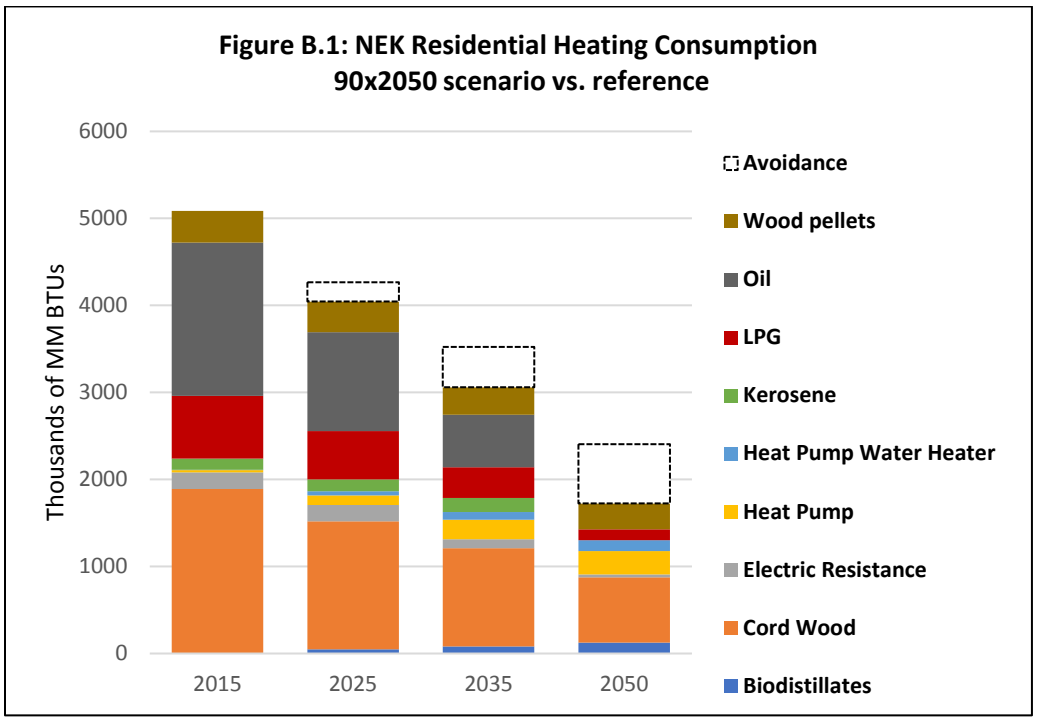
APPENDIX B: SUPPORTING DATA FOR ENERGY PLAN

