SECTION III

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III. REGIONAL ENERGY SUPPLY AND CONSUMPTION

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

Where possible, space heating, transportation, and electric uses have been broken down into subsectors (residential, commercial, industrial, institutional) to provide a more refined understanding of the data. All energy data in this section is expressed in British thermal units (BTUs) (Figure 3.1). The data in this section provides some context for the changes that will need to occur in the future to achieve state and regional energy goals.

A. SPACE HEATING

RESIDENTIAL HEATING SOURCES AND COSTS

Estimates for residential space heating fuel use by household are available from the American Community Survey (ACS). The primary heating sources in the region are fuel oil (including kerosene), electricity, liquid propane (LP), utility gas (such as natural gas), and wood. Utility gas is available in the region, but only in western Franklin County and in the vicinity of Enosburg Falls (see Appendix C for map of service area). Wood includes both cord wood and wood pellets. Fuel oil is the most common residential heating source in the region (43%), followed by utility gas (20%) and wood (19%).

The use of electrical heat pumps and geothermal heating system s in the state and region has been increasing in recent years, but overall use remains low.

Based on the NRPC's estimates, the region currently uses approximately 2.243 trillion BTUs to heat residential units each year. Work completed by the Vermont Energy Investment Corporation (VEIC) for this project, which is discussed in Section IV, does not provide a direct comparison to this calculation, but instead estimates the number of BTUs required to heat single-family homes in the region. To provide some context, the NRPC compared

FIGURE 3.1 BRITISH THERMAL UNITS (BTUs)

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

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

FIGURE 3.2 AMERICAN COMMUNITY SURVEY (ACS)

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

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

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

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

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

this estimate to baseline estimates used by VEIC in the LEAP model. VEIC estimated that approximately 1.828 trillion BTUs are needed to space heat single-family homes in the region each year (this number excludes all other residential units like duplexes and multi-family units in the region).

Figure 3.3 shows estimated residential heating costs.[2] Regional households spend the highest amount on fuel oil. Although only 14% of households use LP gas, the fuel source accounts for 26% of regional residential heating costs.

Wood is estimated to account for 13% of regional residential heating costs, yet this may be a high estimate because many residents in the region use cord wood harvested on their property and may not actually pay for wood. Cost information may vary considerably year to year based on global and regional fuel market prices.

There are approximately 21,650 households in the region. Roughly 75% of regional households are owner-occupied households, and 25% are renter-occupied households. According to the ACS, renter-occupied households are more likely to be heated using utility gas than owner-occupied households (32% versus 17%). This many not be directly related to being renter-occupied, but could instead be due to the fact that households with access to utility gas use it because it is more affordable and many renter-occupied units are in areas with access to utility gas. LP gas and fuel oil heating use is comparable for each type of household, yet 22% of owner-occupied households are heated using wood versus only 7% of renter-occupied households.

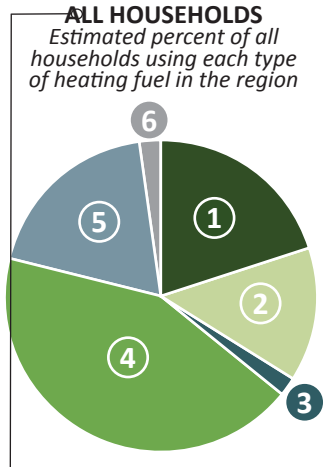
It is important to note that renter-occupied households often have little to no control over the heating source used in their housing unit because renters cannot lawfully change their heating source. In addition, landlords often have little incentive to upgrade to more efficient heating sources when the tenant is paying for heat.

FIGURE 3.3 HOME HEATING ESTIMATES

Heating fuel use by household in the Northwest region, showing current prominence of fossil fuels that exist throughout the region.

Data from 2009-2013 U.S. Census Bureau American Community Survey estimates

	Fuel Type: Space Heating	# of House-holds	Average Use *(Annual)*	% of Use *(All HHs)*	% of Cost *(All HHs)*
1	Utility Gas	4,414	4,175,237 Gallons	20%	16%
2	Bottled/Tank/LP Gas	3,051	3,786,720 Gallons	14%	26%
3	Electricity	470	11,923,470 kWh	2%	5%
4	Fuel Oil/Kerosene	9,328	6,481,465 Gallons	43%	39%
5	Wood	4,008	22,062 Cords	19%	14%
6	Coal/Solar Energy/ Other or No Fuel	379	84 lbs.	2%	0%



[2]Unit costs were calculated as follows: Estimated fuel costs generally come from the U.S. Energy Information Administration and are Vermont specific where possible. Electricity costs were based on Green Mountain Power (GMP) rates. Wood costs are based on prices provided by various dealers.

Several state programs provide assistance to individuals who have difficulty affording heating fuel for their homes. The Vermont Agency of Human Services operates the Fuel Assistance program and the Crisis Fuel Assistance program. The Fuel Assistance program is available to households with a gross household income that is equal to or less than 185% of the federal poverty level (based on household size) to help pay for heating fuel. The Crisis Fuel Assistance program is available to households that have an income up to 200% of the federal poverty level and can provide proof that the household is experiencing a crisis (either the household is out of fuel or very close to running out).

