BENNINGTON COUNTY REGIONAL ENERGY PLAN

BENNINGTON COUNTY REGIONAL COMMISSION
March 2017

EXECUTIVE SUMMARY

This plan was created by the **Bennington County Regional Commission**, in partnership with:

The Energy Action Network

Northwest Vermont Regional Planning Commission

Two Rivers-Ottaquechee Regional Commission

The Vermont Public Service Department

The Vermont Energy Investment Corporation

Several other agencies and organizations also provided support, including: Green Mountain Power, Vermont Agency of Agriculture, Vermont Agency of Commerce and Community Development, Vermont Agency of Transportation, Vermont Agency of Natural Resources, Vermont Energy and Climate Action Network, the Vermont Electric Power Company, Vermont Fuel Dealers Association, Vermont Natural Resources Council, Vermont Sustainable Jobs fund, and others.

Public input was sought through a series of presentations during the development of this draft plan. ***Thanks to the many members of the public who provided valuable feedback.***

SECTION I. INTRODUCTION (PAGE 5)

The Introduction of this plan includes a brief discussion of energy and energy planning, including some key issues that drive renewable energy planning efforts in the BCRC region and elsewhere:

- Energy Security
- Environmental Protection
- Economic Needs and Opportunities

The Introduction concludes with an overview of Vermont's statewide energy goals, as well as a list of the Bennington Region's energy goals. Vermont's **90X50 Energy Goal**—that is, to meet **90%** of Vermont's total energy needs with renewable sources **by 2050**—forms the basis for all energy forecasts and strategies (**Section IV**) listed in this plan.

SECTION II. REGIONAL ENERGY SUPPLY & DEMAND (PAGE 20)

Section II discusses current energy use in the state of Vermont and the Bennington Region, including specific analysis of energy use for *space heating*, *transportation*, and *electricity*. It also discusses how electricity is generated, and the ways through which in-state and in-region renewable energy generation can be expanded in the future.

SECTION III. FUTURE ENERGY USE (PAGE 38)

Section III explores projections of future energy use, and includes a variety of graphs generated through the scenario-based energy modeling software referred to as LEAP (the Long-Range Energy Alternatives Planning System). Future statewide energy use as well as future BCRC region energy use are projected based on scenarios that result in the attainment of Vermont's **90X50** energy goal.

Overall, energy use in the region will need to decrease significantly, although electricity use will need to increase, with more generation coming from renewables, including in-region and imported sources.

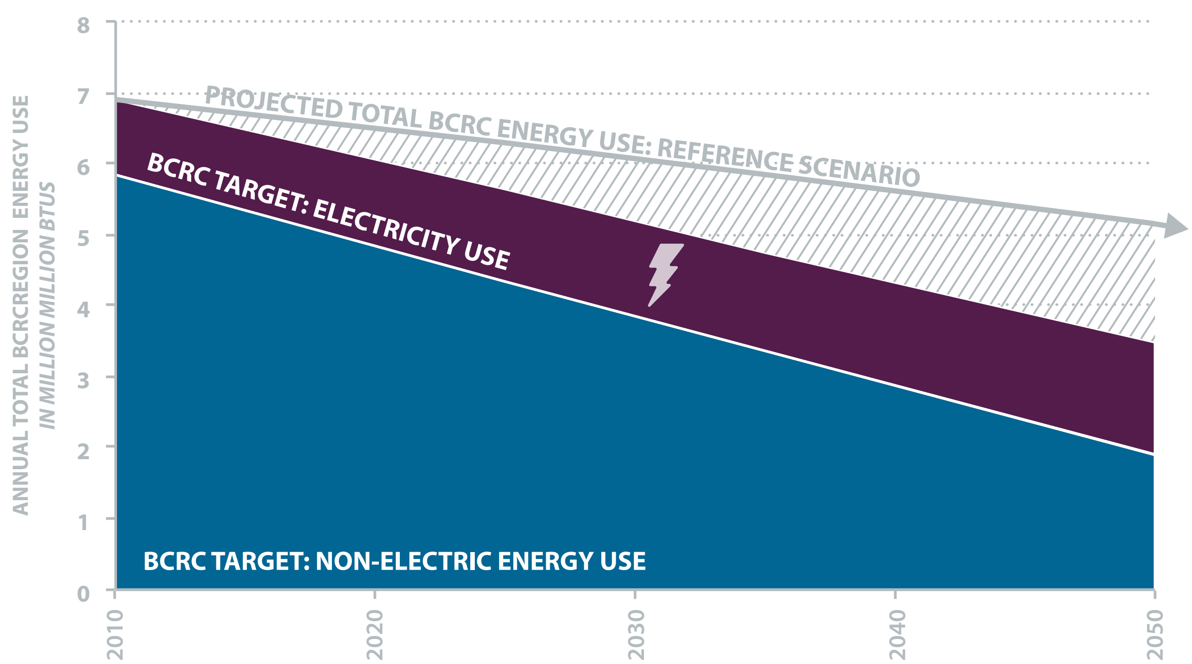


FIGURE A: BCRC FUTURE ENERGY USE TARGETS

*According to the LEAP Systems Model Scenarios, in order to achieve the **90X50** energy goal, the BCRC region will need to dramatically reduce energy use, increasing efficiency and relying on electricity for many more purposes. The "Reference Scenario" demonstrates total projected energy use (electric and non-electric) for the region according to current energy efficiency programs and policies in place, i.e., the likely energy use trend if the region implements all existing statewide efficiency enhancement initiatives. This graph shows that the region must go far beyond current policy if it is to achieve its energy goals.*

SECTION IV. ENERGY STRATEGIES (PAGE 58)

Section IV provides an extensive list of regional energy strategies, which are categorized by sector.

THERMAL STRATEGIES

1. Work with fuel dealers to encourage them to become energy service providers (ESPs).
2. Bring NeighborWorks of Western Vermont "Heat Squad" programs to the Bennington Region.
3. Coordinate efforts with BROC's Weatherization Assistance Program.
4. Expand biomass district heating and combined heat and power systems throughout the region.
5. Promote use of heat pumps (primarily air source for existing buildings).
6. Promote the use of stoves and furnaces that burn woody biomass (cordwood or pellets) in new construction and to replace oil and propane furnaces.
7. Organize and hold a workshop and conduct building walk-throughs for owners of rental housing.
8. Support use of geothermal heating and cooling systems for new construction.
9. Outreach to towns and contractors on use and enforcement of residential and commercial building energy standards for all new construction.

TRANSPORTATION AND LAND USE STRATEGIES

1. Pursue growth and development in compact mixed use centers.
2. Implement improvements that encourage safe and convenient walking and biking.
3. Increase the use of local public transportation services and carpooling.
4. Expand the use of electric vehicles (EVs) in the region by supporting education, availability, and infrastructure.
5. Provide greater access to intercity passenger rail and expand the use of rail for freight transportation.
6. Provide greater access to liquid biofuels for use in commercial vehicles and heavy equipment.

ELECTRICITY CONSERVATION & GENERATION FROM RENEWABLE SOURCES

1. Expand energy storage within the region.
2. Expand and deepen customer participation in electricity conservation programs offered through Efficiency Vermont.
3. Influence behavioral changes to reduce electricity consumption at the individual level.
4. Develop adequate electricity transmission and distribution systems to support increased electricity use in the future.
5. Plan for an adequate amount of new electricity generation from renewable energy resources within the region. This includes in-region capacity for: Hydro, Wind, and Solar generation facilities. The potential for each of these resource is explored through a series of maps at the end of **Section IV**.

SECTION V. ADAPTATION STRATEGIES (PAGE 93)

While the above strategies lay out several ways in which the Bennington Region can achieve its energy goals, they do not take into account some broader changes that will need to be made as the region transitions into its energy future. Section V outlines some of these additional adaptations, including: **Lifestyle Adaptations**, **Economic Adaptations**, and **Agriculture & Food System Adaptations**.

SECTION I.

INTRODUCTION

REGIONAL ENERGY PLANNING INITIATIVE

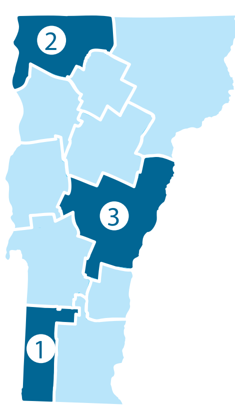
REGIONAL ENERGY PLANNING: 2016

Recognizing that enhanced energy planning at the local and regional level will help advance Vermont's energy goals and facilitate implementation of ideas set forth in the 2016 Vermont Comprehensive Energy Plan, the ***Department of Public Service*** provided funding to support development of new energy plans by three of the state's regional planning commissions: the ***Bennington County Regional Commission (BCRC)***, the ***Northwest Regional Planning Commission (NRPC)***, and the ***Two Rivers-Ottauquechee Regional Commission (TRORC)***. Those plans reference the relevant statewide data and establish a process for producing similar plans in each of the remaining regions around the state. The regional planning process has been supported by staff and technical support from the ***Department of Public Service***, the ***Vermont Energy Investment Corporation (VEIC)***, the ***Energy Action Network***, and other organizations.

REGIONAL ENERGY PLANNING INITIATIVE

2016 REGIONS:

1. **BCRC**
2. **NRPC**
3. **TRORC**



An important aspect of this planning process is that each of the regional plans has been developed using quantifiable energy conservation and renewable energy generation goals developed by VEIC in consultation with the regional planning commissions, using the Long-Range Energy Alternatives Planning System, a computerized system for modeling future energy supply and demand. The model was premised on attainment of the state goal of obtaining **90% of all energy used in Vermont from renewable sources by 2050**. The energy model output provided information on the total amount of energy use statewide and in each region projected over time (from 2010 through 2050), broken down by sector and fuel type. The regional planning commissions then worked with local communities to describe what those numbers meant in practical terms within their regions and developed strategies guided by those quantitative targets.

The regions also worked with officials from several state agencies, nonprofit organizations, interest groups, and utility companies to define parameters that led to creation of renewable energy generation maps. Those maps illustrate areas where renewable energy development would be most appropriate based on a combination of the presence of renewable energy resources and the lack of environmental and locally identified constraints. The regional planning commissions also reached out to local communities to identify general guidelines to be considered when siting these generating facilities, as well as locations well-suited to renewable energy generation or the use of large biomass-based heating and/or co-generation facilities.

ENERGY DEFINED

Every aspect of our lives depends upon energy, which is defined as the capacity of a system to do work. In practical terms, energy is the thing that moves our cars, heats our homes, illuminates the dark, and powers the machinery of industry. And yet, energy is much more than that. Energy allows us to walk, think, breathe, grow, and develop our communities and society. This very same energy also is responsible for rain, wind, ocean currents, and all of the natural forces that shape the Earth. To properly plan for our region's energy future it is necessary to understand what energy is, where it comes from, and the ways in which we use it.

One of the fundamental and absolute physical laws that govern the universe is the First Law of Thermodynamics, which states that energy cannot be created or destroyed. In other words, within a closed system, the amount of available energy is constant. It is not possible to create energy from objects on Earth, only to extract it from objects that already contain a finite amount of energy. The only significant external input of energy into the Earth's otherwise closed system is the energy that is continually imparted to the Earth from the Sun. Once energy is released and used to perform work, it is dissipated (but not destroyed) into forms such as heat energy. Given that the amount of energy available to us is strictly constrained by the amount of energy currently on the Earth and the amount of solar energy that we can capture and use, it quickly becomes clear that the challenge of energy planning involves determining how to safely access and use energy from different sources and how to allocate that limited resource to the many functions that require it.

THE CHALLENGE OF ENERGY PLANNING:

How to safely access and use energy from different sources?

+

How to allocate that limited resource to the many functions that require it?

ENERGY FROM THE SUN

The vast majority of energy present on the Earth derives from the Sun, energy which is actually nuclear in origin, having been released from forces on the Sun when atoms of hydrogen fuse into helium. We most often think of "solar" energy in terms of the devices and architectural designs that have been developed to use the energy in sunlight for space heating, raising the temperature of water, and producing electricity. Energy from the Sun also differentially heats air masses, producing wind which for centuries has been harnessed to do work and recently has become an increasingly important way to generate electricity. The Sun's energy also evaporates water and raises it into the atmosphere, where after falling as rain or snow and then flowing downstream, its energy can be captured and used to generate electricity in hydroelectric facilities.

Plants use a process called photosynthesis to capture and store solar energy. The energy contained in plants has been acquired from the Sun and stored for a relatively short period of time, from a few months in the case of crops like corn to a few years or decades in the case of trees. That stored solar energy, in turn, provides all of the energy in the food that we consume either by eating plants directly or by eating animals that have consumed the plants. The energy contained in plants can also be released through combustion; the resulting energy can be used to heat buildings or to boil water to drive electricity-generating turbines. With additional energy inputs, products like ethanol and biodiesel fuels can be produced from plants, capturing the energy from the plants in a form that can be more easily transported and used.

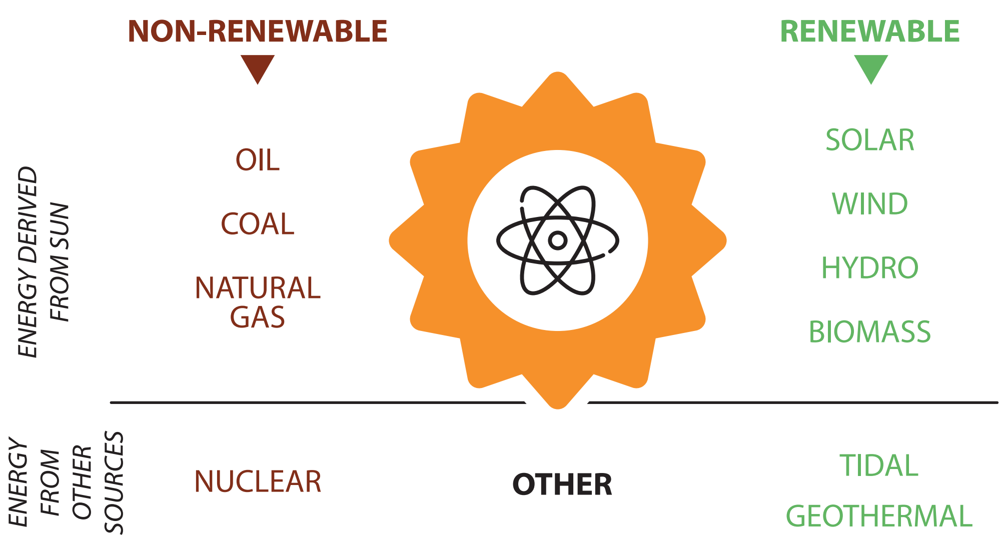


FIGURE 1.1: Most of the energy available to us originated from nuclear fusion in the Sun; only nuclear, tidal, and geothermal do not trace their source to the Sun. The energy sources in red are nonrenewable; once they are depleted their energy is no longer available to us. The sources in green can be considered renewable as they derive energy from ongoing solar radiation, gravity, or heat contained within the Earth.

This same photosynthetic process was taking place for millennia before any humans were around to make use of the solar energy being packaged in this way. In fact, deep layers of compacted organic material containing vast amounts of energy were converted to coal, oil, and natural gas over a period of several hundred million years. The energy from these "fossil fuels" is derived from the Sun, just like the energy released when a wooden log is burned, but it is very dense, containing much more energy in the same volume of material. The solar energy stored in fossil fuels is also distinguished by the fact that it is "non-renewable;" that is, once the Sun's energy is released from the fossil fuel, that source of energy is gone. In contrast, "renewable" energy sources, such as new farm crops or trees, can be regenerated in a relatively short period of time.

Fossil fuels have made possible the dramatic growth in the world's population and economies over the past two centuries. Energy that took hundreds of millions of years to be stored, however, has been consumed in a tiny fraction of that time. Consider, for example, that human activity burns through approximately four billion gallons of oil and liquid petroleum fuels every day, a rate sufficient to continually fill a volume the size of the Bennington Battle Monument every five minutes, and it is easy to understand that the availability and affordability of these energy resources will become a serious issue within the first half of this century. That timeframe is extremely short given that our society must dramatically reduce the amount of energy used while producing most new energy from renewable sources to maintain strong economies and an acceptable quality of life.

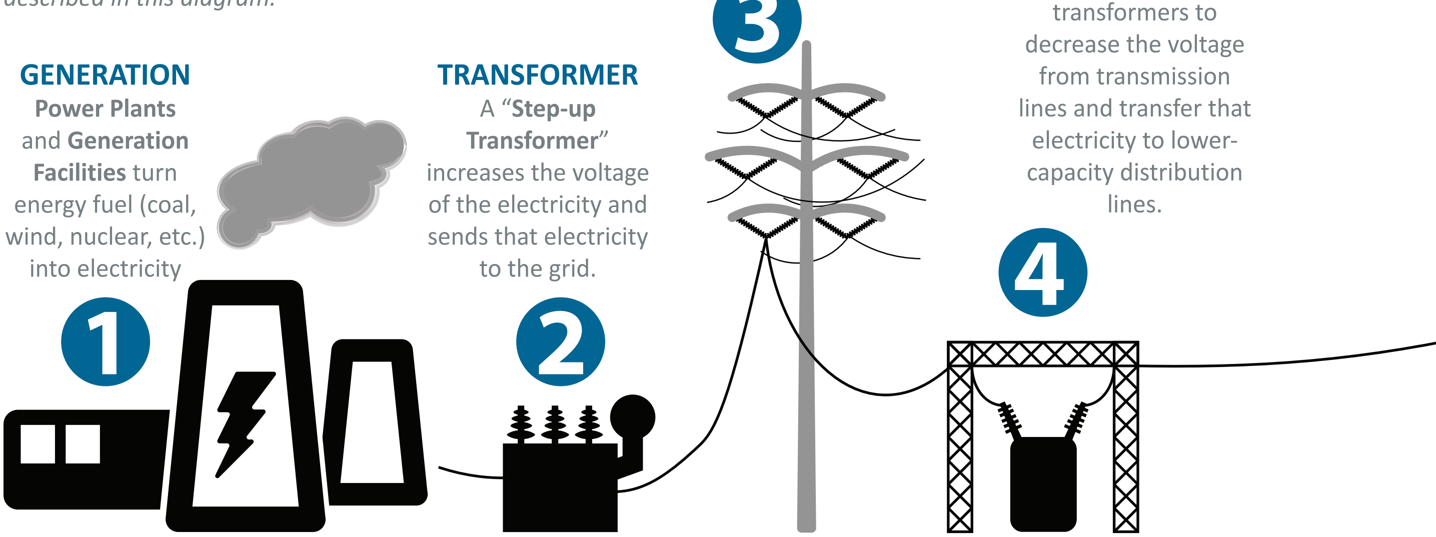
For many years, coal and oil-based energy sources have been the catalyst of great economic expansion. But these non-renewable resources are becoming more difficult to harvest without causing detrimental impacts, as seen through the effects of the coal mining process referred to as mountaintop removal.

ENERGY CARRIERS

A complete picture of energy development and use must include consideration of energy carriers as well as energy sources. Fuels like gasoline and ethanol are energy carriers in that they are produced from primary sources of energy and can be transported and used more conveniently than the original petroleum or biomass product from which they are derived. Of particular importance to our energy future is the ubiquitous energy carrier, electricity (***Figure 1.2***). Everything from the simple light bulbs in our homes to the devices that run the world's digital and telecommunication infrastructure requires electricity. Large amounts of electricity are used to heat and cool buildings and to power appliances and machinery. With future depletion and increased cost of non-renewable fuels and concerns over environmental quality, greater emphasis has been placed on potential uses of electricity for other purposes, especially in the transportation and space heating sectors.

Electric vehicle technology has advanced considerably in recent years; plug-in/electric-gas hybrids, full electric drive, and fuel cell powered vehicles or concepts such as compressed air drive systems, all obtain their power from electricity. There have also been dramatic advances in the use of both geothermal and air source heat pump technology, powered by electricity, to heat and cool buildings and water. These vehicle and thermal systems are highly energy efficient and reduce pollution impacts at the point of use, but do not solve fuel scarcity or all environmental problems because they rely on primary energy sources (nuclear, hydroelectric, fossil fuels, etc.) to generate the electricity that they use. Finding ways to utilize abundant and renewable energy sources to generate electricity, therefore, is one of the great challenges facing society.

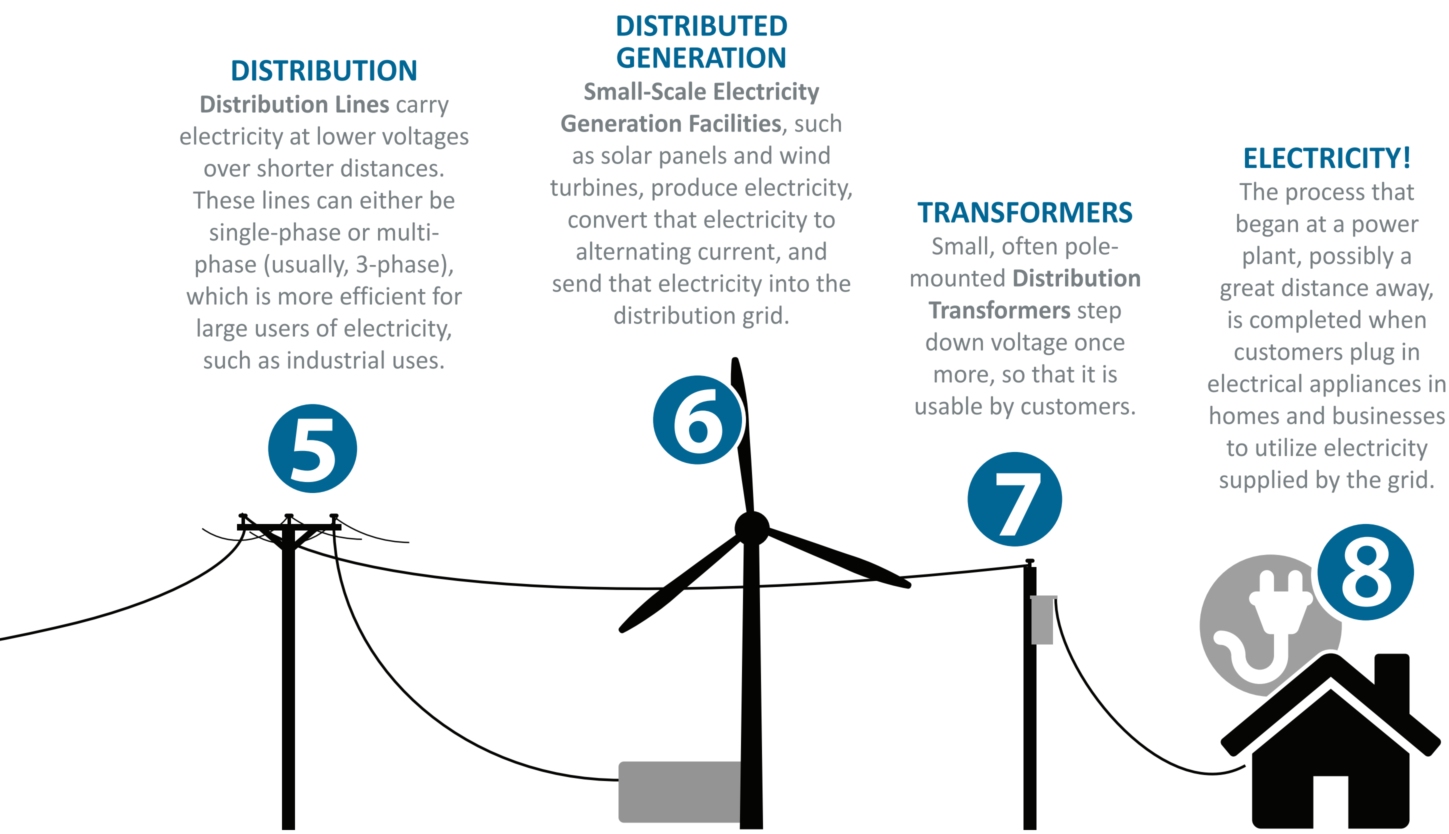
FIGURE 1.2: UNDERSTANDING THE GRID
The major components in the US electrical generation and distribution network are described in this diagram.



Another energy carrier that has received considerable attention lately is hydrogen, the most common element on Earth. While there are compelling reasons to consider hydrogen's potential as a major power source, its low overall efficiency limits future application.

Hydrogen has a very high energy content relative to its weight, but a very low energy content relative to its volume. The technology to extract energy from hydrogen has been developed and proven, and hydrogen can be stored with relative ease and produces virtually no pollution when used. Unfortunately, hydrogen does not occur in usable form in nature; it must be extracted from water or some hydrocarbon such as methane. Obtaining hydrogen from a nonrenewable fossil fuel such as natural gas (composed largely of methane) clearly fails to address the need to develop new renewable energy sources, and extracting hydrogen from water is a very energy intensive process. For these reasons, most research has focused on using renewable energy sources and nuclear energy to generate the electricity that is needed to split hydrogen from oxygen in water molecules.

The other great obstacle preventing hydrogen from becoming a common source of power is the fact that it is very difficult, costly, and energy intensive to transport from where it is produced to where it is used. Some researchers have suggested that liquid hydrocarbons such as methanol, produced with hydrogen (derived from water and renewably generated electricity) and carbon dioxide (from biomass sources), could be effective materials for storing and transporting hydrogen.



KEY ISSUES AND GOALS

The difficulties and challenges presented by a future that will be characterized by reduced reliance on energy from the sources that we have come to rely on are many and complex. These problems and many of the solutions are national and international in scope, and while an awareness of those global concerns is critically important, state and regional plans must focus on actions that are most applicable within our sphere of influence. The following points summarize some of the key challenges and opportunities that will be addressed in this plan, and which create the imperative for the state and regional goals that conclude this section.

Energy Security

Vermont and Bennington County, like the rest of the country and world, have developed a strong reliance on non-renewable sources of energy. The heavy use of these fossil fuels is understandable because they have been easy and inexpensive to obtain and they contain energy in very high densities. The primary use of these fuels locally 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).

Historically, the cost of obtaining energy from oil, coal, and natural gas has been low relative to the energy yielded by those resources. Supply and demand fluctuations will lead to price volatility in the short term, but because deposits of these resources are becoming increasingly difficult to reach and refine, the cost—in both dollars and energy—will rise over time. There may be vast amounts of energy locked in Canada's Athabasca oil sands or in petroleum deposits two miles beneath the sea in the continental shelf off Brazil, but huge amounts of energy are required to heat, drill, transport, and refine the raw materials. If more energy is used to obtain the fuel than exists within the fuel, there is no point in acquiring it (***Figure 1.3***).

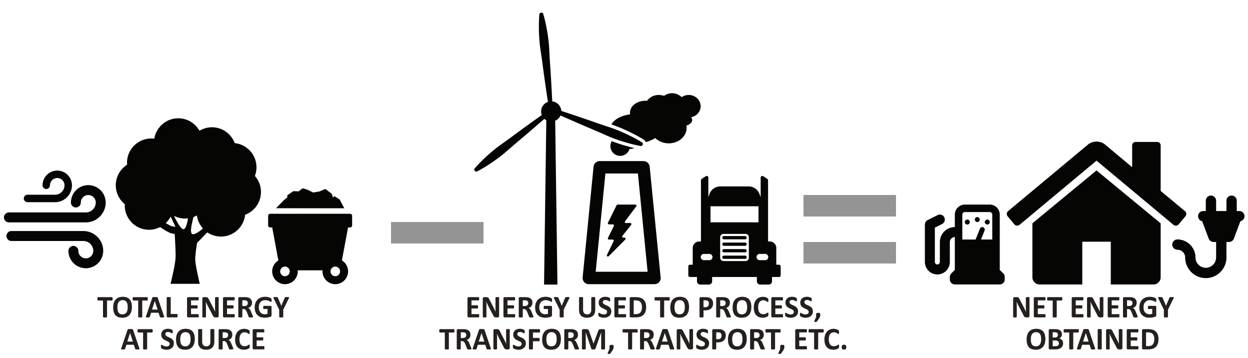


Figure 1.3: *A fuel is only viable if the amount of energy it yields is greater than the amount used to obtain it (and if the cost of producing does not exceed its market value). This "net energy" yield can change over time, as in the case of oil. In the 1920's, for example, 80 barrels of oil could be produced using the energy equivalent of one barrel of oil (80:1 energy return on energy invested). With the most easily accessible oil resources depleted, the net energy yield from today's oil fields is less than 20:1 and falling. Net energy is a key consideration for all energy sources, whether renewable or non-renewable in nature.*

There is no question that over time, the non-renewable energy sources that we have come to rely on will become too costly to continue be our primary transportation, space heating, and electricity-generation fuels. The only realistic way to address this potentially highly disruptive future is to take actions that reduce the total amount of energy that we use and to obtain the vast majority of energy that is needed from renewable sources. Hydro power, solar, and wind can meet the region's and state's increasing electricity needs, and the use of biomass (primarily wood) can replace much of the fossil fuel combustion currently used for space heating. These renewable energy sources offer many advantages, but also present unique challenges.

Although there is a huge amount of solar energy striking the Earth every day, net energy yields from sunlight, wind, falling water, and wood and other biomass sources are low relative to the our historical experience with fossil fuels. Technologies must be carefully selected to ensure that net energy yields are as high as possible. Electricity generation from wind and hydro have high energy returns relative to other renewables, provided they are sited in areas where the resource is sufficiently concentrated and relatively close to end users. Solar energy for thermal applications can be extremely efficient, and photovoltaic generation is becoming more efficient and cost-competitive.

Energy and Emergency Response

In addition to maintaining everyday activities and supporting the economy, energy also helps local communities, regions, and the state resond to and recover from emergencies. This fact was vividly demonstrated in the wake of Tropical Storm Irene when relief supplies were flown in to stricken towns; roads, bridges, and buildings were repaired; and vast amounts of debris were cleared in relatively short order thanks to the power of liquid petroleum fuels. The aftermath of future emergencies will be quite dire without effective planning that includes consideration of the need for reliable energy to operate essential vehicles, machinery, and equipment.

Woody biomass has proven to be a high-yielding heat source, provided it is sustainably harvested and used near its source (limiting transportation costs). Other "renewable" energy technologies are less promising; the energy required to grow, harvest, and process corn into ethanol, and then to transport it for use, often exceeds the energy content of the resulting fuel. Fortunately, most renewable solar-based energy sources are much more efficient than corn ethanol, but it does remind us that it is critically important to consider the efficiency of any new energy source, including renewables.

Vermont currently obtains a significant portion of its electricity supply from hydroelectric facilities in Quebec and Labrador (through contracts with Hydro Quebec). Additional renewable generation in the region, but outside of Bennington County and Vermont, exists, or is being developed, in the form of on and off shore windpower, large-scale solar generation, and river and tidal hydropower. (Electricity generation from biomass at a scale large enough to produce power for the regional power grid is inefficient due to the low energy density of wood and transportation costs that increase rapidly with the size of the facility; use of those biomass resources should preferentially be for space heating - with co-generation from surplus heat energy when practical).

It could be argued that it is possible to meet all of our future electricity needs from these imported renewable sources. That assumption, however, suffers from two principal flaws: poor efficiency and uncertain supply and cost.

A large amount of energy is lost during the transmission of electricity. Siting generation relatively close to points of use in our region would improve efficiency, and in turn reduce the need for costly development of new generation and transmission facilities. Future regional energy costs also face uncertainties linked to increased demand for renewably sourced electricity regionwide. As fossil fuels become more expensive and states' mandates require that communities source more of their power from renewables, costs for renewable electricity may soar if additional supply is not developed to match rise in demand. By developing renewable energy supplies within our region, both inefficiencies and rising energy costs can be prevented.

Aggressive conservation, combined with electricity generated from properly sited in-state solar, wind, and hydro and additional space heating from locally sourced biomass and, where available, geothermal resources offers the best long-term approach to ensuring the region's energy security. There is no question that some significant portion of Vermont's future energy supply will have to be imported, but greater local generation will result in lower costs, less risk, and improved efficiency.

Environmental Protection

Human activity has always affected the Earth, and our use of huge amounts of fossil fuels over the past two centuries has had a profound and enduring impact on air quality, water quality, and climate patterns. Climate change, sometimes referred to as global warming, has resulted from the rapid release of billions of tons of carbon that had been locked in solid and liquid fossil fuels. 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—are already being observed and every effort needs to be made, locally and globally, to limit future damage and adapt to a changing reality. In Vermont, climate change has the potential to alter the composition of our forests, affect the viability of the ski industry, and result in more damaging tropical storms, floods, and other severe events.

Other forms of pollution from fossil fuel combustion (e.g., smog, acid rain) also damage natural ecosystems, adversely affect human health, and cause economic damage. If the region's energy does not come from clean renewable energy sources, it comes from other sources, most often fossil fuels or nuclear. These sources pose risks and cause environmental damage where the fuel is mined and processed as well as where it is used to generate electricity. Although local energy generation siting concerns are significant and are accordingly addressed in Section IV 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 against the environmental and social impacts that strip mining, mountaintop removal, fracking, and fossil-fuel power station operations produce in other states.

Economic Needs and Opportunities

Our economy and lifestyle has been made possible through exploitation of vast amounts of solar energy stored as fossil fuels. Because a majority of the most readily extractable energy from these sources has been used up in just over 100 years, and the cost and difficulty of obtaining these resources will increase over time, we will have to adapt 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 $3.0 billion and the Bennington Region approximately $160 million on energy each year, with the vast majority of those dollars exported to out-of-state, and often foreign, entities in the supply chain. This Plan, like Vermont's Comprehensive Energy Plan (2016), 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 (by reducing the need for driving and by introducing more energy-efficient vehicle technologies), through extensive building weatherization and use of more efficient heating and cooling systems, and through continued efforts at energy conservation.

Those changes will reduce the outflow of money from the region and state, meaning that millions of dollars of additional wealth will be retained annually to circulate in local economies, supporting employment, social services, and improving the quality of life of the resident population. 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 alternative fuels such as wood pellets and cord wood, and construction and servicing of local renewable energy generation facilities can offer new jobs and business development opportunities as well as opportunities for existing fossil fuel-based businesses to diversify using their existing capacity and customer networks.

VERMONT RENEWABLE FUELS INCORPORATED

Energy conservation and renewable energy development offer tremendous opportunities for businesses, while retaining millions of dollars in the local economy each year. Local businesses like ***Vermont Renewable Fuels*** *in Dorset provide examples of these opportunities.*

The Growing Importance of Electricity

Electricity is an essential part of the everyday lives of residents of the region and is critical to the vitality of the regional economy. Vermont receives its electricity primarily from imported sources (since the closing of the Vermont Yankee nuclear power plant). Much of this imported electricity derives from renewable hydroelectricity generated in Canada, with the rest coming from a mix of generating facilities in the northeast and from a growing supply of small- and medium-sized renewable (hydro, wind, solar, and biomass) 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 this slowing in the growth of electric demand. The need for conservation and efficiency improvements in the use of electricity will continue, and be amplified by the likelihood that demand for electricity is expected to increase steadily once again as the energy it carries replaces fossil fuels for transportation, mechanical, and space-heating needs. Electricity provides the most viable path toward meeting the state's energy goals in several key areas. Electrification of the passenger vehicle fleet, 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, a relatively simple and cost-effective transformation in space heating of existing residential buildings often is to weatherize the structure and install highly efficient (electrically driven) air source heat pumps. The only way to accommodate the projected 70% increase in statewide demand (by 2050) for electricity resulting from these changes is to increase imports of renewably generated electricity and significantly expand in-state generation from renewable sources while continuing to pursue conservation and efficiency improvements.

In order to transition away from fossil fuels, Vermonters will need to rely more on electricity, and regions will need to develop more in-state renewable electricity generation facilities.

Adaptation and Lifestyle

Because energy use pervades all aspects of our lives, energy planning efforts must consider everything we do: what we buy, what we eat, where we live and work, how we get from place to place, how we design, build, and heat houses and other buildings, how we use our land, how local and state government functions are carried out, and more. Ultimately, many of the state and regional energy goals will require significant adaptations and lifestyle modifications. For example, over time a more compact land use pattern, with a greater percentage of the population living in and near town and village centers, will reduce energy demand by limiting the need for driving, supporting alternative transportation systems, and allowing use of more efficient space heating systems. These compact mixed use centers will also advance energy goals by supporting strong locally-oriented economies.

Reductions in daily energy use will require more than just efficiency improvements. People will have to alter their behavior patterns, using electric utilities, lighting, and heating systems with greater thought given to limiting energy use. It is especially important for Vermont and the Bennington Region to produce food locally because food (itself a source of energy) produced outside the region and delivered here is a major contributor to our total energy consumption—and much of the energy used to grow, process, and transport food from distant locations is derived from nonrenewable fossil fuels. It also will be critical to determine how to best allocate land resources for the production of adequate amounts of both food and energy.

By adding more bicycle and pedestrian infrastructure and encouraging development that accommodates alternative transportation, the region can lessen its dependence on fossil fuels. Currently the layouts of many areas in the region, such as the commercial area of Northside Drive in the town of Bennington, do not promote bicycling and walking as well as they could. For more information, check out BCRC's 2014 **Bike Parking Report**.

VERMONT'S ENERGY GOALS

The State of Vermont has adopted a number of energy goals through both statute and as guiding principles of its Comprehensive Energy Plan. The recently adopted Renewable Energy Standard, for example, requires electricity to be derived 55% from renewable sources by 2017, rising steadily to 75% renewable by 2032. That same legislation sets an aggressive goal for the amount of electricity obtained from locally distributed energy generation. State law also calls for major reductions in contributions to greenhouse gas emissions, weatherization of 80,000 housing units by 2020, and an increase in the amount of in-state renewable energy obtained from farms and forests.

The Vermont Comprehensive Energy Plan (CEP) provides the most broad-reaching energy goal, and the one that forms the basis of the energy forecasts and strategies contained in this Plan:

90% of Vermont's total energy needs shall be derived from renewable sources by 2050.

This regional energy plan, and similar plans developed in each region around the state, target the "**90X50**" goal, using that objective as a basis for determining the amount of conservation and fuel conversion required in each energy sector as well as the amount of new renewable energy generation required across the state.

The 2016 Vermont Comprehensive Energy Plan includes several additional goals that define benchmarks toward attainment of the 90X50 goal:

- **Reduce total energy consumption per capita by 15% by 2025 and by more than one-third by 2050.**

- **Meet 25% of the remaining energy need from renewable sources by 2025, 40% by 2035, and 90% by 2050.**

- **End use sector goals for 2025 include: 10% of transportation energy demand, 30% of building energy demand, and 67% of electricity energy demand met from renewable sources.**

BCRC REGIONAL ENERGY GOALS

The Bennington Region endorses the Vermont energy goals enumerated above, and will pursue policies and actions intended to achieve them. The 2015 Bennington County Regional Plan and this Bennington Regional Energy Plan include the following goals to further guide actions related to energy conservation and efficiency in our communities:

- **Reduce total energy consumption while maintaining a high quality of life and a vibrant economy.**
- **Encourage energy conservation in residential, commercial, industrial, public/institutional, natural resource, and transportation sectors.**
- **Increase opportunities to make energy choices at the local level.**
- **Assure diversity in the mix of energy sources to minimize the impacts of a supply restriction in any particular fuel.**
- **Decrease reliance on non-local energy sources through conservation, efficiency, and the development and use of local renewable energy sources.**
- **Make energy choices that minimize adverse impacts to the environment.**
- **Maximize energy efficiency by matching fuel type to end use.**
- **Assure both an adequate supply of electricity and a secure distribution network to meet the region’s needs.**
- **Promote a sustainable local economy and personal lifestyles that are consistent with future energy realities.**

ENERGY STRATEGIES

In order to achieve these goals, this plan includes a specific list of strategies—divided into three categories—which are described in **Section IV**.

SECTION II.

REGIONAL ENERGY SUPPLY & DEMAND

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ENERGY CONSUMPTION AND DEMAND

Energy used in Vermont, and in the Bennington Region specifically, is obtained from a variety of sources and is used to heat and cool buildings, to operate appliances, equipment, and lighting, and to transport people and products. The total amount of energy used in Vermont has grown substantially over the past 50 years (***Figure 2.1***), with the most growth seen in the transportation sector, which now consumes more energy than residential, commercial, or industrial uses.

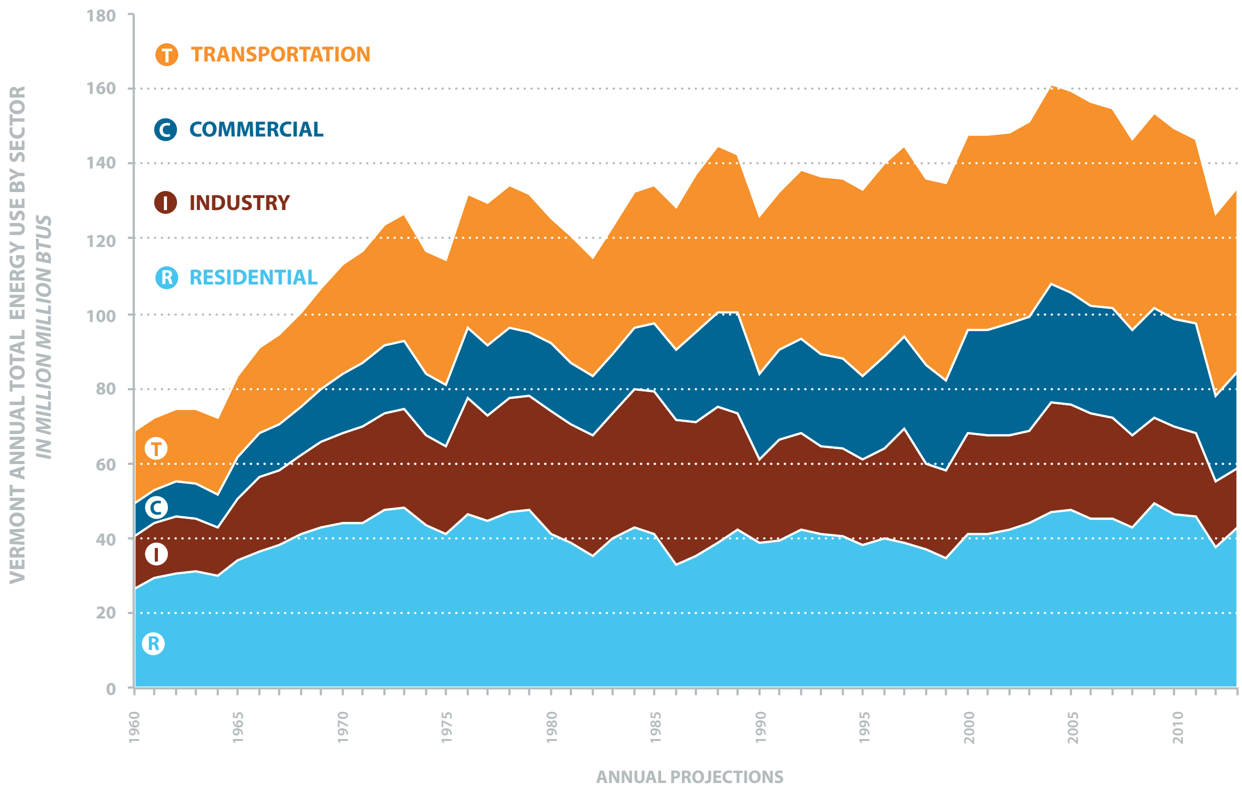

FIGURE 2.1: HISTORICAL ENERGY USAGE IN VERMONT, BY SECTOR, 1960-2014
Energy use in Vermont grew significantly in all sectors in the late half of the twentieth century, reaching what seems to have been a peak in the early 2000's. Total energy use in Vermont declined following the national recession of 2007-2009. Further reductions in energy use will be required to achieve state energy goals.

This section will provide information on regional energy use by sector, with more detailed town-level data included in ***Appendix A***. The amount of electricity that is imported to the region will be considered as well as local energy production and electricity transmission and distribution systems. This understanding of current energy use will provide a basis for considering projections for future savings from conservation and efficiency as well as the need for greater reliance on certain fuels presented in **Section III** of this plan.

Growth and Energy Use

For obvious reasons, the amount of energy used in an area is impacted by factors such as population and economic activity. Growth in energy use in Vermont (shown on the previous page in ***Figure 2.1***) corresponded to consistent growth in population and economic activity from 1950 to 2000. The Bennington Region saw similar growth over that same time period (***Figure 2.2***, below). However, since 2000 growth in the Bennington area has declined (similarly, but to a greater extent, than Vermont as a whole). Between 2000 and 2014, Bennington County's population is estimated to have declined by about 1%, and over that same time, Bennington County's workforce has seen a net decline of over 2,000 workers (more than 10% of the workforce) and about 100 businesses[1]. According to population projections developed by the Vermont Agency of Commerce and Community Development in 2013, also shown in ***Figure 2.2***, that pattern of regional decline may continue for several decades.