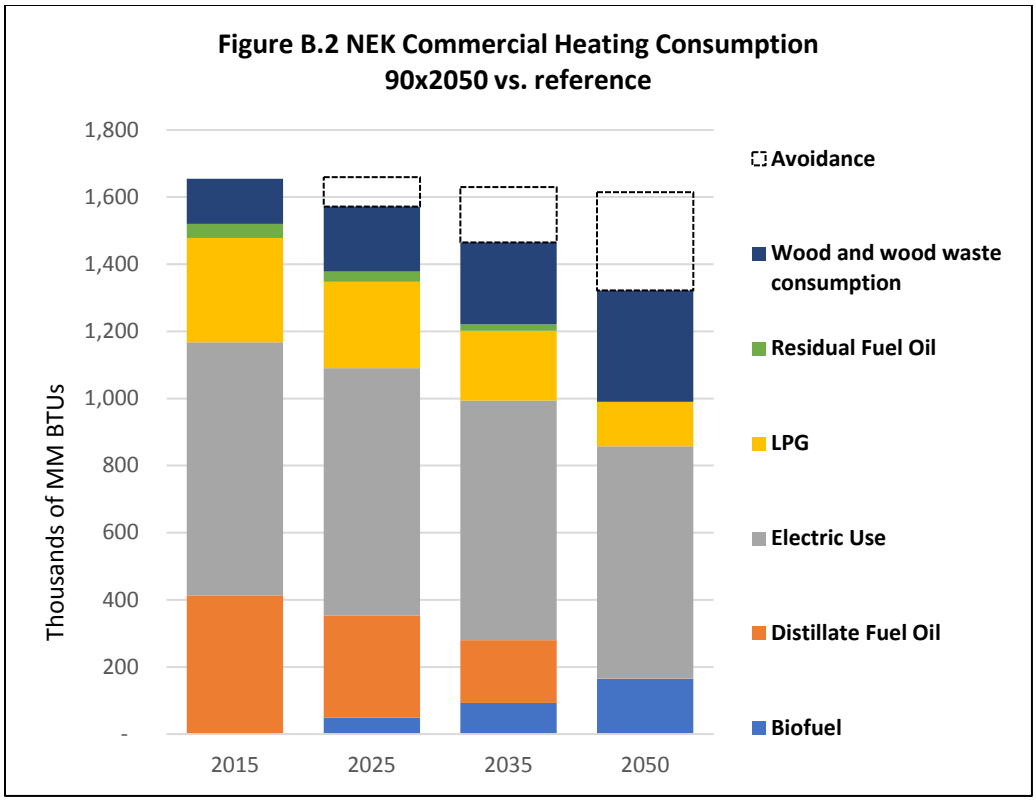
THE VISION FOR 2050

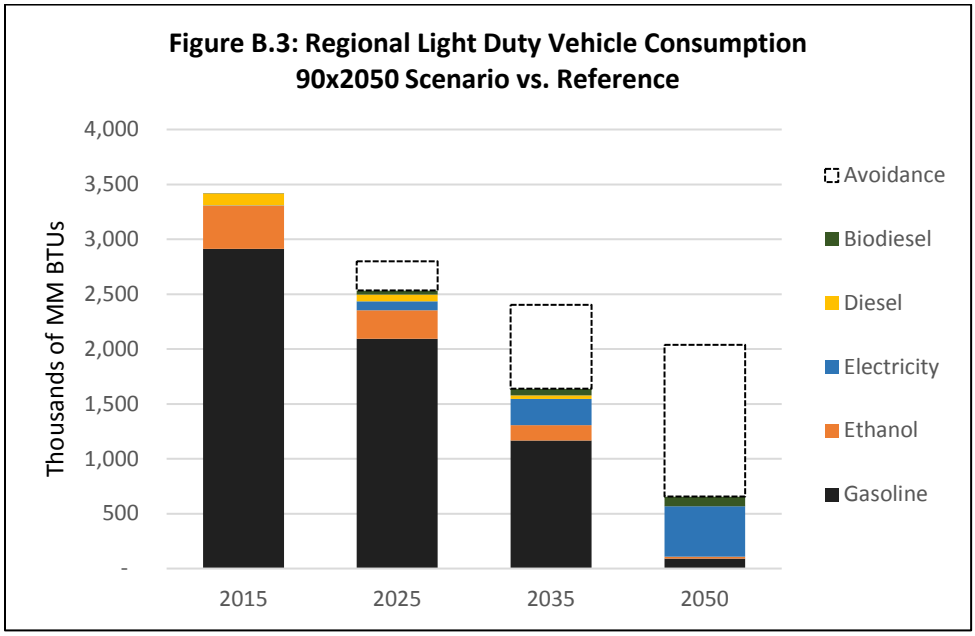
Ryegate's Energy Plan supports Vermont's 2016 Comprehensive Energy Plan (CEP), which contains the following goals:

- 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.

Figures 1 through 3 show what the Northeast Kingdom's total end use of ALL fuels might look like if the "90x2050" goals of the CEP were met. This scenario is based on Long-Range Energy Alternatives Planning (LEAP), an integrated modeling that can estimate and track consumption across all sectors, based on a set of assumptions, such as population growth. This LEAP scenario reduces demand enough to make 90% renewable supply possible. This scenario makes use of wood energy, but there is more growth in electric heating and transportation to lower total energy demand. Where the graphs show "Avoided vs. Reference," that is the portion of energy that is no longer needed because of the efficiency improvements through weatherization, equipment upgrades, and fuel switching. Despite a modest growth rate of population and economy, energy use declines because of efficiency and electrification. Electrification of heating and transportation has a large effect on the total demand because the electric end uses are three to four times more efficient than the combustion versions they replace.







RESIDENTIAL THERMAL ESTIMATES

NVDA developed its residential thermal estimates using American Community Survey (ACS) 5-Year Estimates for primary heating sources. Average household square footages were developed from ACS estimates, as well as American Housing Survey estimates. Included in this estimate are 447 occupied housing units, 372 of which are owner-occupied, and 75 renter-occupied.