FIGURE 3.4 VERMONT FUEL PROGRAMS

Year	Vermont Households Using Fuel Assistance	Vermont Household Using Crisis Fuel Assistance
2010-2011	26,546	14,977
2011-2012	27,400	11,824
2012-2013	27,776	10,560
2013-2014	26,625	7,801
2014-2015	25,147	6,860

Source: *VT Agency of Human Services*

County-level data for each program is not available for the state fuel assistance programs. However, statewide data is available for each program. Figure 3.4 shows the total number of households in Vermont that have used the state fuel programs over the past five years. Approximately 10% of total households statewide used the Fuel Assistance program in 2014–2015 (if estimated regionally, this would equal about 2,164 households). This percentage has held relatively steady over the past five years and illustrates the continuing stress that households face when paying to heat their homes. About 2.6% of households used the Crisis Fuel Assistance program during the same time period, a reduction of more than 50% from 2010–2011. Some of this drop may be related to the drop in home heating oil prices over this time period and cutbacks in state funding of these programs.

COMMERCIAL, INDUSTRIAL, AND INSTITUTIONAL HEATING SOURCES AND COSTS

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

However, a rough estimate of total energy use can be calculated. This is done by calculating the percentage of commercial and industrial establishments in the region versus the state and then multiplying this percentage by the amount of BTUs used by commercial and industrial sectors statewide (which is available from the U.S. Energy Information Agency [EIA]). The region accounts for about 5.7% of all commercial and industrial establishments in the state, which can be estimated to account for approximately 2.4 trillion BTUs. This is approximately the same as the NRPC's estimate for residential heating energy use (2.388 trillion BTUs) and highlights the equal importance of ensuring the efficiency of space heating for all types of structures to achieve the 90 x 50 goal.

There are approximately 6,000 commercial and industrial natural gas customers in Franklin County and Chittenden County according to the 2015 per Vermont Gas Systems annual report. Despite the lack of precise information about the number of commercial, industrial, and institutional organizations that use natural gas in Franklin County alone, it should be noted that the transmission system is located between Highgate and Georgia and between Swanton and Enosburg Falls (see Appendix C). Industrial parks in these communities are serviced by natural gas.

Some institutions in the region, such as schools, utilize biomass heating systems (usually wood pellet systems). The Biomass Energy Resource Center (BERC) database contains records that indicate five schools in the region use biomass systems. According to the state wood utilization forester, Paul Frederick, some of the schools that utilize wood pellet systems currently have difficulty obtaining a supplier from within the region and the

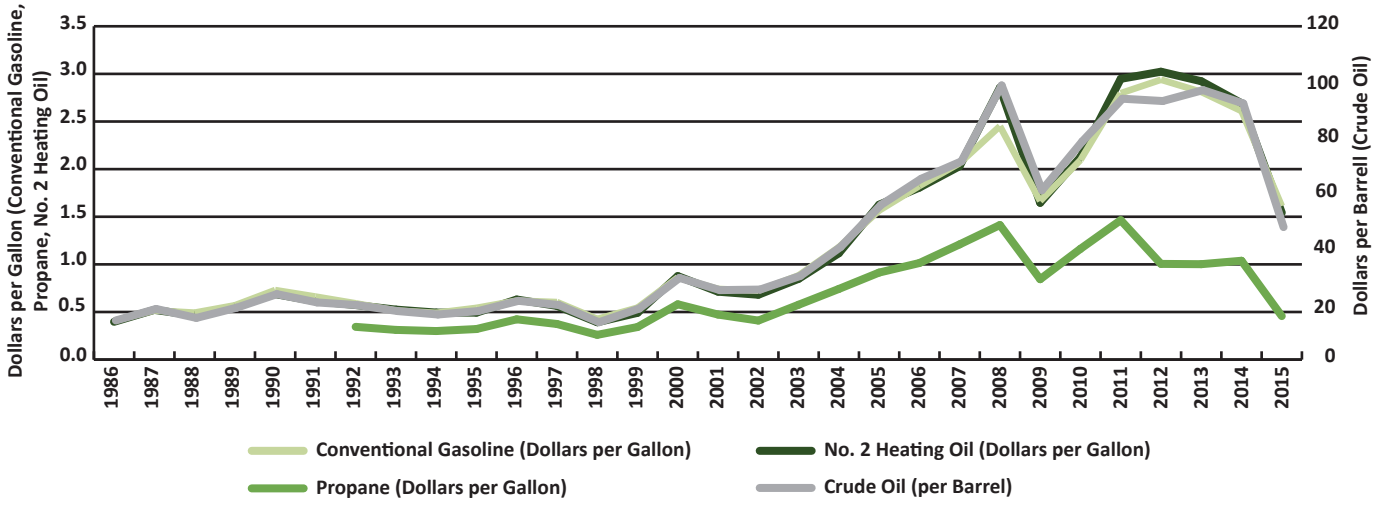
state. Some schools are supplied by companies located as far away as Maine. BERC records also indicate that several multi-family apartments and government buildings (Vermont State Police barracks and Northwest State Correctional Facility) use biomass heating systems, but data from the organization is not comprehensive.

