Chapter Two: Energy

I. INTRODUCTION

Traditionally, Northeastern Vermont Development Association has approached energy planning from a strictly "supply-and-demand" perspective, and this has generally supported the traditional systems that have continued to meet our regional energy needs. The energy trends of the past decade, however, have presented NVDA with the challenge of addressing a much broader perspective, one that transcends current energy production and usage. During this time, several factors created a contentious climate for the future planning of our energy systems. The region has had to contemplate the effect of utility-scale wind development on our mountains; identify ways to ensure forest sustainability as wood-fuels grow in popularity; and seek means to secure long-term affordability of our energy resources for the general public and business communities. In response, NVDA expanded its approach to energy planning and its role in regional energy policy with the intent of seeking a stronger voice in formulating energy policy for NVDA and its member municipalities.

NVDA's statutory role in energy planning is outlined in V.S.A. Title 24, Chp.117 §4348a (3), which stipulates that a regional plan include:

> "… an analysis of energy resources, needs, scarcities, costs and problems within the region across all energy sectors, including electric, thermal, and transportation; a statement of policy on the conservation and efficient use of energy, and the development of renewable energy resources; a statement of policy on patterns and densities of land use likely to result in conservation of energy; and an identification of potential areas for the development and siting of renewable energy resources and areas that are unsuitable for siting those resources or particular categories or sizes of those resources."

The approval process for siting energy generation projects is largely under the jurisdiction of Section 248 of Title 30. The Vermont Supreme Court has expressly exempted projects subject to Section 248 from local permitting. At this time municipalities have only the power to regulate "off-grid" renewables – and must do so in accordance with Vermont Statute.

In accordance with Section 248, energy developers must obtain a Certificate of Public Good (CPG) from the Public Utility Commission (PUC) before beginning site preparation or construction of electric transmission facilities, electric generation facilities, and certain gas pipelines within Vermont[1]. Prior to issuance, the PUC takes into account the environmental, economic, and social impacts of a proposed facility. Municipalities and other groups are allowed to participate in the Section 248 review process, but many find doing so to be difficult and expensive. Moreover, the PUC is only obligated to give "due consideration" to the recommendations of the municipal and regional planning commission in determining if the project "will not unduly interfere with the orderly development of the region."[2] The process has also been complicated by the fact that Vermont statute does not define "due consideration", nor does it indicate whether the courts or the PUC should be the ultimate arbiter.

Previous versions of this plan have been prepared in anticipation of receiving "due consideration" in the Section 248 process. To support the PUC's consideration, NVDA has defined what constitutes a 'substantial regional impact' with regards to development (24 V.S.A. Chp.117 §4345a (17)). This

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[1] Vermont Public Service Board. "Citizens' Guide to the Vermont Public Service Board's Section 248 Process.
[2] City of S. Burlington, 133 Vt. at 447, 344 A.2d at 25

definition is provided within Land Use section of the *Proposed Regional Plan for the Northeast Kingdom 2018* (Chp.1, pg. 24).

Act 174 of 2016 establishes a new set of municipal and regional energy planning standards. If these standards are met, regional and municipal plans may carry greater weight – "substantial deference" – in the Section 248 process. Unlike "due consideration," "substantial deference" is codified in statute to mean:

> "…that a land conservation measure or specific policy shall be applied in accordance with its terms unless there is a clear and convincing demonstration that other factors affecting the general good of the State outweigh the application of the measure of policy."

This regional plan has been revised to meet substantial deference under Act 174. It is important to note, however, that substantial deference does not carry the weight of zoning. Projects that fall under the jurisdiction of Section 248 are still exempt from local zoning and permitting. Nevertheless, this plan reflects our attempt to have a greater say in where energy projects should – and should not – be sited, and it is structured as a resource who municipalities who also wish to seek substantial deference for their local plans. Substantial deference is voluntary for municipalities. Duly adopted local plans that do not meet the enhanced energy planning standards of Act 174 but otherwise meet all the requirements of Chapter 117 will continue to receive due consideration from the PUC in the Section 248 review process. Whether or not a municipality choses to pursue substantial deference, it is hoped that this regional plan will help our municipalities to think comprehensively about energy use, resulting in strategies that conserve existing resources and reduce our reliance on fossil fuels.

Strategy Outline

NVDA's Energy Plan aims to guide the region's energy development for the next eight years in support of Vermont's 2016 Comprehensive Energy Plan (CEP), which contains the following goals:

- 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.
- Achieve three renewable end-use sector goals for 2025: 10% transportation, 30% buildings, and 67% electric power.

The basic components of the Energy Strategy are organized into five main sections:

State and Regional Overview

This section provides an estimate of local consumption across the transportation, thermal, and electrical energy sectors.

Generation and Distribution

This section analyzes the existing framework by which our utilities generate and distribute power, as well as legislation and incentives that will impact future generation.

Future Energy Use and 2050 Projections

This section analyzes the ambitious 2050 goals for Vermont's CEP and how it may impact future energy use in the Northeast Kingdom. Efficiency and conservation are also addressed in support of meeting statewide energy goals.

Energy Resource Analysis and Recommendations

In this section resources are analyzed for their current and future potential as part of the overall energy portfolio in support of 2050 goals. This section includes a region-wide GIS-based analysis, which identifies potential areas for the development and siting of renewable energy resources, areas that are unsuitable for siting those resources or particular categories or sizes of those resources, and potential generation from siting areas.

Regional Goals & Strategies

This section identifies the primary regional challenges for meeting 2050 goals and identifies pathways for meeting them.

II. STATE AND REGIONAL OVERVIEW

Statewide Energy Use

Vermont's total energy consumption is the lowest in the nation and has traditionally ranked among the lowest per capita. As of 2014, Vermont ranks 43rd in per capita consumption (about 223 MM BTUs). However, the state ranks 13th in total energy expenditures per capita (at $5,225). Throughout the U.S., energy prices are rising due to the stress on traditional resources and increasing consumption levels. To address rising energy costs, Vermonters are turning more and more towards supplemental fuels, renewables, co-generation facilities, and efficiency/conservation efforts.

> **What is a BTU?**
>
> BTU stands for **British Thermal Unit**, and it is defined by US Energy Information Administration as the measurement of the quantity of heat required to raise the temperature of one pound of liquid water by 1° F at the temperature that water has its greatest density (approximately 39 °F.
>
> Fuels come in a variety of measurements – by cord, by gallon, by kilowatt – so this plan converts units of measurement into BTUs in order to compare their energy output consistently.
>
> One BTU is a miniscule amount, so BTUs are often measured in the thousands, millions (MM BTUs), or even trillions.

Energy consumption has grown steadily since the 1960s. Historically, leaps in consumption are associated with major economic growth, low energy prices, population growth, and an overall increase in the number of vehicle miles driven. Vermont has limited generation capacity and has relied on Quebec to fulfill part of its energy needs since the early 1980s. With the permanent closure of the Vermont Yankee Nuclear Plant at the end of 2014, the state lost 55% of its generation capacity and now produces less than one-third of the energy it consumes. In addition to Canada, the state relies on the ISO-NE grid for power from neighboring states. Energy use is dominated by transportation and by heating in the frigid winters. About three-fifths of the energy consumed in Vermont are petroleum-based products, which are transported into the state by rail or truck from neighboring states and Canada. The state has limited access to natural gas. There is a natural gas pipeline in the Northeast Kingdom (which is shown on the regional energy maps), but we lack infrastructure to access it. Vermont is the second smallest natural gas consumer per capita, among the states. In 2015, nearly all of Vermont's in-state net electricity generation was produced by renewable energy, including hydroelectric, biomass, wind, and solar resources.[3]

Table 2.1 represents the total primary energy consumption in the state from 2009 to 2014 Petroleum products are by far the leading source of fuel in the state, most of which is used in the transportation and residential heating sectors.

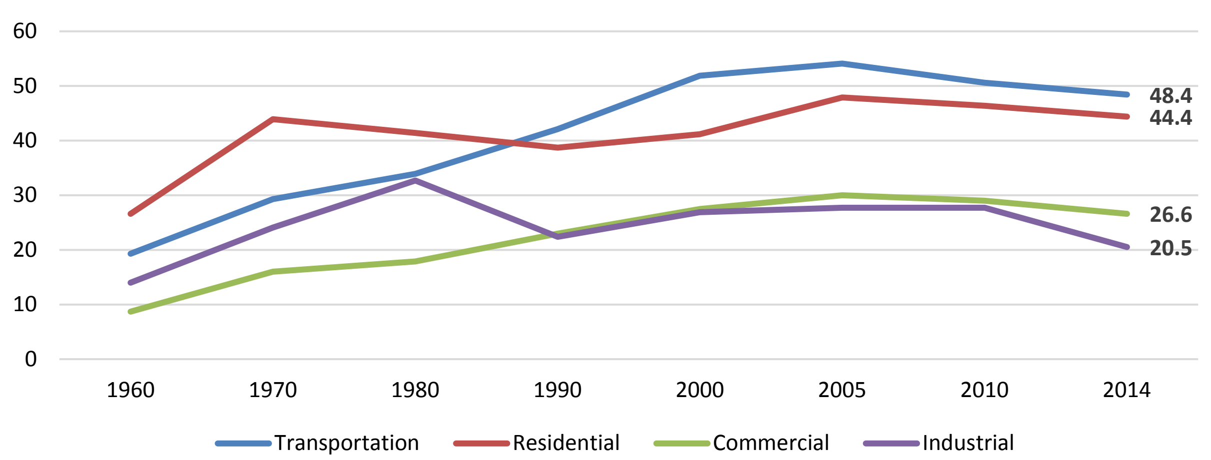
Table 2.1: Primary Energy Consumption Estimates, 2009-2014 (Trillions of BTUs)						
	2009	2010	2011	2012	2013	2014

[3] US Energy Information Administration: Vermont State Energy Profile and Estimates

Coal	0.0	0.0	0.0	0.0	0.0	0.0
Natural Gas	8.7	8.5	8.7	8.3	9.7	10.8
Total Petroleum	84.6	81.8	80.2	75.9	79.4	79.5
Distillate Fuel Oil	27.8	26.6	27.7	24.4	25.3	26.5
Jet Fuel	2.9	1.3	1.3	1.3	1.3	1.2
LPG	9.3	9.0	8.3	9.2	10.4	10.1
Motor Gasoline, excluding fuel ethanol	38.0	37.6	36.2	35.1	35.7	35.3
Residual Fuel Oil	1.2	1.0	0.9	0.6	0.8	0.5
Other	5.4	6.3	5.7	5.4	5.9	8.5
Nuclear Electric Power	56.1	50.0	51.4	52.3	50.6	52.9
Hydroelectric Power	14.5	13.1	13.8	10.6	12.3	11.2
Biomass	19.4	19.0	17.2	16.1	20.8	20.3
Solar/PV	0.1	0.2	0.3	0.5	0.7	0.9
Wind	0.1	0.1	0.3	1.0	2.3	3.0
Net Interstate Flow of Electricity	-35.5	-27.4	-30.0	-73.4	-78.3	-76.9
Net Electricity Imports	8.7	8.3	8.6	39.2	40.1	38.1
Source: U.S. Energy Information Administration, State Energy Consumption Estimates, 1960-2014, released June 2016						

Figure 2.1 outlines Vermont's energy use by sector between 1960 and 2014. While transportation energy use has grown at a faster pace than any other energy sector since 1960, it has dropped by more than 10% since 2000, most likely a result of an increase in fuel efficiency and conservation efforts. Residential sector consumption has grown by nearly 15% since 1990. Residential fluctuations are considered to be normal - resulting from general population growth, an increase in the average house size, and additional modern conveniences. While the drop from 2005 levels may be attributed in part to the great recession, it may also reflect more efficient building practices, such as more efficient heating equipment and better insulated building shells. According to the Energy Information Administration's 2013 Residential Energy Consumption Survey, U.S. homes built in 2000 and later consume only 2% more energy on average than homes built prior to 2000, despite being on average 30% larger.

Figure 2.1: Statewide Energy Use by Sector, 1960-2014
(trillions of BTUs)



Source: U.S. Energy Information Administration, State Energy Consumption Estimates, 1960-2014

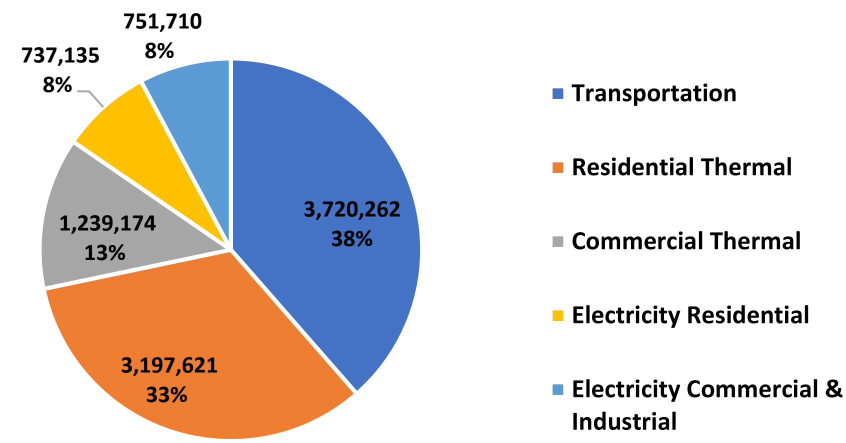
The industrial sector has seen the most significant decrease in consumption since 2010; however, it is unclear as to how much of this reduction is attributed to new energy efficiency measures employed by manufacturers, reduced production levels, or plant closings in Vermont.

Regional Energy Use by Sector

Note: The following regional estimates were developed using multiple sources, including the Department of Public Service, American Community Survey, Vermont Department of Labor. For more information about how these estimates were developed, please see Appendix A.

According to NVDA estimates, residential and commercial thermal use (heating space and water) is the largest energy use at 46%. Transportation[4] is the second largest energy use in the Northeast Kingdom, accounting for 38% of total usage measured in MM BTUs,, followed by electricity at 16%. (Figure 2.2)

Figure 2.2: Regional Energy Use by Sector (MM BTUs), NVDA Estimates



Residential Thermal

On average, a Vermont residence uses 110 MM BTUs annually for heating space and water. [5] Annual usage, however, can vary from as low as 70 MM BTUs to 150 MM BTUs, depending on a number of factors such as total square footage, seasonal use, and age of structure. The age of the Northeast Kingdom's housing stock is likely the most significant contributor to the overall usage. According to most recent American Community Survey Five-Year Estimates (ACS), nearly one-third of owner occupied housing units and nearly one-half of renter-occupied housing units were built prior to 1940. [6] Older homes are likely to be poorly insulated and leakier, driving up consumption and costs.

There are 26,133 occupied and heated households in the Northeast Kingdom, which collectively account for more than 3.2 billion BTUs and $40 million in various heating fuels. (Table 2.2)

Table 2.2: Residential Heating Fuels Used in the Northeast Kingdom

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	3,782	3,713,828	Gallons	14.4%	12.4%	21.1%	23.5%

[4] Transportation data only includes light-duty vehicles, and commercial transportation data is not available.
[5] Vermont Department of Public Service. "Guidance for Regional Enhanced Energy Planning Standards" March 2, 2017
[6] The American Community Survey (ACS) data differs from Census data in that it utilizes annual survey figures, from a smaller cross-section of the population, across a rolling 5-year timeframe to provide data estimates for a given year. The estimates used for this update were from 2011-2015.

Electricity	454	11	GWh	1.7%	0.8%	4.7%	4.0%
Fuel Oil	13,997	9,252,413	Gallons	53.4%	50.6%	62.5%	51.4%
Wood	7,441	36,446	Cords	28.4%	34.1%	10.2%	20.6%
Coal/Coke	115	529	tons	0.4%	0.4%	0.6%	0.5%
Other	344	-		1.3%	1.6%	0.4%	0.0%
Source: NVDA (See Appendix A)							

The region lacks natural gas distribution infrastructure, so oil is the most widely consumed residential heating fuel. Propane -- which is cleaner burning and less expensive than oil but tends to produce less heat per gallon – is the second most used heating fuel for rental stock.

Another contributor to residential thermal usage patterns in the Northeast Kingdom is the high concentration of seasonal homes. According to the 2010 Census, more than one of every five housing units in the NEK is a vacant housing unit intended for "seasonal, recreational, or occasional use". The Vermont Department of Public Service has estimated that "summer" seasonal housing stock – i.e. lake cottages -- may use as little as 5% of a year-round residential structure, while "winter" seasonal housing – like in Burke and Jay – could use as much as 10%. In reality, the seasonal usage lines are blurred, as many communities have seasonal populations that visit throughout the year. NVDA estimates that the region's approximately 8,800 seasonal units accounts for about 45,398 MM BTUs annually in thermal energy.

