Regional Energy Implementation Plan

A Pathway to Achieving Vermont's Energy Goals

Adopted
July 26, 2017

TRORC
Two Rivers-Ottauquechee
REGIONAL COMMISSION

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ACKNOWLEDGMENTS

Direction and review during this project were provided by the TRORC Regional Energy Plan Committee, including:

- Mark Bannon, Braintree
- Don Bourdon, Woodstock
- Steve Campbell, Strafford
- Bill Edgerton, Stockbridge
- Nancy Jones, Bradford
- Nancy Malmquist, West Fairlee
- Sally Miller, Sustainable Woodstock
- Sarah Brock, Vital Communities
- Bob Walker, Thetford

Funded by the Vermont Department of Public Service, VTrans, and the Two Rivers- Ottauquechee Regional Commission

Timeline: This is the final version of the adopted TRORC Energy Implementation Plan. Comments from the Vermont Department of Public Service (DPS), and the attendees of our public comment forums (held on September 27th, 29th and October 5th, 2016) and hearings(held April 12th and 13th 2017) have been considered. The adopted plan will be submitted to the DPS for review after adoption.

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TABLE OF CONTENTS

APPENDICES

FIGURES AND TABLES

Figures

Tables

INTRODUCTION 1

A. Background

In 2011, the State of Vermont released a significantly revised Comprehensive Energy Plan (CEP) intended to address Vermont's energy future for electricity, thermal energy, transportation and land use. The 2011 CEP Plan represented a substantial change in approach to energy in Vermont by setting a very significant set of goals for the state, most notably to transition the state's energy use from 75% fossil fuels to 90% renewable.

"Energy" as used in the CEP and this Plan is not the same as electricity. It is **all** forms of energy used by people for transportation, thermal energy, and electricity. Some examples are propane for cooking, gasoline for cars, electricity for lighting, and wood for heating. All of these types of energy can be expressed in British Thermal Units (BTU's). Most of the charts in this Plan will be shown in Thousand Million BTU's (TMBTU's). A BTU is a measure of the energy content in fuel, and is used in the power, steam generation, heating and air conditioning industries and when comparing different energy sources.

Since 2011, a significant amount of study and analysis has been done to further inform the question of "how" to achieve the goals of the CEP. Beginning in 2013, the Department of Public Service (DPS) conducted the Total Energy Study (TES), which reviewed the technologies and policies that might achieve Vermont's greenhouse gas and renewable energy goals. The 2016 revision of the Comprehensive Energy Plan further refined the goals, policies and strategies of the 2011 CEP. Between revisions, progress has indeed been made toward addressing "how" to achieve the goals, but it is

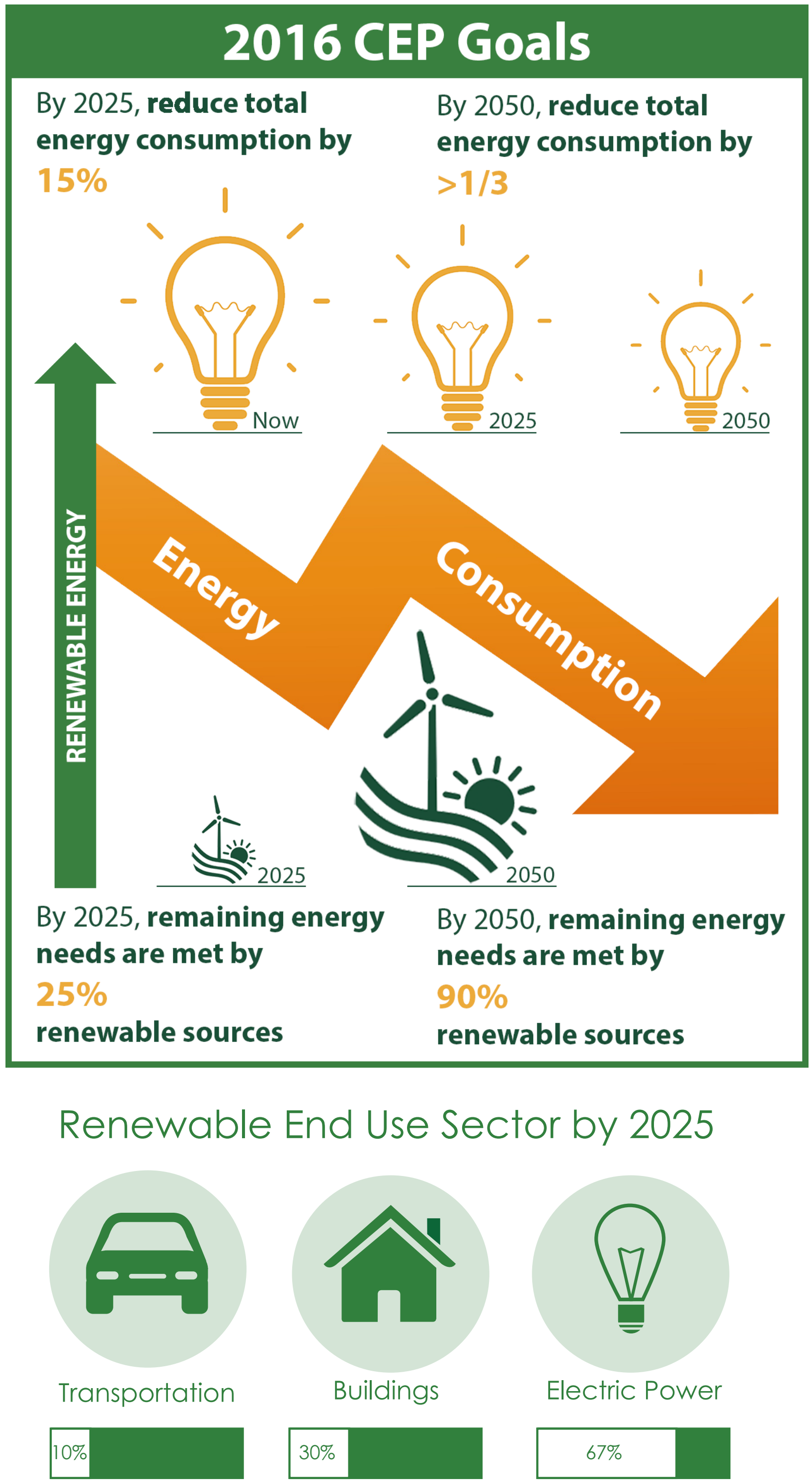
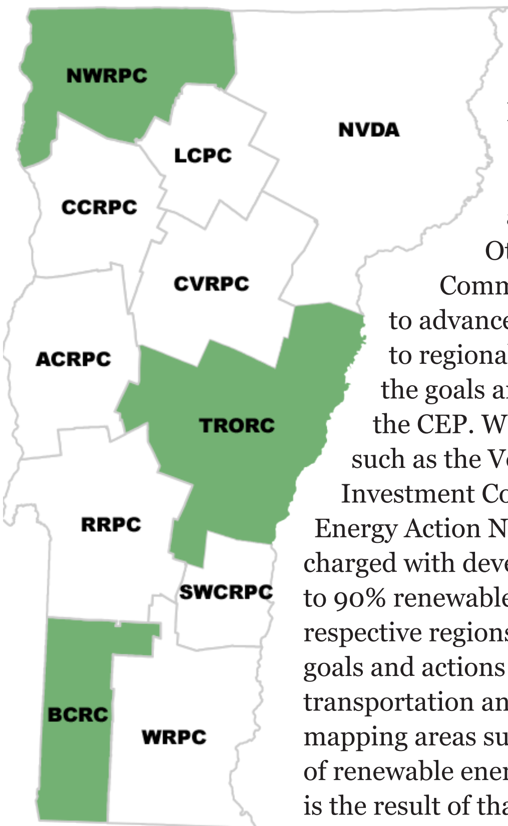


Figure 1: 2016 CEP Goals - VT DPS, 2016

recognized that to do so will require “significant changes in energy policy, fuel supply, infrastructure and technology.”[1]

DPS/RPC Project



In 2015, the Vermont Department of Public Service (DPS), engaged three of Vermont’s eleven Regional Planning Commissions (Bennington Regional Planning Commission, Northwest Regional Planning Commission and the Two Rivers-Ottauquechee Regional Commission) in a pilot project to advance a total energy approach to regional plans consistent with the goals and policies contained in the CEP. Working with organizations such as the Vermont Energy Investment Corporation (VEIC) and the Energy Action Network, the RPCs were charged with developing a model pathway to 90% renewable energy within their respective regions, identifying regional goals and actions relating to heating, transportation and electric power, and mapping areas suitable for different kinds of renewable energy generation. This Plan is the result of that effort.

Summary of Data Collection and Analysis

The Total Energy Study (TES) provided the basis for the data modeling that was used in this Plan. The TES initially proposed three possible models as part of their review.

For the purposes of this Plan, VEIC adapted the Total Energy Study’s TREES scenario (for more information, see Appendix A). Using this scenario, VEIC created and revised a model of the demand and supply of total energy in Vermont known as the Long Range Energy Planning System (LEAP). Intended as a medium- to long-term modeling tool, LEAP was chosen for data assessment in relation to the goals of the CEP. The LEAP model is based primarily on energy demand. The final outcome of VEIC’s efforts is **one** scenario by which the state, on a regional level, could achieve the goals of the Comprehensive Energy Plan. This scenario’s data provides the basis for the strategies described in this Plan.

Historic information was primarily drawn from the Department of Public Service Utility Facts 2013 and Energy Information Administration (EIA) data. Projections came from the Total Energy Study (TES), the utilities’ Committed Supply, and stakeholder input. Assumptions and specific data sources include:

- The population is assumed to grow at 0.35% per year.[2] People per house are assumed to decrease from 2.4 in 2010 to 2.17 in 2050. This supplies the number of households used in the model as the basic unit for residential energy consumption.
- Transportation energy use is based on projections of vehicle miles traveled (VMT). VMT peaked in 2006 and has since declined slightly. Given this, and Vermont’s efforts to concentrate development and to support alternatives to single

occupant vehicles, VMT is assumed in the model to remain flat while population and economic activity grow slightly. VMT county totals are supplied from the Vermont Agency of Transportation (VTrans).

- There will be reductions in energy use due to changes in technology, including building shell and device efficiency improvements.

Based on the LEAP modeling provided, the TRORC Region will go from consuming over 11 TMBTU's in 2015 to around 5.5 TMBTU's in 2050, a nearly 50% decrease in total energy consumption by 2050. Use of fossil fuels will dramatically decrease, while use of electricity and renewable energy sources will increase. The overall increase in electricity use will be primarily due to increased ownership of electric vehicles (EVs) and heat pumps. For more detailed information on the LEAP analysis and additional data, see Appendix A.

B. Key Issues

While the energy goals established in statute and further refined in the CEP provide this Plan with clear and specific guidance as to "where we need to go" as a region to meet energy goals, it is more important to understand why these goals were created. The "why" behind the goals (and the development of this Plan) can be explained by looking at three different motivations that are important regionally and statewide: environmental protection, energy security, and economic needs and opportunities.

Damage after Hurricane Irene - Photo Credit: Kevin Geiger

Environmental Protection

Our reliance on fossil fuels over the past two centuries has had a profound and enduring detrimental impact on climate, air quality, and water quality. Burning fossil fuels has rapidly released billions of tons of carbon. The worldwide impacts of climate change—destruction of ecosystems, sea level rise that threatens millions of homes, farms, and businesses, greater frequency and intensity of drought and severe storms—already are being observed. In Vermont (and in the Region), climate change from past and future emissions will alter the composition of our forests, affect the viability of the tourism economy, and result in more damaging tropical storms, floods, and other severe events. Every effort needs to be made, locally and globally, to limit future damage and adapt to a changing reality.

Air pollution from fossil fuel combustion (e.g., smog, acid rain) also damages natural ecosystems, adversely affects human

Solar Farm in Sharon, VT - Photo Credit: TRORC Staff

health, and causes economic damage. Water quality impacts include leaks from fuel tanks and spills that have damaged surface water and aquifers.

Although local energy generation siting concerns are real and are addressed in Sections 5 and 6 of this Plan, the environmental impacts of obtaining electricity from wind turbines on a Vermont ridgeline or from solar panels along a Vermont roadway should be considered in the context of the impacts of strip mining, wholesale removal of mountains, hydraulic fracturing, nuclear waste, oil spills, and devastating climate impacts.

Environmental protection and a desire to reduce Vermont's contribution to climate change were some of the reasons for the development of the CEP.

Energy Security

The TRORC Region, like Vermont, is reliant upon other states and countries for much of our energy needs. Our region's dependence on fossil fuels is significant. The primary use of these fuels is for space heating, transportation and generation of electricity (although Vermont obtains a significant share of its electricity from hydroelectric and nuclear facilities and relatively little from coal powered generators). According to the US Energy Information Administration, nearly 3/5 of all Vermont households use fuel oil. In the TRORC Region, roughly 13,000 households rely on oil for heating[3] which means a substantial portion of the Region is subject to the price and availability instabilities of a reliance on oil. Of the total 885 million dollars spent annually on residential energy in the state of Vermont, just over 50% ($445.8 million) was spent on fuel oil, kerosene or light propane gas.[4] Vermont's economic system is so closely tied to the availability of fossil fuels that even modest price increases can lead to a slowdown in economic growth and budgetary crises at at the State, municipal, and individual levels. For example, increasing fuel prices make paving and plowing more expensive for town governments. Rising oil prices make it difficult for residents to heat their homes and put enough food on the table (the price and availability of food is usually influenced by fuel prices).

Where the Region's energy is generated is also a concern. Vermont currently obtains much of its electricity from hydroelectric facilities located out of state, primarily Quebec. While 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

New England states that are seeking electricity from renewable sources. Reducing the Region's reliance on imported energy, or at least maintaining the same amount of electrical use from sources located outside Vermont, will certainly make the state and region more energy secure, especially in a future where electricity demand is anticipated to almost double by 2050 as the use of fossil fuels is significantly decreased.

It is possible to have a state and region that is more self-reliant for its energy needs. By utilizing the resources that exist in-state and in-region, long term security concerns about energy supply and energy costs can be decreased.

Economic Needs and Opportunities

Our modern economy and lifestyle has been made possible through the use of vast amounts of solar energy stored as fossil fuels. Because a majority of the most readily extractable energy from these sources has been consumed in just over 100 years, and the cost and difficulty of obtaining these resources will increase over time, we will benefit from adapting our economy and lifestyle in a manner that relies on energy conservation and use of renewable sources of energy. These changes actually represent extraordinary opportunities for economic growth and prosperity if quick and decisive action is taken.

Vermont spends over $2.7 billion dollars (and the TRORC Region approximately $160 million dollars) on energy each year, with the vast majority of those dollars exported out-of-state. This Plan, like Vermont's 2016 Comprehensive Energy Plan, states that overall energy consumption will need to decline by about one-third by 2050 to meet our energy goals. That reduction can be accomplished through changes in land use patterns and the transportation system (reducing the need for driving and by introducing more energy-efficient vehicle technologies), through extensive building upgrades and weatherization; and with energy conservation by means of more efficient appliances and devices.

These improvements will reduce the outflow of money from the region, so that millions of dollars will be retained to circulate in local economies, supporting employment, social services, and improving the quality of life of our communities. Moreover, the changes needed to reduce our energy demand and to produce local renewable energy offer a wide array of business and employment opportunities.

Weatherization of buildings, installation and servicing of new heating systems, procurement and delivery of bio-fuels

Air sealing a window frame with caulk
Photo Credit: Capstone Community Action

such as wood pellets and cord wood, and construction and servicing local renewable energy generation facilities offer new jobs and business development opportunities. Economic growth in the renewable energy sector has been robust over the past five years. Vermont has seen a roughly 20% growth in clean energy employment sectors overall.[5] In 2016, 6% of Vermont's total jobs were in the clean energy sector.

The Growing Importance of Electricity

Electricity is an essential part of our everyday lives and is critical to the vitality of the regional economy. Since the closing of the Vermont Yankee nuclear power plant, Vermont imports most of its electric power. Much of this imported electricity derives from renewable hydroelectricity generated in Canada, with the balance from a mix of generating facilities in the northeast and from a growing supply of small and medium sized renewable in-state sources.

The demand for electricity across residential, commercial, and industrial sectors grew rapidly during the second half of the 20th century, but has leveled off in recent years. It is apparent that a variety of aggressive energy conservation programs implemented through the state's energy efficiency utility, Efficiency Vermont, contributed to slowing the growth of electric demand. The need for electric conservation and efficiency improvements will continue, and be amplified by increases in electric demand due to the decline of fossil fuel energy for transportation and space-heating needs. Electricity provides the most viable path toward meeting the state's energy goals in several key areas. Electrification of passenger vehicles, for example, will dramatically reduce energy use in the transportation sector through use of more efficient drive systems, and the energy that is used can be obtained from renewable sources. Similarly, the easiest transformation in space heating of existing residential buildings often is to weatherize the structure and install highly efficient (electrically driven) air source heat pumps.

Plan Focus

In order to implement the state's energy targets, to achieve the significant reductions outlined by the LEAP scenario, and to address the key issues identified above, this Plan will focus on strategies in four areas of energy transformation.

- ***Thermal Efficiency and Alternative Heating Systems:*** Due to the age of Vermont's housing stock (see Chapter 2, Thermal Energy Challenges), potential gains from improvements to the thermal efficiency of our homes and businesses are substantial.
- ***Transportation System Changes and Land Use Strategies:*** Vermont, because of its rural nature, is very vehicle-reliant. The pattern of development that has been cultivated since the development of the automobile has resulted in a significant portion of our overall energy use (34%) being dedicated to transportation. While the use of electric vehicles and improvements to public transportation will help meet the goals of the CEP, we will also need to reevaluate where we live and work in order to reduce travel.

- ***Energy Conservation and Efficiency of Delivery and End Use:*** Using less energy is the best and lowest-cost option to meet expected demand. Changing our individual energy use behavior to embrace conservation is an important component of meeting the goals of the CEP. Encouraging the installation of energy efficient devices or equipment that will perform the same work using less energy is essential to reducing our overall energy use. Proper load management can also help reduce demand during peak hours, avoiding costly power often generated by fossil fuel plants. Demand response techniques can include time of use rates, smart rates and energy use feedback.
- ***Mapping Energy Generation Resources and Constraints:*** Energy generated by renewable resources is the cornerstone of the CEP and this Plan. In order to achieve 90% of our energy produced by renewables by 2050, we will need to build substantial amounts of local, generation capacity. To do that, we must first identify where the potential for renewable energy generation exists. Town by town, our citizens will have to balance the need for increased capacity with Vermont's landscape and the desires of their communities.

Life of the Plan

As with all policy documents, this Regional Energy Implementation Plan will require review and revision over time. It is important to recognize that there will be new data, new technological advances and possible changes in state and Federal energy policy that will need to be considered and incorporated into the Plan. With each action item that is completed, there will likely be more that should be included as we continue to work toward the goals of the CEP at the regional level.

The primary purpose of this Plan is to identify possible paths to implementing the state's Comprehensive Energy Plan at the regional level. Should the goals of the CEP change, this Plan will likewise need to be changed.

2 THERMAL EFFICIENCY AND ALTERNATIVE HEATING SYSTEMS

"Vermont is the second most petroleum dependent (per capita) state in the country due to its high use of heating oil"

- Northeast Biomass Thermal Working Group

A. Background

According to the 2016 Comprehensive Energy Plan, 28% of energy demand in Vermont is associated with heating fuels. The reliance on heating from non-renewable sources (fuel oil, natural gas and propane) creates a challenge for Vermonters that extends beyond energy issues. Low-income residents may find it challenging to stay comfortable in their own homes due to fuel costs. In 2010, Vermont ranked 44th out of 50 states for energy affordability.[6] In 2010, low-income Vermonters spent an average of $1,870 more per family, per year, on energy bills than is considered affordable.[7]

The 2013 Thermal Efficiency Task Force's Report to the General Assembly, notes that "Investing in thermal efficiency improvements – primarily air sealing, insulation, and heating system replacements – can dramatically reduce heating energy use in a building. At current fuel prices, thermal efficiency investments in a home can bring savings of approximately $1,000 per year over the lifetime of the investment. The value of these savings increases as fuel prices rise."[8] Converting to more efficient heating and improving thermal efficiency will have the effect of reducing financial impacts on low-income communities and moving the Region toward 90% renewable energy by 2050.

Cutting Rigid Foam Board for Insulation
Photo Credit: Capstone Community Action

The CEP promotes efficiency and conservation as top priorities in all energy sectors. In 2011 it recommended creating a whole-buildings efficiency road map—including program delivery, consumer outreach, funding and finance mechanisms, and progress metrics—by the end of 2012.[9] This goal was not met, but the state has made some progress on energy efficiency improvements. Retrofit investments in thermal energy efficiency by Efficiency Vermont and Vermont Gas have reduced energy demand in about 6,700 homes, and investments in thermal efficiency for low-income households eligible for weatherization assistance have reached more than 10,700 homes since 2008, equivalent to roughly $10 million in annual savings.[10] However, the current pace of weatherization improvements will need it to increase exponentially to meet the state's goals.

New Construction

New buildings will need to be built to a significantly higher standard than is provided for by the State's Residential and Commercial Building Energy Code. Net zero constructed buildings are highly efficient and save 30–45% on overall energy costs in comparison with standard buildings.[11] Efficiency Vermont's 2015 Net Zero Energy Feasibility Study determined that new construction of residential and office net zero energy buildings is a cost effective investment. These buildings cost less to own and operate than code buildings from the first year into the long term.[12]

How We Heat

In addition to thermal efficiency improvements, the CEP is seeking a statewide change in how we heat our buildings. This approach will focus primarily on the installation of cold-climate heat pumps which consume far less energy than electric resistance, propane, or oil heating systems. In order to contribute to the state's heat pump installation target (35,000 installed statewide), a total of 3,476[13] will need to be installed in the TRORC Region. Because cold-climate heat pumps are inadequate during extreme sub-zero days (-20 degrees F), homes will require a secondary heat source – preferably one that utilizes some form of woody biomass (wood, wood chip, wood pellet). Pellet stoves are fueled with pellets primarily made of sawdust and wood chips that can effectively heat a home 2,000 square feet and under.[14] Replacement of older wood stoves with advanced wood or pellet stoves may cost less than installing heat pumps and is a shorter term solution that uses available low grade wood resources.

Also worth considering are geothermal or "ground source" heat pumps. These systems are substantially more expensive than cold-climate heat pumps, but can result in significant energy savings. They are better suited to new development than retrofitting into existing buildings due to the technology's requirements. While cold-climate and geothermal heat pumps will work for residences, they cannot adequately meet the demands of some large industrial and commercial users. Thus, the CEP has recognized the need to identify locations for district heating and combined heat and power which is a system for distributing heat in a centralized location.

There are barriers to reaching the CEP's thermal efficiency goals. The purpose of this plan element is to identify these barriers, and to provide solutions through policy and action steps that will effectively remove these barriers when properly implemented.

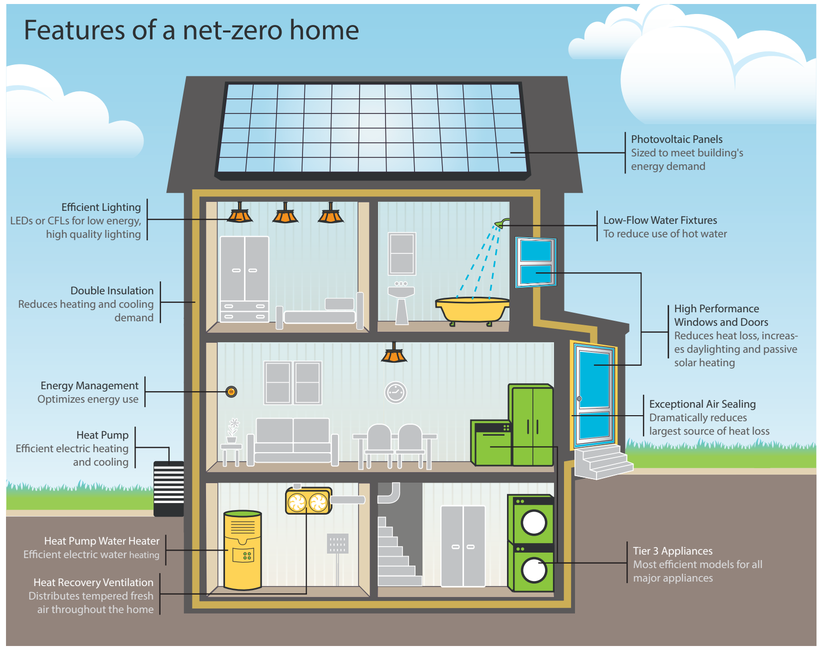


Figure 2 : Features of a net zero Home
Source: Efficiency Vermont

B. Thermal Energy Challenges

Aging Building Stock

Residential houses constitute the majority of Vermont's built environment. Residential energy represents 30% of Vermont's total energy consumption (second only to transportation), with heating being the largest energy consumer.[15] Vermont's climate demands heating.