According to the Vermont Wood Fuel Supply Study: 2010 Update completed by BERC, Franklin County has approximately 39,369 green tons (gt) of net available low-grade (NALG) wood growth, a measure of wood that would be appropriate for use as biomass fuel above and beyond current levels of harvesting. Grand Isle County has approximately 750 gt of NALG wood growth. This leaves these two counties in the Northwest region in the bottom four counties statewide in terms of NALG wood growth. This may limit the region's ability to use locally sourced biomass for heat and electricity production.

COST OF FOSSIL FUEL SPACE HEATING

When analyzing current space heating fuels, it is important to note the current price of fossil fuels, including fuel oil, liquefied petroleum (LP gas, propane) and utility gas (natural gas). Prices for these products are currently low when compared to historical prices, especially when compared to prices in the mid-2000s. Figure 3.5 shows the wholesale prices of each type of fuel as reported by the U.S. EIA. The drop in fossil fuel prices has likely influenced how regional residents currently heat their homes.

FIGURE 3.5 FOSSIL FUEL PRICES OVER TIME



WEATHERIZATION

Weatherization of existing structures is an increasingly important part of the conversation about space heating and thermal efficiency. A state statute includes a goal of improving the energy fitness of at least 20% of the state's housing stock by 2017 (more than 60,000 housing units) and 25% of the state's housing stock by 2020 (approximately 80,000 housing units (24 V.S.A. 578(a)). Regionally, this will require weatherization of approximately 4,300 residential units by 2017 and 5,400 residential units by 2020. By analyzing data from public organizations such as Efficiency Vermont (EVT) and Vermont Gas, we can see that the region is making progress toward these goals.

FIGURE 3.6
REGIONAL WEATHERIZATION GOALS

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

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

Weatherization Challenges

The age of structures in the region is a major challenge to weatherization efforts. About a quarter of the regional housing stock predates World War II according to the ACS (27.5%), and many commercial structures, especially in the Northwest region's village centers, are equally historical. Many of these structures have not been updated to include modern materials that increase the thermal efficiency of structures and decrease fuel costs. Some of the same structures, and even structures constructed through the 1970s, contain building materials like asbestos and vermiculite that make weatherization difficult and expensive for property owners.

The variety of entities completing weatherization work in the region complicates the process of collecting accurate information regarding weatherization. The passage of Act 89 in 2013 by the state legislature aimed to help address this issue. The act requires that building owners meet the state residential and commercial energy standards, which have existed since 1998, when completing most renovations and construction projects. Compliance requires that structure owners complete a residential or commercial building energy certificate after finishing the project to certify that the project meets state standards. Owners are also required to record the certificate in the local town clerk's office. However, the lack of widespread information about the requirements, uncertainty about when certificates are required, and a lack of enforcement make it unclear how many Vermonters and regional residents are meeting these standards. Stricter enforcement and increased education about state energy standards are needed to ensure that Vermont and the region can meet the 90 x 50 goal.

As mentioned before, rental housing poses unique energy-related challenges especially with regard to space heating and weatherization efforts. Tenants are legally unable to make weatherization improvements to their housing units (even if they are financially able to do so). Landlords do not have a financial incentive to weatherize their structures if tenants are required to pay for heating. In addition, most weatherization programs are aimed at homeowners, not landlords. These challenges have the potential to stifle weatherization of the state and regional rental housing stock, which negatively impacts the finances of renters and makes achieving the 90 x 50 goal more difficult. The NRPC, State of Vermont, and public utilities serving the region must look to identify strategies to overcome these challenges with the cooperation of regional partners.

According to the Vermont Comprehensive Energy Plan, energy-efficiency programs, such as the Champlain Valley Office of Economic Opportunity, Vermont Gas, and Efficiency Vermont in the Northwest region, have "facilitated the installation of efficiency improvements in just under 18,300 Vermont housing units" since 2008. Although this progress is admirable, the current rate of weatherization efforts is insufficient to meet the legislature's goal of 80,000 weatherized homes by 2020. Additional efforts will need to be made across the state and the region to hasten weatherization and ensure that the 2020 state weatherization goal and, more prominently, the 90 x 50 goal are met.

Champlain Valley Office of Economic Opportunity

The Champlain Valley Office of Economic Opportunity (CVOEO) is the state-appointed community action agency serving the Northwest region. The organization administers a variety of programs focused on

combating poverty and enabling individuals to reach self-sufficiency. One program operated by CVOEO is the low-income weatherization program in the region. This program is available to homeowners and renters that have a median income that is less than 80% of the state median income (about $43,500). According to CVOEO, the organization typically serves those that are at the lowest end of the economic spectrum. Many of the program's grantees are also eligible for other state programs focused on making heating more affordable, including the Fuel Assistance program.