Wood is used by more than one-third of owner occupied homes, but only about one-tenth of renter-occupied homes. Two affordable housing developments in the region use wood pellets – Maple Street Senior Housing in Hardwick with 16 units, and Mathewson Block in Lyndonville with 6 units. The region's homeowners maintain a strong tradition of burning wood and do so at a much higher rate than the rest of the state. (Figure 2.3). In the late 2000s, instability of fuel prices compelled more homeowners to install wood-pellet stoves and furnaces, as well as outdoor wood boilers for heating water in recent years. Despite a recent drop in fuel oil prices in recent years, combined with a significant shortage of wood pellets during the 2014-2015 heating season, homeowners remain committed to wood. In many cases, fuel oil is actually used as a back-up source to wood.

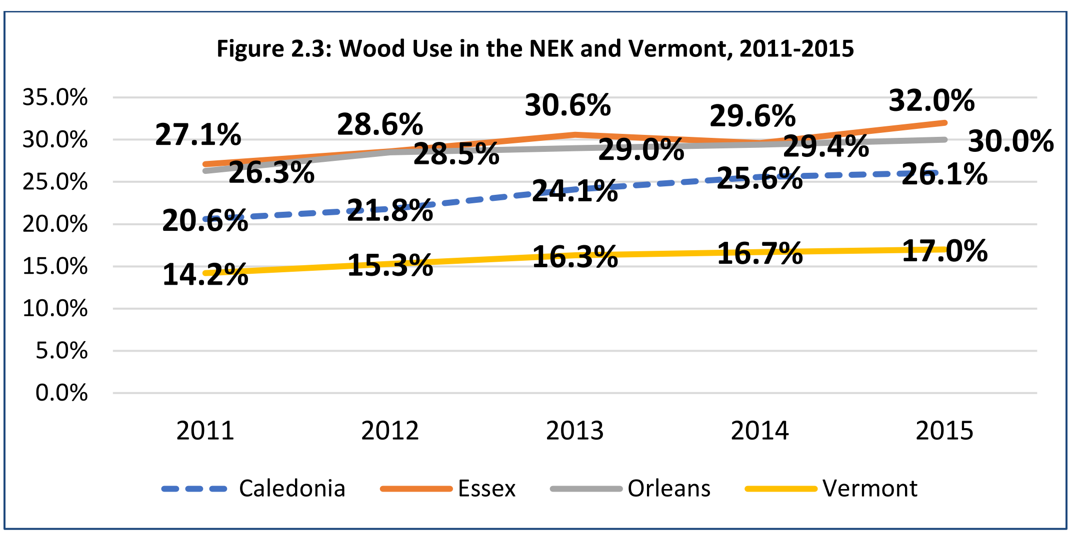


Figure 2.3: Wood Use in the NEK and Vermont, 2011-2015

Source: American Community Survey

Table 2.3: Cost of Fuels, 2011-2016

		November 2011			*November 2016*				
Types of Energy	**BTU/Unit**	**Adj. Effic.**	**$/Unit**	**$/MM BTU**	**Typical Effic.**	**$/Unit**	**$/MM BTU**	***High Effic. ****	***High Efficiency$/MM BTU***
Fuel Oil, gallon	138,200	80%	$4.08	$36.89	80%	$2.23	$20.14	*95%*	*$16.96*
Kerosene, gallon	136,600	80%	$4.45	$40.71	80%	$2.80	$25.65		
Propane, gallon	91,600	80%	$3.37	$46.05	80%	$2.54	$34.64	*95%*	*$29.17*
Natural gas, Ccf	100,000	80%	$1.78	$22.22	80%	$1.41	$17.67	*95%*	*$14.88*
Electricity, kWh (resistive)	3,412	100%	$0.16	$46.37	100%	$0.15	$43.46		
Electricity, kWh (heat pump)**	n/a					$0.15	n/a*	*240%*	*$18.32*
Wood (cord-green)	22,000,000	60%	$192.03	$14.55	60%	$227.00	$17.21		
Pellets (ton)	16,400,000	80%	$263.51	$20.09	80%	$275.00	$20.96		

Source: Department of Public Service, Vermont Fuel Price Report (2011 figures are adjusted for Inflation)
* n/a because heat pumps can only burn in one mode.

Table 2.3 demonstrates the change in heating fuel prices in the last few years. Only the least used fuel – resistance type electricity – has remained stable. Meanwhile the cost of fossil fuels has dropped, while the cost of wood has risen slightly. When oil prices were high, many NEK residents turned to alternative fuels, especially wood pellets, which are cleaner burning, more efficient than cord wood, and relatively easy to use. Stoves and furnaces can be controlled by a thermostat. Their prices have remained relatively stable, although there have been some shortages in recent heating seasons. Wood pellet stoves and furnaces may be a significant investment for most homeowners, so they have continued to use pellets even after the price of heating oil dropped.

In 2015 the Vermont Fuel Price report was amended to account for "High Efficiency" ratings of furnaces, which are manufactured to meet higher efficiency standards can result in savings on energy for the customer.

Heat Pump Technologies:

The Fuel Price Report now includes information on electric-powered heat pump systems, which can deliver up to three times more heat energy than the energy required to operate them. This high return rate – called a coefficient of performance (COP) – offsets the increased electricity usage. All air – even frigid Vermont winter air – contains a significant amount of heat energy. The air source heat pump captures the heat energy from the outside, compresses it, and circulates it into the house at a high temperature. (In hot summer months, the technology operates in reverse, acting as an air conditioner.) Because a heat pump *transfers* heat rather than *generates* it, it requires significantly less energy to operate than a traditional electric, propane, or oil system.

Geothermal or "ground source heat pump systems" operate on the same principle: They extract natural low-temperature thermal energy from the ground during colder months for heating, and transfer thermal energy from the building to the ground in warm months for cooling. A geothermal system in Vermont can save roughly $1,000 to $2,000 annually in heating costs and have a "simple payback time" of between 10-20 years. This technology operates much like a refrigerator, utilizing a heat pump, heat exchanger, and refrigerant.

There are two main types of geothermal systems, open-loop and closed-loop. Open-loop systems utilize a deep rock well or pond to draw water to the heat exchanger where heat flows from the water into cold refrigerant. The refrigerant is then compressed, which greatly raises its temperature and converts it to vapor. Refrigerant vapors then transfer heat to water in a second heat exchanger that is then circulated to heat the building. The process operates in reverse for cooling. Closed-loop systems are slightly different in that they utilize piping in the ground or a pond that can be placed closer to the surface, but then require refrigerant or water with antifreeze to circulate in the piping.

Open-loop systems are more efficient than closed-loop systems and are often cheaper to install because they require less excavation. Open-loop systems are also a good fit for Vermont, since standing column wells can be constructed virtually everywhere. While existing well systems can have geothermal systems installed, installation of this technology is often cheapest during construction of a new building and development of a new well site. A geothermal well resource map is provided at the end of the chapter and identifies existing wells with a high potential for geothermal heating and cooling applications.

Traditionally, geothermal systems have been more efficient than air-sourced heat pumps (ones that just utilize outside air), because the ground/well source systems can take advantage of relatively constant temperatures below the frost line. In recent years, however manufacturers have developed air-sourced "cold climate" pumps that operate more consistently over Vermont's vast temperature ranges. Unlike geothermal units, they do not require excavation or duct work and can be much less expensive to install. Cold climate heat pumps have the capacity to heat about 50% to 70% of a building, depending on the size and layout of the structure. Older homes with multiple ells or wings may be difficult to heat with heat pumps alone, but the pumps may be effective for boosting colder underserved zones. They also may be useful in outdoor workspaces. Despite recent improvements in effectiveness on cold days, a backup heating source is usually required for sub-zero temperatures.

Commercial/Industrial Thermal

Most of the region's commercial/industrial energy usage can be attributed to space heating and process heating. Table 2.4 identifies average heating load per establishments and total MM BTUs consumed annually[7] Heating loads vary significantly and may be highly specific to type of industrial processes. NVDA's estimates were developed using assumptions about business patterns. For example, types of businesses that tend to employ more workers per establishment can be expected to be the larger consumers of heat energy – schools, hospitals and clinics, hotels and restaurants. On the other hand, businesses that have few on-site employees – like real estate agencies – use significantly less.

Table 2.4: Commercial Thermal Energy Use

	# of Commercial Establishments	Average Heating Load (MMBTUs)	Total MMBTUs
Caledonia	722	829	598,292
Essex	103	1,118	115,174
Orleans	631	833	525,708
TOTAL	1,456	851	1,239,174

Source: Department of Public Service, Vermont Department of Labor

To combat high heating costs, RadianTec, a radiant-floor heating manufacturing company in Lyndon, utilizes solar hot water panels and passive solar design to reduce their heat loads. Other commercial operations and institutions have turned to wood. Wood chips - either bole chips or whole tree chips - are well suited for combustion to supply heat, hot water, or steam in institutional, commercial, and industrial settings. The Vermont Fuels for School Program has been very successful

[7] Vermont Department of Public Service. "Guidance for Regional Enhanced Energy Planning Standards" March 2, 2017

implementing wood heating in schools. Six schools in the Northeast Kingdom currently heat with wood: Burke Mountain Academy, Craftsbury Elementary, Danville School, Hazen Union School, and Lyndon Town School currently heat their facilities with wood. Ryegate and Groton students attend the Blue Mountain School in Wells River, which has been heated with wood chips since 1998.

Industrial and commercial enterprises in the state are also moving towards wood-based heating systems, and in some cases co-generation. In the Northeast Kingdom, the North Country Hospital, and Lyndon Furniture utilize wood-chip Combined Heat and Power (CHP) systems to meet partial heat and power needs.

Thermal Efficiency and Weatherization

Regional thermal efficiency and weatherization efforts are spearheaded through four organizations: **Efficiency Vermont**, **Northeast Employment and Training Organization (NETO), 3E Thermal, and Heat Squad**.

Efficiency Vermont, the energy efficiency utility for the state, was established by the Vermont Public Service Board in 1999. The utility is funded by an energy efficiency charge on consumer electric bills, similar to a system benefits charge. Efficiency Vermont offers energy and money-saving programs to consumers that allow them to install and use energy-efficient construction designs, products and equipment. They also offer low-income energy assistance programs.

NETO was incorporated in 1978 as a 501(c)3 agency for the purpose of delivering weatherization programs to low income residents of the Northeast Kingdom. NETO receives most of its funding from the State of Vermont Weatherization Program and receives additional funding from the Department of Energy. Residents who do not qualify for low-income weatherization assistance can still contact NETO for energy audits.

3E Thermal (formerly known as Vermont Fuel Efficiency Partnership) is a statewide program that provides consulting, technical support, and incentives to owners of affordable apartment housing. Since 2010, 3E Thermal has collaborated on several multifamily energy-improvement projects around the NEK, representing a total of more than 250 apartments, each saving more than 6,000 MMBTUs annually. 3E is funded by a thermal efficiency fund created by the legislature that uses revenues from the regional Greenhouse Gas Initiative, a cape-and-trade system covering nine states in the Northeast, and the forward-capacity market, where Efficiency Vermont sells future electric savings through ISO-New England.

Heat Squad, an energy efficiency organization, founded by NeighborWorks of Western Vermont, is actually based in the Rutland area. However, in August of 2017, Heat Squad received $250,000 in grant funding from the Northern Border Regional Commission to expand their services to the Northeast Kingdom. The expansion is expected to result in 233 home energy retrofits over the next three years.

According to Efficiency Vermont, 6,061 efficiency projects have reduced thermal energy consumption in the Northeast Kingdom by more than 37,000 MM BTUS annually. (Table 2.5)

Table 2.5: Thermal Savings in the NEK (MM BTUs), 2014-2016

	2014	2015	2016	Total
Residential	2,986	1,774	2,722	7,481
Commercial & Industrial	3,015	19,982	6,590	29,587
TOTAL	6,001	21,756	9,312	37,069

Source: Vermont Energy Investment Corporation

The Vermont Department of Public Service seeks to optimize thermal performance on all new residential and commercial construction through the enforcement of energy codes. Although codes have been in place since the late 1990s, they have not always been enforced consistently. In 2013, the Vermont legislature passed Act 89, which ties documentation of compliance with energy codes to the local zoning process. Zoning administrators are now required to provide all applicants with Residential Building Energy Codes (RBES) and Commercial Building Energy Codes (CBES). If a municipality issues a certificate of occupancy, the developer must produce certification of compliance with the codes. Act 89 also authorizes the Department of Public Service to adopt "stretch" codes that exceed baseline efficiency, and municipalities have the option to adopt these codes as they become available. The Department of Public Service adopted a stretch code for RBES, and a stretch code for CBES is in development. The Natural Resources Board presumes compliance with stretch codes to meet the energy efficiency criterion of the Act 250 review.

Transportation

The EIA estimates that statewide, the transportation sector alone consumes about three-fifth of all petroleum products, mainly because rural residents drive long distances to work and errands. Regional estimates show transportation to be the second-largest overall energy use, and this estimate does not even include commercial and industrial vehicles. While Vermont ranks 50th in carbon dioxide emission, transportation accounts for more than half of all greenhouse gas emissions.

Energy use in transportation is most greatly influenced by the development patterns of the region. Given that the Northeast Kingdom consists of a rural landscape with small pockets of concentrated development, there are minimal avenues in which energy consumption as part of the transportation sector can be effectively reduced. Long commutes and incidental trips require NEK residents to drive an average of 14,000 miles per year, collectively accounting for more than 693 million vehicle miles travelled, which represents nearly $71 million in fuel costs. (Table 2.6) Nearly all of this energy is non-renewable. Ethanol currently accounts for the vast majority of renewable transportation energy use – about 6.5% of total BTUs – while electricity accounts for a mere .03%.

Table 2.6: Transportation Energy Use in the Northeast Kingdom	
Total Light Duty Vehicles	49,676
Total Internal Combustion Engine (ICE) Vehicles	49,542
Average Miles per gallon for ICE	22
Average annual Vehicle miles travelled ICE	14,000
Total annual VMTs ICE	693,588,00
Total Gallons ICE	31,526,727
Trillion BTUs, Fossil fuel	3.5
MM BTUs, Ethanol	240,357
Trillion BTUs Total ICE	3.7
Total Electric vehicles (EVs) (as of Jan. 2017)	134
Average annual VMT for EVs	7,000
Total annual VMTs for EVs	938,000
Average fuel economy for kWh	3
Total kWh for EVs	312,667
MMBTUs for EVs	1,067

Sources: American Community Survey, Department of Public Service, and NVDA estimates.

Plug-in electric vehicles (EVs) have the greatest potential to reduce Vermont's statewide greenhouse gas emissions. "Refueling," which is as simple as plugging into an electric outlet, costs the equivalent of about $1.00 per gallon. According to Vermont Energy Investment Corporation, there are 1,595 EVs registered in Vermont as of April 2017, marking a 37% increase from the previous year.

There are two types of EVs:

- **All-Electric Vehicles (AEVs)**: An AEV can range as far as 80 miles on a single charge, but on very cold days, this range can be cut in half. AEVs are therefore best used as a second car.

- **Plug-in Hybrid EVs (PHEVs)**: A PHEV generally does not range as far as an AEV, but it can switch over to gasoline when the battery charge runs low, making it a more likely choice for those with longer drives and greater distance from public charging stations. About 75% of EVs registered in Vermont are PHEVs.

Not surprisingly, Chittenden County has the highest concentration of EVs on the road – about one-third of all EVs in the state. Nevertheless, Northeast Kingdom residents are beginning to use them as well. As of January 2017, there were 134 EVs registered in the region. The highest use is found in the region's population centers – St. Johnsbury, Lyndon, Hardwick, Derby, and Newport. There are three EV dealerships in the region – Lamoille Valley Ford in Hardwick, and Twin State Ford and Quality Mitsubishi, both in St. Johnsbury. A limited number of public charging stations have been established around the region (Table 2.7), and more will be needed to support expanded EV use, particularly if more drivers switch to AEVs. All but two of the existing public charging stations are level 2, which can be ideal when a driver can park for at least an hour for work, shopping, or dining. A level 2 is about six times faster than a level 1, which requires several hours of charge time. Only one location currently offers a DC fast charge, which can provide up to 80% battery charge in only 20 minutes. Unfortunately, many hybrids are not equipped to connect to the DC fast charge.