In Orange and Windsor counties, 47% of homes were built before 1970.[16] These older homes were constructed before high energy costs made energy conservation a priority in the built environment. As a result, a substantial number of homes utilize wasteful amounts of energy and are expensive to maintain. According to the Massachusetts Zero Net Energy Buildings Task Force: "With buildings contributing close to 40 percent of greenhouse gas emissions* and consuming 40 percent of energy in the United States, energy efficiency and renewable energy technologies must become central to the way we design and build."[17]

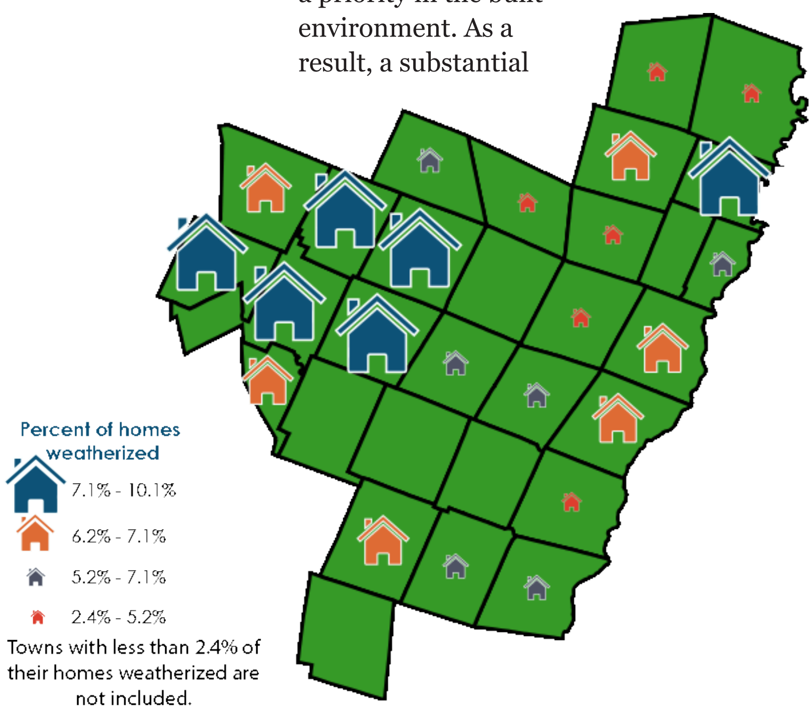


Figure 4 : Percent of Weatherized Homes
Source: Efficiency Vermont, SEVCA, Capstone Community Action

In the TRORC Region, it is estimated that only 4.58% of houses built before 2000 have been weatherized. To achieve the state's goal of 25% of homes, a total of 6,477 of the region's housing units will need to be weatherized by 2020.

Larger Homes

By and large, new homes have grown in size over the past 40 years. In 1973, the average home in the Northeast was roughly 1700 square feet. In 2014, the size of homes in the Northeast had increased by 60% to 2600 square feet.[18] While homes are generally more efficient than in the past, more square footage requires more heating.

Cost of Improvements

The up-front cost of energy efficiency improvements and building-scale renewable energy generation remains a challenge. Despite the demonstrated long-term savings benefits, the capital needed to significantly reduce energy consumption and add renewables are a significant barrier to implementation. When surveyed

** Greenhouse gases help capture and maintain the temperature of the Earth's surface. They include water vapor, carbon dioxide, methane, nitrous oxide, and a variety of manufactured chemicals. Some are emitted from natural sources; others are a result of human activities. Over the past several decades, rising concentrations of greenhouse gases have been detected in the Earth's atmosphere, which leads to an increase in the average temperature of the Earth's surface.*

as part of the East Central Vermont Sustainability Project, 39.5% of those who responded indicated that they could not afford to make their home more energy efficient. Another 33.8% were unable to make energy efficiency improvements because they rent instead of own. Cost is an issue for all homeowners, but especially for low- and moderate-income homeowners.

At the commercial and public sector levels, capital and operating budgets are often set independently of each other. There is no opportunity to use the savings from operations to defray capital investments, thus removing the incentive to implement energy improvements.

Lags in Deploying Energy Efficiency Standards

The owners of the region's buildings (both new and old structures) must be guided toward net zero energy use. Current state residential and commercial building codes were adopted in March 2015 and were modeled after the International Energy Conservation Code (IECC).* The state has found it problematic to immediately adopt new energy codes, however because the U.S. Department of Energy often lags in completing the necessary support software upgrades for programs contractors use to track energy improvements. Net zero energy use cannot be achieved using current efficiency standards.

The system Vermont uses to track adherence to the Residential Building Energy Standards is a challenge. Currently, there are no state code officials or state permits for energy efficiency. Energy efficiency is self-certified by the building contractor, with a requirement that a completed certificate be submitted to the municipality where the building is being constructed. However, many communities are unaware of this requirement and have no way to track the submission of certificates. Towns with local code officials may enforce energy efficiency codes and towns with Certificate of Occupancy (COO) requirements must receive an Energy Code certificate before issuing the COO. Nearly two thirds of TRORCs communities (19) have zoning bylaws, but just under half (9) of them require a COO. (See sidebar.)

To move toward net zero energy use in the built environment, the code must be substantially improved and enforced and contractors and owners must be educated about the code's existence and purpose.

Inadequate Understanding of Programs, Costs and Methods

When surveyed as part of the East Central Vermont Sustainability Project, just over 50% of the respondents indicated that their house was energy efficient. Vermont has an extensive network of organizations with significant experience in energy efficiency services and programs, and this expertise puts our region in a good position to improve thermal efficiency and reduce building energy consumption. This provider diversity can also be a challenge to the average homeowner, who may feel overwhelmed by the multitude of options.

Likewise, service providers may find it challenging to know what assistance, incentives or programs are available, and their customers may not know who to contact to take advantage of them.

Zoning
Barnard
Bethel
Bradford
Braintree
Brookfield
Chelsea
Fairlee
Hartford
Newbury
Norwich
Plymouth
Pomfret
Randolph
Rochester
Stockbridge
Strafford
Thetford
Vershire
Woodstock

Town with zoning in the TRORC Region: Blue indicates TRORC communities that require Certificate of Occupancy

* *Introduced in 1998, the IECC addresses energy efficiency on several fronts including cost savings, reduced energy usage, conservation of natural resources, and the impact of energy usage on the environment.*

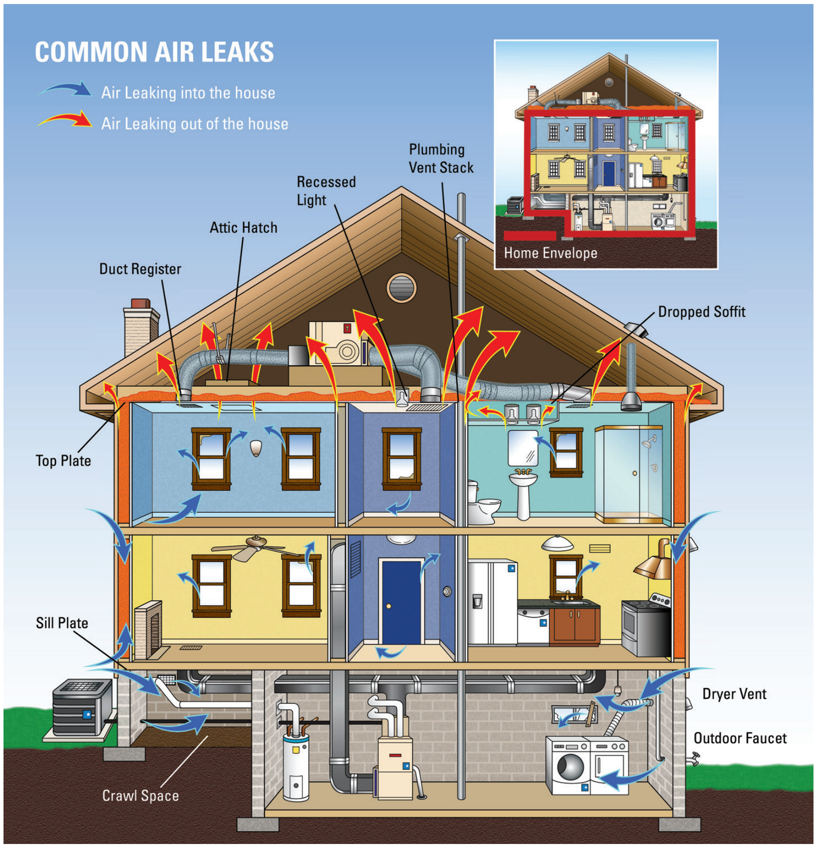


Figure 2: Common Air Leaks in a Home - Source: U.S. EPA

Every improvement project is different. It can be challenging for the layperson to incorporate renewable energy and energy efficiency since these services may not be offered by the same companies. In addition, poorly prioritized improvements can result in lower realized savings.

The prioritization of investments is vital to ensuring where residents can get the best return on their investments. Heat pumps can initially be more expensive than conventional furnaces to install, but can lead to a significant reduction in use of heating fuels, particularly when paired with wood heat. Installing a heat pump without adequately weatherizing the shell of a home, however, may yield a net loss. Weatherization should always be completed prior to, or in tandem with, the installation of a more efficient heating system.

C. Thermal Energy Strategies

Support Increased Funding

With upfront capital cost being a significant barrier to the implementation of thermal efficiency and renewable energy improvements, it is essential that programs that provide funding and financing grow. In particular, programs providing assistance to middle and low-income households must increase in funding. Current financing programs include:

1. Vermont's Heat Saver Loan: http://heatsaverloan.vermont.gov/
2. Property Assessed Clean Energy (PACE) - available for towns that have adopted a PACE district. Repayment of PACE financing is tied to the property, not to the owner.
3. Neighborworks of Western Vermont Energy Loan: https://www.nwwvt.org/energy-loan/
4. Vermont State Employees Credit Union VGreen Energy Savings Solutions loans: https://www.vsecu.com/energy-savings/about/about-vgreen/what-is-vgreen
5. Vermont Economic Development Authority offers energy loans to commercial enterprises http://www.veda.org/financing-options/vermont-commercial-financing/commercial-energy-loan-program/

   and small business https://www.veda.org/financing-options/vermont-commercial-financing/small-business-energy-loan-program/

6. United States Department of Agriculture Section 504 Home Repair Program https://www.rd.usda.gov/programs-services/single-family-housing-repair-loans-grants
7. Efficiency Vermont rebates for central wood pellet furnaces and boilers- $2,000 cash back https://www.efficiencyvermont.com/rebates/list/central-wood-pellet-furnaces-boilers-residential

These financing programs offer key features such as great interest rates, flexible terms, and ease of application. The loans can also be combined with Efficiency Vermont incentives.

While fuel assistance programs are essential, increased funding to Vermont's Weatherization Assistance Program (WAP) is needed. Projects such as the Vermont Fuel Efficiency Partnership which provides "deep-energy" retrofits in multi-family buildings whose tenants are income-eligible for the WAP must be encouraged and supported. Fuel distributors must be encouraged to become Energy Service Providers, expanding what they offer so that more homes can be weatherized and energy efficiency increased.

TRORC can support these programs and initiatives by communicating directly with energy providers, state agencies and the legislature. We can provide input on state level initiatives and we can, if the opportunity presents itself, pursue federal funding to support these programs within our region.

Support the Implementation of the Vermont Energy Code Compliance Plan and Increased Energy Efficiency Standards

The DPS has outlined a pathway to increased energy code compliance in a Plan developed in 2012. The state needs to follow this plan. Concurrently, the state needs to continue to move quickly to adopt the International Energy Conservation Code as it is updated, for both commercial and residential buildings. Standards for achieving net zero design must be incorporated. Some regional builders such as Prudent Living's Southscape community (http://southscapewilder.com/) and VERMOD (http://vermodhomes.com/) are currently constructing net zero possible homes. TRORC can assist communities with continued outreach regarding code compliance. We can also support the DPS as they move forward on adoption of more energy efficient codes.

Dense Packing walls for insulation
Photo Credit: Capstone Community Action

Provide Outreach, Coordination and Education

TRORC can provide education and outreach to our communities, and support other statewide programs for weatherization and thermal efficiency. TRORC can promote the work of community action agencies and energy service providers.

As a regional entity that works with municipalities, TRORC has a broad network of state and local connections. If adequate funding was available, TRORC could develop a staff position that would focus specifically on energy assistance, education and outreach. Without duplicating existing services, such as those that Efficiency Vermont, Vital Communities, Energy Action Network, and GMP offer, a TRORC Energy Planner could act as a clearinghouse of energy information for our communities. Through education and outreach at the municipal level, TRORC could ensure that our residents were aware of the opportunities available to them. We could work closely with active municipal Energy Committees and Energy Coordinators to continually update them on new programs, policies or financing mechanisms for weatherization assistance or alternative heating improvements.

Ideally, a Regional Energy Planner would have a basis of knowledge grounded in implementation, so that this staff person would have experience directly related to the installation and implementation of thermal efficiency and renewable energy improvements. This skill set would be particularly valuable in working with builders and energy service providers to help educate them about their customer's needs, but would also provide homeowners with an independent voice that would help them understand weatherization and other energy efficiency options. Acting as a bridge between state-level service providers, contractors and municipal organizations, TRORC would effectively move the region toward meeting the CEPs goals relating to Thermal Efficiency.

VERMOD Home in Wilder, VT- Photo Credit: VERMOD Homes

Goals, Strategies and Actions: **Thermal Energy**

Goal A: Weatherize at least 25% of the regions housing stock by 2020

Strategy A.1: Weatherize at least 25% of the regions housing stock by 2020 (approximately 6,477 units)

Actions:

1. TRORC will support programs such as Zero Energy Now!, Weatherize Upper Valley with Vital Communities, and GMP's eHome by providing outreach and education to local planning commissions and energy committees and their communities.
2. TRORC will support and promote the Energy Action Network (EAN) energy dashboard and educate towns as to its use and benefits.
3. TRORC will distribute information regarding the available financing mechanisms for weatherization assistance including information about the financial advantages of energy improvements.
4. TRORC should seek funding for an independent staff person who can work with homeowners to understand weatherization and other energy options.
5. TRORC will support state efforts to provide additional funding for weatherization improvements, especially for low and moderate income populations.
6. TRORC will work with utilities to implement their Renewable Energy Standard (RES Tier 3 fuel-switching mandates through education and outreach to help promote weatherization.
7. DPS should work with fuel dealers to encourage them to become energy service providers.
8. Local Energy Committee's should work with owners of rental housing to educate them of the financial benefits of weatherization investments and connect owners with contractors to complete weatherization projects
9. DPS should support K-12, higher education and vocational education initiatives to bring energy ideas and solutions into the classroom by working with organizations such as Vermont Energy Education Program (http://veep.org/.)
10. Local Energy committee's should work with Neighborworks Heat Squad, COVER and community action agencies to promote their weatherization services.
11. DPS should work with local educational institutions such as Vermont Technical College to encourage continued technical training related to energy efficiency improvements.
12. TRORC and towns should support programs and initiatives that encourage the development of small homes (less than 1000 sq feet) as a way to reduce energy use.

Thermal Energy Goals, Strategies and Action continued next page

Goals, Strategies and Actions: **Thermal Energy**

Goal B: By 2020, reach 30% of new buildings built to net zero ,100% by 2030

Strategy B.1: Support net- zero energy construction throughout the region.

Actions:

1. TRORC will support net zero building programs by providing outreach and education to local planning commissions and energy committees and their communities.
2. TRORC will provide outreach to towns and contractors on the use and enforcement of residential and commercial building energy standards for all new construction.
3. TRORC will support statewide efforts to increase energy efficiency code standards and statewide energy code enforcement by communicating regional concerns about enforcement with the Legislature, and encouraging communities that have zoning to include a Certificate of Occupancy when they revise their regulations if they do not already have one. Provide outreach to communities with a COO to ensure that they are tracking submission of the RBES certificate.

Goal C: Install 3,500 efficient cold climate heat pumps by 2050*

Strategy C.1: Support a regional shift away from fossil fuel as a source of heat.

Actions:

1. TRORC will partner with Efficiency Vermont, Green Mountain Power, HVAC contractors, and others to identify and promote cold climate heat pumps.
2. DPS should coordinate all outreach efforts with fuel dealers and electrical contractors (potentially creating opportunities for electrical contractors to work with fuel dealers).
3. TRORC should provide communities with an analysis of potential areas that are suitable for geothermal ground source heat pumps when data is available.
4. Local Energy Committee's provide information to builders and developers regarding the benefits of geothermal systems (including heat pumps).

Thermal Energy Goals, Strategies and Action continued next page

** All heat pumps for this goal must be identified as "qualifying models" by Efficiency Vemront through their rebate program.*

Goals, Strategies and Actions: **Thermal Energy**

Goal D: Increase the use of efficient wood heat

Strategy D.1: Support the adoption of efficient wood and biomass heating systems for new construction, as replacements for fossil fuel furnaces and backup heat systems for heat pumps.

Actions:

1. TRORC and relevant non profits should conduct outreach and education by coordinating with advanced wood heat system vendors and contractors to hold informational public forums.
2. TRORC will encourage increased state incentives and rebates for efficient wood heat equipment, through communication with the Legislature.
3. TRORC should provide outreach and education to communities to ensure residents are aware of existing incentives and rebates.
4. Local Energy Committee's and Planning Commission's should identify potential users of district heating and combined heat and power systems: schools, college campuses, apartment complexes, shopping centers, industrial parks and village centers and incorporate this information into local plans
5. DPS should provide guidance to communities seeking to develop district heating systems.
6. DPS should conduct outreach efforts to public and non-profit entities and housing organizations to provide information on biomass heating options.
7. Local Energy Committee's should partner with project developers to promote the possibility of combined heat and power and district heating options.
8. TRORC will work to maintain forest health as a prerequisite to a sustainable wood energy fuel supply by updating the Regional Plan to protect forests and habitat.
9. The State should support woodstove change out programs to lower heat cost and reduce particulate emissions.

TRANSPORTATION SYSTEM CHANGES AND LAND USE STRATEGIES 3

A. Background

This section address the intersection of transportation, energy, and land use. The other chapters in the Regional Plan on Land Use and Transportation compliment this section and have additional relevant policies and actions.

Vermont is one of 17 U.S. states that consumes more energy for transportation than any other sector.[19] The transportation sector is responsible for 37% of the total energy consumed in Vermont,[20] powered mostly from gasoline (76%) and diesel (20%).[21] To reach state renewable energy goals, Vermonters will need to shift away from petroleum powered vehicles to electricity and biofuels. While transportation fuel switching is vital to reaching state energy and greenhouse gas reduction goals, it is also important to recognize that land use choices are inextricably linked to our transportation system. Vermonters tend to travel farther from their homes to employment, services, and shops than do other Americans.

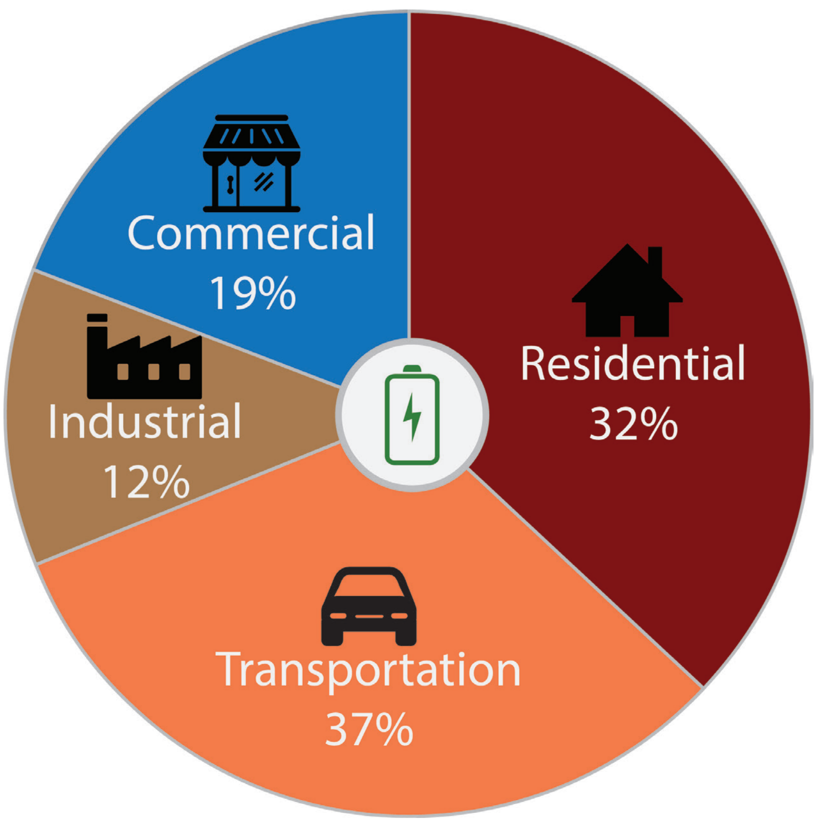


Figure 5: Vermont Energy Consumption, 2013 (U.S. EIA)

The CEP seeks to reduce Vermont's total transportation energy use by 20% from 2015 levels by 2025. In the TRORC Region, the following targets would apply:

- Hold statewide Vehicle Miles Traveled (VMT) per capita levels to 2011 (11,402 VMT per capita).[22]
- Reduce the number of single occupancy vehicle (SOV) trips by 20% by 2030. (75% of vehicle trips in TRORC Region are SOV).
- Triple the number of state park and ride spaces.[23] (TRORC currently has a total of 18 state and municipal park and rides, totaling 558 spaces).
- Increase public transit ridership by 110% to 1.9 million trips annually. Currently, Stagecoach and Advance Transit together count for 950,000 trips annually.
- Quadruple Vermont based passenger rail trips annually.*
- Ten percent of vehicles are Electric Vehicles (EVs) by 2025.(approx. 110).

The 2015 Vermont Transportation Energy Profile notes that "progress toward achieving the CEP objective is likely to lag in the early years due to the necessity of upfront investments and the slow

** We have no data on how many passenger rail trips occur annually in the TRORC region* pace of behavior change. Progress may be particularly slow for metrics related to the vehicle fleet since cars and trucks typically have a long operating life. Thus, cases where the state is currently lagging in achieving a particular objective should not be taken to mean that the objective cannot be achieved." In fact, the state is currently exceeding targets relating to VMT (2014 per capita VMT was 11,356, which is below the 2011 baseline of 11,402). However, on all other CEP transportation targets the state lags behind.

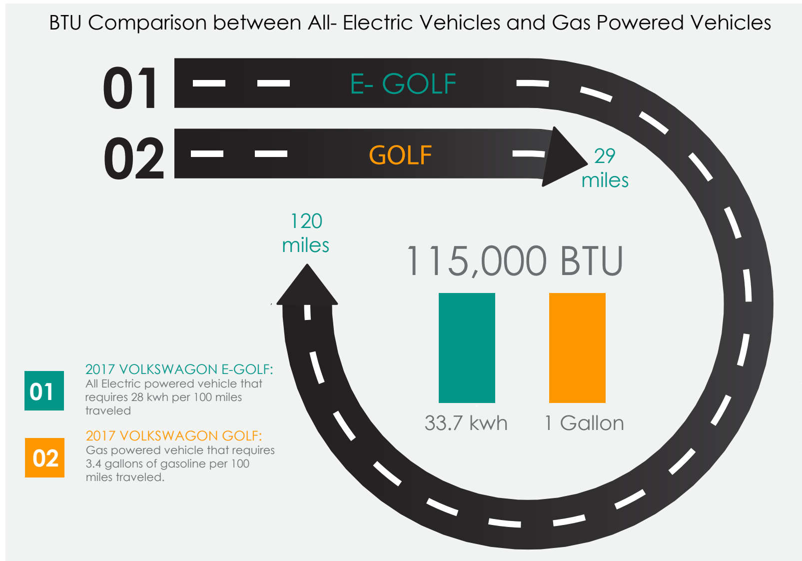


Figure 6: BTU Comparison of Gas vs. Electric Vehicles- Fueleconomy.gov

To achieve these transportation energy goals, the Region's vehicles would need to become more efficient through fuel switching and an increase to almost 90% of all vehicles powered by electricity. As seen in Figure 6 below, an electric vehicle using the same amount of BTU energy as a gas car travels four times farther. Additionally, our pattern of land use and related travel would need to change to reduce daily trips.

B. Transportation and Land Use Challenges

Traditional Patterns of Development

The traditional Vermont landscape is defined by densely populated villages and downtowns, surrounded by open countryside. This pattern is recognized and supported in Vermont's statutory planning goals but it is also the key reason why transportation uses the largest portion of our energy. Where we live, work, go to school, shop, utilize services and recreate determines how far we drive.

Much of Vermont's appeal to homeowners is the ability to own a house in the country. While many communities have small villages or downtowns, residential development in our towns is mostly located outside of these areas on rural roads. The choice to live in a rural setting leads to longer commutes for work, shopping and services.

The rural nature of our region also means that there are limited locations for key centers of employment. Out of the 30 towns in the TRORC Region, only seven could be considered centers of employment. These are Bethel, Bradford, Hartford, Norwich, Randolph, Royalton and Woodstock.* Further, a significant number of those who live in Orange and Windsor counties work outside of the region in the Hanover/Lebanon, NH or Montpelier, VT areas.