CVOEO partners with Efficiency Vermont to have an "efficiency coach" work with homeowners in the program to complete minor work within their housing unit to increase efficiency. The housing unit is then audited and a scope of work created based on audit findings. Weatherization is then completed by CVOEO and inspected by the organization's quality control team. CVOEO receives reimbursement for the work from the State of Vermont after each project has been completed.

The low-income weatherization program currently accounts for retrofits in approximately 1,500 units in CVOEO's territory each year (Addison, Chittenden, Franklin, and Grand Isle Counties). Through the program, approximately 769 retrofits were completed in the Northwest region between March 2010 and February 2015. Retrofits include both major projects, such as reinsulating walls and attics or replacing furnaces, and minor projects, such as upgrading lighting. According to CVOEO, an average retrofit costs approximately $8,500.

However, CVOEO's efforts may be reduced moving forward. The low-income weatherization program lost approximately 30% of its funding in 2015 with the expiration of funding available through the American Recovery and Reinvestment Act (ARRA).

Vermont Gas

Vermont Gas is the natural gas utility serving the region. The organization offers several weatherization programs to its customers. Specific programs for residential customers, both renters and homeowners, include the Retrofit Program and the New Construction Program. Each program allows the customer to install significant building improvements to increase thermal efficiency. The Retrofit Program includes a free energy audit and low-interest financing options. Vermont Gas also provides comparable programs to its commercial customers. The most popular program for both residential and commercial customers provides rebates or other financial incentives to install high-efficiency equipment such as furnaces and water heaters. Figure 3.7 shows the number of customers in the region that have benefited from each program.

Efficiency Vermont

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

Efficiency Vermont reports that it managed contractors that completed 276 residential energy audits in the region between January 2011 and December 2015 through its Home Performance program. This resulted in 129 completed weatherization projects in the region during the same time period, with a high of 31 projects completed in the region during 2014. Efficiency Vermont also operates a comparable Business Energy Assessments program. Data from this program is not readily available.

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

FIGURE 3.7 VERMONT GAS WEATHERIZATION PROGRAMS

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016 to date	Total
Residential Programs											
Residential Home Performance/EVT			1	3	3	3	1	3	4		**18**
Residential Equipment Replacement	51	65	111	92	82	93	119	185	151	7	**956**
Residential Retrofit	8	5	16	8	8	7	8	9	9	1	**79**
Residential Low Income	10	15	14	17	5	13	21	29	8	1	**133**
Residential New Construction		1	12	11	6	7	8	9	11	1	**66**
										Total	**1,252**
Commercial Programs											
Commercial Equipment Replacement	6	4	5	6	11	4	9	11	9	0	65
Commercial New Construction	1	4	1	2	1	4	2	2	2	0	19
Commercial Retrofit	1	6	3	2	6	1	1	5	1	0	26
										Total	**110**

Source: *Vermont Gas. The Vermont Gas service area includes the following municipalities in Franklin County: Georgia, Highgate, Sheldon, St Albans, Swanton, Enosburgh.*

B. TRANSPORTATION

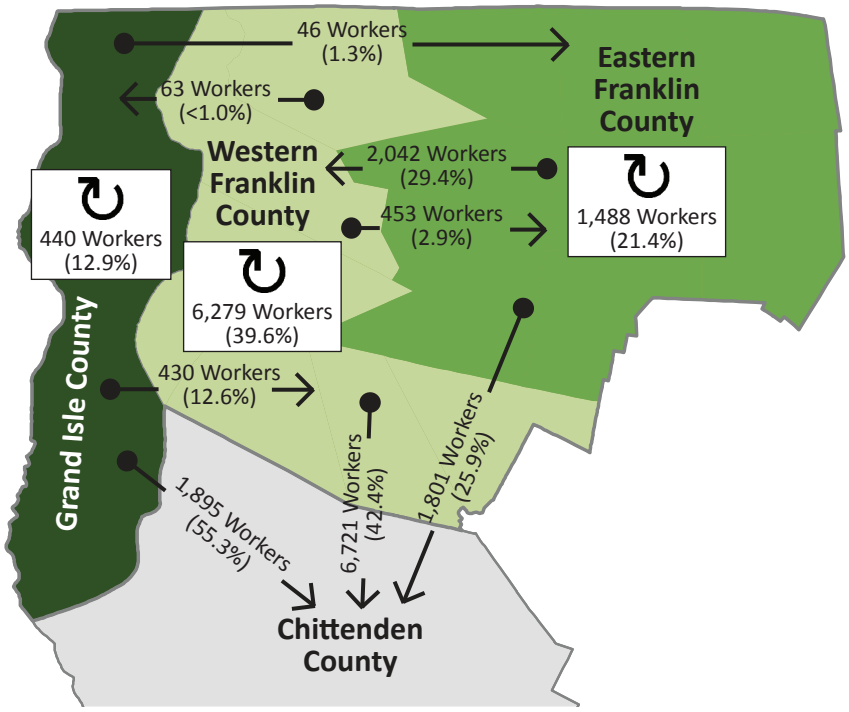
Transportation contributes a considerable amount to the region's total energy use. This is due to several factors: reliance upon the automobile for transportation, land use patterns, and fuel costs.

