Three of the dams are located on the lower portions of the Missisquoi River. A privately owned dam in Sheldon Springs has a generation capacity of approximately 26 MW of electricity; it is the largest dam both on the Missisquoi and in the region. The two other dams on the Missisquoi are located in Highgate and Enosburgh, and they are owned by public electric utilities in Swanton Village and Enosburg Falls, respectively. The fourth dam in the region is located on the Lamoille River in Fairfax and is owned by Green Mountain Power.

Wind

Georgia Mountain Community Wind is the only existing, large-scale wind project in the region. Two of the project's four turbines are located in Franklin County (Georgia), and the other two turbines are located in neighboring Chittenden County. The project generates approximately 10 MW in total (5 MW is estimated to be generated within the region). There are 18 small wind projects in the region.

FIGURE 4.10 RENEWABLE GENERATION

	MW Capacity
Solar	39.1
Wind	5.2
Hydro	43.5
Biofuels	3.1
Solar & Wind Combined	0.1
Total	**91.0**

Source: Department of Public Service

Solar

There is an estimated 39.1 MW of solar generation in the region. The amount of solar generation has almost quadrupled in the last six years. Of this generation, roughly 27 MW comes from medium and large projects of 500 kW or more, while 12 MW is from smaller projects.

Biodigesters

3.1 MW of electricity is generation from anaerobic digesters, with 8 current biodigesters. Biodigester may also be used to produce renewable natural gas (RNG) for thermal use, although there are not currently any biodigesters in the region that produce RNG.

Non-Renewable Energy

There is one non-renewable energy generator in the region: Project 10. This facility, which is located in Swanton, is owned by the Vermont Public Power Supply Authority (VPPSA) and runs on fuel oil and/or biodiesel. The facility is a "peaking" plant that operates only during peak electric loads, which, according to the project's Certificate of Public Good, equals approximately 600 hours per year. The facility can be converted to use natural gas as a fuel and is located near a natural gas line.

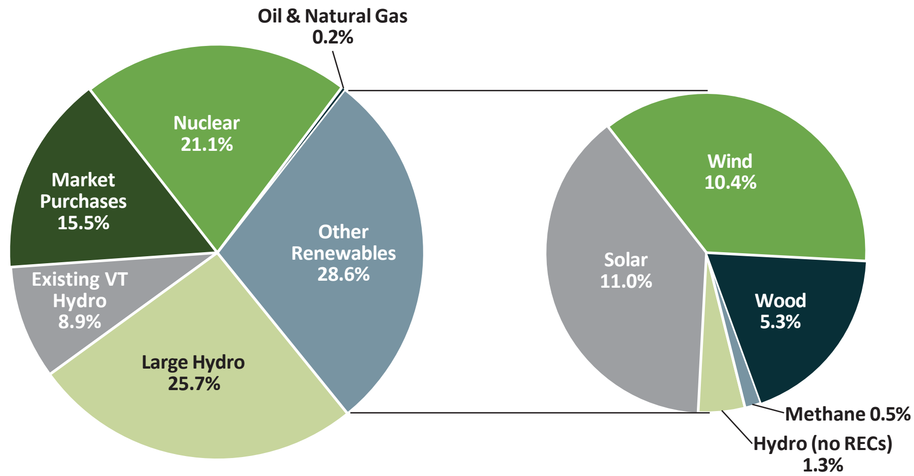
PUBLIC UTILITY ENERGY SOURCES AND IMPORTED ELECTRICITY

Four public utility companies in the Northwest region supply electricity (see Appendix C). Two of these utilities are operated by municipalities: Swanton Village and Enosburg Falls. Both of these utilities are part of Vermont Public Power Supply Authority (VPPSA), an organization that represents 12 municipal electric utilities in Vermont. The other electric utilities servicing the region are Green Mountain Power and Vermont Electric Cooperative (VEC).

Green Mountain Power

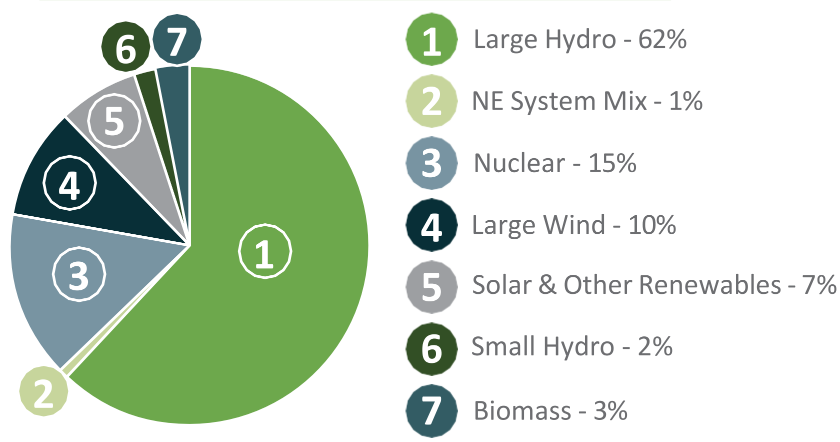
Green Mountain Power generally services the southern and western parts of Franklin County. Figure 4.11 shows sources of electricity distributed by GMP in 2021 (before the sale of renewable energy credits (RECs)). The electricity comes from primarily outside the region with the exception of distributed solar generation and the GMP-owned dam at Fairfax Falls. GMP owns several generation facilities. It also enters into power purchasing agreements with individual power suppliers and purchases power on the open market ("System" power) (Figure 4.11).

FIGURE 4.11 GMP ENERGY PURCHASES BY FUEL - 2021



Source: *Green Mountain Power*

FIGURE 4.12 VEC ENERGY PURCHASES BY FUEL - 2021



Source: *Vermont Electric Cooperative*

FIGURE 4.13 VILLAGE OF ENOSBURG FALLS ELECTRICITY SOURCES

Type of Power	Generator
Hydro	Enosburgh Dam, NY Power Authority, Hydro Quebec, VEPPI
Farm Methane/ Solar/Small Wind	Chester Solar (Chester, MA), Standard Offer
Landfill Gas	Fitchburg Landfill (Fitchburg, MA)
Fuel Oil or Biodiesel	Project 10 (Swanton, VT)
Natural Gas or Oil	System Power (source of supply not identified)
Biomass	McNeil (Burlington, VT), Ryegate (Ryegate, VT), VEPPI

Vermont Electric Cooperative

VEC's territory includes all of Grand Isle County and most of the northern and eastern parts of Franklin County. VEC does not own any electric-generating facilities; it instead has power purchasing agreements with individual electric suppliers and purchases power on the open market. Figure 4.12 shows VEC's energy sources by type of resource (before sale of RECs). Generally, electricity distributed by VEC comes from primarily outside the region with the exception of distributed solar generation and electricity generated from methane on regional farms.

FIGURE 4.14 SWANTON VILLAGE ELECTRIC DEPT.

Type of Power	Generator
Hydro	Highgate Dam, NY Power Authority, VEPPI
Farm Methane/Solar/ Small Wind	Standard Offer
Landfill Gas	Fitchburg Landfill (Fitchburg, MA)
Fuel Oil or Biodiesel	Project 10 (Swanton, VT)
Natural Gas or Oil	System Power (source of supply not identified), Stonybrook (MA)
Biomass	McNeil (Burlington, VT), Ryegate (Ryegate, VT), VEPPI

Enosburg Falls Village and Swanton Village Electric Departments

Despite their small service territories, both the Enosburg Falls Electric Department and Swanton Village Electric Department distribute electricity that is generated from a variety of facilities. Both utilities have dams located in the region (Enosburgh and Highgate, respectively). Both also rely, to some extent, on importing electricity from outside the region.

Enosburg Falls' dam supplied approximately 14% of the power distributed by the Enosburg Falls Electric Department in 2019. The remainder of electricity come from a mixture of hydro, wood, nuclear landfill gas and solar sources.

The Swanton Dam supplied 64% of the electricity distributed by Swanton Village Electric Department in 2019. The McNeil Generating Station in Burlington contributed an additional 17% of the electricity distributed.

SECTION V

V. TARGETS FOR ENERGY CONSERVATION, ENERGY USE, AND ELECTRICITY GENERATION

V. TARGETS FOR ENERGY CONSERVATION, ENERGY USE, AND ELECTRICITY GENERATION

While Section IV focuses on cataloguing the Northwest region's current energy demand and generation capacity, Section V creates targets for regional energy conservation, use and generation. The targets will guide the region toward achieving the state's and region's energy goals.

Achieving these energy goals will be challenging. Intensive conservation methods will need to be employed throughout the region in all sectors. Increased electrification of transportation and space heating will also be needed (combined with the subsequent decrease in fossil fuel use). But perhaps most importantly, total energy demand in the region will need to decrease despite population growth. The specifics of regional conservation and generation targets are covered in detail in Subsection B. Subsection A provides context for how regional targets were developed. Appendix H contains a comprehensive list of regional energy targets.

A. LEAP MODEL AND METHODOLOGY

Energy targets were created by the Department of Public Service using the LEAP (Long-range Energy Alternatives Planning) software to create a model of the demand for and supply of total energy usage in Vermont and the region. LEAP software is a system that allows users to create complex models of future energy use. The LEAP model does not identify specific costs that would be incurred in the future. Instead, it compares 2050 costs among various scenarios, in order to achieve the least-cost alternative to meet legislative goals. The LEAP model also includes impacts that do not result in out-of-pocket costs, such as impacts of pollution. Because of the model's complexity, it is difficult to explain comprehensively. The following scenarios provide some background on the methodology and the inputs used to create both statewide and regional models in LEAP. Appendix A presents the full model results for the region and the state as well as a more thorough explanation of the model assumptions and methodology.

Targets for generation were developed by the Northwest Regional Planning Commission in partnership with the Department of Public Service.

ONE MODEL - TWO SCENARIOS

The model created in LEAP actually contains two scenarios. The first scenario—the reference scenario— models what we will achieve based on current trends. The second scenario is designed to achieve the goal of meeting Vermont's greenhouse gas reduction obligations under the Global Warming Solutions Act (GWSA). This scenario, called the "CAP Mitigation" scenario, is adapted from the Vermont Total Energy Study (TES) Total Renewable Energy and Efficiency Standard (TREES) Local scenarios.[3] More information regarding the TES can be found on the Department of Public Service website.[4]

FIGURE 5.1 PROJECTED ENERGY DEMAND AND FOSSIL FUEL USEAGE

Total electricity demand will double by 2050.

Fossil fuel useage projected to be near zero by 2050.

To meet the GWSA goals, total energy use will need to decline despite a growing population and economy. Electricity use will increase with the intensified use of heat pumps as primary heating sources and the use of electric vehicles. Because those choices are powered by electricity, and electricity is three to four times more efficient compared to fossil fuels, overall energy use will decrease both regionally and statewide.

[3]Required by Act 170 of 2012 and by Act 89 of 2013, the intent of the TES according to the VT Public Service Dept. was "to identify the most promising policy and technology pathways to employ in order to reach Vermont's energy and greenhouse gas goals."

[4] Vermont Total Energy Study: http://publicservice.vermont.gov/publications-resources/publications/total_energy_study

The difference in total energy demand between the reference scenario and the CAP Mitigation scenario is a key point. This difference represents the amount of total energy demand that will need to be eliminated to reach the state's and region's energy goals by 2050. The many challenges that could inhibit regional efforts to reach conservation and generation targets are covered in detail in Section VI.

LEAP INPUTS AND ASSUMPTIONS

This LEAP model was developed for the state Comprehensive Energy Plan and disaggregated for each regional planning commission accounting for share in population, housing units, industries, commercial floorspace, number of vehicles and presence of natural gas pipelines. More information on the LEAP modeling inputs and assumptions can be found in Appendix D of the 2022 Vermont Comprehensive Energy Plan. This disaggregated "share" represents only one of the many paths the Northwest region may take to attain its energy goals and does not necessarily set a mandatory target for the region to achieve.

FIGURE 5.2 THERMAL DIRECTIONAL GOALS

- Significantly decrease use of fossil fuels.
- Significantly increase number of regional residential cold climate heat pumps and heat pump hot water heaters.

B. REGIONAL LEAP MODEL

Because different fuels are measured in different units (e.g., gallons, cords, pounds, cubic feet), the results of the LEAP model can be difficult to compare. To help make comparisons between fuel types easier, the NRPC has decided to report the scenario results in a standard unit: BTUs. To provide some additional context, see Figure 4.1 (page 17).

FIGURE 5.3 CHANGE IN FUEL SOURCE - RESIDENTIAL THERMAL

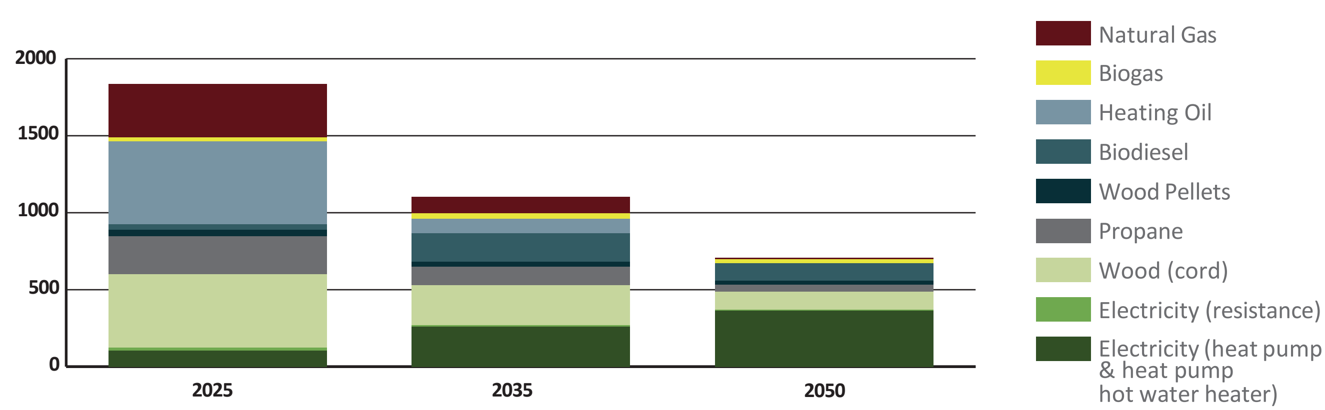
	2021	2050	Difference
Natural Gas	561	10	56x less
Propane	441	44	10x less
Electricity (*Heat Pump & Resistance*)	109	368	3.4x greater
Fuel Oil	947	92	10 x less
Wood (*Pellet & Cord*)	404	20	20x less
Biogas	0	115	-
Other	60	-	-

Source: *U.S. Census American Community Survey and 2023 Regional LEAP Modeling*

SPACE HEATING

To achieve the energy goals, according to the LEAP model, the amount of energy used for residential home space heating demand is expected to fall regionally between the present and 2050 (again, due in large part to heat pumps). It is also due to increasing energy savings gained through weatherization retrofits of existing single-family structures and through the construction of new single-family homes that are compliant with the state's residential building energy standards (RBES). Commercial and industrial retrofits and thermal efficiency upgrades can make a big impact on energy saving efforts.

FIGURE 5.4 CAP MITIGATION SCENARIO: RESIDENTIAL THERMAL ENERGY USE



The model results also show a significant reduction in the use of fossil fuels (or in the case of some fossil fuels, complete elimination) as a residential home heating source. The regional model shows the elimination of fuel oil as a heating source by 2050. Liquid propane and natural gas use are projected to drop substantially during the model time frame.

While electricity use only needs to increase by roughly 3 times to meet residential demand, this represents a 23 times increase in the number of residential heat pumps needed. Heat pumps are most effective when residential properties are fully weatherized, therefore the rate of weatherization will need to dramatically increase as well, although this version of the model does not provide a specific target.

Industrial and commercial space heating demand is also estimated in the LEAP modeling. Due to the lack of existing data on commercial energy heating, it is difficult to accurately determine the scale of change necessary. However, it is clear that industrial and commercial uses will need to transition from fossil fuels to electricity to meet energy goals, including nearly eliminating natural gas usage. To support this transition, there will need to be a large increase in the number of commercial cold climate heat pumps. According to the LEAP model, in 2020 there was an estimated 250 commercial cold climate heat pumps. This would need to increase almost 70 times to 17,394 to meet the 2050 goal.

FIGURE 5.5 TOTAL RESIDENTIAL HEAT PUMPS

2020 (Est.)	1,162	
2025	7,000	**6x** more than 2020
2035	18,821	**16x** more than 2020
2050	27,736	**23x** more than 2020

***Source:** Efficiency Vermont, LEAP Modeling, CAP Mitigation Scenario*

FIGURE 5.6 COMMERCIAL DIRECTIONAL GOALS

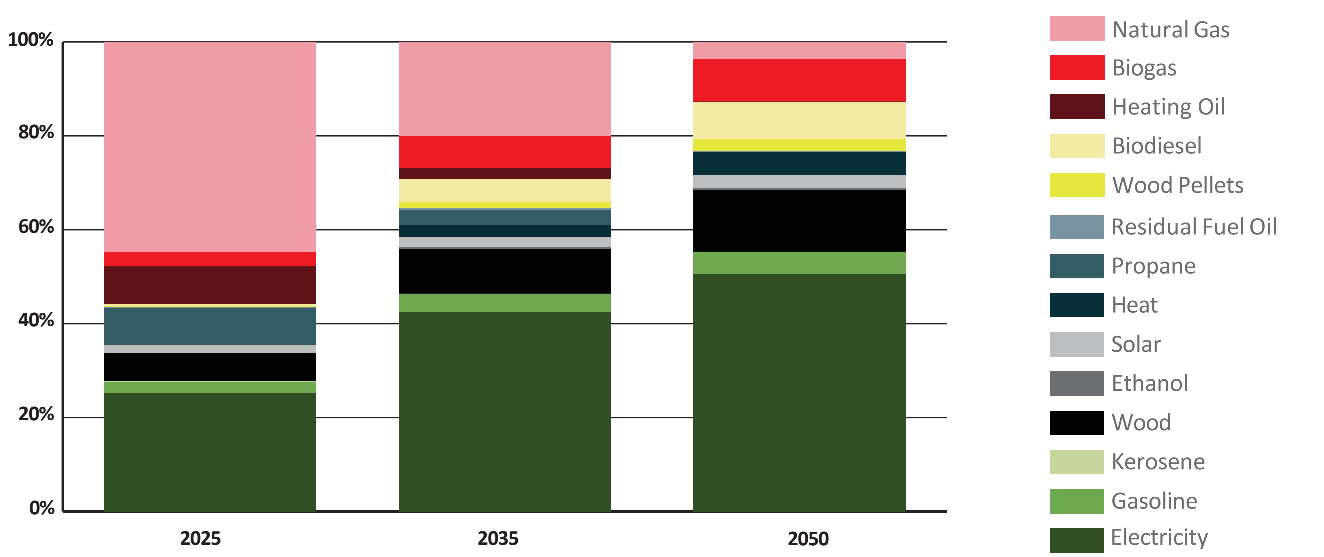
- Significantly decrease use of fossil fuels for commercial and industrial heating.
- Significantly increase number of regional commercial cold climate heat pumps.

FIGURE 5.7 COMMERCIAL COLD CLIMATE HEAT PUMPS

2020	250
2025	4,497
2035	13,601
2050	17,394

Source: Efficiency Vermont, Regional LEAP Modeling, CAP Mitigation Scenari

FIGURE 5.8 CAP MITIGATION TOTAL REGIONAL INDUSTRIAL SECTOR FINAL ENERGY DEMAND (Thousand MMBTUs)



To meet the targets for wood and electricity thermal generation for single family home and commercial heating, there will need to be approximately 720 new high-efficiency wood systems installed and 11,603 new electric heat pumps systems installed in the region by 2050. Targets for 2025 and 2035, targets based on the LEAP model, are shown in Figure 5.3.

TRANSPORTATION

The pace of reduction in gasoline vehicles will have to drastically increase in order to meet the 2050 goals. As part of this transition, adoption of electric vehicles will also need to increase. The region is achieving its goals for plug-in hybrid vehicles (PHEV) but adoption of fully electric vehicles (BEV) has lagged behind. While the average gas vehicle in Vermont has a fuel efficiency of 19 MPG, electric vehicles use far less energy, equivalent to 100 MPG. Therefore, transition to electric vehicles is also expected to reduce total energy use.

The LEAP modeling assumes vehicles miles traveled (VMT) will decrease by 10% by 2050. As VMT currently appears to be increasing statewide and carpooling is decreasing, these trends will need to be reversed to meet the 2050 goal.

FIGURE 5.9 TRANSPORTATION DIRECTIONAL GOALS

- Significantly decrease use of fossil fuels, such as gasoline and diesel.
- Significantly increase adoption of electric vehicles.
- Decrease average vehicle miles traveled.

FIGURE 5.10 TARGET: GASOLINE ENERGY USE

	Gasoline in Thousand MMBTU	% Change from Present Est.
2025	2,372	-25%
2035	1,883	-65%
2050	1,298	-95%

Source: *2023 Regional LEAP Modeling, CAP Mitigation Scenario*
Data Note: *Current est. include only household vehicles, this estimate may also include commercial or fleet vehicles*

FIGURE 5.11 TARGET: ELECTRIC VEHICLE - TOTAL REGISTRATIONS

	Plug-In Hybrid (PHEV)	Battery Electric Vehicle (BEV)	% Change from Present Est. (Total PHEV & BEV)
2025	290	1,939	162%
2035	276	23,427	2,382%
2050	66	51,071	5,902%

Source: *2023 Regional LEAP Modeling, CAP Mitigation Scenario*

Medium and heavy-duty trucks are also expected to transition primarily to electric energy from diesel. To meet regional transportation BTU targets, the region should support policies that would result in more electric vehicles and reduced vehicles miles travelled.