This dispersed pattern of development is further encouraged by the way we regulate development locally. Many communities allow village-scale densities (one to two

* Note that the towns included in Figure 6 include several towns outside of the TRORC Region

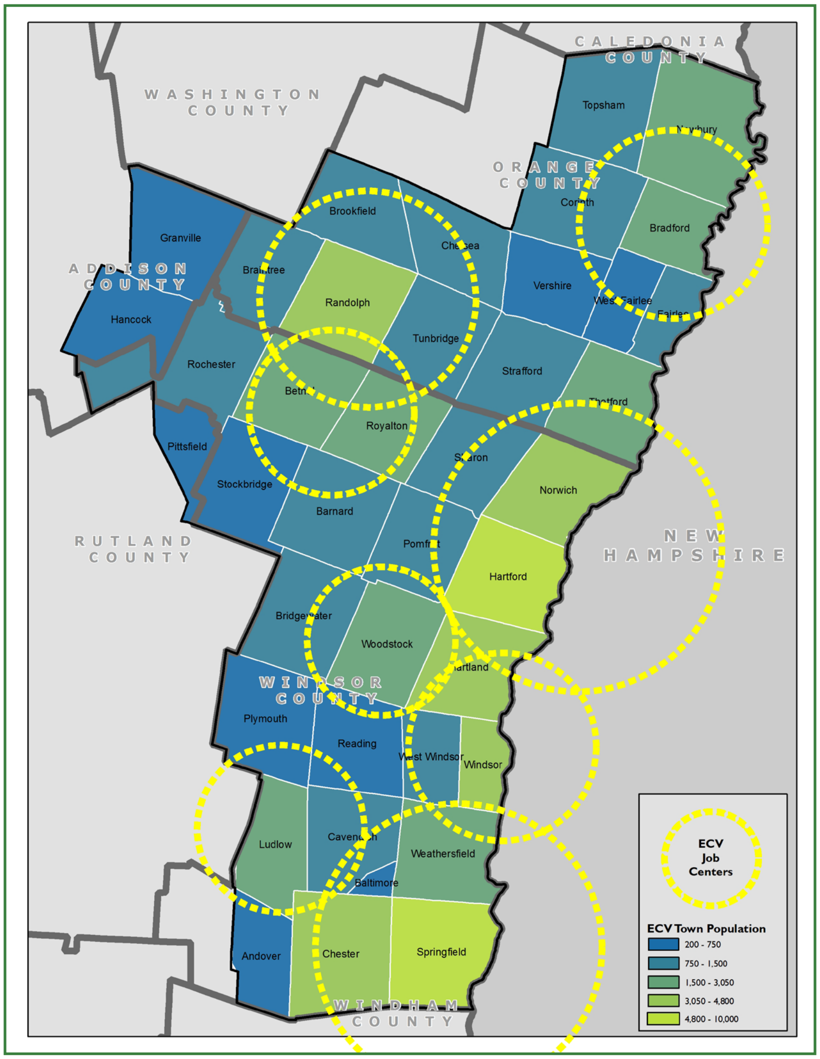


Figure 7: ECV Employment Centers - Source: TRORC

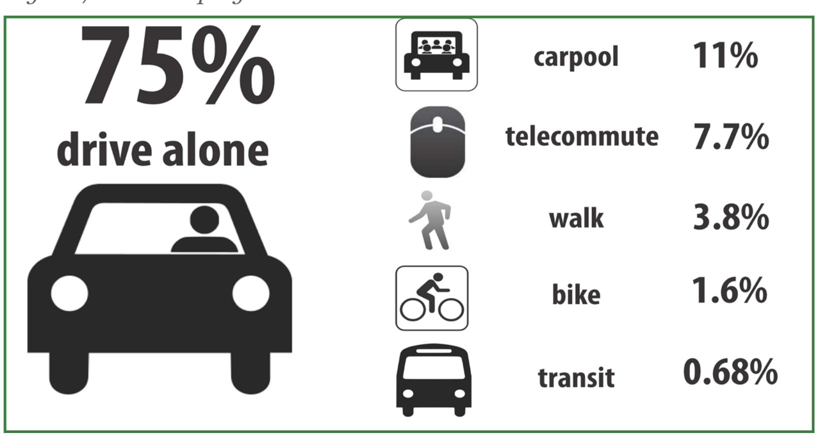


Figure 8: How the Region Gets to Work - Source: TRORC, 2012

acre) in all locations, including rural areas. If this pattern of development persists, these communities will be forced to upgrade or build new roads in rural areas to serve new development, resulting in undue costs to taxpayers for road maintenance and increasing VMT.

Lack of Available Public Transit

Public transit provides less than 1% of the transportation in our region. The rural character of the region presents challenges for a traditional public transportation system. Long distances between homes and employment centers(Figure 7) strain existing commuter bus routes, while the need for transportation in low population density areas presents a uniquely rural challenge to the system. However, transit systems could still replace many SOV trips at a significant cost saving to drivers. The main impediment to greater transit is not that it costs more than cars, it is simply that we like to own cars.

The region has several public transportation services which are vital to our region's population. Elderly and disabled transportation services give alternatives to people who wish to live independently but who are unable to drive themselves.

From Figure 8 on the previous page, it is clear that a significant portion of commuters drive alone to get to work. The Regional Transportation Network map (Figure 9) illustrates that access to public transit is currently too difficult in many parts of our region.

In areas where local transit services are available, other challenges exist. Commuter bus routes that stop at regular intervals along their routes extend the length of the trip, making it quicker for someone with a car to drive themselves instead. The impact of regular stops can also make it challenging to time arrivals and departures in an economic center with hours of employment. Capacity is also an issue. Buses could expand to hold 50 riders versus 24, but that would require transit stops to be reconfigured to accommodate larger vehicles.

Regular fixed route services, such as those in Hartford and Norwich could increase ridership by adding additional buses and increasing the frequency of service. But to do so requires additional buses and drivers, both of which require significant funding. Funding also limits the hours of operation. Fixed route services in our region are currently limited to early morning through evening, which means potential riders who work shifts outside of the traditional 9-5 model cannot take advantage of public transit.

Finally, there are perceptions that public transit is a service geared towards low income citizens. While it is true that these demographic groups benefit from public transit, public transportation services are available and useful to everyone.

Insufficient Commuter Lots

The region has added seven new park and ride lots with over 200 more spaces in the last seven years, but existing park and rides are struggling to meet demand due to space limitations. A number of existing areas could likely serve twice the population of commuters if they had adequate area for expansion. Many existing park and ride areas are not designed or sized to accommodate public transit services (allowing for bus circulation and efficient transfer of passengers). Additionally, there are very limited locations where new commuter lots could be built. New lots are needed at Exit #1 and #3 on I-89 and more spaces are needed at Exit #2 on I-89.

Lack of EV Charging Station Infrastructure

The range of an Electric Vehicle is currently limited to an average of 120 miles on a full charge, although a few models can travel as far as 200-300 miles. Given the distance between our communities

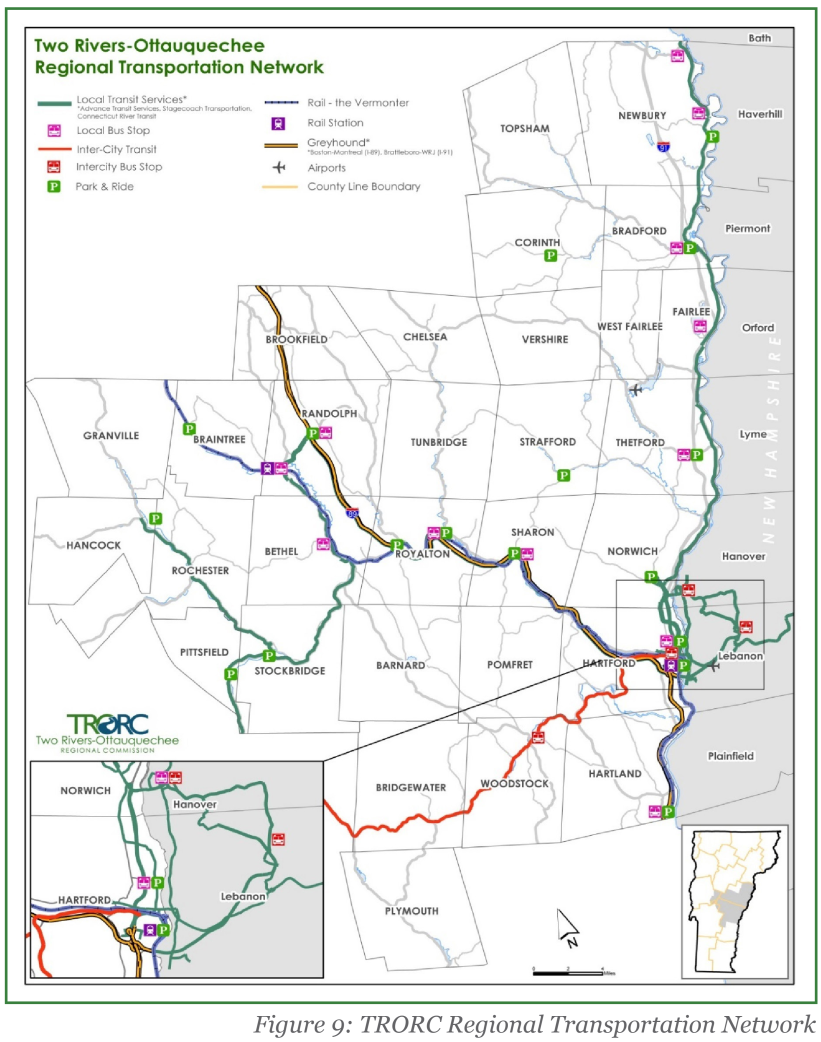


Figure 9: TRORC Regional Transportation Network

Illustration of Smart Growth - Source: ACCD

and centers of employment, it is essential that the ability to recharge EVs is readily available to the EV owner. There are currently only six locations with public EV charging stations in the TRORC region.

Adequate Consideration of Public Transit

Developments that occur in areas that are either right on or nearby a public transit route are sometimes planned without considering this service. If not considered during the planning stage, it is difficult to integrate public transit services into completed site plans. Likewise, the location of residential subdivisions away from a transit line limits public access. Diverting an existing route to a new location is expensive and can have negative impacts on existing services.

Act 250 considers public transit as part of Criterion 5 (Transportation), but at the local level, integration of public transit services into the development review process is less common. It is not yet common that public transit agencies are involved in the beginning of the planning or conceptual design process. This means that design standards for bus pull-offs, sufficient stopping distances/sight lines, bus shelter amenities, bike racks, and sidewalks are not included as part of the permitting process.

C. Transportation and Land Use Strategies

Support Smart Growth and Planning

In order to achieve the CEP's goals, transportation energy use cannot be ignored. Embracing smart growth that directs development into existing centers reduces energy use, and provides cost savings for both households and municipalities, while creating vibrant communities and taking pressure off our natural resources.

Development that is more effectively directed within and adjacent to historic downtowns, villages, and neighborhoods will reduce the need for motorized transportation and make better use of transit. In 2006, via Act 183, Vermont codified its own detailed guiding principles for local and regional land use decisions based upon the smart growth principles. Although communities are not required to plan, those that do are encouraged to uphold planning and development goals that reinforce smart growth principles, such as Complete Streets. Complete Streets focus on multi-modal transportation, public transit and pedestrian travel.

Encouraging economic development initiatives that enable individuals to work in their home communities such as "maker" or "coworking" spaces and expanded high speed internet will reduce VMT. Likewise, communities can support infill development and concentrated commercial and institutional activities in our villages and downtowns.

Encourage Higher Density in Less Rural Areas

In order to reduce VMT, communities will need to continue to encourage compact development, particularly housing, within their villages and downtowns. In turn, they will need to reduce planned density in more rural areas. Given that only modest growth is foretasted for the region, nearly all villages and downtowns can accommodate this growth as infill

Encourage Employers to Support Reduced VMT

Local employers have a role in reducing vehicles miles traveled. On average, Vermonters drive 15 miles to work each way. Assuming a telecommuter works one day a week from home, with two weeks of annual vacation time, telecommuting could decrease round trip commuter travel by roughly 1,500 miles per year per commuter. Employers can encourage carpooling, cycling, or the use of public transportation. For example, Dartmouth College provides a van service for employees in Bradford, Chelsea and Vershire. GW Plastics is working on a van service to Royalton from Barre. State employees can catch a van from Randolph to the National Life building in Montpelier. Area employers including King Arthur Flour, Vital Communities, Hypertherm and RSG, Inc. provide monetary incentives for employees to carpool or take public transit.

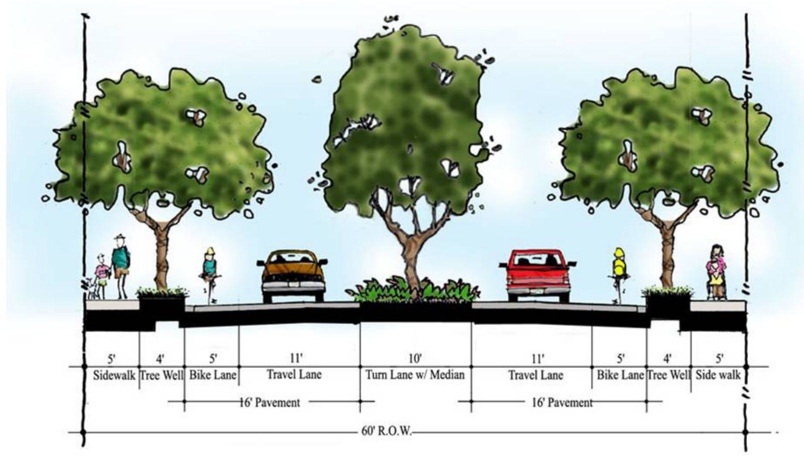


Illustration of a Complete Street

Support Increased Consideration for Public Transit and Electric Vehicles in Local and State Permit Reviews

Clear policy at the Regional level will ensure that under Act 250, public transit and electric vehicles are given adequate consideration. Large scale commercial and residential developments need to consider their relationship with public transit in terms of where they are located and the infrastructure they provide for employees who want to use it. Likewise, developers can include EV charging stations in their plans.

Support the Development of Alternative Forms of Public Transit

In addition to traditional public transit models, growth in forms of transit driven by technology (such as Uber and CarShare Vermont) should be encouraged.

Increase Funding for Public Transit Initiatives and Investments

Public Transit is simply a much better use of our dollars than all of us driving cars. Adding additional busses along existing commuter routes would allow transit providers to expand their hours, create more frequent trips that increase convenience and capture riders who work outside of traditional 9-5 business hours. Larger busses located along transit routes would allow for more riders. The addition of new routes would access under served areas.

Support the Development of Intermodal Transit Facilities

The development of several intermodal transit facilities that would allow commuters to connect with mass transit including trains and buses, could improve regional access to public transit and reduce VMT overall.

Goals, Strategies and Actions: **Transportation**

Goal A: Hold Statewide VMT per capita to 2011 levels (11,402 VMT per capita)

Strategy A.1: Reduce vehicle miles traveled by supporting efforts to provide the Region with opportunities to work closer to home and by requiring public transit opportunities for large scale development.

Actions:

1. TRORC will encourage communities to develop bylaws that allow for the development of "makerspaces"* as a way to reduce VMT. Revise the TRORC Regional Plan to include support for makerspaces in villages and downtowns.
2. TRORC will support continued expansion of high speed internet to allow for telecommuting.
3. TRORC will encourage employers to invest in workplace incentives for carpooling, cycling, public transportation use and telecommuting.
4. TRORC should modify the Regional Plan to include specific language that requires developments that have a Substantial Regional Impact (as defined in the Plan) under Act 250 to demonstrate that they have consulted with transit providers about reasonably accommodating transit.
5. TRORC should modify the Regional Plan to require all residential and large commercial land developments subject to Act 250 to evaluate the appropriateness of installing or reserving space for a transit stop.
6. TRORC will support new bike/pedestrian projects in the region.
7. TRORC should work with groups such as the Vermont Bicycle and Pedestrian Coalition (VBPC), Local Motion, Green Mountain Bicycle Club, and towns to encourage safe bicycling as a transportation alternative in the region.

Goal B: Reduce the number of single occupancy vehicle trips by 20% by 2030, through carpooling and public transit.

Strategy B.1: Support programs and planning initiatives that will reduce single occupancy trips throughout the Region.

Actions:

1. TRORC will support community car sharing by promoting programs such as Go Vermont and CarShare Vermont.
2. TRORC will provide technical assistance to communities interested in implementing Complete Streets to increase density and mixed uses in compact settlements and to foster transit-oriented development along major roads in rural areas.
3. TRORC will continue to identify locations for additional park and rides (state and municipal).

Transportation Goals, Strategies and Actions continued on next page

** A "makerspace" is a physical location where people gather to share resources and knowledge, work on projects, network, and build. Makerspaces provide tools and space in a community environment—a library, community center, private organization, or campus.*

Goals, Strategies and Actions: **Transportation**

Goal B: Strategy B.1: Actions (continued)

4. TRORC will continue to prioritize efforts to expand existing park and ride infrastructure.
5. TRORC will support the development of intermodal transit facilities within the region to allow underserved areas access to multiple forms of transportation.
6. TRORC will push for increased capacity and continue to support local transit providers through technical assistance.
7. TRORC will work with VTrans and local transit providers to ensure a seamless regional transit system.
8. TRORC will work with VTrans to investigate the feasibility of commuter rail along the I-91 corridor.
9. TRORC will work with communities to incorporate the principles of Smart Growth into their municipal plans and bylaws and to support creative economic development concepts that allow residents to live and work in their communities.

Goal C: Increase the percentage of electric vehicles to 5% by 2025, 38% by 2035, and 82% by 2050 in the Region.

Strategy C.1: Ensure that land use policy and regulation are designed to encourage daily use of EVs.

Actions:

1. TRORC should modify the Regional Plan to require that developments subject to Act 250 demonstrate they have or will take steps to incorporate parking sports with EV charging stations in order to meet regional goals
2. TRORC should encourage state policy changes to offer state buyer incentives for EVs.
3. 3. TRORC should promote and share information provided by Drive Electric Vermont including their video highlighting the costs and benefits of EVs.

Goal D: Increase the use of sustainable biofuels.

Strategy D.1: Support investment and development of sustainable biofuels.

Actions:

1. TRORC should support and promote the Vermont Bioenergy Initiative in cooperation with the VT Sustainable Job Fund's Bioenergy Initiative to address on-farm biofuel production under Act 250.
2. TRORC should identify locations for alternative fuel stations in the Region and modify the Regional Plan to include them as allowed uses in appropriate locations.
3. TRORC should support efforts to switch municipal medium and heavy duty vehicles to biodiesel blends.

ENERGY CONSERVATION, EFFICIENCY OF DELIVERY AND END USE 4

A. Background

The CEP recognizes the significant economic and environmental benefits of energy efficiency, conservation, and renewable energy sources, while seeking diverse sources of electricity production, to ensure grid reliability. Since 2005, electricity consumption in Vermont has declined and retail electric rates in Vermont are the second lowest in New England.

The data modeling used to create the scenario that this Plan uses to achieve the goals of the CEP projects a 40% decrease in **overall** energy use in the TRORC region. However, the significant reduction in the use of fossil fuels as part of this energy ultimately requires an increase in our dependence on electricity. As is shown in the graphic above, following the LEAP model developed for this Plan, one possible path for the Region to achieve 90% renewable energy use by 2050 includes increasing electric demand by 9.9% (from 2015 levels) to offset decreases in fossil fuel use. The increase in electric consumption will be due to the utilization of new electric technologies, such as cold climate heat pumps and electric vehicles that rely on electricity. This fundamental change in the type of energy we use will require substantial changes at the utility scale.

Demand- Side Management

Demand-Side Management is the best and lowest-cost option to meet expected demand. Encouraging the installation of energy efficient devices or equipment that will perform work using less energy and improving building shells to reduce the need for building heat is essential to reducing our overall energy use (see How

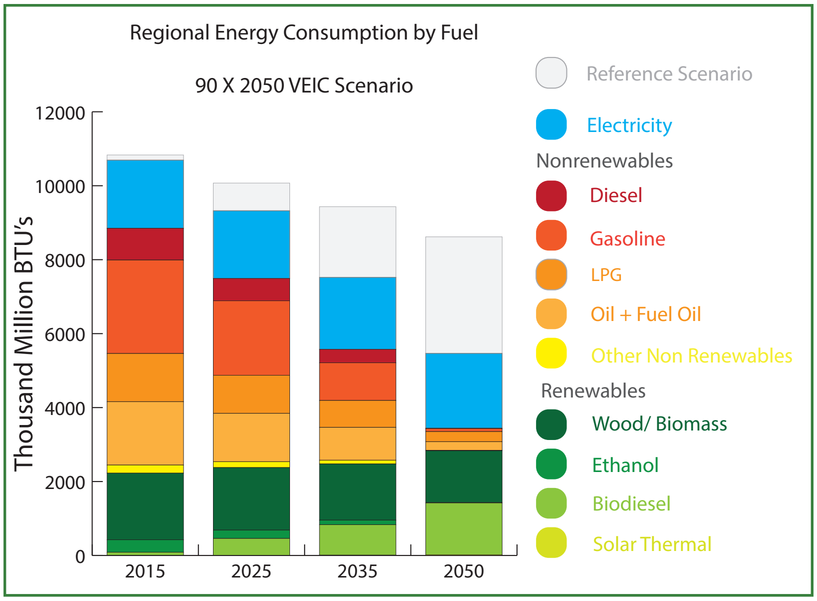


Figure 10: Regional Energy Consumption by Fuel - Source: VEIC

We Heat, Chapter 2). Additionally, proper load management can help reduce demand during peak hours. Demand response techniques can include time of use rates, smart rates and energy use feedback. But even with fully implemented demand-side management, fuel-switching will require new sources of renewable energy.

Conservation & Efficiency

New technology, demand-side management, gains in efficiencies in appliances, upgraded building codes, and renewable generation alone will not be sufficient to achieve the state's energy goals. People will have to alter their behavior patterns and use electric appliances, lighting, and heat with greater thought given to conservation.

Much of what we do depends, in one form or another, on energy. Where we live and work, how we get from place to place, how we design, build and heat our houses, and how we use our land are all patterns

Electricity use in the TRORC Region is predicted to increase from 1.8 TMBTU of electricity to 2.1 TMBTU in 2050

- LEAP Model, 2016

of behavior. Behaviors are controlled by social norms to a large extent.[24] Current social norms do not favor energy conservation, tending toward a more consumptive model. Education sustained over time will have an impact on behavior.

Large-scale energy savings can be achieved by many people making small individual changes such as turning down thermostats, air drying clothes and turning off lights and electronic devices when not in use.

It is important to recognize that from a regional standpoint, TRORC can only indirectly implement many of the strategies related to electricity. Many of the components that are needed to implement this section of the Plan require direct action from utilities, energy generators and state and federal governments, buy-in from our communities, and thousands of individual actions.

B. Challenges

Electricity Will Make Up a Larger Part of Our Energy Future

As indicated earlier in this chapter, Vermont will need to significantly increase the amount of electricity available in order to offset the impacts of fuel switching. Meeting the goals of the CEP will mean that in the TRORC region, we will go from using 1.8 TMBTU of electricity to 2.1 TMBTU. Because 90% of our energy must be from renewable energy, new renewable energy generation facilities will need to be built throughout our region, creating another set of challenges.

Power Distribution System is Not Distributed Generation

The Vermont electric grid was developed to function as an importer of electricity. As with the rest of the United States, Vermont depends on a small number of centralized power plants, the vast majority of which are located outside of the state. This classic model of energy distribution has a number of significant disadvantages due to inefficiencies and power loss over lengthy transmission lines.

Our existing grid is not fully capable of allowing the placement of small renewable energy generation facilities in every community in our region. In the GMP region, for example, parts of Hartford, Hartland, Sharon and Strafford have poor circuit ratings (see figure 11).[25] In addition, energy supply (generation) and loads (end uses) must be instantaneously kept in balance, even as customers change their end uses or renewable energy facilities respond to changes in generation cycle. If the Region is going to transition to 90% renewable energy (with much of it produced in-state), power companies and VELCO will need to increase the pace of system-wide upgrades. This will include line upgrades and, once the technology becomes readily available, the provision of storage technologies such as Tesla's new Powerwall battery system.

Improving Regional and Municipal Planning With Regard to Renewable Energy Generation

While Regional and Municipal plans are required by statute to include an energy chapter which includes a "a statement of policy on the development of renewable energy resources,"[28] most plans do not go beyond indicating "support" for renewable generation. This lack of clear language makes it challenging for developers to determine what locations in a community are suitable and desired for energy development. Additionally, local and regional plans have not provided significant actions to further the goals of the CEP. With the passage of Act 174 in 2016, there is an opportunity for Regional and Municipal energy planning to take a step forward. This plan is the Regional Commission's attempt to do so.

Inadequate Understanding of Programs Costs and Methods

As noted in Chapter 2, Vermont has an extensive network of entities with significant experience in energy efficiency and renewable energy generation services and programs. The number of options is often overwhelming, leading homeowners to be slow at implementing and combining energy efficiency improvements or renewable generation systems.

Renewable Energy Credits Can Be Sold Out of State

All New England states are required to meet state-mandated renewable energy requirements. When renewable energy generation facilities are built, the development gains Renewable Energy Credits (REC) which utilities throughout the region can purchase to claim the renewable attributes of generation that they do not own. In Vermont, many developers utilize the sale of RECs to help fund the construction of the project. The challenge is that RECs are often sold to utilities outside of Vermont. The energy generated by a renewable energy generation facility that has sold its RECs

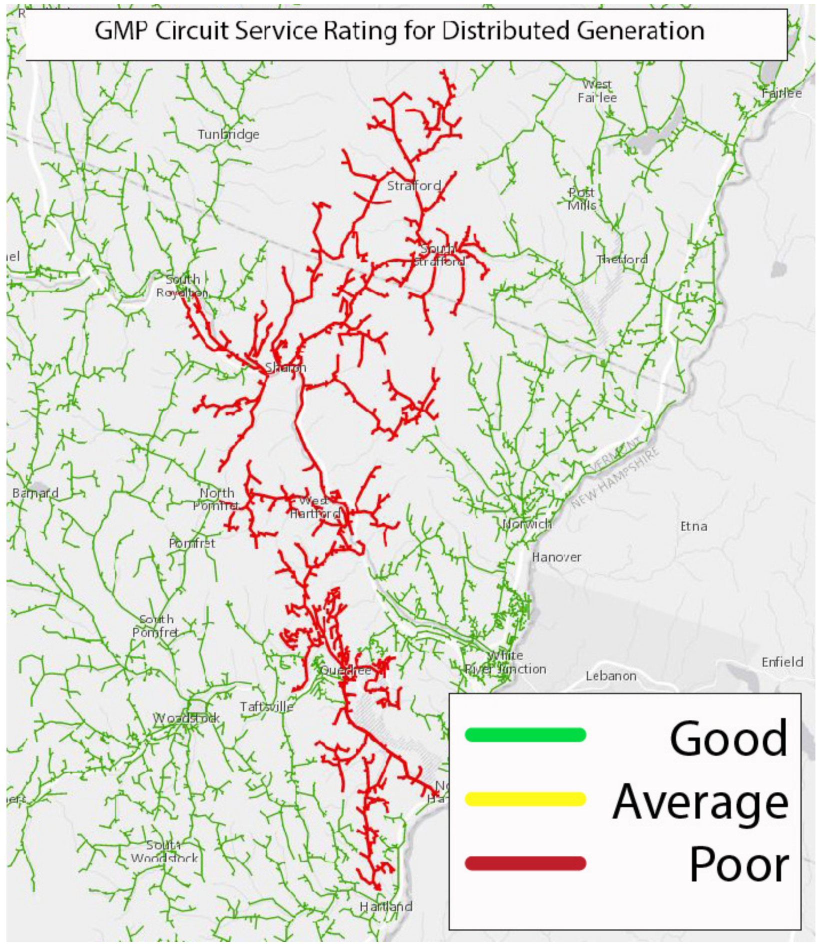


Figure 11: Green Mountain Power Circuit Service Rating - GMP

out of state does not count toward the State's energy goals. But they do count towards local and regional targets. This has caused some conflict and opposition to further renewable energy development.