AUTOMOBILE RELIANCE

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

- Passenger vehicles in the region: 42,471 (2011–2015 ACS)
- Realized MPG in VT (Vermont Agency of Transportation [VTrans]): 18.6 MPG
- Approximate passenger fuel use in the region per year: 3.1 trillion BTUs or 25.9 million gallons
- Vermont per-capita vehicle miles

FIGURE 3.8 NORTHWEST REGION WORKERS



traveled (VMT) in 2014: 11,356 miles—tenth highest in the country (VTrans)
- Mean commute time in the region: 25 minutes in Franklin County and 34 minutes in Grand Isle County (2011–2015 ACS)
- Commuters driving alone: 78% (2011–2015 ACS)
- Commuters using public transportation: 0.5% (2011–2015 ACS)

This much is clear: Vermonters drive a great deal, and they often drive alone. But there is one promising trend: Per-capita VMT have actually decreased in Vermont from a high of 11,402 miles per capita in 2011.

FIGURE 3.9 REGIONAL COMMUTING PATTERNS

- Almost 50% of workers who reside in western Franklin County commute to Chittenden County for work. About 46% of workers commute within western Franklin County.
- More than 75% of eastern Franklin County residents commute to western Franklin County and Chittenden County for work.
- Approximately 75% of Grand Isle County workers commute to jobs outside the county, including a total of 54% of all workers who commute to Chittenden County.

Source: *US Census – Longitudinal Employer-Household Dynamics On The Map tool (2014)*

LAND USE PATTERNS

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

With the development of the Interstate Highway System, land use patterns in the region began to change. Access to less expensive rural land and cheap fuel as well as the region's proximity to Chittenden County, the economic center of Vermont, have altered the way the region has developed over the past 60 years. The result is the loss of working landscape in the region (notably agricultural lands), increased commute times, and increased VMT. The highway system has also contributed negatively to environmental quality and greenhouse gas emissions and has led to changed commuting patterns (Figure 3.9).

FUEL USE AND COSTS

Current land use and commuting patterns have led to heightened transportation costs for individuals and a comprehensive reliance on increasingly expensive fossil fuels. Transportation fuel use and costs for individuals in the region can be estimated using data from the ACS and VTrans. Using the average fuel cost in April 2017, individuals in the region spend approximately $67 million per year in transportation fuel costs (Figure 3.10). This figure is even higher when vehicles owned by regional businesses are considered. In addition, much of this money leaves the local economy.

FIGURE 3.10 ESTIMATED REGIONAL FUEL COSTS

	Regional Estimates
Total # of vehicles in region (ACS)	42,471.00
Average gallons used per vehicle per year (VTrans)	18.6
Total gallons used per year in region	25,930,143.87
Average cost per gallon of gas	$2.31
Total Fuel Costs	**$59,898,632.34**

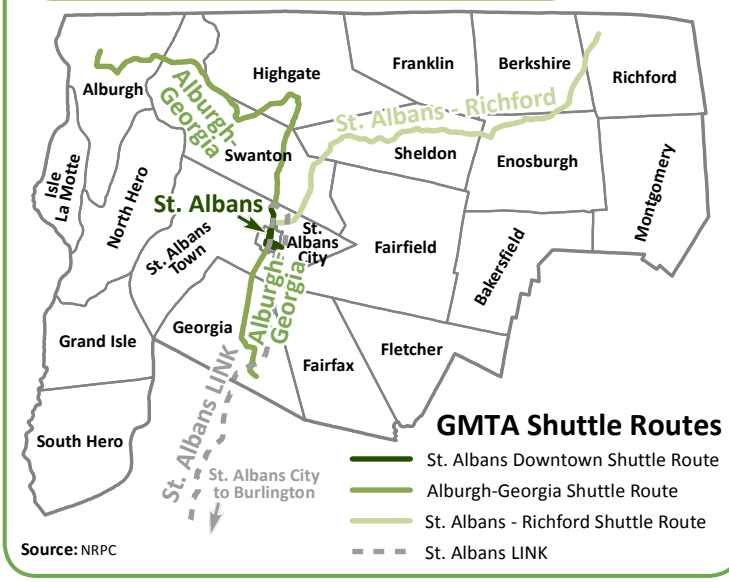
Hybrid and electric vehicles can decrease residents' reliance on fossil fuels. Regionally, hybrid vehicles are becoming more common. As of January 2016, there were 41 electric vehicles registered in the region. This trend is encouraging, but the region still lags behind other parts of the state in converting to alternatively fueled vehicles. This may be due to a variety of reasons, such as electric vehicle cost, electric vehicle range, and the lack of public charging stations. There are currently a few public charging stations in the region, but they are concentrated in three municipalities: St. Albans City, St. Albans Town and Swanton.