ELECTRICITY AND ELECTRICAL GENERATION

Electricity demand will increase significantly in the region under the "Cap Mitigation" scenario. Electricity increases from 20% to 39% of total energy demand between 2015 and 2050. As a result, while advances in energy efficiency are expected to reduce electrical energy usage through 2025, from 2025-2050 electrical use will increase again.

Current regulations require Vermont's utilities ensure electricity is 75% renewable by 2032. Further increasing the percentage of renewable energy in the electricity supply will require interstate coordination to ensure reliability. There exists continued debate as to exact 2050 goals, but fossil fuels are unlikely to form a major part of the electric energy supply by 2050.

FIGURE 5.12 CAP SCENARIO: ENERGY USE FOR PASSENGER CAR & LIGHT DUTY TRUCKS

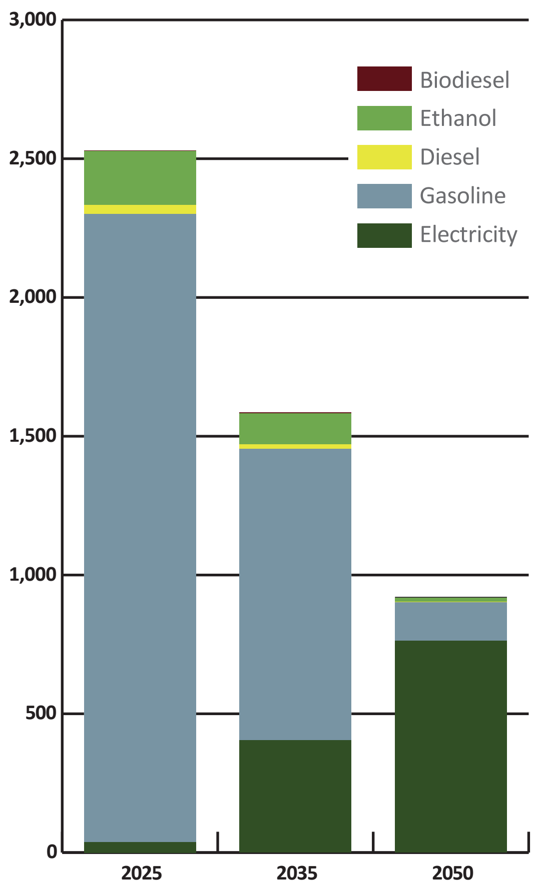
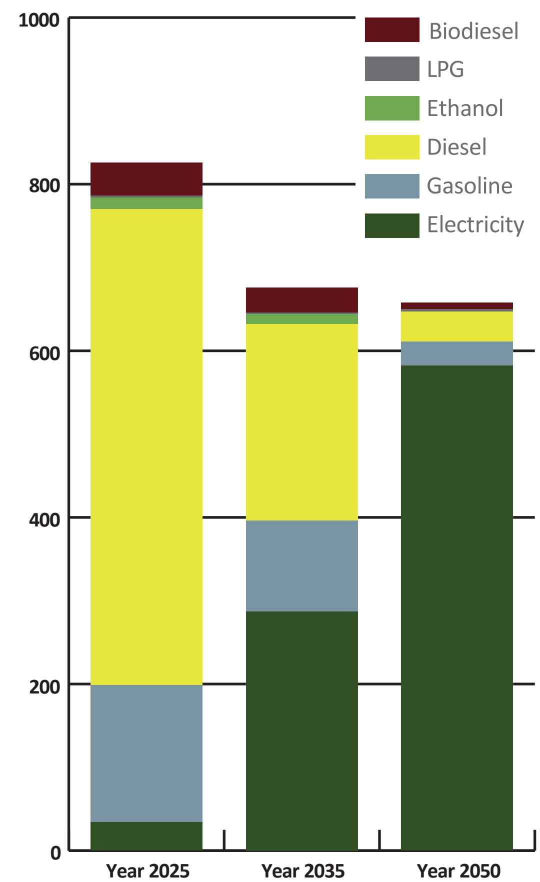


FIGURE 5.13 CAP SCENARIO: ENERGY USE FOR MEDIUM & HEAVY-DUTY TRUCKS



REGIONAL GENERATION TARGETS

Based on the 2050 energy goals and the Vermont Comprehensive Energy Plan, the Department of Public Service worked with regional planning commissions in Vermont to develop targets for new renewable generation. The generation targets are based on the estimated needs to cover the 50% of the region's energy use in 2050. It is expected that the other 50% of energy would be generated out-of-state.

FIGURE 5.14 TOTAL ELECTRICAL ENERGY USE: CHANGE FROM 2020 TO 2050

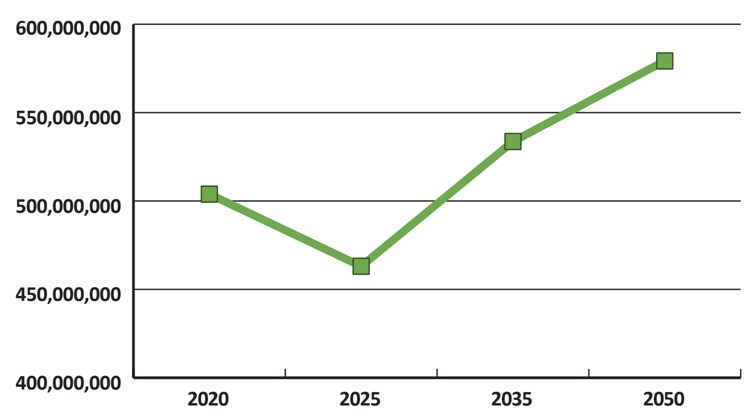


Figure 5.15 displays the regional targets for new renewable generation. The targets envision a high solar mix of renewable generation in the region. These targets display a linear progression to the 2050 generation targets. The generation targets call for only the addition of renewable energy generation sources in the region.

It is important to stress that the generation targets in Figure 5.15 represent only one possible way to derive 90% of total energy from renewable sources by 2050. The intent of the targets is to provide a sense of scale and a basis for discussion regarding the need for future electric generation, and about the siting of electric generation, in the region. Other electricity generation combinations may be possible. To guide the continuing conversation about the generation "mix," a regional MWh target has also been provided for each target year.

FIGURE 5.15 RENEWABLE GENERATION TARGETS

	2025	2035	2050
Solar	15.0	65.0	140.1
Wind	0.2	0.9	1.9
Hydro	0.4	1.9	4.0
Biodigesters	0.2	1.0	2.1
MWH Total (in MWH)	23,396	101,384	218,365

Source: *NRPC Targets based on Department of Public Service Renewable Generation Scenarios Tool*

HYDRO GENERATION

The 2050 hydro generation target of 4 MW was developed based on two assumptions. First, based on the 2008 state study of possible additional capacity in existing dam sites, the region could add 750 kW of hydro. The remainder of the 3.25 MW could come from a number of small run-of-the-river systems. Run-of-the-river systems are flexible lower impact systems that generate electricity, small sites can have an average of 100 kW in generation. New traditional hydro sites were not included in the estimate.

BIODIGESTER GENERATION

Biodigesters take waste product from farms or food production and use anaerobic digestion to turn this waste into byproducts into methane gas and other byproducts that can generate electricity. Based on current technology, biodigesters are best financially suited for farms of 500 or more cows, of which there are currently 19 in the region. Assuming an average150 kw project and that not every farm will have a biodigester, the total assumption is 2.1 MW.

WIND GENERATION

Based upon the analysis in Section V, the Northwest Region generally does not have suitable locations for the construction of "industrial" or "commercial" wind facilities within the region and therefore finds this scale of development does not conform to this plan The NRPC remains committed to achieving new wind generation by 2050, but only through the construction of appropriately scaled wind generation facilities. For the purposes of this plan, NRPC will consider any wind facility with a tower height (excluding blades) in excess of 100 feet tall to be considered an "industrial" or "commercial" wind facility. Based on these constraints, the NRPC has set a wind generation target of 2 MW to be achieved through small-scale wind.

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

SOLAR GENERATION

The remainder of the regional energy generation is expected to come from solar, an additional 140.1 MW, which equates to around 980 acres of solar [Once we have an updated prime solar acreage we will add it here- expected to be about 4% of prime solar land].

REGIONAL MUNICIPAL ELECTRICITY GENERATION

Department of Public Service standards for enhanced energy plans require that regional planning commissions develop targets for each municipality in the region. The NRPC is developing solar, hydro and biodigester targets for municipalities. Wind targets have not been provided to municipalities and are instead considered a regional target. This is because of the limited amount of area in the region that is appropriate for wind generation per mapping completed by the NRPC (see Section VI) and because of the NRPC's position regarding the construction of "industrial" and "commercial" wind facilities in the region as noted above.

RENEWABLE ENERGY CREDITS (REC)

The generation targets do not take into consideration renewable energy credits (RECs). RECs are legally created when a renewable energy generation facility is constructed. RECs can then either be "retired" by their owner or sold within the New England regional market. There is a contentious discussion in Vermont about the current REC system and whether or not the current system should continue to be used. This is due, at least in part, to changes that are currently occurring in regards to the disposition of RECs, particularly for net-metering projects. This discussion is outside the scope of this plan.

For the purposes of this plan, all new renewable generation in the region shall be considered to be progress toward the regional generation targets. Regardless of whether RECs are sold or retired, this plan encourages the development and production of renewable energy in the region.

FIGURE 5.16 CAPACITY FACTOR - NOT ALL GENERATION IS EQUAL

This section provides targets for new renewable generation from solar, wind, and hydro sources. However, there may be a preference for one kind of renewable energy generation vs. another type of renewable generation within the region. It is possible (but not simple) to "swap" one generation type for another (for example, the region could decrease the amount of solar in favor of more wind).

It is important to recognize the different types of renewable energy are not equal, and each have a different "capacity factor" (actual output over time). For example, a solar generation system with a capacity of 100 MW, in practice won't produce energy at that level all the time because the sun is not available for 24 hours a day, 365 days a year. Solar in Vermont is generally considered to have a capacity factor of 14%. Wind generation in VT, on the other hand, has a capacity factor of roughly 35%, because winds are more consistent source of energy than the sun. This means that if a region or community was determined to reduce the number of wind generation needed to reach targeted by the LEAP model, significantly more solar would be needed to make up the lost capacity.

Capacity factors also exist for hydro (40%) and biomass generation facilities (47%).

SECTION VI

VI. STRATEGIES TO ACHIEVE REGIONAL TARGETS

VI. STRATEGIES TO ACHIEVE REGIONAL TARGETS

The results of the LEAP model provide one scenario of future energy use in the Northwest region that ensures that state and regional energy goals are met. However, the LEAP model only provides targets for energy conservation and generation. It does not provide details about how the region may attain the targets set by the model.

This section addresses how the LEAP targets will be attained by examining specific goals, strategies, and implementation steps that the region may use to progress toward the CAP Mitigation Scenario and a more sustainable future.

This section, and the plan as a whole, is guided by the following statements of policy. The NRPC adopts these statements of policy to affirm its commitment to meeting state and regional energy goals and to satisfy the determination standards established by the Vermont Department of Public Service:

STATEMENTS OF POLICY

- NRPC supports conservation efforts and the efficient use of energy across all sectors.
- NRPC supports the reduction of in-region transportation energy demand, reduction of single-occupancy vehicle use, and the transition to renewable and lower-emission energy sources for transportation.
- NRPC supports patterns and densities of concentrated development that result in the conservation of energy.
- NRPC supports the development and siting of renewable energy resources in the Northwest region that are in conformance with the goals, strategies, and standards outlined in this plan.

The strategies are separated into those related to conservation and generation. The conservation strategies look specifically at the topics of electricity conservation, weatherization, and transportation, while the generation strategies explore how and where generation may be developed in the region.

Only strategies and implementation steps that can be completed by the NRPC are included in this plan. Many other strategies and implementation steps could help the region attain its energy goals, but these strategies cannot be achieved by the NRPC and require the action of state agencies, municipalities, public utilities, and individuals. The goals, strategies, and implementation steps outlined in this section are meant to evolve over time to reflect continuing changes in the Northwest region and changes to state and federal policy.

A. CONSERVATION

ELECTRICITY CONSERVATION

Additional electric generation and conservation are both required to ensure that the region can attain the targets set in the LEAP model and in state statutes. The following goals focus on electricity conservation. Policymakers must find ways to further electricity conservation efforts while also increasing the overall use of electricity compared to other energy sources (especially for space heating and transportation). The failure of conservation efforts could severely hinder the region's ability to achieve the CAP Mitigation Scenario.

FIGURE 6.1
RECAP: LEAP ELECTRICITY CONSERVATION TARGETS

To meet the CAP Mitigation Scenario, LEAP establishes the
following targets:

- Total regional electricity demand projected to increase by 100% by 2050.
- Regional electricity use for transportation projected to increase .05% in 2010 to 33% in 2050.
- Use of electric heat pumps to projected to account for 52% of single family home energy thermal energy demand by 2050.

Strategies used to address electric demand focus on supporting further development of energy storage systems (i.e., batteries), which can help address peak-demand issues associated with renewable generation, and on supporting existing programs that address the efficiency of appliances and lighting in Vermont. Smart rates, which use a rate structure that charges more for energy use during peak hours, can be used to reduce peak-hour electricity use. Ensuring this does not unduly impact low income households is paramount to successful implementation.

1 GOAL

Use demand-side management to handle the expected doubling of electric energy demand in the Northwest region by 2050.

STRATEGIES

1. Encourage public utilities to move all customers to smart rates (i.e., charging higher rates during peak demand times), and encourage public utilities to mitigate any differential effects of smart rates on low-income customers.
2. Encourage legislature and/or public utilities to create programs that promote the use of energy storage systems. Using electric storage systems may reduce peak demand and provide emergency back-up power.
3. Support public utilities' efforts to increase customers' knowledge of their energy use. This may happen through increased outreach to and education of customers, but it may also occur through the use of new technology such as real-time monitoring of energy use.
4. Support the efforts of Efficiency Vermont to promote the selection and installation of devices, appliances, and equipment that will perform work using less energy (e.g., ENERGY STAR). This includes "load controllable equipment."
5. Encourage HVAC and weatherization providers to join the Building Performance Professionals Association of Vermont (BPPA-VT) to provide holistic energy advice to Vermonters.
6. Support and encourage school participation in Vermont Energy Education Program (VEEP) activities that foster an educational foundation geared toward energy savings.
7. Support storm proofing of existing generation facilities to prevent shutdowns and reliance on back up fossil fuel generation.

IMPLEMENTATION

1. Work with GMP and regional partners to better promote the use of electricity conservation programs like the GMP eHome program and the Zero Energy Now program (in conjunction with GMP and BPPA-VT).
2. Support and provide outreach for EVT's customer engagement web portal and home energy reports.

THERMAL EFFICIENCY

Weatherizing structures to increase thermal efficiency is a very important part of reducing the region's energy demand by 2050. There is concern about the "missing middle", residents who earn too much to qualify for many incentives but still find it difficult to pay the upfront cost of these projects. Outreach is another challenge that has limited building weatherization and the adoption of alternative heating systems in the region. An organization that can deliver both the message and the services doesn't exist. Businesses that deliver home heating oil, propane, and natural gas might

FIGURE 6.2
RECAP: LEAP THERMAL EFFICIENCY TARGETS

To meet the CAP Mitigation Scenario, LEAP establishes the following targets:

- Total regional thermal energy needs for single family homes projected to drop by 9% by 2050.
- Use of cord wood to heat single family homes projected to decrease by only 20% by 2050.
- Use of electric heat pumps to projected to account for 52% of single family home energy thermal energy demand by 2050.
- Use of natural gas for single family home thermal energy expected to decrease by 68% by 2050.

be ideal for advocating weatherization efforts due to their connections to and frequent contact with business owners, homeowners, and landlords.

The amount of oil and gas being sold by most fuel dealers has declined in recent years, and further declines are expected. It may be in the interest of these companies—as well as the region—to begin transitioning their business models to become energy service providers (ESPs). Doing so will help them expand their current business model to include building audits, the sale of alternative heating systems, and other weatherization-related services. There may be value in working with regional partners to help orient area fuel dealers to this new market segment. Efficiency Vermont has created Efficiency Excellence Network, a program whereby contractors receive training in Efficiency Vermont–related efficiency programs and thus become eligible to be a "participating contractor," which offers benefits including receiving leads from Efficiency Vermont. However, more needs to be learned regarding this program to ensure that it is sufficient for both contractors and customers.

The availability of alternative, efficient heating sources is important to ensure greater thermal efficiency in the region. Heat pumps efficiently provide heat or supplement heat for residential and commercial buildings, particularly if the structure is airtight and well insulated. The NRPC will focus on coordinating with Efficiency Vermont and local public electric utilities to educate property owners about these heat pump systems and available incentives. At present, conversions to heat pump systems are not occurring at a high rate in the region. This may be due to high costs and inadequate incentives, as well as long wait periods for installation. The NRPC supports efforts to reduce the costs of converting to heat pump systems.

Other weatherization efforts can be completed by individual homeowners and businesses or through several local organizations, both public and private, that provide weatherization services in the region. CVOEO provides full-service weatherization programs for low-income homeowners, from audits to financing to contracting. The organization has conducted hundreds of home energy audits and overseen many weatherization projects in the region, but has a much smaller presence in the region compared to Chittenden County.

Efforts to weatherize existing structures should target the region's downtowns and village centers. These areas contain more residential and commercial units and include a very high percentage of rental housing, much of it in older houses that have been converted into multi-family units. Incentives for landlords to undertake energy efficiency improvements and install new alternative heating systems are limited, but the renters or landlords of these units could benefit from reduced heating expenses through such improvements. The region should also assess whether specific incentive programs should be created for older structures in rural areas, considering that many buildings in the region are located outside of existing downtowns and village centers.

FIGURE 6.3 POTENTIAL DISTRICT HEATING SYTEM SITES

Municipality	Site Description: Potential District Heating System Sites
Alburgh	Town/Village Office/ surrounding village/industrial park
Bakersfield	Town Office/School and surrounding village
Berkshire	Town Office/School and surrounding village and East Berkshire Village
Enosburgh	West Enosburgh Village
Fairfax	Village and School
Fairfield	Fairfield Village and East Fairfield Village
Fletcher	Binghamville Village and School
Franklin	Expand school sytem to village and East Franklin/East Berkshire
Grand Isle	Expand school sytem to village and Island Industrial Park
Highgate	Highgate Springs/Tyler Place and East Highgate Village
Isle La Motte	Village and School
Montgomery	Montgomery Village and Center Village
North Hero	Village
Richford	Village
St. Albans Town	St. Albans Bay Village
Sheldon	Sheldon Springs Village/School/Mill and Sheldon Village
South Hero	South Hero Village and Keeler Bay Village

The energy efficiency of newly constructed structures can be addressed through regulatory means. Efficiency Vermont recently adopted a "stretch" code for commercial and residential structures for use in Vermont. A stretch code has higher energy standards than the currently required Residential Building Energy Standards and the Commercial Building Energy Standards. The stretch code currently applies to all residential projects that are subject to Act 250 and can be used by commercial projects to demonstrate compliance with Act 250 Criteria 9(F). A stretch code can be adopted by municipalities to apply to new construction and rehabilitation of structures. Some municipalities may be interested in adopting a building code. Policymakers should remain aware that adoption of a stretch code or building code may increase up-front costs for new construction and renovations.

The potential of geothermal heating, also known as ground-source heat pumps, in the region is relatively unknown. However, the long-term economic benefits of utilizing such systems should be carefully considered by any multifamily residential, commercial, institutional, or industrial developers in the region and should be supported when such systems are feasible. Several facilities in the region currently use biomass heating, but there aren't any district biomass heating facilities in the region (where a central biomass facility heats several structures). Additionally, thermal heat networks can connect sites that produce excess heat, such as manufacturing facilities, to heat other nearby buildings. All three types of systems should be used where appropriate, potentially working in concert. They are particularly appropriate for densely developed areas as they have strong potential to reduce costs and emissions.

The NRPC has developed a list of candidate sites in the region (see Figure 6.3). The list includes large institutions, industrial parks, and areas of dense development.. NRPC will work with regional partners to investigate the feasibility of district heating and combined heat and power at the identified candidate sites and in the region at-large.

2 GOAL

To reduce annual regional fuel needs and fuel bills for heating structures, to foster the transition from non-renewable fuel sources to renewable fuel sources, and meet regional targets for the weatherization of residential households and commercial establishments.

STRATEGIES

1. Support efforts to transfer residential and commercial sectors from heating oil and propane to biofuels, biomass, and electric heat pumps.
2. Support changes that create simplified fuel switching financing that links bill payments, home equity, and public sector incentives.
3. Support the use of geothermal heating and cooling systems for new construction and renovation of existing residential and commercial construction in the region.
4. Support programs that provide assistance to low-income households to weatherize their homes.
5. Endorse the use of Downtown and Village Tax Credit programs to complete weatherization projects in the region's designated areas.
6. Support the creation of additional sustainable forest and biomass-related industries in the region to supply local biomass users.
7. Support greater state enforcement of existing state energy codes (e.g., Residential Building Energy Standards and Commercial Building Energy Standards) to ensure that all renovations of existing structures are energy efficient and meet current standards.