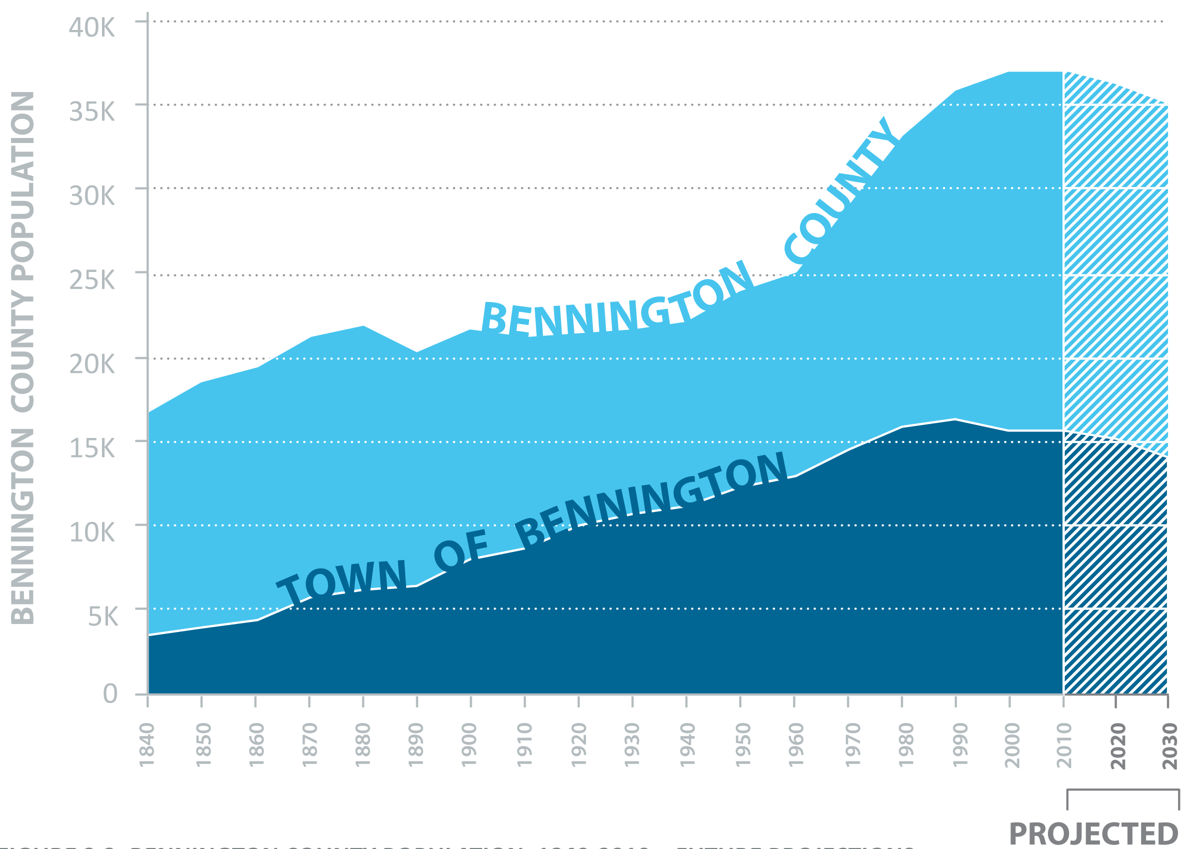

FIGURE 2.2: BENNINGTON COUNTY POPULATION, 1840-2010 + FUTURE PROJECTIONS
The graph above displays historical population growth in Bennington County, as recorded by the decennial census, as well as projections for future population change generated in 2013 by the Vermont Agency of Commerce and Community Development.

The Cost of Energy

In the Bennington Region, recent annual expenditures on energy for space heating, personal transportation, and electricity are estimated to be over $150 million[2] (***Figure 2.3***), amounting to over 4,000 dollars per person. Most of that money leaves the region to pay for imported energy in the form of gasoline, diesel, heating oil, propane, and electricity.

The sector that uses the most imported energy, and the largest user of energy overall, is transportation. Since 2014 (the year used in the calculations portrayed in ***Figure 2.3***, due to data availability), crude oil prices have dropped dramatically, and gasoline and other oil-based fuels have followed. Those prices will inevitably increase in the future, with more money spent on imported energy sources.

Local energy supplies, where they exist in the BCRC region, derive primarily from wood used for heating and electricity generated from the growing number of residential and commercial solar arrays and a few relatively small wind and hydroelectric installations that are used to generate electricity.

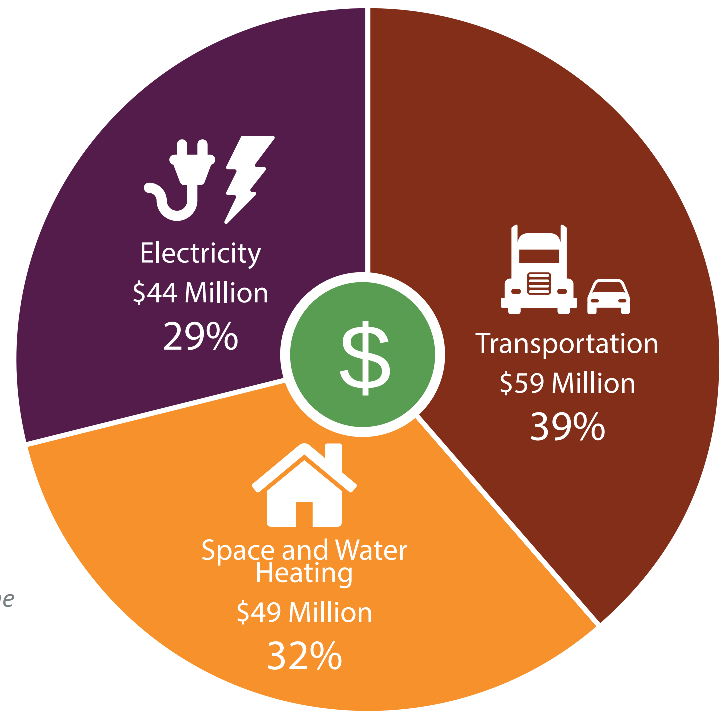

FIGURE 2.3: BCRC REGION ENERGY COST ESTIMATES, 2014

These estimates were created by BCRC staff based on public data from the Census Bureau, the Vermont Department of Motor Vehicles, and the US Energy Information Administration.

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1. Economic data come from the US Bureau of Labor Statistics Quaterly Census of Employment and Wage (QCEW) program, and were accessed through the Vermont Department of Labor Economic and Labor Market Information (ELMI) **Covered Employment Tool***. Data refer to employment and businesses located within Bennington County.*

2. Regional energy cost estimates were developed based on public data from the US Census Bureau's **American Communities Survey** *(ACS) and the US* **Energy Information Administration** *(EIA).*

Space Heating

There are nearly 15,000 households in the Bennington Region, and with an estimated average annual heating cost of $1,700 per capita, a total of over $26 million dollars are spent on various fuel types each year (***Figure 2.4***). With no natural gas pipeline serving the region and efforts to reduce the use of inefficient electric resistance heating, oil is the most widely consumed residential heating fuel in the region. LP gas—cleaner burning but less energy dense than oil—has been installed in many newer homes, and wood, in the form of cord wood and wood pellets, is used in stoves and furnaces as the primary heating fuel in a similar number of homes. The convenience and cost-competitiveness of wood pellets, in particular, has led to widespread adoption of that fuel. Sales of residential pellet stoves, burners for boilers, and new pellet-based whole-house heating systems, have increased significantly in recent years. Historically, use of wood as a fuel has increased when oil and propane prices rose, and decreased when the prices of those petroleum fuels declined. Some households use alternatives for primary heating systems, most likely passive or active solar heating and air source heat pumps (although heat pumps could be classified as a highly efficient electricity-based system).

	Fuel Type: Space Heating	Number of Households	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
1	Tank/LP/etc. Gas	2261 HHs	2.3 Mil Gal	15%	12%	22%	26%
2	Electricity	383 HHs	8.1 GWh	3%	1%	7%	5%
3	Fuel Oil	9779 HHs	7.0 Mil Gal	67%	67%	65%	56%
4	Wood	1993 HHs	12.9K Tons	14%	17%	6%	13%
5	Other	269 HHs	-	2%	2%	0%	-

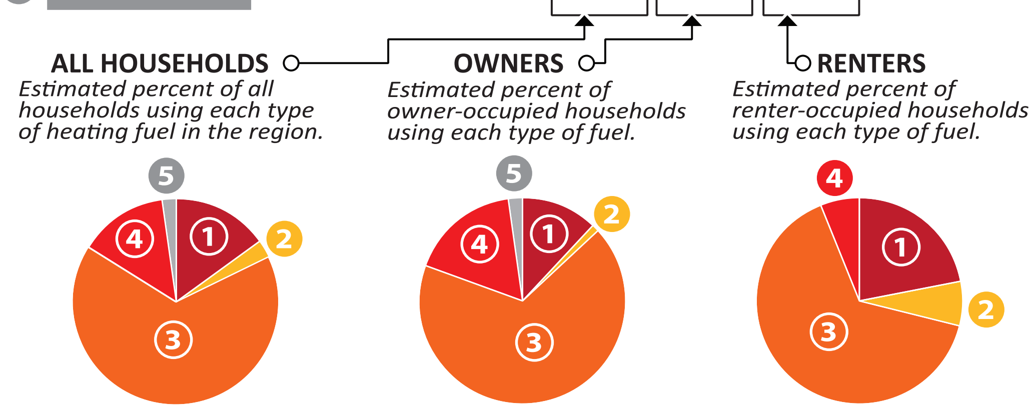


FIGURE 2.4: HOME HEATING ESTIMATES BY FUEL, BCRC REGION, 2014
*The majority of both renter- and owner-occupied households in the BCRC Region use fuel oil. For methodology, assumptions, and town-level data, see **APPENDIX A: BCRC TOWN DEMOGRAPHIC AND HOME HEATING DATA.***

Differences in the heating fuel mix exist among communities in the region. Most of the larger towns, with more densely developed population centers, have a relatively high proportion of households heated with oil and propane. Several of the more rural communities, on the other hand, have a significant number of homes that use wood as a primary heating fuel.

There also appears to be a correlation between the age of the housing stock and the type of fuel used, as towns with older homes tend to use more oil and wood, and those with newer, and often more expensive, homes use more propane and alternative heating systems. The age of the housing stock in a community is particularly important in determining how much fuel a typical home uses since many residential structures built more than 50 years ago are poorly insulated and not well air-sealed. In Bennington, for example, nearly half of the housing units were constructed prior to 1960.

Significant differences in household ownership characteristics also appear to be related to fuel use and energy efficiency of housing stock. In general, owner-occupied housing units are more likely than renter-occupied units to be heated with oil or wood, while a relatively large number of rented units are heated using propane or electricity. Moreover, many rental housing units are located in buildings with relatively poor energy performance, often large older houses that have been divided into multifamily units.

While the overall prevalence of rentals in the region is 28 percent of total housing stock, in some towns—notably Bennington at 38 percent—it is much higher. It is important to recognize these differences in housing characteristics when considering potential strategies for implementing energy conservation and fuel-switching initiatives. Different incentives and technologies will be more effective based on the age, location, and ownership status of the housing stock.

Commercial and industrial uses account for approximately 40 percent of space heating fuel use in the region. There are 1,435 businesses in the region occupying an average of over 12,000 square feet each. Annual heating-related energy costs for these uses amount to over $23 million dollars annually in the region, or over $16,000 per business. Of course, these uses vary widely in size and type of buildings occupied, ranging from small stores or offices to large complexes such as a shopping center, hospital, or college with numerous large buildings. Commercial buildings in the region are heated primarily with oil and propane, and to a lesser degree, wood, while industrial uses consume primarily oil, and some wood, for space heating. Just as in the case of residential structures, the size, location, and nature of commercial and industrial uses will determine the most effective strategies for reducing energy demand and identifying appropriate alternative heating fuels.

Transportation Fuel Use

More energy is used in the transportation sector than for any other activity in Vermont and in the Bennington Region, and the majority of oil and oil-based fuels are used for transportation (***Figure 2.5***). In total, transportation in Vermont consumes about **10 million barrels** of oil per year. In the BCRC region specifically, there are over 25,000 personal vehicles that travel an estimated total of **394 million miles per year**. People rely heavily on their personal vehicles for mobility. For example, an average worker in the town of Bennington commutes a total of approximately 15 miles per day (2010 US Census). With over 8,000 resident workers, mostly commuting in single-occupancy vehicles, daily drives to and from work account for over 100,000 miles per day of travel, and over 1.1 million gallons per year of gasoline consumption just in Bennington. Nearly 70 percent of the transportation fuel used in the region is gasoline; 78 percent when including ethanol that is blended into that fuel. Most of the remaining fuel used is diesel, used in some private cars and trucks as well as commercial trucks, buses, and other heavy vehicles. Expenditures on gasoline and diesel fluctuate with often volatile oil markets, but in recent years have exceeded **$60 million** in the region. Gasoline prices are currently the lowest they have been in several years, but a review of historic price trends and long-term supply and demand projections indicate that the mean price of these fuels will continue to rise over time.

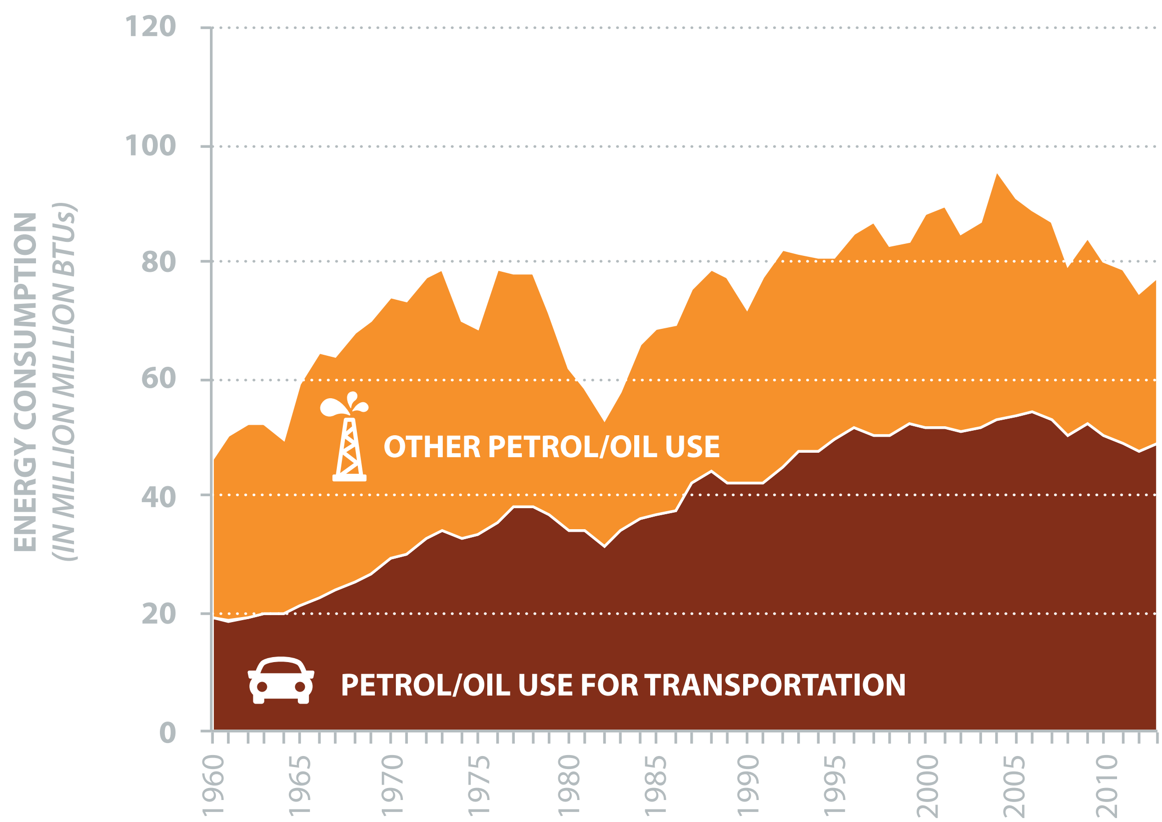


FIGURE 2.5: TRANSPORTATION OIL USE AS A PERCENT OF OVERALL OIL USE IN VERMONT, 1960 - 2014
In the 1960's transportation accounted for less than half of petroleum and oil use in Vermont; but since the 1990's, by which point oil use in the transportation sector had doubled, transportation has been the majority of all oil use.

Transportation Alternatives & Land Use Patterns

Use of alternative vehicles and transportation modes for personal and freight movements can significantly reduce the region's use of fossil fuels. Electric vehicle technology and infrastructure is available and public transportation, carpooling, and rail are all viable options with some presence in the region. Designing communities for walking and biking can dramatically reduce the number of miles driven by residents, and a land use pattern that emphasizes compact mixed use development makes all of these transportation alternatives much more viable.

The use of electricity as a transportation fuel is increasing in Vermont, with over 1,100 electric vehicles registered in the state by early 2016. Approximately 78 percent of those vehicles are so-called plug-in hybrids that can be charged from an external source while also operating like a traditional gas-electric hybrid. Of the total number of electric vehicles in the state, 40 are registered in Bennington County, where there are nine all-electric and 31 plug-in hybrid cars. Most owners of these electric vehicles have charging stations at their homes. In addition, several public charging stations are located in municipal parking lots in downtown Bennington and one in Manchester Center, with several more planned at public parking areas and at local businesses. There are, however, limited options for purchasing and servicing electric vehicles in the region. Although two dealerships do carry plug-in hybrids, none carry all-electric vehicles in their inventories.

Residents and visitors also have access to several other modes of motorized and non-motorized transportation. The *Green Mountain Community Network* (GMCN) is a private non-profit organization that operates out of a facility on Pleasant Street in Bennington. It maintains a fleet of small buses that cover two daily routes on weekdays, a route that runs between Bennington College and Southern Vermont College three days per week, a Saturday route, and daily bus service to Manchester and Williamstown where connections to other bus services and intercity connections can be made. Limited intercity bus service is provided by *Yankee Trails*, with two daily departures from Bennington to Albany, and *Vermont Translines*, which operates a daily route between Burlington and the Albany, NY airport with stops in Manchester and Bennington. Of course, the heaviest use of buses for daily transportation is provided by the school buses that serve most of the public elementary, middle, and high schools in the region. Those buses are not used by as many students as they once were, since many parents drive their children to school and many older students drive their own cars to school.

Carpools, generally used by employees commuting to work, offer significant fuel saving opportunities; every shared ride means one less car on the road burning gasoline. Consider, for example, that four people sharing an average 15-mile commute in a "gas guzzling" SUV (15 miles per gallon) would use one gallon of gasoline per day for the trip. Those same four people driving four separate "fuel efficient" compact cars (30 miles per gallon) would use a total of two gallons of gasoline each day.

Over the course of a year, the savings in fuel and money can be significant. The state's *Go Vermont* program provides online ride matching services to facilitate carpooling. The rate of carpooling varies by town, ranging from near zero in some of the remote rural communities to over 10 percent in Arlington and Bennington where typical carpooling challenges presented by a dispersed rural population commuting in a variety of directions are reduced.

A state-owned rail line enters Bennington from New York State in North Bennington and continues northward along Vermont's "western corridor." A four-mile long rail spur extends from that main line in North Bennington to downtown (at the Bennington Station restaurant). A private company, *Vermont Railway*, has a long-term lease to operate rail services along both of those rail lines. At the present time, there is limited but regular freight movement on the main line, and no rail use on the spur line (other than storage of temporarily idle freight cars). The busy *Pam Am Southern* rail corridor that connects the Albany and Boston areas traverses Pownal.

There currently is no passenger rail service to the region, although recent studies have evaluated alternatives and costs for connecting to the Rensselaer, NY Amtrak station either with a round-trip train each day or with several round-trip bus shuttles between Manchester, Bennington, and the train station.

Bicycle and pedestrian travel has obvious energy-saving and public health benefits. Extensive sidewalk networks exist in Bennington and Manchester as well as in and between the village centers of several smaller towns. Several recent local initiatives and grant-funded projects have begun to improve roadways for use by bicyclists and to develop and extend dedicated bicycle and pedestrian pathways that connect important destinations.

The region's land use pattern, supported by the Bennington Regional Plan (***Figure 2.6***) and the plans and land use regulations of all seventeen municipalities in the region, is characterized by compact development that reduces the need to drive long distances while making it easier to use public transportation and to get around on foot and by bicycle. The amount of energy used and the potential for meeting future conservation goals and transitions to alternative sources of energy are highly correlated with the strengthening of this development pattern.

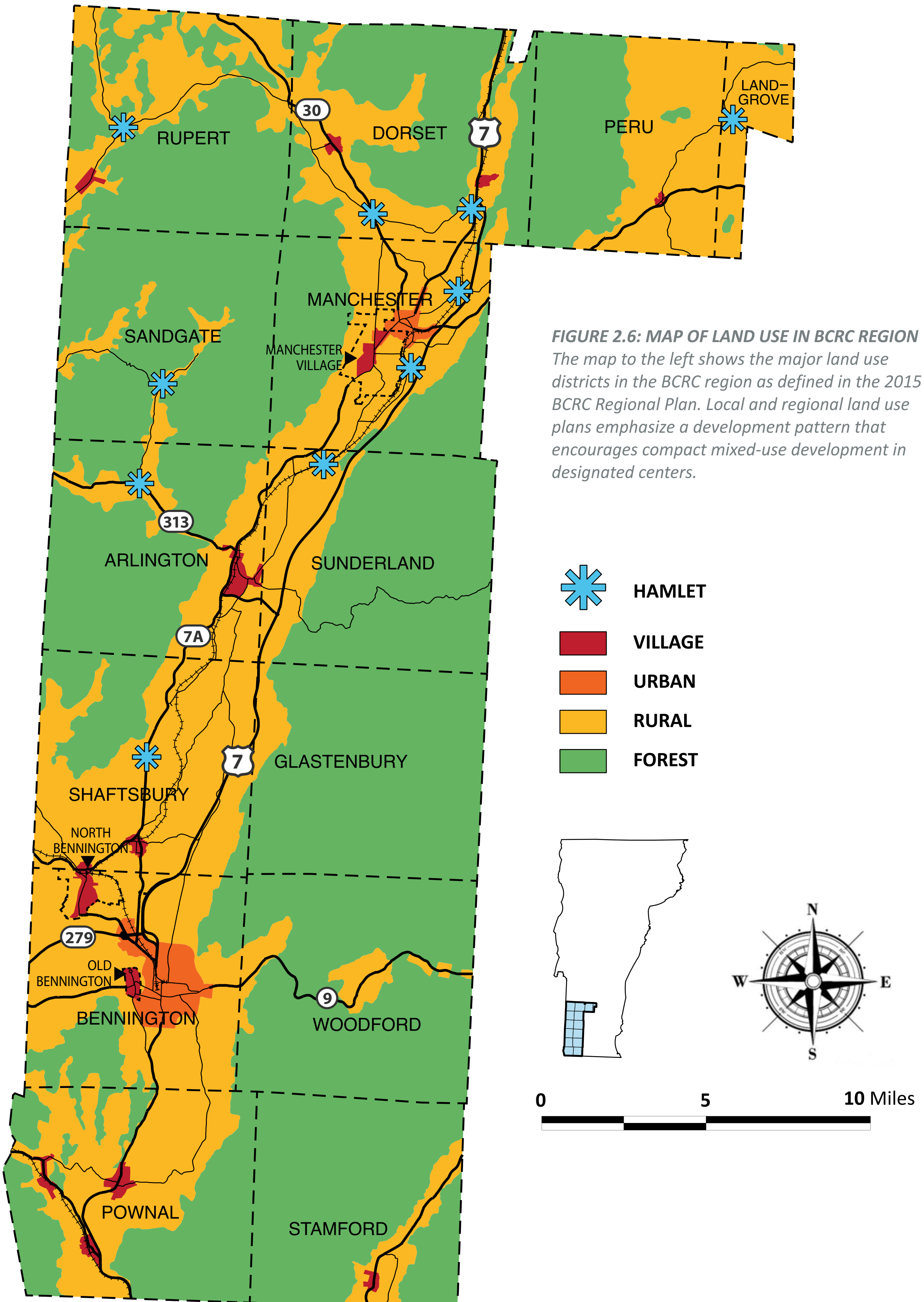


FIGURE 2.6: MAP OF LAND USE IN BCRC REGION

The map to the left shows the major land use districts in the BCRC region as defined in the 2015 BCRC Regional Plan. Local and regional land use plans emphasize a development pattern that encourages compact mixed-use development in designated centers.

Electricity

The amount of electricity used by both households and businesses expanded rapidly for many decades, but began to plateau in the early 2000s, with commercial and industrial consumption accounting for about 60 percent of the total (***Figure 2.7***). It is likely that the introduction and greater availability of energy efficient appliances, machinery, and lighting has contributed to this leveling off of demand for electricity. Electricity use in the BCRC region accounts for about **6%** of Vermont's total annual electricity use.

The state's energy efficiency utility, **Efficiency Vermont**, has played, and continues to play, a critical role in producing savings through its broad-reaching programs in both residential and commercial/industrial sectors. Variations in seasonal electricity demand have been consistent, with highest consumption in the winter months and lowest during the spring and fall. Summer usage rises to an intermediate level due largely to use of air conditioning. The amount of electricity used by an average household in the region has followed a similar trend.

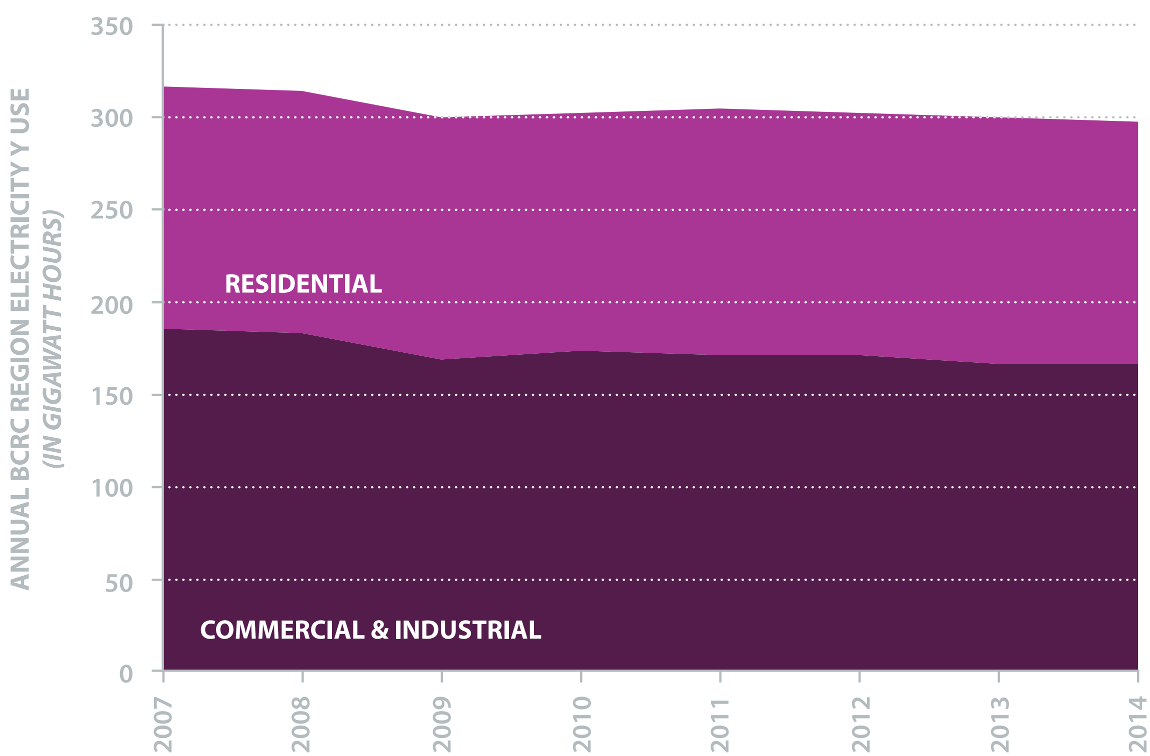


FIGURE 2.7: BENNINGTON REGION ELECTRICITY USE BY SECTOR, 2007-2014
This graph displays all public electricity use for Zip Code areas in the Bennington Region. Commercial and Industrial use, which is greater than Residential use, declined during the national recession, between late-2007 and mid-2009. Residential use has remained relatively level. The same data (for 2014) are broken down into specific Zip codes on the following page in ***Figure 2.8****. Data provided by Efficiency Vermont, a statewide energy efficiency utility that receives electricity consumption data from Vermont ulities and summarizes the data by zip code and town.*

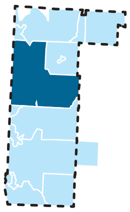
FIGURE 2.8: BENNINGTON REGION ELECTRICITY USE BY ZIP, 2014

*The data from **Figure 2.7** on the previous page is broken down below by zip code area for the year 2014. The town of Bennington and its surrounding areas, where the majority of people and businesses in the region are located, are by far the largest cosumers of electricity in the region.*

RESIDENTIAL

COMMERCIAL & INDUSTRIAL

ARLINGTON | ZIP 05251 + 05252



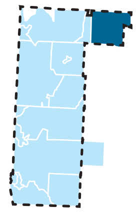
12.5 GWh — AVG: 6,211 kWh

19.1 GWh — AVG: 55,623 kWh

Change in total use since 2007

+1% +18%

PERU | ZIP 05152



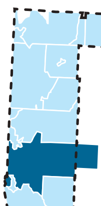
6.3 GWh — AVG: 8,926 kWh

2.8 GWh — AVG: 48,179 kWh

Change in total use since 2007

+2% +92%

BENNINGTON | ZIP 05201



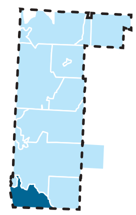
40.8 GWh — AVG: 6,669 kWh

89.7 GWh — AVG: 53,038 kWh

Change in total use since 2007

–1% +3%

POWNAL | ZIP 05260 + 05261



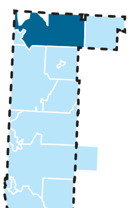
11.0 GWh — AVG: 6,511 kWh

2.6 GWh — AVG: 9,502 kWh

Change in total use since 2007

+3% +9%

DORSET | ZIP 05251 + 05253



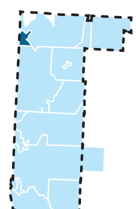
13.1 GWh — AVG: 6,211 kWh

4.2 GWh — AVG: 55,623 kWh

Change in total use since 2007

+0% –1%

RUPERT | ZIP 05776



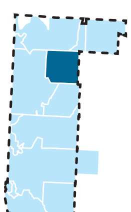
5.3 GWh — AVG: 7,270 kWh

506 MWh — AVG: 6,657 kWh

Change in total use since 2007

–6% +17%

MANCHESTER | ZIP 05254 + 05255



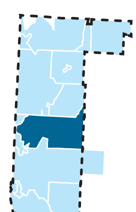
22.3 GWh — AVG: 7,510 kWh

29.2 GWh — AVG: 26,252 kWh

Change in total use since 2007

–3% +30%

SHAFTSBURY | ZIP 05262



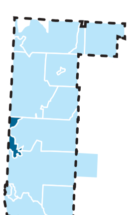
13.0 GWh — AVG: 7,358 kWh

5.5 GWh — AVG: 23,322 kWh

Change in total use since 2007

–1% +7%

NORTH BENNINGTON | ZIP 05257



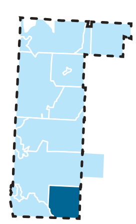
3.2 GWh — AVG: 6,063 kWh

10.7 GWh — AVG: 66,305 kWh

Change in total use since 2007

+3% +12%

STAMFORD | ZIP 05352



5.2 GWh — AVG: 6,234 kWh

872 MWh — AVG: 9,372 kWh

Change in total use since 2007

–29% +24%

As seen on ***Figure 2.8*** on the previous page, the highest rates of electricity usage by household are found in Manchester Village, Peru/Landgrove, and Dorset, probably due to the relatively large size of homes in those communities, while the lowest average residential demand occurs in Arlington/Sandgate and Woodford. Not surprisingly, in towns like Bennington, Arlington, and Manchester, where there are concentrations of businesses and institutional land uses, a majority of electricity demand is from those large nonresidential users. Most of the demand in the region's rural towns is from residential households. Electricity consumption can vary significantly due to changing economic conditions that affect business productivity. This inconsistency is most evident in a town like Peru, where the *Bromley Ski Area* is located, and the need for snow-making and the length of the ski season has a significant effect on annual demand.

Imported Energy

The vast majority of energy used in the Bennington Region is imported in the form of heating fuel (oil and propane), transportation fuels (gasoline and diesel), and electricity. The petroleum heating fuels are distributed by several commercial fuel dealers operating in Bennington County and nearby towns outside the region. Those dealers obtain their oil and propane from large wholesalers, the ultimate point of origin depending on national and world markets and refinery capacities. Transportation fuels, of course, are distributed through the many commercial fueling stations located throughout the region. Electricity flows into the region via the *Vermont Electric Power Company* (VELCO) transmission lines and is distributed to users through a network maintained by *Green Mountain Power* (GMP), the region's electric utility (***Figure 2.9***). The electricity that is delivered to the region is generated from a variety of sources, principally hydroelectric power from Canada and smaller regional generators, and electricity generated from nuclear or fossil fuel powered plants throughout the Northeast.

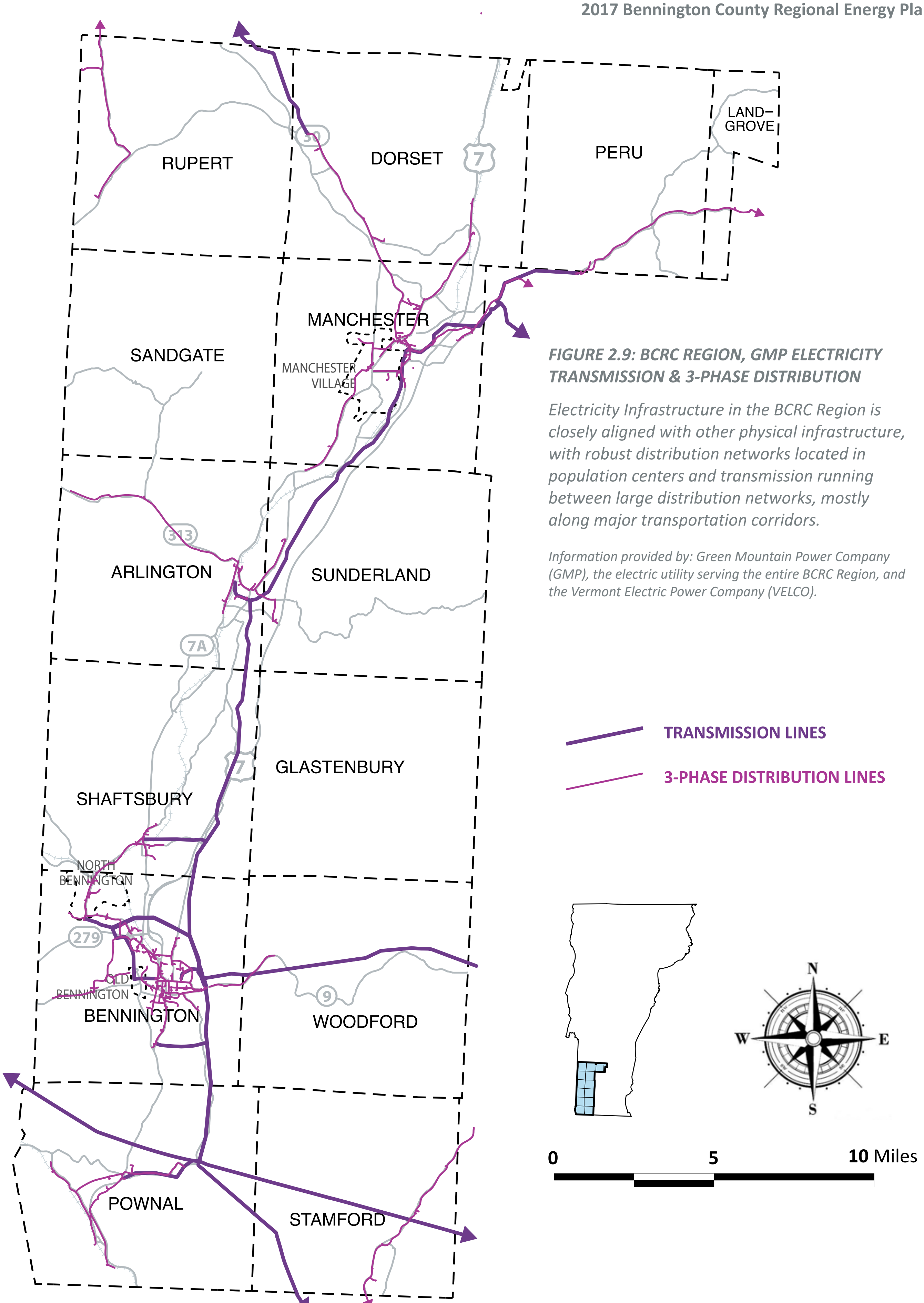


FIGURE 2.9: BCRC REGION, GMP ELECTRICITY TRANSMISSION & 3-PHASE DISTRIBUTION

Electricity Infrastructure in the BCRC Region is closely aligned with other physical infrastructure, with robust distribution networks located in population centers and transmission running between large distribution networks, mostly along major transportation corridors.

Information provided by: Green Mountain Power Company (GMP), the electric utility serving the entire BCRC Region, and the Vermont Electric Power Company (VELCO).

ELECTRICITY FROM RENEWABLE ENERGY SOURCES WITHIN THE REGION

Currently, relatively little electricity used in the region is generated from non-renewable sources, other than the small amounts produced from private generators that are fueled by gasoline and primarily used during power outages. A variety of solar, hydroelectric, and wind facilities are beginning to generate significant amounts of electricity that is fed into the regional electricity distribution system. A detailed statistical overview of all of these energy sources can be viewed at the **Community Energy Dashboard** that has been developed through the efforts of the **Energy Action Network**. (See below.)

BrighterVermont
CommunityEnergyDashboard
BUILDING A BETTER ENERGY FUTURE. TODAY.

The **Community Energy Dashboard** includes an **Energy Atlas** and integrated statistical reporting tool that allows users to see the location and related information for renewable energy projects and to evaluate potential locations for new projects. The Dashboard also enables communities to understand their energy use and make clean energy choices and investments across all energy sectors: electric, thermal, and transportation. This comprehensive information network will support evaluation of the impact of investments in renewables and efficiency in meeting regional and state energy goals.

Solar Generating Capacity

The Bennington Region currently has close to 10 MW of installed solar photovoltaic generation capacity. The largest project in full operation is a 2.2 MW commercial solar array located at the former race track property in Pownal. Additional MWs are generated by commercial and small residential projects that are ground-mounted, with the remainder being small-to-medium sized roof-mounted systems. Just over 0.7 MW are privately owned residential projects. At the present time, only 41 kW of generating capacity are located on farms.

As suggested by the large commercial array in Pownal, that town is home to the greatest generating capacity in the region. Another 2.7 MW of solar generating capacity was developed in Pownal in 2016 through two separate projects, both located in former gravel pits. Nearly 1 MW of solar capacity existed in Bennington as of early 2016 (one 500 kW facility on the west side of town, a 150 kW facility in North Bennington, and numerous small projects throughout the community). At least 12 MW of additional capacity have been proposed in Bennington during the past year: near the County Sheriff's office on Route 7, at the Maneely Industrial Park, and at four locations near the center of town and Route 279. One of the projects planned for an area just northeast of the Route 7/279 interchange, however, was recently denied a *Certificate of Public Good* by the Public Service Board. Other towns with relatively large existing solar generation include Manchester (about 500 kW) and Dorset (about 250 kW). An additional 500 kW project is under consideration in South Shaftsbury.

Wind Generating Capacity

Only a few small residential-scale wind turbines have been installed in the Bennington Region. The total capacity of these facilities, located in Peru, Manchester, and Pownal, is just over 66 kW. Larger commercial projects have been sited on ridgelines just outside the region, in Searsburg and in Berkshire County, Massachusetts. Much of the potential commercial-scale wind generation capacity exists on these north-south oriented ridgelines located on the eastern side of the region and along some prominent peaks and ridges in the Taconic Range on the western side of the region.

One commercial wind turbine company has recently opened a manufacturing plant in an industrial park in East Dorset. That company, *Star Turbines*, produces relatively small turbine systems (6kW to 48 kW capacity) suitable for home, farm, and business use. There may be opportunities to deploy some of these turbines at appropriate locations around the region in the near future.

Hydroelectric Generating Capacity

Hydroelectric facilities once provided a significant amount of the region's electricity, but power generation at most of those dams ceased many years ago. One hydroelectric project that has operated continuously for many years is the facility at Lake Madeline, located on the western flanks of Mount Equinox, a grid-connected project that provides electricity for a monastery and other facilities on the mountain. A dam on the Walloomsac River in Bennington that had been part of a brownfields redevelopment project recently began generating electricity again; that project is rated at 360 kW of capacity. The same company that developed the Walloomsac hydroelectric facility is now working to accomplish a similar redevelopment at a town-owned dam on the Hoosic River in Pownal. That project is expected to have a 500 kW generating capacity. Several small existing dams, mostly located on Paran Creek in North Bennington, and one on the Batten Kill in Manchester Center, have been identified as having a total potential generating capacity of over 200 kW.

Other Sources of Renewable Electricity

Electricity can also be generated from other renewable resources, including woody biomass (especially as a combined heat and power (CHP) project), and biodigesters that use organic waste to produce methane that can be burned to generate power. At this time, none of these facilities exist in the region, although an institutional user in Bennington has considered CHP, and a farm in Bennington explored the potential for a biodigester project.

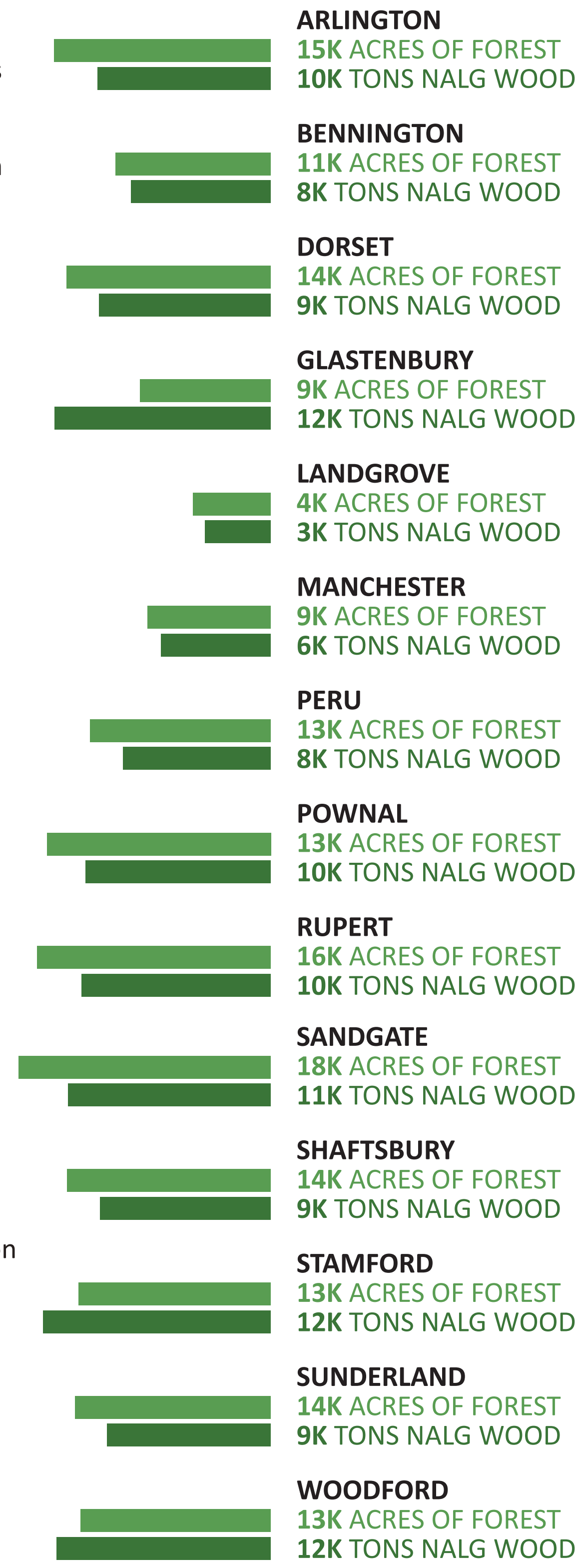
BIOMASS HEAT ENERGY

Biomass is by far the largest current source of energy obtained from the Bennington Region. Much of the cordwood used for heating is sourced from nearby forests. Similarly, many of the woodchips used in institutional heating systems (such as those at Bennington College and at the Mount Anthony Middle School and High Schools) are obtained from forests in or near the region. Approximately three-fourths of the Bennington Region is covered with forests and the amount of new growth is far in excess of the annual harvest, suggesting that a significant amount of additional woody biomass is potentially available to supply local heat energy needs. The proximity of the resource is important since the energy density of wood is low relative to fossil fuels, making it particularly important to minimize transportation costs by procuring the wood close to its end use location.

In 2007, the Biomass Energy Resource Center (BERC) published the Vermont Wood Fuel Supply Study, which was later updated in 2010. The study attempted to quantify the potential for wood harvest in Vermont through three scenarios: *Conservative, Moderate,* and *Intensive*. The numbers to the right in ***Figure 2.10*** reflect the potential harvest by town in the Bennington Region of Net Available Low-Grade (NALG) Wood using the methodology of the *Moderate Scenario* as outlined in the 2007 BERC report[1]. In total, the Bennington Region was estimated to have almost 130,000 Green Tons of NALG wood available for sustainable annual harvest, which is the equivalent of **1 Million-Million BTU's** of energy annually—more energy than the BCRC region currently uses to heat all homes and businesses.

1. In BERC's 2010 revised report, the methodology was changed to be more conservative, reducing the total NALG wood harvest estimates through the moderate scenario by about a third. However, because the 2010 data are not available at town-level, this plan uses methodology of the 2007 scenario. In either scenario, the fundamental finding is the same: the Bennington Region could sustainably harvest far more wood than it does.