PUBLIC TRANSIT

As previously noted, fewer than 1% of regional residents use public transportation during their commute to work. However, public transit will be a key component to reducing transportation costs and meeting state and regional energy goals.

Green Mountain Transit (GMT) provides public transportation to the Northwest region and operates four routes in the region: the Alburgh–Georgia Shuttle, the St. Albans–Richford Shuttle, the St. Albans Downtown Shuttle, and the St. Albans LINK which provides access to Burlington (Figure 3.11). The former two routes terminate in two of the region's industrial parks. However, most of Grand Isle County and eastern Franklin County is without public transportation services. GMT also provides special transportation services to the elderly and disabled in the region. In addition, GMT serves as the fiscal agent for its partner agency, Champlain Islanders Developing Essential Resources (C.I.D.E.R.), which provides transportation to elderly and disabled residents of Grand Isle County. All buses in the region currently run on gasoline.

FIGURE 3.11 GMT SHUTTLE ROUTES



Source: NRPC

There are seven park and ride lots in the region, which are all concentrated in western Franklin County. Southern Grand Isle County and eastern Franklin County do not have park and ride lots and are considered underserved. A park and ride lot location has been identified in South Hero, and NRPC is currently working with VTrans to determine potential locations for additional park and ride lots in the county.

Amtrak serves St. Albans City via the Vermonter Line. According to Amtrak, in 2014 there were approximately 4,400 arrivals and departures at the St. Albans stop. There is no commuter rail service in the region.

The financial costs and environmental impact of moving goods in the region are substantial. Currently, trucks move approximately 83% of goods by weight and 88% of goods by value statewide, according to the 2015 Vermont Freight Plan. St. Albans is home to a private railyard owned by New England Central Railroad. Information about freight capacity and current traffic through the railyard is private and unavailable.

FIGURE 3.12 MEGAWATT TO GIGAWATT CONVERSION

1 MW = .001 GW
1 MWh = .001 GWh

C. ELECTRICITY

ELECTRICITY USE

The 2016 Vermont Comprehensive Energy Plan states that approximately 5.5 GWh of electricity are used statewide each year. This use has remained fairly consistent since 2009 and is down from peak electricity use of approximately 5.9 GWh in 2005.

FIGURE 3.13 REGIONAL ELECTRICITY USE IN REGION - 2013

Sector	Regional Electricity Use	Regional Electricity in Trillions BTUs
Residential (kWh)	194,619,255	0.664
Commercial and Industrial (kWh)	288,131,747	0.983
Total (kWh)	482,751,002	1.647

Source: *Efficiency Vermont*

Electricity use data available from the U.S. Energy Information Administration does not provide details on a regional

level. The LEAP model estimates 2010 regional electricity demand to be 1.832 trillion BTUs per year. This is equivalent to 536.9 MWh per year, which totals approximately 9.6% of the state's electricity use. The LEAP model estimate is relatively close to data available from Efficiency Vermont in 2013. EVT shows regional electricity use accounting for approximately 1.647 trillion BTUs.

As discussed in the next section, electricity use must continue to grow through 2050 in order to meet the 90 x 50 goal.

REGIONAL ELECTRICITY GENERATION

As of January 2017, the Northwest region had the capacity to generate 58.4 MW of electricity through hydro, wind, solar, and biomass technologies, and it had 98.4 MW of total generation capacity from all sources, according to data available from the Community Energy Dashboard.[3] The 58.4 MW of renewable generation in the region is a "raw" number that does not take "capacity factors, renewable energy credits sold, or ownership of the systems" into consideration. The NRPC has estimated renewable generation in the region to be about 182,190.79 MWh per year when factoring capacity factors for solar, wind, and hydro.

The region has four dams with a total generation capacity of approximately 41.4 MW of electricity. Three of the dams are located on the lower portions of the Missisquoi River. A privately owned dam in Sheldon Springs has a generation capacity of approximately 26 MW of electricity. It is the largest dam both on the Missisquoi and in the region. The two other dams on the Missisquoi are located in Highgate and Enosburgh, and they are owned by public electric utilities in Swanton Village and Enosburg Falls, respectively. The dam at Enosburg Falls will undergo extensive repairs within the next five years to remain operating at its current capacity. The fourth dam in the region is located on the Lamoille River in Fairfax and is owned by Green Mountain Power.

Georgia Mountain Community Wind is the only existing, large-scale wind project in the region. Two of the project's four turbines are located in Franklin County (Georgia), and the other two turbines are located in neighboring Chittenden County. The project generates approximately 10 MW in total (5 MW is estimated to be generated within the region). As of January 2017, the Community Energy Dashboard indicated that there were 25 other small-scale wind facilities in the region that have received a Certificate of Public Good from the Public Service Board. Total wind-generation capacity in the region, including half of Georgia Mountain Community Wind, equals 5.26 MW.