Table 2.7: Public Charging Stations for EVs in the Northeast Kingdom

Town	Location	Charge Type
Barton	Barton Village Offices	Level 2
Danville	Marty's First Stop	Level 2 and DC fast
Derby Line	Derby Line Unitarian Universalist Church	Level 2
Hardwick	Lamoille Valley Ford	Level 2
St. Johnsbury	Twin State Ford	Levels 1 and 2
St. Johnsbury	Pearl Street Parking Lot	Level 2
St. Johnsbury	Northeastern Vermont Regional Hospital	Level 2

Source: US Department of Energy's Alternative Fuel Locator

Ethanol, currently the primary source of renewable fuels for light-duty transportation vehicles, can be blended up to 10% with gasoline to form E10. It can be used in any engine that takes regular gasoline. Corn is the most common element used to produce ethanol, even though it can be produced from a variety of elements, including wood. Ethanol burns cleaner than gasoline and is very effective in lowering fuel emissions. Unfortunately, the fuel also has significant problems in cold-weather, which make it less useful for Vermont's climate. While E10 is required in many urban areas that do not meet federal air emission guidelines, this is not the case in Vermont. Many of the blends available in this area are 9% ethanol.

One area in which Vermont is seeing growth in fossil fuel usage is via compressed natural gas. With a reduction in natural gas prices, compressed natural gas is now economical for large industrial applications (utilizing over 150,000 gallons fuel oil annually) and as a transportation fuel. Both the Burlington Department of Public Works and Vermont Gas maintain vehicle fleets fueled with compressed natural gas. Liquified petroleum gas (LPG) can also be used a transportation fuel and produces fewer CO2 tailpipe emissions than conventional gasoline-powered vehicles. The region has one LPG fueling station at the Pick and Shovel in Newport.

Price volatility of gasoline in the first half of the past decade helped to spur an interest in the development of biofuels. Biodiesel is commonly made from soybeans, rapeseed (canola), and sunflowers; all of which can be grown in Vermont. Biofuel can be blended with diesel up to 5% (B5) to be safely used for on-road vehicles. Higher blends, including pure biodiesel (B100) can be used in off-road equipment and farm vehicles, although farm equipment manufacturers have approached the use of biodiesel with caution. Black Bear Biodiesel, located just outside of the region in Plainfield, is a B100 fueling station.

Research has found that oilseed crops, when grown in rotation with other crops, can help to support sustainable, diversified, and profitable agricultural enterprises. The Vermont Bioenergy Initiative, a program of the Vermont Sustainable Jobs Fund, provides early-stage grant funding, technical assistance, and loans to producers. Currently North Hardwick Dairy produces oilseed crops for use as fuel and food-grade. Although the recent drop in fuel prices has reduced some incentive for farmers to enter biofuel production, NVDA encourages further innovation and research into this area as a long-range economic opportunity.

Commercial shipping is one of the highest consumers of transportation fuels and another area in which the region can reduce consumption. As gas prices started to climb in the past decade area, businesses looked for alternative shipping methods and inquiries into the region's rail infrastructure grew. Railroad shipping is most desirable for non-perishable commodity goods. Upon further review it was found that regional rail infrastructure has the potential for growth, with room for increased traffic and a number of underutilized sidings. The Kingdom may also be able to attract additional rail usage if rail beds are upgraded to meet the 286,000 lb. weight limit standard and bridge heights are increased. Both improvements will allow rail cars to be filled to capacity and allow for the double stacking of rail cars, which is now standard across the country. NVDA also supports the re-establishment of the Twin State Line as a means to better connect the Kingdom with greater rail markets in New England.

Development Patterns and Transportation Use

Understandably rural development patterns directly impact transportation energy usage, especially in regards to individual behaviors. With limited transit infrastructure, the region is dominated by single-occupancy light-duty vehicles. Residents typically commute to disparate labor market areas, reducing opportunities for carpooling. VTrans offers grant assistance to municipalities who wish to establish park and rides on municipal, state, or leased property on or near state highways. Mixed-use, higher density neighborhoods encourage more pedestrian use. The following land use principles encourage reduced transportation energy consumption[8]:

1. Encourage the location of new development in or near traditional village and city centers to reduce both sprawl and the number of vehicle miles driven.
2. Support transit-oriented development that fosters the expansion of public transportation and rail use.
3. Encourage the construction of Park and Ride facilities to support carpooling efforts.
4. Encourage the expansion of bicycle and pedestrian facilities such as sidewalks and bike lanes.

Additionally, improved telecommunications infrastructure in this region has the potential to reduce annual VMTs by allowing more workers to telecommute.

Electricity Use

With respect to simply how much electricity is generated here relative to what is consumed, the Northeast Kingdom is a net exporter of energy. This is a major shift from more than a decade ago, when the region relied heavily on Canada, New Hampshire, and the rest of Vermont to meet its electricity demand. In 2016, the total electric usage for the region was 436,355 MWHs, representing a total of roughly 1.48 trillion BTUs. (Table 2.8). Despite the increase in customer counts in the C&I sector since 2014, total usage dropped by .4% over the same period. The number of residential customers increased slightly over the same period, but total residential usage decreased by a fraction

[8] See the Transportation, Land-Use, and Housing Sections of the *Regional Plan for the Northeast Kingdom* for additional energy-related recommendations.

of a percentage point, as did the average residential usage. Similar data on average commercial and industrial use is not available.

Although the commercial and industrial sector only accounts for about 15% of all electrical utility customers, they account for slightly more than half of all usage. Electric costs are a major factor in attracting and retaining major commercial/industrial operations in the region. New England retains the highest electric costs in the lower 48 states for both sectors. In April 2017, the state's average electric retail price was 14.14 cents/kWh in the commercial sector and 10.12 cents/kWh in the industrial sector. These rates are the second lowest in the New England, but still considerably higher than national rates of 10.38 cents/kWh and 6.63 cents/kWh respectively (U.S. Energy Information Administration, Electric Power Monthly). When most large manufacturers are speaking in terms of megawatt-hours (thousands of kilowatt-hours) for power consumption, those price differences are considerable. The former Dirigo Paper Mill utilized on-site hydro and waste steam for electrical generation. Ampersand Gilman Hydro continues to operate the site. Ethan Allen has studied the feasibility of a combined heat-and-power plant with Orleans and Barton Electric for their Orleans facility; and Lyndon Furniture in St. Johnsbury has employed a diesel-fueled electric generator to stabilize their electric costs for several years.

Table 2.8: Annual Electricity Use in the NEK			
Usage by Sector (In MWHs)	2014	2015	2016
Commercial & Industrial	221,395	229,877	220,313
Residential	216,757	218,962	216,042
Total	438,152	448,840	436,355
Avg. Residential Use (in KWHs)	6,323	6,372	6,295
Count of Customer Premises (Customers)			
Sector	**2014**	**2015**	**2016**
Commercial & Industrial	5,808	5,871	5,977
Residential	34,279	34,363	34,317
Total	40,087	40,234	40,294
Source: Vermont Energy Investment Corporation			

According to Efficiency Vermont, 6,061 efficiency projects have achieved savings electrical use in the Northeast Kingdom by 82,324 MM BTUs from 2014 to 2016. (Table 2.9).

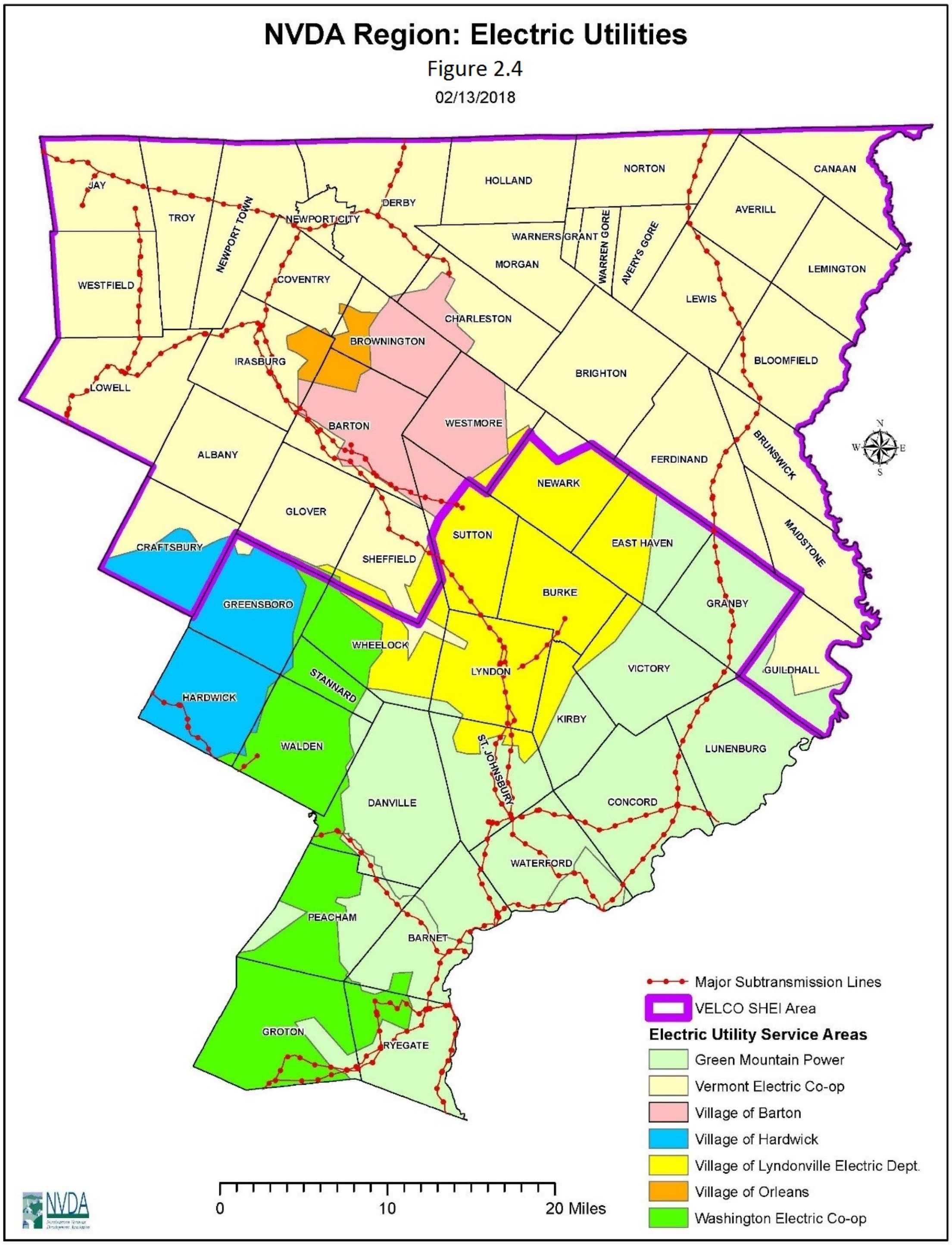
Table 2.9: Electricity Savings Achieved in the NEK, in MWh				
Sector	**2014**	**2015**	**2016**	**Total**
Residential	2,951	3,569	3,286	9,806
Commercial & Industrial	3,953	5,178	4,990	14,122
Total	6,904	8,748	8,276	23,928
Source: Vermont Energy Investment Corporation				

III. GENERATION AND DISTRIBUTION

Electric systems are part of large regional networks that extend beyond state boundaries. Vermont belongs to a network that encompasses the six states of New England. These regional networks are responsible for the general organization and operation of the electric businesses and market territory. However, the vast diversity in state-to-state infrastructure can influence the energy climate in surrounding network states. For Vermont, this translates into major effects on the affordability, cost, and reliability of electrical systems.

Regional Utilities

The Northeast Kingdom is served by seven electric utilities. Figure 2.4 depicts the coverage areas of the region's utilities and the subtransmission lines. Vermont Electric Co-Op serves the largest area, covering over 19 towns in Northern Essex and Orleans Counties. Green Mountain Power also covers a large area in Caledonia and Southern Essex Counties, with the remainder of the region served by Washington Electric Co-Op, and four municipal-owned electric companies. The NEK's municipal electric utilities include Barton Electric, Orleans Electric, Lyndonville Electric, and Hardwick Electric. Together the municipal utilities provide service to 19 different towns and villages (Figure 2.4[9]).



9 Latest version of mapped Utility Service Territories (VCGI ArcGIS) data available.

All the municipally owned utilities throughout the state are represented by the Vermont Public Power Supply Authority (VPPSA). VPPSA acts on behalf of the utilities in the regional buying and selling of power and provides rate studies, central computer services, load forecasting, tax-free financing of certain capital projects, and exploration of new generation options. VPPSA is a part owner in the McNeil Station in Burlington, a 50 MW generator that primarily uses wood, as well as the Highgate Interconnection facility, which is used to bring in power from Hydro Quebec. In 2010, VPPSA completed a 40MW peaking facility in Swanton, Vermont. The facility runs during peak price times to mitigate price spikes that typically occur in the summer and winter.

The region's utility power supply portfolios are made up of a mixture of generation resources, long-term contracts, and short-term contracts. Three of the municipal utilities generate some of their own power through hydro (Hardwick has a facility in Wolcott, just outside of the region.) Orleans Electric's portfolio also includes long-term and short-term contracts; however, it is without generation resources of its own. Figure 2.4 demonstrates the aggregated power supply by fuel type for all utilities serving the Northeast Kingdom. (This power supply mix will vary among each member utility of VPPSA.)

Table 2.10: 2016 Fuel Mix (Before Sales of Renewable Energy Certificates)

VPPSA*		Washington Electric Coop		Vermont Electric Coop		Green Mountain Power	
%	Source	%	Source	%	Source	%	Source
40	Market Purchases	66	Coventry Landfill	59.6	Hydro	34.7	Large Hydro
33	Hydro	13	NYPA (Large Hydro)	19.4	Wind/Solar/Farm Methane/Wood	27.4	Market Purchases
15	Biomass	10	Sheffield (Wind)	17.9	Nuclear	13.8	Nuclear
7	Landfill Gas	5	Small Hydro	3.2	Natural Gas/Oil	5.6	Existing VT Hydro
2	Solar	3	Ryegate (Wood)			8.2	Wind
2	Standard Offer	3	Market Purchase			4.9	Hydro
1	Fossil	<1	GMP System			2.6	Wood
						2.1	Solar
						0.3	Methane
						0.4	Oil & Natural Gas

Source: Integrated Resource Plans, Utility reports, and web sites
*Fuel mix will vary among municipal utility members.

Until it shut down in 2014, Vermont Yankee supplied roughly one-third of Vermont's electric supply. Central Vermont Public Service and Green Mountain Power were the lead owners of the facility. (GMP and CVPS merged in 2012.) . While a large share of this replacement power has come from Hydro Quebec GMP, there is still some nuclear power in the mix from Seabrook, NH. While much of the utilities' power originates from Hydro Quebec, there are other sources from New York Power Authority, as well as smaller facilities throughout the state. Market purchase are power contracts purchased without any known environmental attributes and the fuel mix may change over time.

Green Mountain Power estimates that as of 2016, the market purchase mix is more than half natural gas, followed by nuclear, and oil.[10]

Although the NEK is a net exporter of energy, Vermont has traditionally been a net importer. Technically, the state produces enough generation; however, due to the performance characteristics of the in-state generation, Vermont has relied heavily on its transmission network to import power from neighboring states. When Vermont Yankee shut down, Vermont's net import rate rose significantly, making the state a net importer of power at virtually all hours from New York, New Hampshire, Massachusetts and Canada in order to meet the state's load requirements. Without significant new in-state generation, this situation will be a long-term operating condition.[11]

Purchase & Distribution

The state of Vermont belongs to the ISO-New England Regional Transmission Organization (RTO). The ISO-New England RTO operates all of New England's bulk electric power system and works in coordination with the New England Power Pool (NEPOOL). NEPOOL is Vermont's regional representative of the electric power businesses, including utilities, independent power producers (IPP), suppliers, end-users, and transmission providers. In 1997, the RTO was developed as a means to create competitive wholesale electricity markets. Their responsibilities include developing, overseeing and operating the New England wholesale electric market, as well as managing and planning for regional electric needs.

The RTO wholesale electric market operates on a per-hour bid system that incorporates some short-term and long-term contracts. The bid system requires generation units to bid into the system based on what it costs them to produce for that hour. The hourly price is then set based on the most expensive facility needed to meet demand. As demand increases, the higher-priced facilities are pulled online to meet the increasing load. In Vermont, many of the "peaking" plants utilize diesel fuel. New England is also heavily dependent on natural gas generation facilities, which set the hourly price 85% of the time. Even though natural gas prices have dropped recently, New England households retain the highest electric costs in the country. As part of the RTO, Vermont is subject to these higher electric costs, even though there is only one natural gas generation facility in the state. According to the Public Service Department, the higher pricing is caused by existing long-term contracts and restrictive pipeline infrastructure. In other words, New England is still paying natural gas pricing that was set in a multi-year contract, plus its limited pipeline capacity means it cannot access additional volumes of natural gas outside of those contracts. Massachusetts is currently pursuing the expansion of a major pipeline to be able to utilize larger volumes of natural gas.