Owner occupied units have an average of 2.48 persons per unit, with a median of 772 square feet per person. Rented units also have an average of 2.48 persons per unit, but a median of 496 square feet per person. Table B.1 shows a breakout of heating sources by tenure.

Table B.1: Annual Residential Heating Estimates for Ryegate

Fuel Type: Space Heating	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	101	113,397	gallons	23%	21%	32%	35%
Electricity	7	178,179	KwH	2%	0.8%	5%	3%
Fuel Oil	211	161,139	gallons	47%	47%	47%	43%
Wood	21	660	cords	27%	29%	16%	18%
Coal/Coke	3	17	tons	1%	1%	0%	0%
Other	4	-	-	1%	1%	0%	

The most significant contributor to Ryegate residential heating use appears to be the age of the housing stock. According to ACS 5-year estimates, 41% of Ryegate's owner-occupied housing stock was built prior to 1940. (County-wide, just a little over 30% of owner-occupied housing stock pre-dates 1940.) By contrast, renter-occupied stock is less likely to predate 1940, but more than 40% were built prior to 1960. and about one-fifth of renter occupied housing were built prior to 1940. This is significant because older structures are likely to be "leaky" and poorly insulated, which can nearly double the average thermal use to as much as 80,000 BTUs per square foot. (Department of Public Service). NVDA therefore assumed 80,000 BTUs per square foot for pre-1940 housing stock, 45,000 BTUs for all other.

Although this calculation uses best available data, it clearly has some limitations. First, like most Northeast Kingdom residents, Ryegate residents are likely to use multiple heating sources. Second, this estimate does not account for the seasonal housing units in Ryegate, for which no published heating datasets are available. Department of Public Service guidelines suggest that it is reasonable to assume that seasonal units account for a mere fraction of the average owner-occupied housing unit – about 5%. There are 77 seasonal units in Ryegate. Assuming 5% of the average owner-occupied housing unit (148 MM BTUs), they could collectively account another 571 MM BTUs annually.

HEATING NON-RESIDENTIAL

Non-residential thermal estimates were developed using data from the Department of Public Service and the Vermont Department of Labor's economic and Labor Market Information. (Table 2) The Census does not have estimates on heating sources, but the DPS is able to estimate average heating loads on types of business. (This method does not work for industrial uses, which tend to be highly specific to the function and type of operation. Additionally, this estimate excludes commercial operations likely to be home-based, such as daycares, in order to avoid double-counting

Table B.2: Non-residential heating use in Ryegate

NAICS Code	Estimated Avg. Consumption (MMBtu)	# of Structures in Town	Total MM BTUs
42. Wholesale trade	357	1	357
44-45. Retail trade	295	1	295
48-49. Transportation and warehousing	1,666	2	3332
51. Information	1,568	0	0
52. Finance and insurance	761	0	0
53. Real estate and rental and leasing	432	0	0
54. Professional and technical services	109	3	327
55. Management of companies and enterprises	13,763	0	0
56. Administrative and waste services	302	1	302
61. Educational services	4,534	0	0
62. Health care and social assistance	1,084	1	1084
71. Arts, entertainment, and recreation	1,778	0	0
72. Accommodation and food services	812	0	0
81. Other services, except public administration	174	3	522
TOTAL		12	6219

The above total does not include town-owned buildings, which are all heated by fuel oil:

Table B.3: Town-Owned Structures in Ryegate

Structure	Approx. SF	Avg. Annual Fuel Use (gallons of fuel oil)	MMBTUs
Town Clerk's Office	1,628	758	105
Town Garage	5,044	1,290	179
Fire Station	3,078	1,081	150
TOTAL		3,129	435

Source: 2010 NVDA NEK Municipal Energy Audits

METHODOLOGY FOR DEVELOPING WEATHERIZATION AND EFFICIENCY TARGETS

Weatherization and efficiency targets were based on an estimated 6% increase in number of housing units/commercial establishments over each period. Weatherization projects are assumed to achieve an average of 25% reduction in MM BTUs for residential units and 20% for commercial establishments, although some weatherization projects can achieve deeper savings. For Ryegate, that would represent an average reduction of 34 MM BTUs per residence and 104 MM BTUs per commercial establishment.