Another large-scale wind project, Swanton Wind, has currently entered the regulatory process with the filing of an application with the Public Service Board in August 2016. As proposed, the project would generate 20 MW of electricity.

In January 2017, the Community Energy Dashboard reported that it had approved 9.5 MW of solar generation in the region. This includes several facilities that were "large" when they were permitted: a 2.2 MW project in Sheldon Springs and three 500 kW projects, including one located at the correctional facility in St. Albans Town. In addition, several larger solar facilities, ranging in size from 5 MW to 20 MW, are currently proposed in the region.

Biomass electric generation is also occurring in the region. According to the Community Energy Dashboard, approximately 2.3 MW of electricity was generated from biomass sources in the region as of January 2017. All of this electric generation took place in Franklin County through the use of anaerobic digestion on dairy farms (some woody biomass in the region is used for heating systems, not electric generation).

Green Mountain Power has applied for an anaerobic digester in cooperation with three dairy farms in St. Albans Town. The digester would use manure and food scrap from solid waste districts in the northwest part of the state. The potential capacity of the facility is approximately 800 kW.

[3] http://www.vtenergydashboard.org/

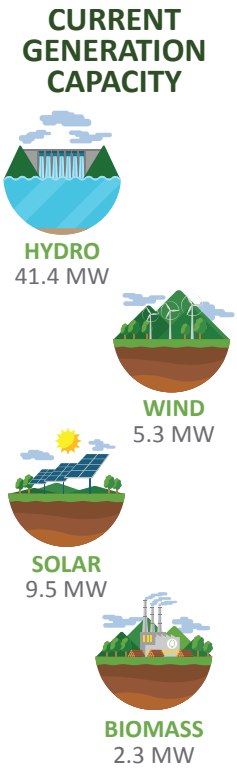
There is one non-renewable energy generator in the region: Project 10. This facility, which is located in Swanton, is owned by the Vermont Public Power Supply Authority (VPPSA) and runs on fuel oil and/or biodiesel. The facility is a "peaking" plant that operates only during peak electric loads, which,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

FIGURE 3.14 REGIONAL GENERATION CAPACITY

Type of Generation	Generation Capacity (in MW) January 2017	Generation Capacity Currenty Proposed (in MW)
Hydro	41.4	0
Wind	5.3	20
Solar	9.5	54.411
Biomass	2.3	0.8
Fuel Oil/Biodiesel	40	0
Other	0	0
Total	**98.4**	**75.211**

1. Current Fuel Oil/Biodiesel Generation is only a peaking plant. It is only permitted for use a maximum of 600 hours per year.
2. Some proposed generation may have been constructed.

Source: *Community Energy Dashboard, Public Service Department, and NRPC*



The amount of currently proposed generation in the region equals 75.211 MW (excluding withdrawn applications), and this total would increase regional generation by 75% (Figure 3.14). All of the proposed projects use renewable energy sources. And although not all of the currently proposed projects will necessarily be built, the amount of generation development has substantially increased since the early 2010s. In addition, this increase is not expected to subside in the near term given the extension of federal tax credits for solar facilities until 2021 and the renewable generation standards set for public utilities in the state Renewable Energy Standard. A full summary of regional renewable generation facilities is located in Appendix E.

PUBLIC UTILITY ENERGY SOURCES AND IMPORTED ELECTRICITY

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

Green Mountain Power

Green Mountain Power generally services the southern and western parts of Franklin County. Figure 3.15 shows sources of electricity distributed by GMP in 2015 (before the sale of renewable energy credits (RECs)). The electricity comes from primarily outside the region with the exception of distributed solar generation and the GMP-owned dam at Fairfax Falls. GMP owns several generation facilities. It also enters into power purchasing agreements with individual power suppliers and purchases power on the open market ("System" power) (Figure 3.15).

Vermont Electric Cooperative

VEC's territory includes all of Grand Isle County and most of the northern and eastern parts of Franklin County. VEC does not own any electric-generating facilities; it instead has power purchasing agreements with individual electric suppliers and purchases power on the open market. Figure 3.16 shows VEC's energy sources by type of resource and energy sources by provider. Generally, electricity distributed by VEC comes from primarily outside the region with the exception of distributed solar generation and electricity generated from methane on regional farms.