FIGURE 2.10: *The graphics below refer to estimates of the amount of forest land (not including certain conserved areas) and potential sustainable annual NALG wood harvest in Green Tons for each town in the region.*



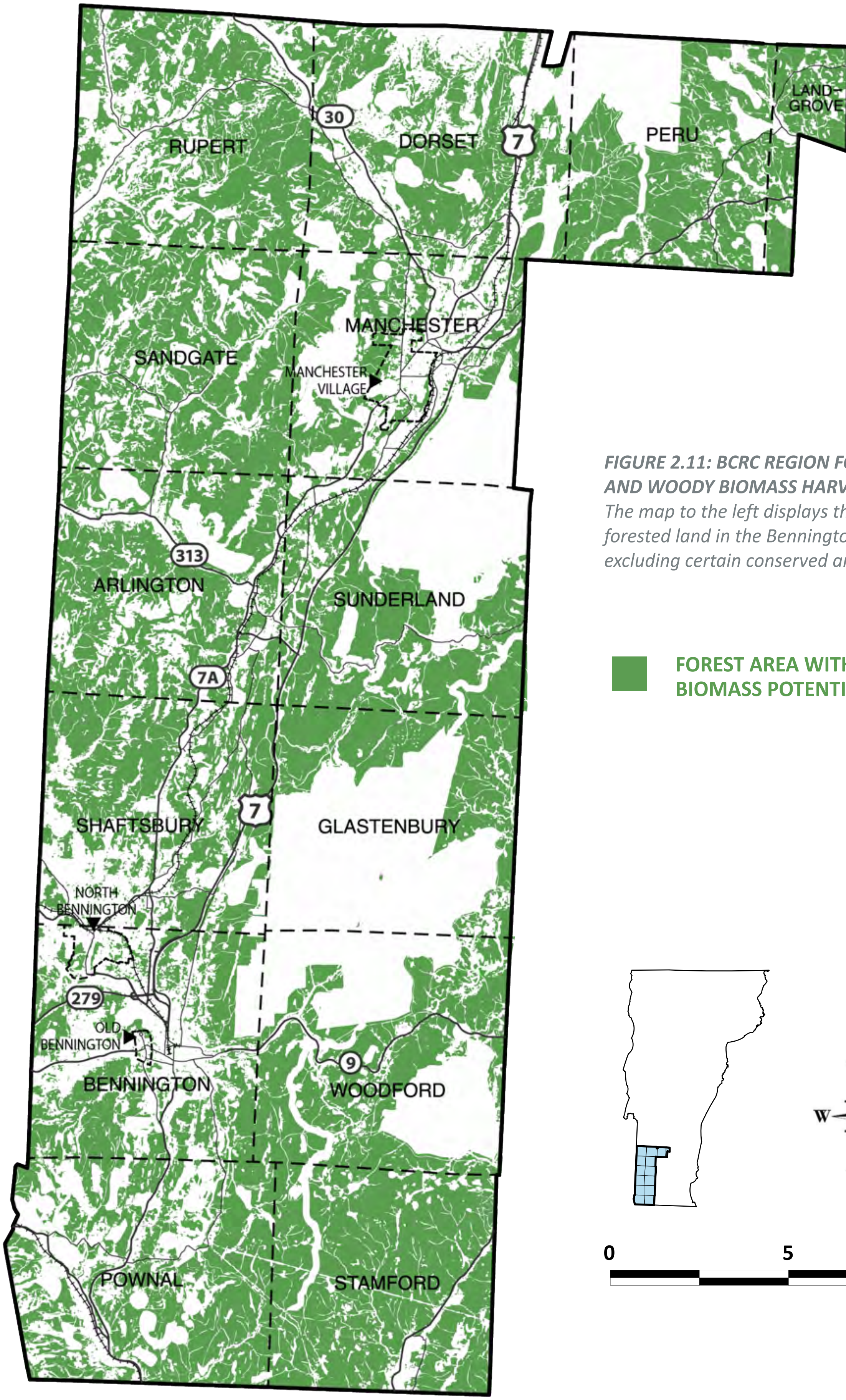


FIGURE 2.11: BCRC REGION FOREST MAP AND WOODY BIOMASS HARVEST POTENTIAL

The map to the left displays the location of forested land in the Bennington Region—excluding certain conserved areas.

FOREST AREA WITH BIOMASS POTENTIAL

SECTION III.

FUTURE ENERGY USE

FUTURE ENERGY USE PROJECTIONS

LEAP SYSTEM

ENERGY DEMAND

ENERGY USE BY FUEL TYPE

RESIDENTIAL ENERGY DEMAND

COMMERCIAL & INDUSTRIAL ENERGY DEMAND

TRANSPORTATION ENERGY DEMAND

FUTURE REGIONAL ENERGY SUPPLY

REGIONAL BIOMASS RESOURCES

ELECTRICITY GENERATION

REGIONAL ELECTRICITY CAPACITY & PRODUCTION

FUTURE ENERGY USE PROJECTIONS

Vermont's goal of obtaining 90 percent of all energy used in the state from renewable sources by 2050 ("90X50") requires significant changes in our transportation system, in the way buildings are heated and cooled, and in the way that we both obtain and utilize electricity. To fully understand the state goal and develop strategies for implementing the actions needed to realize it, an analysis of changes in fuel sources by sector and electricity generation at both the state and regional level is needed. The Vermont Energy Investment Corporation (VEIC) partnered with the regional planning commissions involved in this planning study to develop statewide and region-by-region scenarios that would lead to attainment of the state's energy goal over a 35 year period.

LEAP System

VEIC and the regional planning commissions made use of a program for energy policy analysis and climate change mitigation developed at the *Stockholm Environment Institute* called the **Long Range Energy Alternatives Planning** (LEAP) System to assess current energy use and project future energy supply and demand. The LEAP model is essentially an accounting tool that relies on input data and assumptions to project alternative future supply and demand scenarios. LEAP model components for this project included a target of 90 percent energy supply from renewables by 2050 and baseline data collected from regional sources, utilities, the US Census, the Vermont Public Service Department, and the US Energy Information Administration.

LEAP *Tools for Sustainable Energy Analysis*

The **Long-range Energy Alternatives Planning System** is a widely-used energy modeling software tool. The LEAP System has been utilized by national and state governments and thousands of other organizations in over 190 countries because it offers flexibility in generating sophisticated, multi-variable models at a variety of scales.

Find out more about LEAP at:
www.energycommunity.org

Additional model assumptions were derived from scenario projections established in the Public Service Department's 2014 **Total Energy Study.**

The LEAP model was designed to compare the goal scenario (or 90X50), statewide and regionally, with a reference scenario that assumed a continuation of existing policies that include an increase in vehicle fuel efficiency, and some regional changes resulting from planned expansion of natural gas infrastructure. The 90X50 goal scenario illustrates the types of changes required across all sectors to go beyond the reference scenario and achieve the desired outcomes. An important assumption in the 90X50 scenario is that extensive electrification of heating systems and of passenger vehicles significantly reduces total energy demand because these end uses are three to four times more efficient than the fossil fuel combustion technologies they replace. Those changes highlight the overarching assumptions of greatly expanded utilization of electricity from renewable sources combined with a significant reduction in total energy demand over time.

Energy Demand

The decline in energy consumption required for Vermont to meet its 90X50 energy goal is illustrated in ***Figure 3.1***, which models energy use by sector through 2050. Significant reductions in total residential energy use (driven mostly by space heating improvements) and in total energy used for transportation (largely due to vehicle electrification since the model assumes that total vehicle miles traveled—VMT—remains constant throughout the scenario timeframe) are needed to reduce energy demand to two-thirds of its current level by 2050.

The line at the top of the graph (the reference scenario) tracks energy use assuming Vermont's existing energy policies are implemented and maintained. Therefore, the hatched area represents the additional measures that are needed beyond those assumed in the reference scenario. Note that even the reference scenario shows some decrease in total energy use by 2050, so the total decrease in energy demand required to satisfy the state goal requires savings from implementation of existing policies and programs *plus* significant additional efforts to drive the slope of the total energy demand line downward at a steeper rate.

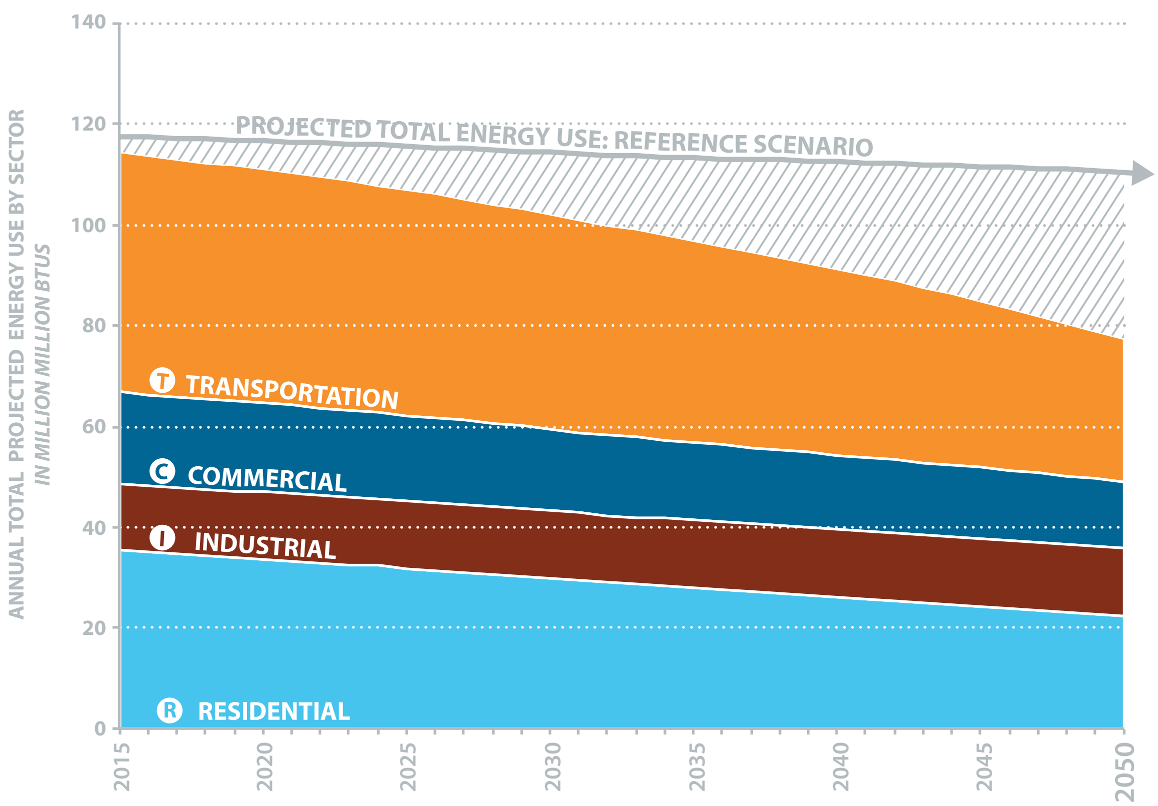


FIGURE 3.1: VERMONT ENERGY USE, 2015 - 2050

Vermont must significantly reduce energy use in order to achieve the 90X50 goal. The LEAP Model scenario used in this plan projects the largest declines in the Transportation and Residential Sectors.

ENERGY USE BY FUEL TYPE

The LEAP program was also used to account for the transition in the amount of energy obtained from each fuel source. This information is critical to developing an understanding of the types of changes that will have to occur statewide and within the region to successfully advance the desired energy goals.

Statewide projections assume a reduction in total energy demand to **90% of present use by 2025**, **82% by 2035**, and **65% by 2050**. Approximately 20% of that demand reduction would be expected to occur by pursuing existing policies and pathways, meaning that new conservation and efficiency strategies will be needed to achieve 80% of the required savings. Particularly notable in the statewide LEAP scenario is the near-complete elimination of our two principal transportation fuels, gasoline and diesel, as well as oil, currently the major fuel used for space heating in many parts of the state, from the energy mix by 2050. Natural gas, while not currently widely used in this area because of a lack of infrastructure (there is no pipeline serving the Bennington Region), also declines steadily in utilization over the 35 year projection period, and is at only 22% of its current level by 2050. Recent proposals to expand natural gas service to new areas of the state through pipeline extensions or establishment of local distribution networks served by compressed natural gas terminals, therefore, need to be considered in this context.

On the other hand, electricity usage in the state is projected to grow by almost 80% statewide by 2050. As noted above, this growth is driven largely by increased use of electricity as a transportation fuel for light-duty vehicles and to drive efficient space heating technologies such as air source heat pumps. The use of wood as a fuel is expected to increase dramatically due to its expanded use for space heating as cordwood and wood pellets displace oil, natural gas, and propane in small residential buildings and as efficient biomass district heating systems become more widespread. The use of liquid biofuels is also projected to increase—primarily as transportation fuels (especially biodiesel for heavy duty vehicles) and for some space heating applications. Current technology requires extensive energy inputs to produce and deliver ethanol (especially) and biodiesel to end users, so assumptions about additional utilization of liquid biofuels rely on as yet unrealized scientific and technological breakthroughs. If the net energy yield of liquid biofuels cannot be radically improved, other changes such as reductions in vehicle miles traveled (VMT), more extensive building weatherization, and other modifications will be needed to ensure achievement of the 90 x 50 goal.

These statewide transitions are reflected to a large degree in the changes projected for the Bennington Region (***Figure 3.2***). Over time, the total amount of energy used should decline by nearly 50 percent, a number higher than the statewide reduction, resulting from lower projected population and economic growth rates in the Bennington Region. At the same time, the use of electricity within the region is projected to increase by 50 percent and will account for 45 percent of total energy by 2050. On the other hand, petroleum transportation fuels steadily decline in the energy mix, being nearly eliminated within the next 35 years. As will be discussed in more detail when examining the transportation and space heating models, liquid biofuels, especially biodiesel, become increasingly prominent energy sources.

Also notable is the fact that the amount of wood used as a primary fuel remains almost constant, but increases (from 13% to 23%) in significance relative to other fuel sources over time as total energy use declines. Finally, compressed natural gas (CNG) shows very little change over time. A greater reliance on CNG, a fuel that is delivered by truck, usually to provide energy for a large businesses or institutions, has been contemplated in the Bennington Region, with discussions even including a possible local distribution network served by CNG docking stations. If widespread use of CNG were to occur in the region, it would affect the LEAP analysis model and could help to replace other less efficient and more environmentally hazardous fossil fuels, at least in the short-run.

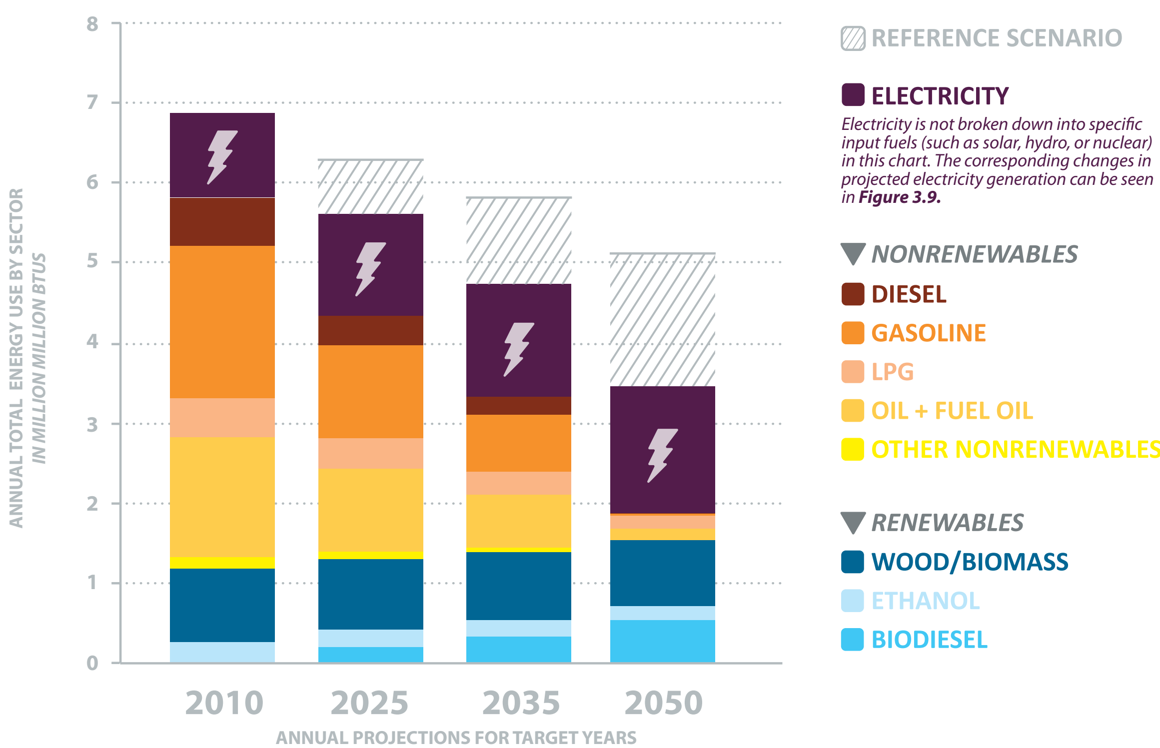


FIGURE 3.2: BENNINGTON REGION, ENERGY USE BY FUEL TYPE, 2010 - 2050

LEAP model projections suggest that the Bennington region will have to decrease energy usage to about half of current levels by 2050 in order to achieve the 90X50 goal—an even greater rate of reduction than Vermont at large.

Residential Energy Demand

Energy consumption in the residential sector accounts for nearly 30 percent of all energy demand in the Bennington region, with approximately 45 million dollars spent annually on heating fuels and electricity in nearly 15,000 households. To achieve overall regional targets that will be sufficient to advance the state's energy goals, the amount of energy used in homes will have to be reduced by approximately 50 percent by 2050 (***Figure 3.3***). This reduction will be achieved through a combination of conservation and efficiency measures. Conservation is achieved through actions such as weatherization of existing buildings and behavioral changes (lowering thermostats, turning off lights and electronics when not in use, etc.) that reduce energy demand.

Efficiency is accomplished through the use of more efficient lighting, appliances, and heating technologies (notably electricity-driven air source heat pumps).

While nearly all residential energy sources decline in use through 2050, it is important to note that the amount of electricity used in the residential sector increases by 17 percent (and more than doubles as a percentage of overall energy use). The increase in electricity use is primarily due to a growing adoption of air source heat pumps as a replacement, or supplement to, existing less-efficient combustion based heating systems. Fossil fuels are nearly eliminated as energy sources, with a small amount of propane (LPG) use remaining, primarily for kitchen appliances, and oil, a fuel that may still be employed in a few larger residential complexes.

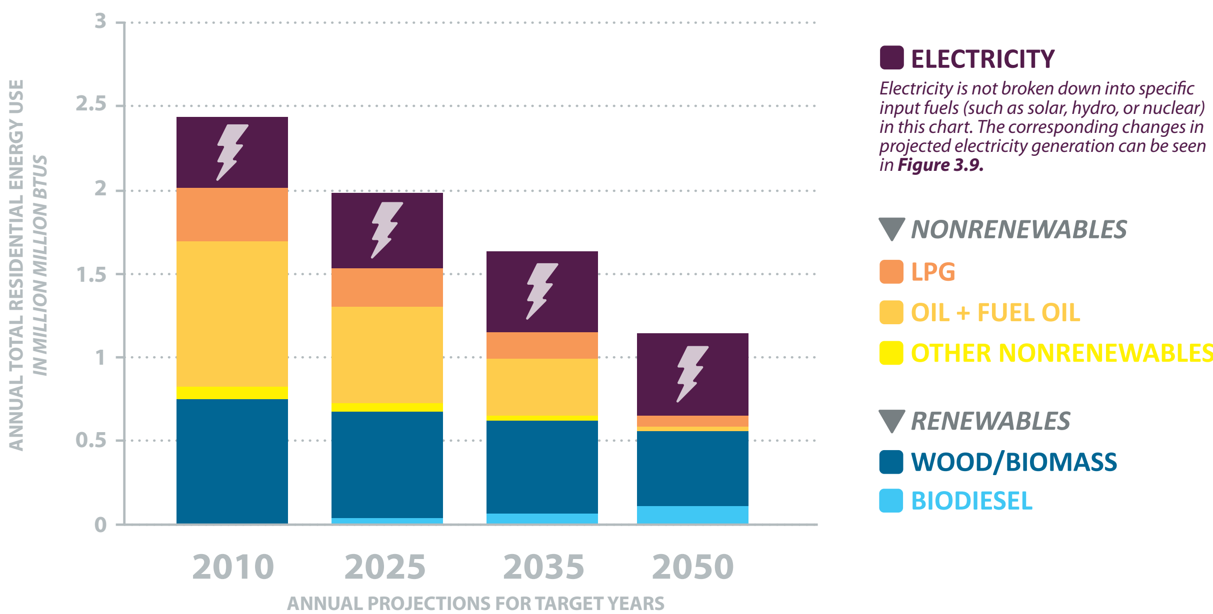


FIGURE 3.3: BENNINGTON REGION—RESIDENTIAL ENERGY USE BY FUEL TYPE, 2010 - 2050
In the residential sector, according to this LEAP scenario, almost all fossil fuel use must be eliminated by 2050,requiring significant gains in efficiency and an increase in the number of homes relying on electricity and wood/biomass.

Nearly 70 percent of residential energy demand is associated with space heating needs. An assessment of energy consumption and changes over time among single-family residences (the majority of regional housing units—consisting of about 11,500 homes) illustrates transitions that are projected to occur through 2050 (***Figure 3.4***). As with overall residential energy usage, consumption of heating fuels will decrease by over 50 percent through 2050. While oil and propane account for approximately two-thirds of current single-family space heating fuel use, the use of those fossil fuels will decrease to a negligible amount by 2050. For example, single-family homes in the region currently burn over 4.5 million gallons of oil per year; that number should fall to 2.8 million gallons by 2025, to 1.7 million gallons by 2035, and to near zero by 2050. The amount of woody biomass fuel (cord wood plus pellets) used will remain nearly constant (pellet use expected to increase while cord wood declines slightly), but will represent a much larger share of the residential space heating market as the total amount of energy use declines. Highly efficient heat pumps, powered by electricity, become prominent, providing heat to a large number of homes, and liquid biofuels are projected to become a significant component of the home heating sector by 2050.

The LEAP model assumes that conservation/ weatherization improvements will reduce residential heating demand by over 30 percent. Nearly 40 percent of the region's housing stock was constructed prior to 1960 and most of those buildings waste energy by being drafty and poorly insulated. Programs operated by *Efficiency Vermont*, *NeighborWorks of Western Vermont*, and the *Bennington-Rutland Opportunity Council's (BROC) Weatherization Assistance Program* have made improvements to over 300 of those housing units, but it is important that most of the remaining 4,500 receive similar energy conservation retrofits.

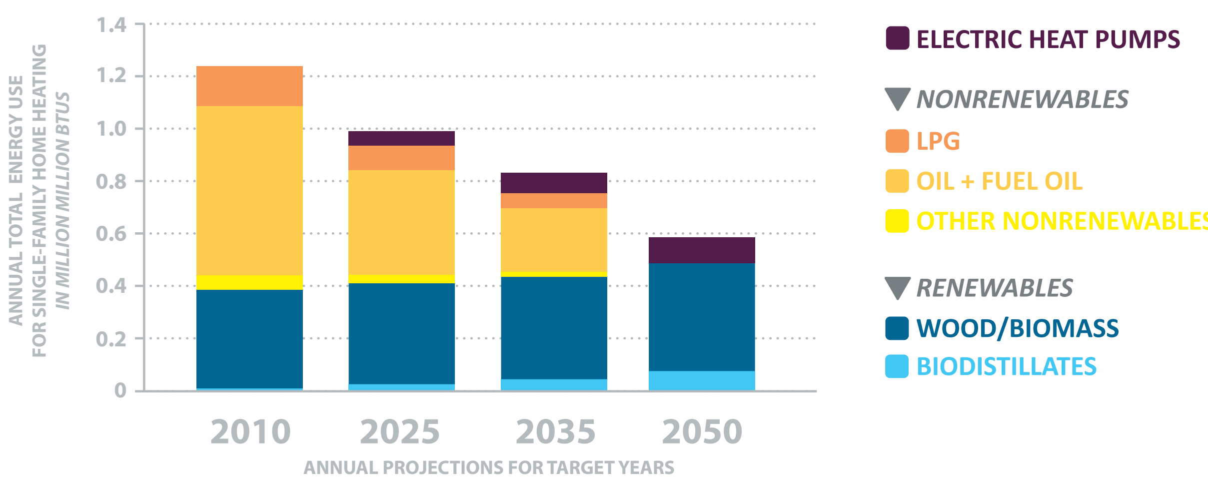


FIGURE 3.4: BENNINGTON REGION ENERGY USE—SINGLE FAMILY RES. HEATING BY FUEL TYPE, 2010 - 2050
According to this LEAP scenario, while total biomass energy use will need to remain roughly constant, the percentage of houses using biomass for heating will need to increase dramatically, with people using more efficient systems and practicing better fuel conservation.

The remaining balance of the home heating energy savings will come from efficiency improvements, particularly the use of "cold climate" air source heat pumps that will be used to retrofit existing homes and in much new construction. In fact, ground source (geothermal) heat pump systems may be even more efficient for new construction. Heat pumps can be used to heat entire homes depending on their size and extent of energy-efficient construction, or may be used as a primary heating source supplemented by another renewable-fuel based heating system. More detail on heat pump technology is provided in **Section IV** of this plan.

Weatherization and efficiency improvements will be responsible for the significant reduction in the amount of energy needed to comfortably heat an average home. For example, the LEAP projections indicate that while a typical single-family home heated with wood uses between five and six cords of wood (or tons of wood pellets) per heating season, a properly constructed new, or weatherized existing, home can be heated with just over three cords/tons per year. Demand for heating fuels will also be reduced by incorporating passive solar heating into all new construction and into renovation projects whenever possible.

Vermont currently consumes petroleum and oil-based fuels at a very high per capita rate compared to other states, largely due to the amount of the heating oil consumed by residences.

Some deviations from the LEAP projections are inevitable. Based on recent experience and strong growth in local manufacturing and distribution of wood pellets, it is likely that pellet stoves and whole-house pellet-based heating systems may form an even larger portion of the home heating market than the currently projected 16 percent. The number of homes heated by some form of wood-based fuel is expected to be well over 50 percent due to the local availability and relatively low cost of this fuel.

At the present time, liquid biofuels are used only in small quantities in some home heating blends (oil/biodiesel). New corrosion-resistant heating systems, more efficient (higher net energy yield) production of biodiesel, and an expanded regional biodiesel manufacturing industry all will be required to realize projected levels of use of this renewable fuel. If those technological and economic breakthroughs do not occur, greater reliance will have to be placed on wood-based fuels and heat pumps.

Multi-family housing in the region, primarily rental units, are currently heated primarily with oil. It is expected that larger residential complexes will move to wood heat, using either wood chips or pellets to heat more efficiently and at lower cost. The Applegate housing development in Bennington, for example, is replacing its aging oil boilers with a modern wood pellet-based district heating system. Smaller multi-family buildings, many of them houses that have been subdivided into two or more apartments, are expected to convert to heat pumps—ideally following comprehensive weatherization retrofits.

These projections suggest general approaches that will be most likely to support the types of transformations that will be necessary to achieve residential sector energy goals.

- **Widespread and extensive weatherization of the region's large inventory of older (pre-1960) housing stock is critical.**
- **A strong move toward wood heat will be needed; such a transition will require new heating equipment (stoves, furnaces) as well as installers and fuel suppliers.**
- **Conversion to wood chip- or pellet-based district heating systems for larger residential complexes will be necessary.**
- **Heat pumps must play a significant role in new construction and especially in retrofits of existing homes; capacity for installation and maintenance of these systems will be crucial.**
- **Technology advances and local supplies of biodiesel will be needed to meet LEAP model projections for use of this renewable fuel.**

Regional strategies designed to take advantage of local resources and drive these changes will be presented in **Section IV**. Those strategies will require extensive local investment and business development as the need for wood-based fuels, locally generated electricity, system installers, and fuel suppliers will grow dramatically over the next 35 years.

Commercial & Industrial Energy Demand

Commercial and industrial uses together account for slightly more total energy demand than do residential uses, although the decrease in consumption in these sectors in the Bennington Region is not expected to be as great as in the residential sector (***Figures 3.6 & 3.7**, next page*). The amount of electricity used in commercial applications is projected to remain relatively constant, as conservation measures continue to be implemented while there is a shift to more electric heat pumps for space heating. Electrification of industrial manufacturing processes (such as autoclaves used in local composites businesses) drives up demand in that sector by 45 percent. Reductions in fossil fuel use will occur in both sectors, with a significant amount of propane use remaining for certain commercial applications and residual fuel oil for industrial applications.

The use of wood (biomass) in commercial (including institutional) and industrial uses will have to grow substantially for the region to meet statewide energy goals by 2050. The LEAP analysis forecasts a tripling in the use of wood energy in the commercial sector and a doubling in the industrial sector by 2050. The many large buildings in these sectors currently use large amounts of oil and propane for space heating. An important opportunity for converting to wood chip and wood pellet based heating systems exists for nearly all of these structures. Moreover, the clustering of these buildings in shopping centers, industrial parks, and institutional campuses makes district heating a viable and cost-effective option for many sites. Bennington College, for example, heats many of its campus buildings with a 400 HP woodchip boiler that has reduced oil consumption by over 300,000 gallons per year. It is important to note, however, that concentrations of wood burning systems could pose threats to air quality unless those systems are properly installed and maintained.

Large-scale wood energy-based district heating systems may offer the ability to generate electricity in certain cases, especially where energy demand is relatively consistent year-round (***Figure 3.5***). A recent assessment of a potential biomass energy system designed to replace the existing oil system at Southwestern Vermont Medical Center has shown that such a "combined heat and power" system could generate up to 350 kW of renewable electricity. The energy and environmental benefits of such systems are complemented by the economic benefits of reducing the amount of money spent on imported energy while supporting opportunities in regional wood fuel businesses.

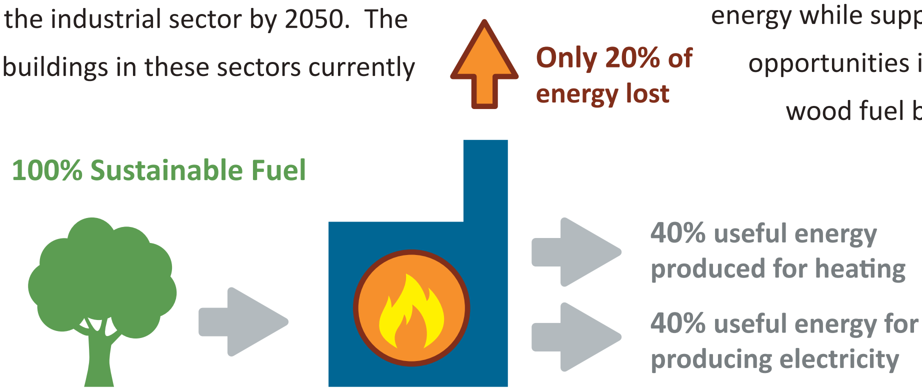


FIGURE 3.5: CHP DIAGRAM. *The region's abundant biomass fuels provide a renewable energy source that can provide heat to large commercial and industrial buildings, and in certain cases, can use combined heat and power (CHP) technologies to also generate electricity.*

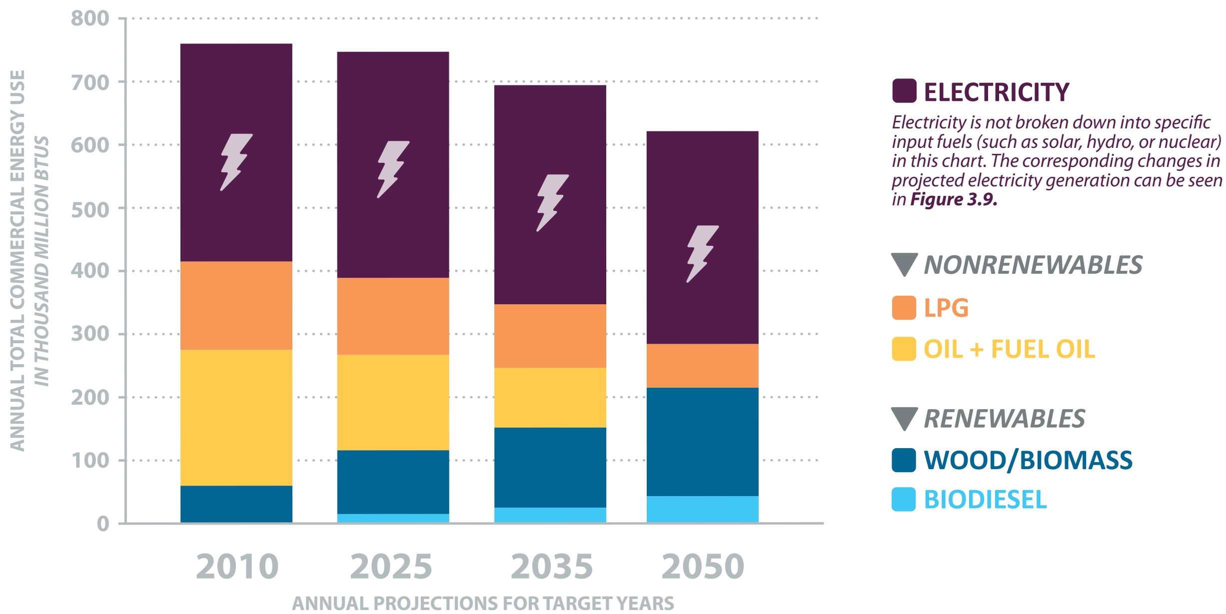


FIGURE 3.6: BENNINGTON REGION ENERGY USE—COMMERCIAL SECTOR, BY FUEL TYPE, 2010 - 2050
The commercial sector will see a more modest decline in energy use, as uses of wood and electricity are expanded, efficiency is improved, and oil is nearly eliminated.

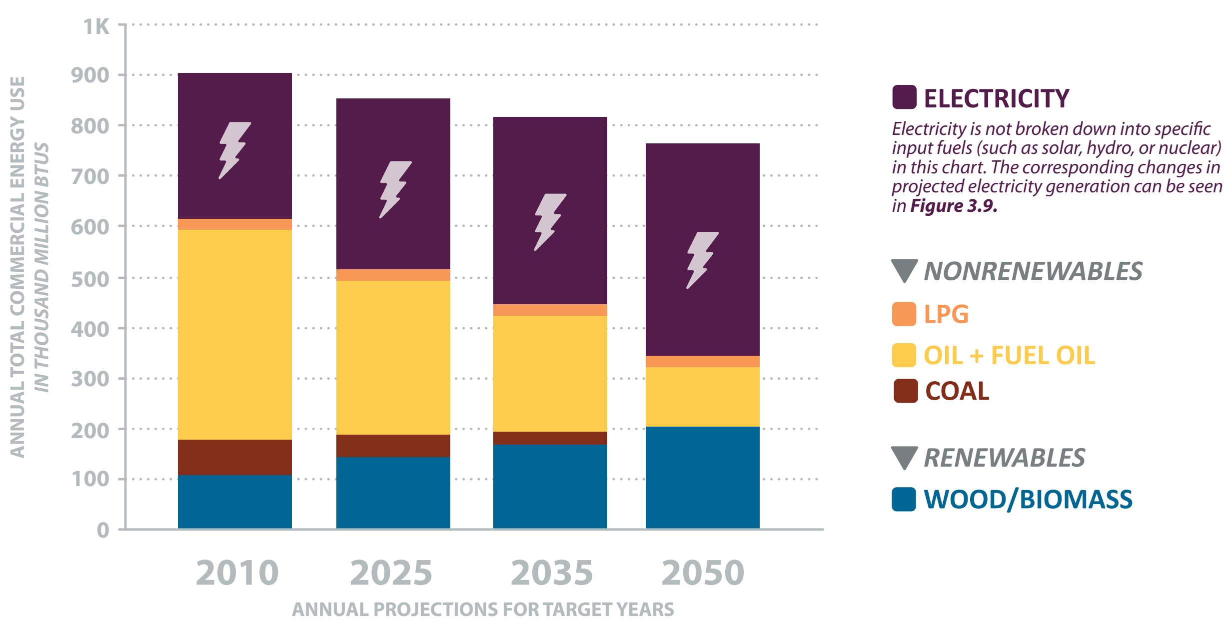


FIGURE 3.7: BENNINGTON REGION ENERGY USE—INDUSTRIAL SECTOR, BY FUEL TYPE, 2010 - 2050
The industrial sector, which includes many of the most high-intensity uses of fuel, will see small declines in overall energy and significant replacement of oil/fossil fuel uses with biomass. Some industrial functions, however, will likely not be able to eliminate oil entirely by 2050, but fortunately, due to savings in other sectors, some oil can remain in use for these purposes (over 100 Billion BTUs annually), with overall energy use still in line with the 90X50 goal.

The region's future demand for transportation fuels is described in more detail below, but it is important to note that transportation is an essential component of all of the region's commercial and industrial enterprises. Commercial businesses require shipments of materials from suppliers for local sales, and distribution and industrial businesses receive raw materials and ship finished products to markets. Tourism also is a major component of the regional economy and it will be necessary to ensure that those visitors have a way to reach the region and have sufficient mobility once here. A greater reliance on rail and public transit is anticipated and alternative fuels—electricity for light vehicles and biodiesel for heavy vehicles—will be used to power the private and commercial vehicle fleet.

With the number of petroleum filling stations expected to decline dramatically with the transition to renewable transportation fuels in the region, it will be necessary to ensure that the tourism sector of the economy adapts to provide convenient access to the region and viable local transportation options.

Biodiesel is expected to become an important fuel in the regional economy, with its application in agricultural uses being particularly significant. Agriculture is expected to become increasingly important to the region's economy over time as the demand for locally produced food grows. The ability to produce biodiesel fuels locally, often for use on the farms where the oil seed crops are grown, offers tremendous opportunities for sustainable energy production. *State Line Farm* in Shaftsbury has already demonstrated the viability of producing vegetable oil and biodiesel fuel from crops for use in local agricultural enterprises.

Soybeans, canola, sunflowers, and other crops can be grown on part of a farm, refined into liquid biofuels on-site, and used to run farm machinery. The net energy benefits of such an application are optimal because transportation costs are minimized. Some farms may specialize in the production of liquid biofuels and export some of the fuels to other farms and businesses in the area.

The energy demand forecasts through 2050 point to key considerations and general approaches for addressing commercial and industrial sector needs.

- **Continuation of conservation and efficiency programs to reduce overall energy demand.**
- **A focus on biomass-based heating systems and district heating system applications for clusters of commercial and industrial buildings. Use of combined heat and power (CHP) technologies whenever feasible.**
- **Greater reliance on electricity due to use of heat pumps in smaller commercial buildings and electrification of industrial processes.**
- **Need to effectively address local and interregional transportation issues.**
- **Integration of local biodiesel production and use into the economy, particularly in agriculture.**

Strategies designed to facilitate these transformations in the region's commercial and industrial energy demand are presented in **Section IV**. Those strategies will, themselves, involve business development and entrepreneurship as well as support from local and state governments.

Transportation Energy Demand

More energy is used for transportation than for any other activity in the region or state, currently amounting to approximately 40 percent of regional energy demand. Personal vehicles owned by residents of the region burn approximately 17 million gallons of gasoline (and up to 3 million gallons of blended ethanol) per year in nearly 400 million miles of driving. Diesel fuel used in trucks, buses, and trains in the region account for another 4 million gallons of fuel consumption.

With nearly all of the region's transportation fuels currently derived from nonrenewable fossil fuels, it is clear that a major transformation in the transportation system will have to occur over the next 35 years to help meet Vermont's energy goals. The overall reduction in transportation energy demand in the region will have to approach 65 percent (***Figure 3.8***), with most of that decline resulting from the near elimination of liquid petroleum fuels (gasoline and diesel) from energy sources used to power vehicles. The amount of gasoline burned by automobiles will need to steadily decline from the current level of 17 million gallons to 10.4 million gallons in 2025, 6.3 million gallons in 2035, to only 250,000 gallons by 2050. The decline in diesel consumption in heavy vehicles mirrors this steady reduction in reliance on gasoline.

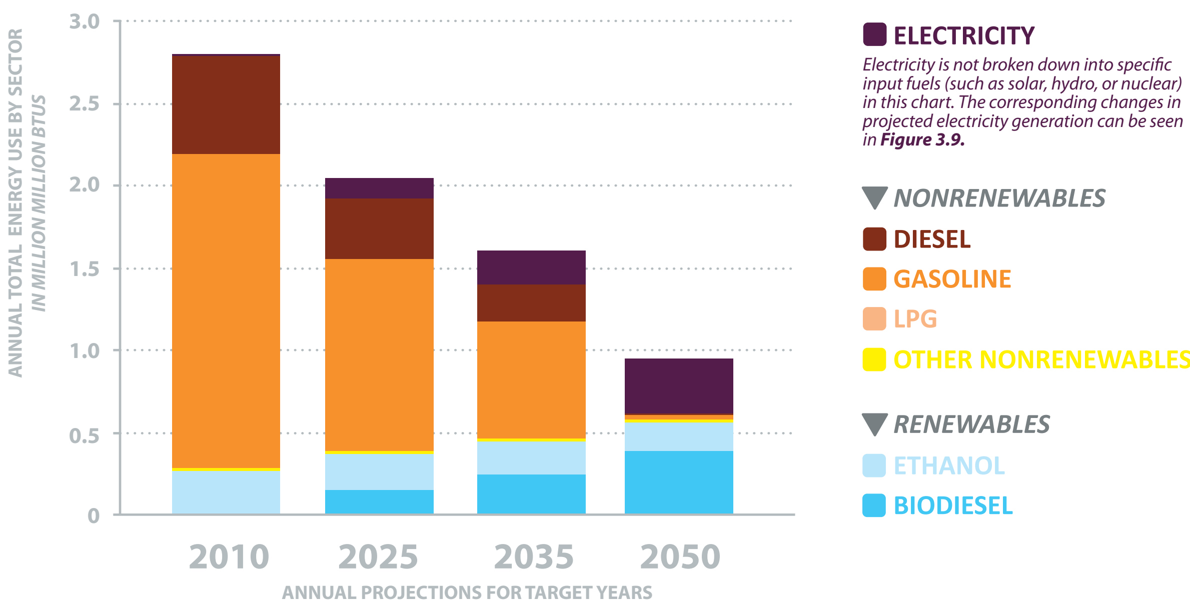


FIGURE 3.8: BENNINGTON REGION ENERGY USE—TRANSPORTATION, BY FUEL TYPE, 2010 - 2050
This graph shows energy use in the transportation sector in the Bennington Region through 2050. Transportation sector fuel usage will need to see the most dramatic decline of any sector in order to achieve the 90X50 goal.

Electricity is projected to assume a major role as a transportation fuel over the next 35 years as highly efficient electric cars begin to replace fossil fuel combustion engines. More electric cars are entering the marketplace ever year (although there currently are no retailers in the Bennington Region), and high-speed charging stations are beginning to appear in many local communities. A growing number of people are also making use of electric-assist bicycles and electric scooters and motorcycles for personal transportation, a trend that supports the forecast by further increasing overall transportation efficiency.

Liquid biofuels, ethanol and biodiesel, are expected to be important transportation fuels in the future as well. Indeed, ethanol is already used extensively as a blend with gasoline, but production of ethanol is notoriously intensive in its consumption of fossil fuels, making its status as a "renewable" energy source (at least with current technology) dubious at best. Future use of ethanol will be as a primary fuel (i.e., not a minor component in a blend) since so little gasoline will be consumed by 2050. Heavy vehicles such as trucks, buses, and trains require diesel because of its greater energy density and ability to power heavy loads. Biodiesel does not deliver quite as much power, but it can be used in these heavy vehicles and while it still requires considerable energy inputs in its production, it can be produced much more sustainably than ethanol. Current challenges with biodiesel include limited availability and the fact that many engine components are degraded by biodiesel (engine manufacturers are already adjusting design to address corrosion issues).

The vegetable oil pressing and biodiesel processing facility at ***State Line Farm*** *in Shaftsbury demonstrates the potential for liquid biofuels in the region.*

The total number of miles driven (vehicle miles traveled or "VMT") has leveled off recently after many years of steady growth in the region. The LEAP model assumes that, even with some population growth through 2050, VMT will remain constant. To achieve this reduction in driving per person over time, along with the targets for alternative fuel use, it will be important to place greater emphasis on a land use pattern than limits the need for driving long distances to work, school, shopping, and other destinations. Compact village centers and downtown areas with a mix of uses surrounded by relatively dense neighborhoods encourage walking and biking and facilitate the use of public transportation systems. Such a development pattern also supports access from outside the region via bus, truck, or rail and simplifies local transportation for visitors arriving using one of these alternative modes.

Several key issues are highlighted by this future vision of the region's transportation system. Foremost is to use limited public funds to maintain existing transportation infrastructure and to support efforts to expand use of alternative fuels and modes. The following factors also suggest approaches and strategies that should be pursued.

- **Electric vehicles for personal transportation will be increasingly common. Businesses that sell and service these vehicles should be available locally and charging infrastructure will have to be widespread.**
- **Liquid biofuel technology needs to advance and fueling and other infrastructure for vehicles that use these fuels will need to become available consistent with the proliferation of those vehicles in the transportation system.**
- **An increased emphasis on compact development patterns, with most residents living in or near, and most new development occurring in, mixed use centers will be an important land use trend over the next 35 years.**

FUTURE REGIONAL ENERGY SUPPLY

Forecasts for energy supply indicate that there will be significant need for additional renewable energy in the form of liquid biofuels and electricity, and that woody biomass will play an increasingly important role in meeting the region's space heating requirements. Prospects for expanded liquid biofuel supplies have already been discussed: technological advances are needed to ensure that net energy yields are high enough for these fuels to be considered renewable. Additional local supply of biodiesel is possible, particularly when produced and used in local agricultural applications. And yet, questions remain about the region's ability to meet growing demand for local resources to support biofuel production, wood-based space heating, and the generation of renewable electricity for heating and transportation, as oil and propane fuel sources will be phased out of the energy system in coming years.

Regional Biomass Resources

Although cord wood, wood pellets, and wood chips are expected to provide energy for heating a majority of the region's buildings by 2050, weatherization improvements and efficient new construction means that there will be only a modest increase in the amount of wood supply needed in the region. The principal challenge in effecting a transition to wood-based heating will be the relatively rapid transition in equipment that will be required along with the need to provide service and fuel delivery for residential, commercial, and institutional customers. The actual resource supply does not appear to be a significant constraint, as was discussed in **Section II**, ***Figure 2.10***.

With over 3 Million Green Tons of wood estimated by the Biomass Energy Resourse Center (BERC) to be available annually for harvest in the state of Vermont and surrounding counties, there is enormous potential for expanded wood-fueled energy. Obtaining an adequate supply of wood to meet future demand is not a simple matter, however, as several key factors require consideration and analysis. Careful forest management will be required to ensure that soil nutrients are not depleted through over-harvesting and that sufficient tops and branches are left on the ground after harvesting. In addition, economic capacity for obtaining, processing, and transporting wood to market will have to be developed within the region. These issues are explored in more depth in the 2012 **Bennington Region Forest Stewardship Plan**.

With approximately three-fourths of the region covered in forests, and extensive forests in neighboring counties, the availability of wood for a source of energy is sufficient to meet future needs.

Electricity Generation

Vermont's supply of electricity currently comes from a combination of in-state and imported sources, with some of those sources classified as renewable and others non-renewable. The recent closing of the Vermont Yankee nuclear power plant in Vernon resulted in a sharp drop in electricity obtained from that source, as well as a significant decline in the amount of electricity generated from in-state facilities. Additional electricity to replace the nuclear-sourced energy has been obtained from regional markets in the northeast, primarily from natural gas powered generators. Hydroelectric energy, primarily from contracts with Hydro Quebec, is a significant source of electricity for the state, and woody biomass provides fuel to two generating facilities in northern Vermont. In-state wind and solar energy are beginning to provide a greater share of Vermont's electricity.