The number of electric utility customers is based on the projected number of households through 2050 and multiplies by the figure by 1.5 (generally, there are more utility customers than households). This estimate assumes an average savings of 400 kWh.

Table C.4 breaks out the types of efficiency measures carried out by Ryegate residential and commercial and industrial customers over the most recent three-year period. The table may help to illustrate the complex nature of interactive effects among efficiency measures that result in negative savings. The installation of a cold climate heat pump, for example, can decrease thermal usage and increase electrical usage. Also, a switch from incandescent bulbs (which emit a substantial amount of heat) to LED bulbs (which emit very little heat) may actually require additional energy to heat space in some instances. 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. It is possible that the "negative" thermal savings in the C&I sector comes from the replacement of light bulbs.

Table B.4: Efficiency Measures by Residential and Commercial & Industrial Customers in Ryegate

	2014		2015		2016		Total	
	Res.	C&I	Res.	C&I	Res.	C&I	Res.	C&I
Air Conditioning Efficiency	1	0	0	0	0	0	1	0
Compressed Air	0	0	0	1	0	0	0	1
Cooking and Laundry	3	0	4	0	2	0	9	0
Hot Water Efficiency	46	0	9	1	5	0	60	1
Light Bulb/Lamp	298	172	375	320	186	234	859	726
Lighting Hardwired Fixture	12	16	170	21	16	84	198	121
Motor Controls	0	0	0	0	0	1	0	1
Motors	1	0	0	0	6	0	7	0
Office Equipment, Electronics	49	0	22	0	15	0	86	0
Refrigeration	6	0	6	0	2	0	14	0
Space Heat Efficiency	1	0	0	0	0	0	1	0
Space Heat Fuel Switch	2	0	0	0	0	0	2	0
Space Heat Replacement	0	0	1	3	2	0	3	3
Thermal Shell	6	0	0	0	2	0	8	0

TRANSPORTATION ENERGY ESTIMATES

Table B.5: Transportation Energy Use in Ryegate

Total Light Duty Vehicles, all internal combustion engines (ICE)	879
Average Miles per gallon for ICE	22
Average annual Vehicle miles travelled ICE	14,000
Total annual VMTs ICE	11,200,000
Total Gallons ICE	509,091
MM BTUs, Fossil fuel	56,176
MM BTUs, Ethanol	3,881
MM BTUs Total ICE	60,057
Total Electric vehicles (EVs) (as of Jan. 2017)	0

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

Table B.6: Public Charging Stations within a 20-mile Radius of Ryegate

Station	Town	Approx. Distance	Type
Marty's First Stop	Danville	13 miles	DC Fast (80% charge in 20-30 minutes, depending on weather)
Pearl Street Municipal Parking Lot	St. Johnsbury	14 miles	Level 2 (10 to 20 miles per hour of charge)
Twin State Ford	St. Johnsbury	14 miles	Level 1 (3-5 miles per hour of charge) Level 2
Northeastern Vermont Regional Hospital	St. Johnsbury	15 miles	Level 2
Sugar Hill Inn	Sugar Hill, NH	17 miles	Level 2
Mill Park Information Kiosk	Plainfield	17 miles	Level 2
Hannaford's	Bradford	17 miles	DC Fast
Bradford Park and Ride	Bradford	17 miles	Level 1
City of Barre	Barre	20 miles	Level 2

Source: US Department of Energy's Alternative Fuel Locator

ELECTRIC UTILITY ESTIMATES

Ryegate's electric utility data has been collected by Vermont Energy Investment Corporation. There are some caveats to this data, which is collected by zip code, and not by town of service. This can lead to errors in some very rural communities. Inconsistencies in reporting among the utility companies, paired with disparate billing cycles, may also produce some errors.

Table B.7: Electricity Use in Ryegate

	2014		2015		2016	
	kWh	MM BTUs	kWh	MM BTUs	kWh	MM BTUs
Commercial & Industrial (kWh)	1,250,149	4,266	1,473,294	5,027	1,310,707	4,472
Residential (kWh)	4,345,969	14,828	4,328,971	14,770	4,243,943	14,480
Total	5,596,118	19,094	5,802,265	19,797	5,554,650	18,952
Average Residential Usage	7,010	24	7,005	24	5,427	23