Transmission

A majority of Vermont's electric transmission system is operated by the Vermont Electric Power Company (VELCO), which was established by Vermont's utilities in 1956. VELCO is responsible for bulk transmission lines with a voltage rating of 115kV and above. Lines with a rating of 34.5kV, 46kV, and 69kV are considered sub-transmission lines. The Northeast Kingdom has roughly 325 miles of transmission and sub-transmission lines (Figure 2.3) and serves as an important gateway for electricity coming from both Canada and New Hampshire.

VELCO is responsible for planning and constructing upgrades that ensure system reliability and maintain the grid. Several upgrades in recent years should significantly increase transmission capacity

[10] Green Mountain Power: Our 2016 Fuel Mix Information
http://www.greenmountainpower.com/2016/12/01/fuel-mix/

[11] VELCO: 2015 Long-Range Transmission Plan
https://www.velco.com/assets/documents/2015Plan_Final_toPSB.pdf

on existing lines: new lines between Irasburg and Newport; upgrades to the St. Johnsbury, Irasburg, and Newport substations; and the reconfiguration of the Hydro Quebec interconnection at Highgate. In 2010 VELCO upgraded the Hill Street substation in Lyndonville, which provided a secondary connection between Lyndonville Electric's grid and the larger VELCO transmission lines. In 2011, a new substation in Jay established redundancy in transmission paths and increased capacity to delivery power to the Jay area.

VELCO maintains a long-range transmission plan that must be updated every three years for the PUC. The plan and subsequent updates are vetted through a stakeholder group called the Vermont System Planning Committee (VSPC), which is made up of VELCO, electric distribution utilities, the Department of Public Services, representatives of demand and supply resources, and representatives of the general public. The most recent Long-Range Transmission Plan (June 2015) acknowledges that a profound transformation of the electric grid is already underway. The grid must become more agile and diverse by retiring traditional base load generation, increasing distributed renewable generation, and investing in demand-side resources, such as energy efficiency and demand response. Emerging technologies, such as heat pumps and electric vehicles, are reflected in the load forecast of the 2015 Plan, but their full impact cannot yet be quantified with confidence.

One ongoing VPSC initiative of particular concern to the Northeast Kingdom is grid congestion in the Sheffield Highgate Export Interface (SHEI), the northwestern area of our region where generation exceeds load. (Figure 2.4) In essence, the region generates far more power than it consumes, causing generation to exceed the capacity of the export line. The continued addition of new sources of generation, like solar, forces existing resources, like Kingdom Community Wind and Sheffield Wind to curtail their output due to the lack of capacity to export power. Adding more renewables to an already full grid at this point can simply mean replacing other renewables. While modest transmission upgrades may help to alleviate some congestion in the short-term, the situation will require robust, long-term solutions that are complex and possibly costly.[12] Utilities, clean energy advocates, regulators and other stakeholders are currently discussing ways that the SHEI limitations can be addressed to reduce or eliminate curtailments of generation located within the interface.

Regional Generation Facilities

(Note: For municipal-level generation estimates, see Appendix B.)

The Northeast Kingdom has a very large share of generation resources compared to other regions of the state. (Table 2.11) The region is home to four major renewable generation facilities: the Ryegate Wood-Chip Plant, the Coventry Landfill methane-generator, the Sheffield Wind Farm, and Kingdom Community Wind in Lowell. Collectively, these facilities produced 80% of the region's total electricity generation that is not net-metered (i.e. grid-tied). 2005 saw the first major jump in regional generation growth with the development of the Coventry Landfill methane generator, which doubled its output in 2009. The region also produces a significant amount of hydro power. Collectively, hydro power (excluding Connecticut River production, which is technically in New Hampshire), the Northeast Kingdom's hydro resources account for 18% of regional generation.

[12] Frank Ettori, SHEI Overview, VSPC, July 12, 2017 v. 2

Table 2.11: Generation Facilities in the Northeast Kingdom					
Owner/Operator – Facility Name	**Location**	**Utility**	**Facility Type**	**kW Capacity**	**Annual Output MWh**
Kingdom Community Wind	Lowell	GMP	Commercial Wind	63,000	*191,174*
Sheffield Wind	Sheffield	WEC	Commercial Wind	40,000	*121,380*
Passumpsic Hydro	Barnet	GMP	Hydro	700	3,851
East Barnet Hydro	Barnet	GMP	Hydro	2,200	7,442
Barnet Hydro	Barnet	GMP	Hydro	490	1,814
Great Bay Hydro Corp. (IPP) – West Charleston (Standard Offer)	Charleston	VEC	Hydro	675	2,655
Barton Village Hydro	Charleston	Barton Village Electric	Hydro	1,400	4,210
Fairbanks Mill	Danville	GMP	Hydro	18	73
West Danville #15	Danville	GMP	Hydro	1,000	3,700
Ampersand Gilman Hydro	Lunenburg	GMP	Hydro	4,850	28,000
Great Falls	Lyndonville	LED	Hydro	1,900	9,600
Vail	Lyndonville	LED	Hydro	350	1,850
Newport 1, 2, 3	Newport	VEC	Hydro	4,000	15,735
Dodge Falls	Ryegate	GMP	Hydro	5,000	27,000
Emerson Falls	St. Johnsbury	GMP	Hydro	230	700
Arnold Falls	St. Johnsbury	GMP	Hydro	350	1,588
Gage	St. Johnsbury	GMP	Hydro	700	2,878
Pierce Mills	St. Johnsbury	GMP	Hydro	250	1,544
North Troy	Troy	VEC	Hydro	460	2,600
Troy Mills Hydroelectric (Standard Offer)	Troy	VEC	Hydro	816	3,210
Maxwell's Neighborhood Energy, LLC (IPP) (Stanard Offer)	Coventry	VEC	Methane	225	1,508
WEC – Coventry Landfill	Coventry	WEC	Methane	8,000	50,506
Maplehurst Farm (Standard Offer)	Greensboro	HED	Methane	150	1,005
Chaput Family Farms (Standard Offer)	Troy	VEC	Methane	300	2,010
Sun CSA 73 (Community Solar)	Barnet	GMP	Solar	150	184
Sun CSA 59 (Community Solar)	Barnet	GMP	Solar	150	184
Barton Solar LLC (Standard Offer)	Barton	VEC	Solar	1,890	2,401
SolarSense VT (Community Solar)	Concord	GMP	Solar	500	613
Coventry Solar (Standard Offer)	Coventry	VEC	Solar	2,200	2,794
Sun CSA 27 (Community Solar)	Lowell	VEC	Solar	150	184
Solaflect Community Solar Park	Lunenburg	GMP	Solar	150	235
Sun CSA 53 (Community Solar)	Lunenburg	GMP	Solar	150	184
Ira Rentals (Standard Offer)	Newport	VEC	Solar	37	47
Bobbin Mill (Standard Offer)	Newport	VEC	Solar	50	64
Ryegate Power Station (IPP)	Ryegate		Wood Chip	167,627	154,785

TOTAL	310,118	647,708
Source: VEPP, Vermont Renewable Energy Atlas. Some outputs were calculated because actual output was not available, including KCW and Sheffield Wind, which are curtailed due to grid congestion.		

There are also three very large generation assets located on the border of the region that deserve to be mentioned. The Comerford Dam, McIndoe Falls Dam, and the Moore Dam are all located on the Connecticut River, which is owned by New Hampshire. Table 2.12presents their generation figures. According to the Department of Public Service, they are not considered Vermont generation assets, but their mere proximity to the region may pose a future benefit to our area.

Table 2.12: State-Line Generation Facilities (Technically located in New Hampshire) in MWhs/year			
TransCanada - Moore Dam	Hydro	271,000.00	Waterford, VT & Littleton, NH
TransCanada - Comerford Dam	Hydro	315,000.00	Barnet, VT & Monroe, NH
TransCanada - McIndoe Falls Dam	Hydro	52,000.00	Barnet, VT & Monroe, NH
Total		**638,000.00**	

SPEED and Standard Offer

In June 2005, Vermont enacted the Sustainably Priced Energy Enterprise Development (SPEED) Program and Renewable Portfolio Goal to provide financial incentives for the development of new renewable generation facilities under 2.2 MW. The program encourages development by providing feed-in tariffs, which pay a set incentive rate/kWh above current market retail prices for power that meets program criteria and agrees to long-term contracts. Specific types of renewable generation were initially assigned different tariff amounts, and the program had a total cap of 50 MW. In the 2012, the legislature increased the cap to a total of 127.5MW that will be rolled out in set allotments over the course of 10 years to limit the impact on rate payers. Changes to the program also addressed how tariff rates are established, with the legislature promoting a reverse auction process to ensure competitive rates. Northeast Kingdom renewable energy development projects with standard offer contracts are noted in Table 2.13 and include all the farm methane generators, as well as hydro and solar, producing in excess of 15,000 MWh a year. In 2015, VPPSA was awarded two Standard Offer contracts for two solar projects (475 kW and 500 kW) to be located in Lyndonville. A contract has also been awarded to Dairy Air, a large wind project in Holland, although that project is still under review by the Public Service Board. Act 56, which established the renewable energy standard for electric utilities (see below), eliminated the SPEED Program, except for the standard offer component.

Net-Metering

In 1998 the Vermont State legislature passed a bill allowing the practice of net-metering. Net-metering requires electric utilities to permit customers to interconnect on-site renewable electricity systems with the grid (e.g. a photovoltaic system with proper DC-AC conversion equipment) and to be billed only for the net amount of power they consume. This effectively creates an incentive equal to the customer's electric rate for the kWh of renewable electricity that they create. There have been several revisions to the net-metering rules over the past several years, including expanding production limits, simplifying permitting, and increasing peak load capacity, making it easier to establish individual and group run net-metered systems.

Although it is approved for a variety of systems -- solar, small wind, combined heat and power, farm methane, and bio-gasification facilities generating up to 500 kW – net metering has been most popular with solar. This has been largely due to the "solar adder," which increased the average price per kWh of solar net-metered generation.

Act 99, which became effective in January of 2017, raised the cap on Vermont's utilities from 4% to 15%, meaning that the utilities have to take on net-metered systems on a first-come, first-served basis to all its customers until the cumulative generating capacity of all net-metered systems equal 15% of the utility's peak demand. New net-metering customers will be compensated at a reduced rate, although the rate is still well above retail electric rates. Instead of applying a solar adder, the new net-metering rule applies a series of adjustments for siting solar on statewide **preferred** sites that have already been disturbed: rooftops, parking lot canopies, brownfields, and gravel pits. There is no site adjustment for installations of 150 kW or more, so the new net metering has the potential – at least in theory – to site small developments away from open fields and other undeveloped areas. To date, utilities serving the Northeast Kingdom have reported a sharp uptick in the number of net metering applications, and in some instances, at double the rate of previous years. In testimony to the Senate Natural Resources and Energy Committee, VEC has noted that since January of 2017 66% of the 2017 net metering capacity is for projects greater than 150kW. This service area (the SHEI) already has significant system constraints, so new net-metered generation will displace existing generation which is less expensive.[13]

The region currently generates nearly 13,000 MWh through net metering. (Table 2.13). There has also been growth in group net metering and community solar programs, which allow individual customers within one utility service territory to invest in a solar project and receive distributed net metering credits. This off-site option can be cost-effective for residents, particularly renters and home owners where solar installations are not possible. Currently, such net metering projects in the area generate 11,792 MWh annually. Utility customers are also able to "sponsor" solar panels in community solar projects outside of the region.

Renewable Energy Standard

Table 2.13: Annual Output Net metering in the Northeast Kingdom (MWh)

	Caledonia	Essex	Orleans	NEK
Solar Net-Metering	5,415	452	3015	8,882
Group Net Metered	836	275	209	1320
Community Solar Array	368	1032	184	1584
Small Wind	489	8	613	1,110
Total	7,108	1767	4021	12,896

Source: Vermont Renewable Energy Atlas

Until 2015, Vermont had a renewable energy portfolio goal for its utilities to meet growth in electricity demand by using energy efficiency and new renewable generation sources. When Act 56 was passed in 2015, this goal was replaced by a mandatory Renewable Energy Standard (RES) for the portfolios of Vermont's electric utilities. The RES has three tiers:

Tier I: 55% starting in 2017, existing total renewables will rise 4% every three years to reach 75% in 2032. A utility can meet this requirement by owning renewable energy or renewable energy certificates (RECs) from any plant, as long as the plant's energy can be delivered in New England.

Tier II: A subset of Tier I RECs, utilities now have a distributed generator requirement connected to Vermont's electric grid. Starting in 2017, 1% of the utility's portfolio must be *distributed renewable generation*, rising .6% each year to reach 10% in 2032. (Unlike energy produced in a large power plant, *distributed* energy is produced on-site or in a decentralized manner, such as district generation,

[13] Vermont Electric Cooperative: Testimony to the Senate Natural Resources and Energy Committee-March 23, 2017

through smaller grid-tied devices.) Utilities can meet this requirement by through the production of distributed renewable energy or through RECs that have come into service after June 30, 2015, are 5 MW or less, and are directly connected to Vermont's grid (i.e. in state generation.)

Tier III: This is an energy *transformation* requirement that starts from 2% in 2017 and rises to 12% in 2032. Utilities meet this requirement either through additional distributed renewable generation or "transformation projects" that replace or reduce fossil fuel consumption. Such projects include home weatherization, installation of heat pumps, the use of biofuels, or incentives to purchase EVs. The municipal utility members of VPPSA are exempted from this requirement until 2019, but VPPSA's program will likely include weatherization and heat pumps, biofuels, energy storage, and EVs and charging infrastructure.

Renewable Energy Certificates (RECs)

Tiers 1 and 2 of the Renewable Energy Standard require utilities to hold Renewable Energy Certificates (RECs) to satisfy their requirements. RECs track how much renewable energy is produced from a project, and they have been a major supporting factor in the development of renewable energy. Because Vermont did not have mandatory renewable energy portfolio standards prior to the passage of Act 56, RECs were less likely to be "retired" (used) in state. Rather, they were often sold to Massachusetts, Connecticut, Rhode Island, Maine, and New York, which already had mandatory standards. Utilities and generators buy and sell RECs on an open regional market. Utilities cannot claim electricity is renewable if the REC from that electricity has been sold. Conversely, a utility can claim 100% renewability if it holds sufficient RECs to offset retail sales, even if it generates with fossil fuel. Act 99 affects the sale of RECs from small and mid-size generation. Under the new net metering rule, customers who keep their RECs (either to sell out of state or to keep for themselves) will be subject to a $0.03 penalty per kilowatt-hour (kWh). By contrast, customers who transfer their RECs to the utility will receive a $0.03 incentive per kWh for the first ten years of their operation. Even for a small residential-scale system, this penalty can amount to thousands of dollars. Although the law is intended to help Vermont utilities meet their renewable energy goals, critics of the legislation argue that it could stymie new solar development once utilities have met their 10% Tier II goals. Also, because energy consumers cannot claim to use renewable energy unless they retain the RECs, it does not support energy consumers who have made a conscious decision to avoid the use of fossil fuel and nuclear power.

Incentives and Subsidies

There are considerable federal incentives that support the market for renewable energy development in Vermont. Without the tax credits and Renewable Energy Credits (RECs), some renewable technologies, such as utility-scale wind, would not be an economically viable resource. There are currently three major federal tax credits supporting the development of renewable energy facilities. Table 2.14 below lists the current federal subsidies and their eligible renewable technologies:

Table 2.14 Federal Subsidies for Renewable Energy Development

Program Name	Applicable Technology
Business Investment Tax Credit (ITC)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, CHP/Cogeneration, Solar Hybrid Lighting, Fuel Cells using Renewable Fuels, Microturbines, Geothermal Direct-Use. This credit has been amended several times, most notably in 2015 in the Consolidated Appropriations Act, when the expiration date for these technologies was extended with a gradual step-down of the credits between 2019 and 2022. An investment tax credit is also available to home owners (such as for solar installations) through 2021.