C. Electricity Strategies

Improve Demand-Side Management

In addition to energy efficiency improvements to reduce heating and cooling costs in our homes and transitioning to electric vehicles, there are other techniques that can be used to reduce energy use. Utilities can install

What are Renewable Energy Credits?

Renewable energy credits (RECs)are the tracking and legal attribute that qualifies electricity as a "green" renewable energy source for accounting purposes. RECs can be "unbundled" from the electric output and sold to anyone that needs renewable credits to comply with state renewable portfolio standards or wants to purchase renewable energy. Electricity that has been "unbundled" from its credits does not count as renewable in terms of meeting Vermont's renewable energy targets. It is important to note that the REC system is only an accounting system. Energy developed renewably is still a renewable resource that will ultimately reduce our reliance on fossil fuels.

Why sell the RECs?

The primary reason Vermont's legislature supported the purchase and sale of RECs was to encourage growth of the renewable energy generation industry. This has been a remarkably successful concept. The sale of RECs has helped keep overall electric rates down, while allowing for the deployment of more renewable energy systems. Many renewable energy generation facilities depend on sale of RECs to capitalize their development.

Do we have to sell the RECs?

Many Vermont renewable energy projects keep their RECs. With the passage of Act 56 in 2015, Vermont will be required to meet 55% of their energy sales from renewable energy in 2017 and 75% in 2032. As a result, more RECs will be retired in state, helping ensure that Vermont is able to reach its renewable energy targets.

Once the credits are sold, are they gone for good?

RECs are sold on a yearly basis. So, the developer of a net-metered solar system could sell the RECs for the first five years of operation to help fund the development of the system, and retire the remaining credits over the life of the system.

Advanced Meter Infrastructure (AMI), which increases system reliability and load management capabilities with two-way communications technology. AMI includes smart meters to enable utilities and customers to track and manage the flow of energy more efficiently, curb peak demand, lower energy bills, and integrate renewable energy sources and storage to the grid.

AMI data and Smart Meter technology can allow utilities to implement Smart Rates, which vary the price of electricity to accurately reflect the cost of electricity: lower rates for low demand and higher rates during peak. This can help influence customers to change their electricity consumption patterns in response to changes in energy price over time or to incentivize payments designed to induce lower electricity use during peak.

Promote Behavioral Change to Encourage Conservation

Programs such as Efficiency Vermont , Go VT and Button Up! are designed to educate people on ways they can change their behavior to reduce energy consumption and greenhouse gas emissions. If provided with well thought out and well organized materials, local energy committees can successfully implement programs like these at the local level. Additionally, as mentioned above, properly designed Smart Rates can either encourage or discourage usage at certain times of the day, for example, which in turn affects resource development and utilization choices. Small changes in routine, such as shifting power-hungry activities to "off-peak" hours in the morning or evening can help ease the load on the Region's power grid.

Encourage the Development and Use of Storage Technology

Electrical Storage can closely align customer loads with periods of lower electric demand, store solar electricity to use during peaks or provide some back-up during power outages. Using storage can help reduce electrical demand peaks across the network, making it more reliable.

Focus Grid Improvements on System Stability, Reliability and Affordability

Green Mountain Power covers a majority of the TRORC Region. The utility is constantly striving to improve existing infrastructure. Improvements to existing facilities are often subject to Act 250 review, which the Regional Commission reviews as part of their technical assistance program. The CEP desires a significant portion of Vermont's energy to be produced near where it is consumed by many coordinated actions by distributed energy users, rather than through singular central control.[27]

Retire More Renewable Energy Credits in State

Changes in legislation have made it possible to retire RECs in-state, thus allowing us to further increase our renewable energy portfolio. Act 56, which was passed in 2015, has increased the number of RECs that need to be retired in state.* Efforts to increase that cap or encourage their retirement in-state, should continue in order to ensure that the goals of the CEP are reached.

Increase the Number of Renewable Energy Generation Facilities

To accommodate the increase in use of electricity due to fuel switching, electric vehicles, etc., the Region will need to encourage the development of new renewable energy generation facilities that retire their RECs in state. In order to ensure that facilities are developed, the Regional Commission and its municipalities will need to clearly identify areas where they are appropriate.

Embrace Enhanced Energy Planning as Defined in Act 174

Act 174 was passed in an effort to support energy planning and the development of renewable energy. The Act creates an optional level of "enhanced energy planning" that would include policies relating to energy conservation, efficiency and the development and siting of renewable energy resources, including an identification of where they are and are not appropriate. This Plan is part of the enhanced energy planning. TRORC will, with proper funding from DPS, assist interested communities with their enhanced energy planning efforts at the local level. Such planning gives a town greater say in state review of power projects.

** Act 56 requires 1% of Tier 2 electric power to be from distributed generators (< 5MW) supporting VT electric grid in 2017 to 10% in 2032*

Goals, Strategies and Actions: **Electricity**

Goal A: Meet 25% of remaining energy need from renewables by 2025, 40% by 2035 and 90% by 2050. Meet end use sector goal of 67% renewable electric by 2025.

Strategy A.1: Support the continued development of renewable energy generation that counts toward the goals of the CEP

Actions:

1. TRORC will encourage communities and residents to identify areas with the potential for renewable energy generation.
2. TRORC will provide education and outreach to municipalities on energy generation.
3. TRORC will advocate for continued incentives that lead to the retirement of Renewable Energy Credits in-state.
4. TRORC will support the implementation of smart rates.
5. TRORC will help interested towns meet the standards set forth in Act 174 for Enhanced Energy Planning.

Goal B: Use Demand-Side Management to manage the expected electric energy demand increase of by 2050 in the TRORC region.

Strategy B.1: Educate our communities about the programs and tools available to further reduce energy demand.

Actions:

1. TRORC should promote Efficiency Vermont and other incentive programs to reduce electric energy use and encourage the use of devices and equipment that perform work using less energy input than otherwise necessary, such as Energy Star or CEE2, 3 or advanced appliances.
2. TRORC should Encourage state policy to adopt energy storage mandates and incentive programs.
3. DPS should promote the use of programs such as eHome and Zero Energy Now!, in conjunction with Green Mountain Power and the Building Performance Professionals Association of Vermont (BPPA-VT), through outreach and education.
4. DPS should work with BPPA-VT to encourage HVAC and weatherization providers to join the organization to provide holistic energy advice to the Region.
5. DPS should support and provide outreach for Energy Action Network's Community Energy Dashboard and Efficiency Vermont's customer engagement web portal and home energy reports.
6. DPS should support efforts to develop programs that encourage energy conservation through behavioral change by advocating for a roll-out of smart rates in the region through work with local energy committees and education and outreach.
7. DPS should provide support for grid improvements that will allow improved renewable energy generation facility coverage in our region by actively participating in the Act 250 and Section 248 review process.

RENEWABLE ELECTRICAL ENERGY GENERATION 5

A. Background

The State's goal of 90% renewable energy by 2050 represents a substantial shift from our energy portfolio. Renewable portfolio standards are state or local level policies that mandate all or certain types of electricity producers to supply a minimum share of their electricity from designated renewable resources.

Sixty percent of Vermont's electricity currently comes from renewable sources, a majority of which is hydropower generated by Hydro Quebec. To reach the state's renewable energy generation targets, more generation will need to be developed (with RECs retired in state).

The growth of the renewable energy generation industry in Vermont over the last five years has been remarkable. As a measure of current growth of commercial solar development in Vermont for example, it took Green Mountain Power (GMP) from 2008-2014 to hit a net metering cap of 4% of peak load, and less than two years to reach the increased cap of 15%.[29] The proliferation of commercial wind energy generation in Vermont has been decidedly slower, primarily due to the costs of development and the complicated permitting requirements. Hydro development has dropped off significantly since the early 1990s, due to a number of factors including the loss of economic incentives and stricter permitting requirements."[30]

Renewable Electrical Energy Generation

The TRORC Region currently produces 88,588 MWh of renewable electric energy generation. All existing or permitted generation capacity as of 2015 was factored into the LEAP modeling used as part of the RPC Energy Project. All goals in this plan are in **addition** to that capacity.

Based on the Two Rivers regional share of the overall state population, and the current renewable energy generation, the regions target generation is 349,307 MWh of electric energy. To reach this goal all towns have a responsibility to contribute to producing renewable energy generation in the state. In-state production will minimize the loss of electricity during transmission, reduce the cost of long distance infrastructure, and set the state to be more financially resilient. We cannot rely solely on generation that is produced elsewhere.

Town level targets are allocated based on each municipality's share of the region's population. Within the region the targets range from around 1,800 MWh to 62,000 MWh. Two-thirds of the towns in the region have a generation target of under

MW vs MWh

Capacity is the maximum power that a power plant can produced and is expressed in (MW). While the total electricity they actually generate over a period of time is expressed in megawatt hours (MWh). For example, a solar farm rated at a power level of 10 MW capacity can potentially generate 10 MWh of electrical energy over an hour in optimal conditions. Over 6 hours in optimal sunny conditions the 10 MW solar PV farm could generate 60 MWh of energy.

~ Climate Council

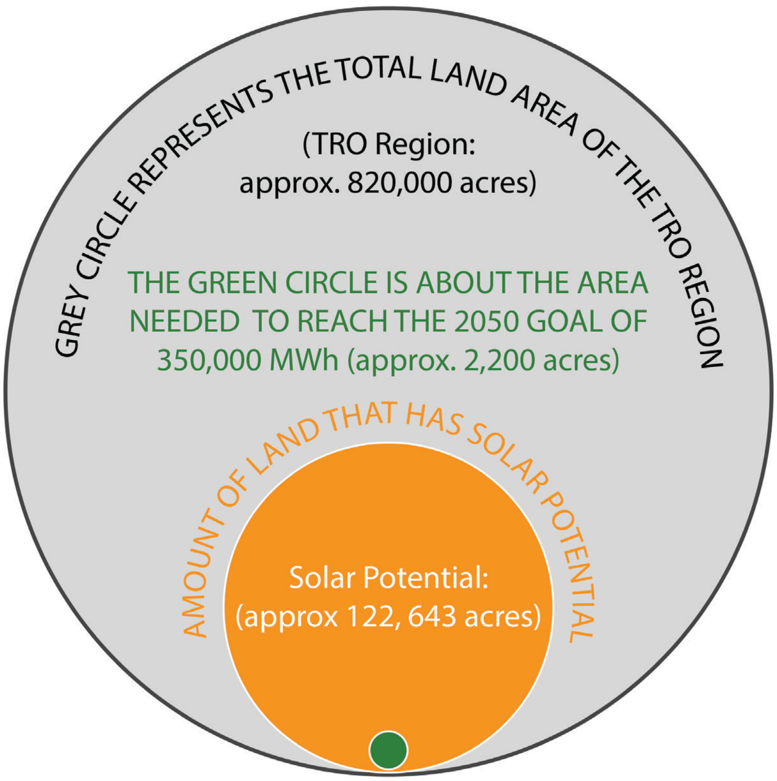


Figure 12: All Solar Scenario Diagram

10,000 MWH which requires 60 acres of land in an all-solar approach. It is important to recognize that the model developed and utilized in this Energy Implementation Plan is full of various assumptions and is one path to reach the state's energy goals. The model helps us create a target using data which gives us a sense of the magnitude of the amount of energy towns need to plan for in the next 30 years. These targets should be used by communities as they formulate their own plans and policies with regard to renewable energy generation, particularly those communities seeking to meet the Enhanced Energy Planning standards of Act 174.

The Two Rivers region includes adequate amounts of land that is suitable for solar and wind systems. Using data from the regional energy maps , the region could produce about 900,000 MWh of prime solar electrical energy generation that has no constraints, within one mile of three phase power, and not within forested land which would utilize approximately 5,500 acres of land. The prime wind potential in the region can produce between 35,000 MWh- 480,000 MWh depending on various factors. In the lower MWh wind potential, that includes land that is not forested, has no constraints, is within one mile of three phase power and has a hub height of 70 feet. The higher MWh potential analyzes the result of wind energy production in forested land.

While there are regional and local targets for renewable electrical energy generation, there is no mandate on the approach that is taken to produce that electricity. Based on the capacity factors of various renewable resources, we have provided three hypothetical scenarios(all solar, mix of solar and wind, and a mix of solar, wind, and hydro) to show how the region could reach the targets and how using a mixed portfolio of electrical energy generation sources can reduce the land and number of generation structures needed.

Scenario 1: All New Solar

To reach the regional target through the approach of using only solar electrical energy generation, the region would need to produce a generating capacity of 285 MW which would require approximately 2,200 acres of land.(See figure 12)

Scenario 2: New Solar and Wind Mix

If the region were to build a mix of wind and solar facilities the amount of land needed to reach the target would be reduced. In this scenario, wind was allocated for 10% of the regional energy production and the remaining 90% was produced for solar. The generation capacity total would be reduced to 269 MW which would utilize about 2,100 acres of land.

Scenario 3: New Solar, Wind, and Hydro Mix

In the last scenario, if a new hydro facility were to be constructed or existing hydro facilities significantly upgraded, in the region as well as some wind turbines the amount of solar needed to reach the target would significantly decrease. This scenario was broken down into 10% wind, 25% hydro and 65% solar. This mix of renewable resources would require a capacity of 222 MW and would need about 1500 acres of land

Solar

Solar is the most viable source of new renewable electric energy generation in the TRORC region due to the nature of our topography and land cover. Based on GIS mapping analysis, there are roughly 123,000 acres of land in our region that have the raw potential* of producing solar energy, which is about 9% of the region's total land area. Not all land that has the potential to generate solar energy is appropriate for this use, however. Many areas have conditions that may make them unsuitable, such as hydric soils, wetlands or flood plains. Other suitable locations may be better used for other purposes, such as locations with prime agricultural soils or as forests.

Roof-top solar (or solar facilities on existing structures) is often considered a viable alternative to commercial-scale production. However, as indicated by the infographic on the previous page, even using extremely optimistic projections, roof-top solar might account for only 51,849 MWh of electrical generation (15% of the projected solar production needed by 2050). As such, even when encouraging extensive development for rooftop solar, a majority of the new renewable solar power generated in the TRORC region will be

WHAT ABOUT ROOFTOP SOLAR?

Rooftop solar will be a piece of the renewable energy genration puzzle, but commercial scale generation will still be the primary generator. Using the perfect (but unlikely) scenario described below, rooftop solar could generate 51,849MWh of electrical generation.

There are roughly 4000 residential structures within the areas that have been identified as having solar potential.
If 100% of those structures are properly oriented and structurally compatible, and each one chooses to install systems at an average of 4905 kWh of electrical energy generation, it could account for...
19,620 MWh

There are roughly 414 small commercial structures (<40K sq ft) within the areas that have been identified as having solar potential.
If 100% of those structures are properly oriented and structurally compatible, and each one chooses to install systems at an average of 24,528 kWh of electrical energy generation, it could account for...
10,154 MWh

There are roughly 90 large commercial structures (>40K sq ft) within the areas that have been identified as having solar potential.
If 100% of those structures are properly oriented and structurally compatible, and each one chooses to install systems at an average of 1,752,000 kWh of electrical energy generation, it could account for...
22,075 MWh

Figure 13: TRO Region Rooftop Solar Capacity Potential

NOT ALL GENERATION IS EQUAL

In some communities, there may be a preference for one kind of renewable energy generation vs. another. It is possible (but not simple) to "swap" one generation type for another (for example, a town could decrease the amount of solar in a community 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 system with a capacity of 100 megawatts, won't produce energy at that level all the time because the sun is not available 24 hours a day, 365 days a year. Solar in Vermont is generally considered to have a capacity factor of 15%. Wind generation in VT, on the other hand, has a capacity factor of roughly 25-30%, because winds are more constant.

** Solar potential is determined using GIS analysis of topography based on slope and direction (azimuth) for ground mounted solar. Additional factors in analysis included the removal of "known level 1 constraints." See Chapter 6 for more information.*

Town	Type	Utility	Capacity kW	Annual kWh	Owner	Stream/River
Bethel	GNM	GMP	330	12000000	Bethel Mills	Third Branch, White River
Newbury	GRD	GMP	970	33000000	Boltonville Hydro	Wells River
Newbury	GRD	GMP	270	1096000	GMP	Wells River
Newbury	GRD	GMP	5	23000	Sardnar Thanhuser	Halls Brook
Bradford	GRD	GMP	1500	4335000	GMP	Waits River
Hartford	GRD	GMP	37400	148850000	TransCanada	Connecticut River
Hartford	GRD	GMP	3790	6904000	GMP	Ottauquechee River
Hartford	GRD	GMP	645	2780000	Simon Pearce Glass	Ottauquechee River
Hartland	GRD	GMP	4000	12100000	North Hartland, LLC	Ottauquechee River
Hartland	GRD	GMP	2180	5834000	GMP	Ottauquechee River
Hartland	GRD	GMP	250	800000	Jay Boeri	Lulls Brook
Woodstock	GRD	GMP	500	1429000	GMP	Ottauquechee River

Table 1: Existing Hydro Generation Facilities, TRORC Region 2015
GNM= Group Net Metered, GRD= Grid, GMP= Green Mountain Power

commercial scale. Existing and proposed commercial solar facilities in our region have ranged from small (1.5kW) to large (20MW). The amount of land needed for a facility depends entirely on the scale. It takes roughly 9 acres for 1MW of solar generation.*

Wind

Wind energy generation has several advantages over solar. Wind turbines have a more significant amount of "up-time" in terms of generated energy because they have the potential to operate 24 hours a day. Additionally, they are able to produce energy during the winter, when sunlight is less available for solar production. But, because of the need for constant wind speed, commercial scale wind energy generation facilities generally require areas with elevated topography (where wind speeds are generally higher). Only 20% of the TRORC region has topography that can offer potential for wind speeds that make commercial-scale wind energy generation+ cost-effective. On average, out of the 30 towns in the TRORC region, only about 16% of the land in each community is elevated enough to offer significant potential for commercial-scale wind. There are potential large wind areas that may be suited for industrial scale power generation in Brookfield, Stockbridge, Tunbridge, Chelsea, Topsham, and Vershire based on a limited analysis that included wind potential, lack of natural resource constraints and access to phase 3 lines. This analysis doesn't take into account the considerable impacts on landowners. These site- specific issues may rule out many of these areas but towns should consider the significant property tax relief that a large project could provide to its residents as well as the important contribution the project is making to the New England renewable energy market. Towns also may benefit from infrastructure upgrades to their road system and electrical grid to build the project. It is

** Based on analysis of existing and proposed facilities in the TRORC region. CEP estimates the amount of acres per MW at 7.*

+ Digitally modeled wind speed (based on topography) analyzed at 3 hub heights.

possible to generate energy in areas with lower wind speed. These are more practical on the residential scale, rather than commercial scale.

While the benefits of wind power are substantial, the location of utility scaled wind energy turbines and associated facilities can adversely interfere with scenic, natural and historic resources. Past versions of the TRORC Regional Plan have focused primarily on the aesthetic impact of these facilities, but it is fair to say that in order to encourage the development of renewable energy, we must accept a reasonable amount of impact to the scenic quality of the region. Our primary concern with these facilities is the impact on our region's natural environment. Because much of the area where even small utility-scale wind systems would be built is currently undeveloped, careful consideration to the impact on natural and wildlife communities must be taken into consideration. Wind generation facilities need to be carefully sited so they don't destroy or significantly imperil necessary wildlife habitat blocks, migratory bird patterns, or wildlife corridors. Wind turbines, associated power lines, access roads, and other components of a generating system have been known to disrupt the physical and ecological relationships of habitats. Approvals or permits for this use should not be awarded unless evidence clearly establishes that habitats will not experience an undue adverse impact.

As with solar, not all land that has the potential to generate wind energy is appropriate for that use. The areas suitable for wind development can be challenging to access and difficult to permit, making them less profitable for the developer.

Anaerobic Digester, Vermont Technical College

Town	Name	Primary Use of Facility
Randolph	Vermont Tech Community Anaerobic Digester	Anaerobic Digester
Newbury	Blue Mountain Union School	Heat
Hartford	Hartford High School	Heat
Randolph	Randolph Union High School	Heat
Topsham	Limlaw Chipping	Heat
Vershire	Mountain School of Milton Academy	Heat
Hartford	White River Junction VA Medical Center	Heat
Sharon	Sharon Elementary	Heat

Table 2: Biomass Facilities in the TRORC Region, 2015

Commercial scale wind may be less desirable than solar, due to the reasons mentioned above.

Hydro

Hydroelectric energy generation has the highest capacity factor of renewable sources. Hydro is one of the lowest-priced, steady power producers available to the TRORC region. There are currently twelve hydroelectric facilities in operation in the TRORC region, which account for 51,840 kW of existing capacity.

There are two main forms of hydropower: run-of-river which uses the natural flow of water to generate power, and facilities that store water behind an impoundment. Run-of-river systems rely on seasonal rainfall and runoff to produce power, resulting in periods of low production. Impounding water behind a dam allows for control of the water flow, resulting in consistent electric production.

Recognizing that the development of new, commercial-scale hydroelectric facilities is unlikely, gains in hydroelectric energy generation will be made by upgrading and improving existing infrastructure including dams that are not currently outfitted for hydro. There are 35 existing dams in the TRORC Region that have the potential to generate hydroelectric power.[32]* However, these facilities only have the estimated capacity of 2,700 kW. It is hoped that through advanced operational controls, more efficient equipment and/or conservation flow turbines, additional energy can be generated at existing facilities within our region.

Hydroelectric development necessitates balancing priorities. While the benefits of generating electricity from local renewable resources are evident, they are not without associated costs. The power output from a hydroelectric facility on a given stream must be moderated by environmental considerations. A minimum stream flow that is adequate to support aquatic life forms, needs to be maintained and impoundments need to be designed with water quality, land use, and recreation considerations in mind.

BIOMASS DEFINED

Biomass, in its simplest form, is defined as organic matter renewable over time. Woody biomass is the accumulated mass, above and below ground, of the roots, wood, bark, needles, and leaves of living and dead woody shrubs and trees.

Biomass also includes manure and herbaceous crops such as switchgrass, miscanthus and reed canarygrass.

Biomass

Biomass generally consists of woody and non-woody solid biomass, and is most commonly used in heating, although it can be used to produce electricity and transportation fuel as well. An estimated 37% of Vermont households heat at least in part with firewood or wood pellets.[41] Larger facilities use wood chips or pellets for heating as well, including schools and institutional facilities. The TRORC Region is home to only one biomass related electricity generator, the Vermont Technical College Community Anaerobic Digester. Using manure and food wastes, the facility harnesses biogasses through anaerobic digestion to fuel a generator that generates power. The system has a capacity of 375 kW of electrical generation, and excess heat is used to supplement the college's heating system. In addition to VTC's digester, six other facilities use large-scale biomass for heating. In addition to heating their own facilities, Limlaw Chipping in Topsham, produces wood chips used for heating of several significant entities including the National Life building, where a number of state offices are located, and Norwich University.

Vermont, with 78% of the state forested, has the potential to increase the use of this renewable resource, and consequently

** Data used includes existing dams with low-to high hazard risk. Existing structures identified as having "significant hazard potential" were not included.*

reduce its dependency on fossil fuels and mitigate climate change.[33] In the TRORC Region, there are 685,000 acres of forestland (84% of our region), which annually produce roughly 91,000 green tons[34] of Net Available Low-grade Growth (NALG) wood—wood that would be appropriate for use as biomass fuel above and beyond current levels of harvesting.

Proper forest management is essential to sustainable woody biomass production. Much of the land enrolled in the Current Use Value Appraisal (UVA) program in the TRORC Region is forested, and as such a forest management plan is required. Most forest management plans are designed to encourage the growth of higher quality wood which will yield a higher harvested value for the landowner. As a result, the bulk of what loggers harvest out of these areas is lower quality wood. 75- 80% of the volume of harvested wood by loggers is typically low grade fiber (pulp, firewood or whole tree chips).

While in many instances, the thicker trunks of the trees not suitable for sawing into boards can be chipped and used for boiler fuel, whole-tree chips that include the tops and branches of the trees are utilized primarily in electricity generation plants such as the power stations in Ryegate and Burlington. The challenge is that these two facilities, the only biomass electricity generation plants in Vermont, cannot utilize all of the low-quality product harvested out of our forests.

Attempts to develop new biomass energy generation facilities have taken place in the TRORC region, the most recent of which was considered in Randolph. However, due to significant local resistance to these facilities, none have been built. The efficiency of large-scale biomass electricity generation facilities remains a barrier as well. A highly efficient gasification biomass system emits roughly 60% of its potential as thermal energy, generating only 40% as electricity. Siting these projects in areas that can receive truck traffic without interfering with residential neighborhoods and also in proximity to large consumers of thermal energy is ideal.

With the closing of pulpwood and biomass consuming facilities in Maine, (a loss of nearly 30-40 % of the market for low grade timber in the northeast), the local market for low-grade wood has been significantly impacted. By supporting and encouraging the development of sustainable biomass systems in the region, TRORC can add another component of energy production in the Region and support the sustainable forestry economy.

Other types of biomass, such as perennial grasses, are now being used nationally as a solid fuel in some power plants as well as targeted as a choice feedstock for such advanced biofuels as cellulosic ethanol. Grass-based biomass can also be pressed into pellets, briquettes, and cubes and used as a heating fuel to replace or complement fuels made from wood fibers. Including a thermal component in the use of solid biomass for energy increases a combustion system's efficiency more than threefold.[35] However, in Vermont, woody biomass remains the most immediately viable and largest potential source of biomass.

There are no specific targets for additional biomass production in the pathway developed with the LEAP model and so in the tables and charts this energy source is likely underestimated. Biomass was left out in part due to a need to further investigate how its production for energy and heating would interact with Vermont's strong policy of forest protection. It is also because investigations into the sustainable production of grass-based biomass are in their early phases. Initial studies indicate that it is possible for Vermont to produce grass-based biomass for energy generation only at a small scale in part due to the lack of available farmland.

Despite the lack of specific targets for the development of biomass, this Plan recognizes that utilization of woody biomass, particularly for heating, will need to be a significant part of the pathway to achieving the state's energy goals.