To realize the goal of obtaining 90 percent of all energy used in Vermont from renewable sources, and with significant growth in the demand for electricity anticipated, a transition in the make-up of the state's sources of electricity will have to occur. The LEAP analysis anticipates some continued supply of electricity from regional nuclear facilities, but by 2050 that will be the only electricity obtained from nonrenewable sources. Because of the large amount of generation required to meet the state's demand, it is assumed that by 2050, 50 percent of the electricity used in Vermont will be imported from other states and Canada.

Other than the relatively small amount derived from nuclear plants, that imported electricity will mostly come from hydroelectric facilities (most likely a majority from Hydro Quebec). Total new hydroelectric supply will amount to over 2,400 GWh annually. Hydroelectric generation (existing and projected new supply) will account for almost half of the state's electricity production by 2050, with a significant amount imported.

In-state hydroelectric generation is severely constrained by limited resources and a regulatory environment that places a high priority on minimizing disturbances to natural riverine flow, making new dam construction all but impossible. Most new in-state generation, therefore, is expected to be supplied from wind and solar energy resources. Although wind currently supplies more electricity to the state than solar energy, the amount of solar development in Vermont is projected to grow more rapidly, eventually exceeding the amount of capacity provided from wind resources (**Figure 3.9**).

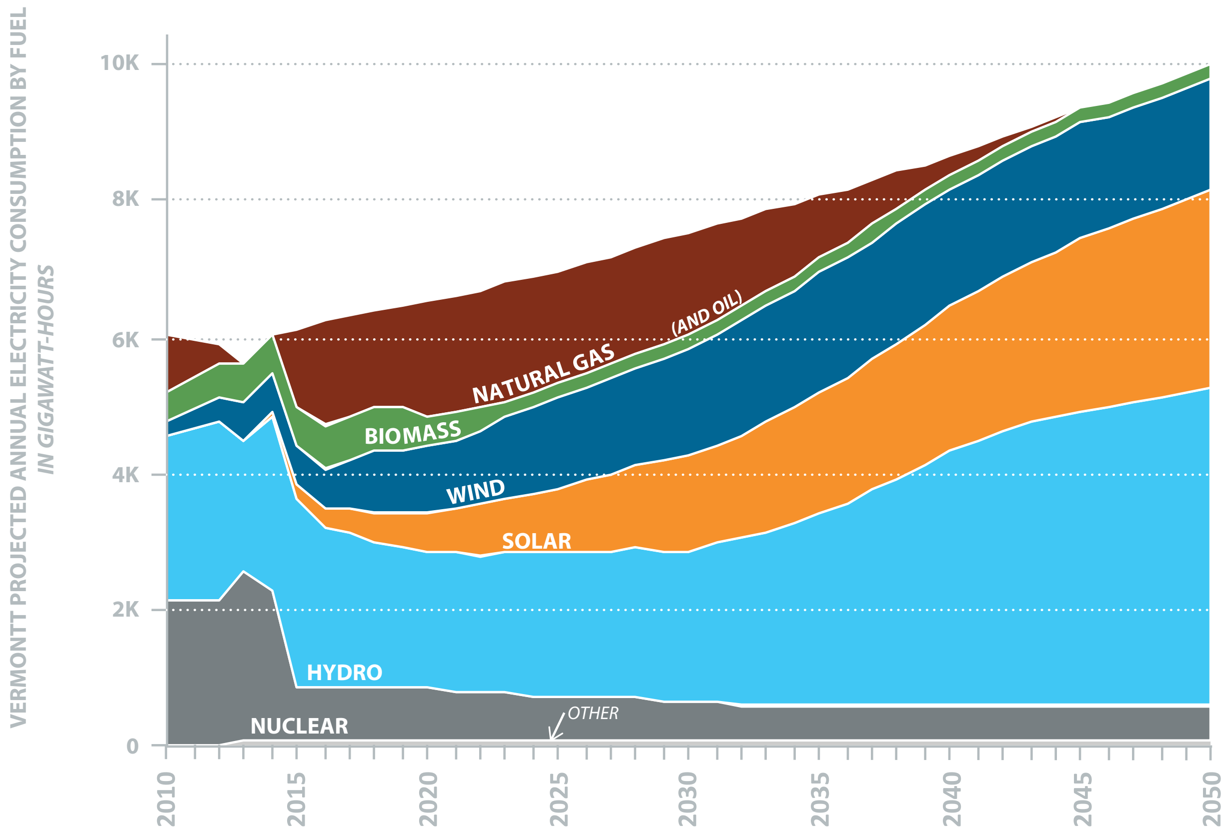


FIGURE 3.9: VERMONT ELECTRICITY CONSUMPTION, BY FUEL SOURCE, 2010—2050.
With the exception of nuclear power from Northeast regional generators, all of Vermont's Electricity sources are projected to convert to renewable fuels by 2050.

Regional Electricity Capacity & Production

It is important to note that the amount of electricity produced per megawatt of installed capacity differs among energy sources. Hydroelectric facilities, because they produce electricity more consistently than wind turbines, have a higher *capacity factor*, and wind turbines, in turn, generally have a higher capacity factor than solar photovoltaic facilities in Vermont. With potential new in-state hydroelectric supply capped at estimated physical limits of under 100 MW of capacity, and with projected generation from in-state solar just slightly more than from in-state wind, the result is that a much greater amount of solar capacity will need to be installed than wind or hydro capacity. However, a relatively small shift to more wind energy would significantly reduce the amount of installed solar capacity needed to meet the 90X50 goal.

Currently, as was discussed in **Section II**, the Bennington region only produces about 4% of the electricity it consumes, deriving from about 10 MW of solar and a very small amount of wind and hydro. Electricity production in the region will need to increase dramatically based on the LEAP scenario modeling analysis. By 2050, the region should be generating a significant amount of electricity from local renewable resources.

Approximately 112 MW of new generating capacity (85 MW solar; 26 MW wind; and 1 MW hydro) will be required within the region to support attainment of state energy goals (***Table 3.1 and Figure 3.10***).

The targets for development and use of new renewable energy sources within the region suggest pathways that should be explored for effective implementation:

- **Widespread weatherization and efficiency improvements (largely through adoption of new heating technologies) will be needed to ensure that the projected supply of heating fuels (wood, electricity, and biodiesel) will be sufficient to meet demand.**
- **Infrastructure will need to be improved to support increased use of electricity, from both local, distributed sources and electricity imported through interstate transmission facilities.**
- **Identification of locations where new renewable energy based generation facilities will be most efficient while also minimizing impacts to the environment, important economic and historic resources, and to residents and businesses.**
- **Section IV of this plan will include strategies to promote these moves toward conservation, efficient alternative heating systems, and policies and geographic analyses that support appropriate generation and use of renewable resources and electricity generation.**

TABLE 3.1: BENNINGTON REGION RENEWABLE ELECTRICITY GENERATION,
The goals for new in-state and in-region generation are listed in the table below for the target years. Wind and solar generation targets have been framed as ranges rather than as specific numbers so that regions and municipalities may determine their ideal mix of solar and wind development based on local resources and constraints. BCRC has identified specific targets for wind (26 MW) and solar (85 MW) based on these ranges. Although the targets look to be much higher for solar energy than wind energy, wind facilities tend to be more efficient relative to their rated capacities in Vermont, so a megawatt of wind can be expected to generated roughly twice as much electricity as a megawatt of solar.

	YEAR	ELECTRICITY CONSUMPTION (GWh)	NEW HYDRO (MW)	NEW WIND (MW)		NEW SOLAR (MW)	
				Low	High	Low	High
VERMONT	2010	5,623	-	-		-	
	2025	6,991	25	65	122	405	608
	2035	8,073	50	260	488	840	1,260
	2050	10,044	93	260	488	1,500	2,250
BCRC REGION	2010	318	-	-		-	
	2025	381	1	9	17	19	30
	2035	421	1	18	34	38	60
	2050	473	1	18	34	68	107
			1	26		85	

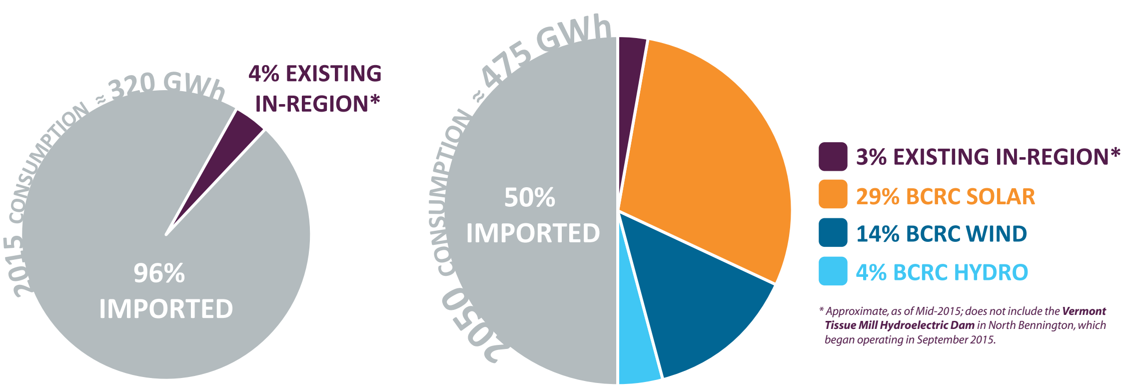


FIGURE 3.10: SOURCE OF BENNINGTON REGION ELECTRICITY, IMPORTED vs. IN-REGION, 2015 and 2050
Electrcity use overall will need to increase significantly in the region by 2050, with in-region renewable generation equivalent to approximately half the expanded 2050 electricity supply.

SECTION IV.

ENERGY STRATEGIES

ENERGY SECTORS AND TARGETS

The previous section of this plan presented short and long range goals for reduction in energy demand and increased use of alternative fuels across all sectors—space heating, transportation, and electricity—in the region. The state's **Total Energy Study** (Vermont Public Service Department, December 2014) and **Comprehensive Energy Plan** (Vermont Public Service Department, January 2016) provide an overview of possible pathways for achieving those goals using a combination of technology, public policy and investments. The Comprehensive Energy Plan also includes information on the many specific programs and initiatives available to advance the goals across each sector.

The purpose of this section of the Bennington Regional Energy Plan is to identify actions specific to this region that are most likely to be successful in sustaining progress toward greatly reducing fossil fuel use through conservation, introduction and acceptance of alternative fuels and technologies, development of local renewable energy resources, and the provision of infrastructure needed to support that transition. Strategies specific to promoting conservation and efficiency in space and water heating (thermal), transportation (including related land use strategies), and electricity are presented, followed by an analysis of the potential for appropriate development of renewable energy resources within the region.

Thermal Strategies

Attainment of Vermont's energy goals requires a dramatic move away from the use of oil and propane for space heating and cooling. Any set of strategies has to begin with reduced fuel consumption through conservation, weatherization of existing buildings and strict adherence to rigorous building energy standards for all new construction. Widespread adoption of alternative fuels and technologies has the potential to reduce energy demand in two ways: through improved overall efficiency, and through greater reliance on locally sourced renewable fuels. The following strategies will require collaboration among local communities, regional organizations such as the BCRC, private businesses, and state agencies. Policy tools that could prove effective, such as a carbon tax with revenues reinvested in conservation and efficiency projects, are not specifically identified in this section since they can be implemented only at the state or federal levels, but the success and the rate of implementation of identified regional initiatives might be enhanced if those, or other, changes were put in place. Information on all of these strategies, as well as local case studies of successful efforts, will be made available on the Community Energy Dashboard.

1 Work with fuel dealers to encourage them to become energy service providers (ESPs).

A consistent challenge that has limited building weatherization and adoption of alternative (renewable based electric or biomass) heating systems has been a lack of resources for sustained outreach and comprehensive follow-through to potential customers. Finding an entity to deliver both the message and the services has been a challenge. Building contractors often are not certified, or necessarily interested in, this type of work and they have only infrequent contact with most property owners. Companies that deliver home heating oil and propane, on the other hand, are known and trusted by business owners, homeowners, and landlords. They also have regular and frequent contact with their customers. Moreover, the amount of oil and gas being sold by most dealers has declined significantly in recent years, with further declines expected. It should be in the interest of those companies to begin to transition their business models to become **energy service providers**. Some area businesses do emphasize efficiency-oriented service calls and upgrading furnaces, but services for building audits, weatherization work (within their own business or in partnership with cooperating building contractors), and sales and service of woodstoves, pellet stoves, biomass furnaces, and biomass fuels all represent significant business opportunities. This business reorientation will result in a steady transition to a more energy efficient regional housing stock. The BCRC strategy will focus on how to help orient area fuel dealers to this emerging market area.

Efficiency Vermont, Bennington College, and other local organizations have offered to work with the BCRC to find ways to help implement this strategy and other energy initiatives. Efficiency Vermont, with support from the Agency of Commerce and Community Development, recently commenced a focused effort to produce energy savings in the Bennington area. This collaboration provides an excellent opportunity to develop a program supported by student-led projects to accomplish the following:

- Organize and hold a forum with fuel dealers that have become ESPs.
- Develop and distribute an information sheet on ESP businesses to all area fuel dealers.
- Hold meetings for fuel dealers and potential partners (BPI certified contractors, pellet manufacturers, etc.).

Bourne's Energy, *located in northern Vermont, provides a full-range of energy services, from home audits to installation and servicing of alternative heating systems. A similar business model could benefit businesses in our region.*

2 Bring NeighborWorks of Western Vermont "Heat Squad" programs to the Bennington Region.

NeighborWorks of Western Vermont (NWWVT) provides comprehensive weatherization services for homeowners, from audits to financing to contracting, through the Heat Squad program. The organization is headquartered in Rutland, but has a service area that includes much of southwestern Vermont, including all of Bennington County. NWWVT has conducted hundreds of home energy audits and has overseen many weatherization projects in Rutland County, but has not had a strong presence or good visibility in our region. One barrier has been a shortage of building contractors qualified to complete the work identified in home energy audits, leading to long delays and discouraging completion of projects. The BCRC strategy will focus on finding ways to make NWWVT's Heat Squad services much more visible and accessible in the region:

- Work with NWWVT to establish and staff a permanent office in the Bennington region.
- Identify and support training for additional weatherization contractors in the area.
- Support NWWVT outreach efforts by helping to organize public meetings, writing newspaper articles, and appearing on public access television and local radio.

Table 4.1: Efficiency Vermont Residential Weatherization Projects by County, 2011-2014*

County	2011	2012	2013	2014
Addison	30	48	99	80
Bennington	53	52	174	80
Caledonia	8	12	24	29
Chittenden	130	160	136	128
Essex	2	1	1	3
Franklin	8	9	18	14
Gland Isle	5	7	3	16
Lamoille	18	31	30	57
Orange	36	38	59	57
Orleans	8	6	19	19
Rutland	152	297	226	178
Washington	134	182	155	148
Windham	79	154	114	132
Windsor	33	59	98	103
VT Total	696	1,056	1,156	1,044

Notes on Table 4.1: *These data include projects completed by partner agencies, including the NWWVT and Green Mountain Power, but they do not include Low-Income Weatherization work (provided by BROC in the BCRC region) or Vermont Gas weatherization projects.*

3 Coordinate efforts with Bennington Rutland Opportunity Council's (BROC) Weatherization Assistance Program.

BROC provides home weatherization services to income-eligible households in our region. Based in Rutland, communication and coordination in Bennington County could be improved to enhance service delivery. The BCRC will help BROC publicize its services through our local networks and will attempt to facilitate coordination among NWWVT, BROC, and other organizations.

4 Expand biomass district heating and combined heat and power systems throughout the region.

The Bennington Middle and High School, and Bennington College campus, are heated with woodchip based systems. Widespread adoption of this technology at appropriate sites will be critical to meeting thermal energy goals. The BCRC strategy will focus on identifying candidate sites (***Table 4.2***), providing education to the owners of those sites, and helping property owners access expertise and resources prior to any major system upgrades or purchases of new system hardware.

- Maintain and update this list of potential schools, college campuses, apartment complexes and buildings, shopping centers, industrial parks, and clusters of businesses.
- Provide information on biomass options to identified property owners and note contacts for outreach by BERC/VEIC. Coordinate these efforts with the Bennington County Sustainable Forestry Consortium. Begin with outreach to public/non-profit entities, housing organizations (Shires Housing, Housing Vermont, Bennington Housing Authority).
- Participate in planning and reviews for projects that involve heating system changes/upgrades (such as the current project at Southwestern Vermont Medical Center).
- As part of the planning for any large-scale district heating project, the BCRC will facilitate communication between the site developer and experts in the field of integrated power generation using CHP (combined heat and power) systems. The potential importance of such systems may vary by type of use and seasonality of energy use, but when feasible, a CHP system can provide valuable and stable electricity to the grid, especially during times when electricity from other renewable sources, such as solar, is not available in sufficient quantity.

*As seen by the examples listed in **Table 4.2**, there are a variety of locations in the region that have the potential to save money and energy by converting to biomass district heating systems. **Applegate Apartments** in Bennington, which is owned by Housing Vermont, plans to link their 104 housing units with a new biomass district heating system. They anticipate saving approximately 50% of current heating costs annually.*

TOWN	#	TABLE 4.2: SITE DESCRIPTION: *POTENTIAL DISTRICT HEATING SYSTEM SITES*
Stamford	**1**	Town office/school building (possibly also fire station and churches)
Pownal	**2**	Former racetrack property (any new businesses at that location) + nearby buildings in Pownal Village (library, church, American Legion, medical building, furniture store,…)
	3	Planned new town hall in Pownal Center Village + fire station + Pownal Elementary School
Woodford	**4**	Prospect Mountain Ski Area + nearby general store
Bennington	**5**	Southern Vermont College campus
	6	Southwestern Vermont Health Care campus
	7	Downtown—as part of, and centered on, potential Putnam block redevelopment (commercial and multi-family buildings)
	8	Monument Elementary School
	9	Bennington Elementary School + Sacred Heart School + former Catamount School buildings
	10	Molly Stark School
	11	K-Mart Plaza shopping center + Kaman Composites
	12	Wal-Mart-Price Chopper Plaza shopping center (possibly adjacent stores along Northside Drive
	13	Hannaford Plaza shopping center + Home Depot + Hampton Inn + Carbone Motors
	14	Bowen Road Industrial Park
	15	Maneely Corporate Park
	16	Morse Industrial Park
	17	NAHANCO and former Northern Cable/TE Connectivity
	18	Applegate Apartments
	19	Willowbrook Apartments
Shaftsbury	**20**	Bernstein Displays - manufacturing building
	21	Shaftsbury Elementary School + fire station + town hall and garage
	22	Peckham Industries
Arlington	**23**	Mack Molding (2 plants) + high school + elementary school + Happy Days pre-school + library (possibly town hall, etc.)
Sunderland	**24**	Sunderland Elementary School
	25	Orvis headquarters
Manchester	**26**	Burr and Burton Academy + Court House
	27	Equinox Resort Hotel + commercial buildings + Equinox on the Battenkill condominiums
	28	Manchester Elementary/Middle School (+ maybe some downtown businesses)
	29	Bourn Brook and Manchester East condominiums
	30	Manchester Knoll and Manchester Commons (Shires Housing)
	31	Equinox Terrace and Equinox Village (multi-family senior housing) + Maple Street School
	32	Town Hall + Public Safety Building + medical building + Manchester Valley Rd industrial park + synagogue + VT Country Store headquarters + Riley Rink
Dorset	**33**	Route 7A industrial park
	34	Dorset School
	35	Town Hall + fire station + church + Wilson House
Peru	**36**	Bromley Mountain Ski Area, hotel, and housing
	37	BBA Mountain Campus

5 Promote use of cold climate heat pumps (primarily air source for existing buildings).

Cold climate heat pumps are a relatively quick and easy way to heat, or provide supplemental heat, for residential and many commercial buildings. If thorough and effective weatherization work is completed, or if a house is already quite well air-sealed and insulated, the great majority of its heating load can be handled by air source heat pumps. Heat pump water heaters also are available and can be integrated with most domestic and small business water systems with relative ease. The BCRC strategy will focus on education of property owners through coordination with Efficiency Vermont and Green Mountain Power, while supporting opportunities to provide incentives and create business opportunities.

- Partner with Efficiency Vermont and Green Mountain Power to broadly communicate information about heat pump systems. Work with Bennington College students to develop outreach materials and public meetings. One public meeting was held recently at Bennington College, with support from Efficiency Vermont and NeighborWorks of Western Vermont.
- Seek incentive funding through Tier 3 of the Renewable Energy Standard (Act 56).
- Coordinate all outreach efforts with fuel dealers and electrical contractors (potentially creating opportunities for electrical contractors to work with fuel dealers).

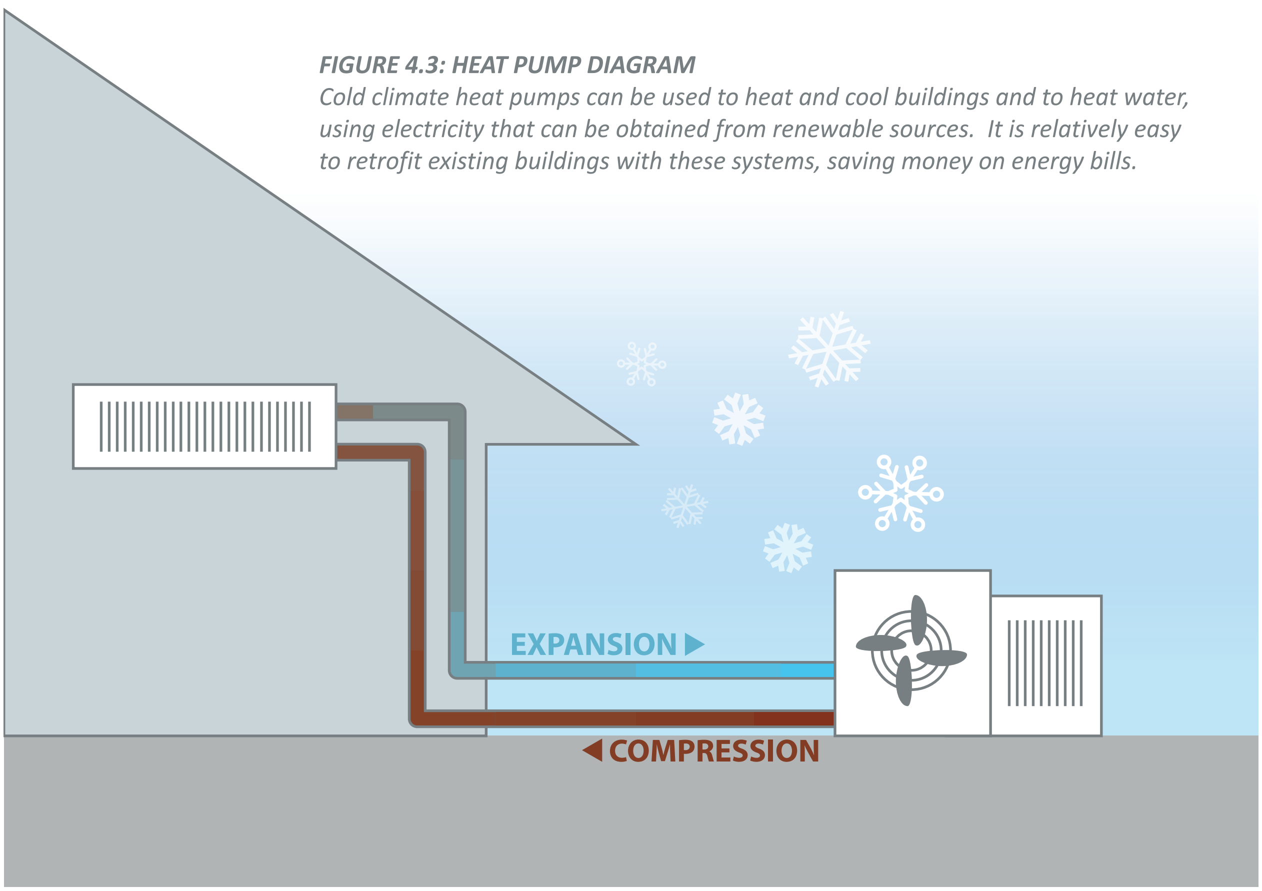


FIGURE 4.3: HEAT PUMP DIAGRAM

Cold climate heat pumps can be used to heat and cool buildings and to heat water, using electricity that can be obtained from renewable sources. It is relatively easy to retrofit existing buildings with these systems, saving money on energy bills.

6 Promote the use of stoves and heating systems that burn woody biomass (cordwood or pellets) in new construction and to replace oil and propane systems.

The BCRC will work with ESPs (per *Thermal Strategy 1*) to be sure that residential and commercial heating fuel customers are aware of the potential for conversions to biomass systems. Information on available stoves, furnaces and boilers, wood and pellet suppliers, and equipment and fuel costs will be provided, as well as sources of low-cost financing such as the Heat Saver Loan program offered locally through VSECU. The BCRC will work with the Bennington County Sustainable Forest Consortium and the Biomass Energy Resource Center to assemble information, case studies, and other information that will support this effort.

BERC
Biomass Energy Resource Center

The **Biomass Energy Resource Center** (BERC) is a program of the **Vermont Energy Investment Corporation** (VEIC). BERC's experts work throughout Vermont, elsewhere in the country, and internationally to advance the use of biomass technology and reduce dependence on fossil fuels. The BERC website lists a variety of biomass-related resources, including: reports, fact sheets, case studies, and links to various other organizations.

7 Organize and hold a workshop and conduct building walk-throughs for owners of rental housing.

The Town of Bennington, in particular, has a very high percentage of rental housing, much of it in older houses that have been converted into multi-family units. Currently, incentives for landlords to undertake energy efficiency improvements and install new alternative heating systems are limited, but units could be greatly improved in quality, and heating expenses reduced, for renters or landlords through such improvements. There is potential for owners of rental housing to increase net revenue from their properties by making them more attractive to a wider segment of the rental market, by reducing heating costs, and by minimizing turnover. The BCRC strategy will focus on outreach to owners of rental housing and will present them with a full array of information on the benefits of these investments. It will also be critical to connect those property owners with contractors and/or energy service providers who can do the necessary work to their buildings.

- Efficiency Vermont has agreed to support this effort by bringing in experts to conduct a workshop and to complete walk-throughs of rental properties. Several owners of residential rental properties have agreed to participate, and plans are underway to expand this effort in the future.
- This strategy area presents another good opportunity to work with Bennington College students, who could develop and distribute information on benefits of weatherization and efficient/renewable energy based heating systems to property owners. Outreach would focus on financing and payback details and results from the pilot project now underway, summarized as case studies for others to follow.

8 Outreach to towns and contractors on use and enforcement of residential and commercial building energy standards for all new construction.

New residential and commercial buildings can be made to meet new “stretch” energy codes. The BCRC strategy will center on working with local officials and contractors to make sure that every new building project conforms to current standards while encouraging conformance with the stretch codes. Systems and resources for municipal officials to integrate evaluations of energy code conformance with building inspections will be explored. A meeting has been scheduled with Efficiency Vermont and Bennington town officials to begin these discussions locally.

9 Support use of geothermal heating and cooling systems for new residential and commercial construction.

The BCRC will assemble information on the benefits of geothermal systems, including case studies of recent projects in our region (Bennington College’s CAPA building, state office buildings in Bennington, retail building in Manchester) and make it available to builders, developers, and entities known to be considering new developments. Geothermal potential is particularly good in Bennington County relative to the rest of Vermont (***Figure 4.4***), and the long-term economic benefits of utilizing such systems should be carefully considered by any multifamily residential, commercial, institutional, or industrial developer.

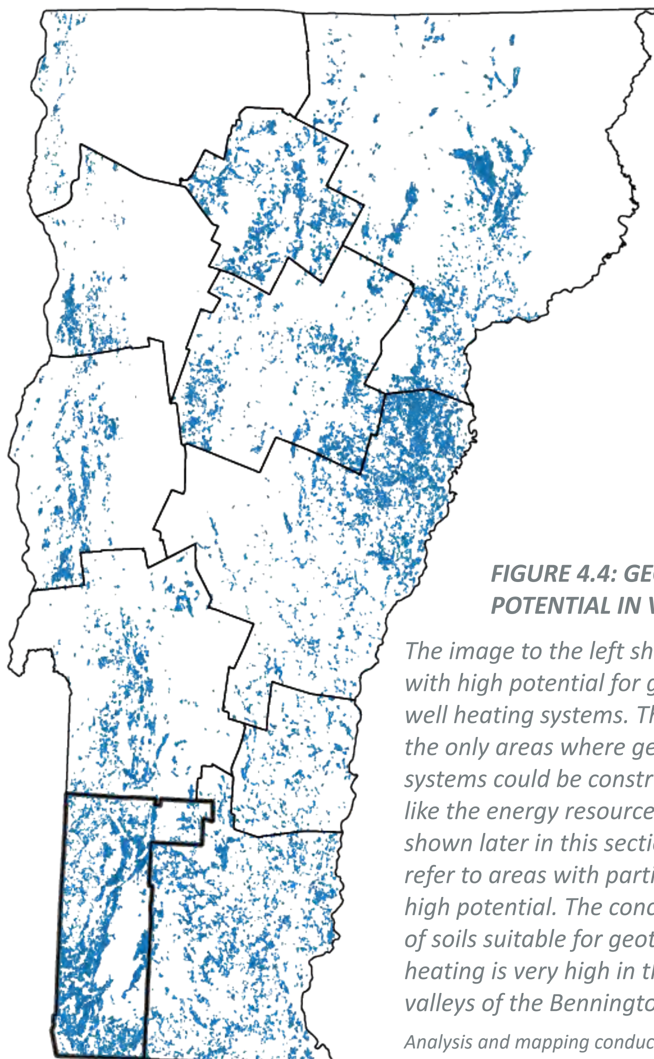


FIGURE 4.4: GEOTHERMAL POTENTIAL IN VERMONT

The image to the left shows soils with high potential for geothermal well heating systems. These are not the only areas where geothermal systems could be constructed, but, like the energy resource maps shown later in this section, they refer to areas with particularly high potential. The concentration of soils suitable for geothermal heating is very high in the main valleys of the Bennington Region.

Analysis and mapping conducted by the Vermont Center for Geographic Information.

Transportation and Land Use Strategies

Energy use associated with transportation currently exceeds that of any other sector, and as shown in Section III of this plan, the required reduction in energy demand from the transportation sector needed to attain Vermont's energy goals is dramatic. Strategies to promote both conservation and efficiency in the transportation system are key to reducing reliance on fossil fuels. Conservation measures are greatly facilitated through a land use pattern that reduces the need for driving while also making it easier to walk, bicycle, and use public transportation. Relatively high population densities in town and village centers that contain a mix of land uses providing goods, services, and employment creates conditions that reduce the need to drive long distances and makes use of alternative transportation modes much more feasible.

The number of electric vehicles (EVs) in use in Vermont has grown steadily in recent years. These electric drive systems are much more efficient than their gasoline and petroleum diesel combustion counterparts, so transitioning to EVs results in dramatic total energy savings, even if the number of miles traveled is not significantly reduced.

Transportation connections to areas outside the region, for both people and freight, also consume large amounts of fossil fuels. Reducing reliance on cars and trucks for these mid- and long-term trips would significantly increase efficiency and lower energy consumption and carbon emissions.

An obvious and effective pathway to a successful transition away from excessive reliance on petroleum transportation fuels exists: a substantial increase in the federal gas tax. Economists and business leaders in the transportation sector all agree that this market based system would affect behavior in ways that would encourage people to live and work in compact centers, purchase fuel-efficient and electric vehicles, use alternative transportation modes, and make greater use of local products and services. As noted in the section on thermal strategies, however, such a policy move is beyond our control and, given the current political environment, highly unlikely to ever occur. Higher fuel costs will come eventually, but until that time, the strategies identified for the region rely on more local actions.

1 Pursue growth and development in compact mixed use centers.

The regional land use plan and the plans of towns and villages in the region all support the concept of high density mixed-use development in compact centers surrounded by rural open land. This development pattern is inherently energy efficient by reducing the amount of driving required to reach destinations and by making alternative transportation modes more viable. Those plans can be strengthened and more effectively implemented in a number of ways.

- The BCRC will work with municipalities to support redevelopment of centers by assisting with the creation of plans for new mixed use development, conducting environmental assessments, and by facilitating coordination among entities that have a role in property development. One example of this approach is the redevelopment planning recently completed for the "Greenberg Block" (***Figure 4.5***) and "Tuttle property" in Bennington's downtown. New development should include the types of housing, commercial attractions, and amenities that support the vibrancy and growth of these areas.
- The BCRC will work with local planning commissions to amend land use regulations and plan infrastructure improvements that support planned mixed use centers. The handbook prepared by the BCRC, **Mixed Use Development in the Bennington Region** (April 2013), provides specific recommendations for regulatory changes and infrastructure improvements. Regulations may also include specific site plan requirements for items like sidewalks, bike racks, and bus stops, while reducing requirements for vehicle parking.
- In village centers where the infrastructure needed to support the desired mix and density of development is not available, the BCRC will support technical assistance projects in cooperation with the *Agency of Commerce and Community Development* and the *Department of Environmental Conservation* that will lead to expanded water supply and wastewater disposal options.
- Programs such as **Village Center** and **Neighborhood Development Area** designations from the *Department of Housing and Community Development* support statewide energy goals by encouraging dense, walkable development in accordance with historic settlement patterns. The BCRC will help towns obtain and maintain these designations by assuring municipal bylaws and plans meet designation requirements and will provide support for revitalizing existing village centers. The BCRC will help identify municipalities with development potential within walking distance of designated centers for participation in the Neighborhood Development Area program.
- Local plans and regulations should promote land conservation and maintenance of the working landscape (i.e., farms, forestry, and supporting uses) over low-density residential development in rural areas. The BCRC should support programs that provide incentives to maintain economically viable rural open lands.

FIGURE 4.5: BENNINGTON AREA-WIDE PLAN, CONCEPTUAL PLANS FOR DOWNTOWN BLOCK
This conceptual mixed use redevelopment plan for a key block in Bennington's downtown would provide a diversity of commercial space, 72 housing units, and attractive open space areas. The BCRC is working with the Town of Bennington to pursue implementation of this plan, as well as other efforts to develop compact, mixed use development in the region's downtowns and village centers.

2 Implement improvements that encourage safe and convenient walking and biking.

People will walk and bicycle more when safe and convenient facilities are provided for their use. The need for these facilities will continue to increase as more people live in and near town and village centers. An important concept for making communities more pedestrian and bicycle friendly is the “complete streets” idea that has been formally incorporated into local and state transportation planning in Vermont. Whenever a transportation project is proposed, it is incumbent upon municipal or state project managers to evaluate the needs of pedestrians and bicyclists and accommodate those needs whenever possible. Additional opportunities are available for developing new dedicated facilities for walking and biking.

- The BCRC will review all new state transportation projects to ensure that complete streets objectives are met. The BCRC will continue to work with municipal officials and staff to develop an awareness of complete streets principles that will be reflected in new town and village transportation projects.
- The BCRC will provide training and sample regulatory language to include in municipal bylaws to ensure that site plan reviews include provisions for requiring features that support pedestrian and bicycle mobility, access, and safety.
- The BCRC will participate in Act 250 land use hearings and request that adequate accommodations be made for bicycle, pedestrian, and public transportation development plans and permit conditions.
- The BCRC will assist municipalities in redesigning streets to improve access for pedestrians and bicycles, and will work to obtain funding to implement those designs. Recent examples of successful street redesign projects include Depot Street in Manchester (***Figure 4.6***), and Benmont Avenue in Bennington, each of which are now moving to implementation.
- The BCRC will identify specific needs for pedestrian and bicycle improvements in the region, including sidewalks, crosswalks, multi-use pathways, and other projects, especially focusing on projects that close gaps in the transportation network and provide access to key destinations in and around town and village centers. Those projects, and implementation plans, will be maintained in the BCRC’s **Active Transportation Project Guide** and updated regularly. Examples of recent projects from the Project Guide now moving to implementation include the “Ninja Path” between Bennington College and the center of Bennington (***Figure 4.7***), the connection between the Applegate and Willow Brook housing developments and the Molly Stark School, and the crosswalks, sidewalks, and road narrowing along Kocher Drive and the US 7 intersection.

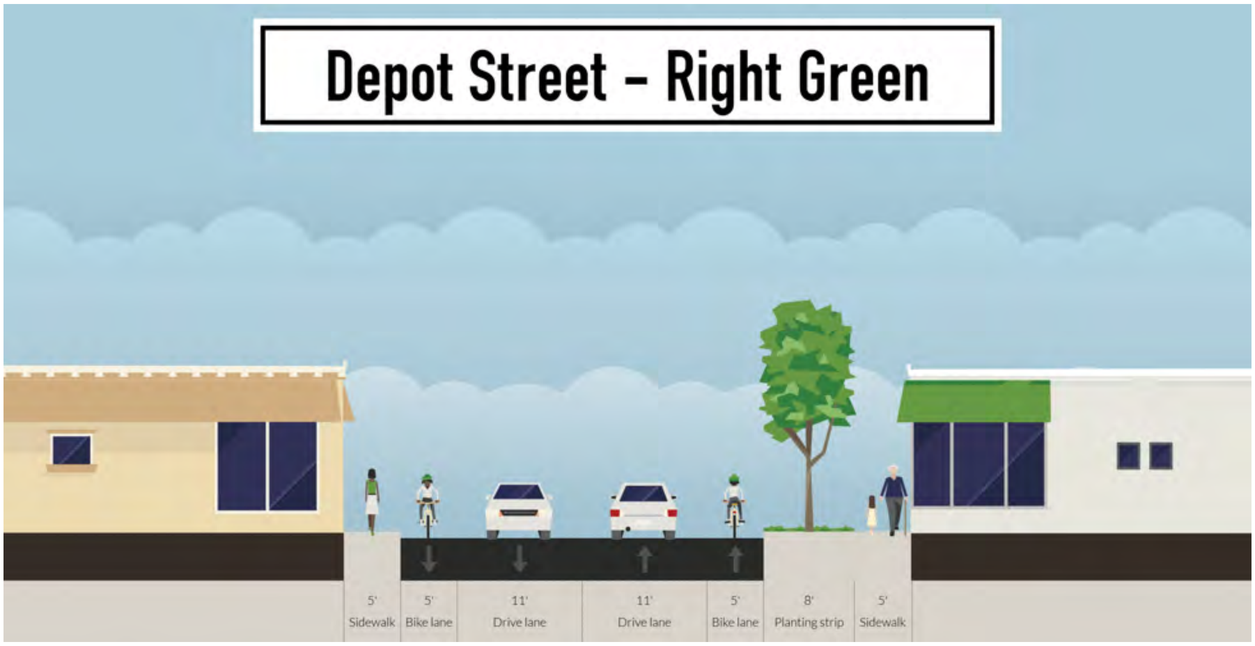


FIGURE 4.6: DEPOT STREET CONCEPTUAL PLAN, MANCHESTER: EXAMPLE SECTION
This section diagram describes the conceptual design for the Depot Street redevelopment project. New on-street facilities will better accommodate cyclists and pedestrians along a critical commercial corridor in downtown Manchester.

FIGURE 4.7: NINJA PATH, BENNINGTON
The "Nina Path" in Bennington will connect Bennington College and North Bennington to downtown Bennington's on-road pedestrian and cyclist facilities, offering pedestrians and cyclists an alternative to the busy commercial corridor along Northside Drive (VT 7A/67A).

3 Increase the use of local public transportation services and carpooling.

Using one vehicle to move multiple people is one of the easiest and most effective ways to conserve transportation fuels. The Green Mountain Community Network (GMCN) bus routes provide an energy efficient transportation alternative for many local trips. Those routes must be convenient and serve destinations when and where demand is highest. Furthermore, the potential for energy savings by expanding ridership on school buses (versus use of private vehicles) is dramatic, as discussed in the Bennington Town Energy Plan (July 2012). Carpooling can also result in dramatic energy savings; a significant opportunity exists through ride-sharing to major employment centers in Bennington, Manchester, and for residents from the region who work in the Albany, NY metro area.

- The GMCN should regularly review and update their route schedules to ensure that they are effectively addressing transportation needs and opportunities.
- Local businesses should consult with GMCN and determine how a route providing commuting services might operate in Bennington. Testing such a route during the annual “Way to Go” commuter program would be a way to promote buses as a transportation option and to see how popular such a service might be in the future.
- The BCRC should work with towns and business groups, such as the regional chambers of commerce, to promote carpooling. In addition to active participation in the Way to Go program, businesses can provide information to employees about the Go Vermont ride share system and provide their own ride-matching services. Information about improved park and ride lots should be provided to employees as well.

4 Expand the use of electric vehicles throughout the region by supporting education, availability, and infrastructure.

Widespread adoption of electric vehicles (EVs) is essential if the region is to meet its energy demand reduction and renewable energy targets. Electric vehicles can replace petroleum fueled vehicles for the vast majority of local trips within the region, but few people have purchased or leased EVs at this time. The limited presence of EVs in the local area means that people are not generally familiar with them, and with minimal demand, regional car dealerships have no motivation to supply them or to develop the capacity for servicing them (although EVs require much less service than a typical gasoline or diesel vehicle). Expanded public EV charging (refueling) infrastructure would encourage commuters and visitors to the area to consider EVs, and would be another way to raise the profile of this transportation option.

- The BCRC should work with the Drive Electric Vermont program to publicize the merits of EV ownership and use to residents and to area auto dealerships. Initially, the emphasis should be on case studies and data that shows how most households can easily replace one of their vehicles with an EV. Events where people can see and operate an EV would be particularly effective, especially when combined with outreach through local newspapers and public access television.
- Municipalities can support public awareness and acceptance of EVs by replacing some of their vehicles with EVs and by providing charging stations at prominent locations in municipal parking lots.
- The BCRC should work with Drive Electric Vermont to provide information to businesses, schools, and other major institutions about how to install charging stations for the use of employees and customers.
- Electric-assist bicycles are a low-cost and extremely efficient transportation option for many people. These vehicles should be included in any outreach efforts on EVs and should be included in events showcasing electric vehicles.

The Town of Bennington has installed several new high-speed electric vehicle charging stations, like this one in downtown Bennington, in municipal parking lots.

5 Provide greater access to intercity passenger rail and expand the use of rail for freight transportation.

Although Bennington County is located relatively close to one of the busiest passenger rail stations in the country, the Amtrak station in Rensselaer, NY, there is no direct connection between that key transportation hub and communities in our region. A simple and user-friendly connection would offer attractive new transportation alternatives for residents and for visitors to the area, greatly reducing the need for people to drive their personal vehicles into and out of the region. Improved rail infrastructure also would make it more feasible to ship some products more efficiently (***Figure 4.8***).

- The BCRC will continue to cooperate with VTrans on a proposal to establish a direct bus shuttle connection between the Rensselaer Amtrak station, Bennington, and Manchester. The shuttle would operate two or three express round trips daily and be included in the Amtrak schedule and ticketing system. The BCRC should continue to seek legislative support for funding and work with Bennington and Manchester to identify and develop shuttle stop locations, car rental opportunities, and to publicize the new service.
- The BCRC, municipalities, and state agencies should support projects that maintain the integrity of the existing main rail lines through the region and should preserve rail access to important industrial sites along rail spurs. Projects that would help facilitate efficient transfers of freight between rail and truck, including development of a local transloading facility, should be supported.

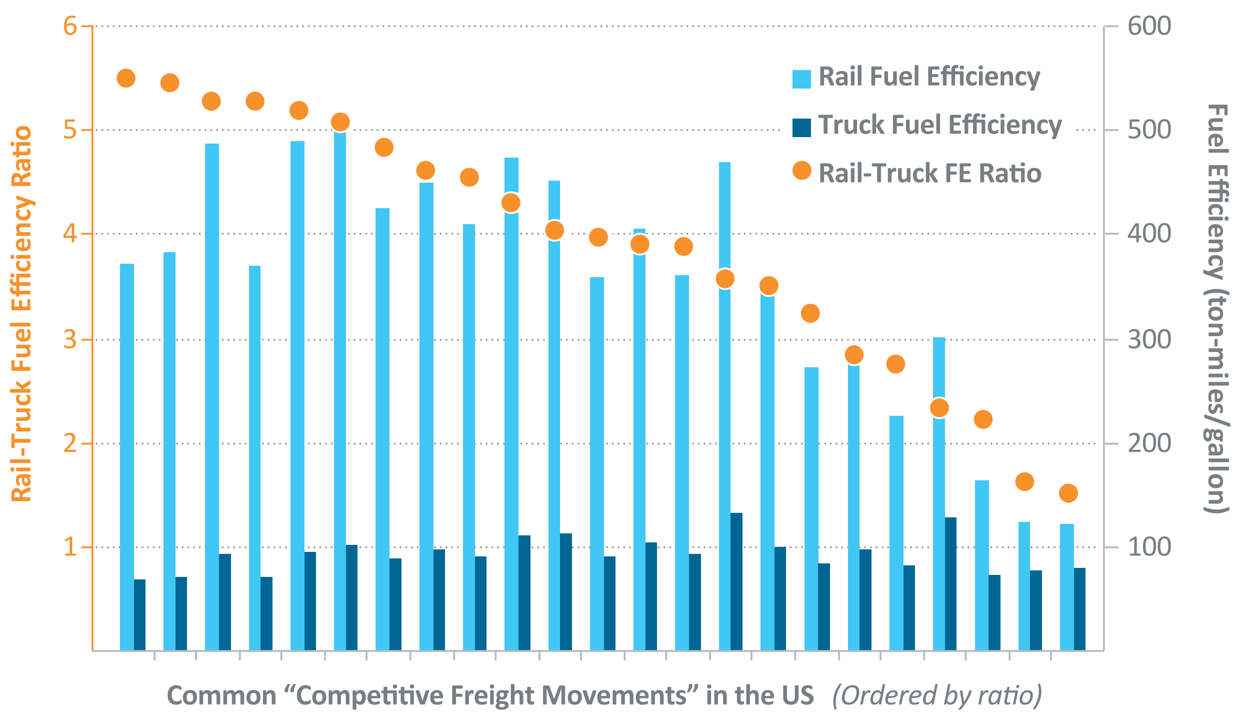


Figure 4.8: Relative Fuel Efficiencies of Freight Movement by Rail Versus Truck
Data are shown for a variety of "Competitive Movements" (various trips that are commonly made by both rail and truck). Rail movements are from 1.9 to 5.5 times as fuel efficient as truck movements, and were found to be more efficient in every one of the 23 movements analyzed above. Data from Federal Railroad Administration, **Comparative Evaluation of Rail and Truck Fuel Efficiency on Competitive Corridors Report***, 2009.*

6 Provide greater access to liquid biofuels for use in commercial vehicles and heavy equipment.

Liquid biofuels are projected to meet a considerable share of the region's future transportation energy demand (see **Section III**). Significant technological advances will be necessary to ensure that these fuels are truly renewable, and the efficiency of this energy source and its value to the regional economy will be enhanced if they are produced relatively close to their point of use.