IMPLEMENTATION

1. In partnership with municipalities, utilities, and other regional stakeholders, educate owners of rental housing about weatherization and funding opportunities, particularly in village areas. This may include investigating the creation and implementation of a revolving loan program to fund weatherization improvements to rental properties in the region.
2. Study and assess the feasibility of biomass district heating and/or combined heat and power systems in the region, particularly in areas of the region with large institutions.
3. Work with the county forester and state wood utilization forester to implement strategies identified in the Northwest Region Forest Stewardship Plan to encourage the sustainable development of wood products industries in the region. This includes utilizing low-quality wood locally for pellet production.
4. Provide technical assistance to municipalities to revise their zoning regulations to allow and encourage the location of forestry- and biomass-related industries in appropriate locations.
5. Provide outreach to municipal officials and contractors regarding the use and enforcement of residential and commercial building energy standards for all new construction, including new stretch codes.
6. Strategize with CVOEO about ways to increase the use of the weatherization assistance programs in the Northwest region.
7. Work with Efficiency Vermont to assess the effectiveness of the Efficiency Excellence Network in order to ensure that the program is effectively serving both consumers and contractors and working toward state energy goals. Work with local fuel dealers, and other regional stakeholders such as Franklin County Industrial

FIGURE 6.4
RECAP: LEAP TRANSPORTATION ENERGY TARGETS

To meet the CAP Mitigation Scenario, LEAP establishes the
following targets:

- Total regional transportation energy demand projected to decrease by 58% by 2050.
- Gasoline and diesel demand projected to drop from 89% of demand in 2015 to 7% of demand in 2050.
- Electricity, ethanol, and biodiesel projected to account for 91% of transportation energy demand in 2050.

Development Corporation (FCIDC) and Lake Champlain Island Economic Development Corporation (LCIEDC), to encourage fuel dealers to become energy service providers.

TRANSPORTATION

Transportation is an area that the NRPC has long been actively involved in and one that will greatly influence the region's ability to meet the targets set by the LEAP model. The state statute (Title 24 Chapter 117) enables the NRPC to have a considerable influence on land use and transportation issues in the region, especially in the Act 250 process and through the implementation of the Transportation Planning Initiative (TPI), a program through which the Vermont Agency of Transportation coordinates policy development and planning with regional planning commissions.

The following three goals are focused on three different issues that pertain to transportation: compact development, rail use, and fuel type. The compact development goal is focused on issues that the NRPC is already actively involved in promoting through the implementation of the Northwest Regional Plan: additional regional development in or near existing growth centers and villages, increased bicycle and pedestrian infrastructure, and increased access to public transportation. Compact development located in or adjacent to existing growth centers has the potential to significantly decrease regional transportation energy demand and costs by reducing VMT and potentially increasing the use of public transportation. The increasing use of rail in the region, by both passengers and freight, will also decrease energy demand and costs. Finally, transitioning from fossil fuels to renewable, cleaner sources of energy equates to more efficient energy use, but it will require addressing infrastructural challenges that come with changing fuels.

3 GOAL

Hold VMT per capita to 2011 levels through reducing the share of single-occupancy vehicle (SOV) commute trips, increasing the share of pedestrian and bicycle commute trips, increasing public transit ridership, and focusing regional development in or near existing growth centers and villages.

STRATEGIES

1. New public and private transportation infrastructure shall be designed and built to interconnect with existing adjacent land development(s) and with adjacent lands that have the potential for future land development. This will ensure more efficient traffic patterns and bicycle/pedestrian movement within the region.
2. Support efforts to make regional transit authorities like Green Mountain Transit statutory parties to all Act 250 applications in the region.
3. Require a public transit stop for all residential and large commercial land developments subject to Act 250 if a stop is not currently available and the development is along an existing or planned fixed service route.
4. Support planning for municipal streetscape improvements and on-street parking in state-designated village areas. This may require some cooperation with the Vermont Agency of Transportation in some villages due to the existence of state roads.
5. Support municipal efforts to plan for future compact development that includes opportunities for walking, use of public transportation, and other forms of transportation that are an alternative to the SOV. Municipal efforts may include capital budgeting, streetscape plans, revitalization plans, or adoption of an "official map" (as outlined in 24 V.S.A. Chapter 117, to identify future municipal utility and facility improvements such as road or recreational path rights-of-way, parkland, utility rights-of-way, and other public improvements).
6. Support changes to public transportation funding in the state that alters how public transit routes are funded. Support efforts for state funding of public transportation routes that serve stops on federal and state highways (in a similar manner to the existing highway funding system) and require municipal funding primarily for public transportation routes that serve local roads.

7. Work with large regional employers to investigate and determine if "cash out" programs that allow employees to obtain cash in exchange for the ability to park at their job site are viable in the region and at specific employer locations.

IMPLEMENTATION

1. Utilize Complete Streets implementation policies, as outlined in the Transportation section of the regional plan, when reviewing Act 250 applications within the region to ensure greater connectivity of bike and pedestrian networks within the region's cities, villages, regionally designated growth centers, and transitional areas. This includes working with municipalities to adopt Complete Streets policies.
2. Study current park-and-ride capacity and identify future park-and-ride sites within the region in cooperation with VTrans. Support efforts to triple the number of park-and-ride locations in the region by 2050 as outlined in the Vermont Comprehensive Energy Plan.
3. Continue active participation with the Green Mountain Transit Board of Commissioners and support increased levels of public transportation service to the Northwest region.
4. Work with regional municipalities to investigate and institute local zoning changes that allow for greater residential density within regional downtowns, growth centers, and villages.
5. Provide education and technical assistance to municipalities to decrease parking requirements in their zoning regulations and to allow on-street parking in villages.
6. Develop ways to incentivize capital budgeting, official maps, and other planning efforts by municipalities to focus on expanding public infrastructure (including district heat, water and wastewater infrastructure) for future compact development.
7. Investigate methods that discourage sprawl and other types of land development, including subdivision, that threaten the regional working landscape and potentially increase transportation energy use.

4 GOAL

Increase region-based passenger rail trips and rail freight tonnage in the region.

STRATEGIES

1. Support bringing the Vermonter rail line service to Montreal.
2. Support increased rail freight service to the region on existing active rail lines.

IMPLEMENTATION

1. Be an active participant in anticipated VTrans feasibility studies concerning commuter rail service between St. Albans and Montpelier to Chittenden County.
2. Work with municipalities to identify future passenger station sites in the region.
3. Work with New England Central Railroad, regional development corporations, VTrans, the Chittenden County Regional Planning Commission (CCRPC), the City of Burlington, the City of St. Albans, and other partners to study constraints and opportunities for increased freight traffic within the Northwest region.

5 GOAL

Increase the share of renewable energy in transportation by increasing the use of electric vehicles and for heavyweight vehicles less carbon-intensive fuels such as electricity, biofuels, and compressed natural gas.

STRATEGIES

1. Require all commercial, industrial, and multifamily developments subject to Act 250 to provide electric vehicle (EV) parking spots and infrastructure to supply electricity for charging.

2. Continue to support Vermont Agency of Commerce and Community Development (ACCD) grant opportunities for municipalities to install electric charging stations and infrastructure in designated areas.
3. Support financial incentives for those that develop direct current (DC) fast electric charging stations.
4. Support the development and creation of biofuels other than ethanol production and distribution infrastructure in the region.
5. Support the efforts of municipal fleet operators to replace inefficient vehicles with more efficient vehicles, including heavy-duty vehicles that operate on biofuels.
6. Support state programs to encourage business fleets to convert to electric vehicles

IMPLEMENTATION

1. Work with Efficiency Vermont and municipalities to identify local zoning barriers to allow for electric vehicle charging stations.
2. Partner with Drive Electric Vermont, Lake Champlain Islands Economic Development Corporation and Franklin County Industrial Development Corporation to develop ways to celebrate and showcase employer investments in EV-friendly workplaces and new, innovative transportation programs in the region.
3. Work with municipalities to acquire grant funding for the installation of DC fast charging infrastructure at locations strategically located along major travel corridors, in transit hubs such as park-and-ride lots, and in designated downtowns and villages.

6 GOAL

Increase the number of municipal energy committees in the Northwest region.

STRATEGIES

1. Support the creation of municipal energy committees in the Northwest region, community volunteer groups that focus on increasing energy efficiency in their municipalities and sharing information on existing programs with residents.
2. Support municipal projects that align with the goals and strategies of this plan.
3. Support municipal energy committees with project and grant management for energy and climate resilience projects that are consistent with this plan.

IMPLEMENTATION

1. Advocate for the creation of municipal energy committees in the region, and provide municipalities with technical support when creating such committees.
2. Work with Energy Action Network to provide available data to municipal planning commissions and energy committees to aid municipal energy planning work.

7 GOAL

Increase local food production and consumption.

STRATEGIES

1. Support the efforts of the Healthy Roots Collaborative and other regional organizations focused on expanding the local food system.

IMPLEMENTATION

1. Implement the existing language in the Northwest Regional Plan that calls for limiting the loss of primary agricultural soils and active farmland. In addition, implement the existing language in the Northwest Regional Plan that calls for mitigating the impacts to primary agricultural soils and active farmland when these areas are to be developed, including the construction of renewable energy generation facilities.
2. Work with regional municipalities to institute local zoning changes that provide additional protections to productive agricultural land and primary agricultural soils.

B. GENERATION

As seen in the results of the LEAP model, achieving the state's energy goals will take more than improvements to energy efficiency and reductions in energy use. It will also require additional energy generation, particularly of electricity.

ELECTRICITY GENERATION

Electricity generation strategies focus on continued support of existing state programs that encourage renewable generation development such as net-metering programs and the Standard Offer Program. Strategies also focus on the creation of more accessible, internet-based information for electricity generation developers and for the general public regarding grid limitations and the Certificate of Public Good process. Implementation will primarily focus on the NRPC aiding municipal energy planning efforts, which includes working with municipalities to identify preferred locations for future generation development in municipal plans. It also includes working with municipalities to identify and develop effective policies to protect significant cultural, historical, scenic, or natural resources. The development of these policies can address many of the concerns that communities and citizens in the region have expressed with regard to solar and wind generation facilities. The NRPC will work with municipalities to ensure that municipal plans receive an affirmative "determination" from the Northwest Regional Planning Commission.

The NRPC would like to further investigate the public benefits provided to municipalities either directly from renewable energy generation developers or as a condition of a Certificate of Public Good. The NRPC is interested in determining whether the current system creates equitable outcomes or if it can be improved to provide greater equity to all municipalities impacted by a renewable energy generation facility, even if the facility is only located in one municipality. This is particularly relevant when discussing "industrial" or "commercial" wind generation facilities.

The NRPC finds it to be essential that all decisions regarding new renewable energy generation facilities take into consideration concerns about health and safety. The noise, vibration, glare, or other impacts from generation facilities shall be mitigated by developers to ensure that such impacts do not have an undue adverse impact upon neighboring properties. This includes any impacts that pertain from electric or magnetic fields, or from construction activities associated with the facility.

It is hard to know exactly what the future makeup of Vermont's electricity generation will be, but it is important to support a diverse, distributed, and robust set of generation facilities in the region. This will ensure resiliency, equity, and adaptability for the future.

8 GOAL

Increase the renewable energy generation capacity in the Northwest region through a mix of generation types including solar, wind, hydro, and biodigesters.

STRATEGIES

1. Support the development of individual home and community-based renewable energy projects in the region through the following programs: Vermont Small Scale Renewable Energy Incentive Program, Clean Energy Development Fund, and tax and regulatory incentives including net-metering.
2. Support changes to net-metering rules and other regulatory tools to provide financial incentives in order to encourage siting of renewable generation facilities on the built environment (such as parking structures and rooftops) and other disturbed lands (such as former landfills, brownfields, or gravel pits). Support changes to net-metering rules that disincentivize development on land identified in this plan

as a location with known and possible constraints. Encourage multiple uses in conjunction with the development of renewable generation facilities, such as grazing of livestock, recreation, or parking.

3. Continue to support the Standard Offer Program (Figure 5.6) to foster deployment of diverse and cost-effective renewable energy resources, and support the continued evaluation of this program to determine if the program should be extended or changed.
4. Support the creation of "solar maps," like the maps developed by Green Mountain Power, to make interconnection information available to the general public and accessible online. Local electric utilities could partner with the NRPC to create these maps.
5. Support efforts by local utilities and private individuals to maintain and upgrade existing renewable electric generation facilities in the Northwest region and the state.
6. Support the development of additional methane digesters on farms in the Northwest region, especially those that utilize manure from multiple farms and/or food waste.
7. Support the creation of incentives for locating new renewable energy generation facilities within a half-mile of three-phase distribution line or electric transmission line infrastructure. Ensure new transmission lines and three-phase power lines associated with renewable energy projects do not create forest fragmentation or have an undue adverse impact on necessary wildlife habitats, ecological systems, and water and/or air quality.
8. Investigate potential new technologies including geothermal facilities to produce electricity, and support local research into their application.

FIGURE 6.5 STANDARD OFFER PROGRAM

In 2009, the Vermont legislature created the Standard Offer Program, which is designed to encourage the development of renewable energy generation facilities by establishing prices for new renewable energy based on the cost of developing a project plus a reasonable rate of return. Through the program, renewable energy developers can receive a long-term, fixed-price contract for renewables facilities up to 2.2 MW in size. The original program cap was 50 MW, which was amended to 127.5 MW in Act 170 of the 2011–2012 legislative session. All facilities to be built through the program are required to receive a Certificate of Public Good from the Public Service Board.

IMPLEMENTATION

1. Maintain determination of enhanced energy plan compliance through the Public Service Department in order to ensure that the plan is given greater weight in the Certificate of Public Good process.
2. Provide assistance to municipalities to identify potential areas for development and siting of renewable energy generation facilities. Work with municipalities to identify areas, if any, that are unsuitable for siting renewable energy generation facilities or particular categories of renewable energy generation facilities. Ensure that municipalities include this information in their municipal plans and work to ensure that municipal plans are given an affirmative regional determination of enhanced energy plan compliance by the NRPC so that municipalities may receive "substantial deference" in the Certificate of Public Good process.
3. Work with municipalities to specifically identify significant cultural, historical, or scenic resources in their communities. Work with municipalities to protect these resources through the development of a statement of policies on the preservation of rare and irreplaceable natural areas and resources as well as scenic and historic features and resources, as required by 24 V.S.A. 4382, and include such policies in municipal plans.
4. Identify, catalog, and map potential brownfield sites and other previously disturbed sites in the region that may be appropriate for future solar generation facilities.
5. Investigate public benefits provided to municipalities either directly from renewable energy generation developers or as a condition of a Certificate of Public Good. Assess if the current system is equitable to all municipalities impacted by a renewable generation facility, or if the current system can be improved to

provide greater equity to all municipalities impacted by a renewable energy generation facility.

ENERGY RESOURCE MAPS AND THE PUBLIC SERVICE BOARD

The Vermont Public Service Board has jurisdiction over all energy generation facilities that are a part of the public electrical grid. The board provides its approval to an energy generation facility by issuing a Certificate of Public Good to that facility. A proposed energy generation facility must meet the criteria found in 30 V.S.A. §248 in order to receive a Certificate of Public Good. The role of regional planning commissions in the Certificate of Public Good process is outlined in 30 V.S.A. §248(b)(1), commonly referred to as Section 248:

> *With respect to an in-state facility, will not unduly interfere with the orderly development of the region with due consideration having been given to the recommendations of the municipal and regional planning commissions, the recommendations of the municipal legislative bodies, and the land conservation measures contained in the plan of any affected municipality.*

In addition, regions and municipalities may receive "substantial deference" instead of "due consideration" during a Certificate of Public Good proceeding if the region or municipality has received an affirmative determination of energy compliance. This potentially provides regional and municipal plans with greater weight before the Public Service Board.

In recent Certificate of Public Good proceedings, the Public Service Board has frequently found that municipalities and regional planning commissions have not had language, or maps, that have provided for "land conservation measures" that are specific and/or well-reasoned enough to have a real impact on the siting of renewable generation facilities through the Certificate of Public Good process. Through the creation of the following regional energy generation maps, the NRPC is planning for the development of additional renewable generation facilities in the region (using the LEAP model targets as a basis of conversation) and providing for clarity regarding regional land conservation measures and specific policies.

The NRPC has developed renewable energy generation maps for four renewable energy resources: solar, wind, hydro, and biomass. The following subsection provides a basic explanation of how the maps were created and how they are intended to be used and/or integrated into the Northwest Regional Plan. This is followed by subsections explaining the intent behind the maps of each renewable energy resource. Maps created while developing this project are provided in Appendix C.

ENERGY GENERATION MAPS METHODOLOGY

NRPC staff worked with other regional planning commissions (RPCs), the Department of Public Service and other project partners in the state to develop criteria that would inform and guide the siting of renewable energy generation facilities. The NRPC and the other RPCs each create maps that provide a macro-scale look at different factors that impact the siting of facilities.

Spatial data showing generation potential, which was originally compiled by the Vermont Sustainable Jobs Fund, form the basis of the NRPC's mapping. The NRPC then identifies conservation resources in the region that are considered worthy of protection from development. These resources are selected through conversations with project partners, analysis of the current Northwest Regional Plan, and public input. Other known and possible constraints are developed at the state level.

Known constraints are conservation resources that shall be protected from all future development of renewable generation facilities. Possible constraints are conservation resources that the NRPC intends to protect, to some extent, from the development of renewable generation facilities. The presence of possible constraints on a parcel does not necessarily preclude the siting of renewable generation facilities on a site;

siting in these locations could occur if impacts to the affected possible constraints are mitigated, preferably on-site.

When considering locations for future renewable energy generation facilities, the NRPC encourages developers to target regional locations with generation potential that do not contain any known or possible constraints. These areas are shows as "prime" on the renewable energy generation maps in Appendix C. Further, if prime areas are located within a half-mile of existing transmission or three-phase distribution infrastructure, the NRPC finds that these areas should be given further preference by the Public Service Board. Areas with high generation potential but that also contain possible constraints are identified on the regional energy generation maps as "base" areas. These areas may be appropriate for the development of renewable energy generation facilities, but they should be given less preference than prime areas.

A full list of the known constraints and possible constraints identified by the NRPC for each type of generation (solar, wind, biomass, hydro), along with information about data sources, may be found in Appendix B.

It should be noted that the energy generation maps are based on the best available geographic data. They are macro-scale maps meant to guide the development of renewable generation facilities. The NRPC expects that some applicants or parties will be able to provide on-site information that is more accurate regarding the presence of known and/or possible constraints. This information will need to be taken into account by the NRPC and the Public Service Board when reviewing applications for renewable generation facilities to ensure that known constraints are not impacted and to ensure that impacts to possible constraint areas are mitigated. The energy generation maps are not intended to be used without the accompanying goals and policies of the NRPC contained in this plan.

FIGURE 6.6 ROOFTOP SOLAR – POTENTIAL CAPACITY

NRPC has approximated potential solar generation from both commercial/ industrial and residential rooftops in region. The analysis estimates that 25% of all residential, commercial and industrial structures may be correctly sized for solar generation and have actually installed solar panels. NRPC then estimated that a typical residential system would generate 4 kW of electricity and that a typical commercial or industrial system would generate 20 kW of electricity.

Based on these assumptions, the Northwest region could potentially generate 28.8 MW of electricity from rooftop solar generation. About 21.6 MW would come from residential rooftops and 7.2 MW would come from commercial and industrial rooftops.

Additional development of structures in the region would provide additional generation capacity. While these assumptions allow for only rough approximations, they do provide a sense that rooftop solar may be a viable way to meet at least a portion of the regional generation targets.

NORTHWEST REGIONAL ENERGY GENERATION MAPS AND STANDARDS

Solar Generation Facilities - LEAP Generation Target 140.1 MW

The NRPC has determined that several types of locations in the region should be targeted for future solar generation. These locations are not shown on the solar generation maps, yet are considered "preferred locations" by the NRPC. In no particular order, these preferred locations include the following:

- Rooftops of structures
- Former landfill sites
- Brownfield sites and Superfund sites that are not located in a state or regionally designated downtown or village center
- Abandoned and active earth resource extraction sites (sand pits, gravel pits, rock quarries)
- Surface parking lots

The preferred locations are often a good fit for solar generation facilities (provided that site-specific standards are met). These sites are typically underutilized (e.g., former landfill sites, brownfield sites, and earth resource extraction sites) or are already heavily developed (e.g., rooftops and parking lots). Solar siting should be prioritized in these locations.

FIGURE 6.8 SOLAR POTENTIAL DIAGRAM

There currently is a lack of geographic data that accurately shows parking lots, former landfills, existing and abandoned quarries and potential brownfield locations in the region. NRPC is actively working to develop this data to help provide additional guidance for future development of solar facilities.

Many parts of the region are suited to solar development, but western Franklin County and Grand Isle County stand out. Western Franklin County is where the greatest regional electrical demand is located, so developing solar in this area is ideal in terms of electrical grid efficiency. Grand Isle County has less electrical demand and may also have some grid capacity restrictions based on comments made by the public electric utility serving the area, Vermont Electric Cooperative. Both areas also have a substantial amount of area that is prime solar yet also contains a possible constraint. In many of these locations, the possible constraint on the site is typically primary agricultural soils or protected lands.