Certificate of Public Good (CPG)

Any new renewable electrical energy generation facility that is connected to the grid, must apply for a certificate of public good (CPG, also known as Section 248 Permit). As part of this process, the Public Service Board must find that:

- The Project must 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.
- The Project must meet a need for present and future demand for services. The Project will not have an adverse impact on system stability and reliability.
- The Project will not have an undue adverse impact on aesthetics, historic sites, air and water purity, the natural environment, the use of natural resources, and public health and safety, with due consideration having been given to the criteria specified in 10 V.S.A. §14724a(d) and 6086(a)(1) through (8) and (9)(K) and greenhouse impacts.

State agencies, municipalities and the regional planning commissions are considered parties by right, in a Section 248 proceeding. Although the CPG process includes elements of review that are similar to Act 250, it is a very different process. Any facility that applies for a CPG is exempt from consideration under a municipality's zoning regulations. However with the ratification of Act 174 in 2016, Regional Commissions and communities that are granted a determination of energy compliance for enhanced energy planning will have their respective municipal plans receive " substantial deference" instead of mere"due consideration" in the CPG process

For many communities, the process of intervening in a CPG can be expensive, difficult and time consuming.[36] The highly technical and legal nature of the CPG process can make it challenging for municipal officials to understand how to actively and effectively participate in the process. In the case of smaller solar energy generation facilities (<15kW) which are subject to an expedited CPG process, municipalities have no voice at all.

Improve Regional and Municipal Energy Planning for Renewable Energy

As long as the goals of the CEP remain a part of state policy and if Regional Planning Commissions and municipalities wish to play a part in achieving those goals, TRORC and municipalities should take an active role in energy planning. By utilizing available energy data produced by the Regional Commission and other organizations, municipalities can identify where renewable energy generation facilities are preferred, and at what scale is most appropriate for reaching the goals of the CEP. In addition, Towns can provide specific standards that will help protect significant natural or scenic areas in accordance with the vision of the community.

Continue to Support Legislative Changes that Reward good planning

In the 2015 Solar Siting Task Force report, the Task Force indicated that it "seeks to strengthen the contribution that town and regional planning will make to the siting of solar generation contemplated in the state's Comprehensive Energy Plan. Accomplishing this requires both effective regional and local planning for solar generation and the effective consideration of the guidance such planning offers in the Section 248 regulatory process..." Recognizing that this goal should apply to all forms of renewable energy, Act 174 gives communities who take the time to consider their role in reaching the goals of the CEP more significant consideration under the Section 248 process. Good energy planning should continue to be recognized as requiring some level of GIS energy data analysis, the identification of areas where renewable energy generation is appropriate and the inclusion of language which provides clear, written standards for review under Section 248.

Vermont State House Montpelier, VT- Photo Credit: Wangkun Jia

Goals, Strategies and Actions: **Renewable Energy Generation**

Goal A: Meet 25% of remaining energy need from renewables by 2025, 40% by 2035 and 90% by 2050. Meet end use sector goal of 67% renewable electric by 2025.

Strategy A.1: Support the continued development of renewable energy generation that counts toward the goals of the CEP

Actions:

1. TRORC will encourage communities and residents to identify areas with the potential for renewable energy generation.
2. TRORC will provide education and outreach to municipalities on energy generation.
3. TRORC will develop easy to understand materials about the state's energy goals and how they interact with local and regional planning.

Goal B: Increase the amount of renewable energy generated in the TRORC region to 163 MW by 2050

Strategy B.1: Facilitate new generation projects through state incentives, better mapping, and clearer local and regional policies.

Actions:

1. TRORC should work with DPS to develop a Renewable Energy Siting guide and maps and work with communities to identify areas where renewable energy generation is appropriate and preferred.
2. TRORC should support and encourage state efforts to provide stable and predictable renewable energy policy incentives including net metering and standard offer.
3. TRORC should advocate for a stronger regional role in the PSB permitting process.
4. TRORC should continue to support efforts at the legislative level to strengthen the capacity of regional planning commissions and municipalities to plan for renewable energy generation and provide that information to the PSB and DPS in a manner that will be meaningful in the §248 CPG process.

RENEWABLE ENERGY PLANNING AT THE MUNICIPAL LEVEL

6

A. Regional Impacts of Energy Generation

Regional electrical generation has positive potential to our communities, through the generation of jobs as well as adding to the tax base. While larger-scale commercial facilities will generate more energy than residential, and would have a more substantial impact on the economy, they would likewise have more potential negative impacts.

Facilities like combined-cycle gas combustion turbines that are used for district electrification and heating are more appropriate than other fossil fuel-driven facilities. These systems could offset otherwise needed transmission infrastructure upgrades, reduce reliance on fossil fuels for heating, and provide moderately priced energy to parts of Vermont. While there are potential opportunities for gas-powered generation facilities, TRORC believes that in order to reduce our reliance on fossil fuels (a primary goal of the CEP), we must focus on energy generation that is sustainable.

It is the preference of this Plan that new energy generation facilities that are proposed within the TRO Region be based on renewable resources. We believe that there are opportunities for generation through wind, solar, hydro and biomass, each of which has its own unique impact and potential.

The development of new renewable energy generation facilities in the TRORC is a necessary component of reaching the state's energy targets. However, in order to protect our natural, scenic and historic resources while encouraging renewable energy development, a regional inventory of areas for renewable energy generation and their constraints has been developed.

This guide is intended to provide communities with the background, data and suggested approaches needed to effectively address the impacts of renewable energy generation facilities while working toward the goals of the Vermont Comprehensive Energy Plan.

B. How to Effectively Plan for Renewable Energy Generation Facilities

Consider CEP Generation Targets

The process should begin with an understanding of how your community can work toward the goals of the CEP. Through modeling and data analysis, TRORC has developed renewable energy capacity targets for each town that can be used to reach the goals of the CEP (Appendix C). Communities should review this information as a starting point to determine how much renewable energy generation should occur in their community to achieve the 90/50 goal.

It is important to understand that these targets are not exact. The LEAP model is based primarily on demand. If population grows more than anticipated, the targets will increase. The recommended approach is to utilize a target range for your community.

Barriers to Good Planning

Energy planning needs to be improved at the regional and municipal level. Prior regional and local energy planning has mainly been aspirational and not based on generation targets or on detailed mapping

Land use planning in Vermont is optional for municipalities unless a community wants to adopt zoning or subdivision regulations.[37] Even for those communities that do have a plan, it is not required that their plan be consistent with the state's planning goals (Section 4302). While communities that have a plan must address energy, and must have policies that support renewable energy generation, there is no requirement that there be an in depth analysis of potential locations for new facilities.

Many communities have grown resistant to the development of commercial-scale renewable energy generation facilities because they feel that these facilities break with the distinct rural character of their communities or negatively impact natural resources. While renewable energy is by and large supported by Vermonters,* the "not in my back yard" phenomenon is not uncommon when a facility is proposed.

Important Considerations

Before a community begins to plan for renewable energy generation facilities, it is essential to recognize several things:

- **Consider "Enhanced Energy Planning:"+ –** Act 174 establishes rules that provide communities with the opportunity to have their plans receive greater consideration (referred to as "substantial deference") in the CPG process. Through the standards set by the Department of Public Service, the Regional Commission is authorized to review municipal plans (when requested) to determine if the state's "Enhanced Energy Planning" standards are met.
- **Completely prohibiting renewable energy generation facilities from your community is not "in the public good."** –The primary purpose of the CPG process is to determine whether a proposed renewable energy generation facility successfully meets the criteria required to determine that it is "in the public good." Over the past several years, statute has been revised to give communities a more significant voice in this process. But, in the case of a Municipal Plan that attempts to outright prohibit (or has the effect of prohibiting) renewable energy generation completely, it will be seen by the Public Service Board running counter to the "public good" concept, as the need for such energy is a state priority.
- **Plans need firm language, and clear, written standards –** General plan language that speaks of protecting vague viewsheds or scenic areas is not useful to the PSB. Protected areas must be clearly identified. Municipal plans are required to include "a statement of policies on the preservation of scenic and historic features and resources." If municipal plans do not include an adequate inventory of these locations, and the town does not wish all or specific parts of these areas to be developed, it will be very important to identify exact locations

**Vermont Public Radio, VPR Poll, 2016 – 70% indicated support for a "large solar array" in their community. 56% indicated support for large wind power turbines in their community.*

+ NOTE: This language reflects standards that will be released in November of 2016.

as part of this plan. In past decisions of the PSB relating to renewable energy generation facilities, it has been made clear that generalizations will not carry weight with the Board. Protected areas must be clearly identified – a Plan cannot say "all roads are scenic," but instead must say something like "The North Road is considered a scenic resource due to its open view of the eastern slope of the Green Mountains." Specificity with regard to what are you are protecting is essential.

Additionally, it will be important to describe why these areas are significant, whether because of the presence of a known endangered species, or because the bulk of the community uses an area for outdoor recreation. Documentation of the resource's importance is necessary to developing a good energy plan.

Communities must use strict language like "shall" and "must" to make it clear that a provision is mandatory, and the provision must apply to all commercial development within a specific area.

- ◇ **Bad Example:** "Commercial solar farms should not be seen in scenic spots."
- ◇ **Good Example:** "All commercial development in the scenic overlay shall be screened so as to minimize visual impact from adjacent public roads."

- **Identify Where Renewable Energy Generation is Preferred** - Indicating good locations for renewable energy generation that are clearly supported by the policies of the Plan is important. Such an approach would clearly be consistent with legislative intent to encourage renewable energy generation.
  By identifying where the locally preferred locations are or developing standards for what constitutes a preferred site and why they are preferred, towns are providing clear guidance to developers and the Public Service Board. Direct public support for preferred locations as outlined in the municipal plan, will be appealing to developers.
- **Communicate with Developers** – Most renewable energy generation developers are interested in working with communities to ensure that their development is well-received.

  Specificity with regard to what you are protecting, why you are protecting it and where it is, is essential.

IMPORTANT THINGS TO CONSIDER WHEN SOLICITING INPUT

Surveys – Written surveys must be crafted so that they are easily understood. Additionally, the method of distribution must be carefully considered so as to have a maximum rate of return.

Online Surveys – Not all residents have access to or are comfortable using the internet. Online surveys should never be the primary method of data collection.

Public Forums – Need to be well organized and well run. Including food as part of the program (particularly for an evening forum) can help increase attendance.

Localized or "Coffee Table" discussion groups – Bringing the conversation to a specific part of your community, particularly one that has a particularized interest in proposed changes can be beneficial.

Targeted presentations – There are many community groups that can provide an excellent audience and valuable input into your process. This could include church groups, local business organizations, etc.

Involve the Public

All good planning processes require public input beyond the public hearings required by statute for Municipal Plans. Engaging the public in discussions about potential changes to the Town Plan early and often is strongly suggested as part of this guide. Communities should consider:

- Outreach: Place regular articles in the town newsletter or local paper of record to give updates on what issues or potential changes to the Plan are being discussed.
- Collect Public Input: The best plans utilize multiple methods to collect public input. Methods include (but are not limited to):
    - ◇ Written or Online surveys
    - ◇ Live surveys
    - ◇ Public forums
    - ◇ Coffee table discussion groups
    - ◇ Targeted presentations

Bradford Planning Meeting - Source: Staff

- Present Proposals: As you work through the process, be sure to keep the public involved. Multiple presentations at varying intervals will keep people informed and allow you to receive valuable input. This may allow you to better refine your energy plan into something that adequately reflects the community's vision while still working toward the goals of the CEP.

Find a Balance

The state's energy goals are written into statute, and it is a requirement of statute that municipalities include policies on renewable energy generation (as well as energy conservation). Ideally, communities will see the positive benefits of working towards the state's energy goals, but it is important to strike a balance between those goals and a community's vision for the future.

Bring it Together

Using map data and guidance from the public, your community can write an energy plan that specifically addresses issues relating to renewable energy generation. It can reflect the vision of your community and provide adequate opportunity for growth of renewable energy generation that will reach the regional and state targets.

COMMERCIAL- SCALE RENEWABLE ENERGY FACILITY SITING GUIDE

7

A. Background

The State of Vermont has spent a number of years analyzing the issues relating to energy siting. In 2012, Governor Shumlin formed the Energy Generation Siting Policy Commission. The Siting Commission was tasked with developing recommendations and guidance on best practices for the siting approval of large-scale renewable energy generation projects (those projects that exceeded the net metering threshold at the time), and for public representation in the siting process. Ultimately, one of the key components of the Siting Commission's final report was an "increased emphasis on planning."[38]

In 2015, in response to the rapid growth of solar development, the legislature created the Solar Siting Task Force. In their report to the legislature in 2016, the Solar Siting Task Force echoed the recommendations of the Siting Commission, acknowledging that "effective planning has the potential to shape the municipal, regional and state energy future."[39] One of the most important parts of such planning is mapping where projects should and shouldn't go.

Utilize Available Map Data

TRORC has generated map data that indicates where raw energy generation potential exists for solar, wind and hydro.* This does not mean that they should go there, only that these are the areas where solar, wind, hydro resources are present. This data should be the **starting point** for the local identification of where renewable energy generation should be located within your community.

Solar Siting

Sites with raw solar potential are flat to gently sloping and face east, south, or west. Significant growth in the solar energy production sector in Vermont has sometimes led to a backlash against proposed facilities. The primary concern is one of aesthetics. For some, it is challenging to reconcile the appearance of a solar farm against the traditional rural character of the region. Residents may also perceive a loss of property value when a solar facility locates near their home, although there is no hard data available to support this perception.

Also of concern are the natural resource implications of solar farms. Often these facilities are proposed in areas that are being used for agricultural purposes on valuable prime agricultural soils. While it is possible to conduct some forms of farming on land occupied by a solar system (such as small ruminant grazing – see Appendix D), most agricultural uses become impractical. For those farmers that lease land for feed production, the removal of actively used farmland from the pool of available land has the potential to negatively impact their operation.

Wind Siting

Only certain ridges are tall, and big enough to have raw wind potential. Wind energy generation, although not as prolific as solar, also has opposition due to aesthetic and noise impacts. Because these facilities must locate on ridgelines in order to maximize production, they are visible from a much greater distance than solar. Additionally, residents who neighbor a

** A map of biomass land cover is included as well, but it is not a representation of potential beyond identifying what could be harvested for biomass energy production.*

wind facility may experience negative effects from the noise and flicker of the spinning turbines.[40]

Large scale wind energy facilities can have environmental impacts as well. Much of the land on our ridges is undeveloped, making it prime wildlife habitat. The installation of wind energy generation facilities and the infrastructure needed to maintain them (roads), leads to the fragmentation of continuous blocks of forestland, which can disrupt migration patterns for wildlife.

Hydro Siting

Not surprisingly, sites with hydro potential are along rivers with steep drops. As discussed earlier in this section, LEAP modeling suggests that additional hydro capacity can be achieved by retrofitting existing dams.

The development of new hydroelectric projects is challenging. New hydro projects must seek permitting from the Federal government, which is time consuming and expensive. Any development in our waterways requires a strict analysis of potential environmental impacts.

Hierarchy of Suitability

All of the lands within the region have been analyzed on a rough scale using map data supplied by DPS to rank them in terms of "raw potential"; areas that are unsuitable because of high value resources; areas with constraints; areas with no known or possible constraints (prime area); or being in a state "preferred area". The maps in Appendix B were made by first identifying areas that have raw potential for certain types of power production based upon certain qualities of the landscape. For example only certain ridgelines are believed to have enough wind resource to justify building a wind turbine. As mentioned earlier only lands with good exposure and gentle slopes make sense for solar development. (It should be noted that the maps do not take into account whether lands are clear or forested). Preferred locations come in two forms- state preferred areas that are defined as such in 30 V.S.A. § 8005a (Act 174), and specified locations identified by the town.

Raw Generation Potential Locations

This area is shown on the solar and wind maps and includes solar generation potential based on solar radiation, slope and direction as well wind generation potential based on topography. Solar potential does not distinguished between open or forested areas.

Unsuitable (Prohibited Locations)

The Regional Plan identifies some areas as poor locations for most forms of development due to their natural or scenic value, and to protect our citizens from potential natural disasters. These areas have already been removed and are not shown in the constraint or prime areas on the maps. The following locations shall be considered regionally unsuitable for renewable energy generation facilities:

- Floodways shown on FEMA Flood Insurance Rate Maps (except as required for hydro facilities)
- Class 1 Wetlands as indicated on Vermont State Wetlands Inventory maps or identified through site analysis
- Wilderness Areas, including National Wilderness Areas

- Unsuitable Areas as identified in a duly adopted Municipal Plan that has received a determination of energy compliance from the Department of Public Service or the Regional Planning Commission

Constraints

There are many areas that have the potential for renewable energy generation, but include known or possible constraints that may make these locations less desirable on a site-by-site basis. These areas are neither preferred nor unsuitable. Development in these areas will require more detailed mapping at the site level as well as an evaluation of the impacts on the particular resources present. State supplied map data used in this Plan has "known" constraint areas removed and therefore these do not show on the maps under constraints. From a policy level this Plan makes no distinction between known or possible and simply combines both as constraints. Constraints include:

- Historic districts, landmarks, sites and structures listed, or eligible for listing, on state or national historic registers
- State or federally designated scenic byways, and municipally designated scenic roads and viewsheds
- Special flood hazard areas identified by National Flood Insurance Program maps (except as required for hydro facilities)
- Public and private drinking water supplies, including mapped source protection areas
- Primary agricultural soils mapped by the U.S. Natural Resources Conservation Service
- Agricultural Soils (VT Agriculturally Important Soil Units)
- Protected Lands (Updated 07/26/2016 – State Fee Lands and Private Conservation Lands)
- Deer Wintering Areas (as Identified by ANR)
- Act 250 Agricultural Soil Mitigation areas (as Identified by ANR)
- ANR's Vermont Conservation Design Highest Priority Forest Block Datasets
- Priority Forest Blocks – Connectivity, Interior and Physical Land Division (as Identified by ANR)
- Hydric Soils (as Identified by ANR)
- River Corridor Areas as identified by the Vermont Department of Environmental Conservation
- Class 2 Wetlands as indicated on Vermont State Wetlands Inventory maps or identified through site analysis
- Vernal Pools (as Identified by ANR

or through site analysis)

- State-significant Natural Communities and Rare, Threatened, and Endangered Species

Prime Areas

Recognizing that there may be other areas that are also well-suited to the development of renewable energy generation, the following criteria should be applied to proposals that are not in areas indicated above. These areas are shown on the maps under prime. If a proposed development is not on the list above, but meets ALL of the criteria below, it shall be considered a prime area for the purposes of this Plan:

- Must not be identified as an Unsuitable Area
- Must not be identified as a Constraint Area
- Must be located in an area that has reliable and safe access to the grid (as determined by the local power provider)

Preferred Areas

While the development of any type of renewable energy generation facility is subject to review on a site by site basis, some areas are better suited than others. Act 174 specifically identifies state preferred areas. These areas are typically small and are not shown on the maps. They are:

- A parking lot canopy over a paved parking lot, provided that the location remains in use as a parking lot and is not located in an area identified as unsuitable by this Plan or the Municipal Plan of the municipality in which the development is proposed.
- A new or existing structure that is not located in an area identified as unsuitable by this Plan or the Municipal Plan of the municipality in which the development is proposed.
- Land certified by the Secretary of Natural Resources to be a brownfield site as defined under 10 V.S.A. § 6642, provided that the location is not in an area identified as unsuitable by this Plan or the Municipal Plan of the municipality in which the development is proposed.
- A sanitary landfill as defined in 10 V.S.A. § 6602, provided that the Secretary of Natural Resources certifies that the land constitutes such a landfill and is suitable for the

Concept Design of Parking Lot Solar Canopy- Photo Credit: SunCommon development of the plant.

- The disturbed portion of a gravel pit, quarry, or similar site for the extraction of a mineral resource, provided that all activities pertaining to site reclamation required by applicable law or permit condition are satisfied prior to the installation of the plant.
- A specific location designated in a duly adopted municipal plan under 24 V.S.A. chapter 117 for the siting of a renewable energy plant or specific type or size of renewable energy plant, provided that the plant meets any siting criteria recommended in the plan for the location, provided that it is not located in an area identified as unsuitable by this Plan.
- A site listed on the National Priorities List (NPL) that has received confirmation from the U.S. Environmental Protection Agency or the Vermont Agency of Natural Resources (ANR), and is not located in an area identified as unsuitable by this Plan or the Municipal Plan of the municipality in which the development is proposed.
- A new hydroelectric generation facility at a dam in existence as of January 1, 2016, or a hydroelectric generation facility that was in existence but not in service for a period of at least 10 years prior to January 1, 2016 and that will be redeveloped for electric generation, if the facility has received approval or a grant of exemption from the U.S. Federal Energy Regulatory Commission.
- A tract previously developed for a use other than siting a plant on which a structure or impervious surface was lawfully in existence and use prior to July 1 of the year preceding the CPG application.

The maps included as part of this guide were developed at the regional scale. As such, they do not include preferred locations. Communities should use their local knowledge to identify additional preferred areas. They can include preferred locations as legislated in Act 174:

> Other considerations when identifying preferred areas within communities include existing infrastructure. For example, an area with immediate access to three-phase power or an upland area with existing road access may be more desirable than an area without.

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38. Energy Generation Siting Policy Commission, Siting Electric Generation in Vermont: Analysis and Recommendations, April 2013
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Two Rivers-Ottauquechee Regional Energy Modeling

A Pathway to Reaching Vermont's Energy Goals

Appendix A: Outputs and Methodology

February 2017

Contents

A. Introduction

This document supplements the regional energy plans created by each Regional Planning Commission (RPC). It was developed by Vermont Energy Investment Corporation (VEIC) as documentation to modeling work performed for the RPCs. An award from the Department of Energy's SunShot Solar Market Pathways program funded the creation of a detailed statewide total energy supply and demand model. The VEIC team used the statewide energy model as a foundation for the region-specific modeling efforts. More detailed methodology is included at the end of this report.

B. Statewide Approach

Historic information was primarily drawn from the Public Service Department's Utility Facts 2013[1] and EIA data. Projections came from the Total Energy Study (TES)[2], the utilities' Committed Supply[3], and stakeholder input.

Demand Drivers

Each sector has a unit that is used to measure activity in the sector. That unit is the "demand driver" because in the model it is multiplied by the energy intensity of the activity to calculate energy demand.

The population change for each region is calculated from town data in *Vermont Population Projections 2010-2030*.[4] Growth rates are assumed constant through 2050.

RPC	Annual Growth
Addison	0.00%
Bennington	0.02%
Central VT	0.12%
Chittenden	0.48%
Lamoille	1.46%
Northwest	0.87%
NVDA	0.21%
Rutland	-0.27%
Southern Windsor	0.24%
Two Rivers	**0.29%**
Windham	0.34%

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.

[1] Vermont Public Service Department, *Utility Facts 2013*, http://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Utility_Facts/Utility%20Facts%202013.pdf

[2] Vermont Public Service Department, *Total Energy Study: Final Report on a Total Energy Approach to Meeting the State's Greenhouse Gas and Renewable Energy Goals.* December 8, 2014. http://publicservice.vermont.gov/sites/psd/files/Pubs_Plans_Reports/TES/TES%20FINAL%20Report%2020141208.pdf.

[3] Vermont Public Service Department provided the data behind the graph on the bottom half of page E.7 in *Utility Facts 2013.* It is compiled from utility Integrated Resource Plans

[4] Jones, Ken, and Lilly Schwarz, *Vermont Population Projections-2010-2030*, August, 2013. http://dail.vermont.gov/dail-publications/publications-general-reports/vt-population-projections-2010-2030.

Projected change in the **energy demand from the commercial sector** was based on commercial sector data in the TES. The demand driver for the commercial sector is commercial building square feet which grow almost 17% from 2010 to 2050.

The team entered total **industrial consumption** by fuel from the TES directly into the model. It grows from 1.1 TBtu in 2010 to 1.4 TBtu in 2050.

Transportation energy use is based on projections of vehicle miles traveled (VMT). VMT peaked in 2006 and has since declined slightly.[5] Given this, and Vermont's efforts to concentrate development and to support alternatives to single occupant vehicles, VMT per capita is assumed to remain flat at 12,000.

The regional models use two scenarios. The **reference scenario** assumes a continuation of today's energy use patterns, but does not reflect the Vermont's renewable portfolio standard or renewable energy or greenhouse gas emissions goals. The main changes over time in the reference scenario are more fuel efficient cars because of CAFE standards and the expansion of natural gas infrastructure. The **90% x 2050 $_{\text{VEIC}}$ 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.

C. Regionalization Approach

The demand in the statewide model was broken into the state's planning regions. Residential demand was distributed according to housing units using data from the American Community Survey. Commercial and industrial demand was allocated to the regions by service-providing and goods-producing NAICS codes respectively. Fuel use in these sectors was allocated based on existing natural gas infrastructure. In the commercial sector, it was assumed that commercial fuel use per employee has the same average energy intensity across the state. All commercial natural gas use was allocated to the regions currently served by natural gas infrastructure, and the rest of the fuel was allocated to create equal consumption by employee.

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

[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.

distributed among regions without access to natural gas, as it was assumed that other non-electric fuels were primarily used for combustion purposes, and that purpose could likely be served more cheaply with gas. Transportation demand was primarily regionalized through population. The passenger rail sector of transportation demand was regionalized using Amtrak boarding and alighting data to create percentages of rail miles activity by region.[6] The freight rail sector of transportation was regionalized using the following approach: in regions with freight rail infrastructure, activity level was regionalized by share of employees in goods-producing NAICS code sectors. Regions without freight rail infrastructure were determined using a Vermont Rail System map and then assigned an activity level of zero.[7] A weighting factor was applied to regions with freight rail infrastructure to bring the total activity level back up to the calculated statewide total of freight rail short-ton miles in Vermont. Each region's share of state activity and energy use is held constant throughout the analysis period as a simplifying assumption.

D. Results

The numbers below show the results of the scenarios in "final units," sometimes referred to as "site" energy. This is the energy households and businesses see on their bills and pay for. Energy analysis is sometimes done at the "source" level, which accounts for inefficiency in power plants and losses from transmission and distribution power lines. The model accounts for those losses when calculating supply, but all results provided here are on the demand side, so do not show them.