- The BCRC should support expansion of oil seed crop production in the region, with local manufacture of vegetable oils and biodiesel such as those produced at State Line Farm in Shaftsbury.
- Use of liquid biofuels to power vehicles and equipment used in local agricultural and forestry operations should be strongly encouraged; the BCRC will assist in efforts to obtain funding and expand related business opportunities.
- Municipalities and the state should consider opportunities for purchasing vehicles and heavy equipment that can use biodiesel and should attempt to purchase biodiesel from local suppliers when available. The BCRC should work with local officials and the state to publicize successful case studies.

The BCRC region's rural layout and mostly road-based transportation network poses a challenge to our energy goals. However, by pursuing the strategies listed in this plan, as well as other solutions, residents of the region can cut fossil fuel usage without sacrificing the qualities that make the Bennington region a great place to live.

Electricity Conservation & Generation from Renewable Sources

Vermont will have to rely much more heavily on renewable energy delivered through electricity to meet its energy goals, and that growth in demand for electricity is reflected in the targets for the Bennington Region (**Section III**). Because of the growing demand, largely from the transportation and space heating sectors, it will be necessary to conserve electricity, improve the efficiency with which electricity is delivered and used, and significantly increase the amount of electricity generated from renewable energy sources within the region.

1 Expand the use of electricity conservation programs offered through Efficiency Vermont.

Efficiency Vermont, the state's energy efficiency utility, has over 70 programs and services to conserve electricity and improve efficiency. These programs have effectively curtailed the growth of electricity demand in Vermont in recent years while supporting comprehensive energy efficiency efforts in all sectors. Every effort should be made to continue to foster utilization of existing and new programs and incentives offered through Efficiency Vermont.

- The BCRC and local energy committees should continue to host workshops and other educational initiatives designed to increase awareness and utilization of electricity conservation and efficiency opportunities: energy audits, discounts and incentives for new and replacement electric appliances and equipment, and other initiatives.
- Work with Efficiency Vermont, utilities, municipalities, and commercial and industrial property owners to ensure that all exterior lighting (street lights, parking area lighting, etc.) is converted to LED fixtures.

2 Expand energy storage within the region.

Electricity storage is a developing technology that has the potential for dramatically improving access to electricity produced by intermittent renewable energy sources, such as wind and solar, by making it available for use when it is most needed.

- The BCRC should support initiatives and incentives provided through Green Mountain Power, Efficiency Vermont, and private businesses to encourage the use of new residential and commercial scale battery storage devices.
- Regional policies and municipal land use regulations should recognize the importance of energy storage and provide for its development in conjunction with the development of renewable energy electricity generation projects.

3 Influence behavioral changes to reduce electricity consumption at the individual level.

An average household in the Bennington Region uses over 7,000 kWH of electricity each year. Simple behavioral changes—turning off lights and appliances when not in use, reducing the use of dishwashers, hanging clothes out to dry instead of using an electric dryer—can easily reduce electricity consumption by over ten percent per household. In aggregate, those savings can amount to over 10 GWh and $1.5 million dollars in energy expenditures per year. Similar savings can be realized through behavioral changes in other sectors.

- The BCRC will support the rollout of innovative consumer feedback programs offered by Efficiency Vermont and utility companies. These programs provide clear information on electricity usage and guidance for changes that will reduce electricity consumption.
- Electricity can be more efficiently used by shifting demand to times of the day that match times of peak local generation.
- Full integration of “smart grid” technology throughout the region, accompanied by “smart rate” pricing plans will support this efficiency balancing of electricity demand.
- The **Community Energy Dashboard** should be widely publicized and used by the BCRC and local energy committees to illustrate case studies and statistics demonstrating energy savings.

4 Develop adequate electricity transmission and distribution systems to support increased electricity use in the future.

Much of the region’s future electricity supply will have to be imported from outside the region, as is the case currently. Electricity from Hydro Quebec and other relatively distant renewable sources will need to be brought to the region through transmission lines and distributed into the local grid. At the same time, the Green Mountain Power distribution network will need to handle both the increased imported electricity and electricity from over 80 MW of new generating capacity built within the region. Green Mountain Power’s grid capacity in the Bennington Region is quite high, although upgrades are needed in the Pownal area.

- Cooperate with VELCO in assuring that the electricity transmission system in the region, and leading into the region, has capacity to deliver electricity to the region and to transmit electricity from any large-scale generation facility planned for the region to the grid.
- The BCRC should coordinate regional energy planning with Green Mountain Power, ensuring that areas planned for new renewable energy generation projects are consistent with the capacity of the grid infrastructure and that any upgrades needed are implemented.
- Support local electricity generation from renewable energy resources, especially distributed generation that directly supports the local grid.

5 Plan for an adequate amount of new electricity generation from renewable energy resources within the region.

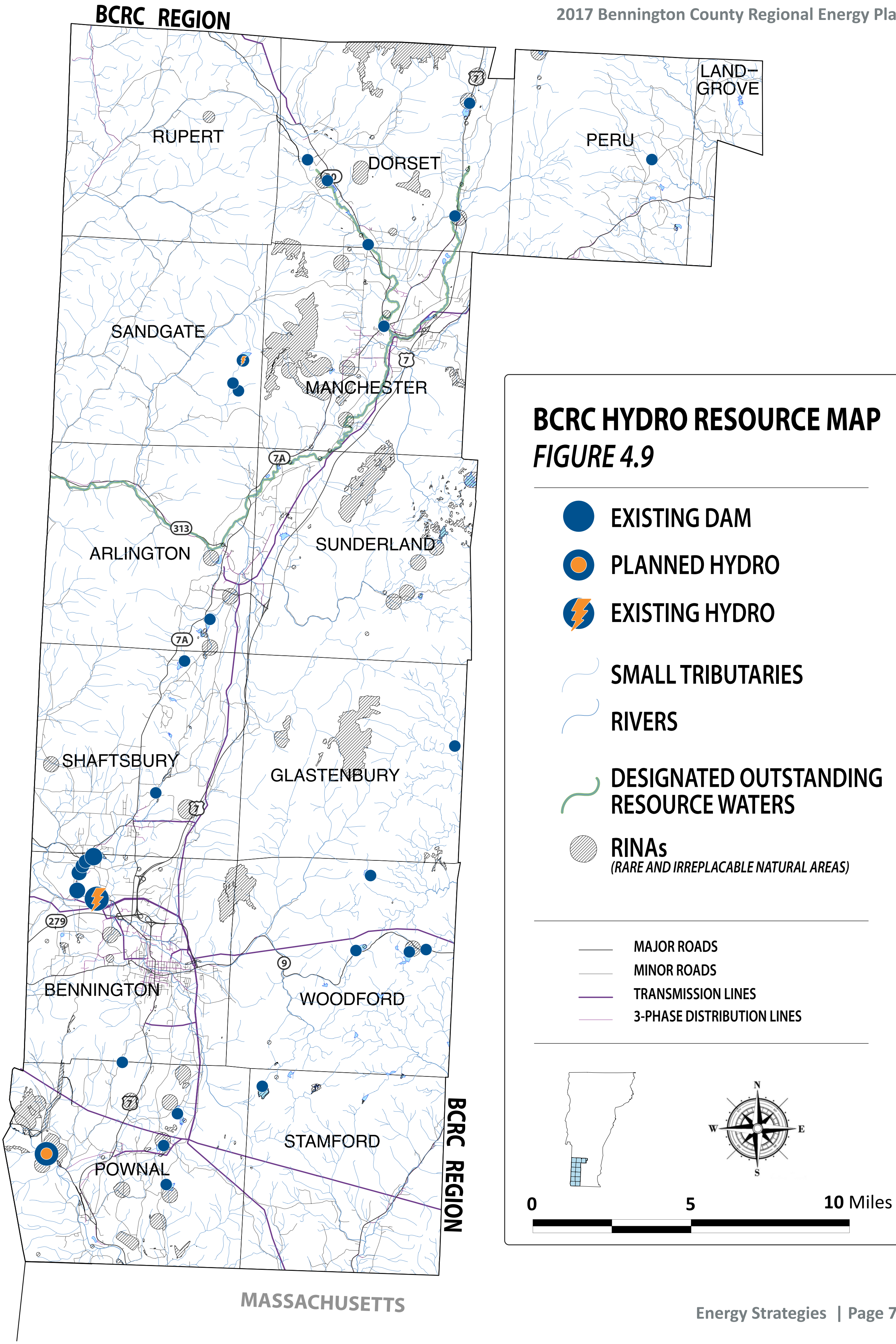
The Bennington Region will need to develop over 100 MW of new generating capacity from hydro, wind, and solar resources within the region over the next 35 years. It is extremely important that those generating facilities be sited in locations with good access to the energy resources while not adversely impacting important environmental or community resources. The renewable energy resource maps in this section illustrate the guidelines considered when determining appropriate locations for these facilities. These maps and guidelines can be used to evaluate preferred locations for generation around the region, to satisfy Act 174 mapping requirements for municipal and regional plans, and to provide input during Public Service Board regulatory (Section 248) proceedings. Municipalities are encouraged to reference renewable energy resource maps for their own use and to adopt and modify the guidelines based on local concerns and opportunities.

HYDRO

2050 GOAL: **1 MW**

At least 1 MW of hydroelectric generating capacity should be developed in the BCRC region by 2050. Two existing hydroelectric sites are already generating electricity. One, located in Sandgate, is very small, and the other, located in Bennington, is significantly larger at 360 kW generating capacity. There is another relatively large facility planned in Pownal, which, combined with the Bennington facility, represent about half of the region's potential production. Many smaller sites at existing dams also offer some potential.

Unlike wind and solar resources, which require a complex study to analyze generation potential, hyrdoelectric (or "hydro") development in the region is limited to existing dam facilities. In total, Vermont hopes to generate almost 100 MW from in-state hydroeletric by 2050. Details of Vermont's potential hydro generation can be found in Community Hydro's 2007 Report, **The Undeveloped Hydroelectric Potential of Vermont**. Many other regions have large dam structures, some of which are already or have in the past been used for hydroeletric generation, but Bennington does not have any large-scale facilities. Several large hydroelectric facilities exist nearby along the Deerfield River, but because there is no potential for large scale (>1 MW capacity) generation in the region, achieving the BCRC region's 2050 goal for hydroelectric generation will require development at several small facilities.


BCRC REGION
RUPERT
DORSET
PERU
LAND-GROVE
SANDGATE
MANCHESTER
ARLINGTON
SUNDERLAND
SHAFTSBURY
GLASTENBURY
BENNINGTON
WOODFORD
POWNAL
STAMFORD
BCRC REGION
MASSACHUSETTS
BCRC HYDRO RESOURCE MAP
FIGURE 4.9
EXISTING DAM
PLANNED HYDRO
EXISTING HYDRO
SMALL TRIBUTARIES
RIVERS
DESIGNATED OUTSTANDING RESOURCE WATERS
RINAs
(RARE AND IRREPLACABLE NATURAL AREAS)
MAJOR ROADS
MINOR ROADS
TRANSMISSION LINES
3-PHASE DISTRIBUTION LINES
N
S
E
W
0
5
10 Miles

WIND AND SOLAR ENERGY RESOURCE GUIDELINES AND MAPS

As part of the statewide Regional Energy Planning Initiative, regional planning commissions, state agencies, and other interest groups developed criteria to help identify appropriate locations for renewable energy generation facilities. These conditions were used to produce maps that identify places where the energy resource is available as well as the location of environmental resources that could prevent or complicate development. These maps are included on the following pages of this plan and can be downloaded from the **BCRC website** at a larger scale. The **Community Energy Dashboard** includes the same GIS layers that were used in this analysis, and allows users to access them through a digital, interactive interface. Though a map of existing electric generation sites is provided in this plan as **Appendix E**, up-to-date information on permitted and active generation sites can be viewed through the Dashboard's **Energy Atlas**. The following section explains the key components of the mapping analysis in more detail.

Mapping Definitions

BASE RESOURCE ANALYSIS

The most fundamental element of the energy resource maps is the natural existence of potential for each of the energy resources—referred to as *Solar Resource Area* and *Wind Resource Area*. The analyses used to produce maps of wind and solar resource areas were conducted by the **Vermont Center for Geographic Information**. These are the same analyses featured on the **Community Energy Dashboard**. Areas on each of the respective energy resource maps where these resources do not exist are left white. In other words, if the underlying potential for resource development does not appear to exist for a particular area, nothing else is shown there. It is important to note, however, that these analyses of resource area were conducted digitally and at a large scale, and thereby will not exactly reflect actual conditions on the ground.

WIND RESOURCE AREA

Areas where there is likely to be sufficient wind at a specified height for wind energy development.
The analysis used digital wind speed models to determine wind speed at various heights (30, 50, and 70 meters) and identified areas with the highest wind speeds at each of those heights.

SOLAR RESOURCE AREA

Areas where there is likely to be sufficient solar radiation for solar energy development.
The GIS-based analysis factored in direction, slope, and location of land through a digital terrain model to map area with high solar radiation potential. Certain areas where development was not possible—such as rivers and roads—were also removed.

KNOWN CONSTRAINTS

Conditions that preclude development.

Known Constraints include ecological and physical conditions that would very likely prevent the development of renewable energy infrastructure according to existing development requirements and Vermont environmental regulations. Known Constraints have been "masked" out of the resource maps. In other words, any location where a Known Constraint exists appears blank, the same as areas where wind and solar resources are likely to be poor.

Known Constraints include:

1. ***Vernal Pools:*** *Seasonal wetlands that provide conditions for various species' habitats. (Mapping includes a 50 foot buffer around all Vernal pools.)*

2. ***DEC River Corridors:*** *Rivers and land adjacent to rivers that is necessary to maintain the natural movement, or meandering, of a river.*

3. ***FEMA DFIRM Floodways:*** *Areas most likely to be impacted by base floods (1% annual likelihood) where development is limited.*

4. ***State-Significant Natural Communities and Rare, Threatened, and Endangered Species:*** *Areas where natural conditions exist and include rare species or a valuable educational scientific resource.*

6. ***National Wilderness Areas:*** *Federally owned land that is preserved in natural conditions.*

7. ***Class 1 and 2 Wetlands:*** *All identified Class 1 and 2 Wetlands*

POSSIBLE CONSTRAINTS

Conditions that could (but will not necessarily) prevent development.

Possible Constraints include ecological and physical conditions that might impact or prevent the development of renewable energy infrastructure according to existing development requirements and Vermont environmental regulations. Possible Constraints are included in the "Secondary Resource" areas (defined on the following page).

Possible Constraints include:

1. ***VT Agriculturally Important Soils:*** *All soils rated as agriculturally important, including "Prime" agricultural soils and soils of statewide or local importance.*

2. ***FEMA Special Flood Hazard Areas:*** *All zones with a 0.2% chance or higher of flooding annually.*

3. ***Protected Lands:*** *All state fee lands and privately owned conserved lands.*

4. ***Deer Wintering Areas (DWAs):*** *Identified deer winter habitat area.*

5. ***ANR VT Conservation Design Highest Priority Forest Blocks:*** *Unfragmented natural areas with high ecological and habitat value.*

6. ***Hydric Soils:*** *Areas where soils are saturated for some part of the year, leading to biological conditions similar to wetlands.*

PRIME RESOURCE

*Areas with resource generation potential and **no Known or Possible Constraints.***

The Prime Resource Area for each resource—referred to on the maps as “Prime Wind” and “Prime Solar” respectively—refers to the area where renewable energy development may be most favorable due to the presence of good energy resources and a lack of environmental constraints.

Most of the region’s high elevation forest land overlaps with the “Conservation Design” Possible Constraint area, thereby removing many otherwise ‘“Prime” sites from consideration. However, carefully planned wind energy development still may be feasible in many of the secondary resource areas.

SECONDARY RESOURCE

*Areas with good renewable energy resource generation potential and **no Known Constraints, but at least one Possible Constraint.***

The Secondary Resource area—“Secondary Wind” and “Secondary Solar” on the maps—refers to the area where resource development is possible, but may be impeded by certain conditions (Possible Constraints). The areas that appear as Secondary Resource on the maps are not necessarily less optimal for resource development than Prime Resource areas, but at least one identified environmental constraint may complicate, or if severe enough, preclude development. The amount of Secondary Resource located in each region was used in the process of determining regional goals for renewable energy development.

REGIONAL AND LOCAL CONSTRAINTS

Regional constraints are physical or human conditions that have been identified by the region for consideration in developing renewable energy facilities that are not included in the statewide Known and Possible Constraint lists. These constraints will vary by region and may impact development in the same way as Known or Possible Constraints, depending on the nature of the resource and the specific site.

Each municipality in the region can also add locally-identified resources—constraints such as scenic viewsheds or unique natural areas, as well as preferred sites for energy generation, such as abandoned gravel pits—to their local energy plans.

However, regional and local constraints may not have the effect of prohibiting all types of renewable energy generation or of precluding development of sufficient renewable energy to meet state, regional, and local energy targets. To uphold the designation of locally-identified contraints, municipal plans must reference studies, planning documents, or other supporting data.

GRID INFRASTRUCTURE

Another important element of the Energy Resource maps is the location of grid infrastructure, including *three-phase distribution lines* and *high-capacity transmission lines*. These are shown on both the wind and solar resource maps. The location of transmission and distribution infrastructure was not specifically factored into the mapping analysis or the development of energy generation goals at a regional scale. (More details on the creation of regional energy generation goals can be found in **Appendix C: Regional Renewable Generation Targets and Methodology**). However, grid infrastructure location and capacity will play an important role in determining the economic feasibility of a certain site for a renewable energy generation facility.

For more detailed information on grid infrastructure and capacity, interested parties should visit Green Mountain Power's "**Solar Map**," an online interactive GIS-based map that shows the specific capacity of each section of GMP's grid.

HOW TO USE THE RESOURCE MAPS

These wind and solar resource maps, and the corresponding data, should be used to inform energy planning efforts by municipalities and regions. They may also be used for conceptual planning or initial site identification by those interested in developing renewable energy infrastructure. They should ***NOT***, however, take the place of site-specific investigation for a proposed facility, and should therefore not be thought of as "siting maps." The step-by-step analysis used to develop these maps may be conducted specifically for any site where renewable energy development has been proposed, and in that sense, these maps provide a model for the process that should be undertaken when evaluating the siting of a renewable energy development.

More details on the process of properly siting renewable energy generation facilities can be found in **Appendix D, Renewable Energy Generation Facility Siting Guidelines**.

> **Individual municipalities** should refine these renewable energy resource maps by adding additional locally identified constraints to development and preferred locations for solar, wind, and hydro generation, as well as thermal applications. These enhanced municipal-level resource maps should be given deference at Public Service Board Section 248 proceedings unless there is a clear conflict with the energy goals of this Regional Energy Plan.

WIND

2050 GOAL: **26 MW** *(new capacity)*

The Bennington Region, due to its geography, has significant potential for wind energy development. The ridges of the Green and Taconic mountain ranges run north-south through the region and have very high average high wind speeds. Wind energy development has already occurred along these same mountain areas just outside of the region in Searsburg and in Massachusetts. There is no commercial scale wind, however, currently in the region, and there are only a few smaller turbines. Because wind speeds are lower in valley areas it is not practical to encourage commercial wind energy development in these low-lying areas. Therefore, while the region can hope to achieve a small amount of its 2050 goal of 26 MW of new wind capacity through residential-scale (<10 kW) wind turbines, the only realistic way to reach the goal will be through some level of commercial-scale development. Relatively few commercial wind turbines (at least 1 MW capacity) in a limited number of prime resource areas would allow the region to achieve its goal. Planning efforts should focus on identifying areas that would be most appropriate for such developments. Initial mapping analysis indicated that a few such areas stand out in the region, including those listed to the right.

REGIONAL CONSTRAINT: RESIDENTIAL STRUCTURES

Based on public feedback throughout the planning process related to concerns over the visual and physical impacts of wind turbine facilities, placement of turbines larger than 1 MW in capacity in the Bennington Region should not take place within a one-kilometer of any residential structure. A one-kilometer buffer is therefore displayed for all residential structures in the region on the BCRC wind resource map.

GOOD LOCATION EXAMPLES

While there are many areas with high wind speeds in the Bennington Region, there are also many areas where natural or physical conditions could make wind development challenging. Based on the mapping analysis, a few areas appear to have potential for wind development.

Some examples include:

A Western Arlington

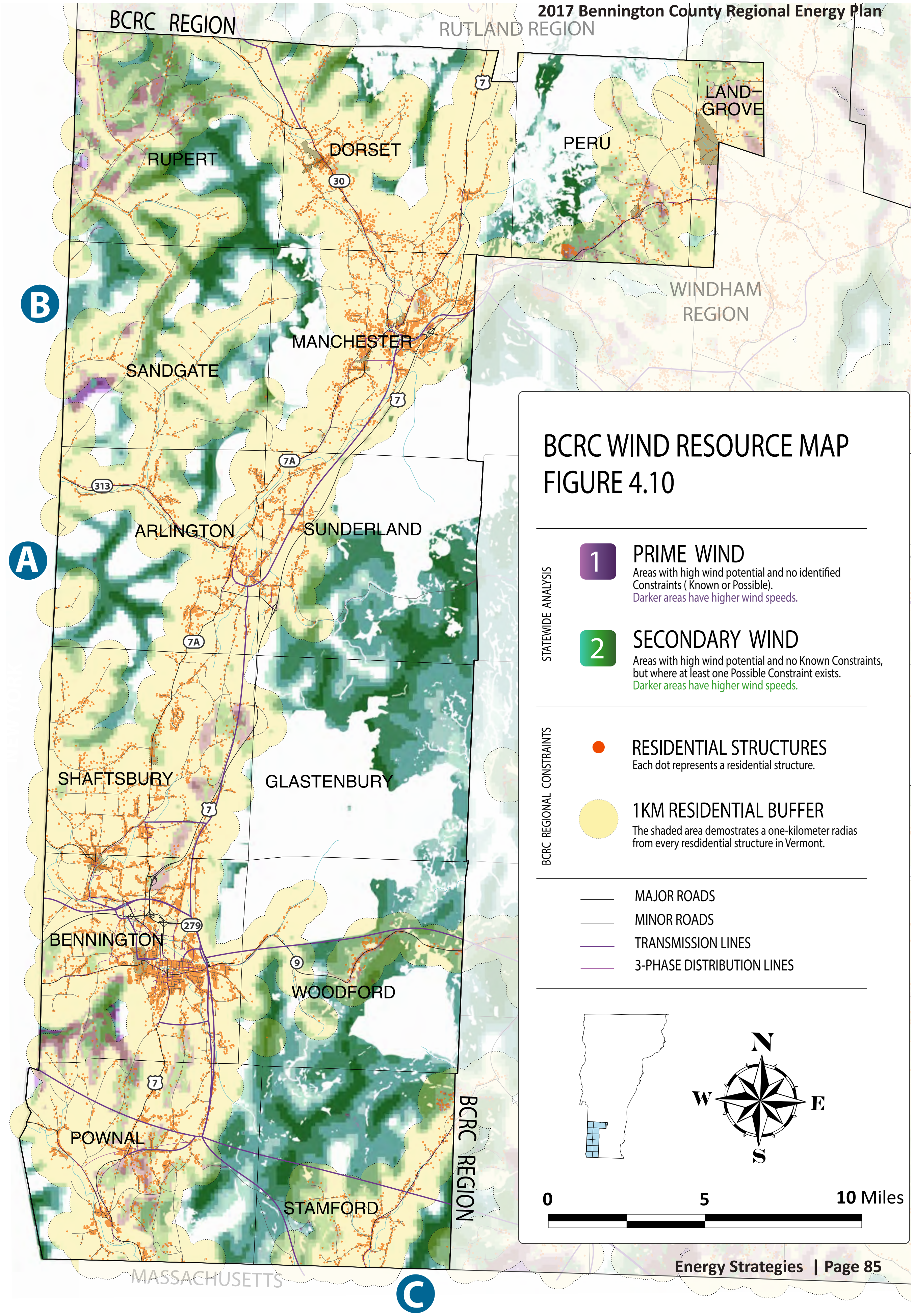
The area of Big Spruce Mountain in the Taconic mountains range in western Arlington has high wind potential, although environmental and aesthetic constraints may exist.

B Western Sandgate

Also among the Taconic range, the area surrounding Egg Mountain in Sandgate has a large concentration of high wind speeds. However, proximity to infrastructure could be a challenge in this location.

C Southeastern Stamford

The northern edge of the Hoosac Mountain ridge that runs into southern Stamford may be a prime location for wind development, and there are already several commercial-scale wind turbines on the same ridge just across the border in Massachusetts.


BCRC WIND RESOURCE MAP
FIGURE 4.10
STATEWIDE ANALYSIS
1
PRIME WIND
Areas with high wind potential and no identified Constraints (Known or Possible).
Darker areas have higher wind speeds.
2
SECONDARY WIND
Areas with high wind potential and no Known Constraints, but where at least one Possible Constraint exists.
Darker areas have higher wind speeds.
BCRC REGIONAL CONSTRAINTS
RESIDENTIAL STRUCTURES
Each dot represents a residential structure.
1KM RESIDENTIAL BUFFER
The shaded area demostrates a one-kilometer radias from every resdidential structure in Vermont.
MAJOR ROADS
MINOR ROADS
TRANSMISSION LINES
3-PHASE DISTRIBUTION LINES
N
S
E
W
0
5
10 Miles
BCRC REGION
RUTLAND REGION
WINDHAM REGION
MASSACHUSETTS
RUPERT
DORSET
PERU
LAND-GROVE
SANDGATE
MANCHESTER
ARLINGTON
SUNDERLAND
SHAFTSBURY
GLASTENBURY
BENNINGTON
WOODFORD
POWNAL
STAMFORD
A
B
C
7
30
7A
313
279
9

SOLAR

2050 GOAL: **85 MW** *(new capacity)*

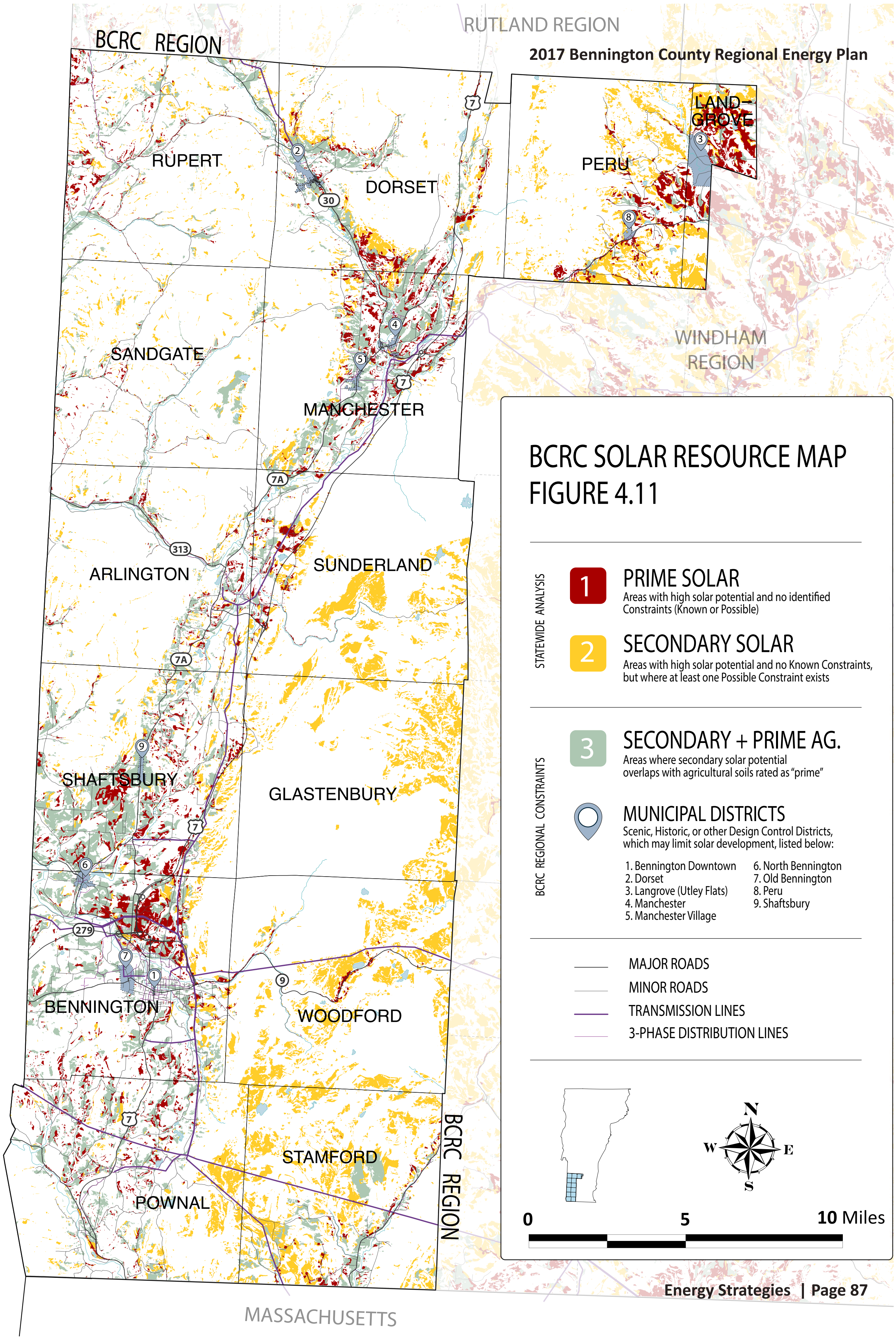
The Bennington Region has ample potential to develop solar photovoltaic (PV) energy resources. While solar is not as efficient in Vermont as it is in some southern areas of the US with very high rates of solar radiation, it is a critical component of the state's renewable energy generation plans. According to the state's energy goals, solar will be the largest source of in-state renewable energy generation by 2050.

The State of Vermont already has several solar PV generation facilities, with 230 MW of capacity across the state. Currently, the Bennington Region is home to 9.9 MW of solar generating capacity, much of which is located at two 2.2 MW facilities in Pownal. Nearly 150 other solar installations exist in the region (as of 2016), from small residential systems to larger net-metered and commercial facilities.

According to the goals laid out in this plan, the Bennington region will account for approximately **85 MW** of the nearly **1,650 MW** of new solar capacity in the state of Vermont by 2050, or just over 5% of Vermont's total solar capacity. While that level of capacity is small relative to the statewide total, it represents a dramatic increase from current capacity, and will require significant investment and planning.

As opposed to wind energy development, which will most efficiently be generated almost entirely from a small number of commercial-scale developments in the region, solar energy development will require a mix of installations throughout the region, including rooftop and ground-mounted systems at a range of sizes. It will be necessary to develop a number of commercial-scale (>150 kW capacity) arrays. A number of sites that may be well-suited to low-impact solar energy development have been identified (listed on **Page 91**). Ideally, municipalities also will identify such areas in their own local plans. On the following pages, BCRC regional solar development goals are broken down with more detail, with 2050 goals listed for each town.

Although the mapping analysis is not meant to be used as a siting map, it may be useful in helping to determine areas that have high potential for solar energy development. Areas with high solar energy potential tend to be located in low-lying valleys—unlike areas of high wind energy potential—which means that areas with high solar potential in the Bennington region tend to be near areas of existing development and electrical grid infrastructure.


BCRC SOLAR RESOURCE MAP
FIGURE 4.11
STATEWIDE ANALYSIS
1 PRIME SOLAR
Areas with high solar potential and no identified Constraints (Known or Possible)
2 SECONDARY SOLAR
Areas with high solar potential and no Known Constraints, but where at least one Possible Constraint exists
BCRC REGIONAL CONSTRAINTS
3 SECONDARY + PRIME AG.
Areas where secondary solar potential overlaps with agricultural soils rated as "prime"
MUNICIPAL DISTRICTS
Scenic, Historic, or other Design Control Districts, which may limit solar development, listed below:
1. Bennington Downtown
2. Dorset
3. Langrove (Utley Flats)
4. Manchester
5. Manchester Village
6. North Bennington
7. Old Bennington
8. Peru
9. Shaftsbury
MAJOR ROADS
MINOR ROADS
TRANSMISSION LINES
3-PHASE DISTRIBUTION LINES
N
W
E
S
0
5
10 Miles
BCRC REGION
RUTLAND REGION
WINDHAM REGION
MASSACHUSETTS
RUPERT
DORSET
PERU
LAND-GROVE
SANDGATE
MANCHESTER
ARLINGTON
SUNDERLAND
SHAFTSBURY
GLASTENBURY
BENNINGTON
WOODFORD
STAMFORD
POWNAL
7
30
7A
313
279
9

While it may seem that there is little solar potential in the region (especially relative to the region's 2050 goal of 85 MW which far exceeds the amount of existing capacity), that is not the case. With almost 11,500 acres of *Prime Solar* resource area—not to mention an additional 64,000 acres of *Secondary Solar*, much of which could be appropriate for development—there is ample room to accommodate the needed infrastructure while still focusing development in areas that do not contain critical resources. This relationship is demostrated in **Figure 4.12** below, which compares the total physical area in the region to the amount of *Prime Solar* resource area to the amount of acreage that would be needed to achieve the 2050 goal (assuming, just for the sake of inquiry, that all new solar was developed through ground-mounted systems—which is *not* the objective of this plan, as discussed in the next paragraph).

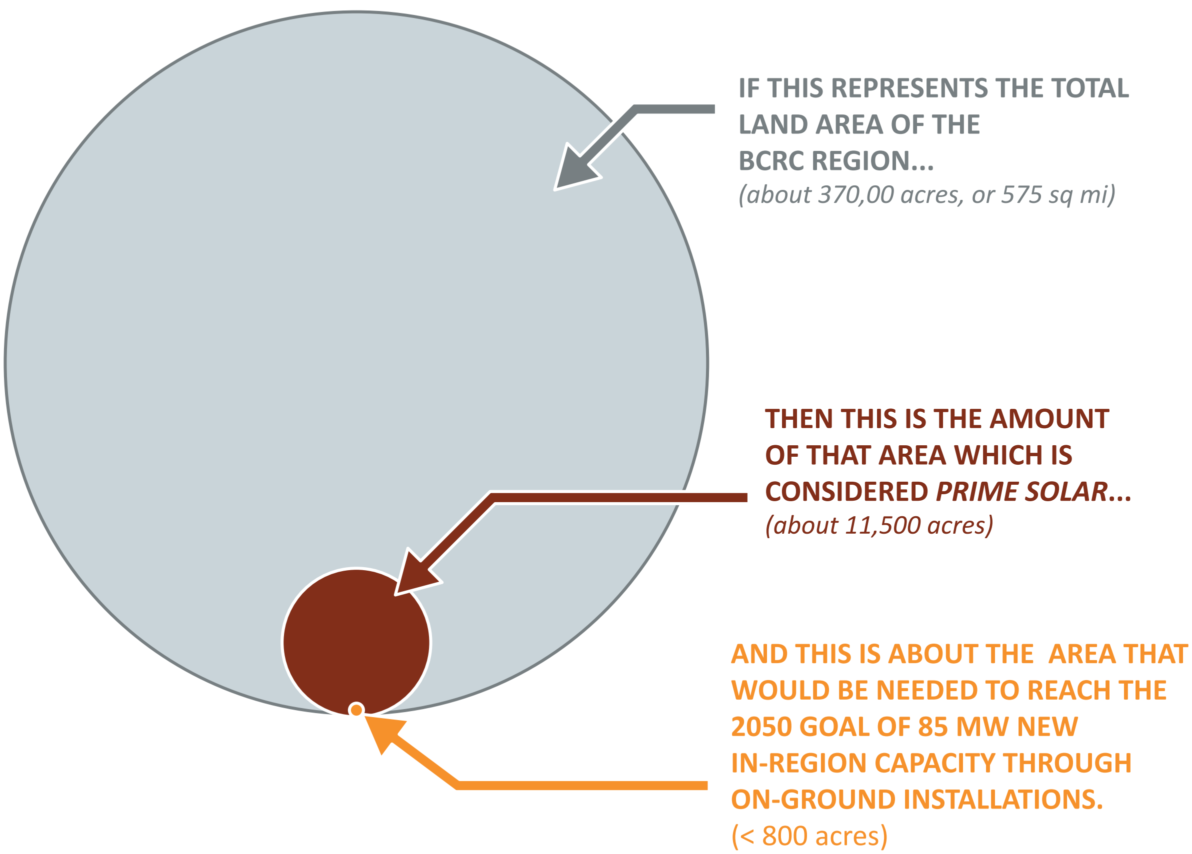


FIGURE 4.12: SOLAR POTENTIAL DIAGRAM

The diagram above compares the relative size of 1) all land in the region, 2) the total amount of "Prime Solar Area," and 3) the amount of land that would be required to achieve the region's 2050 solar goal of 85 MW new capacity purely through ground-mounted systems (just for the sake of analysis). Not only does the region have more than enough potential to achieve it's goal, the amount of prime solar area alone in the BCRC is roughly equivalent to the amount of land that would be required to achieve the entire state's 2050 solar goal!

ROOFTOP SOLAR

The mapping analysis refers to solar potential and other conditions on the ground but does not consider the potential that exists on already-built structures in the region. Rooftop solar is limited by physical issues such as roof pitch and direction, structural issues, site constraints (such as limited solar access) and, most fundamentally, the availability of structures. In order to quantify the potential for rooftop solar in the region, an analysis of rooftop solar energy potential was completed (***Figure 4.13***).

It is estimated that the Bennington Region has the potential to generate ***at most*** around 34 MW, or about 40% of the region's 2050 solar goal from rooftop-mounted PV systems. In order to achieve that, however, an enormous increase in the rate of rooftop solar development would have to take place in the next 35 years, and due to the economic and physical challenges associated with rooftop solar, it is unlikely that such an increase would be feasible. Therefore it is reasonable for the region to **strive to achieve between 20% and 30% of the overall 2050 solar energy development goal of through rooftop solar.**

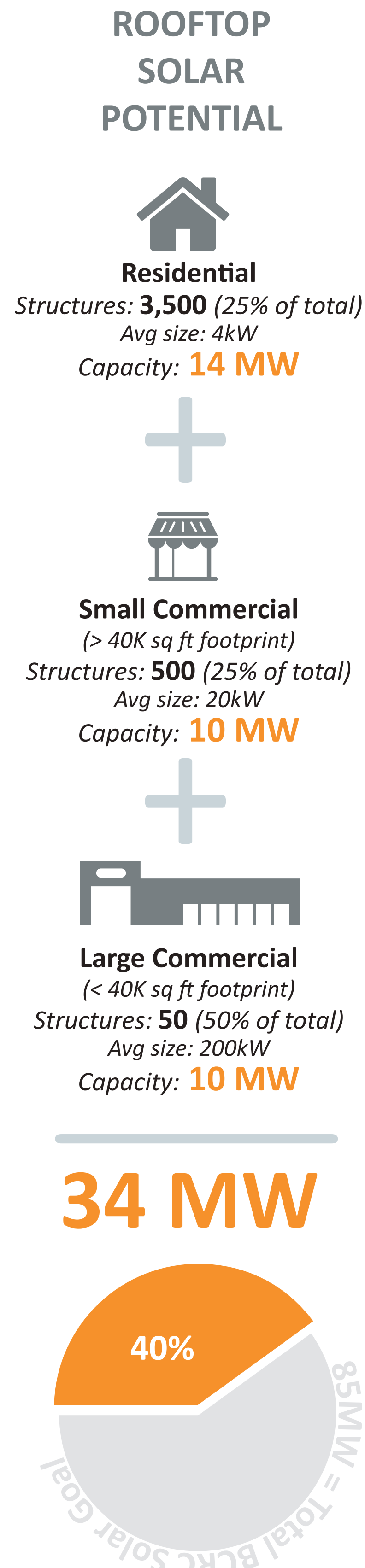


FIGURE 4.13: *Even in the extremely ambitious scenario laid out in the graphic to the right, rooftop solar would not be able to provide even half of the region's solar goal. Therefore, while rooftop-mounted solar remains an important part of the regions's energy future, it cannot replace the need for more efficient ground-mounted installations.*

Notes on methodology: *It was assumed that 50% of all residential and small commercial structures would be unable to accommodate rooftop solar due to physical conditions, and that 50% of those who could accommodate solar would choose to do so. It was also assumed that 50% of all large commercial overall would install solar. Estimates on structure counts were created using GIS analysis of Vermont E-911 data from the Vermont Center for Geographic Information.*

SOLAR BY TOWN

In order to develop specific goals for solar generation capacity for BCRC towns by 2050, both the number of people living in a town and the amount of *prime solar* resource area in a town were considered to generate each town's share of BCRC's overall 2050 solar goal (approximately 85 MW of new capacity). The goals also account for the amount of existing solar in each town. The 2050 goals for new solar capacity for each BCRC town are shown in bold below, in the last column (***Table 4.14***). This methodology is similar to that used in calculating the regional goals, discussed in detail in **Appendix C**, although proximity to 3-phase power lines is included in this case. Please see the methodology in **Appendix C** for an example calculation.

	2015 Population	Prime Solar (Acres)	Prime Solar in one mile of 3-phase *(Acres)*	Solar Installations *(Count, 2015)*	Existing Solar Capacity *(kW, 2016)*	**2050 Goal, New Capacity *(MW)***
Arlington	2,453	493	402	10	260.2	**4.0**
Bennington	15,483	3,034	2,682	46	2,532.3	**25.1**
Dorset	2,172	1,113	995	17	683.6	**5.2**
Glastenbury	9	51	0	0	0	**0.0**
Landgrove	111	1,835	1,729	2	3.4	**5.9**
Manchester	4,339	1,870	1,856	23	1,017.3	**10.4**
Peru	335	2,338	1,016	4	49.7	**3.7**
Pownal	3,484	1,083	586	6	4,538.7	**1.6**
Rupert	595	603	458	5	62.5	**2.2**
Sandgate	481	206	0	0	16.3	**0.6**
Shaftsbury	3,535	2,693	2,045	17	603	**10.5**
Stamford	878	302	254	3	30.2	**1.9**
Sunderland	985	708	696	1	110.8	**3.4**
Woodford	340	185	75	1	3.2	**0.7**

FIGURE 4.14: TOWN-LEVEL SOLAR DATA IN THE BCRC REGION

This table displays a variety of data for each town in the BCRC region related to existing solar capacity and potential generation. Population estimates come from the Census Bureau, and existing solar data come from the Department of Public Service and refer only to on-grid solar. To calculate town 2050 capacity goals, an average of percentage of the region's population and percentage of prime solar within one mile of 3-phase power as multiplied by regional existing and projected new capacity, with existing and projected new capacity, with existing installed capacity within the town then subtracted from the result. See Appendix C for an example. .

POSSIBLE SITES FOR LARGE SOLAR PROJECTS

The following list includes examples of sites in the Bennington Region where solar facility development would be particularly well-suited. Generally, they refer to large spaces that are unlikley to impact ecological conditions, scenic viewsheds, or identified issues.

Former Landfills

- Bennington, Houghton Lane
- Sunderland

Gravel Pits

- Barlow, N. Pownal (500 kW proposed)
- Triland Partners site, Pownal (2.2 MW proposed)
- Off Cider Mill Road in Shaftsbury
- Off Tunic Road in Shaftsbury
- Off Airport Road in Shaftsbury
- Sunderland, South of Orvis HQ, east of US 7
- Manchester, near Riley Rink (currently active)

Large Rooftops

Large shopping plazas:

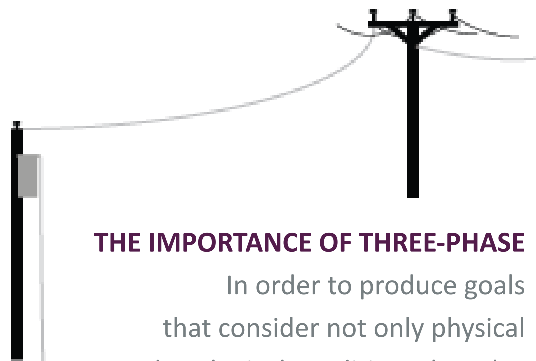
- K-Mart, Bennington
- Wal-Mart/Price Chopper, Bennington
- Hannaford, Bennington
- Home Depot, Bennington

Schools

- MAU High School and Middle School
- Pownal Elementary
- Shaftsbury Elementary
- Arlington Elementary (100 kW installed in 2016)
- Arlington High School
- Sunderland Elementary
- Manchester Elementary
- Burr and Burton Academy
- Dorest Elementary (84 kW installed)
- Long Trail School

Other Commercial/Industrial:

- NSK, Bennington
- Industrial buildings along Water Street in North Bennington (Chemfab/Water Street Apartments, NAHANCO, former Northern Cable/TE Connectivity)
- Bernstein Display, Shaftsbury
- Mack Molding (newer building) in Arlington, plus vacant land on property
- WCW Inc. factory in Manchester (1.3 MW proposed)
- Riley Rink (already has some ground-mounted solar)
- Manchester public safety building



THE IMPORTANCE OF THREE-PHASE

In order to produce goals that consider not only physical and ecological conditions, but also logistical issues, the 2050 BCRC town-level solar goals only factored in prime solar areas that exist within one mile of three-phase power lines. Three-phase power is often needed to connect solar installations to the grid, and therefore poses limitations on where solar (especially larger solar facilities) may be constructed. Also, the presence of nearby three-phase power serves as a simple way to consider the amount of grid infrastructure in an area. Thereby, towns that are likely to be able to accommodate more distributed generation have higher goals.

Renewable Energy Generation Facility Siting Guidelines

The following list of guidelines explains the process by which site feasibility should be determined for renewable energy generation facilities in the BCRC region. It is the responsibility of the developer of a facility to review and complete this process.