Based on conversations with the Department of Public Service and other RPCs, it is the NRPC's understanding that it is generally less expensive to interconnect ground-mounted solar when it is close to existing transmission lines or three-phase distribution lines. The NRPC analyzed the amount of prime solar acres located within a half-mile of transmission lines and three-phase distribution lines. The NRPC's analysis found about 10,259 acres of prime solar (with known and possible constraints removed) within a half-mile of transmission or distribution infrastructure. It is in these areas that the NRPC would like to target future solar generation (if generation is not to be located in "preferred locations," as identified above).

There is more electric infrastructure in southern and western Franklin County than in other parts of the region. These same areas also are close to Chittenden County, a region that may have a difficult time meeting its generation targets due to its considerable electric demand and smaller land mass on which to site generation facilities. There is some concern that southern and western Franklin County may see more than its fair share of new solar generation facilities. However, the NRPC understands that siting facilities in these areas will provide landowners with financial benefits and that it may be necessary to provide electricity to meet state economic and energy needs.

Wind Generation Facilities

The Department of Public Service sets a lower target for wind generation than solar generation in the region. The Northwest region is already home to half of the Georgia Mountain Community Wind project, which generates approximately 10 MW of electricity (the electricity generated is purchased by Burlington Electric). The generation targets call for an additional 2 MW of new wind generation in the Northwest region by 2050.

Prime wind generation data is available from the Vermont Sustainable Jobs Fund. Wind potential at wind "hub" heights of 50 meters (164 feet) and 70 meters (230 feet), as provided in the dataset, have been regionally mapped (see Appendix C).

Smaller, net-metering scale wind generation may be possible throughout most of the region at lower elevations. More information is needed regarding the viability and affordability of these systems, but generally the NRPC views these types of facilities favorably provided that impacts to known constraints are avoided, impacts to possible constraints are mitigated, and site-specific concerns are addressed. NRPC does not support the construction of "industrial" or "commercial" wind generation facilities within the region. For more information, please see Section V.

The regional wind generation maps in Appendix C do not show many wind generation areas with high generation potential. This is due to the existence of known constraints, most notably conservation habitat design blocks and source protection areas for public water supplies. This is consistent with existing language in the Northwest Regional Plan.

As stated earlier, known constraint areas have been removed from the map and are not suitable for renewable generation development. The remaining portion of the region with considerable wind generation potential constitutes a relatively small area that can effectively generate electricity from wind. Meeting the 2 MW target for new wind generation in areas without known or possible constraint areas may be a challenge.

To compensate for the challenge of meeting the wind generation target, the NRPC may need to plan for additional generation from other renewable sources—most likely, solar. Hydro, biomass, and even geothermal sources would probably be insufficient to produce the amount of electricity required to keep the region on track to meet the CAP Mitigation Scenario.

There has been an ongoing call from concerned citizens and advocacy groups for site-specific standards for large-scale wind generation facilities in Vermont, especially regarding sound. Concerns have also been raised regarding aesthetics, surface water degradation, and the "flicker effect" (caused by moving turbine arms in front of the sun). The Public Service Board has been tasked with creating sound standards for wind generation facilities per Act 174. These standards were adopted in July 2017. The NRPC finds that the other potential concerns raised regarding wind generation facilities should continue to be studied by the Department of Public Service and the Public Service Board but are not addressed by this plan.

Hydro Generation Facilities

The growth of hydro generating capacity in the region is desirable because of the positive effect it may have on baseload electrical production (according to the Department of Public Service, most new in-state hydro can't be considered baseload power because the dams are required to operate as "run-of-the-river" and therefore aren't always a reliable source of generation in the summertime). Hydro generation is a more consistent and reliable source of renewable generation than both wind and solar generation. Investment in existing and new hydro sites should meet environmental standards established by the State of Vermont Agency of Natural Resources.

The NRPC supports continued import of hydro-generated electricity from the New York Power Authority projects in the St. Lawrence River Valley and from Hydro-Québec. However, the commission is concerned about the long-term price of electricity from these projects. In recent years, several projects have been proposed in Vermont and New York to construct privately owned DC transmission lines from the Canadian border to various points on the New England grid, including several locations in Vermont. These transmission lines will allow additional electricity to be transmitted to the United States from Canada, primarily from Hydro-Québec, which will subsequently be sold on the ISO New England grid. This potentially will mean that Vermont public utilities will be competing with public utilities from southern New England for electricity generated by Hydro-Québec. The NRPC is concerned that this increased competition with public utilities from outside the state may lead to higher wholesale electricity costs and higher electricity rates for Vermonters. Although the region and state may need to continue to rely on Hydro-Québec for some hydro generated electricity to

FIGURE 6.9 EXISTING HYDRO FACILITIES WITH GENERATION POTENTIAL

Name	Stream	Owner	Year Built	Hazard Classification	Potentia kW
Mud Creek	Mud Creek	State of VT - DFW	1957	Low	8
Johnsons Mill	Bogue Branch	Perry Cooper	1928	Low	5
Trout Brook Reservoir	Trout Brook	Town of Enosburg		Low	4
Bullis Pond	Rock River	Town of Franklin	1843	Low	9
Lynch	Abenaki Bay-TR	Karen Lynch	1969	Low	1
Browns Pond	The Branch	Jamie Rozzi	1920	Low	29
Fairfield Pond	Dead Creek-TR	Swanton Light & Power Department		Low	15
Lake Carmi	Pike River-TR	State of VT - DEC	1970	Low	14
Fairfield Swamp Pond	Dead Creek	State of VT- DFW	1967	Low	18
Swanton	Missisquoi River	Swanton Light & Power Department	1920	Low	850
St. Albans North Reservoir	Mill River	City of St. Albans	1895	High	6
St. Albans South Reservoir	Mill River	City of St. Albans	1910	Significant	6
Silver Lake	Beaver Meadow Brook-TR	City of St. Albans	1912	Significant	3
Source: Agency of Natural Resources, data may be incomplete				**Total Potential kW**	**1,019**

ensure that the CAP Mitigation Scenario is met, the NRPC finds additional in-state renewable generation to be preferable. The commission is also concerned about equity issues regarding the communities most impacted by the development of these projects.

The NRPC generally supports hydro generation in the region—but due to the regulatory complexity of permitting and relicensing dams, the cost of refurbishing existing dams, and the potential effects that dams may have on wildlife, it finds that meeting the LEAP target for hydro would be tremendously difficult. The NRPC is
committed to planning for and exploring hydro generation at existing sites, but the commission believes that planning for additional generation from other renewable sources and advances in electricity storage may be needed to ensure that the CAP Mitigation Scenario can be attained.

Biomass Generation Facilities

Biomass, in various forms, can be used to produce heat and electricity. For several reasons, the LEAP model does not provide a target for biomass electric generation or thermal generation (or at least for thermal generation from a "district heating facility"—a central facility that would provide heat to several structures).

Electrical generation from biomass is specifically not addressed by LEAP due to concerns about how additional large-scale biomass electric generation, specifically from wood sources, may impact climate change and air quality in the region. There are also concerns about the efficiency of using biomass to generate electricity. However, in the event that a biomass heating facility is proposed in the region, NRPC recommends the proposed facility operator assess whether the facility could also cost effectively provide electrical generation (i.e., a Combined Heat and Power facility).

Some farms in the Northwest region currently use “cow power” biomass to generate electricity. “Cow power” utilizes methane released from cow manure to fuel an engine. The engine, in turn, creates electricity. There are five “cow power” facilities located on farms in Franklin County. A facility in St. Albans Town currently under construction is slated to use manure and food scraps from the solid waste district to generate electricity. Food scraps are another fuel source that may open up possibilities for additional generation. The NRPC supports using methane digesters to the greatest extent possible in the region given its renewable nature, the financial support it can provide to regional farmers, and additional water quality benefits.

Thermal generation is the more probable route for utilizing biomass, especially from forests (i.e., “woody biomass”) in the region. The LEAP model also does not provide a target for thermal generation from a central biomass facility (i.e., district heating), but instead it provides some targets for distributed thermal generation that are addressed in Section VI and Appendix A. New district heating facilities that utilize woody biomass for thermal generation should be located in areas that have a relatively dense collection of possible system users. Downtowns and villages (and probably some hamlets) should be targeted as possible future sites of district heating facilities.

The development of a district heating facility entails high capital costs for both the “power plant” and the distribution network. Ensuring buy-in from prospective local users is necessary for economic viability and is certainly a challenge to facility development.

Developing future district heating facilities may be difficult, especially in the short term, because many ideal sites are served by relatively low-priced natural gas. Future district heating ideally would be located in eastern Franklin County, where biomass resources are most abundant. Grand Isle County may also be a potential location for a district heating facility due to a lack of competition with natural gas. However, Grand Isle County lacks local biomass resources and would most likely need to be supplied from other parts of the region, or from outside the region, making such a facility less economically viable.

When discussing the use of woody biomass, it is important to consider the long-term sustainability of the region’s forest. It takes time for forest regeneration to occur after logging. The region should not become overly reliant on biomass for electrical or thermal generation in order to ensure that the region’s forests are sustainable over the long term. That said, woody biomass will continue to be an important, affordable, and accessible fuel source for heating individual structures in rural locations in the region.

Biomass from agricultural crops can be used in the production of biofuels. Although the research in this field is evolving, using agricultural land to produce crops to be manufactured into biofuels in the region could provide an economic opportunity for regional farmers. Ideally, production facilities where agricultural products are manufactured into biofuels would be located on farms or in appropriate locations within the region’s villages.

New technologies continue to develop, including the emergence of geothermal heat as an electricity source. Investigating which technologies are suitable for our region and its residents will be an ongoing process. It is hard to know exactly what the future makeup of Vermont’s electricity generation will be, but it is important to support a diverse, distributed, and robust set of generation facilities in the region. This will ensure resiliency, equity, and adaptability for the future.

SECTION VII

VII. FEASIBILITY AND CHALLENGES

A. FEASIBILITY

B. IMPLEMENTATION CHALLENGES

VII. FEASIBILITY AND CHALLENGES

A. FEASIBILITY

Combined with the LEAP model results, the analysis of existing energy demand and supply provides a framework for discussing the region's energy present and future. From that framework, the NRPC has developed goals, strategies, and implementation actions for both conservation and generation that will help the region achieve the CAP Mitigation Scenario. Despite challenges posed by grid limitation and by site-specific siting issues, the generation goals and strategies, guided by the LEAP generation targets, are feasible for the region to achieve in terms of both the amount of electricity needed to reach projected demand and the amount of land required to generate the electricity.

The identified conservation goals and strategies may be more difficult for the NRPC to implement. Energy conservation goals will require changes by individual consumers in the region. The NRPC can facilitate and help coordinate the efforts of other organizations in the region (e.g., public utilities, Efficiency Vermont, CVOEO) but has little influence in the area of electric and thermal energy.

The third area of conservation—transportation—is different. One of the NRPC's core functions is to coordinate transportation planning for the region. Combined with the NRPC's experience in land use planning—a discipline inextricably linked to transportation planning—the commission is well suited to implement transportation goals and strategies. Progress on transportation implementation actions will be prioritized, though electric and thermal goals will continue to be pursued.

B. IMPLEMENTATION CHALLENGES

The NRPC faces several challenges in achieving the CAP Mitigation Scenario. Many cannot be resolved by the NRPC alone and will require the cooperation and coordination of the federal government, state government, and private sector. Other challenges, such as those posed by Chittenden County's future electricity demand, will require the NRPC to make policy decisions that will have an impact on the achievement of state energy goals. Key implementation challenges include the following:

- **High Upfront Costs** – While efficient technologies such as heat pumps and electric cars are more affordable to operate, they also tend to have higher up-front costs. Incentives have been created to help Vermonters, especially low-income Vermonters, access these technologies. Unfortunately, many residents still find a gap between the subsidized cost and the amount they can afford. Increased incentives, especially for middle income households, as well as the quickly improving technology could help to alleviate this barrier for the region's residents. There is also a need to substantially increase the capacity of existing programs for low-income residents, such as the low-income weatherization programs to reduce wait times.

- **Complex and Intertwined Systems** – The ways in which we heat our spaces, fuel our vehicles, and power our homes are complex and can impact each other in surprising ways. Installing heat pumps or other electric technologies can often require expensive panel upgrades. Heating technologies like heat pumps are often only efficient if a home has been sufficiently weatherized, which can be a complicated and expensive undertaking. The expense of systems also means that residents will often only upgrade their furnace or other equipment when their current one fails. This slow rate of change, along with the complex upgrades often needed can be a barrier to implementation, but additional funding could encourage residents to make these improvements sooner and in an order that enables increased efficiency, such as weatherization before heat pump installation.

- **Split-Incentives** – in many rental housing options, the landlord is responsible for building maintenance while the tenant is responsible for utility bills. Typically, utility bill costs are not disclosed to future renters prior to signing a lease. As a result, the landlord may not have a strong financial incentive to invest into home improvements such as weatherization or heat pumps. As a result, renters may face high utility costs with few options to address them. This is a particular problem given that in the Northwest Region the median renter household has half the income of the median owner-occupied household. Finding new ways to incentivize both landlords and tenants as well as provide targeted outreach and education on this topic could help to alleviate this issue.

- **Baseload vs. Intermittent Electricity** – Solar and wind generation technologies create electricity intermittently: when the sun is shining and when the wind is blowing, respectively. Unfortunately, the times when these generation sources are operating do not always correspond to the times when electric demand is at its peak. "Baseload" electricity, or electricity that is available on demand, is needed to ensure that peak demand can be met at any time. At present, baseload electricity is typically generated by fossil fuel, nuclear, or hydro generation sources; this may change in the future. Research indicates that solar and wind generation often complement each other, and increased solar generation in the region has helped the region address peak loads. Still, reaching the 2050 goal will require the development of alternative technologies such as more efficient and large-scale batteries, which will enable renewable technologies to supply baseload electricity. Biomass from farm and landfill gas as well as run-of-the-river hydro can be used to generate energy more consistently than solar or wind, providing a more reliable baseload. Each option comes with potential environmental & siting impacts that will need to be carefully considered to create a balanced system.

- **Grid Limitations** – The Vermont electrical grid was developed to have a one-way flow of electricity and distributed renewable generation can impact the function of the electrical grid. As with the rest of the United States, Vermont has historically depended on a small number of centralized power plants—the vast majority of which are located outside of the state.

  With growth in distributed renewable generation, the way in which electricity is generated has changed. In some parts of the region, the grid may not be fully capable of allowing the placement of all scales of renewable energy generation facilities in every community. According to Green Mountain Power, its portion of the regional grid should be able to deal with additional solar generation, but there is less information available from VEC, the Village of Swanton, and the Village of Enosburg Falls. If the region and state are going to become more reliant on distributed solar generation, or even become a net exporter of renewable energy, Vermont public utilities and Vermont Electric Power Company (VELCO) will need to increase the pace of system-wide upgrades. This may be a difficult task to complete without directly impacting ratepayers and the cost of electricity in the state and the region. Proposed investments by GMP and VELCO would add an estimated 108 MW in increased voltage limits.

- **Inclement Weather** – Increased reliance on electricity for regional heating and transportation energy needs could be challenged by the region's weather. Winter storms and high winds often threaten the region's electrical distribution infrastructure. Downed power lines could impact the ability of some regional households to produce heat or to have a means of transportation if the household is solely reliant on electric heat pumps and/or electric vehicles. Although this challenge may be addressed through increasingly concentrated regional development and improved battery technology, households might still need to have a secondary means of heating their homes (and carry the cost of maintaining a secondary heating source). Other means of overcoming the challenge of inclement weather include creating grid redundancy, creating microgrids (i.e., grids that can disconnect and operate when the main grid is not functioning), and developing more accurate weather prediction tools such as VELCO's weather analytics tool.

- **Difficulty in Developing New Hydro** – As mentioned, it is difficult to develop new hydro power sources, even at existing dam sites. Achieving the LEAP target of hydro generation in the region may be difficult if not impossible. Due to the relatively high-capacity factor associated with hydro generation, “replacing” the need for hydro with more solar generation will be difficult. Run-of-the-river hydro has less ecological impacts and could offer more year-round power for the region. Understanding and supporting the implementation of newer, more efficient and less disruptive renewable generation will help the region gain the benefits of renewables with less of the drawbacks.

- **Issues with Biofuels, Ethanol, Renewable Natural Gas, and Heat Pumps** – The LEAP targets are very reliant upon biofuels and ethanol as an energy source for heavy vehicles. Current technology and economics would make a transition from diesel to biodiesel and ethanol unlikely. Significant technological advances will be necessary to make the use of biofuels on such a large scale possible and truly renewable (currently, biofuels production requires considerable fossil fuel inputs). There may also be major infrastructural challenges to creating a supply chain to distribute and sell biofuels in the region and the state. This plan does not support the use of ethanol as an alternative fuel due to the high environmental and energy costs of producing ethanol.

  Manufacturing biodiesel fuels locally may be an economic opportunity for local farmers. UVM Extension has successfully worked with Borderview Farms in Alburgh to grow crops that are converted to biofuels. It remains to be seen if this success story can be replicated on other farm in the region or on a commercial scale.

  The LEAP analysis does not factor in the potential use of “renewable” natural gas by VGS in the future. VGS has started to purchase renewable natural gas from farms. The gas is produced by processing cow manure in an anaerobic digester to create natural gas. The economic viability of renewable natural gas, its impacts on climate change, and its classification as a “renewable” resource should be analyzed in future updates to this plan.

  The LEAP analysis only factors in the energy use of heat pumps for heating. It does not factor in the use of heat pumps for cooling. Use of heat pumps for cooling may have a substantial effect on electricity demand in the summer, especially given the potential warming effects of climate change on the region. This issue should be addressed in future revisions to the LEAP analysis.

- **Proximity to Chittenden County** – Although the LEAP generation targets appear to be achievable in the Northwest region and for most of the state, it may be much more difficult for neighboring Chittenden County to attain its LEAP generation targets. Chittenden County’s existing electricity demand is larger than that of the Northwest region, and the electric demand in Chittenden County is growing at a faster rate than in the rest of the state. There will likely be pressure on the regions surrounding Chittenden County to “help” meet its generation targets. The NRPC specifically expects there to be pressure to develop additional solar in southern and western parts of the region due to these areas being adjacent to Chittenden County. This is especially true given grid limitations that exist in Addison County and Washington County. The NRPC will need to decide whether or not it is appropriate for the region to be an energy “exporter” to Chittenden County. The effects of additional generation in the region will need to be weighed against the potential monetary benefits that additional generation may have for some of the region’s landowners, as well as the positive impacts that it may have both in helping the state achieve the CAP Mitigation Scenario and on the overall state economy. Many regional residents rely on Chittenden County for employment.

- **Reliance on Cord Wood and Biomass** – While reduced from original modeling, the LEAP model still depends heavily on cord wood use as a single-family home heating source (and for commercial and industrial heating, too). The NRPC has some questions about how this increased demand will be met regionally and about the potential environmental impacts of increased reliance on wood—particularly with regard to climate change.

The continued reliance on cord wood for heating and its impacts on greenhouse gas emissions as well as the sustainability of its harvest in the region should be monitored. As the impacts of climate change on the Northwest region become clearer, the widespread use of cord wood should be reassessed to ensure that its use continues to be in the best interest of the region and the state. In addition, information from the Biomass Energy Research Center indicates that the region has less low-grade wood that can be used for biomass heating than other regions of Vermont. This may limit efforts in the region to expand the use of biomass for heat and electricity generation. Biomass generation that utilizes farm or landfill gas can help to meet renewable generation goals without threatening our forests.

- **Lack of Site-Specific Guidelines for Solar and Wind Generation Facilities** – The energy generation maps in the plan address which conservation resources should be protected from development of renewables and which conservation resources should be subject to mitigation if impacted by development of renewables. This plan does not provide site-specific guidelines for how solar or wind should be placed on a site if it is deemed appropriate for development. The issues of screening, stormwater management, fall distance, sound levels, and aesthetics have not been addressed in this plan. The NRPC did not address these issues directly in this plan primarily due to the unique challenges that each particular site poses to renewable development, but these factors are considered by the Project Review Committee.

  The legislature has developed setback requirements for solar facilities and has enabled municipalities to develop solar facility screening ordinances, but concerns persist about whether enough has been done to protect the state's working landscape. Sentiment is even stronger in the state regarding the need for siting standards for wind generation facilities. Of particular concern to the NRPC are the possible economic inequities that can result through the siting of large generation facilities in the region. The NRPC advocates for changes to the Section 248 process ensuring that the economic benefits provided by a developer are distributed equally to all municipalities that are impacted by a proposed facility.

- **Impacts on Local Energy Companies** – The changing energy landscape may have negative impacts on local energy companies, such as heating fuel and gas stations, that cannot evolve their business model. In the short term, this may hinder regional citizens from accessing new, innovative heating and transportation technologies locally. In the long term, it may lead some local energy companies to disband, with lost jobs as a consequence. There are several programs in the state and region to help retrain workers who currently work in the fossil fuel industry. Certain sectors, including weatherization and green technology installation, will require additional labor and can provide careers for those transitioning out of fossil fuel industries.

- **Lack of RBES and CBES Outreach and Enforcement** – Although Efficiency Vermont has provided some outreach to local contractors and the general public regarding the requirements of Residential Building Energy Standards (RBES) and Commercial Building Energy Standards (CBES), there is still a lack of knowledge about the programs. The state also lacks the ability to enforce the code. Combined, this could slow regional and statewide weatherization efforts. Increased education and outreach on these standards and the benefits of higher standard builds could help to increase implementation of RBES and CBES.