The graphs below show the more efficient 90% x 2050 $_{\text{VEIC}}$ scenario, which is one path to reduce demand enough to make 90% renewable supply possible. This scenario makes use of wood energy, but there is more growth in electric heating and transportation to lower total energy demand. Where the graphs show "Avoided vs. Reference," that is the portion of energy that we do not need to provide because of the efficiency in this scenario compared to the less efficient Reference scenario.

[6] National Association of Railroad Passengers, "Fact Sheet: Amtrak in Vermont," 2016, https://www.narprail.org/site/assets/files/1038/states_2015.pdf.
[7] Streamlined Design, "Green Mountain Railroad Map" (Vermont Rail System, 2014), http://www.vermontrailway.com/maps/regional_map.html.

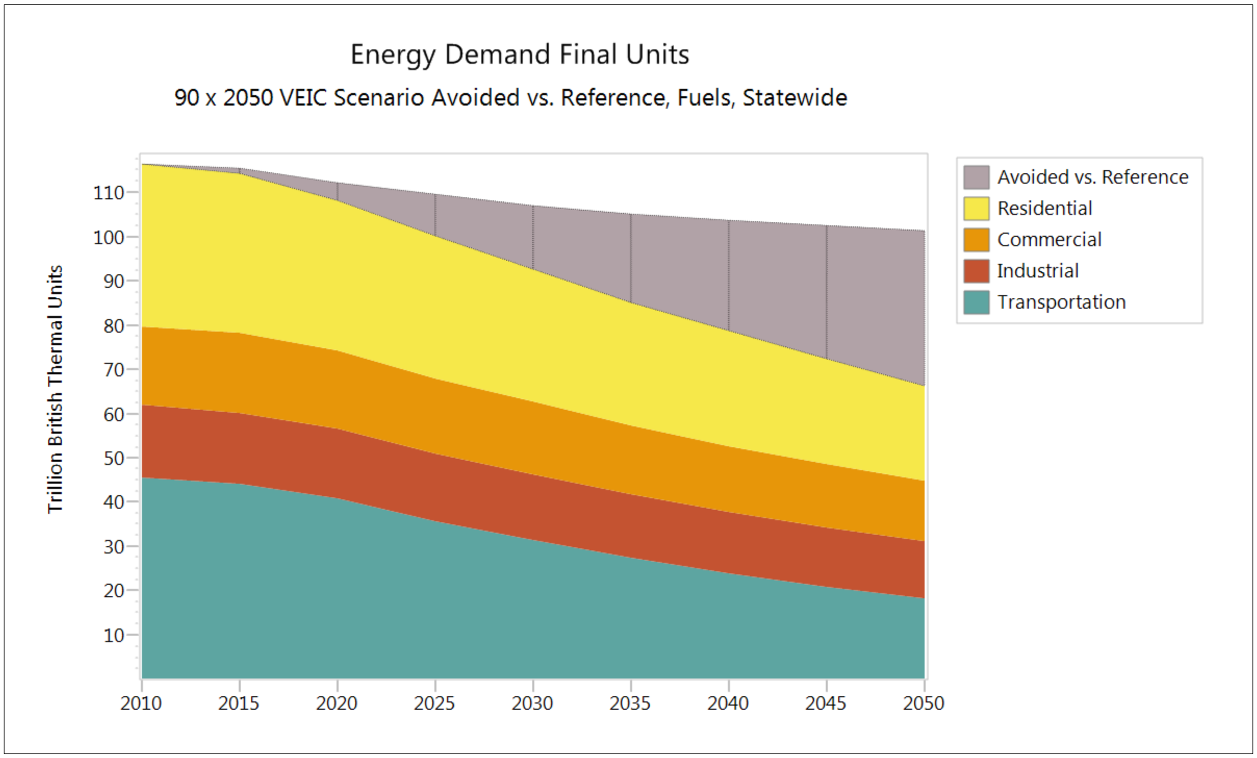

Figure 1 - Statewide energy consumption by sector, 90% x 2050 $_{\text{VEIC}}$ scenario compared to the reference scenario

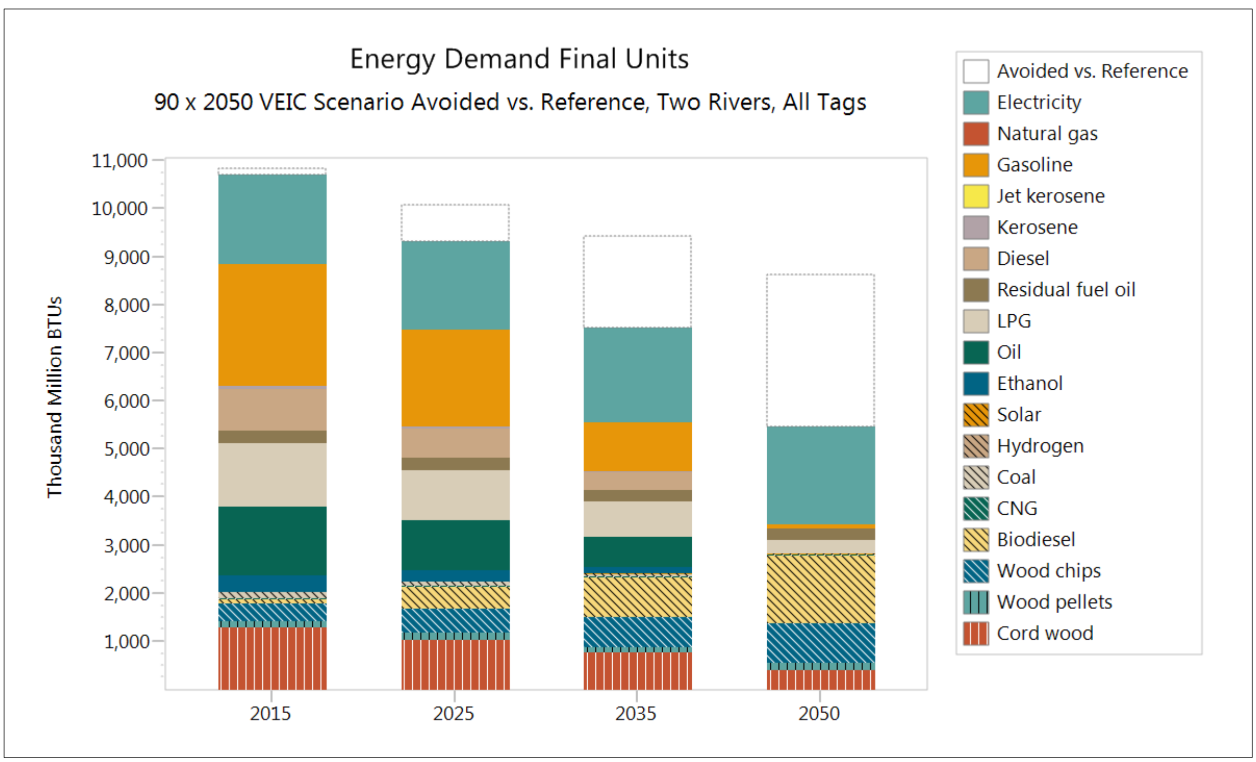

Figure 2: Regional energy consumption by fuel. 90% x 2050 $_{\text{VEIC}}$ scenario compared to the reference scenario

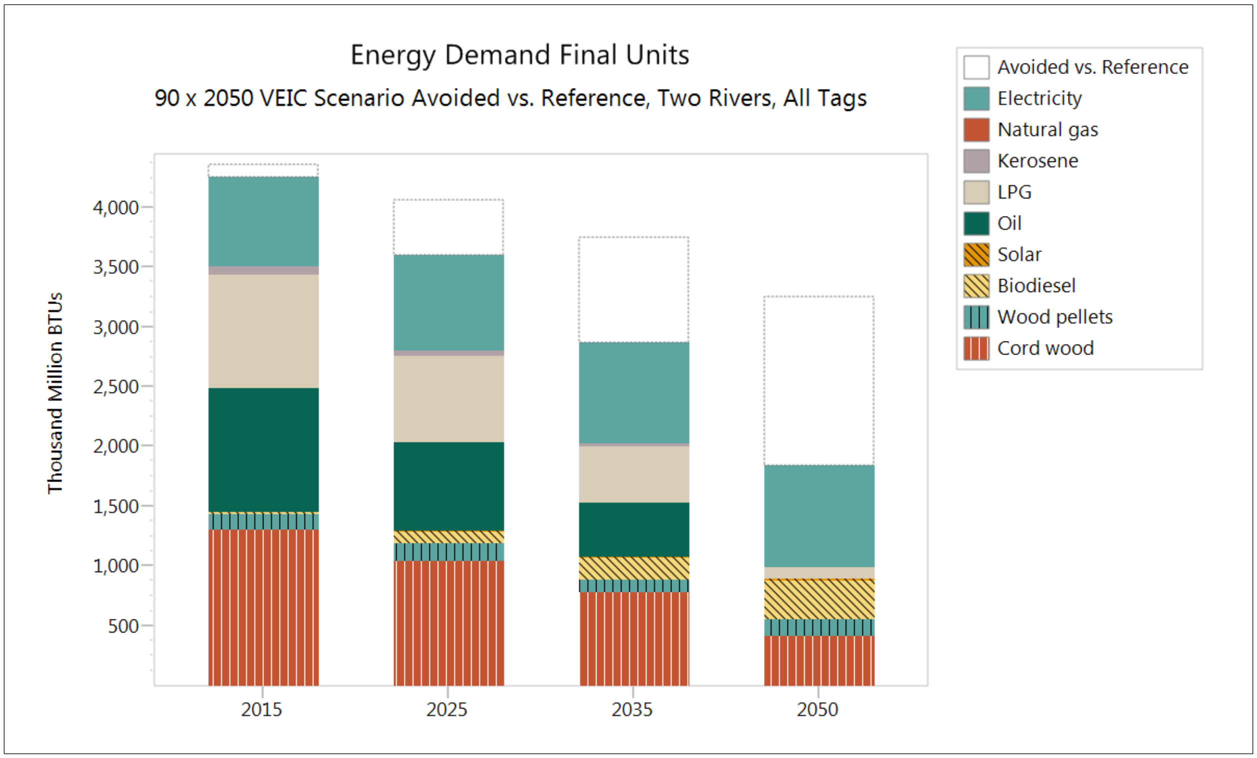

Figure 3: Regional residential energy consumption by fuel, 90% x 2050 $_{\text{VEIC}}$ scenario compared to the reference scenario

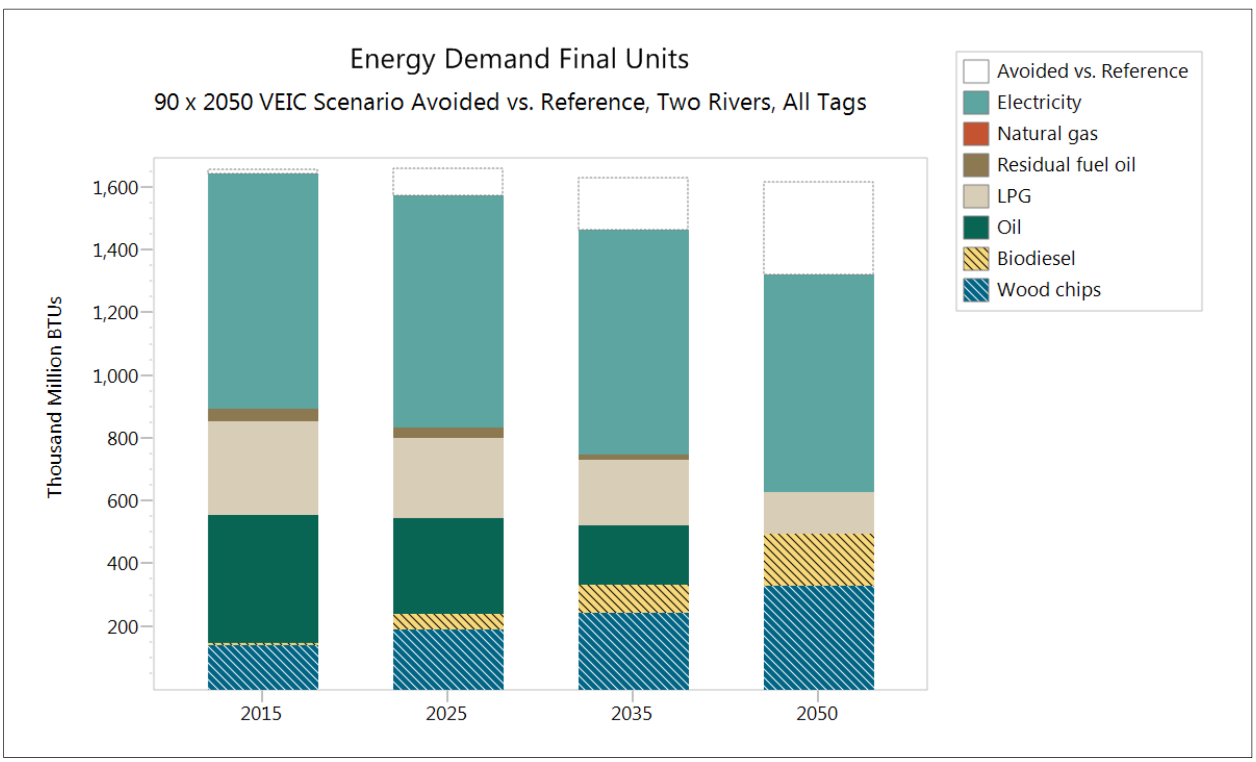

Figure 4: Regional commercial energy consumption by fuel, 90% x 2050 $_{\text{VEIC}}$ scenario compared to the reference scenario

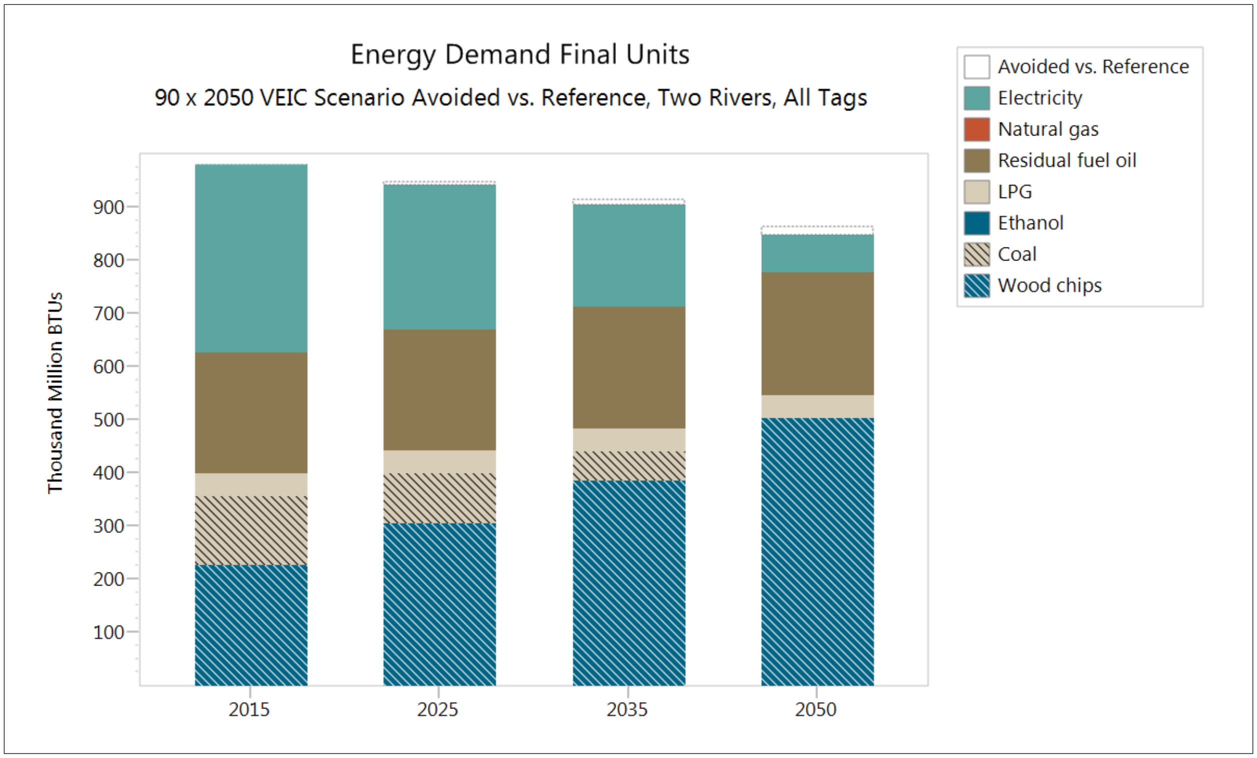

Figure 5: Regional industrial energy consumption by fuel

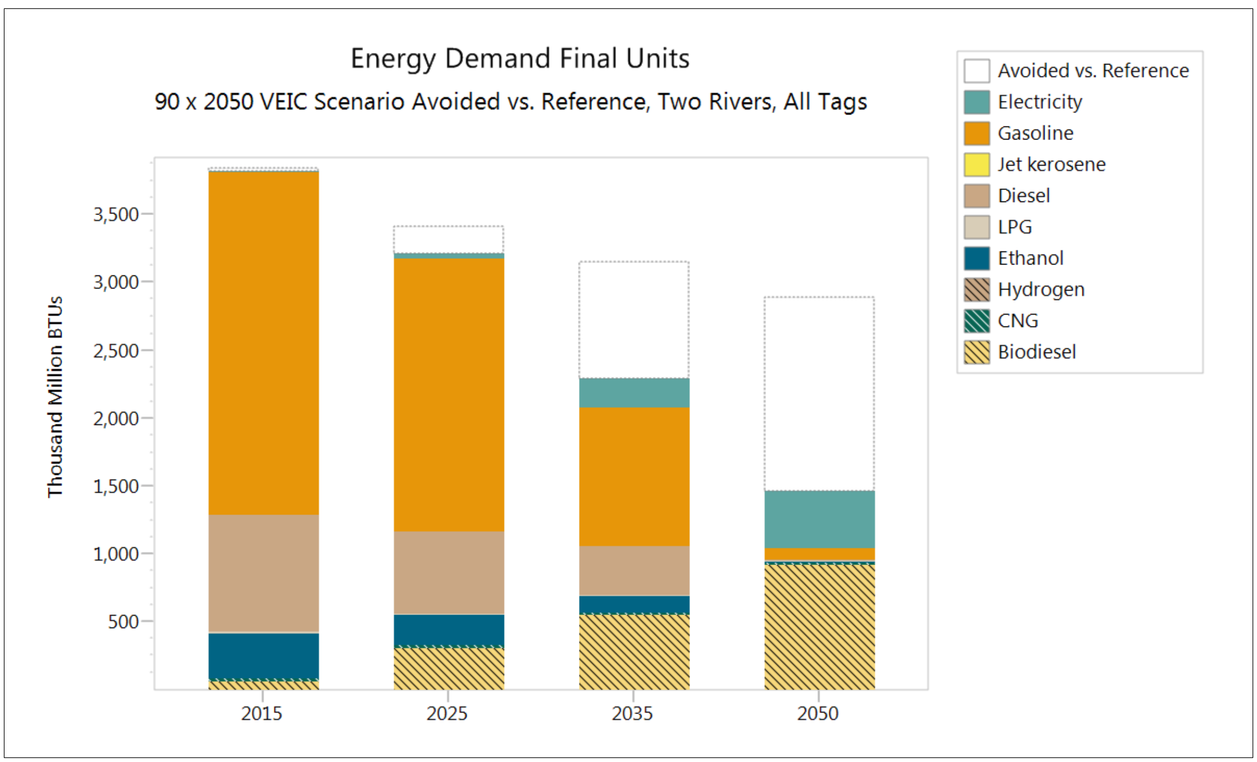

Figure 6: Regional transportation energy consumption by fuel

E. 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

[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.
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[10] Frederick P. Vermont Residential Fuel Assessment: for the 2007-2008 heating season. Vermont Department of Forest, Parks and Recreation. 2011.
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served by the natural gas pipeline. The team also assumed that few multi-family homes rely on cordwood as a primary heating source.

- 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]

[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.

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.

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

[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.

plug-in 40 gasoline hybrid vehicles from the Energy Information Administration Annual Energy Outlook.[16]

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.

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[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.

[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.

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 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

[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.

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 $_{VEIC}$ scenario, consistent with the historical growth rates of rail 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.

[32] National Association of Railroad Passengers, "Fact Sheet: Amtrak in Vermont," 2016, https://www.narprail.org/site/assets/files/1038/states_2015.pdf.

[33] Joseph Barr, AICP et al., "Vermont State Rail Plan: Regional Passenger Rail Forecasts."

Appendix B: Energy Mapping

The Regional Energy Implementation Plan includes four maps which are intended to aid communities in determining the most appropriate areas to locate renewable energy generation facilities in their towns. Utilizing town-level energy targets developed through the LEAP model, communities can further refine their policies relative to renewable energy generation system siting. **These maps are intended for planning use only.**

Making the Maps

Maps for this project were developed using Geographic Information Systems (GIS). Each map utilizes available data to identify the areas where potential renewable energy generation is possible and then modifies those data layers to reflect constraints that may impact that potential. For each of the four focus-types of renewable energy, we analyzed the following:

Solar

Topography of land analyzed based on solar radiation, slope, and direction (azimuth) for ground-mounted solar.

Wind

Digitally modeled wind speed (based on topography) analyzed at three turbine hub heights. (50,70 meter)

Hydro

No new dams considered. Existing dams analyzed for potential capacity based on Community Hydro report.

Biomass

Land coverage used to determine amount of harvestable wood.

Refining the Maps

Once the base maps were developed, we further refined the dataset to exclude areas that, by their nature, cannot or should not be developed and those areas that may include a resource that a community may wish to protect.

Unsuitable Areas – Includes FEMA Floodways, National Wilderness areas, and Class 1 wetlands. These areas are not shown in the constraint or prime areas.

Constraints – Constraints on the maps include some of the areas that may impact the siting of renewable energy generation facilities, but do not necessarily preclude their development. This includes areas such as source protection areas, deer wintering areas, habitat blocks, prime agricultural soils, etc. These areas are identified as locations with potential on the maps, but are colored to identify that they have a possible constraint that might have an impact on development potential. These areas are shown on the maps as constraints. Additional areas with known constraints supplied by DPS are not shown on the map as orange but are not precluded as unsuitable. The EIP text intentionally does not distinguish between known or possible constraints as both areas may be feasible to develop on a case by case basis.

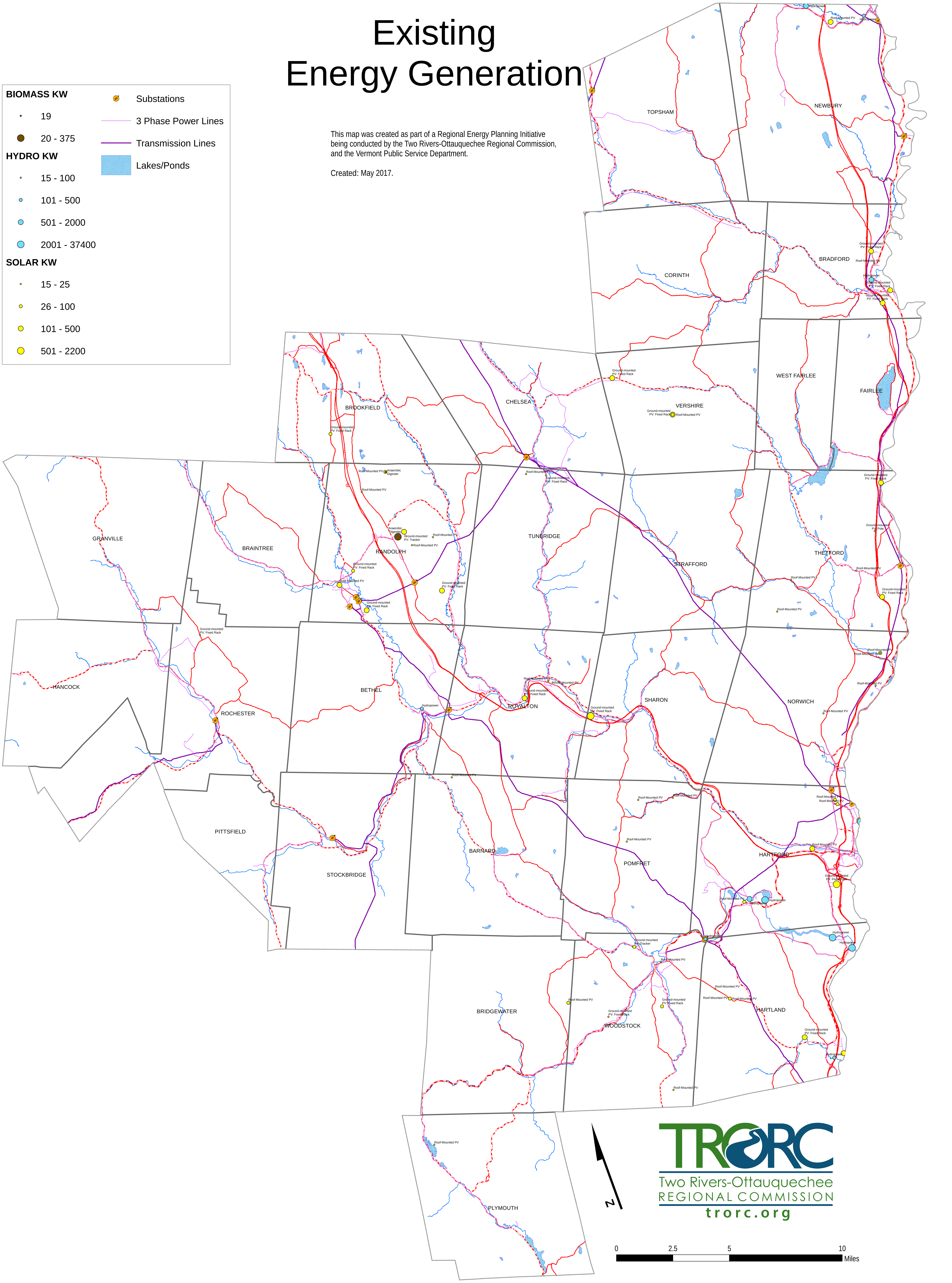
Prime Areas- Include areas that have raw potential and that are not identified in an unsuitable or known constraint area.