1. **Identify locations where renewable energy resource is present in sufficient quantity to make development technically and economically feasible.**

2. **Identify areas with Known Constraints and eliminate areas with Level 1 Constraints from consideration.**

3. **Identify areas with Possible Constraints and note site-specific concerns, and investigate those conditions.**

4. **Identify regionally and/or locally[1] identified conditions, including:**

    A) Areas where development must be avoided;

    B) Areas of special concern where development may or may not be feasible based on site conditions; and

    C) Areas where energy development is encouraged.

5. **Determine any additional considerations that are relevant to the project, such as:**

    A) Any scenic viewsheds that are impacted;

    B) Siting and screening needed to mitigate visual impact on nearby properties;

    C) Location of electricity infrastructure; or

    D) Location of transportation infrastructure for site access.

***1.** Municipalities are encouraged to develop their own renewable energy facility siting guidelines. Draft language and links from the BCRC and examples of other language are provided in **Appendix D: Town Energy Planning and Renewable Siting Guidelines**.*

SECTION V.

ADAPTATION STRATEGIES

LIFESTYLE ADAPTATIONS

ECONOMIC ADAPTATIONS

AGRICULTURE & FOOD SYSTEM ADAPTATIONS

LIFESTYLE ADAPTATIONS

Previous sections of this plan have already covered some of the adaptive strategies that should be encouraged to support attainment of regional and state energy goals. It will be important for individuals, businesses, and institutions to acquire and use new technologies such as electric vehicles, alternative heating systems, efficient lighting and appliances, and distributed renewable energy systems that support a smart grid. The technological and economic infrastructure to support those transitions must also be made available through local businesses and utilities.

New technology alone will not be sufficient. People must recognize that certain energy-saving behavioral changes will need to be adopted as well. Large-scale energy savings can be achieved by effectively encouraging many people to make small individual changes such as turning down thermostats, air drying clothes, and turning off lights and electronic devices when not in use. Transportation and land use adaptations will also be critical. Choices about where to live and how to get from place to place will be critical. These changes will happen incrementally, but people need to begin thinking about them now and municipalities should take steps to make it easier to develop and live in higher density mixed-use centers.

These individual behavioral and lifestyle adaptations need to be supported and complemented by an economic system that reflects the principles of energy efficiency. There are significant opportunities for economic growth and prosperity that can be achieved by emphasizing energy conservation, local energy production, and development and use of local resources in local and regional markets.

ECONOMIC ADAPTATIONS

The area once relied primarily on locally available resources to fuel its economic prosperity, and those resources, together with locally available renewable energy resources, should be looked to as important economic assets in the future. The long-term cost and availability of energy is a serious issue that needs to be confronted when planning for the region's economy. As abundant and relatively inexpensive nonrenewable energy sources are depleted, local, regional, and national economies will have to adjust to new models that do not rely on continued broad-based growth requiring expanded energy inputs. This realization has led to a focus on "sustainable local economies," centering on the idea that economic systems must be developed that can function with less total energy. Such systems orient toward local production and markets, fueled by locally produced energy, and served by transportation modes that do not rely on gas and diesel fueled cars and trucks.

Existing local and regional businesses will remain important to residents of Bennington County in years to come, but the economy will need to adapt to take advantage of opportunities offered by things such as local renewable energy resources, production and distribution of local foods, manufacturing of goods using locally available resources, and industries that support economic sectors that function with lower energy requirements. Key points in the development of a sustainable regional economy include:

- Conserving agricultural and forest land and supporting farm and forest product businesses. An emphasis on production of food for local markets significantly reduces energy use and keeps local money from being exported.
- Reliance on local resources whenever possible to address local needs and opportunities.
- Production of as much of the region's energy demand as possible using local resources (while working to significantly reduce total energy use through conservation measures).
- Ensuring there are opportunities and incentives for money paid into the local economy to circulate within the community.
- Developing markets for local goods and manufactured products in nearby communities.
- Supporting alternative transportation modes and public transportation options.
- Retaining and developing local human resources.

The production and consumption of food is a major component of economic activity. Moreover, food is the energy that fuels our lives and any discussion of energy planning must, therefore, give due consideration to the regional agriculture and food systems.

AGRICULTURE & FOOD SYSTEM ADAPTATIONS

Food contains energy (calories—actually kilocalories—are a measure of energy) originally derived from the sun, essential to the physical and economic health of communities. Beyond that reality, however, is the more practical issue that it takes a tremendous amount of energy (and money) to produce, transport, process, and prepare the food that we consume. In fact, ten percent of the total US energy budget is used for food production (Scientific American, January 2012).

The significance of this fact to the regional economy can be illustrated by considering a few simple facts. An average person consumes approximately 2,000 calories (kcal) per day; that is the energy equivalent of 7,940 Btu. Because of the high energy inputs (farm machinery, petrochemical fertilizers, transporting the food an average of 1,500 miles to Bennington, energy-intensive processing, storage, etc.), 79,400 Btu per person per day is required to bring that food energy to our resident population. Over the course of a year, then, food production for Bennington's residents requires 1.028 trillion Btu, or the equivalent of over seven million gallons of oil, similar to the amount used for residential space heating in the region.

The total expenditures on food are equally interesting. Vermont is estimated to spend approximately two billion dollars each year on food, or about $3,200 per year per person (Vermont Farm to Plate Strategic Plan, 2011). With a population of 35,484, residents of the Bennington Region spend approximately $113 million dollars on food, the vast majority of which is imported to the region.

The corollary to this fact, of course, is that nearly all local dollars spent on food purchases are exported from the region. By relying to a much greater extent on locally produced food, and food with a higher energy yield per energy input, the region could significantly reduce overall energy use while supporting growth in a potentially important sector of the local economy.

The transportation savings associated with local food production are an obvious energy conservation benefit. In addition, consumption of more grains, vegetables, and fruits encourages greater energy efficiency since the energy inputs for those foods are significantly lower than the energy inputs required for the production of dairy, meat, and poultry products. Production methods that minimize tilling and the need for petrochemical fertilizers also improve energy efficiency.

Organizations involved in the regional food system, including Northshire Grows and the Bennington Farm to Plate Council, worked with the BCRC and Bennington College to develop an inventory of the local food system and to begin to develop a plan for building a more robust agricultural economy.

Although there are a number of small local producers and significant demand for local food, there is a need to better match those elements of the market and to ensure that all of the supporting components needed to ensure the growth of a vibrant local food economy are in place.

One approach may be to facilitate contracting between large food users (the local colleges, school districts, hospital, and similar institutions) and producers to help those small farmers grow their businesses and to encourage others to enter into farming. Because the cost of land can restrict entry into farming for many people, consideration could be given to allowing farmers to use prime agricultural land at some of those locations (e.g., college campuses) for little or no cost.

Once a certain level of production capacity is achieved, there will be a demand for food processing, storage, distribution, and other support services. An important aspect of the growth in local food production will also be creation or expansion of retail outlets for locally produced food so it is easily and conveniently available to the general public. Growth in this economic sector will also encourage agricultural diversification, leading to the production of a greater variety of foods.

As pointed out in **Section IV**, siting solar and wind renewable energy facilities on farms (on non-prime agricultural soils) has the dual benefits of producing a reliable supply of electricity while also supporting the viability of the agricultural enterprise. Information on solar and wind options should be provided to farmers and owners of agricultural land to ensure that such benefits can be realized.

The Bennington Region, along with other parts of Vermont, has a rich history of providing its own energy through a variety of sources. The strategies described in this plan outline a course towards becoming more energy independent again, while pursuing the state's 90X50 energy goal.

CONCLUSION

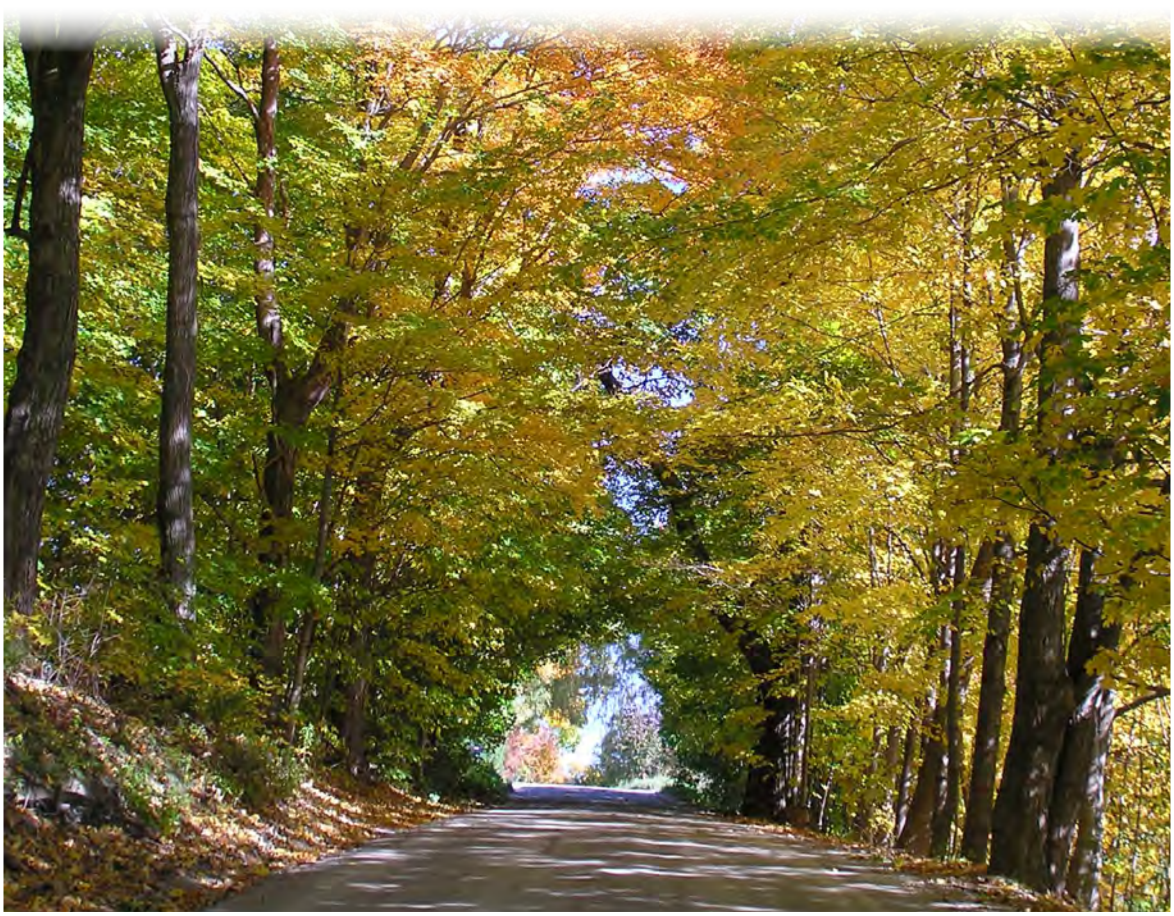
Vermont has established ambitious goals that call on residents, businesses, and communities to work to reduce the amount of energy that is used in the state and to transition to the use of renewable fuels in the transportation, space heating, and electricity sectors. This Plan has provided information on the amount of energy currently used in our region and the sources of that energy, as well as a scenario illustrating the types of changes that will need to occur to support realization of the state's energy goals. Those changes may appear extreme, but as the plan points out, the resulting environmental, economic, and energy security benefits provide strong incentives to pursue the types of implementation measures presented in Section IV.

This Plan should be used to guide the Bennington County Regional Commission as it develops its annual work plans, to help focus attention on key issues and opportunities within the region, and to provide a framework for the evaluation of proposed energy conservation and development projects. Municipalities should use the Plan as a resource and guide for development of their own energy plans, or to develop enhanced energy, transportation, and land use elements of their comprehensive plans. The renewable energy siting guidelines, resource maps, and general targets for future renewable energy capacity will prove helpful as municipalities develop plans that provide a meaningful basis for determinations in state regulatory proceedings.

For the Plan to be effective, it will be necessary to maintain an active energy planning program at the BCRC, supported by an energy committee that includes representatives from various communities with a diversity of interests and experience. The BCRC also will need to fully integrate energy planning into the technical assistance it provides to its member municipalities. Continued support and coordination with the Vermont Energy Investment Corporation, the Energy Action Network, the Department of Public Service, and other state agencies and departments will be essential as well. Improvements in the development and maintenance of accurate estimates of energy demand, fuel use, and electricity generation from renewable energy sources will be needed to track progress toward goals and to help adjust local, regional, and statewide strategies and actions. Moreover, the BCRC will need to remain engaged in statewide energy planning to ensure that future plan updates and information provided to local governments remains up to date and consistent with new information and state policies.

The BCRC will adopt this Energy Plan as a component of its comprehensive Regional Plan. Once adopted, the combined plans (Energy Plan and comprehensive Regional Plan) will be submitted to the Public Service Department for review under the newly promulgated "Determination Standards for Energy Compliance." If approved by the Department subsequent to that review, the Plan will have elevated "substantial deference" status at Section 248 Certificate of Public Good proceedings. The BCRC will then be responsible for reviewing municipal plans under those same Determination Standards. Municipal plans approved through this process will be afforded similar "substantial deference" status in Section 248 proceedings.

A central message of this Plan is that the quality of life and the economic future of the region is dependent on access to a sufficient amount of clean renewable energy. Planning for land use, transportation, agriculture and food systems, and community and economic development must consider energy efficiency and the wise development of renewable energy resources. The Bennington County Regional Energy Plan provides a basis for this comprehensive approach to the future.



APPENDICES

APPENDIX A. BCRC TOWN DEMOGRAPHIC AND HOME HEATING DATA

APPENDIX B. LEAP SYSTEM MODELING, BCRC REGION

APPENDIX C. REGIONAL RENEWABLE GENERATION TARGETS AND METHODOLOGY

APPENDIX D: TOWN ENERGY PLANNING AND RENEWABLE SITING GUIDELINES

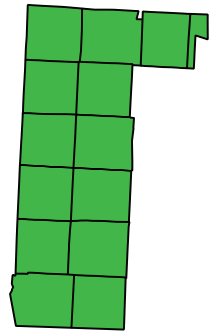
APPENDIX E: EXISTING ELECTRIC GENERATION SITES

APPENDIX A.

BCRC TOWN DEMOGRAPHIC & HOME HEATING DATA

Appendix A includes basic demographic and energy use data, mostly generated from Census estimates, for each town in the BCRC Region.

BCRC REGION



Population

Total Population (2014): **35,211**

Population Density: **61 people per sq. mile**

Households

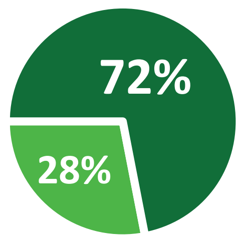
Total Households *(2014)*: **14,722**

OWNERS

Total HHs Owned: **10,219**
Avg. Owner HH Size: **2.4**

RENTERS

Total HHs Rented: **4,503**
Avg. Renter HH Size: **2.1**



Businesses

Total businesses in BCRC Region (*2014*): **1435**

Total employees working in BCRC Region (*2014*): **16555**

Total employed residents in BCRC Region (*2014*): **17,094**

Average employment wage in BCRC Region (*2014*): **$40,208**

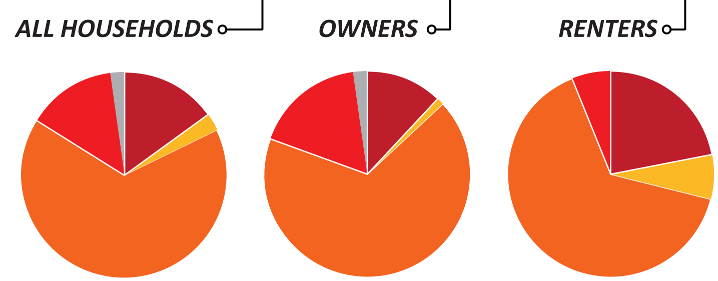
Residential Transportation Fuel Use

Number of vehicles (2014): **25,303**
Mean vehicles per household: **1.9**
Estimated miles traveled: **394.5 Million Miles**
Estimated gallons of fuels used: **17.3 Million Gallons**
Estimated total cost: **$59.3 Million**
Percent of resident employees driving alone to work: **77%**
Average commute time: **21 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1971**
Percent of Housing Built Since 2000: **9%**
Percent of Housing Built Before 1960: **37%**
Median Annual Household Income: **$48,388**
Total Energy Use: **1,437 Billion BTUs**
Total Cost: **$26,129,000**
Mean Cost per Household: **$1,700**

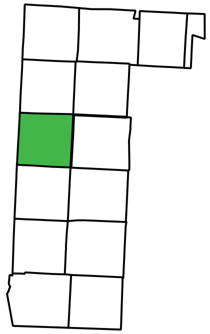
Fuel Type: Space Heating	Number of House-holds	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	2261 HHs	2.3 Mil Gal	15%	12%	22%	26%
Electricity	383 HHs	8.1 GWh	3%	1%	7%	5%
Fuel Oil		7.0 Mil Gal	67%	67%	65%	56%
Wood	1993 HHs	12.9K Tons	14%	17%	6%	13%
Other	269 HHs	-	2%	2%	0%	-



Space Heating for Businesses

Mean Estimated Building Space for Businesses: **12,105 sq. ft**
Total Energy Use: **1,042 Billion BTUs**
Estimated Total Annual Cost: **$23,276,000**
Average Annual Cost per Business: **$16,220**

Arlington



Population

Total Population (2014): **2,354**

Population Density: **56 people per sq. mile**

Households

Total Households *(2014)*: **1,070**

OWNERS

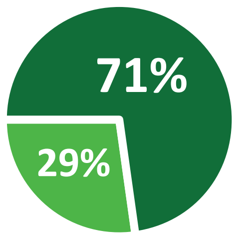
Total HHs Owned: **757**

Avg. Owner HH Size: **2.2**

RENTERS

Total HHs Rented: **313**

Avg. Renter HH Size: **2.2**



Businesses

Total businesses in Arlington (*2014*): **102**

Total employees working in Arlington (*2014*): **924**

Total employed residents in Arlington (*2014*): **1,340**

Average employment wage in Arlington (*2014*): **$45,482**

Residential Transportation Fuel Use

Number of vehicles (2014): **1,821**

Mean vehicles per household: **1.7**

Estimated miles traveled: **28.4 Million Miles**

Estimated gallons of fuels used: **1.2 Million Gallons**

Estimated total cost: **$4.3 Million**

Percent of resident employees driving alone to work: **74%**

Average commute time: **21 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1963**

Percent of Housing Built Since 2000: **15%**

Percent of Housing Built Before 1960: **47%**

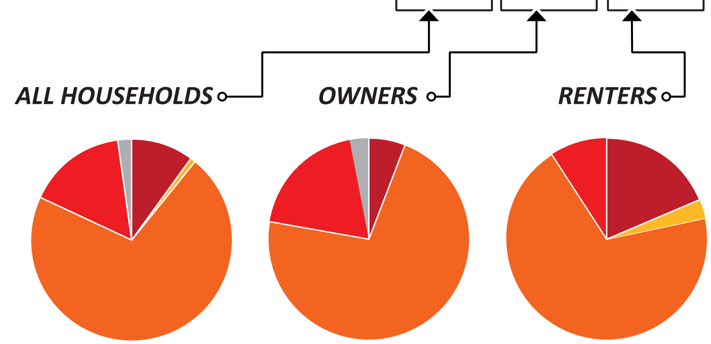
Median Annual Household Income: **$54,861**

Total Energy Use: **101 Billion BTUs**

Total Cost: **$1,698,000**

Mean Cost per Household: **$1,500**

Fuel Type: Space Heating	Number of House-holds	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	106 HHs	97K Gal	10%	6%	19%	18%
Electricity	9 HHs	174 MWh	1%	0%	3%	2%
Fuel Oil	757 HHs	514K Gal	71%	71%	70%	64%
Wood	175 HHs	1.1K Tons	16%	19%	9%	16%
Other	19 HHs	-	2%	3%	0%	-



Space Heating for Businesses

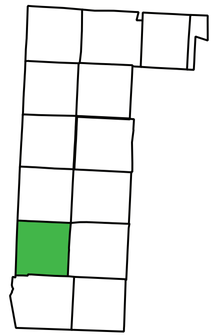
Mean Estimated Building Space for Businesses: **14,240 sq. ft**

Total Energy Use: **87 Billion BTUs**

Estimated Total Annual Cost: **$2,890,347**

Average Annual Cost per Business: **$28,337**

Bennington



Population

Total Population (2014): **15,575**

Population Density: **369 people per sq. mile**

Households

Total Households *(2014)*: **6,096**

OWNERS

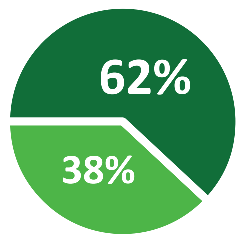
Total HHs Owned: **3,554**

Avg. Owner HH Size: **2.5**

RENTERS

Total HHs Rented: **2,542**

Avg. Renter HH Size: **2.1**



Businesses

Total businesses in Bennington (*2014*): **603**

Total employees working in Bennington (*2014*): **9805**

Total employed residents in Bennington (*2014*): **6,790**

Average employment wage in Bennington (*2014*): **$39,289**

Residential Transportation Fuel Use

Number of vehicles (2014): **9,402**

Mean vehicles per household: **1.5**

Estimated miles traveled: **146.6 Million Miles**

Estimated gallons of fuels used: **6.4 Million Gallons**

Estimated total cost: **$22.0 Million**

Percent of resident employees driving alone to work: **75%**

Average commute time: **17 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1963**

Percent of Housing Built Since 2000: **8%**

Percent of Housing Built Before 1960: **48%**

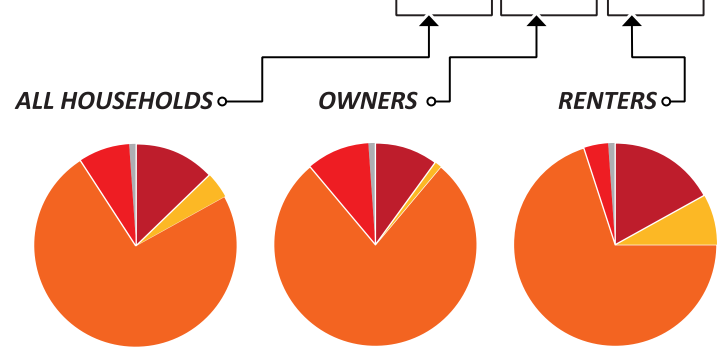
Median Annual Household Income: **$36,990**

Total Energy Use: **584 Billion BTUs**

Total Cost: **$10,283,000**

Mean Cost per Household: **$1,600**

Fuel Type: Space Heating	Number of Households	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	791 HHs	762K Gal	13%	10%	17%	22%
Electricity	225 HHs	4.5 GWh	4%	1%	8%	7%
Fuel Oil	4538 HHs	3 Mil Gal	74%	77%	70%	64%
Wood	465 HHs	3.0K Tons	8%	10%	4%	8%
Other	68 HHs	-	1%	1%	1%	-



Space Heating for Businesses

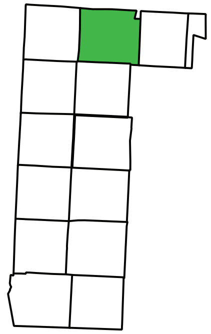
Mean Estimated Building Space for Businesses: **16,881 sq. ft**

Total Energy Use: **612 Billion BTUs**

Estimated Total Annual Cost: **$20,289,686**

Average Annual Cost per Business: **$33,592**

Dorset



Population

Total Population (2014): **2,118**

Population Density: **44 people per sq. mile**

Households

Total Households *(2014)*: **937**

OWNERS

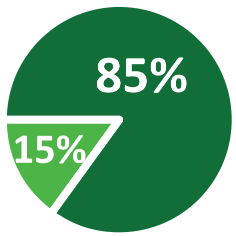
Total HHs Owned: **749**

Avg. Owner HH Size: **2.4**

RENTERS

Total HHs Rented: **188**

Avg. Renter HH Size: **1.7**



Businesses

Total businesses in Dorset (*2014*): **102**

Total employees working in Dorset (*2014*): **675**

Total employed residents in Dorset (*2014*): **1,159**

Average employment wage in Dorset (*2014*): **$43,765**

Residential Transportation Fuel Use

Number of vehicles (2014): **1,790**

Mean vehicles per household: **1.9**

Estimated miles traveled: **27.9 Million Miles**

Estimated gallons of fuels used: **1.2 Million Gallons**

Estimated total cost: **$4.2 Million**

Percent of resident employees driving alone to work: **80%**

Average commute time: **19 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1973**

Percent of Housing Built Since 2000: **6%**

Percent of Housing Built Before 1960: **39%**

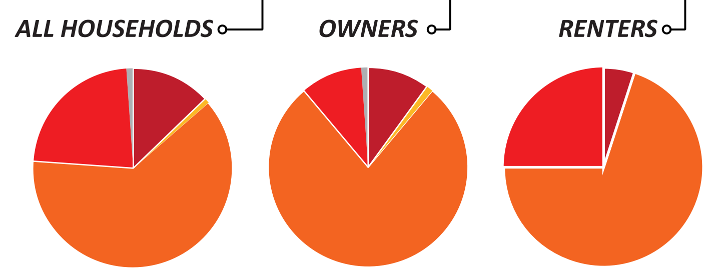
Median Annual Household Income: **$71,307**

Total Energy Use: **96 Billion BTUs**

Total Cost: **$1,749,000**

Mean Cost per Household: **$1,700**

Fuel Type: Space Heating	Number of Households	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	123 HHs	148K Gal	13%	15%	5%	26%
Electricity	5 HHs	168 MWh	1%	1%	0%	2%
Fuel Oil	587 HHs	427K Gal	63%	61%	70%	52%
Wood	212 HHs	1.3K Tons	23%	22%	25%	20%
Other	10 HHs	-	1%	1%	0%	-



Space Heating for Businesses

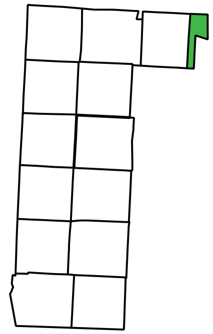
Mean Estimated Building Space for Businesses: **10,784 sq. ft**

Total Energy Use: **66 Billion BTUs**

Estimated Total Annual Cost: **$2,188,874**

Average Annual Cost per Business: **$21,460**

Landgrove



Population

Total Population (2014): **132**

Population Density: **14 people per sq. mile**

Households

Total Households *(2014)*: **71**

OWNERS

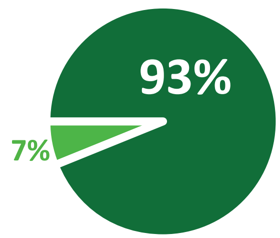
Total HHs Owned: **67**

Avg. Owner HH Size: **1.8**

RENTERS

Total HHs Rented: **4**

Avg. Renter HH Size: **2.3**



Businesses

Total businesses in Landgrove (*2014*): **9**

Total employees working in Landgrove (*2014*): **38**

Total employed residents in Landgrove (*2014*): **59**

Average employment wage in Landgrove (*2014*): **$30,470**

Residential Transportation Fuel Use

Number of vehicles (2014): **191**

Mean vehicles per household: **2.7**

Estimated miles traveled: **3.0 Million Miles**

Estimated gallons of fuels used: **0.1 Million Gallons**

Estimated total cost: **$0.4 Million**

Percent of resident employees driving alone to work: **56%**

Average commute time: **21 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1977**

Percent of Housing Built Since 2000: **5%**

Percent of Housing Built Before 1960: **40%**

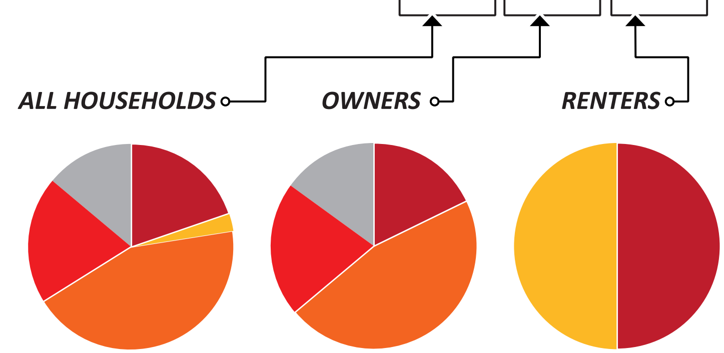
Median Annual Household Income: **$79,375**

Total Energy Use: **6 Billion BTUs**

Total Cost: **$108,000**

Mean Cost per Household: **$1,400**

Fuel Type: Space Heating	Number of Households	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	14 HHs	13K Gal	20%	18%	50%	37%
Electricity	2 HHs	40 MWh	3%	0%	50%	6%
Fuel Oil	31 HHs	20K Gal	44%	46%	0%	39%
Wood	14 HHs	75 Tons	20%	21%	0%	18%
Other	10 HHs	-	14%	15%	0%	-



Space Heating for Businesses

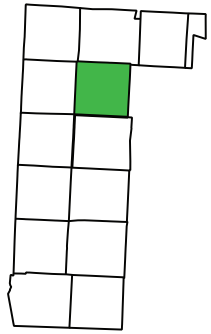
Mean Estimated Building Space for Businesses: **10,833 sq. ft**

Total Energy Use: **5.8 Billion BTUs**

Estimated Total Annual Cost: **$194,019**

Average Annual Cost per Business: **$21,558**

Manchester



Population

Total Population (2014): **4,352**

Population Density: **103 people per sq. mile**

Households

Total Households *(2014)*: **2,044**

OWNERS

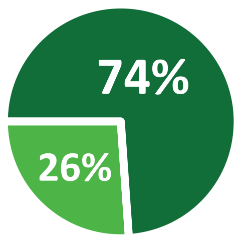
Total HHs Owned: **1,435**

Avg. Owner HH Size: **2.2**

RENTERS

Total HHs Rented: **609**

Avg. Renter HH Size: **1.8**



Businesses

Total businesses in Manchester (*2014*): **423**

Total employees working in Manchester (*2014*): **3930**

Total employed residents in Manchester (*2014*): **2,139**

Average employment wage in Manchester (*2014*): **$42,012**

Residential Transportation Fuel Use

Number of vehicles (2014): **3,207**

Mean vehicles per household: **1.6**

Estimated miles traveled: **50.0 Million Miles**

Estimated gallons of fuels used: **2.2 Million Gallons**

Estimated total cost: **$7.5 Million**

Percent of resident employees driving alone to work: **69%**

Average commute time: **12 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1978**

Percent of Housing Built Since 2000: **11%**

Percent of Housing Built Before 1960: **29%**

Median Annual Household Income: **$45,147**

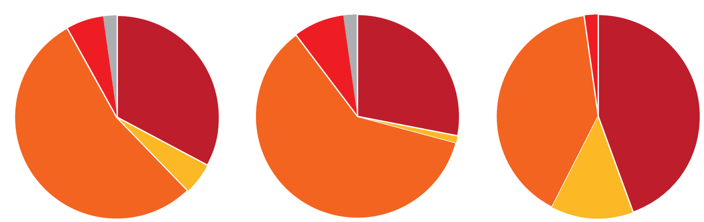
Total Energy Use: **187 Billion BTUs**

Total Cost: **$3,919,000**

Mean Cost per Household: **$1,900**

Fuel Type: Space Heating	Number of Households	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	673 HHs	635K Gal	33%	28%	44%	48%
Electricity	99 HHs	1.9 GWh	5%	1%	13%	7%
Fuel Oil	1110 HHs	766K Gal	54%	60%	40%	40%
Wood	127 HHs	783 Tons	6%	8%	2%	5%
Other	35 HHs	-	2%	2%	0%	-

ALL HOUSEHOLDS *OWNERS* *RENTERS*



Space Heating for Businesses

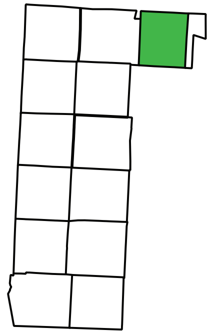
Mean Estimated Building Space for Businesses: **11,598 sq. ft**

Total Energy Use: **294 Billion BTUs**

Estimated Total Annual Cost: **$9,762,864**

Average Annual Cost per Business: **$23,080**

Peru



Population

Total Population (2014): **348**

Population Density: **9 people per sq. mile**

Households

Total Households *(2014)*: **158**

OWNERS

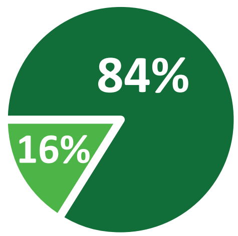
Total HHs Owned: **130**

Avg. Owner HH Size: **2.2**

RENTERS

Total HHs Rented: **28**

Avg. Renter HH Size: **2.0**



Businesses

Total businesses in Peru (*2014*): **23**

Total employees working in Peru (*2014*): **234**

Total employed residents in Peru (*2014*): **190**

Average employment wage in Peru (*2014*): **$27,123**

Residential Transportation Fuel Use

Number of vehicles (2014): **283**

Mean vehicles per household: **1.8**

Estimated miles traveled: **4.4 Million Miles**

Estimated gallons of fuels used: **0.2 Million Gallons**

Estimated total cost: **$0.7 Million**

Percent of resident employees driving alone to work: **80%**

Average commute time: **17 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1978**

Percent of Housing Built Since 2000: **10%**

Percent of Housing Built Before 1960: **19%**

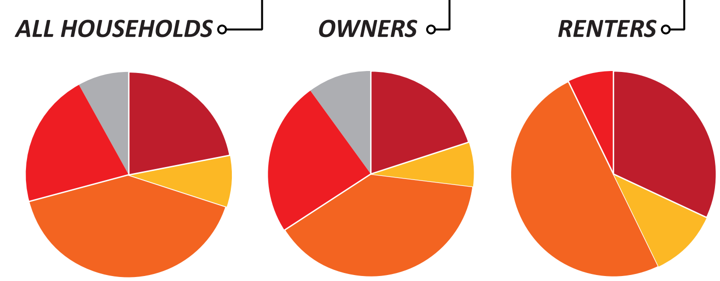
Median Annual Household Income: **$61,250**

Total Energy Use: **16 Billion BTUs**

Total Cost: **$318,000**

Mean Cost per Household: **$1,900**

Fuel Type: Space Heating	Number of Households	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	35 HHs	37K Gal	22%	20%	32%	35%
Electricity	12 HHs	337 MWh	8%	7%	11%	17%
Fuel Oil	65 HHs	46K Gal	41%	39%	50%	31%
Wood	33 HHs	210 Tons	21%	24%	7%	18%
Other	13 HHs	-	8%	10%	0%	-



Space Heating for Businesses

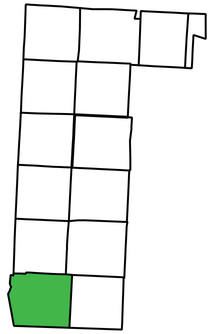
Mean Estimated Building Space for Businesses: **8,967 sq. ft**

Total Energy Use: **12 Billion BTUs**

Estimated Total Annual Cost: **$410,425**

Average Annual Cost per Business: **$17,845**

Pownal



Population

Total Population (2014): **3,495**

Population Density: **75 people per sq. mile**

Households

Total Households *(2014)*: **1,408**

OWNERS

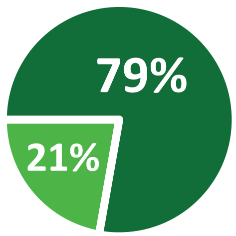
Total HHs Owned: **1,075**

Avg. Owner HH Size: **2.6**

RENTERS

Total HHs Rented: **333**

Avg. Renter HH Size: **2.2**



Businesses

Total businesses in Pownal (*2014*): **32**

Total employees working in Pownal (*2014*): **187**

Total employed residents in Pownal (*2014*): **1,862**

Average employment wage in Pownal (*2014*): **$28,278**

Residential Transportation Fuel Use

Number of vehicles (2014): **2,803**

Mean vehicles per household: **2.0**

Estimated miles traveled: **43.7 Million Miles**

Estimated gallons of fuels used: **1.9 Million Gallons**

Estimated total cost: **$6.6 Million**

Percent of resident employees driving alone to work: **84%**

Average commute time: **23 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1972**

Percent of Housing Built Since 2000: **11%**

Percent of Housing Built Before 1960: **27%**

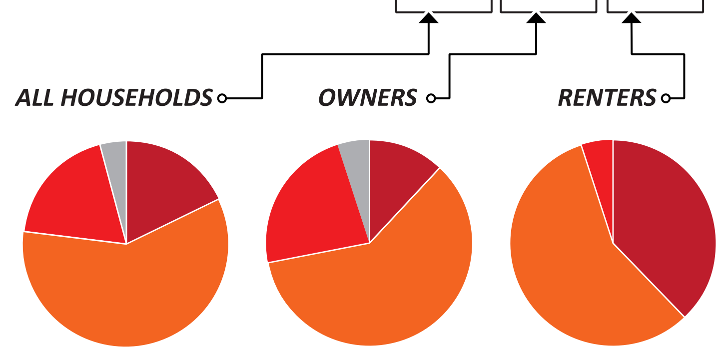
Median Annual Household Income: **$58,831**

Total Energy Use: **154 Billion BTUs**

Total Cost: **$2,752,000**

Mean Cost per Household: **$1,800**

Fuel Type: Space Heating	Number of House-holds	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	257 HHs	268K Gal	18%	12%	38%	30%
Electricity	0 HHs	0 KWh	-	-	-	-
Fuel Oil	836 HHs	664K Gal	59%	60%	57%	51%
Wood	264 HHs	1.9K Tons	19%	23%	5%	18%
Other	51 HHs	-	4%	5%	0%	-



Space Heating for Businesses

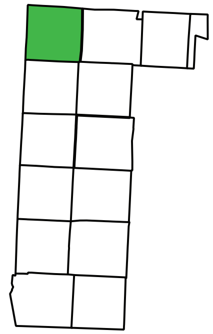
Mean Estimated Building Space for Businesses: **20,507 sq. ft**

Total Energy Use: **39 Billion BTUs**

Estimated Total Annual Cost: **$1,305,889**

Average Annual Cost per Business: **$40,809**

Rupert



Population

Total Population (2014): **620**

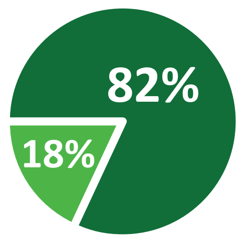
Population Density: **14 people per sq. mile**

Households

Total Households *(2014)*: **281**

OWNERS
Total HHs Owned: **237**
Avg. Owner HH Size: **2.1**

RENTERS
Total HHs Rented: **44**
Avg. Renter HH Size: **2.5**



Businesses

Total businesses in Rupert (*2014*): **23**

Total employees working in Rupert (*2014*): **54**

Total employed residents in Rupert (*2014*): **316**

Average employment wage in Rupert (*2014*): **$39,096**

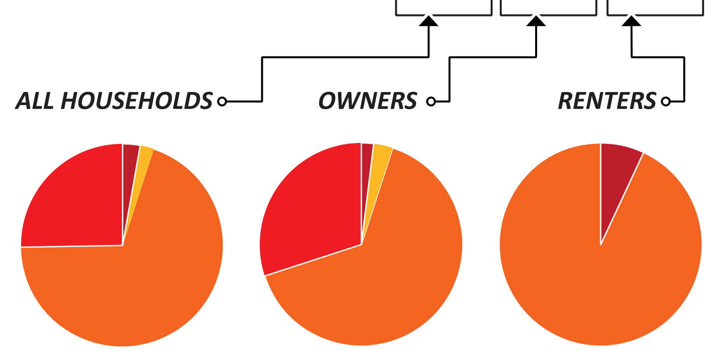
Residential Transportation Fuel Use

Number of vehicles (2014): **549**
Mean vehicles per household: **2.0**
Estimated miles traveled: **8.6 Million Miles**
Estimated gallons of fuels used: **0.4 Million Gallons**
Estimated total cost: **$1.3 Million**
Percent of resident employees driving alone to work: **69%**
Average commute time: **21 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1953**
Percent of Housing Built Since 2000: **3%**
Percent of Housing Built Before 1960: **56%**
Median Annual Household Income: **$49,219**
Total Energy Use: **27 Billion BTUs**
Total Cost: **$472,000**
Mean Cost per Household: **$1,500**

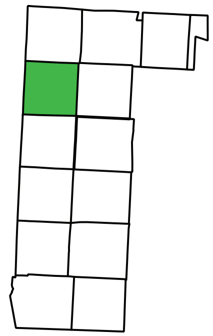
Fuel Type: Space Heating	Number of Households	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	8 HHs	8K Gal	3%	2%	7%	5%
Electricity	7 HHs	209 MWh	2%	3%	0%	7%
Fuel Oil	195 HHs	135K Gal	69%	65%	93%	62%
Wood	71 HHs	437 Tons	25%	30%	0%	25%
Other	0 HHs	-	0%	0%	0%	-



Space Heating for Businesses

Mean Estimated Building Space for Businesses: **6,956 sq. ft**
Total Energy Use: **9.6 Billion BTUs**
Estimated Total Annual Cost: **$318,380**
Average Annual Cost per Business: **$13,843**

Sandgate



Population

Total Population (2014): **516**

Population Density: **12 people per sq. mile**

Households

Total Households *(2014)*: **182**

OWNERS

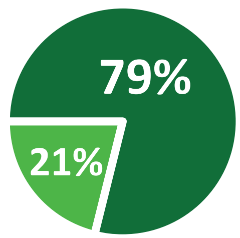
Total HHs Owned: **144**

Avg. Owner HH Size: **2.7**

RENTERS

Total HHs Rented: **38**

Avg. Renter HH Size: **2.8**



Businesses

Total businesses in Sandgate (*2014*): **5**

Total employees working in Sandgate (*2014*): **na**

Total employed residents in Sandgate (*2014*): **200**

Average employment wage in Sandgate (*2014*): **na**

Residential Transportation Fuel Use

Number of vehicles (2014): **381**

Mean vehicles per household: **2.1**

Estimated miles traveled: **5.9 Million Miles**

Estimated gallons of fuels used: **0.3 Million Gallons**

Estimated total cost: **$0.9 Million**

Percent of resident employees driving alone to work: **82%**

Average commute time: **29 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1965**

Percent of Housing Built Since 2000: **13%**

Percent of Housing Built Before 1960: **44%**

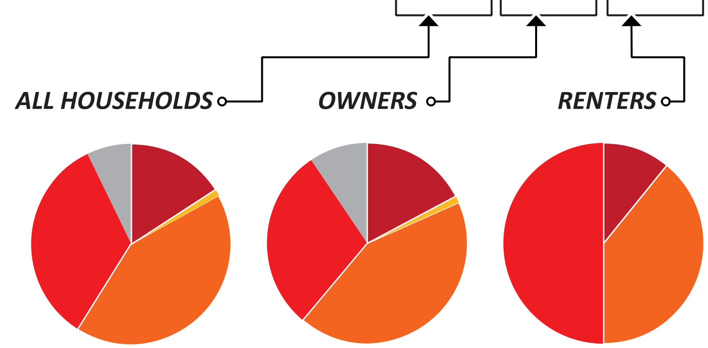
Median Annual Household Income: **$50,000**

Total Energy Use: **22 Billion BTUs**

Total Cost: **$399,000**

Mean Cost per Household: **$2,000**

Fuel Type: Space Heating	Number of Households	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	29 HHs	39K Gal	16%	17%	11%	31%
Electricity	1 HHs	38 MWh	1%	1%	0%	2%
Fuel Oil	76 HHs	66K Gal	42%	42%	39%	37%
Wood	61 HHs	426 Tons	34%	29%	50%	29%
Other	13 HHs	-	7%	9%	0%	-



Space Heating for Businesses

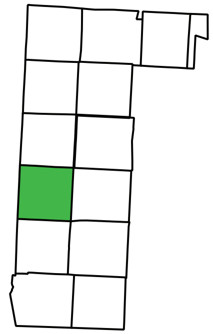
Mean Estimated Building Space for Businesses: **5,000 sq. ft**

Total Energy Use: **1.5 Billion BTUs**

Estimated Total Annual Cost: **$49,749**

Average Annual Cost per Business: **$9,950**

Shaftsbury



Population

Total Population (2014): **3,558**

Population Density: **83 people per sq. mile**

Households

Total Households *(2014)*: **1,548**

OWNERS

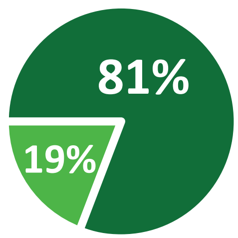
Total HHs Owned: **1,272**

Avg. Owner HH Size: **2.3**

RENTERS

Total HHs Rented: **276**

Avg. Renter HH Size: **2.5**



Businesses

Total businesses in Shaftsbury (*2014*): **61**

Total employees working in Shaftsbury (*2014*): **530**

Total employed residents in Shaftsbury (*2014*): **1,902**

Average employment wage in Shaftsbury (*2014*): **$42,091**

Residential Transportation Fuel Use

Number of vehicles (2014): **3,060**

Mean vehicles per household: **2.0**

Estimated miles traveled: **47.7 Million Miles**

Estimated gallons of fuels used: **2.1 Million Gallons**

Estimated total cost: **$7.2 Million**

Percent of resident employees driving alone to work: **85%**

Average commute time: **23 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1967**

Percent of Housing Built Since 2000: **4%**

Percent of Housing Built Before 1960: **40%**

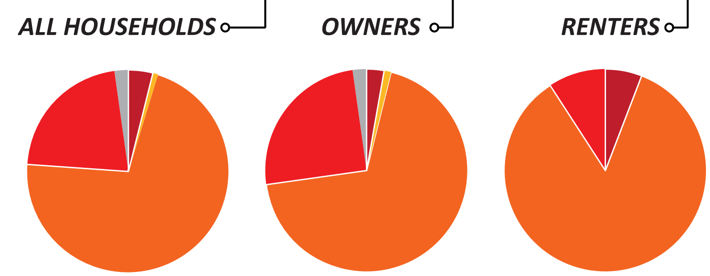
Median Annual Household Income: **$63,382**

Total Energy Use: **159 Billion BTUs**

Total Cost: **$2,601,000**

Mean Cost per Household: **$1,600**

Fuel Type: Space Heating	Number of House-holds	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	56 HHs	60K Gal	4%	3%	6%	7%
Electricity	13 HHs	413 MWh	1%	1%	0%	3%
Fuel Oil	1116 HHs	816K Gal	72%	69%	85%	68%
Wood	338 HHs	2.2K Tons	22%	25%	9%	23%
Other	25 HHs	-	2%	2%	0%	-