- **Limits of Regional Jurisdiction** – There are limits to how much the NRPC can do to ensure that the 2050 goal is accomplished. The commission can influence state policy and implement projects that fall within RPC's jurisdiction in state statutes, but many of the changes that will be required will need to happen on a macro scale (i.e., federal and state policy) and on a micro scale (i.e., the choices of individuals in the region). The NRPC will need to be cognizant of its limitations when implementing this plan.

Despite the challenges involved in implementation, it is important to remember the key issues this plan hopes to address: energy security, environmental protection, economic need/opportunities, and equity. Without making significant changes to how the Northwest region generates and uses energy, our energy future will be less secure, our environment less healthy, and our economic situation potentially dire. The NRPC finds that any and all progress toward the goals of this plan is important. A lack of action at the state, regional, and local levels may have calamitous consequences.

APPENDIX A

APPENDIX A - SUMMARY RESULTS AND METHODOLOGY

Summary Results and Methodology

Introduction

The Vermont Comprehensive Energy Plan includes a detailed description of the LEAP modeling process in Section 2.2 that was used for this update. Refer to https://publicservice.vermont.gov/comprehensive-energy-plan.

This document is an update of the 2017 Regional Energy Plan which supplemented the regional energy plans created by each Regional Planning Commission (RPC). The 2017 plan 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 modelingefforts. 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] andEIA 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%202 013.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 *UtilityFacts 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 commercialsector 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. Itgrows 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 concentratedevelopment and to support alternatives to single occupant vehicles, VMT per capita is assumedto remain flat at 12,000.

The regional models use two scenarios. The **reference scenario** assumes a continuation of today's energyuse 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 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 wasdistributed 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 regionswith 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 freightrail 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 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

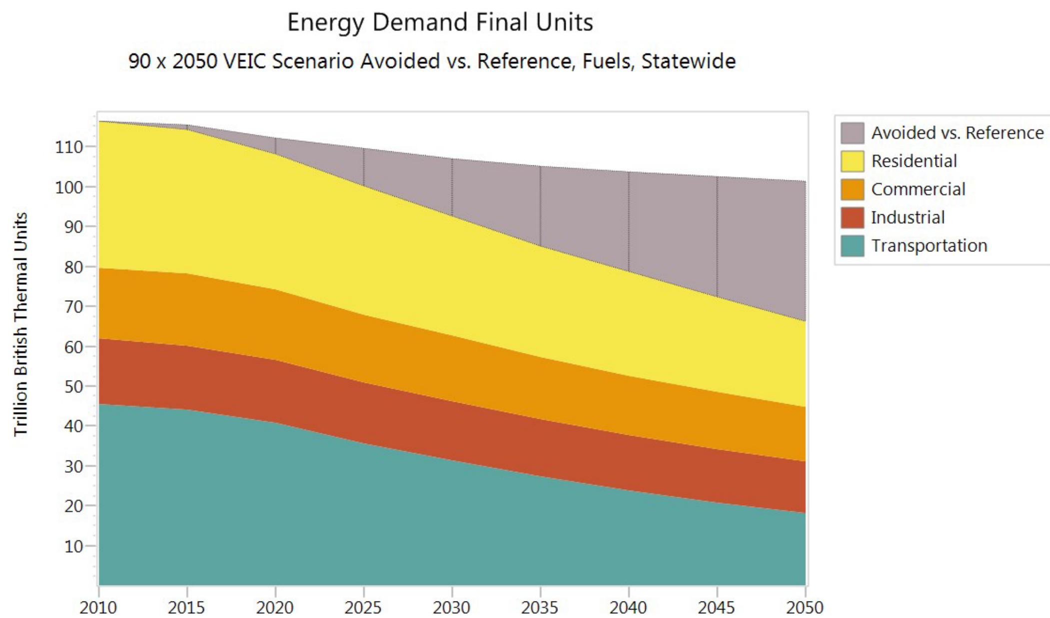


Figure 1 - Statewide energy consumption by sector, 90% x 2050 VEIC scenario compared to the reference scenario

Regional Total Energy Consumption

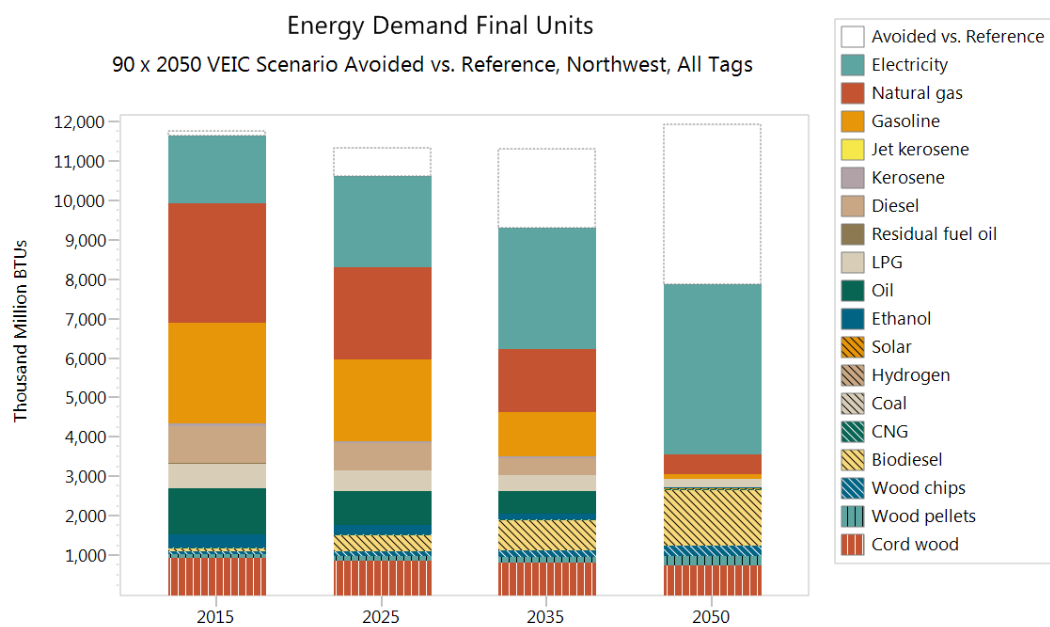


Figure 2: Regional energy consumption by fuel

Regional Energy Consumption by Sector

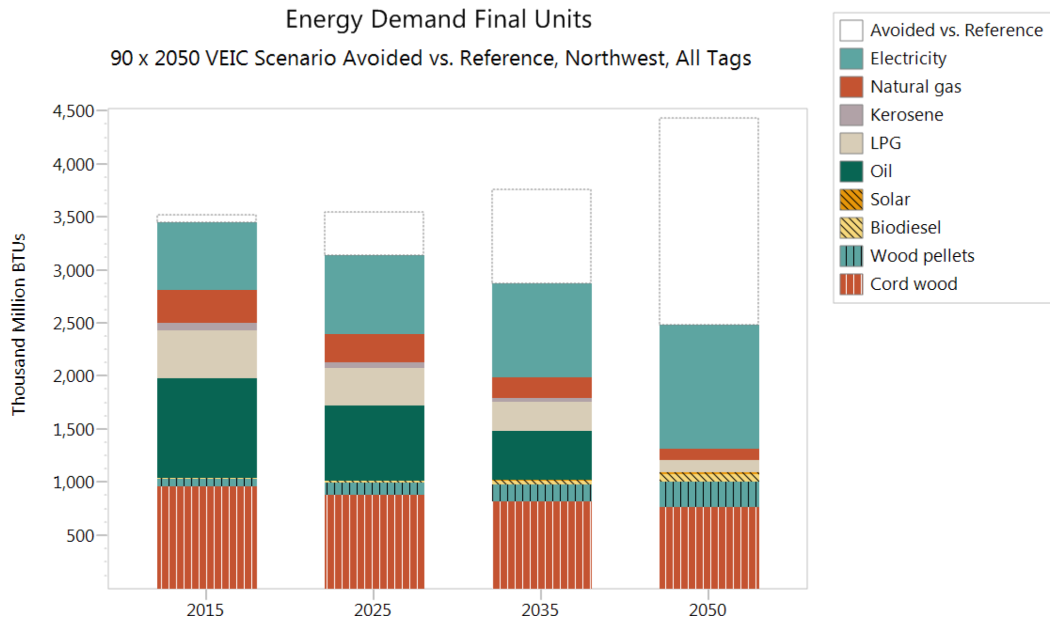


Figure 3: Regional residential energy consumption by fuel

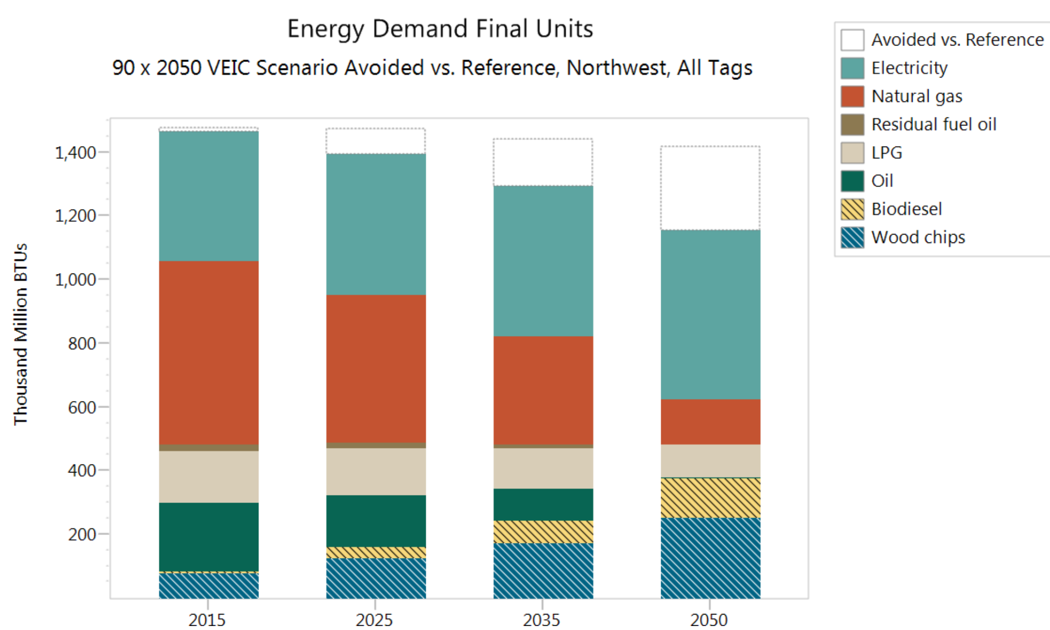


Figure 4: Regional commercial energy consumption by fuel

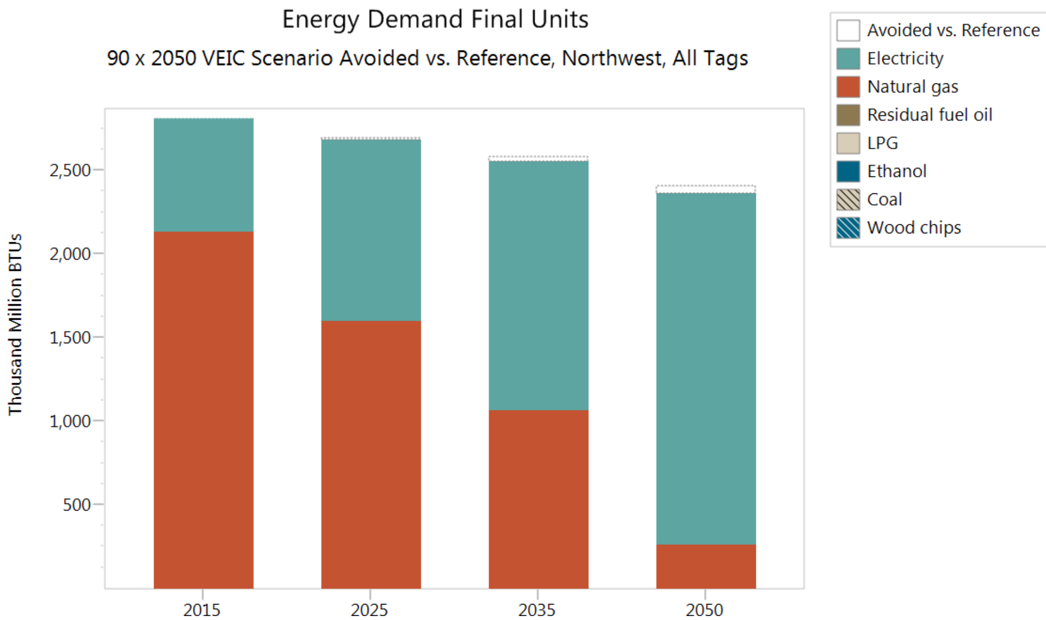


Figure 5: Regional industrial energy consumption by fuel

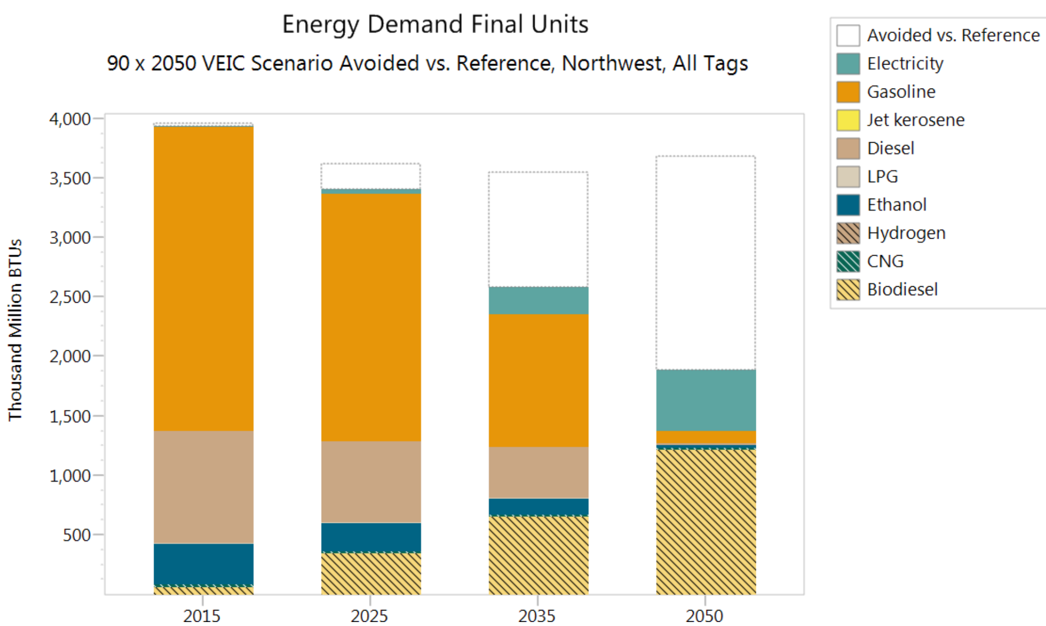


Figure 6: Regional transportation energy consumption by fuel

Detailed Sources and Assumptions

Residential

The TES provides total fuels used by sector. We used a combination of industry data and professional judgement 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.

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[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.

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[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.

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 plugin 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]

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[13] Efficiency Vermont, "Electric Usage Chart Tool," https://www.efficiencyvermont.com/tips-tools/tools/electric-usage-chart-tool.
[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

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[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] US 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

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[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."

APPENDIX

B

APPENDIX B - ENERGY RESOURCE MAPPING

A. EXPLANATION OF CONSTRAINTS

B. SOLAR GENERATION MAPS

C. BIOMASS MAPS

D. WIND GENERATION MAPS

E. HYDRO GENERATION MAPS

F. EXPLANATION OF MUNICIPAL CONSERVATION LAND USE AREAS

APPENDIX B - ENERGY RESOURCE MAPPING

The following is a list of the known constraints and possible constraints that have been included on the regional energy generation map in Appendix C (solar, wind, woody biomass, and hydroelectric). The energy generation maps are not intended to be used without the accompanying goals and policies of the NRPC contained in this plan. For more information about how the energy generation maps shall be used, please see Section V of the plan (see: Energy Resources Maps and the Public Service Board, Energy Generation Maps Methodology, and Northwest Regional Energy Generation Maps and Standards).

A. EXPLANATION OF CONSTRAINTS

The following is an explanation of known and possible constraints used by the NRPC to create the regional energy generation maps. This list of constraints shall also be considered by the NPRC during the review of generation project applications (Section 248) in the Northwest Region:

KNOWN CONSTRAINTS

Known constraints are considered high-priority resources and for this reason energy generation facilities shall not be located in areas where known constraints exist. For this planning initiative, known constraints have been removed from the base layer of each applicable type of resource (solar, wind, biomass, hydro).

POSSIBLE CONSTRAINTS

Possible Constraints are lower-priority resources. These resources often impact the siting process for generation facilities. New generation facilities shall not have an undue adverse impact upon possible constraints. Often, site-specific mitigation solutions are possible when possible constraints exist on a parcel. Therefore, possible constraints have been included in the area designated as "base" on the regional energy generation maps (solar, wind, biomass, hydro).

B. SOLAR GENERATION MAPS

STATE KNOWN CONSTRAINTS

- **Confirmed Vernal Pools:** There is a 600-foot buffer around confirmed vernal pools. (*Source: ANR*)
- **State Significant Natural Communities and Rare, Threatened, and Endangered Species:** Rankings S1 through S3 were used as constraints. These include all of the rare and uncommon rankings within the file. For more information on the specific rankings, explore the methodology for the shapefile. (*Source: VCGI*)
- **River Corridors:** Only mapped River Corridors were mapped. Does not include 50 foot buffer for streams with a drainage area less than 2 square miles. (*Source: VCGI*)
- **National Wilderness Areas:** (*Source: VCGI*)
- **FEMA Floodways:** (*Source: VCGI*)
- **Class 1 and Class 2 Wetlands:** (*Source: VCGI*)

REGIONALLY IDENTIFIED CRITICAL RESOURCES (REGIONAL KNOWN CONSTRAINTS)

- **Designated Downtowns, Designated Growth Centers, and Designated Village Centers:** These areas the center of dense, traditional development in the region. This constraint does not apply to roof-mounted or parking lot canopy solar within such designated areas. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: NRPC*)

- **FEMA Flood Insurance Rate Map (FIRM) Special Flood Hazard Areas:** Special flood hazard areas as digitized by the NRPC were used—just 100-year flood plain (500-year floodplain not mapped). The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: NRPC*)
- **Ground and Surface Waters Drinking Protection Areas:** Buffered Source Protection Areas (SPAs) are designated by the Vermont Department of Environmental Conservation (DEC). SPA boundaries are approximate but are conservative enough to capture the areas most susceptible to contamination. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: Vermont Agency of Natural Resources [ANR]*)
- **Vermont Conservation Design Highest Priority Forest Blocks:** The lands and waters identified here are the areas of the state that are of highest priority for maintaining ecological integrity. Together, these lands comprise a connected landscape of large and intact forested habitat, healthy aquatic and riparian systems, and a full range of physical features (bedrock, soils, elevation, slope, and aspect) on which plant and animal natural communities depend. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: ANR*)
- **Public Water Sources:** A 200-foot buffer is used around public drinking water wellheads. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: ANR*)
- **National Natural Landmark – Chazy Fossil Reef:** The Chazy Fossil Reef in Isle La Motte has been designated a National Natural Landmark by the US Department of Interior. (*Source: NRPC*)
- **Municipal Conservation Land Use Areas:** Conservation Land Use Districts, as designated in municipal plans, that include strict language that strongly deters or prohibits development have been included as a regional known constraint. The inclusion of this resource as a regional constraint is consistent with the goals and policies of the Northwest Regional Plan. Specific municipal land use districts included are outlined in Section D.

STATE POSSIBLE CONSTRAINTS

- **Potential and Probable Vernal Pools:** There is a 600-foot buffer around unconfirmed vernal pools. (*Source: ANR*)
- **Protected Lands:** This constraint includes public lands held by agencies with conservation or natural resource oriented missions, municipal natural resource holdings (ex. Town forests), public boating and fishing access areas, public and private educational institution holdings with natural resource uses and protections, publicly owned rights on private lands, parcels owned in fee by non profit organizations dedicated to conserving land or resources, and private parcels with conservation easements held by non profit organizations. (*Source: VCGI*)
- **Features from ANR's Vermont Conservation Design:** Highest Priority Interior Forest Blocks, Highest Priority Connectivity Blocks, Highest Priority Physical Landscape Blocks and Highest Priority Surface Water and Riparian Areas.
- **Deer Wintering Areas:** Deer wintering habitat as identified by the Vermont Agency of Natural Resources. (*Source: VCGI*)
- **Hydric Soils:** Hydric soils as identified by the US Department of Agriculture. (*Source: VCGI*)
- **Agricultural Soils:** Local, statewide, and prime agricultural soils are considered. (*Source: VCGI*)
- **Act 250 Agricultural Soil Mitigation Areas:** Sites conserved as a condition of an Act 250 permit. (*Source: VCGI*)

REGIONALLY IDENTIFIED RESOURCES (REGIONAL POSSIBLE CONSTRAINTS)

- **Class 3 Wetlands:** Class 3 wetlands in the region have been identified have been included as a Regional

Possible Constraint. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan (*Source: ANR*)

- **Municipal Conservation Land Use Areas:** Conservation Land Use Districts, as designated in municipal plans, that include strict language that deters, but does not prohibit development, have been included as a regional possible constraint. Specific municipal land use districts included are outlined in Section D.