Raw Potential Areas- Include initial generation potential areas on the maps that may have unsuitable areas or constraint areas present.

Existing Energy Generation

This map was created as part of a Regional Energy Planning Initiative being conducted by the Two Rivers-Ottauquechee Regional Commission, and the Vermont Public Service Department.

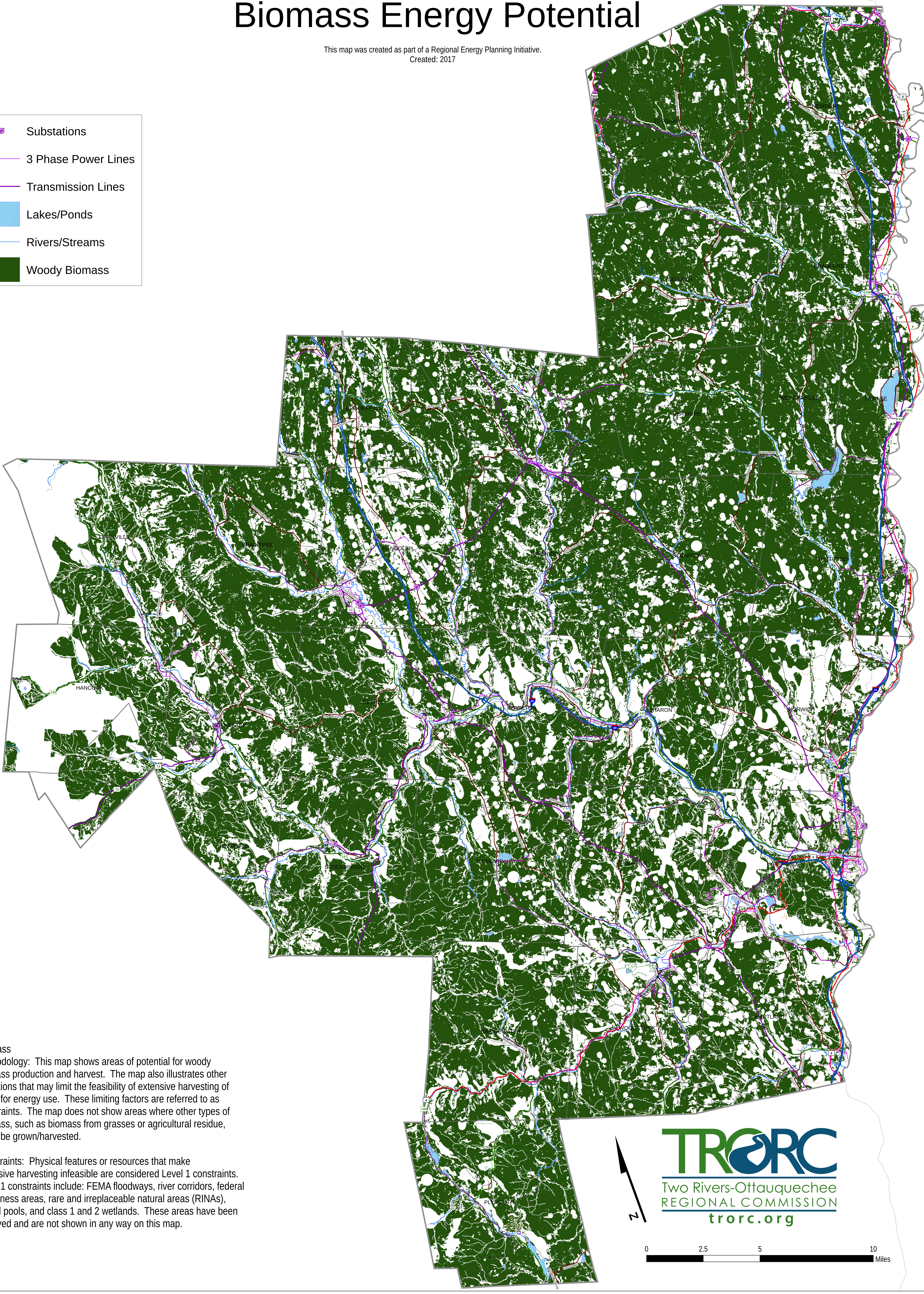
Created: May 2017.



Biomass Energy Potential

This map was created as part of a Regional Energy Planning Initiative.
Created: 2017

- Substations
- 3 Phase Power Lines
- Transmission Lines
- Lakes/Ponds
- Rivers/Streams
- Woody Biomass



Biomass
Methodology: This map shows areas of potential for woody biomass production and harvest. The map also illustrates other conditions that may limit the feasibility of extensive harvesting of wood for energy use. These limiting factors are referred to as constraints. The map does not show areas where other types of biomass, such as biomass from grasses or agricultural residue, could be grown/harvested.

Constraints: Physical features or resources that make extensive harvesting infeasible are considered Level 1 constraints. Level 1 constraints include: FEMA floodways, river corridors, federal wilderness areas, rare and irreplaceable natural areas (RINAs), vernal pools, and class 1 and 2 wetlands. These areas have been removed and are not shown in any way on this map.

N

0 2.5 5 10 Miles

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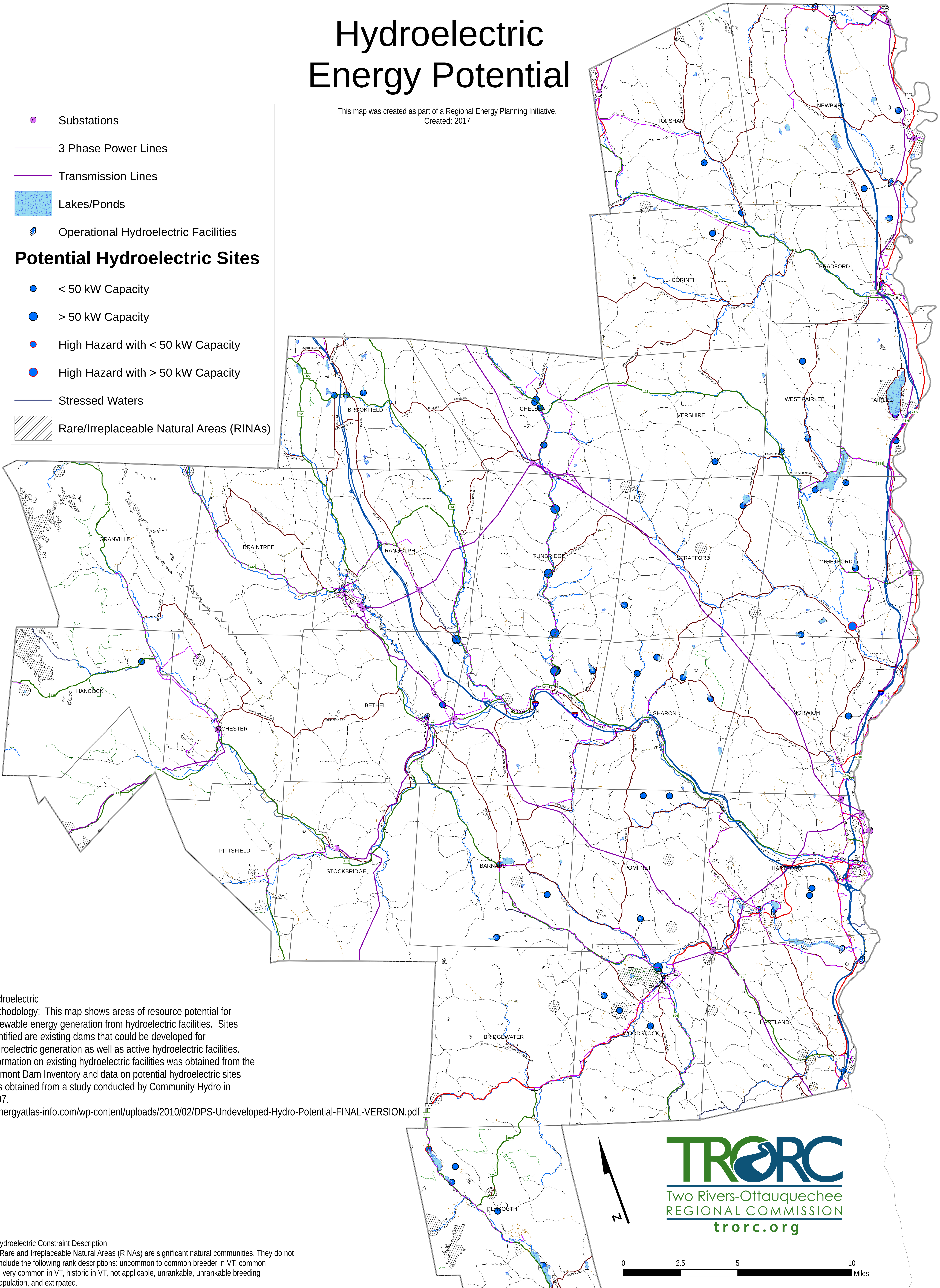
Hydroelectric Energy Potential

This map was created as part of a Regional Energy Planning Initiative.
Created: 2017

- Substations
- 3 Phase Power Lines
- Transmission Lines
- Lakes/Ponds
- Operational Hydroelectric Facilities

Potential Hydroelectric Sites

- < 50 kW Capacity
- > 50 kW Capacity
- High Hazard with < 50 kW Capacity
- High Hazard with > 50 kW Capacity
- Stressed Waters
- Rare/Irreplaceable Natural Areas (RINAs)



Hydroelectric
Methodology: This map shows areas of resource potential for renewable energy generation from hydroelectric facilities. Sites identified are existing dams that could be developed for hydroelectric generation as well as active hydroelectric facilities. Information on existing hydroelectric facilities was obtained from the Vermont Dam Inventory and data on potential hydroelectric sites was obtained from a study conducted by Community Hydro in 2007.
vtenergyatlas-info.com/wp-content/uploads/2010/02/DPS-Undeveloped-Hydro-Potential-FINAL-VERSION.pdf

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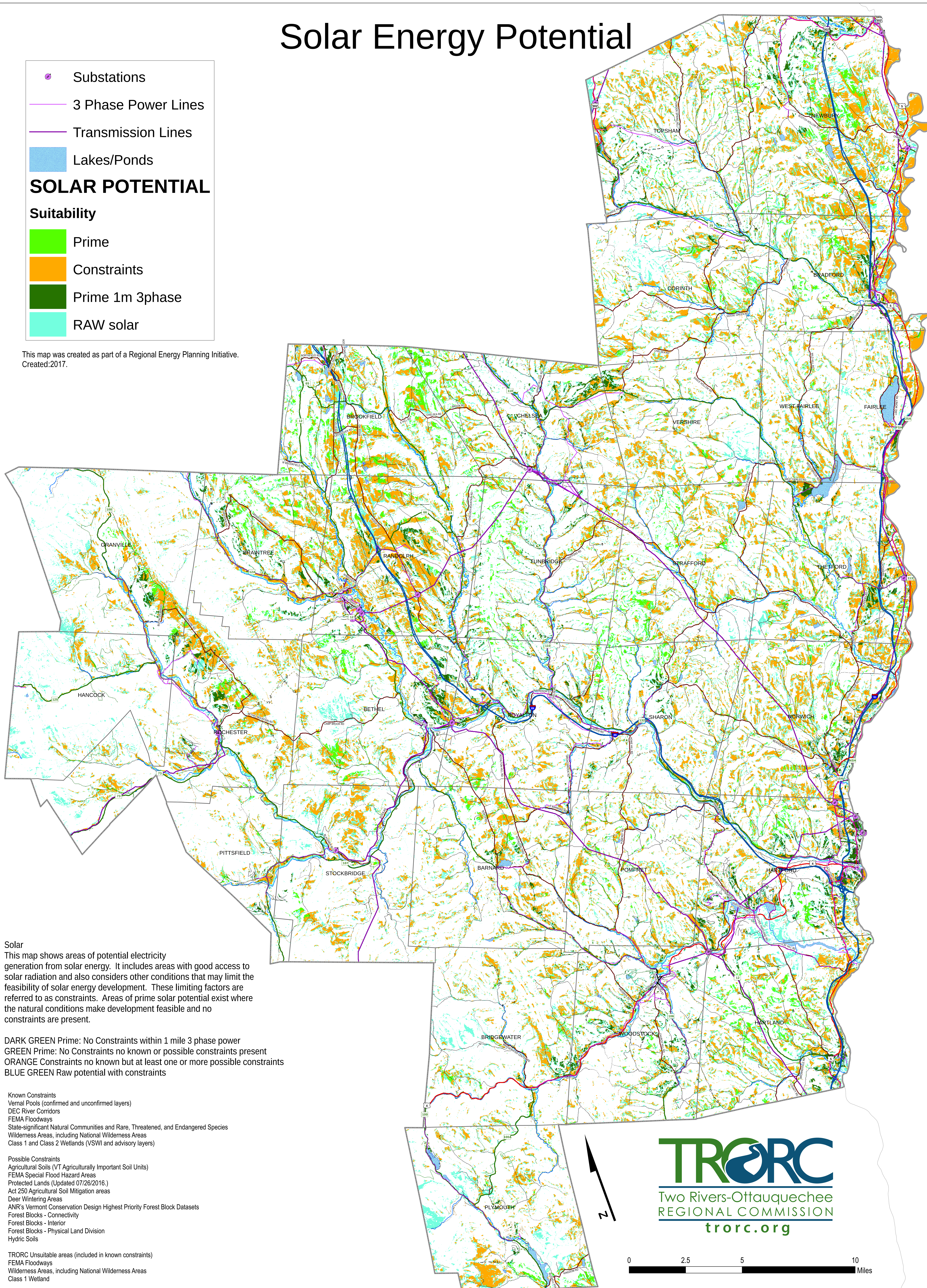
Hydroelectric Constraint Description
* Rare and Irreplaceable Natural Areas (RINAs) are significant natural communities. They do not Include the following rank descriptions: uncommon to common breeder in VT, common to very common in VT, historic in VT, not applicable, unrankable, unrankable breeding population, and extirpated.

Solar Energy Potential



This map was created as part of a Regional Energy Planning Initiative.
Created:2017.

Solar
This map shows areas of potential electricity generation from solar energy. It includes areas with good access to solar radiation and also considers other conditions that may limit the feasibility of solar energy development. These limiting factors are referred to as constraints. Areas of prime solar potential exist where the natural conditions make development feasible and no constraints are present.

DARK GREEN Prime: No Constraints within 1 mile 3 phase power
GREEN Prime: No Constraints no known or possible constraints present
ORANGE Constraints no known but at least one or more possible constraints
BLUE GREEN Raw potential with constraints

Known Constraints
Vernal Pools (confirmed and unconfirmed layers)
DEC River Corridors
FEMA Floodways
State-significant Natural Communities and Rare, Threatened, and Endangered Species
Wilderness Areas, including National Wilderness Areas
Class 1 and Class 2 Wetlands (VSWI and advisory layers)

Possible Constraints
Agricultural Soils (VT Agriculturally Important Soil Units)
FEMA Special Flood Hazard Areas
Protected Lands (Updated 07/26/2016.)
Act 250 Agricultural Soil Mitigation areas
Deer Wintering Areas
ANR's Vermont Conservation Design Highest Priority Forest Block Datasets
Forest Blocks - Connectivity
Forest Blocks - Interior
Forest Blocks - Physical Land Division
Hydric Soils

TRORC Unsuitable areas (included in known constraints)
FEMA Floodways
Wilderness Areas, including National Wilderness Areas
Class 1 Wetland

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Wind Energy Potential

This map was created as part of a Regional Energy Planning Initiative.
Created:2017.

Wind
This map shows areas of potential wind energy development. It includes areas with good access to wind resources and also considers other conditions that may limit the feasibility of wind energy development. These limiting factors are referred to as constraints. Areas of prime wind potential exist where the natural conditions make development feasible and no constraints are present.

DARK GREEN Prime: No Constraints within 1 mile 3 phase power
GREEN Prime: No Constraints no known or possible constraints present
ORANGE Constraints no known but at least one or more possible constraints
BLUE GREEN Raw potential with constraints

Known Constraints
Vernal Pools (confirmed and unconfirmed layers)
DEC River Corridors
FEMA Floodways
State-significant Natural Communities and Rare, Threatened, and Endangered Species
Wilderness Areas, including National Wilderness Areas
Class 1 and Class 2 Wetlands (VSWI and advisory layers)

Possible Constraints
Agricultural Soils (VT Agriculturally Important Soil Units)
FEMA Special Flood Hazard Areas
Protected Lands (Updated 07/26/2016.)
Act 250 Agricultural Soil Mitigation areas
Deer Wintering Areas
ANR's Vermont Conservation Design Highest Priority Forest Block Datasets
Forest Blocks - Connectivity
Forest Blocks - Interior
Forest Blocks - Physical Land Division
Hydric Soils

TRORC Unsuitable areas (included in known constraints)
FEMA Floodways
Wilderness Areas, including National Wilderness Areas
Class 1 Wetland

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Appendix C: Renewable Energy Targets & Data

Municipal Energy Targets

The targets provided in this appendix represent the amount of new renewable energy capacity (solar, wind and hydro) that each community will need to develop in order to achieve the CEP's goal of 90% renewable by 2050 (based on the LEAP model).

Generation Target- This is the amount of new generation needed by 2050.

Prime Potential- This is area where potential generation exists and is unencumbered by constraints. Most communities have significantly more potential, but those areas that are not considered prime may have a constraint (such as prime agricultural soils) that makes it a less desirable location for a new facility

Prime Within 1-mile of 3 phase- Three-phase power is necessary for larger renewable energy generation facilities, making those areas with prime potential that are located within a mile of three-phase power the most suitable for new facilities.

Data Sources

For the purposes of this project, the Vermont Energy Investment Corp adapted the Total Energy Study's TREES scenarios (for more information, see Appendix A). Using this scenario, VEIC created and revised a model of the demand and supply of total energy in Vermont. Historic information was primarily drawn from the Public Service Department's Utility Facts 2013 and Energy Information Administration (EIA) data. Projections came from the Total Energy Study (TES), the utilities' Committed Supply, and stakeholder input.

Regional Energy Data

Estimates of current energy use consist primarily of data available from the American Community Survey (ACS), the Vermont Agency of Transportation (VTrans), the Vermont Department of Labor (DOL), and the Vermont Department of Public Service (DPS), Efficiency Vermont (EVT), Energy Information Administration (EIA) . Targets for future energy use are reliant upon the Long-range Energy Alternatives Planning (LEAP) analysis for the region completed the Vermont Energy Investment Corporation (VEIC).

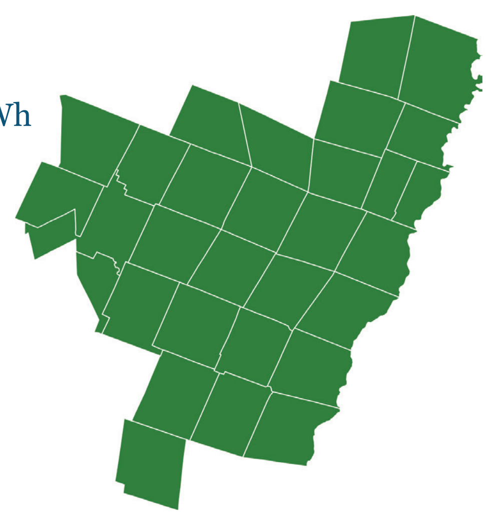
There are some shortcomings and limitations associated the data used in the Regional Energy Data Summary. For instance, assumptions used to create the LEAP analysis are slightly different than assumptions used to calculate current municipal energy use. Regardless, the targets established here show the direction in which change needs to occur to meet local, regional and state energy goals. It is important to remember that the targets established by LEAP represents only on way to achieve energy goals. There may several other similar pathways that a municipality may choose to take in order to meet the 90x50 goal.

Regional Energy Target

New Regional Generation Target: 314,376-349,307 MWh

Prime Solar Potential: 28,744 acres
Prime Solar within 1 mile of 3 phase: 13,473 acres

Prime Wind Potential: 15,025 acres
Prime Wind within 1 mile of 3 phase: 4,722 acres



1. Regional Summary

The Regional Summary worksheet summarizes all data that is required to be in the Regional Plan if the plan is to meet the "determination" standards established by the Vermont Department of Public Service.

1A. Current Regional Transportation Energy Use

Transportation Data	Municipal Data
Total # of Vehicles (ACS 2011-2015)	36,765
Average Miles per Vehicle (VTrans)	11,356
Total Miles Traveled	417,503,340
Realized MPG (VTrans)	18.6
Total Gallons Use per Year	22,446,416
Transportation BTUs (Billion)	2,703
Average Cost per Gallon of Gasoline (RPC)	2
Gasoline Cost per Year	51,851,221

This table uses data from the American Community Survey (ACS) and Vermont Agency of Transportation (VTrans) to calculate current transportation energy use and energy costs.

1B. Current Regional Residential Heating Energy Use

Fuel Source	Municipal Households (ACS 2011-2015)	Municipal % of Households	Municipal Square Footage Heated	Municipal BTU (in Billions)
Natural Gas	535	2.2%	47,491,800,000	47
Propane	5785	24.0%	551,628,720,000	552
Electricity	1026	4.3%	79,726,440,000	80
Fuel Oil	10494	43.6%	1,034,349,240,000	1,034
Coal	47	0.2%	5,121,120,000	5
Wood	5766	23.9%	602,550,840,000	603
Solar	50	0.2%	4,643,160,000	5
Other	316	1.3%	31,805,040,000	32
No Fuel	69	0.3%	5,315,520,000	5
Total	**24088**	**100.0%**	**2,362,631,880,000**	**2,363**

This table displays data from the ACS that estimates current Regional residential heating energy use.

1C. Current Regional Commercial Energy Use

	Commercial Establishments in Municipality (VT DOL)	Estimated Thermal Energy BTUs per Commercial Establishment (in Billions) (VDPS)	Estimated Thermal Energy BTUs by Commercial Establishments in Municipality (in Billions)
Regional Commercial Energy Use	1603	0.725	1,162

The table uses data available from the Vermont Department of Labor (VT DOL) and the Vermont Department of Public Service (DPS) to estimate current municipal commercial establishment energy use in the municipality.

1D. Current Electricity Use *

Use Sector	Current Electricity Use
Residential (kWh)	192,795,930
Commercial and Industrial (kWh)	202,575,426
Total (kWh)	395,371,356

*This table displays current electricity use within the municipality with data from the ACS, DPS, and VT DOL. More accurate data will be available soon from Efficiency Vermont (EVT).

1E. Residential Thermal Efficiency Targets

	2025	2035	2050
Residential - Increased Efficiency and Conservation (% of municipal households to be weatherized)	33%	67%	100%

This table displays targets for thermal efficiency for residential structures based on a methodology developed by DPS using data available from the regional Long-range Energy Alternatives Planning (LEAP) analysis and ACS. The data in this table represents the percentage of municipal households that will need to be weatherized in the target years.

1F. Commercial Thermal Efficiency Targets

	2025	2035	2050
Commercial - Increased Efficiency and Conservation (% of commercial establishments to be weatherized)	6%	9%	18%

This table shows the same information as Table 1E, but sets a target for commercial thermal efficiency. Information from the VT DOL is required to complete this target.

1G. Thermal Fuel Switching Targets (Residential and Commercial) - Wood Systems

	2025	2035	2050
New Efficient Wood Heat Systems (in units)	0	0	0

This target was calculated using data from LEAP and ACS. This table provides a target for new wood heating systems for residential and commercial structures in the municipality for each target year. Due to the LEAP model forecasting a large decrease in wood use resulting in a negative number of targets we have put zero in for this section. Towns are encouraged to use efficient wood heat.

1H. Thermal Fuel Switching Targets (Residential and Commercial) - Heat Pumps

	2025	2035	2050
New Heat Pumps (in units)	190	502	1,052

This table provides a target for new heat pump systems for residential and commercial structures in the municipality for each target year. This target was calculated using data from LEAP and ACS.

1I. Electricity Efficiency Targets

	2025	2035	2050
Increase Efficiency and Conservation	-0.6%	5.7%	9.9%

Data in this table displays a target for increased electricity efficiency and conservation during the target years. These targets were developed using regional LEAP analysis. Towns are encouraged to consider increased efficiency targets.

1J. Use of Renewables - Transportation

	2025	2035	2050
Renewable Energy Use - Transportation	9.6%	23.1%	90.3%

This data displays targets for the percentage of transportation energy use coming from renewable sources during each target year. This data was developed using the LEAP analysis.

1K. Use of Renewables - Heating

	2025	2035	2050
Renewable Energy Use - Heating	50.8%	63.0%	92.4%

This data displays targets for the percentage of heating energy use coming from renewable sources during each target year. This data was developed using information from the LEAP analysis.

1L. Use of Renewables - Electricity

	2050
Renewable Energy Use - Electricity (MWh)	314,376- 384,238

This data displays the target for electricity generation coming from renewable sources within the region for 2050. This data was developed using information from the regional planning commission and DPS. This data is the same as the data in Table 1Q.

1M. Transportation Fuel Switching Target - Electric Vehicles

	2025	2035	2050
Electric Vehicles	255	1,805	3,754

This tables displays a target for switching from fossil fuel based vehicles (gasoline and diesel) to electric vehicles. This target is calculated on Worksheet 2 by using LEAP and ACS data.

1N. Transportation Fuel Switching Target - Biodiesel Vehicles

	2025	2035	2050
Biodiesel Vehicles	448	843	1,423

This tables displays a target for switching from fossil fuel based vehicles to biodiesel-powered vehicles. This target is calculated on Worksheet 2. by using LEAP and ACS data.

1O. Existing Renewable Generation

Renewable Type	MW	MWh
Solar	9.53	11,688
Wind	0.05	153
Hydro	50.84	178,143
Biomass	0.39	1,612
Other	0.00	-
Total Existing Generation	**60.81**	**191,596**

Table 1O shows existing renewable generation in the region as of 2015, in MW and MWh, based on information available from the Vermont Department of Public Service.