Space Heating for Businesses

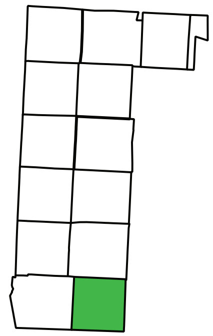
Mean Estimated Building Space for Businesses: **15,594 sq. ft**

Total Energy Use: **57 Billion BTUs**

Estimated Total Annual Cost: **$1,892,898**

Average Annual Cost per Business: **$31,031**

Stamford



Population

Total Population (2014): **878**

Population Density: **22 people per sq. mile**

Households

Total Households *(2014)*: **364**

OWNERS

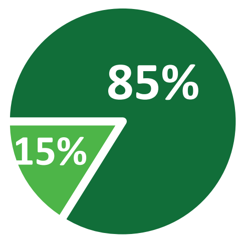
Total HHs Owned: **313**

Avg. Owner HH Size: **2.4**

RENTERS

Total HHs Rented: **51**

Avg. Renter HH Size: **2.6**



Businesses

Total businesses in Stamford (*2014*): **19**

Total employees working in Stamford (*2014*): **67**

Total employed residents in Stamford (*2014*): **441**

Average employment wage in Stamford (*2014*): **$28,452**

Residential Transportation Fuel Use

Number of vehicles (2014): **758**

Mean vehicles per household: **2.1**

Estimated miles traveled: **11.8 Million Miles**

Estimated gallons of fuels used: **0.5 Million Gallons**

Estimated total cost: **$1.8 Million**

Percent of resident employees driving alone to work: **84%**

Average commute time: **24 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1965**

Percent of Housing Built Since 2000: **14%**

Percent of Housing Built Before 1960: **45%**

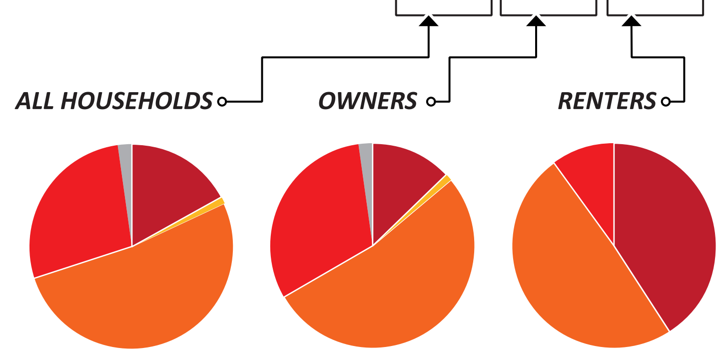
Median Annual Household Income: **$59,000**

Total Energy Use: **40 Billion BTUs**

Total Cost: **$739,000**

Mean Cost per Household: **$1,900**

Fuel Type: Space Heating	Number of Households	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	58 HHs	64K Gal	16%	12%	41%	7%
Electricity	4 HHs	133 MWh	1%	1%	0%	3%
Fuel Oil	179 HHs	141K Gal	49%	49%	49%	41%
Wood	95 HHs	647 Tons	26%	29%	10%	24%
Other	6 HHs	-	2%	2%	0%	-



Space Heating for Businesses

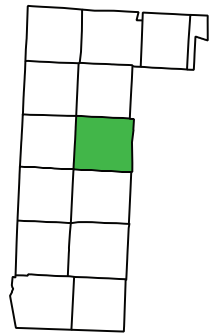
Mean Estimated Building Space for Businesses: **9,539 sq. ft**

Total Energy Use: **11 Billion BTUs**

Estimated Total Annual Cost: **$360,676**

Average Annual Cost per Business: **$18,983**

Sunderland



Population

Total Population (2014): **934**

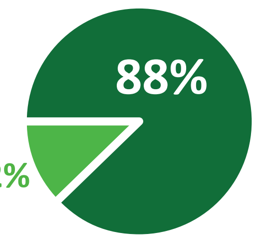
Population Density: **21 people per sq. mile**

Households

Total Households *(2014)*: **405**

OWNERS
Total HHs Owned: **357**
Avg. Owner HH Size: **2.3**

RENTERS
Total HHs Rented: **48**
Avg. Renter HH Size: **2.4**



Businesses

Total businesses in Sunderland (*2014*): **29**

Total employees working in Sunderland (*2014*): **111**

Total employed residents in Sunderland (*2014*): **519**

Average employment wage in Sunderland (*2014*): **$41,406**

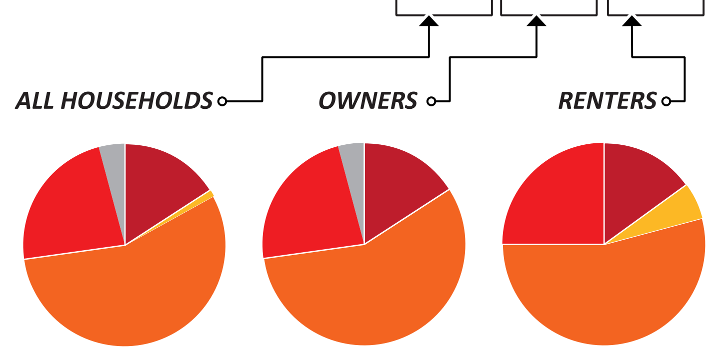
Residential Transportation Fuel Use

Number of vehicles (2014): **775**
Mean vehicles per household: **1.9**
Estimated miles traveled: **12.1 Million Miles**
Estimated gallons of fuels used: **0.5 Million Gallons**
Estimated total cost: **$1.8 Million**
Percent of resident employees driving alone to work: **75%**
Average commute time: **21 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1978**
Percent of Housing Built Since 2000: **15%**
Percent of Housing Built Before 1960: **31%**
Median Annual Household Income: **$53,869**
Total Energy Use: **43 Billion BTUs**
Total Cost: **$774,000**
Mean Cost per Household: **$1,800**

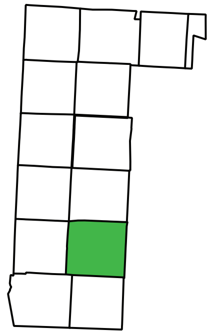
Fuel Type: Space Heating	Number of House-holds	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	63 HHs	73K Gal	16%	16%	15%	29%
Electricity	3 HHs	63 MWh	1%	0%	6%	1%
Fuel Oil	228 HHs	174K Gal	56%	57%	54%	48%
Wood	95 HHs	606 Tons	23%	23%	25%	21%
Other	16 HHs	-	4%	4%	0%	-



Space Heating for Businesses

Mean Estimated Building Space for Businesses: **1,121 sq. ft**
Total Energy Use: **1.9 Billion BTUs**
Estimated Total Annual Cost: **$64,672**
Average Annual Cost per Business: **$2,230**

Woodford



Population

Total Population (2014): **322**

Population Density: **7 people per sq. mile**

Households

Total Households *(2014)*: **153**

OWNERS

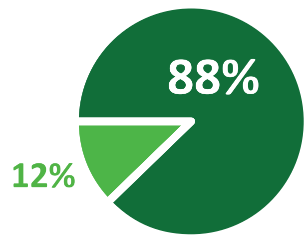
Total HHs Owned: **126**

Avg. Owner HH Size: **2.2**

RENTERS

Total HHs Rented: **27**

Avg. Renter HH Size: **1.5**



Businesses

Total businesses in Woodford (*2014*): **4**

Total employees working in Woodford (*2014*): **na**

Total employed residents in Woodford (*2014*): **170**

Average employment wage in Woodford (*2014*): **na**

Residential Transportation Fuel Use

Number of vehicles (2014): **283**

Mean vehicles per household: **1.8**

Estimated miles traveled: **4.4 Million Miles**

Estimated gallons of fuels used: **0.2 Million Gallons**

Estimated total cost: **$0.7 Million**

Percent of resident employees driving alone to work: **88%**

Average commute time: **27 Minutes**

Space Heating For Households

Median Year Built for Housing Units: **1969**

Percent of Housing Built Since 2000: **8%**

Percent of Housing Built Before 1960: **36%**

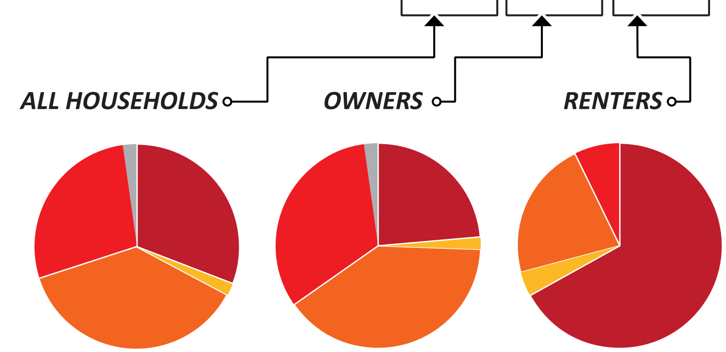
Median Annual Household Income: **$41,023**

Total Energy Use: **2 Billion BTUs**

Total Cost: **$312,000**

Mean Cost per Household: **$1,900**

Fuel Type: Space Heating	Number of Households	Avg. Use *(Annual)*	Percent of Use *(All HHs)*	Percent of Use: Owner	Percent of Use: Renter	Percent of Cost *(All HHs)*
Tank/LP/etc. Gas	48 HHs	44K Gal	100%	24%	67%	44%
Electricity	3 HHs	76 MWh	6%	2%	4%	4%
Fuel Oil	56 HHs	41K Gal	117%	40%	22%	28%
Wood	43 HHs	272 Tons	90%	33%	7%	24%
Other	3 HHs	-	6%	2%	0%	-



Space Heating for Businesses

Mean Estimated Building Space for Businesses: **10,833 sq. ft**

Total Energy Use: **2.6 Billion BTUs**

Estimated Total Annual Cost: **$86,231**

Average Annual Cost per Business: **$21,558**

Home Heating Estimates Methodology

This section outlines the data gathering and analysis process that the BCRC used to generate both regionwide and town estimates for home heating fuel source and costs.

*This analysis does not include non-residential building data

1 **Retrieve Fuel Type Data** from US Census Bureau American Factfinder website. To locate specific sets of data, use the 'Guided Search' feature of the American Factfinder data portal. Arlington town data, taken from ACS 2013 five year estimates:

Total:	1,109 HHS
Owner Occupied:	779 HHs
Utility gas	0
Bottled, tank, or LP gas	56
Electricity	0
Fuel oil, kerosene, etc.	521
Coal or coke	4
Wood	181
Solar Energy	0
Other fuel	17
No fuel used	0
Renter Occupied:	330 HHs
Utility gas	0
Bottled, tank, or LP gas	47
Electricity	7
Fuel oil, kerosene, etc.	254
Coal or coke	0
Wood	22
Solar energy	0
Other fuel	0
No fuel used	0

2 **Retrieve Household Size Data** from American Factfinder and generate approximate square footage by household type.

*National square feet per person medians taken from the American Housing Survey for the United States: 2011, published in 2013 by the US Census Bureau. Arlington example:

	Avg. ppl per HH	Ntnl. median square ft per person	Total HHs	Total estimated square ft
Owner	2.24	800	779	= 1,395,968
Renter	1.99	500	330	= 328,350

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

BCRC combined 'solar energy' and 'other fuel' categories for this analysis.

Arlington example for fuel oil in owner- and renter-occupied HH:

Owner Occupied	Total 779 HHs	Percentage of housing		Approx. SqFt of Owner-occupied housing heated by fuel type:
Fuel oil, kerosene, etc.	521	(521 / 779) ~67%	Multiply by SqFt/HH: 1,395,968	= 933,632
Wood	181	(181 / 779) ~23%		= 324,352

Home Heating Estimates Methodology

4 Calculate Energy Required for Heating with an assumed heating rate of 60,000 BTUs per sq.ft. of housing in VT.

Assumed heating rate is a conservative estimate assuming generally low residential energy efficiency, and is based on a combination of federal and online sources. Other regions may use a lower (more efficient) rate closer to 50,000 BTUs.

Arlington example:

Type of Fuel (Owner Occupied)	Total Sq. Feet of Housing		Approx. BTUs of Energy used Annually for Heating
Fuel oil, kerosene, etc.	933,632	Multiply by BTUs/SqFt: 60,000	= 56,017,920,000
Wood	324,352		= 19,461,120,000

5 Calculate Quantities of Fuel Consumed with assumed rates of energy per unit of each fuel type.

Fuel efficiencies based on several federal and additional sources.

Approximate efficiencies used in BCRC calculations:

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

Arlington example:

Fuel Oil Heating Demand for Owner Occupied Homes	56,017,920,000 BTUs/year	Divided by: 140,000 BTUs/gallon	= 400,128 Gallons Fuel Oil per Year

6 Calculate Cost of Fuel Consumed with assumed prices for each fuel types.

Prices for fuel inputs fluctuate often, so prices used here are estimates that can be adjusted over time.

Estimated prices used in BCRC calculations:

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

Arlington example:

Fuel Oil Consumed in Owner Occupied Homes	400,128 Gallons/Year	Multiplied by: $2.75/Gallon	= $1,100,352.00 per Year

7 Calculations Done

Compile final calculations and display them as tables and graphs in the corresponding sections of the plan.

Business Heating Estimates Methodology

This section outlines the data gathering and analysis process that the BCRC used to generate both regionwide and town estimates for business heating fuel costs.

1 Retrieve Count of Commercial Establishments in region.
Town-level commercial counts are available from the Vermont Dept of Labor.

2 Locate Data on Business Establishment SqFootage.
BCRC sourced town-level sq. footage estimates from a Bennington County Employers Report completed by *Infogroup* for BCRC in January 2015. Since the study lacks data for the towns of Landgrove and Woodford, the median sq.footage value from other towns (10,833 square feet) was used.

3 Calculate Approximate BTUs with SqFootage with an assumed heating rate of 60,000 BTUs per sq.ft. of buildings in VT.
Assumed heating rate is a conservative estimate assuming generally low building energy efficiency, and is based on a combination of federal and online sources.

4 Calculate Average Heating Costs for Commercial Establishments with assumed heating source distribution and unit costs.
Fuel shares sourced from Energy Information Administration's State Energy Data System by way of Department of Public Service (with Natural Gas share split evenly between Propane and Distillates for Bennington County). Fuel unit prices sourced from U.S. Energy Information Administration online database.

Fuel Type	Share of Commercial Buildings	Price per fuel unit to heat one sq. ft. (60,000 BTU)	BCRC
Electricity	34%	$2.59	0.88
Propane	30.5%	$2.27	0.69
Distillates (Heating Oil)	28.5%	$1.18	0.34
Biomass	7%	$1.16	0.08
		Total:	$1.99

5 Estimate Costs by Town and Average Business with average heating cost of $1.99 per 60,000 BTUs in commercial buildings.
Divide total heating costs by number of businesses to calculate average annual heating costs per businees in each town:

Town:	2014 # of Businesses	Estimated Total Commercial Sq. Ft.	Estimated Average Sq. Ft. per Business	Estimated Total Annual BTUs	Estimated Total Annual Heating Cost ($)	Estimated Average Annual Cost per Business ($)
Arlington	102	1,452,435.5	14,240	87,146,130,000	2,890,347	28,337
Bennington	604	10,195,822	16,881	611,749,320,000	20,289,686	33,592
Dorset	102	1,099,936.5	10,784	65,996,190,000	2,188,874	21,460
Manchester	423	4,905,962	11,598	294,357,720,000	9,762,864	23,080
Peru	23	206,243.5	8,967	12,374,610,000	410,425	17,845
Pownal	32	656,225.5	20,507	39,373,530,000	1,305,889	40,809
Rupert	23	159,990	6,956	9,599,400,000	318,380	13,843
Sandgate	5	24,999.5	5,000	1,499,970,000	49,749	9,950
Shaftsbury	61	951,205	15,594	57,072,300,000	1,892,898	31,031
Stamford	19	181,244	9,539	10,874,640,000	360,676	18,983
Sunderland	29	32,498.5	1,121	1,949,910,000	64,672	2,230
Calculated using median estimated Sq.Footage of 10,833:						
Landgrove	9	97,497	10,833	5,849,820,000	194,019	21,558
Woodford	4	43,332	10,833	2,599,920,000	86,231	21,558

Residential Transportation Estimates Methodology

This section outlines the data gathering and analysis process that the BCRC used to generate both regionwide and town estimates for residential transportation fuel use and costs.

1 **Retrieve Data from US Census Bureau American Factfinder**
The following data have been sourced from ACS 2010-2014 5-year estimates:
- # of Vehicles
- % Residents Commuting Alone to Work
- # of Households
- Average Commute Time

Some 2014 Data unavailable for Landgrove, so 2008-2012 ACS estimate used.

2 **Estimate Miles Traveled** by dividing total vehicle miles traveled in VT by total vehicles in VT.
2012 value for Total Vehicle Miles Traveled in VT sourced from 2014 State Transportation Statistics report from U.S. Bureau of Transportation Statistics.
Total Vehicles in VT count sourced from ACS 2009-2013 5-year estimates.
7,216,000,000 / 462,795 = 15,592 VMT per vehicle in VT
Multiply No. of Vehicles by estimated miles traveled per vehicle.

3 **Estimate Gallons of Fuel Used** by dividing total estimated miles traveled in each town by average MPG of vehicles in VT.
Estimated average MPG for VT sourced from VTrans = 22.8 miles / gallon
http://vtransplanning.vermont.gov/sites/aot_policy/files/VTEPAugust%2028%202013%20FINAL.pdf

4 **Calculate Total Fueling Costs** by multiplying total estimated gallons of fuel used in each town by national average price for a gallon of gasoline.
National average price for all gasoline (2014) sourced from U.S. Energy Information Administration = $ 3.425 / gallon of gasoline

Town	No. Vehicles	No. HHs	Vehicles/HH	Estimated Miles Traveled	Estimated Gal. of Fuel Used	Estimated Total Cost (in Dollars)	% Residents Commuting Alone to Work	Average Commute Time
Arlington	1,821	1,070	1.7	28,393,032	1,245,308	4,265,181	74 %	21
Bennington	9,402	6,096	1.5	146,595,984	6,429,648	22,021,546	75 %	17
Dorset	1,790	937	1.9	27,909,680	1,224,109	4,192,573	80 %	19
Landgrove	191	71	2.7	2,978,072	130,617	447,364	56 %	21
Manchester	3,207	2,044	1.6	50,003,544	2,193,138	7,511,497	69 %	12
Peru	283	158	1.8	4,412,536	193,532	662,848	80 %	17
Pownal	2,803	1,408	2.0	43,704,376	1,916,859	6,565,241	84 %	23
Rupert	549	281	2.0	8,560,008	375,439	1,285,878	69 %	21
Sandgate	381	182	2.1	5,940,552	260,551	892,386	82 %	29
Shaftsbury	3,060	1,548	2.0	47,711,520	2,092,611	7,167,191	85 %	23
Stamford	758	364	2.1	11,818,736	518,366	1,775,402	84 %	24
Sunderland	775	405	1.9	12,083,800	529,991	1,815,220	75 %	21
Woodford	283	153	1.8	4,412,536	193,532	662,848	88 %	27

APPENDIX B.

LEAP SYSTEM MODELING, BCRC REGION

Appendix B includes the outputs and methodology report for the LEAP System Scenario Model, generated by the Vermont Energy Investment Corporation.

Contents

Statewide and RPC Energy Modeling

Outputs and Methodology through May, 2016

Introduction

This document supplements the regional energy plans created by each Regional Planning Commission (RPC). It was developed by Vermont Energy Investment Corporation (VEIC) under a contract with the Bennington County Regional Commission 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. A list of assumptions made in the modeling process is included at the end of this report.

Statewide Model Methodology

VEIC created and revised a model of the demand and supply of total energy in Vermont and within each region. 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 is assumed to grow at 0.35% per year.[4] *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 in the model for* ***residential energy*** *consumption.*

Projected change in the ***energy demand from the commercial sector*** *was based on commercial sector data in the TES. The demand driver for the commercial sector is commercial building square feet.*

[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.

*The team entered total **industrial consumption** by fuel estimates from the TES directly into the model. **Transportation energy** use is based on projections of vehicle miles traveled (VMT). This metric has risen through most of American history and people had assumed it would continue to do so. However, 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.*

*The **electricity supply** is based on the TES[2], the utilities' Committed Supply[3], and other sources as needed to meet the 90x50 goal and the demand projected in the model.*

Table 2 shows the capacity added in the model between 2015 and 2050. This is a scenario that meets the 90x50 goal and many others are possible.

Table 1: New Capacity Added 2015-2050

	New Capacity by 2050 (MW)	**Source**
New In-state hydro	*93*	*Barg, 2007[7]*
Solar	*1,500 – 2,250*	*TES*
Wind	*260 - 488*	*Brings wind to 25% of generation*

Table 2 shows the capacity factor and source for hourly data for each renewable energy type. The hourly data was used to determine generation from each resource and to identify the timing, frequency, duration, and magnitude of mismatch between supply and demand. These outputs informed discussions of load management, regional trading, curtailment, and energy storage.

Table 2: Capacity Factor and Hourly Profile

Capacity Factor		***Generation Profile Source***	***Precision***
Demand	*n/a*	*2013 VT load from ISO-NE[5] scaled up to the model's 2025 GWh*	*hourly*
In-state hydro	*48%*	*Calculated from existing Committed GWh of supply and installed MW capacity*	*annual*
New In-state hydro	*52%*	*USGS 2007-2015 flow of White River at West Hartford* *15-minute data from 2013, which was chosen as a year with near average flow and little missing data*	*15-minute*
Hydro-Quebec	*70%*	*GMP's contract: 7am – 11pm, 7 days a week*	*hourly*
Solar	*13.7%*	*NREL 2013 NSRDB, 30° tilt, no tracking*	*30-minute*
Wind	*38%*	*NREL Eastern Wind Dataset[6]* *10-minute data for 17 simulated sites in Vermont, 2004-2006, 2005 was chosen because output was between the other two*	*10-minute*
Biomass[7]	*90% (max)*	*Dispatched if the other renewables are not meeting demand*	*calculated from others*

[5] ISO-New England, Zonal Information, *SMD Hourly Data.* http://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/zone-info

[6] NREL, 2012, *Eastern Wind Dataset,* http://www.nrel.gov/electricity/transmission/eastern_wind_methodology.html

[7] Biomass fired electric plants such as McNeil and Ryegate operate like fossil fuel plants in that their fuel can be stored for use when electricity is needed. The 90% capacity factor reflects the ability to run nearly constantly, but the actual runtime depends on the ability of other renewable energy to meet demand.

Scenarios

*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 expansion of natural gas infrastructure and more fuel efficient cars because of CAFE standards. The **$90x50_{VEIC}$ 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 replacing diesel in heavy duty vehicles and electricity replacing gasoline in light duty vehicles.*

*The statewide demand in the **$90x50_{VEIC}$ scenario** is shown in Figure 1. The colored areas show the energy consumed by sector in the 90x50 scenario. The gray area at the top shows additional efficiency in the 90x50 compared to the reference scenario. The top of the gray area would be the top of a graph of the reference scenario. 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.*

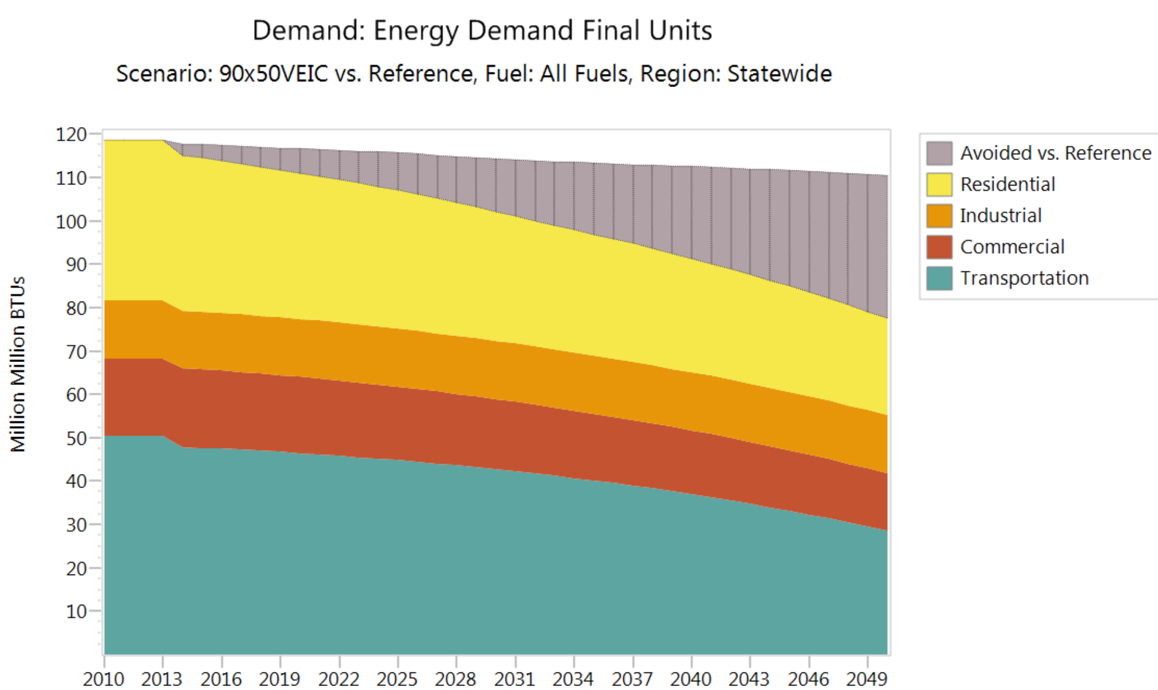


Figure 1 - Statewide Energy Demand by Sector

The statewide electricity supply is shown in Figure 2. Committed supply forms the foundation of this graph, but it is relatively short term. When those commitments end, the model meets the growing electricity demand with natural gas electricity from the New England market. To meet the 90% goal, wind, solar, and hydro ramp up.

Figure 2

Figure 2 - Statewide Electricity Supply by Fuel, 90x50VEIC and Reference Scenarios

Regional Models

The demand in the statewide model was broken in to the Bennington, Two Rivers, and Northwest regions, and rest of state. 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.

The supply model was not broken into regions, as no region is going to host a small share of the Seabrook nuclear reactor that provides some of their electricity for example. Instead, to aid in planning and discussion, each region's "share" of new (installed after 2015) in-state generation by 2050 is shown in

Table 3. The capacity is allocated according to the region's 2050 modeled electricity consumption. This table excludes new energy purchased from Hydro Quebec, the natural gas generation from the New England grid, and the small amount of nuclear energy that utilities are currently committed to buy.

Table 3 - Regional share of 2050 Consumption and Cumulative New Capacity

Region[8]	Year	Electricity Consumption (1000 GWh)	New Wind (MW)	New Hydro (MW)	New Solar (MW)
Statewide	*2015*	*5,623*	*-*	*-*	*-*
	2025	*6,991*	*49*	*25*	*445*
	2035	*8,073*	*195*	*50*	*926*
	2050	*10,044*	*400*	*93*	*2.250*
Bennington	*2015*	*318*	*-*	*-*	*-*
	2025	*381*	*3*	*1*	*21*
	2035	*421*	*18*	*1*	*64*
	2050	*473*	*26*	*1*	*85*

The numbers in the table above reflect one possible way to achieve 90% of total energy from renewables. New capacity shown in the table is based on projected future demand. In reality, the regional allocations will be different when factoring in resource availability and existing capacity. The table is only meant to give a sense of scale and a basis for discussion.

[8] New capacity shown in the table is based solely on projected future demand. Regional allocations will be different when factoring in resource availability and existing capacity.

Regional Results

Bennington

Total Demand

Figure 3: Statewide Energy Demand by Fuel, 90x50VEIC and Reference Scenarios

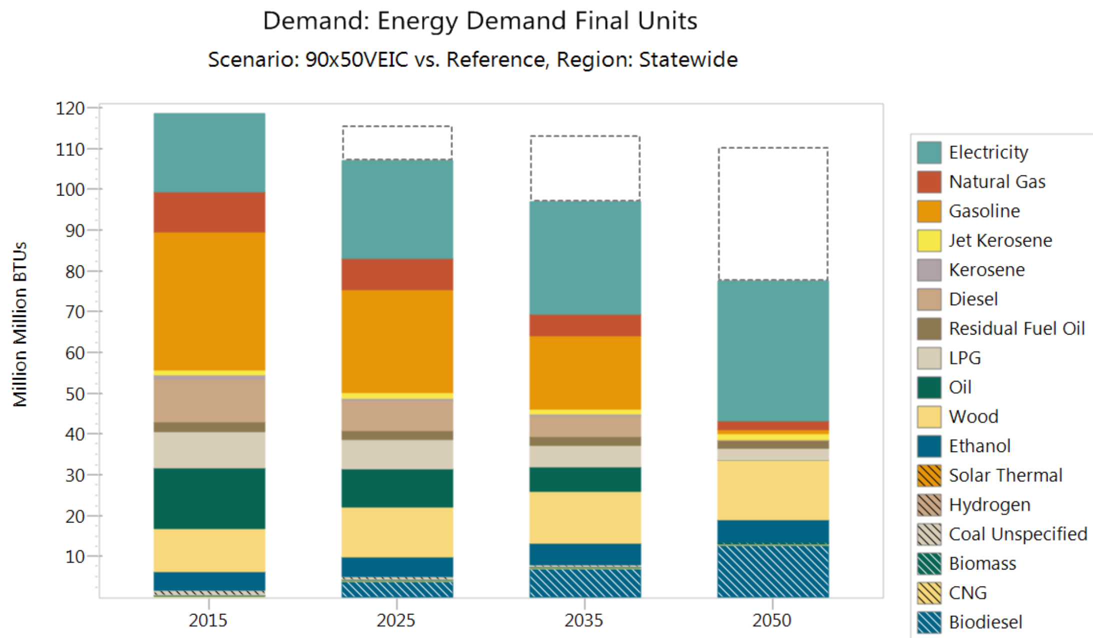


Table 4: State Energy Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC vs. Reference, Region: Statewide				
Units: Million Million BTUs				
Fuels	**2015**	**2025**	**2035**	**2050**
Electricity	19.206	23.878	27.573	34.306
Natural Gas	9.947	7.690	5.281	2.188
Gasoline	33.734	25.380	17.963	0.890
Jet Kerosene	1.180	1.255	1.305	1.380
Kerosene	1.041	0.643	0.392	-
Diesel	10.531	7.392	4.994	0.230
Residual Fuel Oil	2.340	2.231	2.132	1.972
LPG	8.947	7.067	5.402	2.901
Oil	14.798	9.510	5.897	0.046
Wood	10.730	12.051	12.872	14.533
Ethanol	4.575	4.823	5.109	5.522
Solar Thermal	0.006	0.051	0.087	0.157
Hydrogen	-	-	-	-
Coal Unspecified	1.170	0.731	0.439	-
Biomass	0.080	0.149	0.196	0.275
CNG	0.230	0.247	0.264	0.300
Biodiesel	0.110	3.949	6.994	12.766
Total	**118.624**	**107.049**	**96.900**	**77.467**

Figure 4: Bennington Demand by Fuel, 90x50VEIC and Reference Scenarios

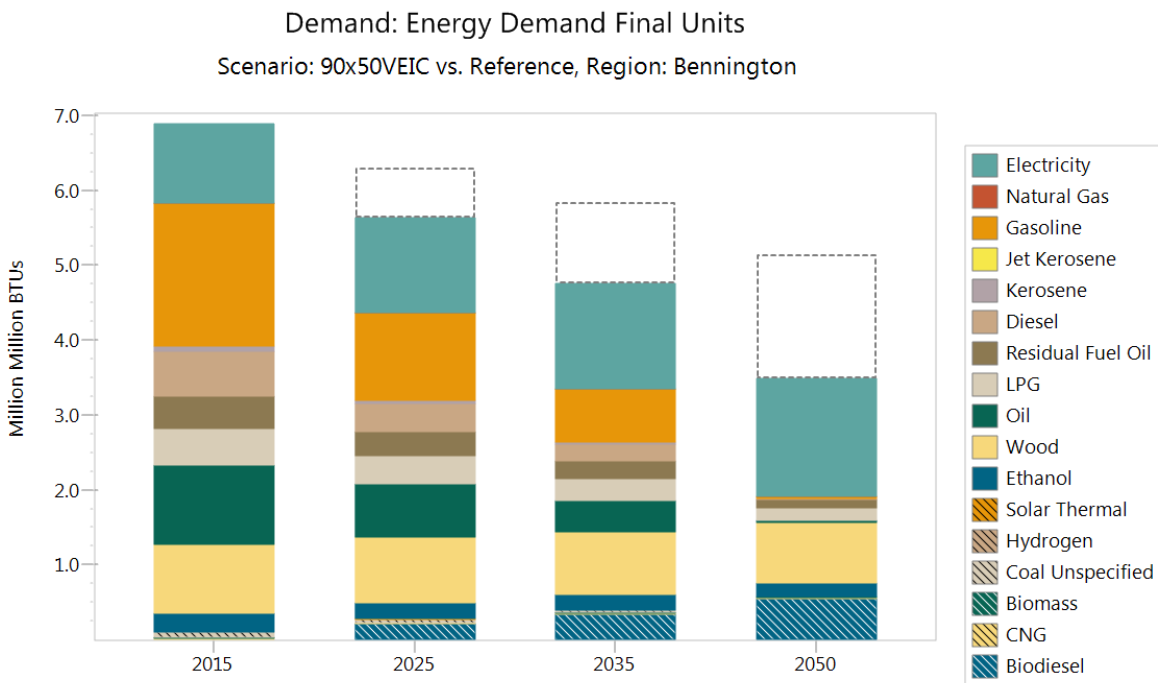


Table 5: Bennington Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC vs. Reference, Region: Bennington				
Units: Million Million BTUs				
Fuels	**2015**	**2025**	**2035**	**2050**
Electricity	1.054	1.269	1.405	1.582
Natural Gas	0.002	0.002	0.001	0.001
Gasoline	1.907	1.164	0.712	0.028
Jet Kerosene	-	-	-	-
Kerosene	0.073	0.050	0.030	-
Diesel	0.597	0.367	0.223	0.007
Residual Fuel Oil	0.436	0.319	0.239	0.118
LPG	0.485	0.380	0.287	0.161
Oil	1.064	0.712	0.424	0.026
Wood	0.916	0.873	0.839	0.809
Ethanol	0.259	0.221	0.203	0.175
Solar Thermal	0.000	0.003	0.005	0.008
Hydrogen	-	-	-	-
Coal Unspecified	0.070	0.044	0.026	-
Biomass	0.004	0.008	0.010	0.014
CNG	0.013	0.014	0.014	0.015
Biodiesel	0.006	0.204	0.337	0.541
Total	**6.887**	**5.628**	**4.755**	**3.487**

Residential

Figure 5: Statewide Residential Demand by Fuel, 90x50VEIC and Reference Scenarios

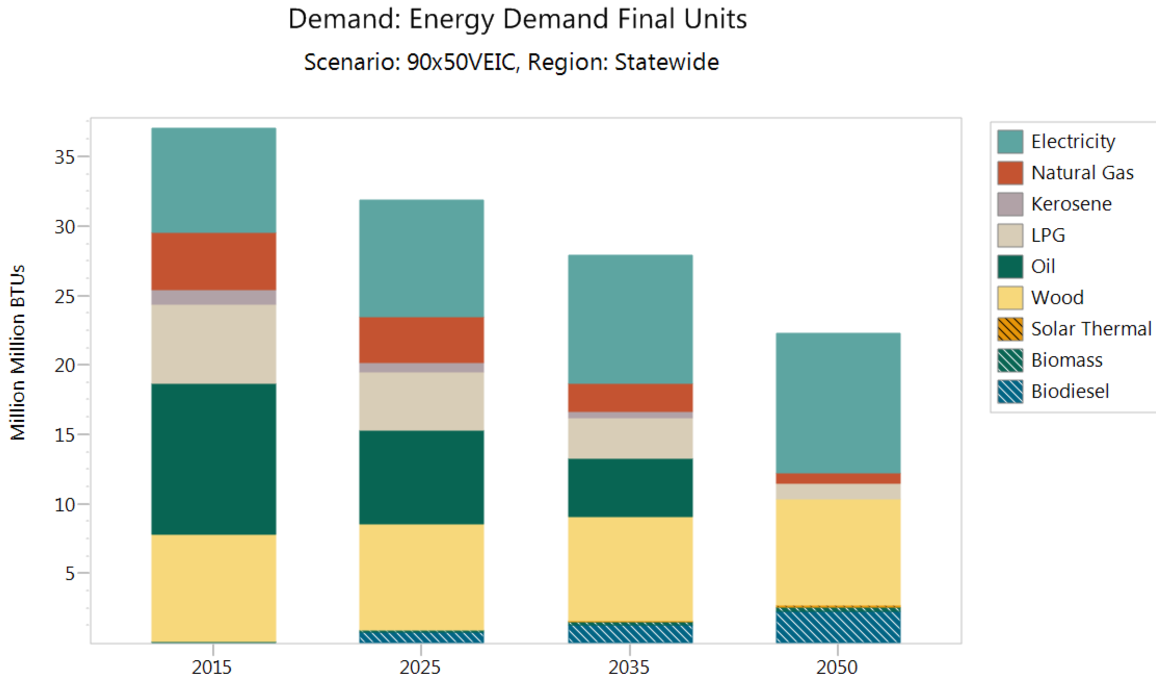


Table 6: Statewide Residential Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC, Region: Statewide				
Units: Million Million BTUs				
Fuels	**2015**	**2025**	**2035**	**2050**
Electricity	7.496	8.401	9.246	10.055
Natural Gas	4.147	3.339	2.065	0.708
Kerosene	1.041	0.643	0.392	-
LPG	5.667	4.179	2.947	1.106
Oil	10.898	6.770	4.197	-
Wood	7.730	7.621	7.525	7.696
Solar Thermal	0.006	0.051	0.087	0.157
Biomass	0.080	0.149	0.196	0.275
Biodiesel	-	0.736	1.272	2.258
Total	**37.064**	**31.890**	**27.928**	**22.255**

Figure 6: Bennington Residential Demand by Fuel, 90x50VEIC and Reference Scenarios

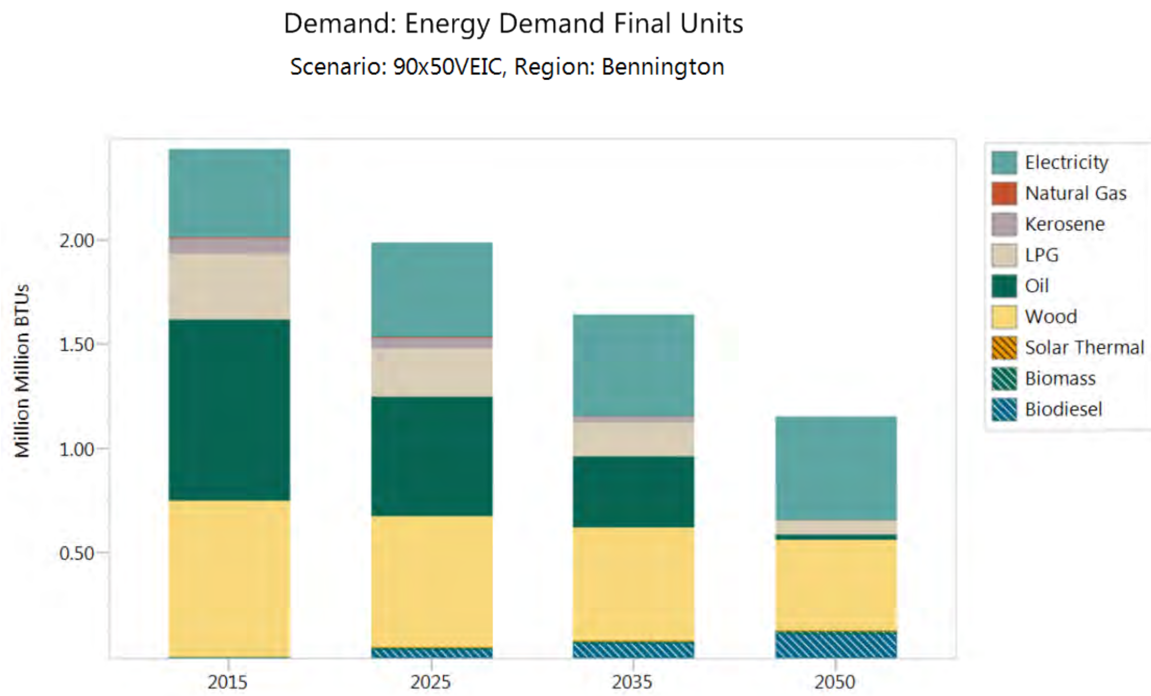


Table 7: Bennington Residential Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC, Region: Bennington				
Units: Million Million BTUs				
Fuels	**2015**	**2025**	**2035**	**2050**
Electricity	0.421	0.450	0.481	0.492
Natural Gas	0.002	0.002	0.001	0.001
Kerosene	0.073	0.050	0.030	-
LPG	0.317	0.231	0.160	0.068
Oil	0.869	0.575	0.339	0.024
Wood	0.748	0.627	0.543	0.434
Solar Thermal	0.000	0.003	0.005	0.008
Biomass	0.004	0.008	0.010	0.014
Biodiesel	-	0.041	0.068	0.112
Total	**2.434**	**1.986**	**1.638**	**1.152**

Single Family Space Heating

Figure 7: Statewide Single Family Heating Energy Demand by Fuel, 90x50VEIC and Reference Scenarios

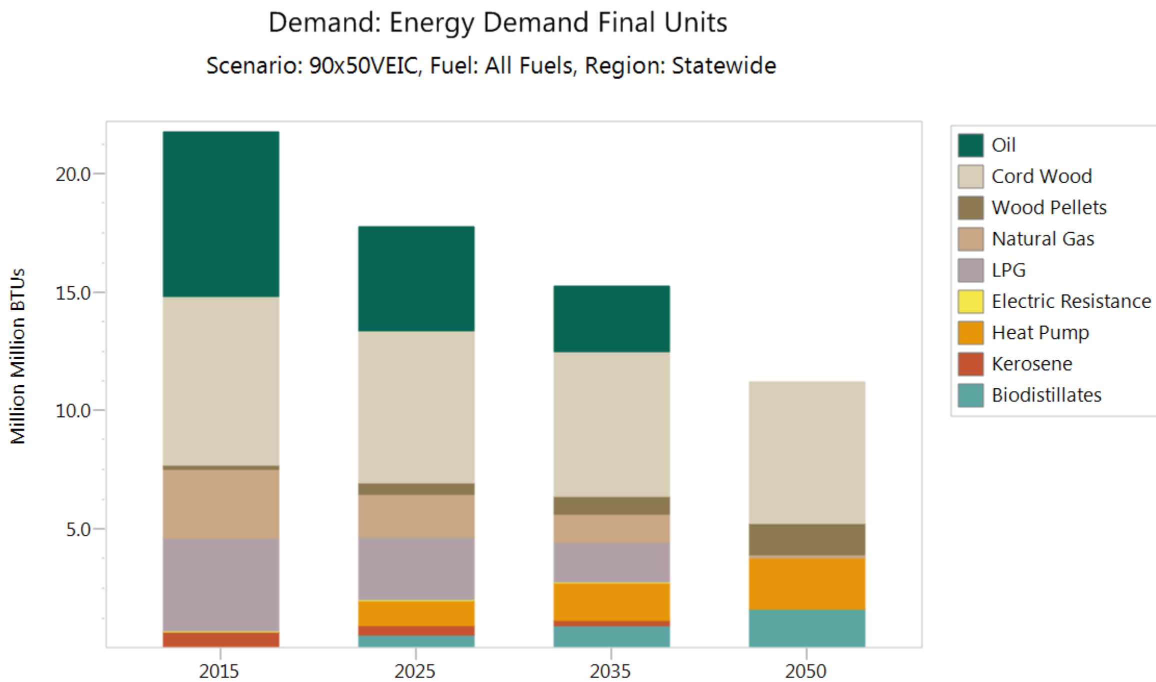


Table 8: Statewide Single Family Heating Energy Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC, Fuel: All Fuels, Region: Statewide				
Units: Million Million BTUs				
Heating Type	**2015**	**2025**	**2035**	**2050**
Oil	6.971	4.400	2.762	-
Cord Wood	7.136	6.411	6.154	6.015
Wood Pellets	0.189	0.500	0.757	1.285
Natural Gas	2.916	1.804	1.186	0.151
LPG	3.898	2.659	1.670	-
Electric Resistance	0.073	0.046	0.029	-
Heat Pump	0.000	1.048	1.587	2.174
Kerosene	0.608	0.384	0.241	-
Biodistillates	-	0.500	0.871	1.575
Total	**21.791**	**17.751**	**15.257**	**11.201**

Figure 8: Bennington Single Family Heating Energy Demand by Fuel, 90x50VEIC and Reference Scenarios