OTHER MAP FEATURES

- **Three-Phase Distribution Lines:** All available utilities with service in any of the three regions (*Source: Green Mountain Power, Swanton Village Electric Department, Vermont Electric Coop, and Village of Enosburg Falls*) were mapped.
- **Transportation Infrastructure:** These were removed in the initial analysis performed by VCGI. Does not include parking lots. (*Source: VCGI*)
- **VELCO Transmission Lines and Substations:** (*Source: VCGI*)
- **Water Bodies:** Major water bodies (i.e., >1 square kilometer in surface area) are shown on maps as "Lakes/Ponds." (*Source: VCGI*)

C. BIOMASS MAPS

STATE KNOWN CONSTRAINTS

- **Confirmed and Unconfirmed Vernal Pools:** There is a 600-foot buffer around confirmed or unconfirmed vernal pools. (*Source: ANR*)
- **State Significant Natural Communities and Rare, Threatened, and Endangered Species:** Rankings S1 through S3 were used as constraints. These include all of the rare and uncommon rankings within the file. For more information on the specific rankings, explore the methodology for the shapefile. (*Source: VCGI*)
- **River Corridors:** Only mapped River Corridors were mapped. Does not include 50-foot buffer for streamswith a drainage area less than 2 square miles. (*Source: VCGI*)
- **National Wilderness Areas:** (*Source: VCGI*)
- **FEMA Floodways:** (*Source: VCGI*)
- **Class 1 and Class 2 Wetlands:** (*Source: VCGI*)

REGIONALLY IDENTIFIED CRITICAL RESOURCES (REGIONAL KNOWN CONSTRAINTS)

- **Designated Downtowns, Designated Growth Centers, and Designated Village Centers:** These areas the center of dense, traditional development in the region. This constraint does not apply to roof-mounted solar within such designated areas. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: NRPC*)
- **FEMA Flood Insurance Rate Map (FIRM) Special Flood Hazard Areas:** Special flood hazard areas as digitized by the NRPC were used—just 100-year flood plain (500-year floodplain not mapped). The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: NRPC*)
- **Ground and Surface Waters Drinking Protection Areas:** Buffered Source Protection Areas (SPAs) are designated by the Vermont Department of Environmental Conservation (DEC). SPA boundaries are approximate but are conservative enough to capture areas most susceptible to contamination. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: Vermont Agency of Natural Resources [ANR]*)
- **Vermont Conservation Design Highest Priority Forest Blocks:** The lands and waters identified here are the areas of the state that are of highest priority for maintaining ecological integrity. Together, these lands comprise a connected landscape of large and intact forested habitat, healthy aquatic and riparian systems, and a full range of physical features (bedrock, soils, elevation, slope, and aspect) on which plant and animal natural communities depend. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: ANR*)
- **Public Water Sources:** A 200-foot buffer is used around public drinking water wellheads. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: ANR*)

- **National Natural Landmark – Chazy Fossil Reef:** The Chazy Fossil Reef in Isle La Motte has been designated a National Natural Landmark by the US Department of Interior. (*Source: NRPC*)
- **Municipal Conservation Land Use Areas:** Conservation Land Use Districts, as designated in municipal plans, that include strict language that strongly deters or prohibits development have been included as a regional known constraint. The inclusion of this resource as a regional constraint is consistent with the goals and policies of the Northwest Regional Plan. Specific municipal land use districts included are outlined in Section D.

STATE POSSIBLE CONSTRAINTS

- **Protected Lands:** This constraint includes public lands held by agencies with conservation or natural resource oriented missions, municipal natural resource holdings (ex. Town forests), public boating and fishing access areas, public and private educational institution holdings with natural resource uses and protections, publicly owned rights on private lands, parcels owned in fee by non-profit organizations dedicated to conserving land or resources, and private parcels with conservation easements held by non-profit organizations. (*Source: VCGI*)
- **Deer Wintering Areas:** Deer wintering habitat as identified by the Vermont Agency of Natural Resources. (*Source: VCGI*)
- **Hydric Soils:** Hydric soils as identified by the US Department of Agriculture. (*Source: VCGI*)
- **Agricultural Soils:** Local, statewide, and prime agricultural soils are considered. (*Source: VCGI*)
- **Act 250 Agricultural Soil Mitigation Areas:** Sites conserved as a condition of an Act 250 permit. (*Source: VCGI*)

REGIONALLY IDENTIFIED RESOURCES (REGIONAL POSSIBLE CONSTRAINTS)

- **Class 3 Wetlands:** Class 3 wetlands in the region have been identified have been included as a Regional Possible Constraint. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan (*Source: ANR*)
- **Municipal Conservation Land Use Areas:** Conservation Land Use Districts, as designated in municipal plans, that include strict language that deters, but does not prohibit development, have been included as a regional possible constraint. Specific municipal land use districts included are outlined in Section D.

OTHER MAP FEATURES

- **Three-Phase Distribution Lines:** All available utilities with service in any of the three regions (*Source: Green Mountain Power, Swanton Village Electric Department, Vermont Electric Coop, and Village of Enosburg Falls*) were mapped.
- **Transportation Infrastructure:** These were removed in the initial analysis performed by VCGI. Does not include parking lots. (*Source: VCGI*)
- **VELCO Transmission Lines and Substations:** (*Source: VCGI*)
- **Water Bodies:** Major water bodies (i.e., >1 square kilometer in surface area) are shown on maps as "Lakes/Ponds." (*Source: VCGI*)

D. WIND GENERATION MAPS

STATE KNOWN CONSTRAINTS

- **Confirmed and Unconfirmed Vernal Pools:** There is a 600-foot buffer around confirmed or unconfirmed vernal pools. (*Source: ANR*)

- **State Significant Natural Communities and Rare, Threatened, and Endangered Species:** Rankings S1 through S3 were used as constraints. These include all of the rare and uncommon rankings within the file. For more information on the specific rankings, explore the methodology for the shapefile. (*Source: VCGI*)
- **River Corridors:** Only mapped River Corridors were mapped. Does not include 50 foot buffer for streams with a drainage area less than 2 square miles. (*Source: VCGI*)
- **National Wilderness Areas:** (*Source: VCGI*)
- **FEMA Floodways:** (*Source: VCGI*)
- **Class 1 and Class 2 Wetlands:** (*Source: VCGI*)

REGIONALLY IDENTIFIED CRITICAL RESOURCES (REGIONAL KNOWN CONSTRAINTS)

- **Designated Downtowns, Designated Growth Centers, and Designated Village Centers:** These areas the center of dense, traditional development in the region. This constraint does not apply to roof-mounted solar within such designated areas. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: NRPC*)
- **FEMA Flood Insurance Rate Map (FIRM) Special Flood Hazard Areas:** Special flood hazard areas as digitized by the NRPC were used—just 100-year flood plain (500-year floodplain not mapped). The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: NRPC*)
- **Ground and Surface Waters Drinking Protection Areas:** Buffered Source Protection Areas (SPAs) are designated by the Vermont Department of Environmental Conservation (DEC). SPA boundaries are approximate but are conservative enough to capture areas most susceptible to contamination. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: Vermont Agency of Natural Resources [ANR]*)
- **Vermont Conservation Design Highest Priority Forest Blocks:** The lands and waters identified here are the areas of the state that are of highest priority for maintaining ecological integrity. Together, these lands comprise a connected landscape of large and intact forested habitat, healthy aquatic and riparian systems, and a full range of physical features (bedrock, soils, elevation, slope, and aspect) on which plant and animal natural communities depend. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: ANR*)
- **Public Water Sources:** A 200-foot buffer is used around public drinking water wellheads. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan. (*Source: ANR*)
- **National Natural Landmark – Chazy Fossil Reef:** The Chazy Fossil Reef in Isle La Motte has been designated a National Natural Landmark by the US Department of Interior. (*Source: NRPC*)
- **Municipal Conservation Land Use Areas:** Conservation Land Use Districts, as designated in municipal plans, that include strict language that strongly deters or prohibits development have been included as a regional known constraint. The inclusion of this resource as a regional constraint is consistent with the goals and policies of the Northwest Regional Plan. Specific municipal land use districts included are outlined in Section D.

STATE POSSIBLE CONSTRAINTS

- **Protected Lands:** This constraint includes public lands held by agencies with conservation or natural resource-oriented missions, municipal natural resource holdings (ex. Town forests), public boating and fishing access areas, public and private educational institution holdings with natural resource uses and protections, publicly owned rights on private lands, parcels owned in fee by non-profit organizations dedicated to conserving land or resources, and private parcels with conservation easements held by non-profit organizations. (*Source: VCGI*)

- **Deer Wintering Areas:** Deer wintering habitat as identified by the Vermont Agency of Natural Resources. (*Source: VCGI*)
- **Hydric Soils:** Hydric soils as identified by the US Department of Agriculture. (*Source: VCGI*)
- **Agricultural Soils:** Local, statewide, and prime agricultural soils are considered. (*Source: VCGI*)
- **Act 250 Agricultural Soil Mitigation Areas:** Sites conserved as a condition of an Act 250 permit. (*Source: VCGI*)

REGIONALLY IDENTIFIED RESOURCES (REGIONAL POSSIBLE CONSTRAINTS)

- **Class 3 Wetlands:** Class 3 wetlands in the region have been identified have been included as a Regional Possible Constraint. The inclusion of this resource as a regional constraint is consistent with goals and policies of the Northwest Regional Plan (*Source: ANR*)
- **Municipal Conservation Land Use Areas:** Conservation Land Use Districts, as designated in municipal plans, that include strict language that deters, but does not prohibit development, have been included as a regional possible constraint. Specific municipal land use districts included are outlined in Section D.

OTHER MAP FEATURES

- **Three-Phase Distribution Lines:** All available utilities with service in any of the three regions (*Source: Green Mountain Power, Swanton Village Electric Department, Vermont Electric Coop, and Village of Enosburg Falls*) were mapped.
- **Transportation Infrastructure:** These were removed in the initial analysis performed by VCGI. Does not include parking lots. (*Source: VCGI*)
- **VELCO Transmission Lines and Substations:** (*Source: VCGI*)
- **Water Bodies:** Major water bodies (i.e., >1 square kilometer in surface area) are shown on maps as "Lakes/Ponds." (*Source: VCGI*)

E. HYDRO GENERATION MAPS

KNOWN CONSTRAINTS

- None

REGIONALLY IDENTIFIED RESOURCES (REGIONAL POSSIBLE CONSTRAINTS)

- **National Scenic and Recreational Rivers:** Known constraint; Missisquoi and Trout Rivers. This constraint will only be incorporated into the Hydroelectric Resource Map. Dams occurring within an impacted area will be displayed as such on maps. (*Source: Digitized by the BCRC from Upper Missisquoi and Trout Rivers, Wild and Scenic Study Management Plan*)

POSSIBLE CONSTRAINTS

- **"303d" List of Stressed Waters:** Possible constraint. This constraint will only be incorporated into the Hydroelectric Resource Map. Dams occurring within an impacted area will be displayed as such on maps. (*Source: ANR*)
- **Impaired Water:** Possible constraint. This constraint will only be incorporated into the Hydroelectric Resource Map. Dams occurring within an impacted area will be displayed as such on maps. (*Source: ANR*)

- **State Significant Natural Communities and Rare, Threatened, and Endangered Species:** Rankings S1 through S3 were used as constraints. These include all of the rare and uncommon rankings within the file. For more information on the specific rankings, explore the methodology for the shapefile. (*Source: VCGI*)

OTHER MAP FEATURES

- **Three-Phase Distribution Lines:** All available utilities with service in any of the three regions (*Source: Green Mountain Power, Swanton Village Electric Department, Vermont Electric Coop, and Village of Enosburg Falls*) were mapped.
- **Transportation Infrastructure:** These were removed in the initial analysis performed by VCGI. Parking lots are not included. (*Source: VCGI*)
- **VELCO Transmission Lines and Substations:** (*Source: VCGI*)
- **Water Bodies:** Major water bodies (i.e., >1 square kilometer in surface area) are shown on maps as "Lakes/Ponds." (*Source: VCGI*)

F. EXPLANATION OF MUNICIPAL CONSERVATION LAND USE AREAS

The NRPC conducted an analysis of municipal conservation land use area. The analysis reviewed the written descriptions of conservation land use areas from each municipal plan in the region. The intent of the analysis was to see if the conservation land use areas contained language that restricted future development (including the development of renewables). After review, the conservation land use areas from each municipal plan were divided into the following categories:

STRONGLY DETERS

These conservation land uses areas use language that prohibits development or only permits limited, low-density residential development. These areas are included as Regional Known Constraints on the Regional Energy Generation maps. Municipal conservation land use areas that meet this description include:

- Alburgh Town & Village – Conservation Land A
- Enosburgh – Conservation District
- Enosburgh Falls – Conservation District
- Fletcher – Forest District
- Fletcher – Conservation District
- Franklin- Conservation District
- Grand Isle – Off-Shore Island District
- Montgomery – Conservation District II
- North Hero – Conservation District
- Richford – Recreation/Conservation District and Water Supply District
- St. Albans Town – Conservation District

DETERS

Several conservation land use areas in the region are described in municipal plans as areas where land use shall be restricted to conservation, forestry, and agricultural uses and/or are described as land that is geographically unsuitable for development. These areas are included as Regional Possible Constraints on the Regional Energy Generation maps. Municipal conservation land use areas that meet this description include:

- Alburgh Town and Village – Conservation Land B
- Bakersfield – Conservation District
- Fairfax – Conservation District
- Fairfield – Uplands District
- Fairfield – Pond & Swamp District
- Highgate – Forest Reserve District

- Highgate – Protected District
- Montgomery – Conservation District I
- Richford - Forest/Conservation District
- Sheldon – Rural Lands II
- Swanton Town and Village – Conservation District

NEUTRAL

These conservation land use areas may be identified in municipal plans as being geographically or topologically unsuitable for development, yet contain language that allows for some types of development. These areas have not been included on the Regional Energy Generation maps. Municipal conservation land use areas that meet this description include:

- Berkshire – Conservation District
- Georgia – Natural Areas District
- Georgia – Recreation District
- South Hero – Conservation District

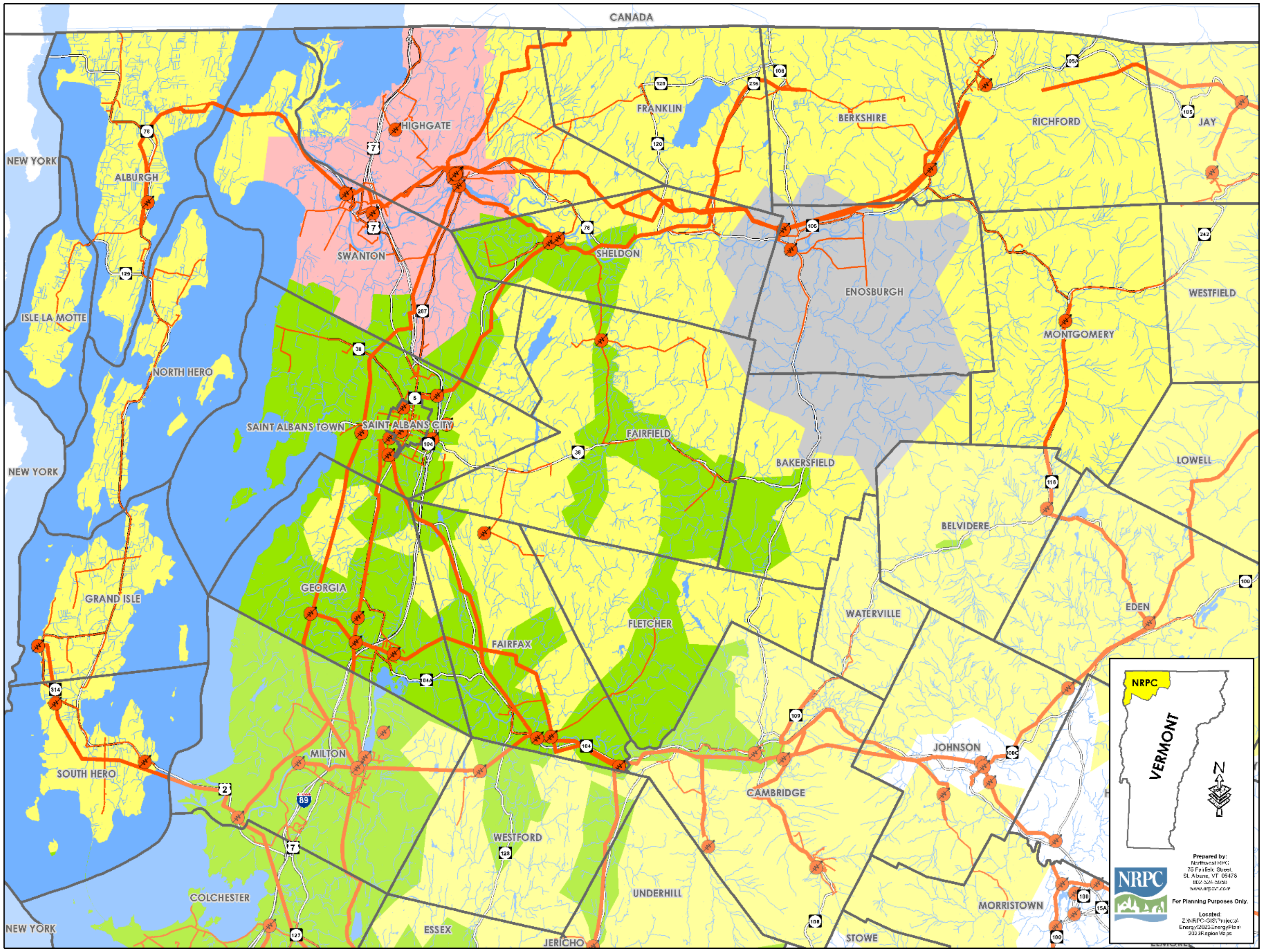
DEVELOPMENT MAY OCCUR

These conservation land use areas do not contain language that restricts development. These areas have not been included on the Regional Energy Generation maps. No municipal conservation land use areas currently meet that description.

APPENDIX

C

APPENDIX C - REGIONAL GENERATION MAPS



Utility Service Areas

Northwest Region, VT
Act 174
Energy Development Improvement Act

This map and the corresponding data is intended to be used to inform energy planning efforts by municipalities and regions. This may also be used for conceptual planning or initial site identification by those interested in developing renewable energy infrastructure. The maps do **NOT** take the place of site-specific investigation for a proposed facility and cannot be used of as "siting maps."

Legend

- Substation
- 3 Phase Power Line
- Transmission Line

Utility Service Area Features

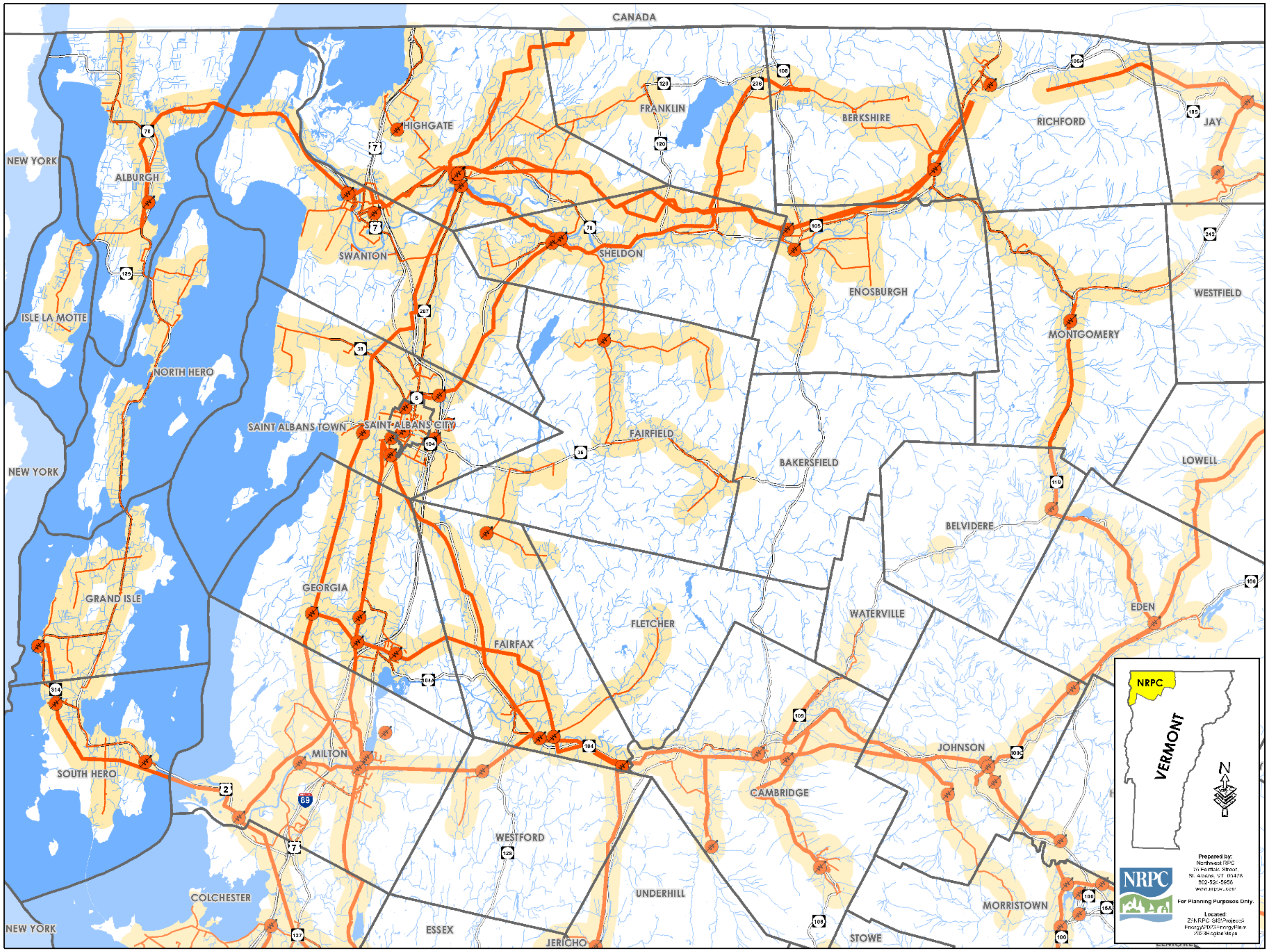
- Green Mountain Power
- Swanton Village Electric
- Vermont Electric Co-op
- Enosburg Falls Electric

Sources: VCGI
Disclaimer: The accuracy of information presented is determined by its sources. Errors and omissions may exist. The Northwest RPC is not responsible for these. Questions of on-the-ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not sufficient for delineation of features on-the-ground. This map identifies the presence of features, and may indicate relationships between features, but is not a replacement for surveyed information or engineering studies.