Modified Accelerated Cost-Recovery System (MARCS)	Solar Water Heat, Solar Space Heat, Solar Thermal Electric, Solar Thermal Process Heat, Photovoltaics, Landfill Gas, Wind, Biomass, Geothermal Electric, Fuel Cells, Geothermal Heat Pumps, Municipal Solid Waste, CHP/Cogeneration, Solar Hybrid Lighting, Anaerobic Digestion, Fuel Cells using Renewable Fuels, Microturbines, Geothermal Direct-Use. Also amended in the Consolidated Appropriations Act, the "placed in service" deadline for bonus depreciation was extended to January 2018.
Renewable Energy Production Tax Credit (PTC)	Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Municipal Solid Waste, Hydrokinetic Power (i.e., Flowing Water), Anaerobic Digestion, Small Hydroelectric, Tidal Energy, Wave Energy, Ocean Thermal. This credit phases down for wind commencing construction after December 2016 and expires for other technologies.

Vermont provides a tax credit that investors can claim in addition to the federal credit. Efficiency Vermont provides a link to rebates and incentives for small-scale renewables and efficiency improvements. https://www.efficiencyvermont.com/rebates). With regards to municipal tax, Vermont law allows municipalities to waive the property taxes for solar facilities and any land, not to exceed one-half acre, on which it is built.

Property-Assessed Clean Energy (PACE) Districts allow property owners to borrow money to pay for such things as energy efficient water heaters, lighting, furnaces, boilers, windows, programmable thermostats, and insulation, as well as solar heating, PV, wind and biomass systems. The amount borrowed is typically repaid via a special assessment on the property over a period of up to 20 years. In Vermont, local governments are authorized to create PACE Districts to provide financing. Participating property owners must agree to a special assessment and lien on the property and pay a one-time, non-refundable fee to support the reserve fund created to cover losses in the event of foreclosure of participating properties. The district may release a lien on a property once the property owner has met the terms of the loan. At this time only a few towns are implementing PACE Districts. Municipalities may have been slow to adopt PACE because of a perceived administrative burden. Since 2011, VEIC has received funding to provide most of the administrative support to town. More outreach and education about PACE may be necessary.

Other Energy Facilities

The electricity system is the major energy network in the region. However, it is important to mention the Northeast Kingdom's other major energy infrastructure. The Portland Pipeline is a major crude oil pipeline that stretches from Portland, Maine into Canada. In our region, the pipeline runs from Guildhall northwest to Jay before crossing into Canada. While Vermont doesn't tap into the pipeline, its existence in our region as major transporter of oil is important for potential future use.

The Portland Natural Gas Transmission system also just touches the region. The transmission line also runs from Portland, Maine into Canada and is owned by TransCanada, a major Canadian energy supplier. The line just barely passes through the state in Canaan, Vermont before reaching Canada. A spur has recently been created from this line, but only serves the Ethan Allen Manufacturing Plant in Beecher Falls. Future potential to expand this transmission system into the region remains possible.

Granite State Power Link (GSPL)

Plans have been announced for the development of a new electric transmission line in Vermont and New Hampshire that will deliver up to 1,200 MW of hydro power to southern New England. The infrastructure will consist of two converter stations (one in Vermont), 59 miles of high-voltage direct current line (used for transmitting large amounts of power over great distances), 109 miles of alternating-current line, and a switching station in New Hampshire. The line is proposed to be built adjacent to an existing VELCO transmission corridor and will require a 150 foot expansion. About 53 miles of GSPL will be high-voltage direct current line running through the towns of the Essex County. (Table 2.15) Because the NEK portion of the line is direct-current only, the line will not expand the region's transmission capacity to host new energy development (like wind or solar). The project is located alongside an existing transmission corridor, so visual impacts are expected to be minimal. Project developers are currently working with Vermont Association of Snow Travelers (VAST) to explore recreation opportunities, and the project will bring revenues and other financial benefits into the region and affected communities. The project has been found to be in conformance with NVDA's regional plan

Table 2.15: Vermont Communities in the GSPL

Community	Approximate miles
Norton	4.6
Avery's Gore	0.7
Averill	1
Lewis	6.7
Bloomfield	5.1
Brunswick	3
Ferdinand	5.7
Granby	8.5
Victory	2.4
Lunenburg	3.8
Concord	8.8
Waterford	2.1

IV. FUTURE ENERGY USE AND 2050 PROJECTIONS

(Note: for municipal targets in support of these goals, see Appendix A.)

NVDA's Regional Energy Plan was developed in support of Vermont's 2016 Comprehensive Energy Plan (CEP), which contains the following goals:

- 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.
- Achieve three renewable end-use sector goals for 2025: 10% transportation, 30% buildings, and 67% electric power.

What follows below is one possible strategy, developed by Vermont Energy Investment Corporation, which uses a regionalized scenario of the statewide Long-Range Energy Alternatives Planning (LEAP) model. Historic information was primarily drawn from the Public Service Department's Utility Facts 2013 and U.S. Energy Information Administration data. Projections came from the Vermont Public Service Department's Total Energy Study (TES), and Integrated Resource Plans from the utility companies.

The "90x2050" approach has two major underlying concepts:

1. **Reducing energy use**: Aggressive weatherization, efficiency, and conservation measures are critical in reducing total energy demand to the point where it can be primarily met through renewable sources. Conservation involves reducing or eliminating unnecessary energy use and waste (e.g. lowering thermostats, limiting hours of operation, etc.). Efficiency also involves reducing the total amount of energy consumed, but the reduction comes from improving equipment or operating processes that use energy. Weatherization improvements are energy efficiency measures such things as insulating walls and ceilings, installing programmable thermostats, and replacing inefficient machinery. The net result is that less energy is used, while the overall costs needed for energy are reduced as well. Energy efficiency improvements typically have a cost, but the payback periods will vary depending upon the cost of the improvement and the amount of energy that is saved.

2. Replacing traditional fuel sources: The 90x205 model replaces traditional fossil-fuels with electricity, which can come from clean renewable sources like hydro and solar. Fuel switching primarily occurs by providing residential heating units with heat pumps, but efficient wood burning systems (like wood pellet furnaces) and bio fuels play an important role as well. Fuel switching also occurs by gradually replacing fossil-fuel burning automobiles with EVs. 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. Even if the region's population grows and the economy expands, overall energy use declines because of efficiency and electrification.[14]

Regional end-use models (Figures 2.5 through 2.8) are derived from two scenarios:

1. The "**reference" scenario** assumes a business-as-usual continuation of today's energy use patterns but does not reflect the Vermont's renewable portfolio standard or renewable energy or greenhouse gas emissions goals. The main changes over time in the reference scenario are more fuel-efficient cars because of CAFE standards.

[14] Vermont Energy Investment Corporation: NVDA Modeling, Summary Results and Methodology

2. The “**90% x 2050 scenario”** is designed to achieve the goal of meeting 90% of Vermont’s total energy demand with renewable sources.

What follows below shows 2015 usage according to the reference scenario, and then displays energy use from subsequent years based on the 90x2050 scenarios. “Avoidance” is the energy that is no longer needed because of aggressive weatherization, efficiency upgrades, and fuel switching.

Residential and Commercial Heating by 2050

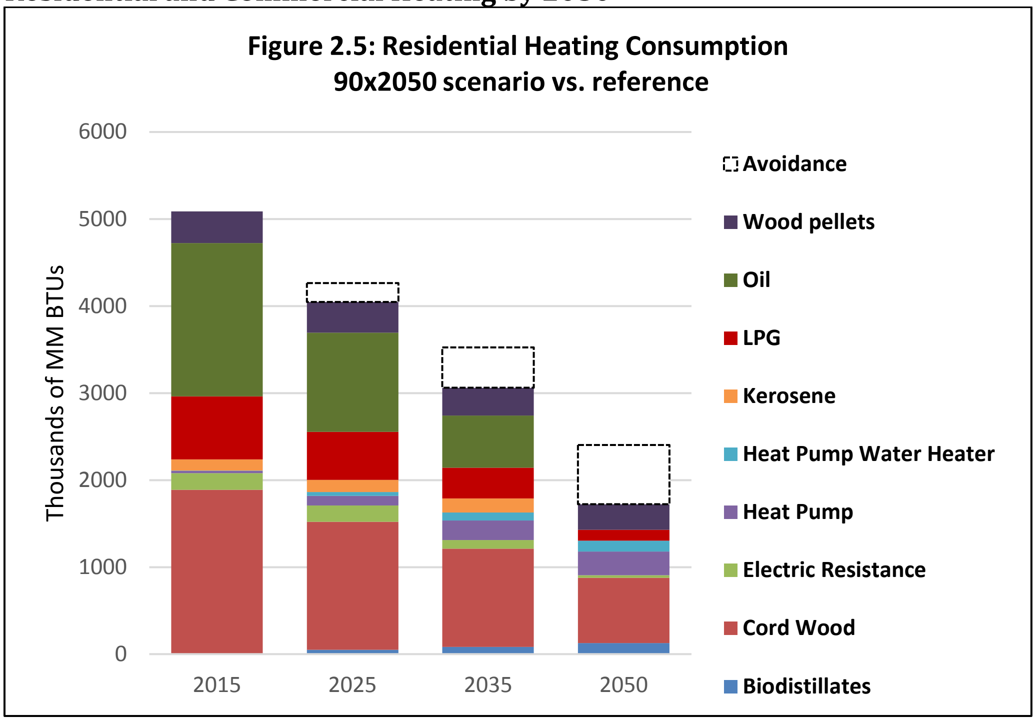


Figure 2.5: Residential Heating Consumption 90x2050 scenario vs. reference

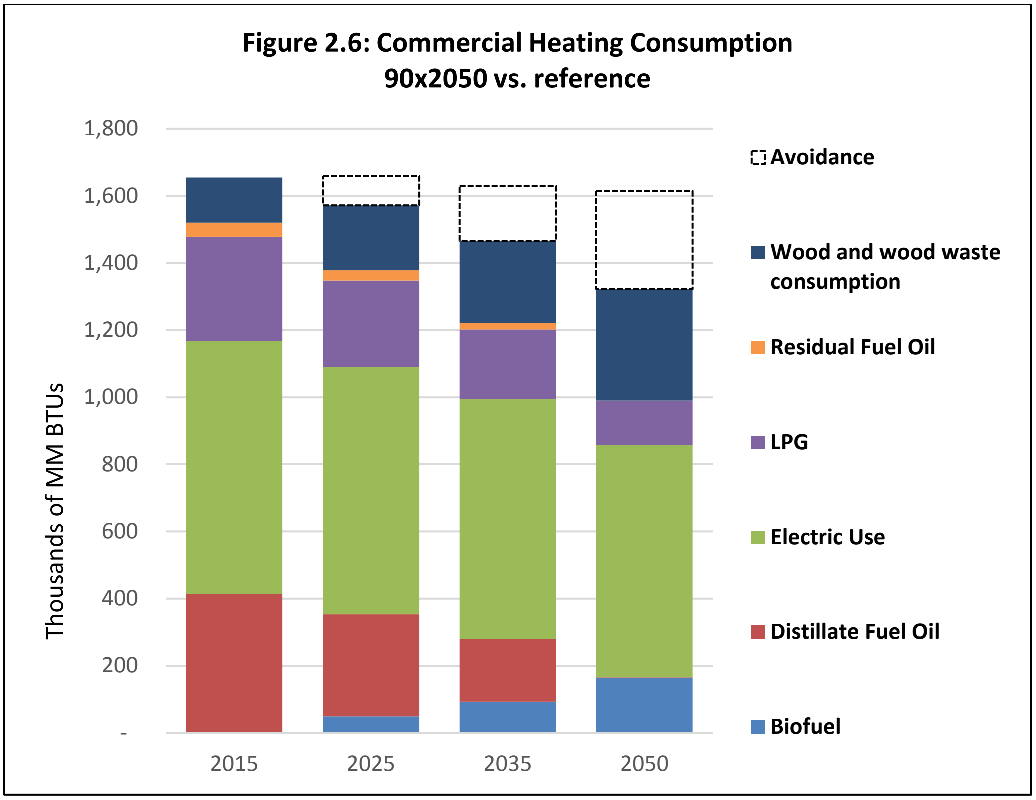


Figure 2.6: Commercial Heating Consumption 90x2050 vs. reference

Residential demand was based on counts of housing units from American Community Survey and assumed a constant population growth rate of 0.21%, based on calculations from Vermont Population Projections 2010-2030. Residential demand also assumed that household size would decrease from 2.4 in 2010 to 2.17 in 2050. (More about the declining household size can be found in NVDA's Housing Plan.)

Projected change in the energy demand from the commercial sector was based on commercial sector data in the Total Energy Study, which showed commercial building square footage growing by almost 17% from 2010 to 2050.

In these scenarios, the use of electricity for residential heating nearly doubles. This increase offsets a slight decrease in electricity for the commercial sector, where wood and wood scraps and biofuels play a more significant role. Neither estimate accounts for the use of solar in water heating. According to the Vermont Renewable Energy Atlas, there are nearly 40 solar powered water heating systems in the Northeast Kingdom.

Table 2.16 establishes weatherization and fuel switching targets in support of the 90x2050 targets for residential and commercial heating in the Northeast Kingdom. These targets were developed with assistance from the Department of Public Service using the assumptions from the regionalized model from VEIC.

Table 2.16: Weatherization and Fuel Switching Targets for the Northeast Kingdom

By Year	2025	2035	2050
Estimated number of households	28,050	30,044	32,180
% of households to be weatherized	22%	35%	60%
# of households to be weatherized	6,073	10,568	19,323
Estimated number of commercial establishments	1,571	1,692	1,822

% of commercial establishments to be weatherized	5%	8%	14%
# of commercial establishments to be weatherized	75	130	248
% of households with efficient wood heat systems (e.g. pellet furnaces, stoves)	56%	43%	31%
# of households with efficient wood heat systems	15,648	12,863	9,992
% of households with heat pumps	17%	14%	31%
# of households with heat pumps	4,642	9,814	13,352
% of commercial establishments with efficient wood heat systems	15%	17%	22%
# of commercial establishments with efficient wood heat systems	229	291	401
% of commercial establishments with heat pumps	6%	10%	13%
# of commercial establishments with heat pumps	87	162	239

These projections assume a constant increase in the number of housing units and commercial establishments of about 0.6% and a weighted average heat load derived from existing municipal-level energy consumption estimates from by NVDA. (See Appendix B for a full explanation of municipal estimates.) Weatherization targets assume an average savings of 25% for residential heat load and 20% for commercial heat load.

Targets in Table 2.16 use methodology from the Department of Public service. Overall efficiencies achieved through the use of heat pumps (particularly in the residential sector) will reduce the use of supplemental heat. Nevertheless, we anticipate a continued need for efficient wood heating systems, particularly in older structures with multiple heating zones. The commercial sector is less likely to see a reliance on heat pumps, partly due to the relative lack of commercial development pressure in the region, not to mention the fact that a number of commercial establishments are already using efficient biomass systems.

Electricity use is expected to increase dramatically by 2050 so demand-side management and upgrades, such as hardwiring, lighting fixtures, and appliances is also an important part of this scenario, especially since electricity is replacing other fuel-burning thermal applications. Table 2.17 establishes targets for electrical equipment upgrades.

Table 2.17: Electrical Equipment Upgrade Targets for the Northeast Kingdom			
By Year	2025	2035	2050
Estimated number of customers	41,551	44,055	46,487
# of customers to upgrade equipment	10,769	16,923	24,808
% of customers to upgrade equipment	26%	38%	53%

This estimate assumes an average savings of 400 kWh per project and assumes a projected number of customers by multiplying the number of housing units by 1.5 (to account for multi-units and non-residential customers.

Table 2.18 provides some historical data on weatherization, fuel-switching, and equipment upgrades accomplished to date. Measures that achieve thermal savings and electrical efficiency are often inextricably linked because they have *interactive* effects. For example, the installation of a cold climate heat pump may produce thermal savings, but it may also increase electrical use because it is replacing a fuel-oil system (thus making demand-side management critical). Also, in industrial settings a switch from incandescent bulbs (which emit a substantial amount of heat) to LED bulbs (which emit very little heat) can actually require additional energy to heat the space. A heat pump water heater in a finished basement collects heat from the space and delivers the heat to the water, meaning the basement requires additional heat.

Individuals and businesses can access a variety of resources, both public and private, for services ranging from energy audits to financing to contracting. Local energy committees have led successful campaigns to replace lighting with LED bulbs, encourage the purchase of Energy Star appliances, and educate consumers about incentives for more efficient options such as heat pumps. Additionally, improvements to battery storage may reduce peak demand. The development and use of real-time monitoring technology will also make customers more efficient users of electricity.