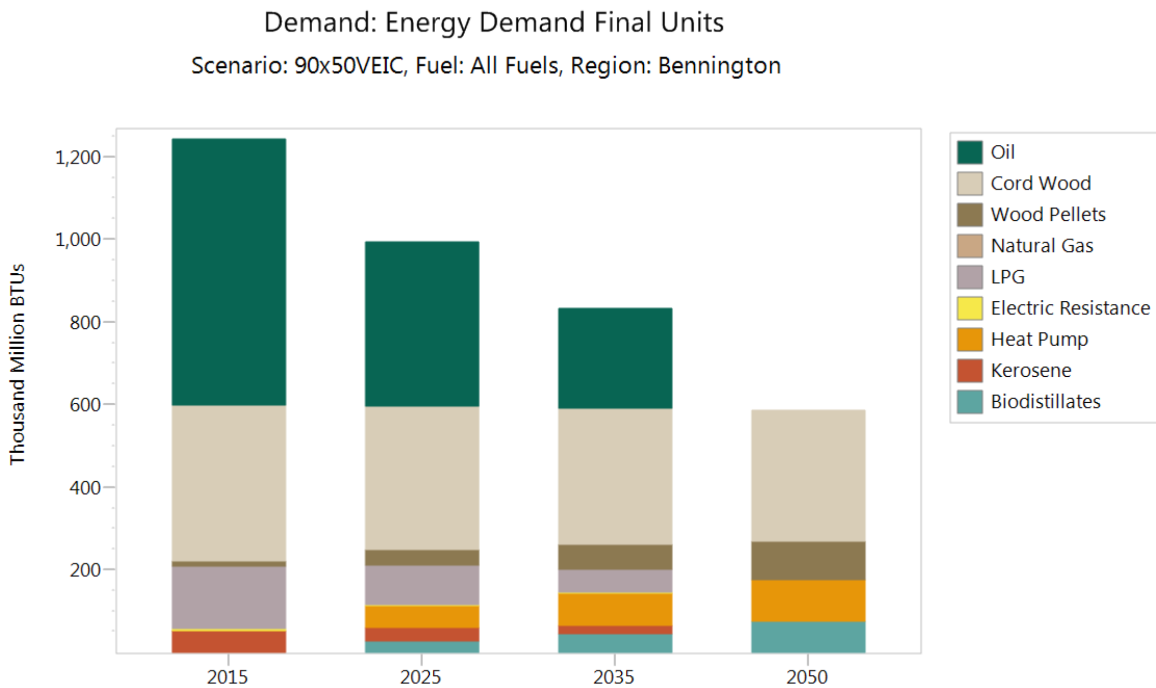


Table 9: Bennington Single Family Heating Energy Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC, Fuel: All Fuels, Region: Bennington				
Units: Million Million BTUs				
Heating Type	**2015**	**2025**	**2035**	**2050**
Oil	0.645	0.398	0.241	-
Wood	0.388	0.385	0.39	0.411
Natural Gas	-	-	-	-
LPG	0.152	0.094	0.057	-
Electric Resistance	0.004	0.003	0.002	-
Heat Pump	0.000	0.054	0.078	0.098
Kerosene	0.054	0.033	0.020	-
Biodistillates	-	0.027	0.046	0.077
Total	**1.242**	**0.993**	**0.832**	**0.586**

Commercial

Figure 9: Statewide Commercial Energy Demand by Fuel, 90x50VEIC and Reference Scenarios

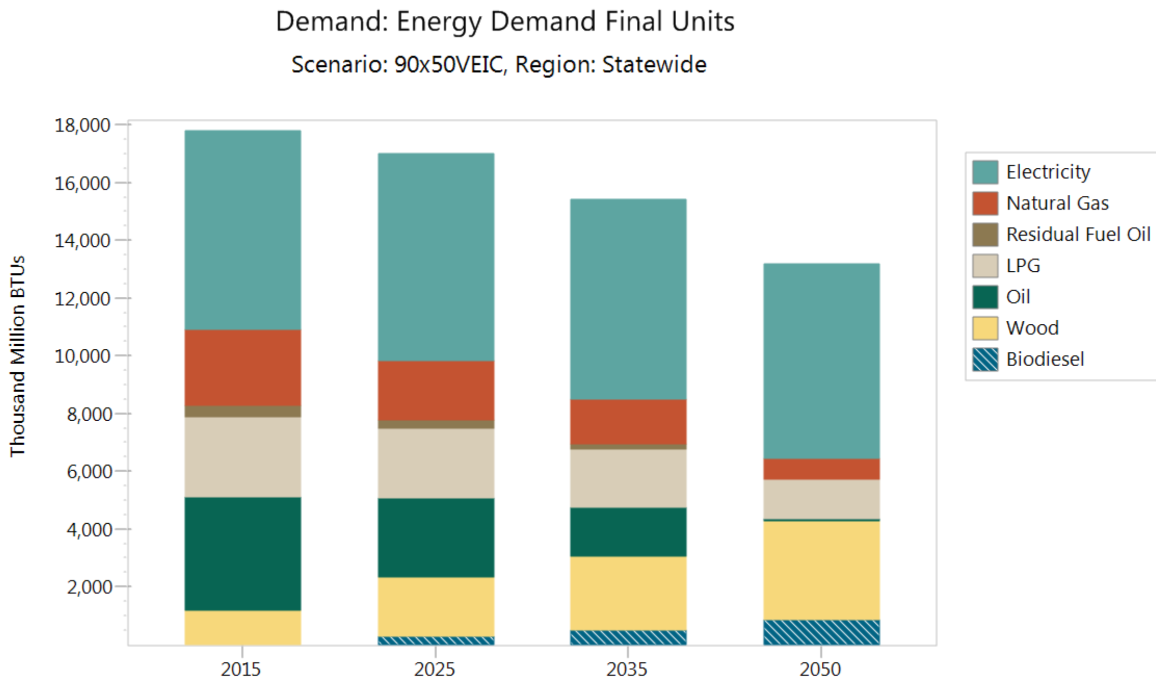


Table 10: Statewide Commercial Energy Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC, Region: Statewide				
Units: Million Million BTUs				
Fuels	**2015**	**2025**	**2035**	**2050**
Electricity	6.900	7.155	6.943	6.737
Natural Gas	2.600	2.069	1.547	0.730
Residual Fuel Oil	0.400	0.279	0.172	-
LPG	2.800	2.432	2.014	1.375
Oil	3.900	2.740	1.700	0.046
Wood	1.200	2.030	2.547	3.437
Biodiesel	-	0.298	0.508	0.859
Total	**17.800**	**17.004**	**15.431**	**13.186**

Figure 10: Bennington Commercial Energy Demand by Fuel, 90x50VEIC and Reference Scenarios

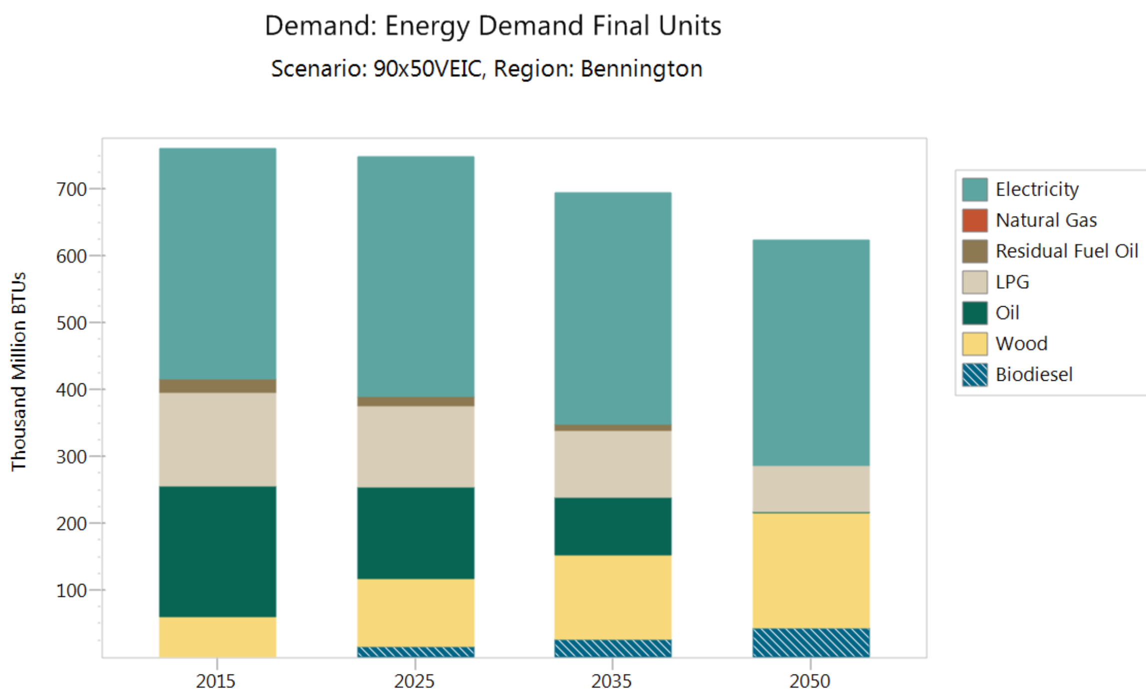


Table 11: Bennington Commercial Energy Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC, Region: Bennington				
Units: Million Million BTUs				
Fuels	**2015**	**2025**	**2035**	**2050**
Electricity	0.345	0.358	0.347	0.337
Natural Gas	-	-	-	-
Residual Fuel Oil	0.020	0.014	0.009	-
LPG	0.140	0.122	0.101	0.069
Oil	0.195	0.137	0.085	0.002
Wood	0.060	0.101	0.127	0.172
Biodiesel	-	0.015	0.025	0.043
Total	**0.760**	**0.747**	**0.694**	**0.623**

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Industrial

Figure 11: Statewide Industrial Energy Demand by Fuel, 90x50VEIC and Reference Scenarios

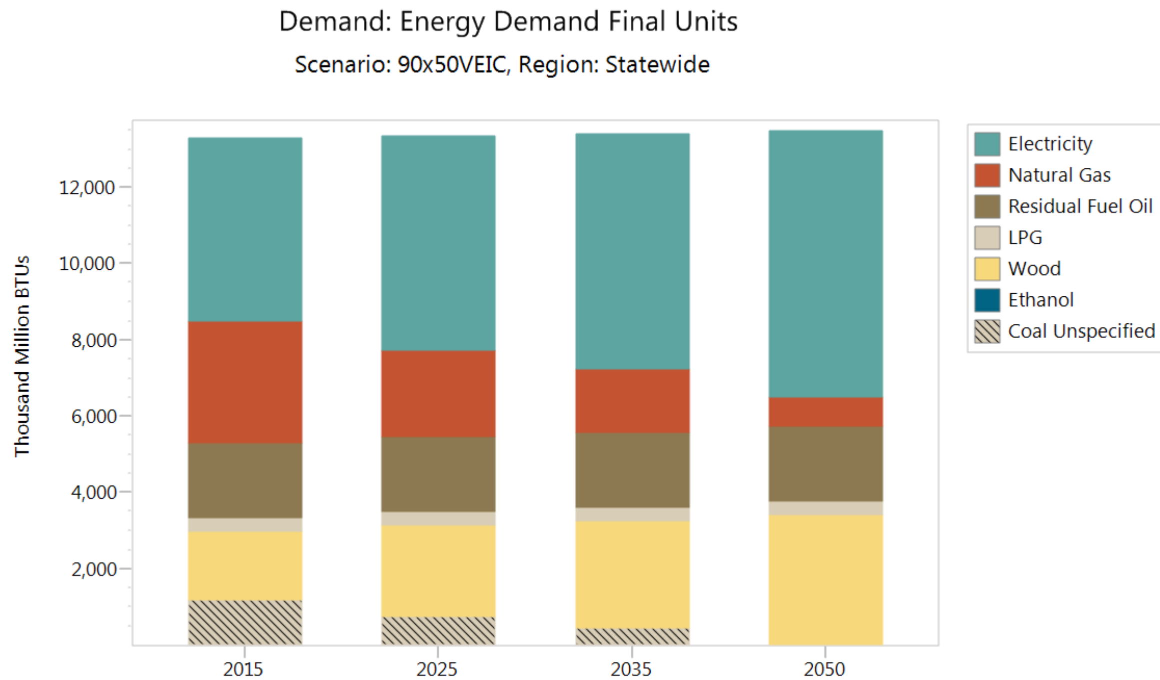


Table 12: Statewide Industrial Energy Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC, Region: Statewide				
Units: Million Million BTUs				
Fuels	**2015**	**2025**	**2035**	**2050**
Electricity	4.800	5.625	6.175	7.000
Natural Gas	3.200	2.281	1.669	0.750
Residual Fuel Oil	1.940	1.952	1.960	1.972
LPG	0.370	0.366	0.364	0.360
Wood	1.800	2.400	2.800	3.400
Ethanol	-	-	-	-
Coal Unspecified	1.170	0.731	0.439	-
Total	**13.280**	**13.356**	**13.406**	**13.482**

Figure 12: Bennington Industrial Energy Demand by Fuel

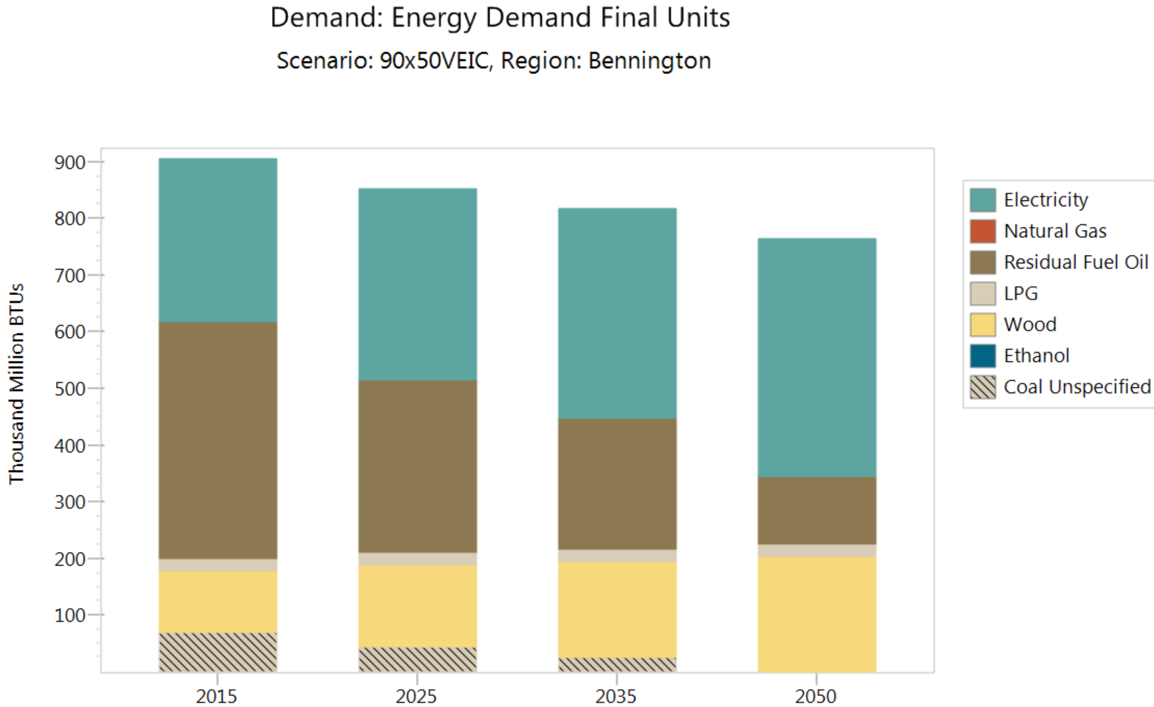


Table 13: Bennington Industrial Energy Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC, Region: Bennington				
Units: Million Million BTUs				
Fuels	**2015**	**2025**	**2035**	**2050**
Electricity	0.288	0.338	0.371	0.420
Natural Gas	-	-	-	-
Residual Fuel Oil	0.416	0.305	0.230	0.118
LPG	0.022	0.022	0.022	0.022
Wood	0.108	0.144	0.168	0.204
Ethanol	-	-	-	-
Coal Unspecified	0.070	0.044	0.026	-
Total	**0.905**	**0.852**	**0.817**	**0.764**

Transportation

Figure 13: Statewide Transportation Demand by Fuel, 90x50VEIC and Reference Scenarios

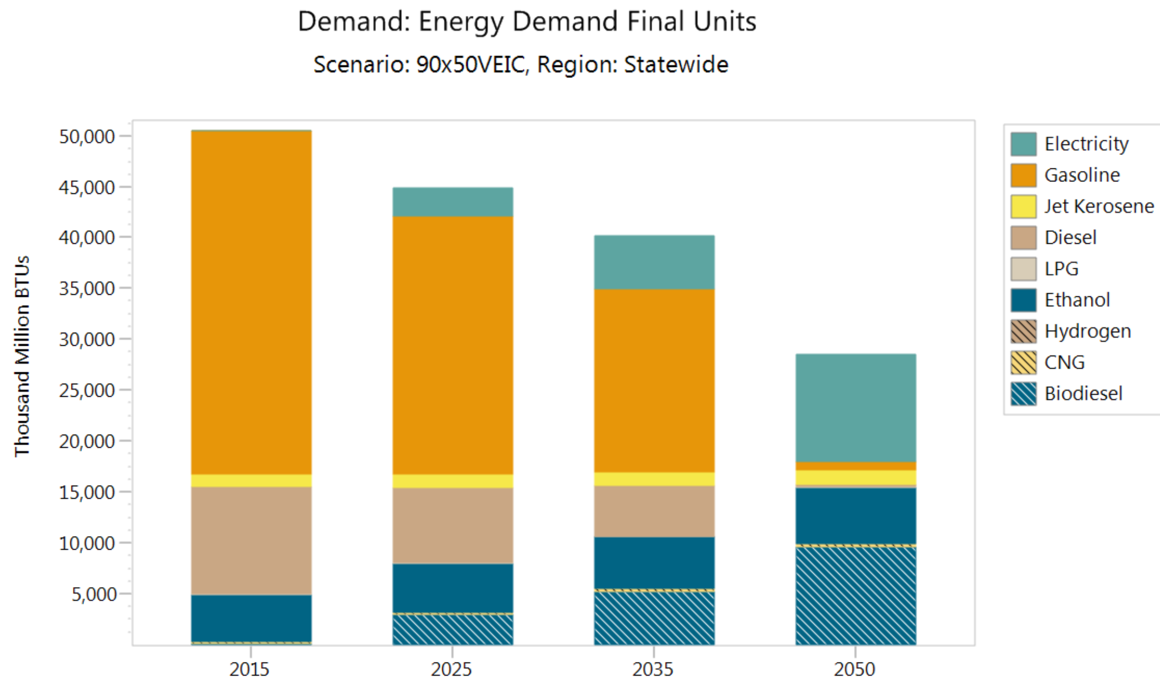


Table 14: Statewide Transportation Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC, Region: Statewide				
Units: Million Million BTUs				
Demand: Energy Demand Final Units				
Fuels	**2015**	**2025**	**2035**	**2050**
Electricity	0.010	2.696	5.209	10.514
Gasoline	33.734	25.380	17.963	0.890
Jet Kerosene	1.180	1.255	1.305	1.380
Diesel	10.531	7.392	4.994	0.230
LPG	0.110	0.089	0.077	0.060
Ethanol	4.575	4.823	5.109	5.522
Hydrogen	-	-	-	-
CNG	0.230	0.247	0.264	0.300
Biodiesel	0.110	2.916	5.214	9.648
Total	**50.480**	**44.799**	**40.135**	**28.544**

Figure 14: Bennington Transportation Demand by Fuel, 90x50VEIC and Reference Scenarios

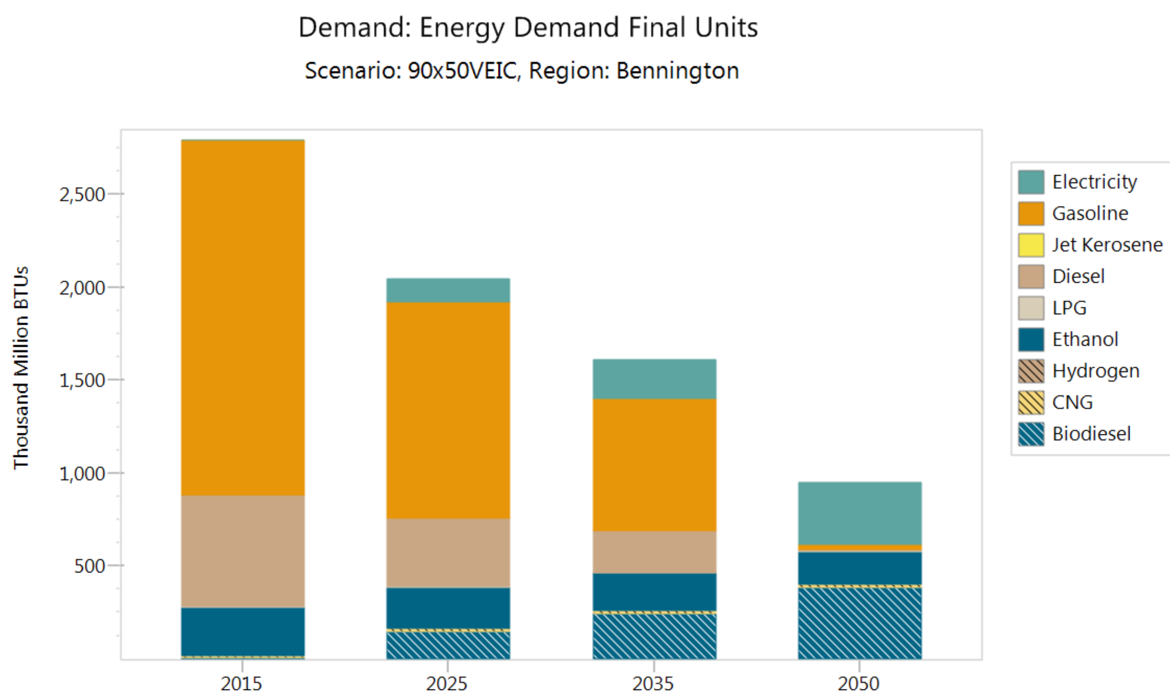


Table 15: Bennington Transportation Demand by Fuel

Demand: Energy Demand Final Units				
Scenario: 90x50VEIC, Region: Bennington				
Units: Million Million BTUs				
Demand: Energy Demand Final Units				
Fuels	**2015**	**2025**	**2035**	**2050**
Electricity	0.001	0.124	0.206	0.333
Gasoline	1.907	1.164	0.712	0.028
Jet Kerosene	-	-	-	-
Diesel	0.597	0.367	0.223	0.007
LPG	0.006	0.005	0.004	0.003
Ethanol	0.259	0.221	0.203	0.175
Hydrogen	-	-	-	-
CNG	0.013	0.014	0.014	0.015
Biodiesel	0.006	0.149	0.243	0.386
Total	**2.788**	**2.043**	**1.606**	**0.948**

Demand Sources and Assumptions

Key Assumptions

- ***Population:*** 2050 projection derived from trends through 2030 as projected in *Scenario A,* State of Vermont Population Projections 2010-2030, August, 2013. Produced by Ken Jones and Lilly Schwarz.
- ***People per household:*** Derived from TES inputs provided by Dr. Ken Noble.
- ***Commercial square feet:*** Derived from TES inputs provided by Dr. Ken Noble.
- ***Unoccupied houses****: Assumed stagnant from 2010 Census numbers. Unoccupied homes were assumed to have similar profiles to the seasonal homes identified in the census.*
- ***Occupied houses****: derived by population projections and population per household.*
- ***Multi-family households****: Number as identified by 2010 US Census.*
- ***Regionalization:*** *Residential demand was regionalized using town-level population and housing data from the American Community Survey. Commercial demand was regionalized using the percent of state workers in commercial work by NAICS code by region. Industrial fuel use was regionalized using the percent of state workers in industrial work by NAICS code by region.*

Demand*:*

Residential*: The TES provides total fuels used by sector. We used a combination of industry data and professional judgement to determine demand inputs at 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, etc.). Assumption 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*
> - *EIA Vermont State Energy Profile*
> - *2007-2008VT Residential Fuel Assessment*
> - *EIA Adjusted Distillate Fuel Oil and Kerosene Sales by End Use*
>
> *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, the team assumed a slightly higher percentage of multi-family homes use natural gas as compared to single family homes, given the high number of multi-family units located in the Burlington area, which is served by the natural gas pipeline. The team also assumed that few multi-family homes rely on cordwood as a primary heating source.*
- *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 90x50 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, together, 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 in-house efficient products experts.*

Water Heating

Water heating estimates were derived from the Efficiency Vermont Technical Reference Manual.

Appliances and Other Household Energy Use: *EnergyStar appliance estimates and the Efficiency Vermont Electric Usage Chart 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

Data from the Vermont Agency of Transportation provided statewide vehicles per capita and miles per capita data. The EIA Annual Energy Outlook, in combination with CAFÉ standards, provided projected changes in light and heavy duty vehicle fuel economy. This information was combined with information from TES transportation workbooks.

Amtrak information provided passenger rail estimates. The TES provided air travel estimates.

Projections for number of electric vehicles come from the electric vehicle focus area brief in the Comprehensive Energy Plan.

APPENDIX C.

REGIONAL RENEWABLE GENERATION TARGETS AND METHODOLOGY

Appendix C provides a brief overview of the process used to determine regional renewable electricity generation development goals.

REGIONAL GOAL DEVELOPMENT

As Vermont pursues its 90X50 Energy Goal, which will nearly eliminate the use of fossil fuels from many activities—such as transportation and building heating—it will be necessary to transfer many of those uses to electricity. Therefore, even while electrical systems and appliances will likely continue to increase in efficiency, significantly more electricity will need to be produced. Some of that will come from imported sources, such as hydroelectricity from Hydro Quebec and other providers, but much of it will also need to be generated by in-state renewable facilities. In-state production will minimize transmission losses, infrastructure costs (from long-range transmission), and economic risk associated with imported electricity. Increasing in-state production will also increase direct and indirect economic benefits to Vermonters.

In order to develop achievable in-state electricity generation goals, the LEAP System model outputs suggest that the state of Vermont will need to consume over 10,000 GWh of electricity by 2050. That's almost double the 5,600 GWh that were consumed by Vermont in 2010. Of the electrical supply needed to accommodate the more-than-10,000 GWh of consumption, the LEAP model suggests that about half could come from in-state renewable sources. This will require adding between **1,500 - 2,250 MW of Solar**, between **260 - 488 MW of Wind**, and about **93 MW of Hydro** in Vermont by 2050. Based on regional resources and environmental constraints, the BCRC region should aim to develop between **68 - 107 MW of Solar**, and between **18 - 34 MW of Wind** to help achieve state goals. From these ranges, BCRC has identified specific goals of **85 MW of Solar**, **26 MW of Wind**, and **1 MW of Hydro** developments in the region by 2050.

The Hydro potential, as mentioned in Section IV, was determined by analysis of existing dam structures in Vermont and refers only to existing dams and hydro facilities, i.e., it does not consider any potential from new dam construction. For that reason, locations for potential new Hydro development are limited to existing dams. In the BCRC region, there is likely less 1 MW of potential gain from new and existing dam facilities.

With solar and wind, however, the geographic distribution of potential generation facilities is much more difficult to determine. As the energy maps and corresponding analyses in **Section V** of this plan showed, plenty of physical potential exists in the BCRC region to accommodate this demand (as is true in all regions). The challenge, then, is to develop in-region generation goals that, when considered together, lay a path towards successful attainment of Vermont's long-term 90X50 energy goal.

METHODOLOGY FOR REGIONAL WIND AND SOLAR GOALS

In order to develop more specific goals for in-state wind and solar generation, the regional planning commissions, in partnership with the Department of Public Service and the Vermont Center for Geographic Information, developed a simple formula to determine regional electricity generation target ranges partially based on the energy potential mapping analysis presented in **Section IV** of this plan. By averaging a region's share of the *Secondary Resource* area for each resource with the that region's share of the state's population—which served as an easy proxy for that region's share of electricity consumption—a total percentage of overall capacity for each resource for each region was identfied. In other words, the calculation showed the percent of total solar capacity and total wind capacity that each region should hope to achieve.

Using that percentage, the LEAP System's total estimated amount of capacity needed by 2050 (including between 1,500 - 2,250 MW of new solar and 260 - 488 MW of new wind, as well as all existing capacity) was allocated regionally. From there, regional goal ranges were reduced by the amount of capacity that existed in that region for each resource (as of 2016). Facilities that have been developed after these goals were created should be considered "new generation" for the purpose of these plans. The final goal ranges, therefore, reflect the total capacity that the LEAP System suggests is needed by 2050, allocated based on resource availability, demand, and existing capacity. From these target ranges, each regional planning commission can identify a more specific generation target based on a regional conditions assessment. An example of the calculation (for the BCRC region) is shown below in **Figure C.1**.

FIGURE C.1: REGIONAL RENEWABLE GENERATION GOAL FORMULA—BCRC REGION SOLAR EXAMPLE

	% VT Population in BCRC Region (2015)	% VT Secondary Solar within BCRC Region	VT 2050 Goal Ranges for Total Solar Capacity *(MW)**	BCRC Existing Solar Capacity *(MW, 2016)*	BCRC Goal Ranges for Total Solar Capacity *(MW)*	**2050 Goal, New Capacity *(MW)***
BCRC Region	5.6	4.8	1,500 - 2,250	9.911	68 - 107	85

*** INCLUDES CURRENT & NEW CAPACITY.***

$$\frac{(.058 + .048)}{2} \times \begin{matrix} 1{,}500 \text{ (LOW RANGE)} \\ 2{,}250 \text{ (HIGH RANGE)} \end{matrix} - 9.911 = \begin{matrix} 68 \text{ (LOW RANGE)} \\ 107 \text{ (HIGH RANGE)} \end{matrix} \sim 85$$

AVERAGE

PERCENT OF VT'S POPULATION AND PERCENT OF SECONDARY RESOURCE

TO GET APPX. CAPACITY FOR RESOURCE DEVELOPMENT IN-REGION

MULTIPLY

SHARE OF RESOURCE CAPACITY BY PROJECTED 2050 VT SOLAR GOAL

TO GET REGION'S APPX. SHARE OF PROJECTED RESOURCE DEVELOPMENT

SUBTRACT

EXISTING SOLAR CAPACITY FROM TOTAL PROJECTED 2050 BCRC GOAL

TO GET NEW SOLAR DEVELOPMENT GOAL FOR THE REGION

IDENTIFY

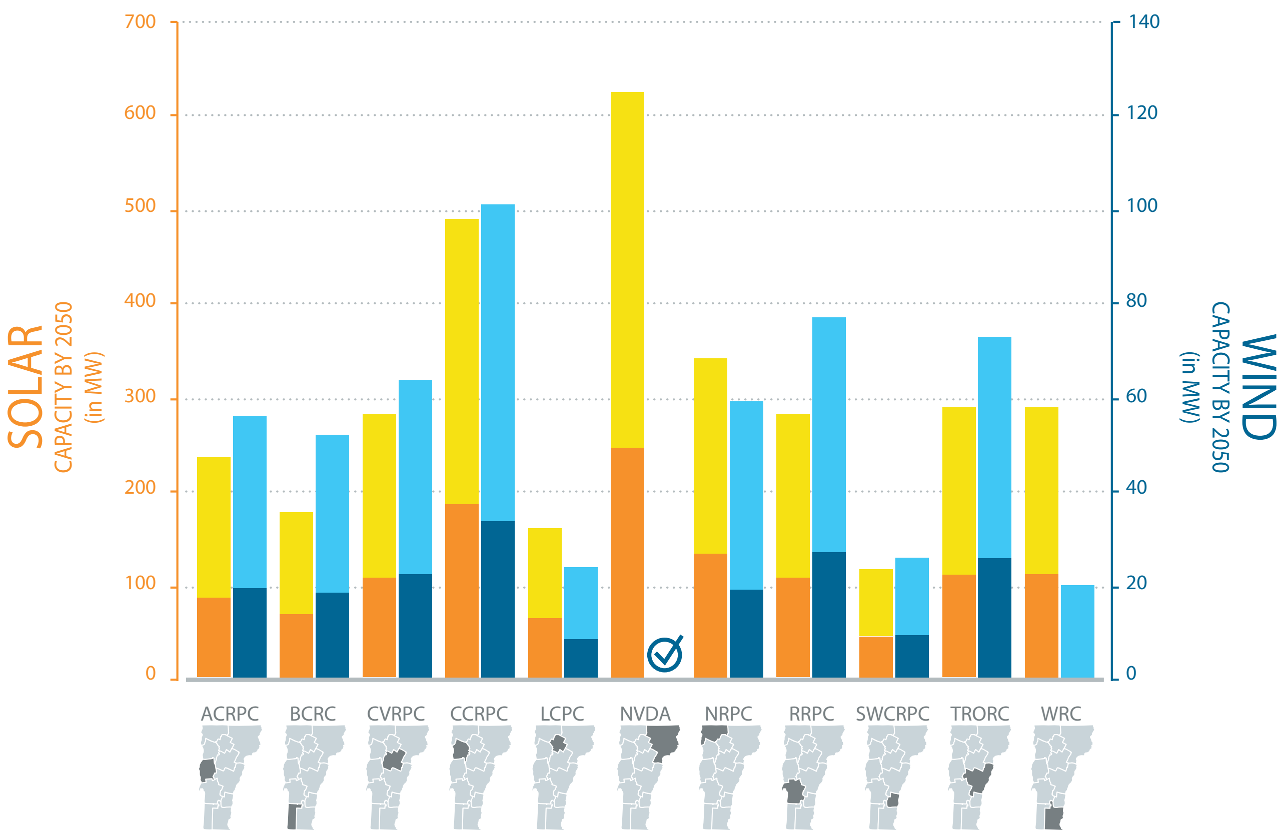
SPECIFIC REGIONAL GOAL BASED ON RANGES AND REGIONAL CONDITIONS

REGIONAL GOALS

By averaging population and *secondary resource area*, the calculation accounted for the concentrations of population and urban infrastructure that exist in more densely populated regions, suggesting higher capacities for in-region generation, but also factored in the prevalence of areas of resource availability, thereby considering where facilities would most likely be feasible to develop. In the end, no region has particularly high or low overall goals. The Chittenden region, which has by far the largest population, also has the highest goals, but less populated regions that have more land and more secondary resource area (such as the Northeastern Vermont Region and the Windham Region) also have relatively high goals. Because the amount of existing capacity was factored in, some regions with more existing renewable generation facilities were reduced. In the Northeastern Vermont Region (which would have the highest wind generation goal of any region, if existing capacity were not included) the amount of existing wind exceeds the region's suggested goal, so NVDA has effectively accomplished its 2050 goal related to wind development according to this process.

The Bennington has a relatively small population, with a moderate amount of solar and wind resource areas. Moreover, because the potential to develop Hydro in the region is very limited (less than 1 MW of capacity likely from existing dams), some additional wind and solar generation may be necessary.

FIGURE C.2 REGIONAL WIND AND SOLAR GOALS RANGES—NEW CAPACITY BY 2050
Goals have been presented as ranges so that regions may determine their best mix of solar and wind generation. Below, lower goal ranges are shown in dark shades and higher goal ranges are shown in light shades.



METHODOLOGY FOR TOWN SOLAR GOALS

To better understand how the region can achieve its goal of 85 MW new solar capacity by 2050, the BCRC developed a methodology to determine new solar capacity targets for each town in its region. The formula used for these calculations is simple and similar to that used for the regional projections just discussed. In order to calculate town-level targets, the BCRC first considered a town's share of the region's population and averaged that with its allocation of the region's prime solar land in proximity to 3-phase transmission infrastructure. These averaged proportions approximate each town's overall capacity to develop new solar based on existing conditions and demand.

The BCRC formula took each town's capacity and factored it against the future total solar generation needed in the region as determined by the LEAP System, combining the total existing (**3.6667 MW**) and new solar capacity (**85 MW**) required to meet 2050 goals. Town goals were then reduced by the amount of existing local capacity (as of 2015 - facilities that have been developed after these goals were created should be considered "new generation" for the purpose of these plans). The final goals, therefore, reflect town-level capacity that the LEAP System suggests is needed by 2050, allocated based on resource availability, demand, and existing capacity. A summary of final town-level targets are displayed in **Section IV** of this plan. An example of the calculation for the town of Bennington is shown below in **Figure C.3**.

FIGURE C.3 TOWN-LEVEL SOLAR GOAL FORMULA—TOWN OF BENNINGTON EXAMPLE

	2015 Town Population	Total BCRC Regional Population	Town Prime Solar in one mile of 3-phase *(Acres)*	Total Regional P. Solar in one mile of 3-phase *(Acres)*	Total Regional New Solar Generation *(MW)*	Town Existing Solar Capacity *(MW, 2015)*	**2050 Goal, New Capacity *(MW)***
Bennington Town	15,483	35,200	2,682	12,793	85	2.5323	25.1

$$\frac{(15{,}483 / 35{,}200) + (2{,}682 / 12{,}793)}{2} \times 85 - 2.5323 = 25.1$$

AVERAGE

PERCENT OF BCRC'S POPULATION AND PERCENT OF PRIME RESOURCE

TO GET TOWN'S APPX. CAPACITY TO DEVELOP AND CONSUME SOLAR ENERGY

MULTIPLY

SHARE OF RESOURCE CAPACITY BY PROJECTED 2050 BCRC SOLAR GOAL

TO GET TOWN'S APPX. SHARE OF PROJECTED RESOURCE DEVELOPMENT

SUBTRACT

EXISTING TOWN SOLAR CAPACITY FROM PROJECTED 2050 TOWN GOAL

TO GET NEW SOLAR DEVELOPMENT GOAL FOR TOWN

APPENDIX D.

TOWN ENERGY PLANNING & RENEWABLE SITING GUIDELINES

Appendix D contains a brief overview of a suggested process for developing standards and guidelines related to the siting of renewable energy generation facilities.

PURPOSE

The following section is intended to be used as a resource by municipalities in the Bennington Region for developing renewable energy facility siting guidelines. Municipalities should seek public input and encourage participation among community members. Strong municipal energy planning will be the product of diverse input and widespread community support. The suggested process for creating siting guidelines is listed below, along with examples of criteria and conditions that municipalities may wish to include.

PROCESS

STEP 1 Define the purpose of renewable generation facilities and set local goals.

It is important that a municipality clearly define its purpose and goals related to the development of renewable energy since local goals must work together with regional and state goals if Vermont is going to successfully realize its overall 90X50 energy objectives. The first step in successful local energy planning will be for a municipality to review state and regional energy plans and to specify what role it can play in implementing the plans.

STEP 2 Establish general facility siting guidelines.

Certain considerations may be applicable to a variety of different renewable generation facilities. Therefore, before establishing site-specific considerations, a municipality should articulate general criteria that apply to all renewable generation facilities. The following list includes examples of criteria that municipalities may wish to apply more generally. This is not meant to be an exhaustive list, and it is not suggested that municipalities necessarily include any one of the following examples:

- Facilities should be consistent with all existing energy planning objectives at the statewide, regional, and local levels. Plans to be consulted include the Vermont Comprehensive Energy Plan, the Vermont Long-Range Transmission Plan, the utility's Integrated Resource Plan, and the Regional Energy Plan;
- When possible, sites selected for development should be located proximate to existing infrastructure, including electrical grid and transportation access, as well as other types of infrastructure to minimize costs and negative impacts associated with new construction;

- Preservation of natural resources, scenic views, and other physical and aesthetic conditions critical to the sense of place in a community should be maintained; *areas of high importance should, in such instance, be specifically identified in municipal energy plans as sites that are not appropriate for facility development (discussed in* ***Step 3****)*;
- Project development should include planning and funding for decommissioning and site restoration once a facility's useful life has ended; a site must be returned to pre-project condition through the decommissioning process;
- The need for screening from neighboring sites should be considered. Existing topography and other natural features can often be used to create screening, and facilities should be designed accordingly;
- Facilities that generate significant sound should not be located within a specified distance of residential structures; *requirements related to sound (which would most likely apply to wind development) should articulate specific decibel levels and distances where possible*.

STEP 3 Identify preferred areas and conditions for facility development.

It is most helpful if municipalities can identify specific preferred sites for renewable facility development. In addition to identifying specific sites, municipalities should develop a list of criteria to be used to identify other preferable locations for development. These criteria should clearly reference type of renewable generation facility (Hydro, Wind, or Solar) and varying levels of generating capacity in conjunction with the conditions to be met for siting the facilities. Siting and facility preferences may include the following:

- Roof-mounted solar systems;
- Areas near large-scale commercial or industrial buildings;
- Brownfield sites;
- Unused areas where past uses have replaced or significantly impacted the natural landscape, including former gravel pits, quarries, or landfills;
- Areas where topography and existing features naturally screen a site from common view;

STEP 4 Follow the Siting Review Process outlined in Section VI to identify areas that are not suitable for development, and establish any Local Constraints.

Using the process outlined at the end of Section IV (page 92) of this plan, municipalities should review potential sites according the Known, Possible, and Regional Constraints that were used to develop the Wind and Solar Resource Potential Maps. Those constraints are summarized below.

Known Constraints include:

Vernal Pools: *Seasonal wetlands that provide conditions for various species' habitats. (Mapping includes a 50 foot buffer around all Vernal pools.)*
DEC River Corridors: *Rivers and land adjacent to rivers that is necessary to maintain the natural movement, or meandering, of a river.*
FEMA DFIRM Floodways: *Areas most likely to be impacted by base floods (1% annual likelihood) where development is limited.*
State-Significant Natural Communities and Rare, Threatened, and Endangered Species: *Areas where natural conditions exist and include rare species or valuable educational scientific resources.*
National Wilderness Areas: *Federally owned land that is preserved in natural conditions.*
Class 1 and 2 Wetlands: *All identified Class 1 and 2 Wetlands.*

Possible Constraints include:

VT Agriculturally Important Soils: *All soils rated as agriculturally important, including "Prime" agricultural soils and soils of statewide or local importance.*
FEMA Special Flood Hazard Areas: *All zones with a 0.2% chance or higher of flooding annually.*
Protected Lands: *All state fee lands and privately owned conserved lands.*
Deer Wintering Areas (DWAs): *Identified deer winter habitat area.*
ANR VT Conservation Design Highest Priority Forest Blocks: *Unfragmented natural areas with high ecological and habitat value.*
Hydric Soils: *Areas where soils are saturated for some part of the year, leading to biological conditions similar to wetlands.*

BCRC Regional Constraints include:

Prime Agricultural Soils: *Areas with agricultural soils rated as "prime" should be preserved for potential agricultural applications when possible.*
Historical and Cultural Districts: *Special zoning districts can limit development for aesthetic or other purposes and are often inappropriate areas for siting renewable energy generation.*
Residential Wind Buffer (1KM): *Wind turbines should not be located in excessive proximity to residential areas so as to mitigate potential impacts of sound pollution or other ambient externalities. This plan recommends that at least one kilometer distance from residences be respected.*

Local Constraints:
Similar to the process for defining preferred locations, a process for identifying locations considered inappropriate for facility development should be created. It is most helpful if municipalities can identify specific sites that are not appropriate for renewable facilities. For areas that are not specifically identified, a list of conditions that would define an inappropriate site should be provided to be considered in addition to the environmental, economic, and social impacts that are analyzed in the Section 248 review process, and the Statewide and Regional Constraints listed above.

APPENDIX E.

EXISTING ELECTRIC GENERATION SITES

Appendix E provides a visual of existing renewable electric generation sites over 15 kW capacity throughout the region. Updated information on permitted and existing generation sites may be viewed online through the **Commuity Energy Dashboard's Energy Atlas**.

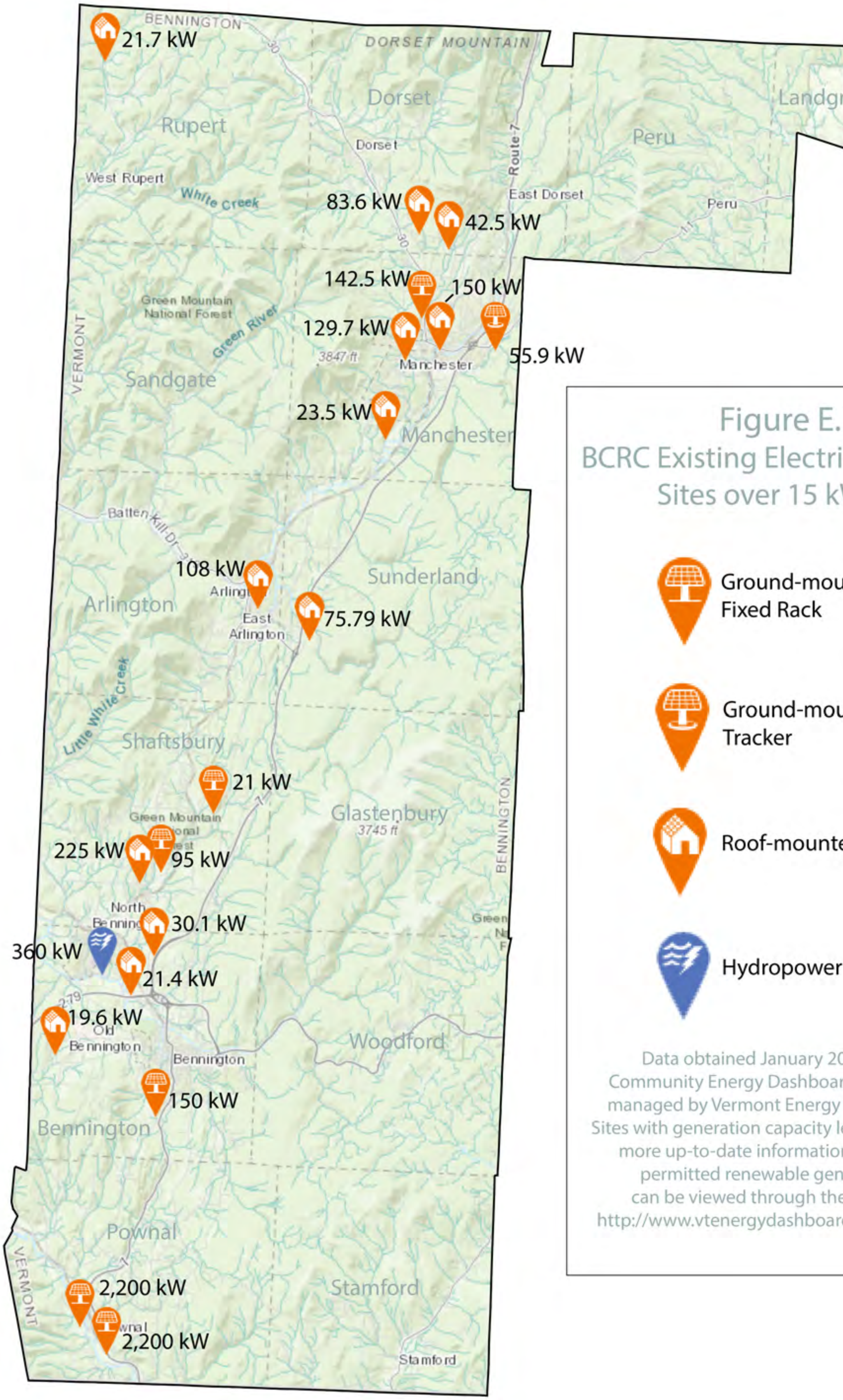


Figure E.1
BCRC Existing Electric Generation Sites over 15 kW Capacity

- Ground-mounted PV: Fixed Rack
- Ground-mounted PV: Tracker
- Roof-mounted PV
- Hydropower

Data obtained January 2017 from the Community Energy Dashboard's Energy Atlas, managed by Vermont Energy Action Network. Sites with generation capacity less than 15kW and more up-to-date information on active and permitted renewable generation sites can be viewed through the Energy Atlas: http://www.vtenergydashboard.org/energy-atlas