0 1 2 3 4 Miles

Transmission and 3 Phase Power Infrastructure

Northwest Region, VT
Act 174
Energy Development Improvement Act



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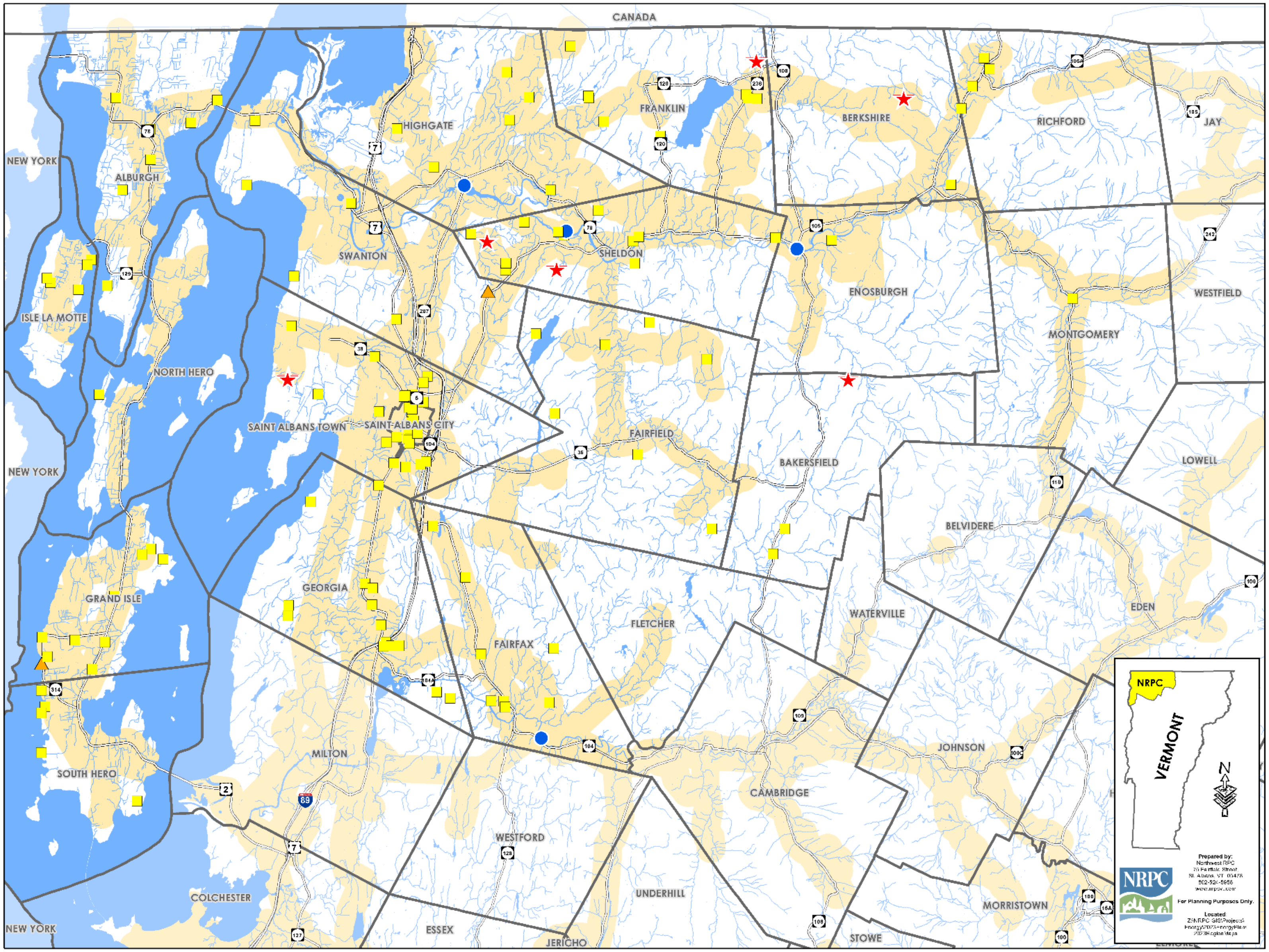
Legend

- Substation
- 3 Phase Power Line
- Transmission Line
- 1/2 Mile Buffer* (3 Phase Power Line & Transmission Line)

*The half mile buffer shows where generation facilities can be located without significant loss of power in transit to transmission lines.

Sources: VCGI
Disclaimer: The accuracy of information presented is determined by its sources. Errors and omissions may exist. The Northwest RPC is not responsible for these. Questions of on the ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not sufficient for delineation of features on-the-ground. This map identifies the presence of features, and may indicate relationships between features, but is not a replacement for surveyed information or engineering studies.

0 1 2 3 4 Miles



Existing Generation Facilities

Northwest Region, VT
Act 174
Energy Development Improvement Act

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Legend

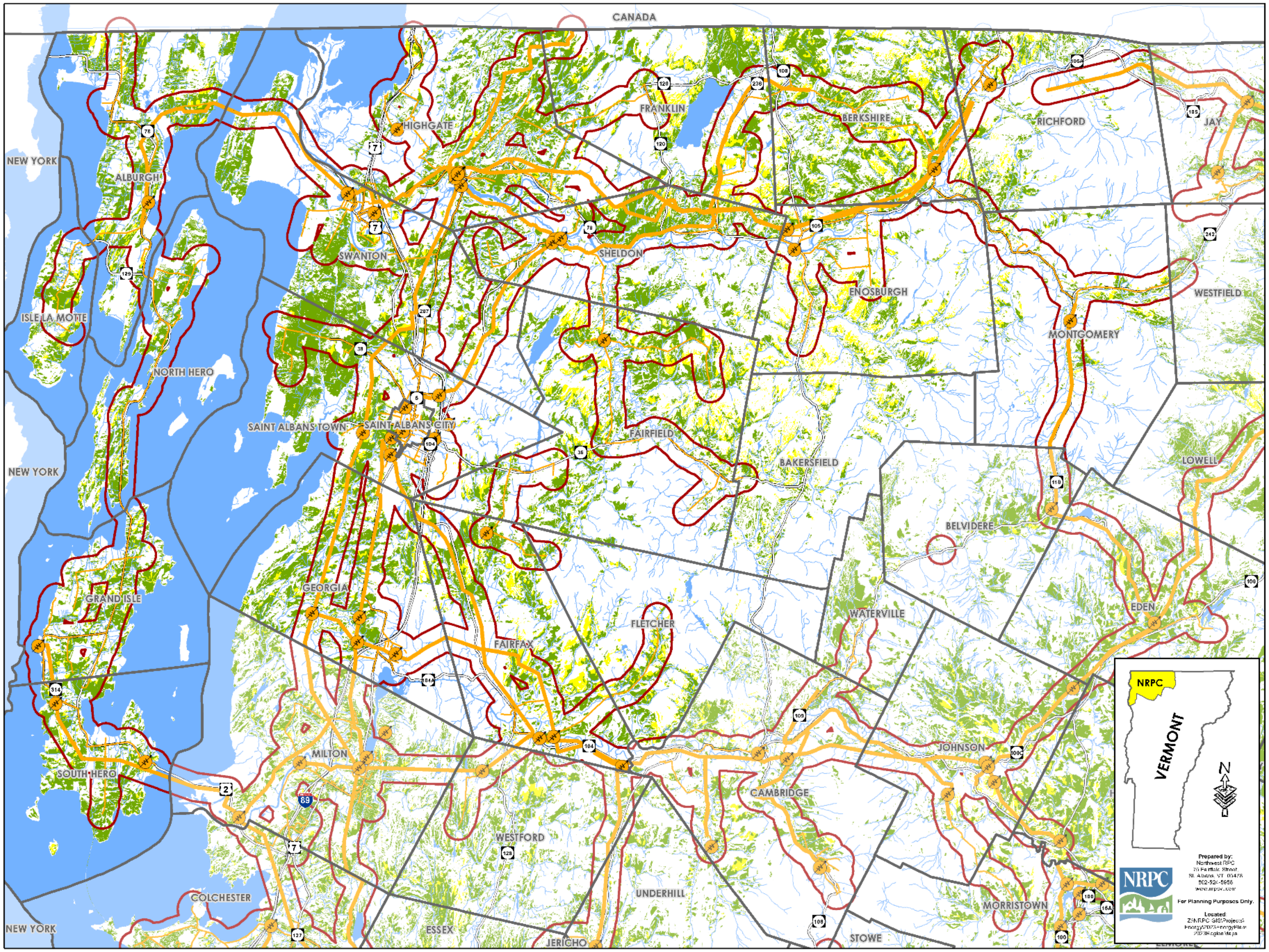
- Biomass Facility
- Hydro Facility
- Solar Facility
- Wind Facility
- 1/2 Mile Buffer* (3 Phase Power Line & Transmission Line)

Note: Only generators 15kW are shown on the map. A full list of all generators is available. The facility locations shown here are approximate and may not reflect exact location. Projects constructed after 2023 may not be shown.

*The half mile buffer shows where generation facilities can be located without significant loss of power in transit to transmission lines.

Sources: VCGI
Disclaimer: The accuracy of information presented is determined by its sources. Errors and omissions may exist. The Northwest RPC is not responsible for these. Questions of on-the-ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not sufficient for delineation of features on-the-ground. This map identifies the presence of features, and may indicate relationships between features, but is not a replacement for surveyed information or engineering studies.

0 1 2 3 4 Miles



Solar

Northwest Region, VT Act 174 Energy Development Improvement Act

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Legend

- Substation
- 3 Phase Power Line
- Transmission Line
- 1/2 Mile Buffer* (3 Phase Power Line & Transmission Line)
- Prime Solar/No Known Constraints
- Base Solar/Possible Constraints

*The half mile buffer shows where generation facilities can be located without significant loss of power in transit to transmission lines.

Sources: VCGI
Disclaimer: The accuracy of information presented is determined by its sources. Errors and omissions may exist. The Northwest RPC is not responsible for these. Questions of on the ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not sufficient for delineation of features on-the-ground. This map identifies the presence of features, and may indicate relationships between features, but is not a replacement for surveyed information or engineering studies.

0 1 2 3 4 Miles

Wind

Northwest Region, VT
Act 174
Energy Development Improvement Act

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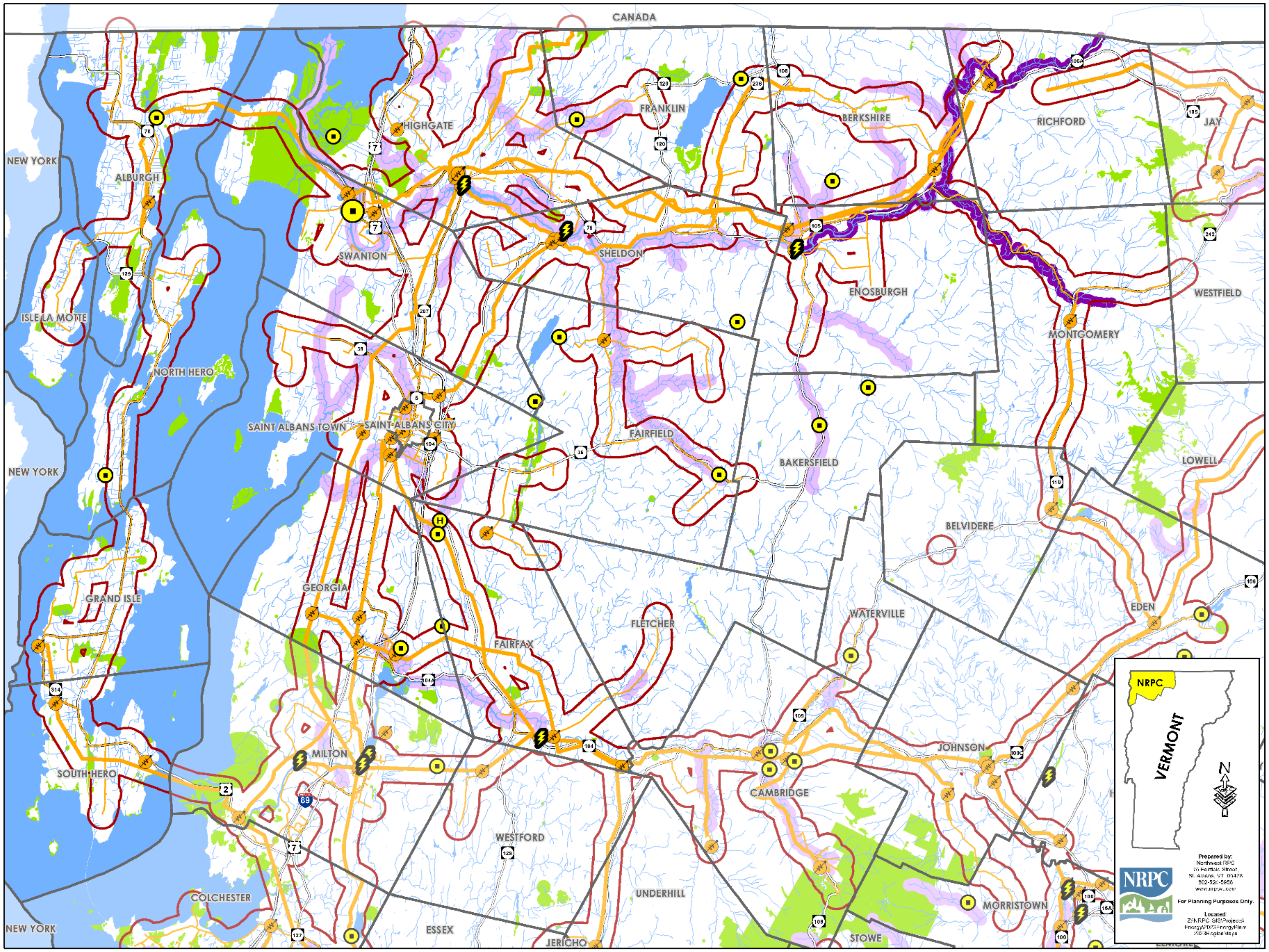
Legend

- Substation
- 3 Phase Power Line
- Transmission Line
- 1/2 Mile Buffer* (3 Phase Power Line & Transmission Line)
- **Prime Wind**
  Areas of high wind potential and no known constraints.
  Darker areas have higher wind speeds.
- **Base Wind**
  Areas of high wind potential and a presence of possible constraints.
  Darker areas have higher wind speeds.

*The half mile buffer shows where generation facilities can be located without significant loss of power in transit to transmission lines.

Sources: VCGI
Disclaimer: The accuracy of information presented is determined by its sources. Errors and omissions may exist. The Northwest RPC is not responsible for these. Questions of on-the-ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not sufficient for delineation of features on-the-ground. This map identifies the presence of features, and may indicate relationships between features, but is not a replacement for surveyed information or engineering studies.

0 1 2 3 4 Miles



Hydro

Northwest Region, VT Act 174 Energy Development Improvement Act

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Legend

- Substation
- 3 Phase Power Line
- Transmission Line
- 1/2 Mile Buffer* (3 Phase Power Line & Transmission Line)
- Designated Outstanding Resource Water
- Known Constraint - Designated National Wild & Scenic River
- Possible Constraint - Stressed or Impaired Water
- Possible Constraint - Rare & Irreplaceable Natural Areas

Potential Hydroelectric Facility

- < 50 kW Capacity
- > 50 kW Capacity
- High Hazard with < 50 kW Capacity
- High Hazard with > 50 kW Capacity

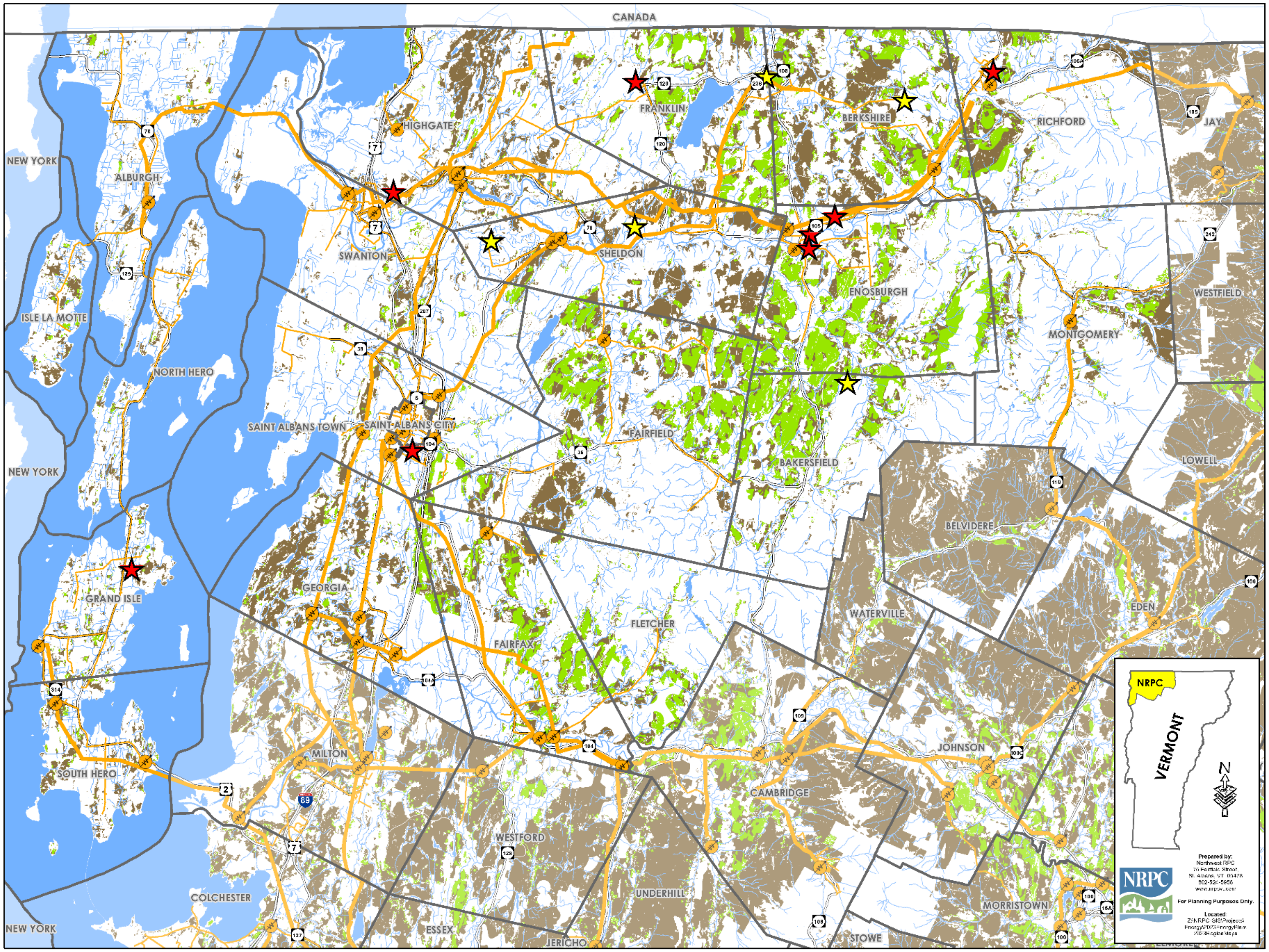
Operating Hydroelectric Facility

- Dam not on National Wild and Scenic River
- Dam on National Wild and Scenic River

*The half mile buffer shows where generation facilities can be located without significant loss of power in transit to transmission lines.

Sources: VCGI
Disclaimer: The accuracy of information presented is determined by its sources. Errors and omissions may exist. The Northwest RPC is not responsible for these. Questions of on-the-ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not sufficient for delineation of features on the ground. This map identifies the presence of features, and may indicate relationships between features, but is not a replacement for surveyed information or engineering studies.