1P. Renewable Generation Potential

Renewable Type	MW	MWh
Rooftop Solar	32	39,371
Ground-mounted Solar	15,331	18,801,632
Wind	30,752	94,284,099
Hydro	2	6,370
Biomass and Methane	0	0
Other	0	0
Total Renewable Generation Potential	**46,116**	**113,131,472**

Renewable generation potential is based on mapping completed by the regional planning commission that is based on the Regional Determination Standards and associated guidance documents developed by DPS. The renewable generation potential is expressed in MW and MWh by the type of renewable resource (solar, commercial wind, hydro, etc.).

1Q. Renewable Generation Targets

	2050
Total Renewable Generation Target (in MWh)	314,376- 384,238

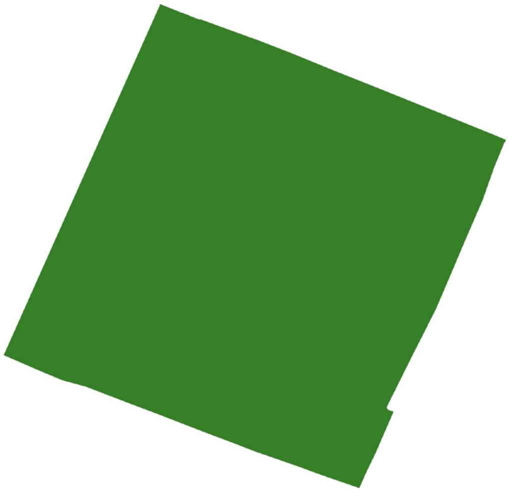
Renewable generation targets for municipalities were developed by the regional planning commission.

1R. Sufficient Land

	Y/N
Renewable Sources	Y
Surplus of Generation Area	32,387%

This table shows whether or not there is sufficient land in the region to meet the renewable generation targets based on the renewable generation potential in the region.

Barnard



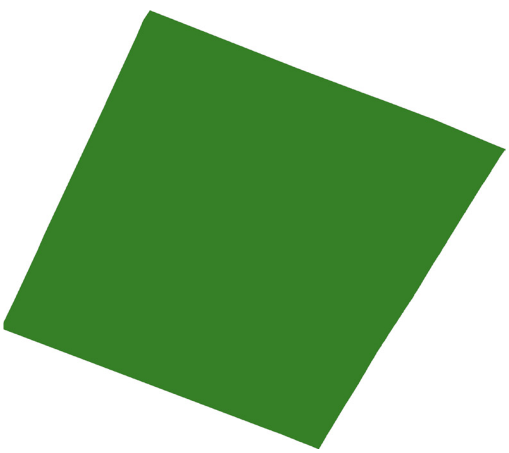
New Generation Target: 5,317- 6,498 MWh

Prime Solar Potential: 613 acres
Prime Solar within 1 mile of 3 phase: 296 acres

Prime Wind Potential: 726 acres
Prime Wind within 1 mile of 3 phase: 303 acres

Current Renewable Energy Generation: 96 MWh

Bethel



New Generation Target: 11,397- 13,930 MWh

Prime Solar Potential: 1517 acres
Prime Solar within 1 mile of 3 phase: 798 acres

Prime Wind Potential: 215 acres
Prime Wind within 1 mile of 3 phase: 0 acres

Current Renewable Energy Generation: 1,258 MWh

Bradford

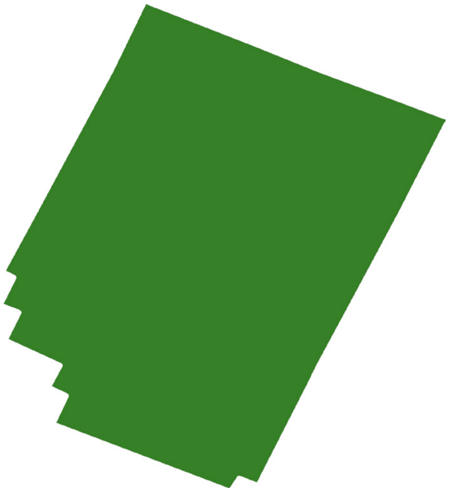
New Generation Target: 15,703- 19,193 MWh

Prime Solar Potential: 960 acres
Prime Solar within 1 mile of 3 phase: 436 acres

Prime Wind Potential: 0 acres
Prime Wind within 1 mile of 3 phase: 0 acres

Current Renewable Energy Generation: 5,710 MWh

Braintree



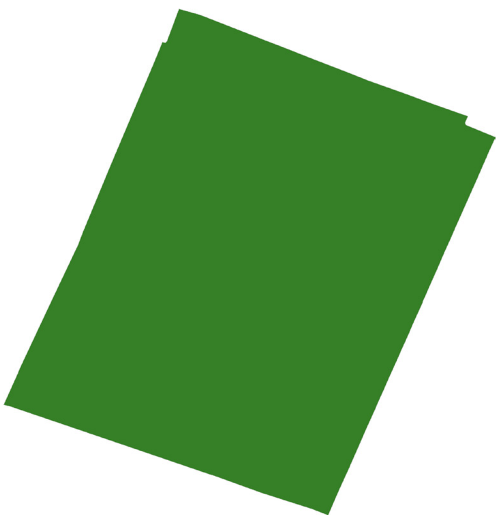
New Generation Target:6,995- 8,550 MWh

Prime Solar Potential: 1291 acres
Prime Solar within 1 mile of 3 phase: 441 acres

Prime Wind Potential: 429 acres
Prime Wind within 1 mile of 3 phase: 10 acres

Current Renewable Energy Generation: 208 MWh

Bridgewater



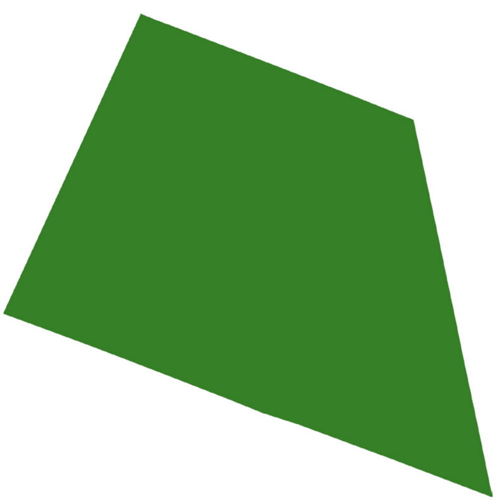
New Generation Target: 5,255- 6,423 MWh

Prime Solar Potential: 410 acres
Prime Solar within 1 mile of 3 phase: 174 acres

Prime Wind Potential: 213 acres
Prime Wind within 1 mile of 3 phase: 30 acres

Current Renewable Energy Generation: 110 MWh

Brookfield



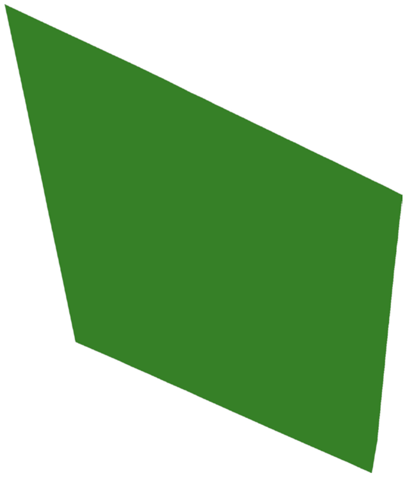
New Generation Target: 7,254-8,866 MWh

New Solar Capacity Target: 4 MW
Prime Solar Potential: 1936 acres
Prime Solar within 1 mile of 3 phase: 232 acres

New Wind Capacity Target: .58 MW
Prime Wind Potential: 1030 acres
Prime Wind within 1 mile of 3 phase: 151 acres

Current Renewable Energy Generation: 175 MWh

Chelsea



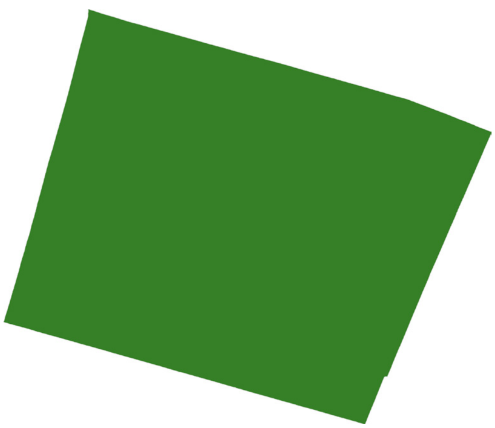
New Generation Target: 6,950- 8,495 MWh

Prime Solar Potential: 1309 acres
Prime Solar within 1 mile of 3 phase: 649 acres

Prime Wind Potential: 1702 acres
Prime Wind within 1 mile of 3 phase: 803 acres

Current Renewable Energy Generation: 25 MWh

Corinth



New Generation Target: 7,675- 9,380 MWh

Prime Solar Potential: 641 acres
Prime Solar within 1 mile of 3 phase: 139 acres

Prime Wind Potential: 98 acres
Prime Wind within 1 mile of 3 phase: 1 acres

Current Renewable Energy Generation: 86 MWh

Fairlee

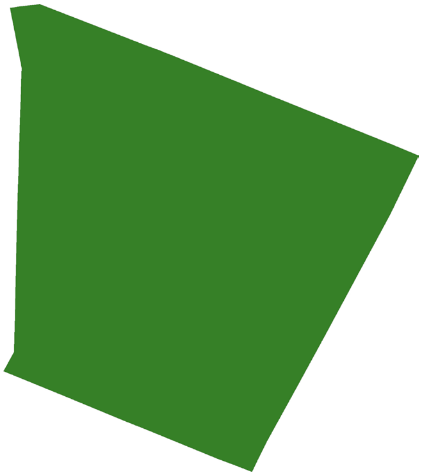
New Generation Target: 5,485- 6,704 MWh

Prime Solar Potential: 343 acres
Prime Solar within 1 mile of 3 phase: 240 acres

Prime Wind Potential: 0 acres
Prime Wind within 1 mile of 3 phase: 0 acres

Current Renewable Energy Generation: 49 MWh

Granville



New Generation Target: 1,673-2,045 MWh

Prime Solar Potential: 622 acres
Prime Solar within 1 mile of 3 phase: 315 acres

Prime Wind Potential: 185 acres
Prime Wind within 1 mile of 3 phase: 75 acres

Current Renewable Energy Generation: 25 MWh

Hancock

New Generation Target: 1,813- 2,216 MWh

Prime Solar Potential: 111 acres
Prime Solar within 1 mile of 3 phase: 64 acres

Prime Wind Potential: 116 acres
Prime Wind within 1 mile of 3 phase: 105 acres

Current Renewable Energy Generation: 25 MWh

Hartford

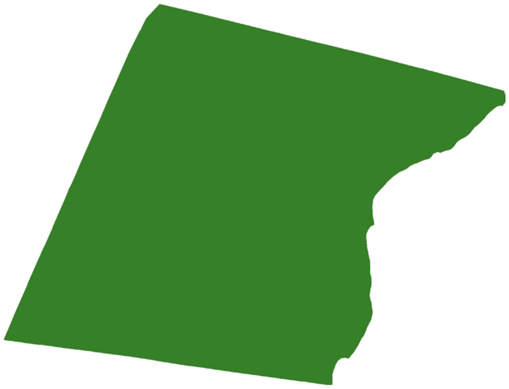
New Generation Target: 55,873- 68, 289 MWh

Prime Solar Potential: 2468 acres
Prime Solar within 1 mile of 3 phase: 2004 acres

Prime Wind Potential: 0 acres
Prime Wind within 1 mile of 3 phase: 0 acres

Current Renewable Energy Generation: 146, 298 MWh

Hartland



New Generation Target: 19,049- 23,282 MWh

New Solar Capacity Target: 11 MW
Prime Solar Potential: 1622 acres
Prime Solar within 1 mile of 3 phase: 542 acres

New Wind Capacity Target: 1.51 MW
Prime Wind Potential: 321 acres
Prime Wind within 1 mile of 3 phase: 103 acres

Current Renewable Energy Generation: 22,850 MWh

Newbury

New Generation Target: 12,441- 15,206 MWh

Prime Solar Potential: 2319 acres
Prime Solar within 1 mile of 3 phase: 938 acres

Prime Wind Potential: 67 acres
Prime Wind within 1 mile of 3 phase: 65 acres

Current Renewable Energy Generation: 4,699 MWh

Norwich

New Generation Target: 19,167- 23,426 MWh

Prime Solar Potential: 1203 acres
Prime Solar within 1 mile of 3 phase: 620 acres

Prime Wind Potential: 16.4 acres
Prime Wind within 1 mile of 3 phase: 0 acres

Current Renewable Energy Generation: 613 MWh

Pittsfield

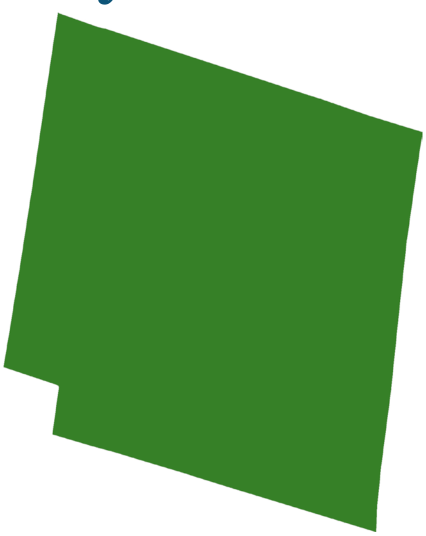
New Generation Target: 3,065- 3,747 MWh

Prime Solar Potential: 148 acres
Prime Solar within 1 mile of 3 phase: 80 acres

Prime Wind Potential: 154 acres
Prime Wind within 1 mile of 3 phase: 18.1 acres

Current Renewable Energy Generation: 10 MWh

Plymouth



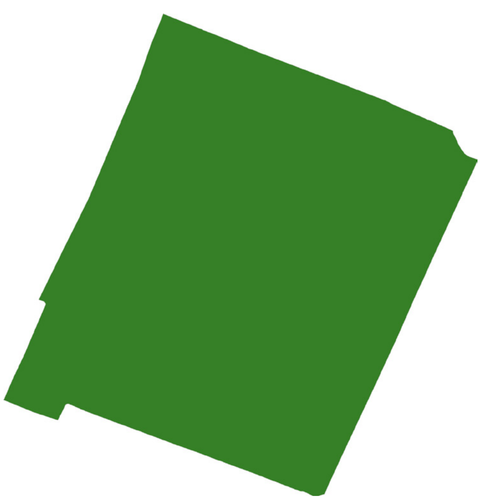
New Generation Target: 3,475-4,248 MWh

Prime Solar Potential: 475 acres
Prime Solar within 1 mile of 3 phase: 126 acres

Prime Wind Potential: 963 acres
Prime Wind within 1 mile of 3 phase: 202 acres

Current Renewable Energy Generation: 12 MWh

Pomfret



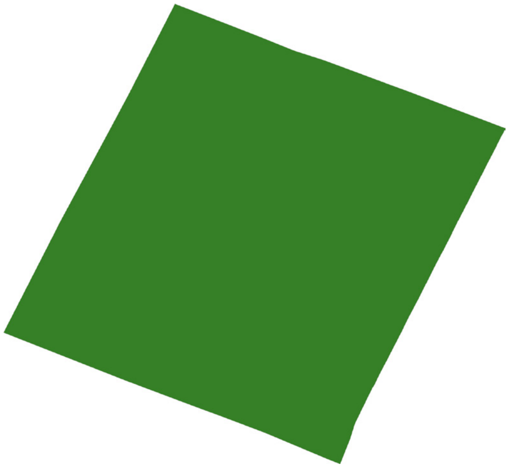
New Generation Target: 5,075-6,203 MWh

Prime Solar Potential: 518 acres
Prime Solar within 1 mile of 3 phase: 131 acres

Prime Wind Potential: 358 acres
Prime Wind within 1 mile of 3 phase: 59 acres

Current Renewable Energy Generation: 123 MWh

Randolph



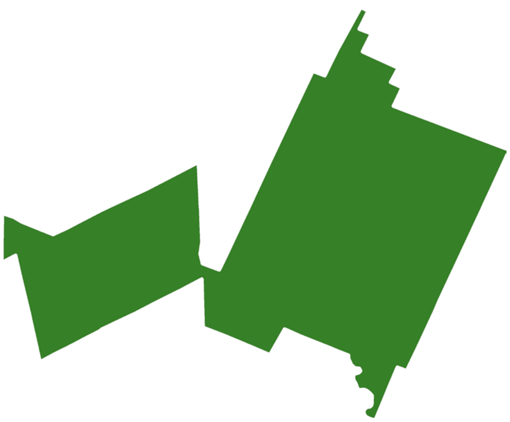
New Generation Target: 26,825- 32,786 MWh

Prime Solar Potential: 1658 acres
Prime Solar within 1 mile of 3 phase: 973 acres

Prime Wind Potential: 93 acres
Prime Wind within 1 mile of 3 phase: 20 acres

Current Renewable Energy Generation: 2,540 MWh

Rochester



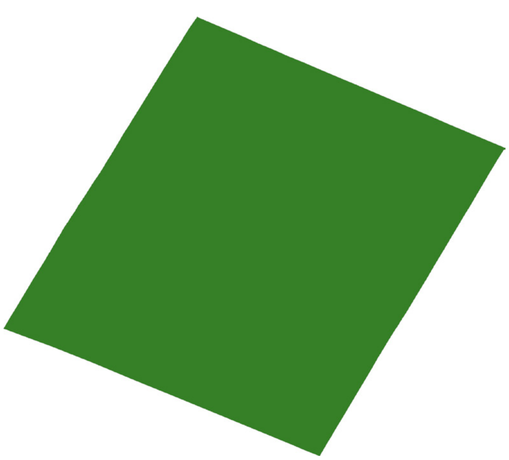
New Generation Target: 6,395- 7,816 MWh

Prime Solar Potential: 833 acres
Prime Solar within 1 mile of 3 phase: 506 acres

Prime Wind Potential: 236 acres
Prime Wind within 1 mile of 3 phase: 163 acres

Current Renewable Energy Generation: 135 MWh

Royalton



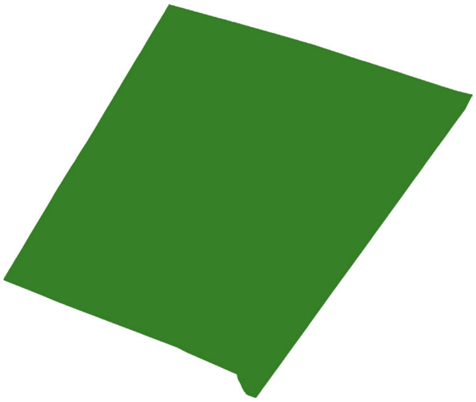
New Generation Target: 15,568- 19,028 MWh

Prime Solar Potential: 974 acres
Prime Solar within 1 mile of 3 phase: 636 acres

Prime Wind Potential: 358 acres
Prime Wind within 1 mile of 3 phase: 43 acres

Current Renewable Energy Generation: 184 MWh

Sharon



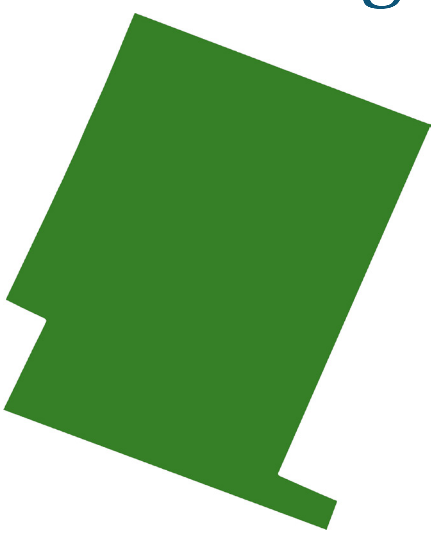
New Generation Target: 8,433-10,307 MWh

Prime Solar Potential: 784 acres
Prime Solar within 1 mile of 3 phase: 339 acres

Prime Wind Potential: 453 acres
Prime Wind within 1 mile of 3 phase: 66 acres

Current Renewable Energy Generation: 2,808 MWh

Stockbridge



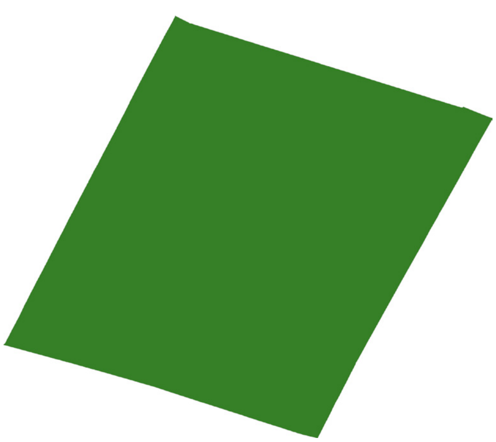
New Generation Target: 4,132- 5,050 MWh

Prime Solar Potential: 287 acres
Prime Solar within 1 mile of 3 phase: 80 acres

Prime Wind Potential: 1169 acres
Prime Wind within 1 mile of 3 phase: 439 acres

Current Renewable Energy Generation: 49 MWh

Strafford



New Generation Target: 6,164-7,534 MWh

Prime Solar Potential: 894 acres
Prime Solar within 1 mile of 3 phase: 0 acres

Prime Wind Potential: 1644 acres
Prime Wind within 1 mile of 3 phase: 0 acres

Current Renewable Energy Generation: 230 MWh

Thetford

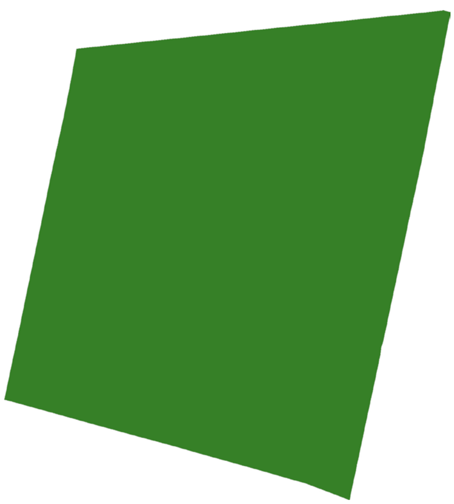
New Generation Target: 14,530-17,759 MWh

Prime Solar Potential: 1148 acres
Prime Solar within 1 mile of 3 phase: 762 acres

Prime Wind Potential: 0 acres
Prime Wind within 1 mile of 3 phase: 0 acres

Current Renewable Energy Generation: 503 MWh

Topsham



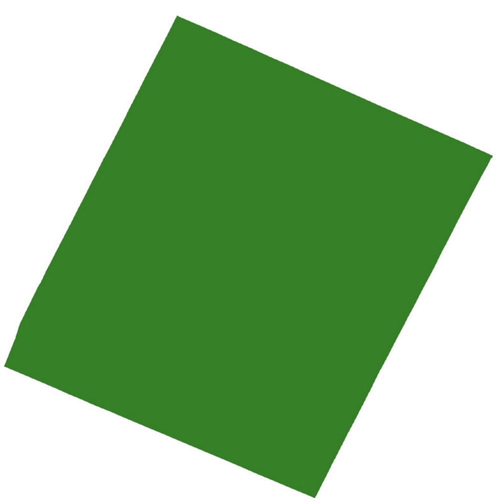
New Generation Target: 6,586-8,049 MWh

Prime Solar Potential: 800 acres
Prime Solar within 1 mile of 3 phase: 487 acres

Prime Wind Potential: 1305 acres
Prime Wind within 1 mile of 3 phase: 998 acres

Current Renewable Energy Generation: 25 MWh

Tunbridge



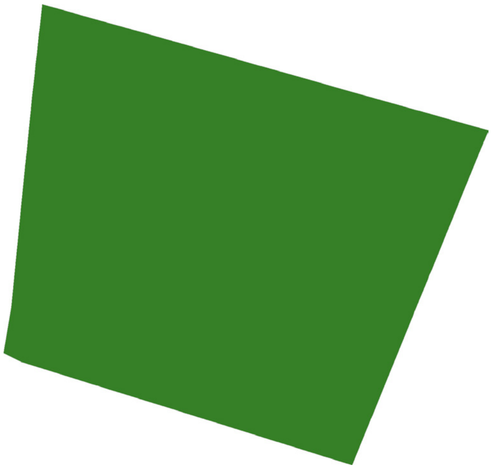
New Generation Target: 7,209-8,811 MWh

Prime Solar Potential: 1196 acres
Prime Solar within 1 mile of 3 phase: 384 acres

Prime Wind Potential: 1847 acres
Prime Wind within 1 mile of 3 phase: 511 acres

Current Renewable Energy Generation: 135 MWh

Vershire



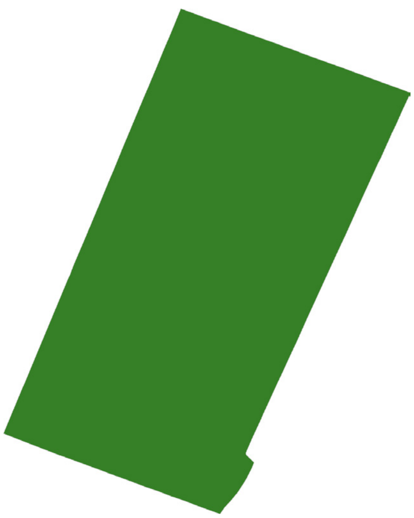
New Generation Target: 4,098-5,009 MWh

New Solar Capacity Target: 2 MW
Prime Solar Potential: 473 acres
Prime Solar within 1 mile of 3 phase: 199 acres

New Wind Capacity Target: .33 MW
Prime Wind Potential: 963 acres
Prime Wind within 1 mile of 3 phase: 401 acres

Current Renewable Energy Generation: 245 MWh

West Fairlee



New Generation Target: 3,660-4,474 MWh

Prime Solar Potential: 179 acres
Prime Solar within 1 mile of 3 phase: 50 acres

Prime Wind Potential: 11.8 acres
Prime Wind within 1 mile of 3 phase: 0 acres

Current Renewable Energy Generation: 49 MWh

Woodstock

New Generation Target: 17,112-20,915 MWh

Prime Solar Potential: 1010 acres
Prime Solar within 1 mile of 3 phase: 828 acres

Prime Wind Potential: acres: 518 acres
Prime Wind within 1 mile of 3 phase: 157 acres

Current Renewable Energy Generation: 2,273 MWh