Table 2.18: Efficiency Measures by Count in the Northeast Kingdom

	2014		2015		2016		Total	
	Res.	C & I	Res.	C&I	Res.	C&I	Res.	C&I
Air Conditioning Efficiency	63	81	90	196	71	28	**224**	**305**
Compressed Air	0	57	0	10	0	12	**0**	**79**
Cooking and Laundry	323	1	265	76	244	0	**832**	**77**
Design Assistance	0	29	0	12	0	9	**0**	**50**
Health and Safety	9	0	12	0	8	0	**29**	**0**
Hot Water Efficiency	1,059	9	696	4	617	8	**2,372**	**21**
Hot Water Fuel Switch	1	0	0	0	0	0	**1**	**0**
Hot Water Replacement	2	0	2	2	2	0	**6**	**2**
Industrial Process Efficiency	0	40	0	8	0	15	**0**	**63**
Light Bulb/Lamp	70,113	14115	61,755	17,859	51,767	16,837	**183,635**	**48,811**
Lighting Efficiency/Controls	38	800	2	722	20	144	**60**	**1,666**
Lighting Hardwired Fixture	3,886	4185	5,030	6,764	4,484	7,139	**13,400**	**18,088**
Motor Controls	3	21	0	57	1	22	**4**	**100**
Motors	229	0	243	3	387	1	**859**	**4**
Office Equipment, Electronics	1,773	34	1,492	0	751	1	**4,016**	**35**
Other Fuel Switch	0	0	0	5	0	0	**0**	**5**
Refrigeration	461	129	320	317	238	83	**1,019**	**529**
Space Heat Efficiency	162	9	116	14	129	7	**407**	**30**
Space Heat Fuel Switch	27	1	27	6	19	5	**73**	**12**
Space Heat Replacement	4	10	43	38	113	9	**160**	**57**
Thermal Shell	225	1	152	11	156	7	**533**	**19**
Ventilation	194	93	66	88	32		**292**	**181**
Water conservation	0	0	0	1	0	1	**0**	**2**
Source: Vermont Energy Investment Corporation								

Transportation Energy Use by 2050

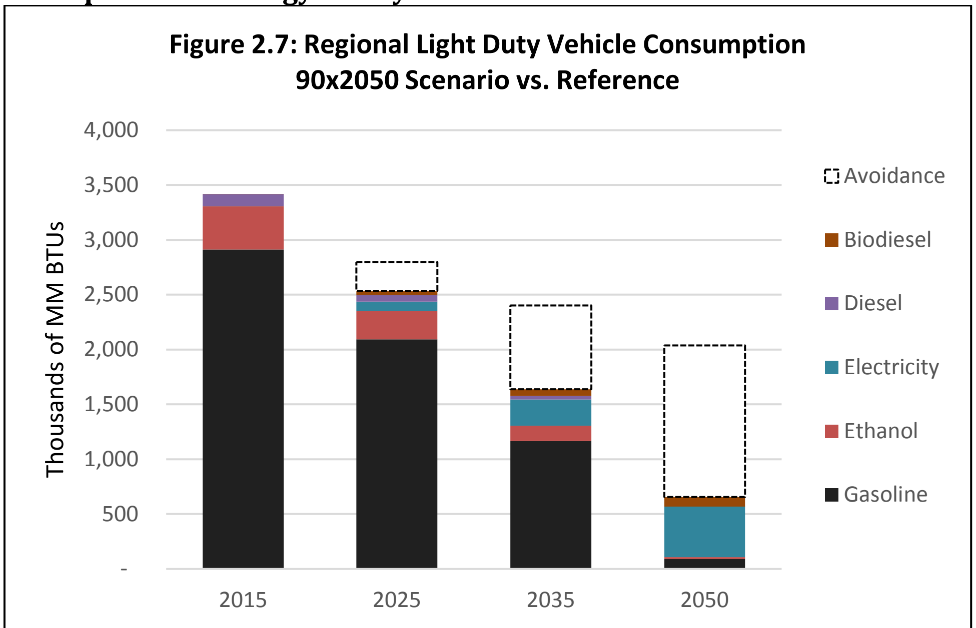


Figure 2.7: Regional Light Duty Vehicle Consumption 90x2050 Scenario vs. Reference

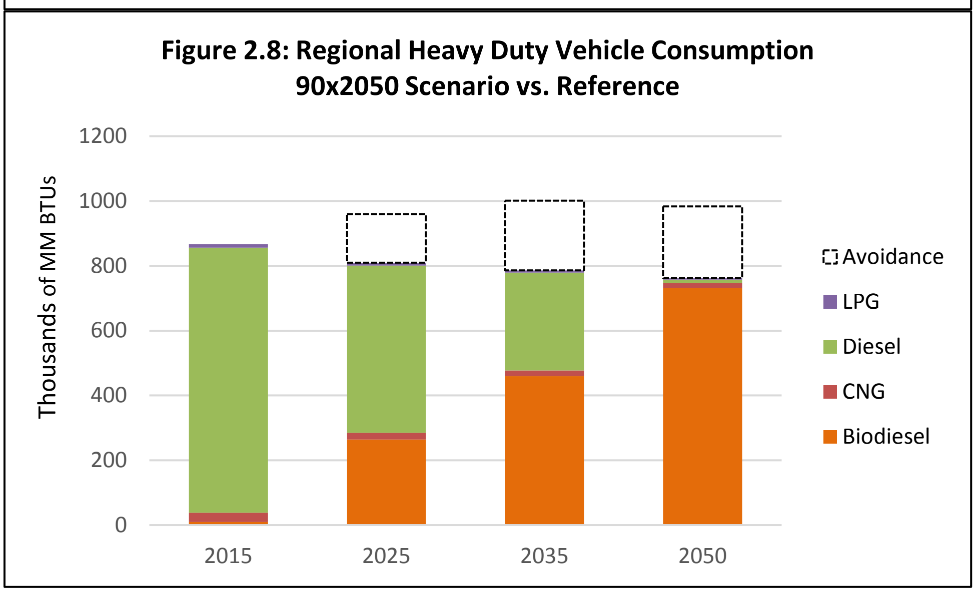


Figure 2.8: Regional Heavy Duty Vehicle Consumption 90x2050 Scenario vs. Reference

Biodiesel, which is currently being sources from oilseed grown in the Northeast Kingdom, is the most significant agent of change in use among heavy-duty vehicles and farm equipment. Among light-duty vehicles (LDVs), the gradual conversion from fossil fuel to EVs is expected to have a dramatic impact on electricity use in the Northeast Kingdom. These estimates assume gradual gains in fuel efficiencies from 3 miles per kWh to 4 miles per kWh, which helps to reduce total energy use by more than two-thirds from 2015 levels, even though the number of light duty vehicles on the road increase. In 2050, end-use electricity consumption in LDVs increases by more than 153 times, or more than 15,000%.

Clearly, the switch to EVs in the rugged Northeast Kingdom is a tall order, requiring significant investment in charging infrastructure, not to mention performance improvements on steep terrains and in cold temperatures, battery storage, and affordability. Table 2.19 uses vehicle counts from American Community Survey to identify targets for achieving fuel switching goals for LDVs.

Table 2.19: Fuel Switching Targets for Light-Duty Vehicles in the Northeast Kingdom			
By Year	2025	2035	2050
Estimated number of light-duty vehicles	53,153	56,874	60,855
# of EVs	5,618	17,937	38,603
% of LDVs	11%	32%	63%

V. ENERGY RESOURCE ANALYSIS AND RECOMMENDATIONS

The 90x2050 projections – which will nearly eliminate the use of fossil fuels—will require transferring many of our uses to electricity. Therefore, even while electrical systems, appliances, and vehicles will likely continue to increase in efficiency, 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 as well.

90x2050 projections indicate that residential non-thermal electrical use alone could exceed 614,000 MWh by 2050. Additionally, conversion to light-duty EVs could require more than 135,000 MWh over that same period. Understandably, these projections counter earlier regional estimates, which showed only modest increases in regional electrical consumption to 462,353 MWh by 2020.[15] It is important to remember that the 90x2050 projections incorporate sweeping and long-range changes to the way we live and work.

Where – and how -- would energy generation occur? In support of the 90x2050 goals, each region has a set of generation targets. Because our region already generates a disproportionate share of energy relative to our low population, the Northeast Kingdom's new generation targets are the lowest in the state. (Table 2.19) While generation targets can be met through a variety of renewable technologies, the Northeast Kingdom does not have any generation targets specific to wind. Nevertheless, great care and consideration shall be given to the siting of new generation.

Table 2.19: In-state Generation Targets	
Regional	New MWh
Addison	172,978
Bennington	293,182
Central Vermont	418,530
Chittenden	845,236
Lamoille	185,927
Northeastern	18,680
Northwest	260,438
Rutland	439,276
Southern Windsor	194,612
Two Rivers	396,631
Windham	97,716

Policy Statements

This region has a responsibility to plan for adequate supply of energy to meet local energy demand. Planning activities may include the production, storage, siting, and distribution of energy. Individuals, businesses, organizations, and communities are encouraged to explore emerging energy supply, efficiency, and net-metering opportunities that meet accepted environmental standards in order to satisfy their power demand.

New industrial/utility energy development shall meet the highest standards required by law. Permitting authorities shall first consider current and historical land use and the culture of the region, community opinion, economic benefit, as well as the land owner's rights. Any development shall to the extent possible be done so as to mitigate adverse impacts to the region. Any utility-scale energy generation project deemed acceptable by the Public Utility Commission shall

[15] NVDA Wind Study Report, March 26, 2015

include a plan for distributing benefits to the towns in the region proportional to the adverse effects experienced by that town. Long term maintenance, safety issues, decommissioning, and land reclamation procedures required at the end of the energy project's life must also be included in the project plan.

This plan aims to balance environmental quality and important natural resources with energy production. Significant local and regional support and clearly demonstrated benefits should exist in any energy proposal. This is especially relevant when siting commercial- or utility-scale wind facilities, which could have impacts on neighboring communities. "Commercial" and "utility" are defined in this plan as:

Commercial-scale: facilities with a capacity of more than 10 kW (which would be considered residential), but less than 100 kW. These structures typically have a height of just over 120 feet. (The wind tower at Burke Mountain is 123 feet high.) These structures are referred to as "business-scale" in the Vermont Renewable Energy Atlas.

Utility-scale: Wind turbines with a capacity of 1MW or more. These structures are referred to "commercial scale" in the Vermont Renewable Energy Atlas.

The region has recently experienced a sharp increase in the number of renewable energy applications which will worsen already congested transmission, particularly in the Sheffield-Highgate Export Interface (SHEI), where several existing generators are frequently curtailed by the ISO. While NVDA encourages appropriately scaled renewable energy development, NVDA has a commitment to ensure that such development is sustainable and feasible and does not merely substitute one renewable resource with another. NVDA supports energy development that will not exacerbate curtailment at issue within the SHEI. It is unlikely that any single solution will solve congestion within the SHEI and, as such, it is anticipated that incremental progress will be achieved as partial solutions are implemented. In the meantime, NVDA will support projects that are consistent with the land use and conservation measures in this plan and in duly adopted plans of impacted municipalities. Additionally, we will expect project developers to work with utilities and other stakeholders to explore innovative strategies that shift generation away from the hours when generation exceeds load within the SHEI area or otherwise avoids exacerbating congestion on the grid. An example of such a project would pair a battery with a solar facility to control when the project's power is exported to the grid. In determining support for such a measure, NVDA will seek guidance from the long-range Transmission Plan and Integrated Resource Plans in the region and will consult with utilities, VELCO, and other stakeholders.

Siting Potential

This plan is accompanied by a series of maps (Appendix C) that can assist in the process of identifying potential areas for siting and quantifying generation output. Underlying assumptions were made about suitability factors, such as slope and direction of land, elevation and wind speeds, and access to three-phase power. Additional statewide layers identified *known* constraints and *possible* constraints, and a third layer has identified *regional* constraints:

Known constraints are areas not likely to be developed for renewable energy because they contain one or more of the following: vernal pools; river corridors; FEMA floodways; significant natural communities; rare, threatened and endangered species, national wilderness areas, wetlands (Class 1 and Class 2).

Possible constraints are areas that would likely require mitigation because they contain the one or more of the following: agricultural soils; special flood hazard areas (outside of the floodway); protected (conserved) lands; deer wintering areas; Act 250 mitigated agricultural soils; hydric soils, and highest priority forest blocks.

Regional constraint: NVDA's regional plan has long held that rural areas should receive very little commercial or industrial development unless it occurs in an established industrial park, or in an area specifically designated in the local bylaw or plan as being well suited to such uses. Lands with an elevation of 2,000 feet or more merit consideration as a special class of rural lands that should be protected from any large-scale commercial or industrial development characterized by a constructed height of 100' or more, and an acre or more of permanent site disturbance, such as clear-cutting. These lands, as indicated on attached siting potential maps, contain one or a combination of factors that make them unsuitable to such development – contiguous forest cover; sensitive wildlife and plant habitat; conservation lands and recreational assets; managed forestland; and headwaters and ephemeral surface waters, which are highly vulnerable to erosion and man-made disturbance. This high-elevation forest cover must be kept unfragmented for the attenuation of flood flows, the benefit of wildlife habitat and linkage, and public enjoyment through passive recreation.

The maps accompanying this plan do not carry the weight of zoning, and the siting of renewables on prime acreages (i.e. without known constraints) is not a foregone conclusion. Rather regional maps should be viewed as a starting point for our member municipalities to determine suitable and unsuitable locations for renewable energy development. This plan's siting considerations for each specific energy technology on the following pages should not be considered exclusive. They too should be seen as a starting point for creating effective local specification and constraints.

Our estimates for potential generation outputs are therefore deliberately conservative to account for the designation of local siting constraints. In most instances, only ***prime*** acreage (areas with no constraints at all) were used to calculate output potential. Even with a highly conservative estimate, potential generation vastly exceeds the regional generation target. This plan strongly encourages municipalities to conduct additional site investigations to identify local constraints (as well as preferred sites in addition to existing statewide preferred sites) in order to address the environmental, aesthetic, civic, economic, and cultural concerns unique to each community.

Table 2.20: Estimated Potential Energy Generation in the Northeast Kingdom		
	MW	**MWh**
Residential rooftop solar generation	15.0	18,412.2
Small commercial rooftop solar generation	3.0	3,343.2
Large commercial rooftop solar generation	5.9	7,225.9
Ground mounted solar	652.6	800,340.3
Wind (residential scale only)	13.6	23,405.2
Methane Digesters	430.0	2,260,080.0
Hydro	2.9	10,238.6
Total Generation	1,123.0	3,123,045.4

Solar

Total output potential:	**829,321.6 MWh**
Rooftop assumptions:	NVDA assumed one out of every 10 residential structures (including seasonal, many of which are inhabited part-time year-round). The region has relatively few commercial structures, so NVDA determined small commercial suitable for solar (less than 40,000 sq. ft.) for solar to be 10% of all commercial structures, and large commercial

	structures suitable for solar (more than 40,000 sq. ft.) to be just 3% of all commercial structures. The number of commercial structures was determined with NAICS classification counts used for determining commercial thermal energy use. (See Appendix B.)
Ground mounted assumptions:	Approximately eight acres of land are required to produce one MW of solar energy. In order to account for contingencies (property owners not interested in leasing their land, interconnection costs that may be too high, and unsuitability of specific sites) NVDA estimated only 1MW for every 60 prime solar acres. Acres with possible constraints were not included in the calculation.

Overall solar resources in Vermont are quite good, and solar energy can be harnessed effectively for primary and secondary energy needs. The two main types of solar energy systems are photovoltaic (PV), which generates electricity, and solar thermal, which generates hot air or hot water for water and/or space heating. For some homeowners in our region, solar electricity systems have proven more cost effective than extending power lines to the home. A typical off-grid system consists of photovoltaic (PV) modules that convert solar energy to electricity, batteries that store the electricity (if off-grid), and an inverter that converts DC power to AC for use in conventional electric appliances. As a rough rule of thumb, a 1 kilowatt photovoltaic system can be expected to produce 3-3.5 kWh/day on average in Vermont.

Solar water heating systems typically utilize collectors to capture the sun's energy, a pump to circulate a solution through the collectors to extract heat energy, and a well-insulated storage tank to hold the heated water for use as needed (this can be integrated with an existing water-heating system). An appropriate size solar water-heating system can provide one-half to two-thirds of a household's annual hot water needs – typically 100% in summer, but as little as 25% in winter. In Vermont, these types of systems tend to pay themselves off in less than two decades.