0 1 2 3 4 Miles



Woody Biomass

Northwest Region, VT
Act 174
Energy Development Improvement Act

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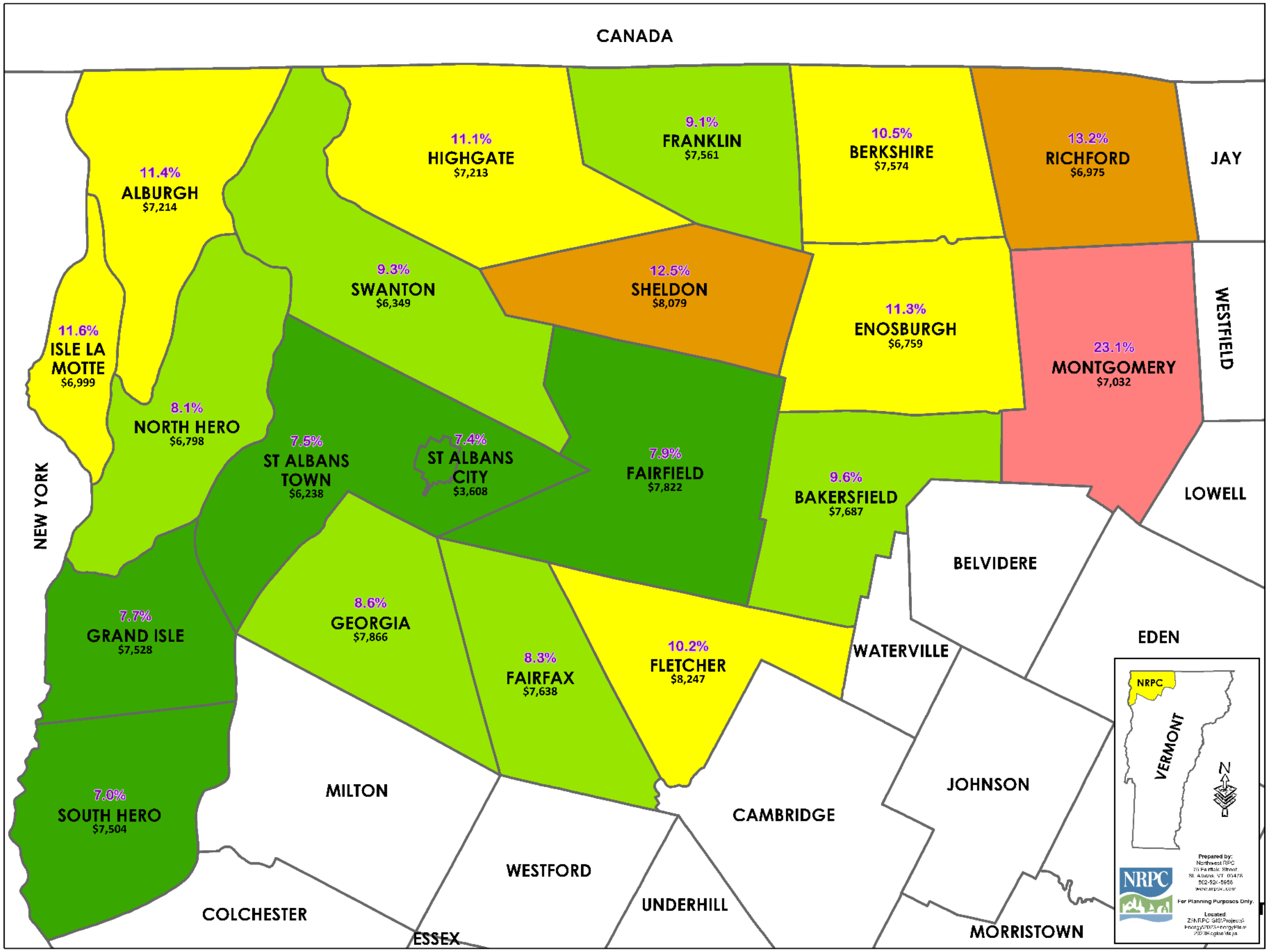
Legend

- Biomass System
- Methane Digester
- Substation
- 3 Phase Power Line
- Transmission Line
- Prime Woody Biomass/ No Known Constraints
- Base Woody Biomass/ Possible Constraints

Note: The prime and base biomass shows where biomass, specifically cordwood, could potentially be harvested. The location of biomass generation facilities, including methane digesters, is more site specific and therefore does not have prime or

Sources: VCGI
Disclaimer: The accuracy of infomation presented is determined by its sources. Errors and omissions may exist. The Northwest RPC is not responsible for these. Questions of on-the-ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not sufficient for delineation of features on-the-ground. This map identifies the presence of features, and may indicate relationships between features, but is not a replacement for surveyed information or engineering studies.

0 1 2 3 4 Miles



Energy Burden

Northwest Region, VT
Act 174
Energy Development Improvement Act

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Legend

0.0% Percent of Energy Burden

$0,000 Total Energy Spending

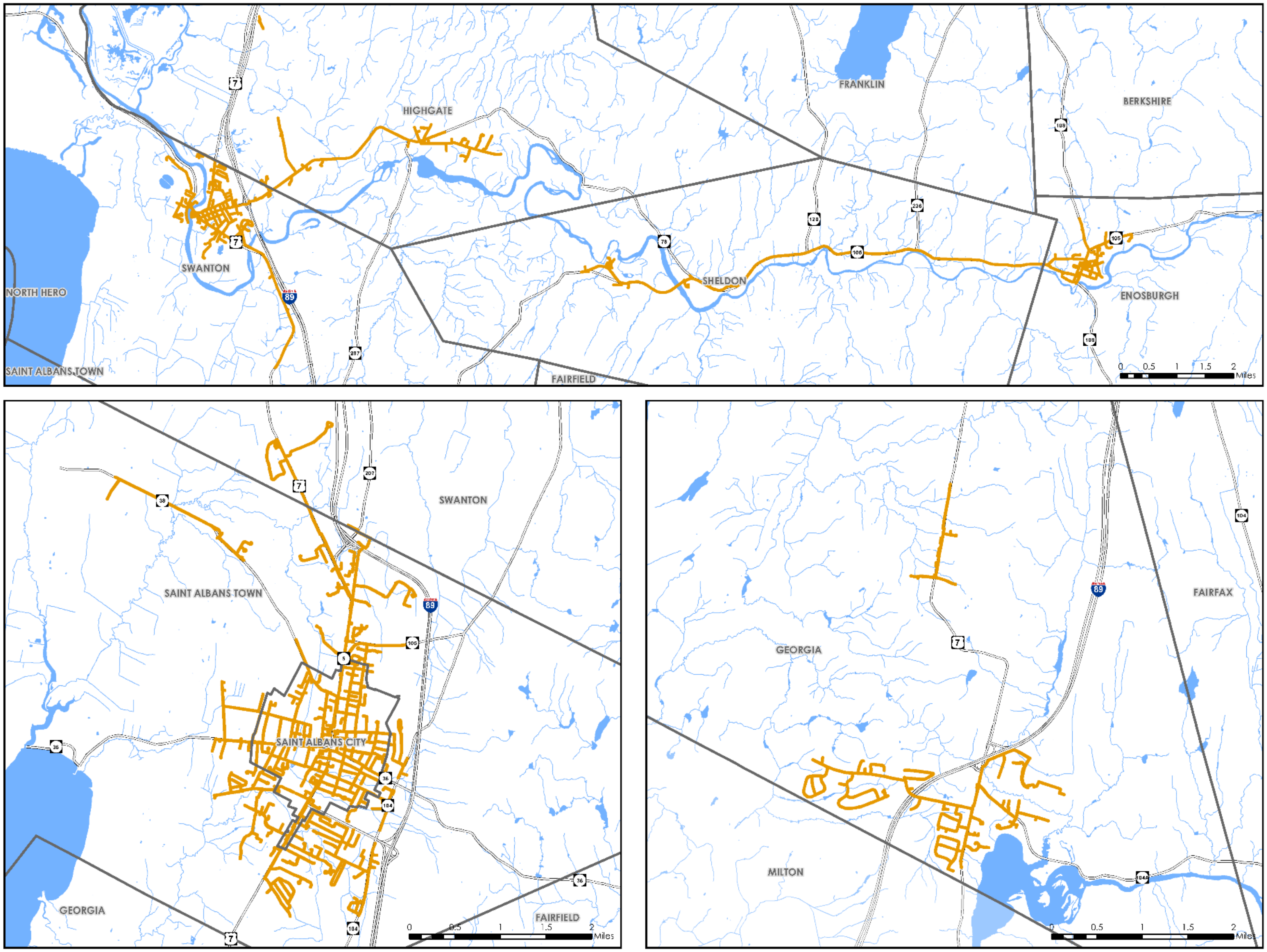
Energy Burden

- Up to 8%
- 8.1% to 10%
- 10.1% to 12%
- 12.1% to 15%
- More than 15%

Energy burden is the percentage of income spent on energy including transportation, heating, and electricity. This map shows average household energy burden by municipality. The data is for general context more than direct community or individual comparison.

Sources: Efficiency Vermont
Disclaimer: The accuracy of information presented is determined by its sources. Errors and omissions may exist. The Northwest RPC is not responsible for these. Questions of on-the-ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not sufficient for delineation of features on-the-ground. This map identifies the presence of features, and may indicate relationships between features, but is not a replacement for surveyed information or engineering studies.

0 1 2 3 4 Miles



Natural Gas Lines

Northwest Region, VT
Act 174
Energy Development Improvement Act

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Legend

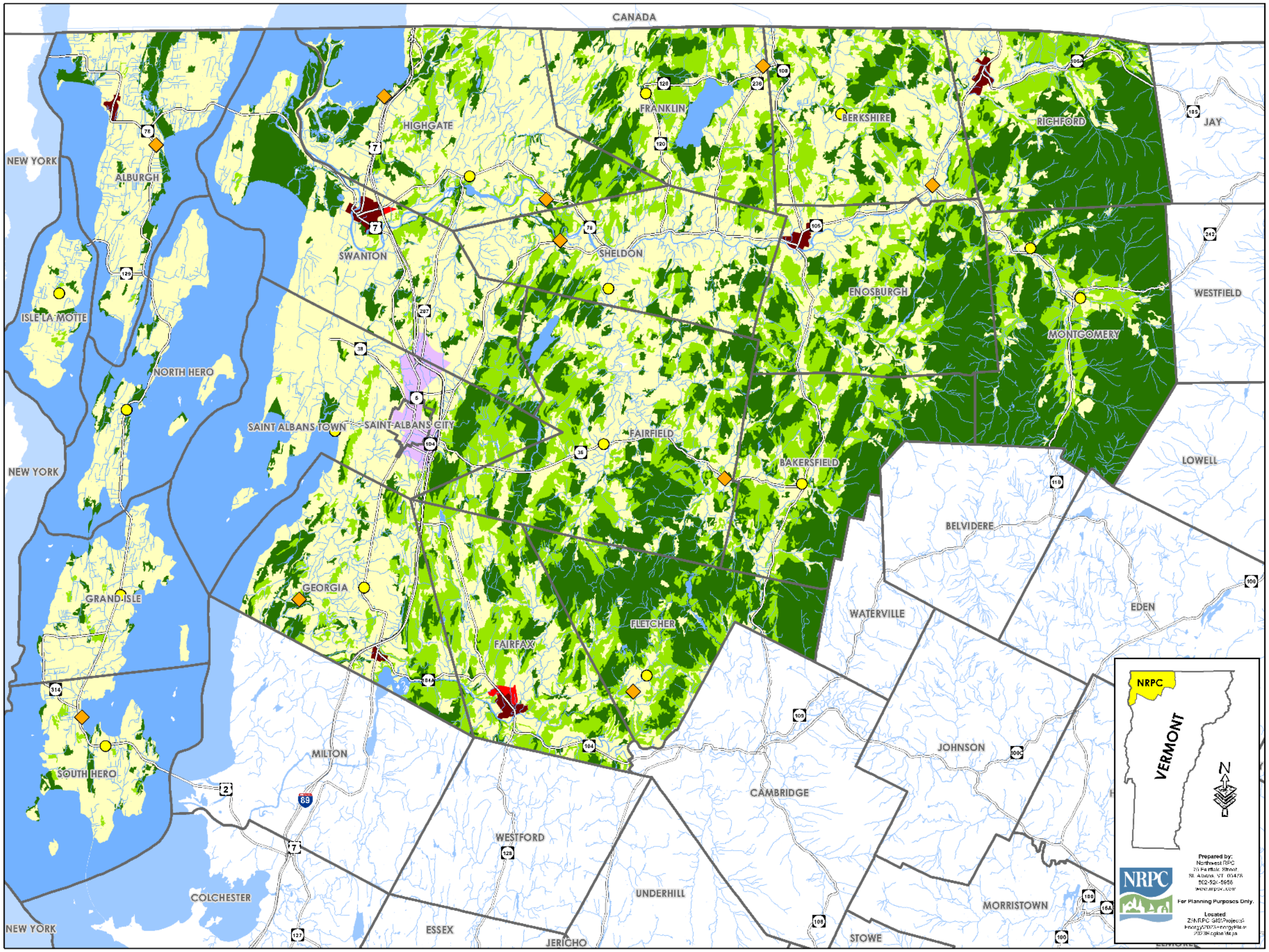
Natural Gas Line

Sources: VCGI
Disclaimer: The accuracy of information presented is determined by its sources. Errors and omissions may exist. The Northwest RPC is not responsible for these. Questions of on-the-ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not sufficient for delineation of features on-the-ground. This map identifies the presence of features, and may indicate relationships between features, but is not a replacement for surveyed information or engineering studies.

Prepared by:
Northwest RPC
75 Fairfield Street,
St. Albans, VT 05478
802-524-5958
www.nrpcvt.com

For Planning Purposes Only.

Located:
Z:\NRPC-GIS\Projects\Energy\2022EnergyPlan\2023RegionMaps



Proposed Land Use

Northwest Region, VT
Act 174
Energy Development Improvement Act

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Legend

- Village
- Hamlet

Proposed Land Use Features

- Regional Growth Area
- Sub-Regional Growth Area
- Transitional Growth Area
- Agricultural Resource Planning Area
- Conservation & Forest Resource Planning Area
- Rural Planning Area

Sources: VCGI
Disclaimer: The accuracy of information presented is determined by its sources. Errors and omissions may exist. The Northwest RPC is not responsible for these. Questions of on-the-ground location can be resolved by site inspections and/or surveys by a registered surveyor. This map is not sufficient for delineation of features on-the-ground. This map identifies the presence of features, and may indicate relationships between features, but is not a replacement for surveyed information or engineering studies.

0 1 2 3 4 Miles

APPENDIX

D

APPENDIX D - SUMMARY OF PLANNING APPROACH AND PROCESS

APPENDIX D - SUMMARY OF PLANNING APPROACH AND PROCESS

This plan is the result of more than two years of work completed by NRPC staff, NRPC commissioners, and various stakeholders throughout the region and the state. This plan builds on previous energy planning efforts in the region and the efforts of the Public Service Department.

The Northwest Regional Planning Commission Energy and Climate Committee was formed in early 2022 with a combination of existing commissioners and members of the public who applied to serve on the committee. Those applications were reviewed by staff and approved by NRPC's Personnel Committee. NRPC's Energy and Climate Committee started meeting in April 2022, and met monthly with a few breaks through May 2024. Agendas and minutes for these meetings can be found on NRPC's website (nrpcvt.com).

Public meetings are scheduled for the following dates and locations:

June 5th, 2024 at 8:30 a.m. - In-person Public Meeting at the Lake Champlain Islands Economic Development Office 3501 US Route 2, North Hero

June 13th at 7:00 p.m. - Virtual Public Meeting Via Zoom
https://us02web.zoom.us/j/89410414398?pwd=JSR7xXzHBYWCql1FZAbgJZPeuvMHev.1
Meeting ID: 894 1041 4398
Passcode: 825362
Phone in: 1(301)715-8592

June 18th at 5:00 p.m. - In-person Public Meeting at the Northwest Regional Planning Commission Office
75 Fairfield Street, St. Albans, VT

June 26th at 6:00 p.m. - NRPC Board Meeting, Public Invited, Stone House, St. Albans Town Bay Park

June 27th at 9:00 a.m. - Official Public Hearing (Hybrid) at Northwest Regional Planning Commission, 75 Fairfield Street, St. Albans, VT or
https://us02web.zoom.us/j/89410414398?pwd=JSR7xXzHBYWCql1FZAbgJZPeuvMHev.1
Meeting ID: 894 1041 4398
Passcode: 825362
Phone in: 1(301)715-8592

July 31st at 7:00 p.m. - NRPC Board Meeting, Official Public Hearing, Public invited
Virtual Meeting, Via Zoom, Final Public Hearing, Meeting ID 846 7249 5167
Physical Location- NRPC Office, 75 Fairfield St., St. Albans
https://us02web.zoom.us/j/84672495167
Phone in: 1(312)626-6799 or 1(646)558-8656

APPENDIX

E

APPENDIX E - LISTS OF ACRONYMS

APPENDIX E - LISTS OF ACRONYMS

- ACCD – Vermont Agency of Commerce and Community Development
- ACS – American Community Survey
- ANR – Vermont Agency of Natural Resources
- BCRC – Bennington County Regional Commission
- BERC – Biomass Energy Resource Center
- BTU – British thermal unit
- CAP – Climate Action Plan
- CBES – Commercial Building Energy Standards
- CCRPC – Chittenden County Regional Planning Commission
- CEP –Vermont Comprehensive Energy Plan
- C.I.D.E.R. - Champlain Islanders Developing Essential Resources
- CNG – compressed natural gas
- CPG – Certificate of Public Good
- CVOEO – Champlain Valley Office of Economic Opportunity
- DC – direct current
- EAN – Energy Action Network
- EEU –Energy Efficiency Utility
- EIA – Energy Information Administration
- EJ – Environmental Justice
- EPA – Environmental Protection Agency
- ESP – energy service provider
- EV – electric vehicle
- EVT – Efficiency Vermont
- FCIDC – Franklin County Industrial Development Corporation
- GMP – Green Mountain Power
- GMT – Green Mountain Transit
- GT – green tons
- kW – kilowatts
- LEAP – Long-range Energy Alternatives Planning
- LP(G) – liquefied petroleum gas (propane)
- NAICS - North American Industry Classification System
- NALG – net available low-grade growth (wood)
- NRPC – Northwest Regional Planning Commission
- NYPA – New York Power Authority
- MW – megawatts
- RBES – Residential Building Energy Standards
- REC – Renewable Energy Credit
- RINAs – rare and irreplaceable natural resources
- RPC - regional planning commission
- TES – Total Energy Study
- TPI – Transportation Planning Initiative
- TRORC – Two Rivers-Ottauquechee Regional Commission
- UST –underground storage tank
- VCGI – Vermont Center for Geographic Information
- VEC – Vermont Electric Cooperative
- VEIC – Vermont Energy Investment Corporation
- VELCO – Vermont Electric Power Company
- VMT – vehicle miles traveled
- VPPSA – Vermont Public Power Supply Authority
- VTrans – Vermont Agency of Transportation
- VY – Vermont Yankee

APPENDIX

F

APPENDIX F - NORTHWEST REGION - EXISTING RENEWABLE GENERATION FACILITY SUMMARY

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The following is a summary of all existing renewable generation facilities in the Northwest Region organized by municipality.

EXISTING REGIONAL GENERATION

Municipality	Solar Facilities	Solar Capacity (MW)	Wind Facilities	Wind Capacity (MW)	Hydro Facilities	Hydro Capacity (MW)	Anaerobic Digester Sites	Anaerobic Digester Capacity (MW)	Other Sites	Other Capacity (MW)
Alburgh	53	1.87	1	0.01	0	0.00	0	0.00	0	0.00
Bakersfield	34	0.26	0	0.00	0	0.00	1	0.40	0	0.00
Berkshire	14	0.13	0	0.00	0	0.00	1	0.60	0	0.00
Enosburgh	50	1.15	2	0.01	2	0.98	0	0.00	1	0.00
Fairfax	206	1.66	0	0.00	1	4.20	0	0.00	17	0.12
Fairfield	75	1.40	1	0.01	0	0.00	0	0.00	3	0.03
Fletcher	32	0.23	0	0.00	0	0.00	0	0.00	8	0.05
Franklin	48	0.53	0	0.00	0	0.00	1	0.19	1	0.01
Georgia	151	2.61	2	5.17	0	0.00	0	0.00	11	0.08
Grand Isle	109	6.50	0	0.00	0	0.00	0	0.00	20.8	0.00
Highgate	40	1.40	0	0.00	2	11.96	0	0.00	0	0.00
Isle La Motte	20	0.24	0	0.00	0	0.00	0	0.00	0	0.00
Montgomery	25	0.21	0	0.00	0	0.00	0	0.00	0	0.00
North Hero	34	0.23	0	0.00	0	0.00	0	0.00	0	0.00
Richford	29	0.32	1	0.01	0	0.00	1	0.60	1	0.01
St Albans City (Solar Only)	126	4.44	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
St Albans Town (Solar Only)	193	10.38	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
St. Albans	*N/A*	*N/A*	2	0.01	0	0.00	0	0.00	26	0.15
Sheldon	53	4.16	0	0.00	1	26.38	2	0.76	2	0.01
South Hero	108	0.84	1	0.00	0	0.00	0	0.00	1	0.01
Swanton	81	0.72	1	0.00	0	0.00	1	0.23	6	0.05

Source: Survey of distributed generation conducted by DPS, GMP St. Albans Solar Data, ANR Dam Generation Data, NRPC Corrections based on local permitting. Other sites includes battery storage systems and mixed solar/wind facilities.

APPENDIX G

APPENDIX G – Municipal Analysis Targets

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NRPC will provide updated municipalized LEAP data by the end of 2024.