FIGURE 3.15 GREEN MOUNTAIN POWER ELECTRICITY SOURCES

Ownership	Subtype	Generator Description
Owned Generation	Joint Owned	McNeil Generating Plant (31%), Millstone 3 (Nuclear), Stony Brook (gas/oil fired facility), Wyman #4 (oil fired)
	Wholly Owned	GMP Hydroelectric (32 facilities), oil-fired (6 facilities), solar and wind generators (2 large facilities)
Power Purchase Agreements	Long-Term Units	NextEra Seabrook (nuclear), Granite Reliable Wind (wind), Moretown Landfill (landfill methane), Ryegate (biomass), Stony Brook (oil), New York Power Authority (hydro)
	Long-Term System	HydroQuebec Vermont Joint Owners Agreement, (HQUS PPA)
	Short-Term Unit	Amersand Gilman, North Harland, other small independent producers
	Short-Term System	J.P. Morgan, Shell, Citigroup, exGen, and NextEra energy contracts ("do not convey generation attributes from particular sources")
	Standard Offer (SPEED)	Biomass, farm or landfill methane, hydro, solar
	VEPPI	Vermont's Quality Facilities under PURPA (hydro)

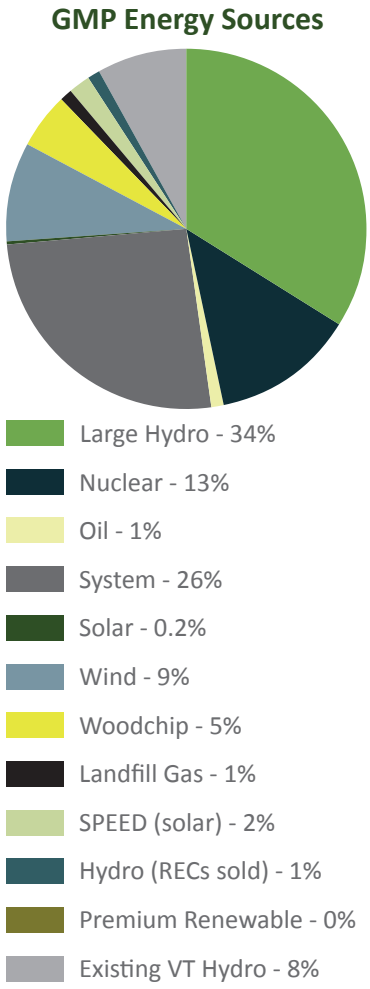
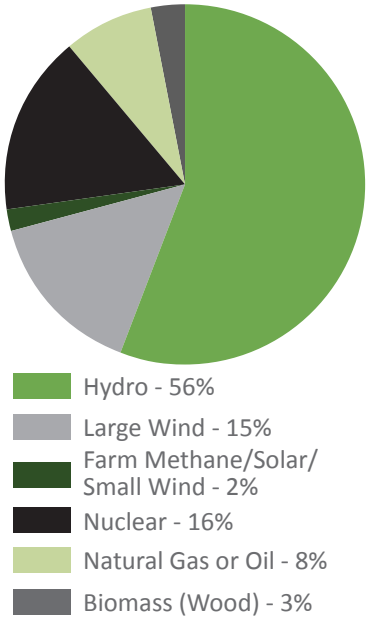


FIGURE 3.16 VERMONT ELECTRIC CO-OP ELECTRICITY SOURCES

Type of Power	Generator
Large Hydro	Hydro-Quebec, NY Power Authority (St. Lawrence and Niagra)
Small Hydro	VEPPI and two Warner's hydro generators
Large Wind	First Wind, LLC (Sheffield, VT) and Kingdom Community Wind (Lowell, VT)
Farm Methane/Solar/ Small Wind	Standard Offer
Nuclear	NextEra Seabrook
Natural Gas or Oil	System Power (source of supply not identified)
Biomass	Ryegate Woodchip Facility (Ryegate, VT)



Enosburg Falls Village and Swanton Village Electric Departments

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

Enosburg Falls' dam supplied approximately 12.82% of the power distributed by the Enosburg Falls Electric Department in 2014. About 27.6% of the electricity distributed in 2014 came from Hydro-Québec, and about 28.2% came from the utility purchasing electricity on the open market (Figure 3.17).

The Swanton Dam supplied 74.3% of the electricity distributed by Swanton Village Electric Department in 2014. The McNeil Generating Station in Burlington contributed an additional 17.7% of the electricity distributed. Notably absent from the list is Hydro-Québec, which did not provide any electricity to Swanton Village Electric Department.

FIGURE 3.17 VILLAGE OF ENOSBURG FALLS ELECTRICITY SOURCES

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

FIGURE 3.18 SWANTON VILLAGE ELECTRIC DEPT. SOURCES

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

What is particularly striking about Swanton Village Electric Department is that approximately 98.7% of the electricity generated on its system in 2014 came from what are generally considered renewable sources: hydro and biomass. This is a considerably larger use of renewable sources compared to the other three public utilities servicing the region.

It is also worth noting that about 74.2% of the electricity distributed by Swanton Electric in 2014 was produced within the region at the utility's dam in Highgate (Figure 3.18).

Several existing dams in the region do not currently produce electricity, yet they could potentially be used in the future. According to the Vermont Renewable Energy Atlas, the future generation capacity of these dams could be in excess of 1 MW (Appendix C). The possible future use of these dams is a point of controversy given the related environmental impacts. This topic is discussed in greater detail in Section V (see Figure 5.9).

Appendix C contains maps that shows areas in the region with solar and wind generation potential.