Solar energy can also be harnessed through passive solar design (day-lighting and space heating) with Green Building Design. This includes orienting buildings close to true south, as well as using appropriate windows on the south wall, installing thermal mass (brick, concrete, or water) to store the sun's energy, and using appropriate levels of insulation. Through these designs, as much as 60% of a building's space heat can be derived from the sun. This type of heating is termed "passive solar" because no moving parts are needed, the collection and storage system is built into the structure. Green Building Design principles also attempt to maximize the amount of natural light a building receives, in order to reduce the energy costs associated with daytime lighting.

Active and passive solar systems are custom built based on the building site, building and purpose of the solar system. There are many factors that bear on siting solar systems. Many homes and businesses have good rooftop sites, or good sites nearby for ground mounted systems. Unfortunately, some do not, such as properties where there is limited southern exposure. One way to address this situation is through the development of "community-sized" PV projects or co-operative systems on the order of a few hundred kilowatts up to a few megawatts. There are a number of community solar sites in our region, which also allow renters and homeowners where rooftop solar will not work to take advantage of solar by "sponsoring" an off-site panel. Utility-scale PV developments are also becoming popular in other areas of the U.S. Often referred to as solar parks, farms, or ranches, these utility-scale PV installations are designed for the sale of merchant power (MWh) into the electric grid and can utilize several acres of land. Public concerns surrounding solar installations of this size usually focus on aesthetics and transmission line development.

Siting policies for solar:

- NVDA has determined that the following types of locations in the region should be prioritized for future solar generation. Even though these locations are not shown on the regional solar maps due to a lack of GIS data, these sites should be considered "preferred locations" for siting solar:

- Rooftops of structures, residential and commercial. (Our conservative estimates show the region's total potential output from rooftop solar alone could amount to 23.9 MW, or 6.3% of the high end of the LEAP model projections for solar for 2050 of 377.2 MW).
- Brownfield sites not located in a designated downtown or village center
- Earth extraction sites (e.g. gravel pits, quarries), active or abandoned
- Parking lot canopies and surface parking lots
- Farms, where more than 50% of the power generated is used by the farm
- Industrial parks, where more than 50% of the power generated is used by the tenants of the industrial park
- Undersized lots and otherwise undevelopable land in existing industrial parks

- The Northeast Kingdom has a robust agricultural economy, and NVDA discourages siting ground-mounted solar in a manner that fragments productive agricultural soils, effectively removing farmland from production for decades. To this end, NVDA encourages municipalities to explore and identify local constraints that minimize farmland fragmentation. These measures may include agricultural overlays (regulatory), as well as conservation easements (non-regulatory). A number of land exploration tools, such as land evaluation and site analyses (LESAs) can help municipalities prioritize agricultural lands for protection. NVDA will assist local planning commissions to identify local constraints as appropriate.
- Notwithstanding the above concern, NVDA recognizes that successful integration of solar into active agricultural uses can help farms reduce expense, generate extra income, and remain viable. NVDA encourages on-farm solar that, to every extent feasible, uses existing farm structures, or is sited in a manner that supports grazing, the establishment of pollinator crops, or simply to create buffers between organic and non-organic production areas. NVDA will showcase best on-farm generation practices in the region and will cite "Guide to Farming Friendly Solar," produced by the Two Rivers Ottauquechee Regional Planning Commission, as a vital resource.

Wind

Total output potential:	**23,405.2 MWh**
Assumptions:	In accordance with Act 174 guidelines published in March of 2017, regional plans are allowed to submit plans to the Department of Public Service that do not establish targets for utility scale wind. This is especially important for the Northeast Kingdom, which has no targets for wind generation due to the existing level of production. When accounting for NVDA's regional constraint, the balance of prime wind acreages is just over 38,000. We estimate that new generation will be primarily farm- and residential-scaled. Even though no significant acreage is required for a farm- or residential scaled turbine, NVDA's estimate

	assumed a contingency of 1 turbine for every 25 prime acres, with an average capacity of 9.5 kW. Some towns have no prime acres. For these towns, we assumed a broader contingency of 1 turbine every 75 acres. The purpose of the contingency was similar to that of solar: to account for property owners not interested in leasing their land, prohibitive interconnection costs, and unsuitability of specific sites (including neighbor objections.

Wind energy has recently been on the forefront of the renewable energy movement. The U.S. Department of Energy has announced a goal of obtaining 5% of U.S. electricity from wind by 2020, a goal consistent with the current rate of growth of wind energy nationwide. Vermont is currently ranked 34th out of the lower 48 states for wind energy potential.

The Northeast Kingdom, the region that the NVDA serves, has considerable experience with utility-scale wind turbines. Caledonia County is home to First Wind's Sheffield turbines. Green Mountain Power's Kingdom Community Wind turbines are located in Lowell (Orleans County). Three additional projects were proposed, but not carried out: The East Haven Wind Farm (Essex County), Seneca Mountain Wind (Caledonia and Essex Counties), the Encore Redevelopment project in Derby (Orleans County). It follows that the NVDA's Board of Directors has become quite familiar with arguments both for and against industrial wind complexes.

The siting of wind turbines has raised concerns about aesthetic impacts, erosion, water quality impacts, noise, land scarring, and effects on wildlife, property values, public health, and local economic drivers, such as tourism. Because of our region's mountainous terrain, the ideal location for utility-scale wind turbines is on North-South oriented ridgelines with elevations between 2000 and 3500 feet above sea level. Each utility-scale tower can range in height from 135 feet to 500 feet tall, requiring specified FAA lighting for towers over 200 feet. For purposes of this plan, smaller non-utility scale wind systems are defined as turbines under 200 feet in height, including the length of the blades. Larger (utility-scale) ridgeline generation facilities may contain as few as 1 to as many as 40 or more turbines. Because of the variations in wind speed, the output of a wind facility is considered intermittent power, and the energy generated is generally 20-30% of what a conventional power generation facility of the same rated peak capacity would produce. Wind speeds need to be within an optimum range specific to the tower technology. If any wind speeds or gusts are registered over the optimum range the wind tower is usually shut down for safety purposes.

Siting policies for wind:

- The NVDA has first-hand experience with the divisiveness that accompanies wind projects and the damage that the projects visit upon communities. In 2012, the NVDA Board of Directors voted 39 to 3 in favor of a resolution calling for a suspension of development of new industrial wind projects in the region. The Board called for the formation of a committee to study industrial wind energy in the region and develop findings and recommendations. The committee's findings and recommendations would be reviewed by the NVDA's Executive Committee and then by the full Board of Directors. As a result of this effort, the NVDA has developed the following position on industrial wind energy:

  "The NVDA sees one clear benefit to industrial wind energy, one clear problem, and a host of troubling questions. The clear benefit is the tax relief that industrial-scale wind turbines bring to their host towns. The clear problem is the bitter divisions that wind brings to our communities. The troubling questions involve the unreliability of wind energy, the amount of energy produced versus the social and environmental disruption, the costliness of the electricity, and the dubiousness of the claims of environmental benefit. We are even more troubled by the potential impacts on human health, essential wildlife habitat, water quality, aesthetics, property values, and our tourism industry. We are also

troubled by the state's energy policies, the state's permitting process, and the ease with which the public good as expressed in our municipal and regional plans can be overridden by people who may never have even visited our region.

It is the position of the NVDA that no further development of industrial-scale (sic[16]) wind turbines should take place in the Northeast Kingdom.

- Existing small turbines in the region are sited in very low-density areas and on farmland. NVDA strongly urges municipalities to consider density in their specifications, as even small wind turbines can produce noise that is incompatible with many residential areas. This can be established through the use of noise ordinances or through required distances from nearby residential uses, as specified in a locally adopted municipal plan with Substantial Deference.

- The Northeast Kingdom has no new generation targets for wind due to the large amount of energy generation currently coming out of the region. In keeping with the policies and recommendations in the Land Use Plan, the regional wind generation maps in Appendix C do not show many wind generation areas with high generation potential. This is due to the existence of known constraints, including upland areas of 2,000 ft or more, headwaters, forest coverage of site class 1, 2, or 3, priority forest habitat blocks, and state natural areas and fragile areas.

Hydro

Total output potential:	**10,238.7 MWh**
Assumptions:	NVDA's analysis takes into account only existing dams not being accessed for hydropower. Generation information comes from a 2008 Agency of Natural Resource study of small hydropower resources.

Existing hydro-power facilities in the Northeast Kingdom collectively produce more than 118,000 MWh annually, accounting for more than 18% of our regional generation. (Table 2.13) The three Connecticut River Dams, though not considered part of our regional generation, are three of the largest hydro facilities in the Northeastern U.S. Together the Moore, Comerford, and McIndoe Falls Dams produce an additional 638,000 MWh of electricity annually (double what the region consumes).

Hydro facilities can be a good source of base-load power when regular rainfall is received. For river-run facilities, power generation is dependent upon continuous levels of rainfall and must run when the flow is at optimum levels. This can mean producing electricity when it might not be needed. Dams, on the other hand, have the advantage of storing their resource for later use. Unfortunately, drought can severely limit the production capacity of dams as well. Hydro power facilities can also alter the ecosystem of a waterway. Both reservoir and river-run systems can increase water temperature, decrease water speed, limit oxygen and increase nitrogen levels, and alter riparian areas. These changes to the ecosystem cause stress to fish populations and riparian-habitat wildlife[17]. Today, new hydro facility design and upgrades are engineered to mitigate or lessen negative impacts on the ecosystem.

Overall hydro-power is considered a long-term resource and is relatively secure and stable. Generation costs for hydropower vary considerably between facilities. Many of the facilities in the

[16] The language regarding "scale" of renewable energy development has since evolved. For all intents and purposes the preferred term is "utility-scale," although in context of the 2012 wind study, the terms "industrial" and "utility" may be used interchangeably.
[17] Foundation for Water Energy and Education

region were built in the early 1900's and have needed significant upgrades over the years. Upgrading existing hydro and permitting new hydro can prove to be very costly and consequently raises the production costs for the facility.

Siting policies for hydro:

- While this energy source is renewable, the ability to create new hydro-power generation is limited. Some of the best hydro resources in the region are already generating, while permitting new facilities has been a long and difficult process. At this time, facilities in other regions of the state are facing some significant challenges in relicensing. Our focus for regional hydro-power should be focused on maintaining our existing generation infrastructure, upgrading aging infrastructure, and improving safety standards. The development of new facilities should be pursued where practical.

Methane

Total output potential:	**2,260,000 MWh**
Assumptions:	NVDA's estimate used the Farm to Plate Atlas for a count of dairy farms in the region. The waste from 4 to 6 cows can produce about 1 kW of energy. On-site systems were only considered, so farms known to have small herds were excluded from the estimate. Because digesters are a significant investment in equipment and maintenance, NVDA assumed a contingency of about 1 in every 8 farms.

Methane, a common gas found in the environment, can be burned to produce electricity. Large amounts of methane are produced through the anaerobic digestion of manure, agricultural wastes, and other organic wastes. Both large farms and landfills offer the best potential to utilize this resource. The only large-scale landfill in the region is already being utilized for methane generation, but there are at least 20 dairy farms with enough capacity to sustain a manure-methane generation facility. In agricultural practices, manure is collected in various containment systems, where it can be heated up for methane gas production and collection. The remaining manure by-product can be spread on fields as fertilizer, the dry solids can be used for animal bedding, and the excess heat can be used for other purposes such as greenhouse heating.

In agricultural practices, the procedure also destroys harmful pathogens, reduces water quality impacts, reduces manure odors, and provides a new source of income to local farmers. The Blue Spruce Farm in Bridport, Vermont was the first farm in the state to develop a manure-methane generation system. In the Northeast Kingdom the Maplehurst Farm, Maxwell Farm, and Chaput Family Farms have installed anaerobic digester systems and collectively produce more than 4,500 MWh annually. All three are enrolled in the Standard Offer program, which offers long-term fixed prices for generation without having to go through the program's reverse auction process.

Food scraps and food residuals (byproducts from processing) can also be used to produce energy in a similar manner. The expansion of the region's agricultural processing sector, paired with Act 148's mandatory diversion of food scraps from the waste stream, creates additional opportunity to generate energy. Research with food waste is already underway at Vermont Technical College, but additional exploration is needed to make this feasible here in the NEK.

Siting policies for methane:

- Manure methane generation should be expanded in the region's energy mix. As with farm-friendly solar generation, manure methane generation may protect the viability of working farms by reducing production expense and generating extra income for the farmer. NVDA encourages municipalities to identify potential production sites in their plans and provide appropriate guidance for siting with regard to screening, noise, and odors.

- Existing on-site technologies are costly and only make economic sense for larger farms. (In Europe, central methane digestion systems do allow smaller farmers to process animal wastes, but trucking is involved.) Emerging technologies in Europe may prove to be more cost-effective for smaller farms. NVDA encourage the ongoing use state and federal grants, tax credits, incentives, and technical assistance to combat the high start-up costs of methane generation for the region's farmers.
- NVDA should work with the region's food system leadership group, as well as other proponents of the Regional Food System Plan, to ensure that the region's agricultural producers have access to technical services, grants, and other incentives to refine and maximize digester technologies.
- Food scraps and residuals may play a role in the region's energy generation portfolio as well. NVDA supports energy recovery that supports the highest and best use of waste materials, namely the food recovery hierarchy that prioritizes the reduction of waste. This policy is consistent with NVDA's Utility and Facilities Plan.

Biomass

Biomass has significant potential to reduce the region's fossil fuel consumption. The majority of our fossil fuel consumption is for transportation and home heating uses, only a small portion of fossil fuels are used in electricity generation for the region. Wood chips, wood pellets, and biodiesel hold the greatest potential for Vermont to transition these uses towards renewable energy. The expansion of these resources will also offer strong support for our traditional economy (forestry and agriculture) and stabilize regional fuel costs. In the next few years, biomass usage should be promoted and expanded as a significant resource to diversify the region's energy portfolio and meet future energy needs.

The region already supports a large-scale wood-chip fueled electric generation facility. The Ryegate Power Station is the second largest electric generation facility in the region. Capable of generating 172,367 MWh annually; the plant operated at 100% capacity in 2009, but was idle in the spring of 2012. New power purchase agreements have been drafted and the plant resumed production in June 2012. Ryegate Power Station is a good example of the difficulties in making an electric-only wood generation plant profitable and competitive. Overall, the ease of handling, local availability, low emissions, and general low-costs of wood resources will allow the region an opportunity to expand this resource if fossil fuel prices climb.

One of the most efficient uses for wood-fuels is co-generation, the simultaneous production of both heat and power, such as the system in North Country Regional Hospital that generates a third of its electric needs and heats the entire hospital. Recent studies looking at co-generation opportunities in the region indicate that it works best when there is an equal need for heat and power[18]. Balanced heat and power loads are easier to provide for on the small scale, such as for an individual business but larger plants are more desirable, since they can secure more renewable energy incentives and the capital cost/kWh improves. Large co-gen applications (10+MW) may make sense if an equally large heat user can be found, such as a manufacturer that requires tremendous heat loads. Some engineers propose developing district heating systems along with co-gen plants in areas where a considerable industrial heat user is not available. District heating systems are utilized throughout Europe and one will soon come on-line in Montpelier. Unfortunately most of Vermont's communities do not have

[10] *Town of Sutton - Burke Lumber Site Redevelopment: Wood Supply Assessment & Wood Pellet Manufacturing Facility Feasibility Study/Business Plan* (June 2009, Innovative Natural Resource Solutions for NVDA), St. Johnsbury-Lyndon Industrial Park Energy Study (2007).

the density to support nor afford the $400/linear foot installation cost district heating requires for distribution. In addition, the average connection cost for district heating is around $5,000 per homeowner. In other words, district heating is not an easy sell to tax payers.

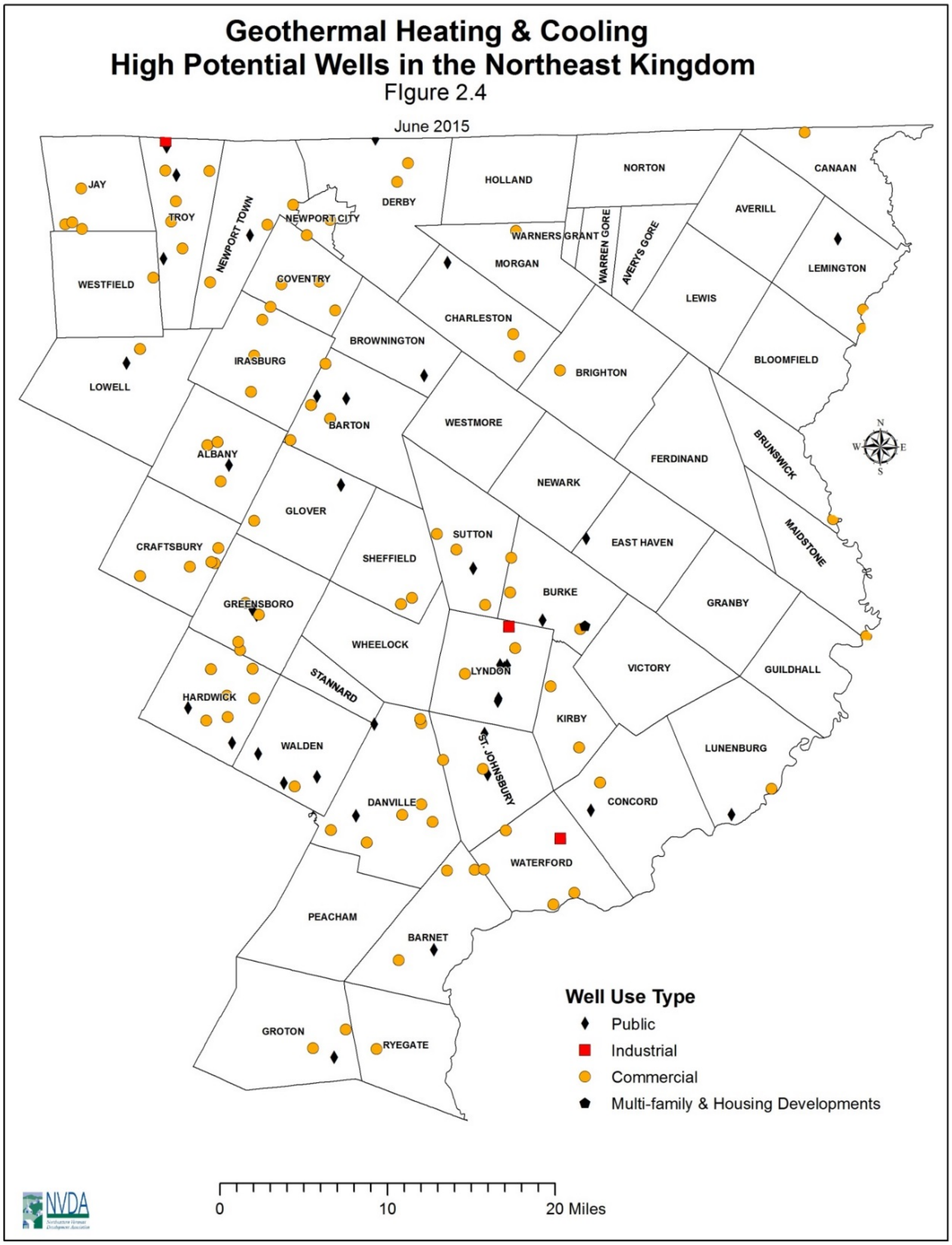
Siting policies for biomass:

- Siting wood-generation and co-generation facilities can be fraught with challenges. Noise, emissions, truck traffic, and unsightly smoke stacks are concerns when siting facilities near residential neighborhoods. Municipalities are strongly encouraged to develop performance standards for industrial uses.

- These facilities use a renewable fuel that grows at a specific rate, so overharvesting of the regional woodshed is a concern. The plan strongly urges a commitment to responsible stewardship of the region's forestry resources, accomplished through the use of forestry overlays that minimize fragmentation (regulatory), or enrollment in Vermont's Current Use Program and conservation easements (non-regulatory). A number of planning tools are available to municipalities, including forestry land evaluation and site analyses (FLESAs), that can help municipalities prioritize lands for protection. NVDA encourages local planning commissions to seek technical assistance.

Geothermal

Geothermal has great potential for expansion in the Northeast Kingdom, with the most promising systems being open-loop well systems. This technology is also one of few renewable resources that can directly reduce fuel oil consumption used for space heating and should be encouraged in both existing and new construction in the region. There are numerous sites throughout the region where geothermal can be used. (Figure 2.4)


Geothermal Heating & Cooling
High Potential Wells in the Northeast Kingdom
FIgure 2.4
June 2015
JAY
TROY
NEWPORT TOWN
NEWPORT CITY
DERBY
HOLLAND
NORTON
CANAAN
AVERILL
WARNERS GRANT
WARREN GORE
AVERY'S GORE
MORGAN
LEMINGTON
WESTFIELD
COVENTRY
LEWIS
CHARLESTON
BROWNINGTON
IRASBURG
BLOOMFIELD
BRIGHTON
LOWELL
BARTON
WESTMORE
ALBANY
BRUNSWICK
FERDINAND
NEWARK
GLOVER
MAIDSTONE
SUTTON
EAST HAVEN
CRAFTSBURY
SHEFFIELD
BURKE
GRANBY
GREENSBORO
WHEELOCK
VICTORY
GUILDHALL
LYNDON
STANNARD
HARDWICK
KIRBY
WALDEN
LUNENBURG
ST. JOHNSBURY
DANVILLE
CONCORD
WATERFORD
PEACHAM
BARNET
GROTON
RYEGATE
Well Use Type
Public
Industrial
Commercial
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NVDA

A Healthy and Sustainable Regional Food System

The food we eat has a profound impact on our region's energy use and carbon footprint. The complexity of processes and practices along every point in our food system -- from production, to processing, to distribution, to waste – has significant environmental and ecological implications, making food the number one cause of global warming.[19] Fortunately, the region's vibrant agriculture sector has helped to make Vermont a leader in access to local food. The Northeast Kingdom is the only region of Vermont to adopt a comprehensive Food System Plan, one that is built on a "soil to soil" model that seeks to localize the production, processing, distribution, consumption, and composting of our region's agricultural resources. The emerging Food System Leadership Group, is responsible for overseeing the implementation of the five-year plan. Their work can intersect with regional energy planning efforts in a number of ways, including:

The reduction of food waste: There has been a concerted effort to divert discarded food and food scraps from landfilling, as evidenced by the many schools, institutions, and municipalities that have established programs for collecting and composting food scraps. However, perfectly edible food often gets discarded as well. Food waste is a serious economic and environmental problem that persists, even in the face of rising food insecurity. Food waste is any food product that gets discarded, at any point along the supply chain: from produce left to rot in the fields, from expired foods discarded by the retailer, to leftovers scraped from dinner plates into the garbage bin. Anywhere from 25% to 40% of our nation's food ultimately goes to waste, nearly all of which ends up in landfills, where it produces methane that is 21 times more potent that CO2 as a greenhouse gas. Food waste contributes 4.4 gigatons of carbon dioxide equivalent into the atmosphere every year. If food waste were a country, it would be ranked just behind the U.S. and China as the third largest emitter of greenhouse gas emissions.[20] The NEK Food System Plan is focused on redirecting waste, both edible food to food secure populations, and food scraps and residuals to appropriate composting facilities and to digesters. The region has limited infrastructure for handling organic wastes, so a successful and efficient system will likely be a combination of trucking/hauling and on-site management.

Shared distribution and warehousing: In theory, a more localized food system reduces energy because it entails fewer "food miles" in getting the food from farm to table. Unfortunately, much of the region's agricultural product is currently distributed in and out of the region in a less-than-truckload capacity. Among the smallest of producers, the distribution system could be a Subaru. The NEK Food System Plan has identified a number of opportunities for shared distribution and storage, all of which can reduce transportation miles and greenhouse gas emissions. Coordination and oversight of these shared opportunities is needed to make this distribution system efficient.

Conservation and Regenerative Agricultural Practices: An array of practices that feed the soil can also increase the rate of carbon sequestration. While there is no single blueprint for success, a number of farmers in the region are implementing techniques such as diversified cover cropping and conservation tillage to mitigate the loss of topsoil and stem erosion. Grass farming and rotational grazing can reduce energy inputs, reduce erosion, and improve water quality as well. The NEK Food System Plan seeks to promote practices that improve environmental stewardship and overall soil health. It is imperative that farmers can access the technical assistance and resources that will help them achieve this.

[19] Paul Hawken. *Drawdown: The Most Comprehensive Plan Ever Proposed to Reduce Global Warming*, Penguin (2017)
[20] Ibid.

REGIONAL ENERGY GOALS & STRATEGIES

An adequate, reliable, diverse, and secure energy supply will benefit the region.

- Promote a diversified energy portfolio for the region.
- Support the upgrade of regional transmission systems to continue to reduce constraints.
- Support the maintenance and upgrade of existing energy generation facilities and related infrastructure.
- Encourage local responders to plan for emergency energy resources (VEM Emergency Generator Grant Program generators).

Affordable energy alternatives will be available for the region's users that decrease the region's reliance on fossil fuel.

- Assist in the development of businesses that support alternative energy use.
- Work with Tier 3 energy service providers to promote the installation of cold climate heat pumps and geothermal systems by facilitating outreach and education on their benefits.
- Partner with Efficiency Vermont and Tier 3 energy service providers to increase the use of efficient wood heat and biomass systems.
- Support the development of small-scale renewable resources, such as wind and solar, and the use of supplemental sources (wood) to stabilize energy costs.
- Promote and support rail infrastructure as a cost-effective transportation resource for the energy industry.
- Encourage and support agricultural production of biofuels and oilseed crops and explore ways to broaden access to processing infrastructure.
- Identify potential users of district heating and wood heating systems and provide assistance to communities seeking to develop them.
- Encourage the legislature to increase incentives and rebates for efficient wood heat systems.
- Provide outreach and education among vendors, contractors, and the general public through venues such as tradeshows and workshops.
- Provide communities with an analysis of potential areas that are suitable for ground source heat pumps.
- Support upgrade and trade-out programs and incentives for older, higher emission wood burning stoves and boilers.

Decrease the region's reliance on single occupancy vehicle trips and gas/diesel powered vehicles.

- Continue to advocate for better telecommunications infrastructure so employees can work from home.
- Encourage local employers to reduce VMTs through programs such as ride sharing and Go Vermont.

- Support and expand access to liquid biofuels for use in commercial vehicles and heavy equipment.
- Support and expand the use of electric powered busses and vans among the public transportation providers serving the region.
- Work with cycling advocacy groups such as Local Motion by hosting safe on-road cycling workshops.
- Provide training to local zoning and development review boards to consider infrastructure for alternative transportation in their review of site plans.
- Provide technical and grant writing assistance to local planning commissions who plan for multi-modal circulation and better connectivity with alternative transportation modes.
- Promote the use of the region's cycling infrastructure such as the Cross Vermont Trail and the Lamoille Valley Rail Trail and support the efforts of local groups who work to maintain them.
- Support municipalities and local businesses to install EV charging stations at convenient locations, such as in front of restaurants, stores, businesses, or entertainment or recreational facilities, where users would want to park for periods of two to four hours. Explore and pursue incentives to defray the cost of installation and administration so that users pay only for electricity.

Net-metering capacity in the region will be maximized.

- Encourage municipalities to become "clean energy districts" and participate in the PACE program (Property Assessed Clean Energy). This would provide consumers with options to more affordably implement grid tied renewable energy systems.
- Support solar panel safety training programs for fire fighters and first responders.

Energy efficiency and weatherization will be an integral part of the energy portfolio.

- Assist municipalities in reducing their energy costs through conservation, efficiency, and weatherization programs.
- Support and promote the Energy Action Network (EAN) energy dashboard and educate communities about its use and benefits. Support crowdsourcing on efficiency and weatherization efforts at the local level (e.g. Vermont Community Energy Dashboard).
- Support Local Energy Committee/Coordinator efforts to reduce energy consumption, improve efficiency and weatherization, and develop new generation resources.
- Encourage municipalities to conduct energy audits and weatherization programs.
- Encourage businesses to make energy efficiency investments and develop energy efficient production methods.
- Promote energy efficient building design and construction methods (e.g. Green Building Design, LEED certification, and Passive Design).
- Promote Energy Efficiency Utility program resources by making web links available on municipal/regional web sites.

- Work with partner organizations and Energy Efficiency Utilities EEUs to offer workshops and educational opportunities to businesses on efficiency in new construction, retrofits, and conservation practices.
- Identify large energy usage customers (including large businesses, manufacturing facilities, and schools) as a target audience and encourage participation in commercial and industrial EEU programs.
- Facilitate strategic tree planting to maximize energy benefits by encouraging communities to participate in the ArborDay Energy Saving Trees Program.
- Support local zoning initiatives that incent the development of small and/or net-zero homes.
- Ensure that developments subject to Act 250 consider new energy requirements by encouraging the compliance with commercial energy stretch codes, particularly among proposed commercial uses that are high energy consumers.
- Showcase the cutting-edge work of local architects and contractors who incorporate green building practices through NVDA's web site and newsletters.
- Promote the use of the Vermont Home Energy Profile among prospective buyers and sellers of homes. Work with local contractors to become BPI certified in energy-efficient retrofit work in order to assist with these profiles.
- Ensure that local zoning administrators have information on Residential Building Energy Standards and Commercial Building Energy Standards (RBES and CBES). Host and facilitate training sessions for local officials. Encourage communities with zoning to require Certificates of Occupancy. Encourage the local adoption of "stretch codes".
- Work with local affordable housing organizations to promote and improve the supply of the region's net-zero and near-net zero housing supply, such as Vermod homes.
- Review local zoning bylaws and offer technical assistance to development review boards when evaluating the energy efficiency implications of site plans for proposed developments.

Weatherize at least 25% of the region's housing stock by 2020.

- Actively advocate for the continuation and expansion of funding programs that support thermal efficiency and renewable energy improvements, especially programs that are targeted to middle- and low-income households.
- Coordinate with and promote efficiency programs and weatherization assistance programs (such as Efficiency Vermont, NE TO, 3E Thermal, and Heat Squad) for low-income households and apartment buildings.
- Cosponsor and organize weatherization workshops for home and businesses with EEUs.
- Facilitate or sponsor a workshop for owners of rental housing (including farm labor housing) to encourage implementation of energy efficiency.
- Encourage residents to hire Efficiency Excellence Network (EEN) contractors when completing energy efficiency projects by including links to the EEN on municipal/regional websites.
- Make information available about lending programs that can improve the efficiency of older housing stock, such as Efficiency Vermont's "Heat Saver" loan and USDA Direct and Guaranteed Loan Programs, for single homes and multi-family homes.

Energy generation that provides the best cost-benefit to the region will be promoted.

- Promote wood-based energy generation to support the region's forest industry.
- Encourage the development of energy facilities and resources that help sustain local agriculture and forestry (i.e. grass/wood-pellets, small-wind, solar, farm-methane, wood-chip, biodiesel).

Environmental and aesthetic impacts of energy generation and usage will be considered.

There will be broad public participation in the decision-making process.

- Encourage the Vermont Legislature to develop policies that support the development of solar, small-wind, hydro-electric, farm methane, biodiesel and biomass generation facilities, while respecting current local land use and the culture of the region.
- Encourage the PUC to examine the long-term sustainability of proposed facilities.

Assessment of local needs and values on new energy development will be encouraged.

- Encourage towns to address energy development in town planning and zoning.
- Provide assistance to businesses/municipalities to develop cogeneration and other alternative energy strategies.

Reduce the region's carbon footprint through the expansion of a closed loop soil-to-soil regional food system that sustains and feeds the people of the Northeast Kingdom.

- Coordinate movement and storage of goods to achieve maximum efficiency.
- Redirect food scraps and other organics from the waste stream in a manner that maximizes efficiency and minimizes hauling.
- Support and further the goals and strategies of the NEK Food System Plan through its Leadership Group.
- Identify and publicize opportunities for shared truck space among existing growers and producers.
- Generate better awareness of existing distribution resources, such as freight service.
- Identify and publicize opportunities for shared storage space among existing growers and producers.
- Explore the feasibility of establishing a leased storage facility.
- Assess market demand for products and existing shippers and distributors already moving to external (New York and Boston) markets (including opportunities for backhauling).
- Identify infrastructure needed to maximize inbound, outbound, and internal freight movement.
- Promote the use of and increase the amount of on-farm power and community energy generation and the use of renewable energy for farming and food production (such as

anaerobic digesters, solar, wind, biomass, and biodiesel, in accordance with local and regional planning priorities).

- Support local incentives for siting solar installations away from most productive agricultural soils.
- Explore the use of compost heat recovery; identify challenges, opportunities, and funding sources.
- Provide and increase opportunities for onsite and commercial composting training and education, sustainable farming methods focused on reduction and reuse of wastes (closed-loop nutrient systems), and shared facilities and infrastructure to transfer and store compost.
- Establish a coordinated marketing campaign that dispels the perceptions around local food costing more and extols the long-range benefits of staying local (e.g. dollars re-circulated into the economy, food miles travelled).
- Explore the feasibility of a developing a "food miles" measurement that can be used in marketing local foods.