Table B.8: Savings Achieve in Ryegate, 2014-2016

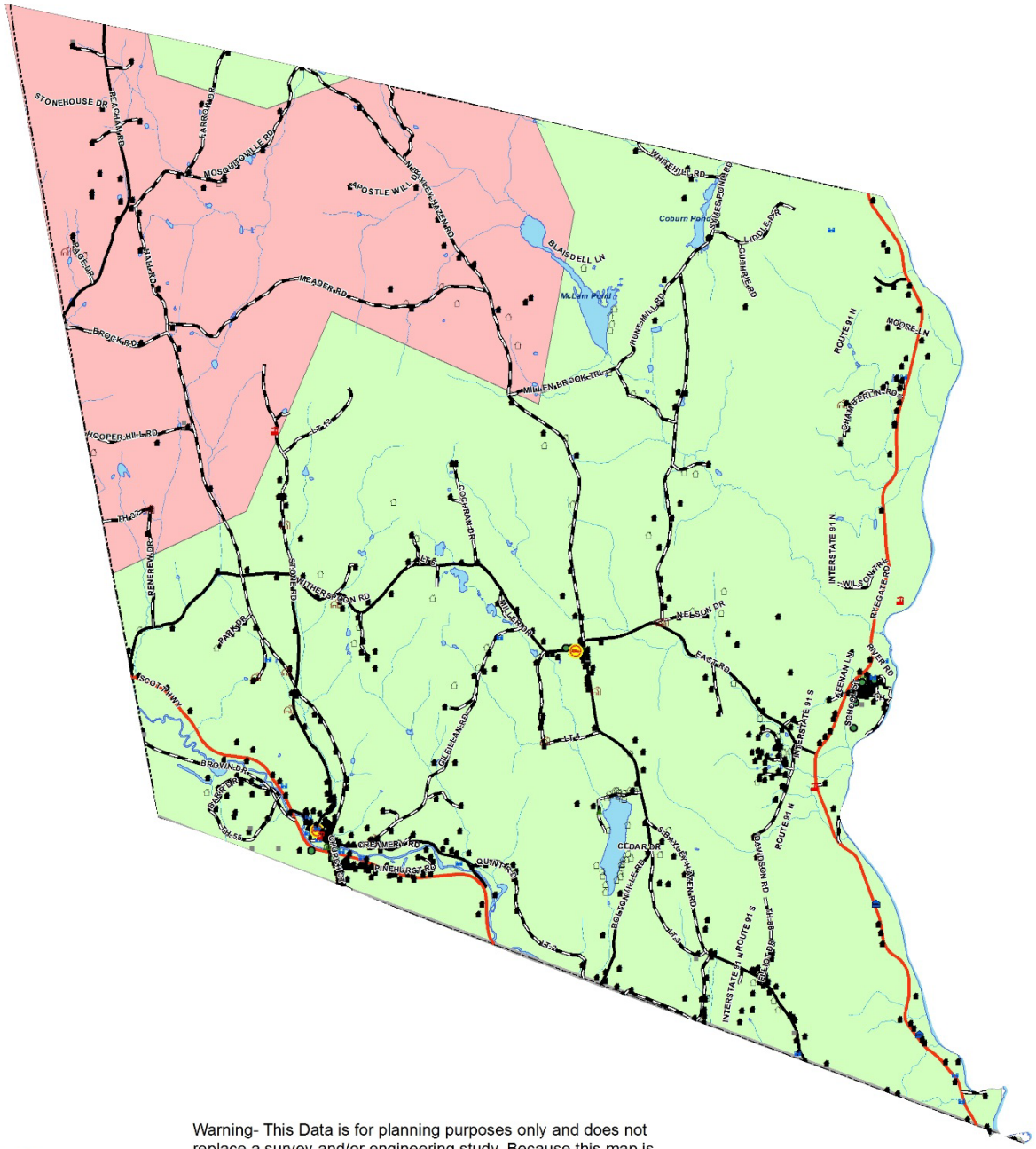
	2014	2015	2016	Total
Electric Savings (KWh)	24,444	51,362	71,023	146,829
Residential	11,475	32,829	17,806	62,110
Commercial & Industrial	12,969	18,533	53,217	84,719
Thermal Savings (MMBTU)	45	134	(4)	175
Residential	50	(3)	26	73
Commercial & Industrial	(5)	137	(30)	102
Total Customer Cost Savings	$6,989	$11,391	$10,797	$29,177
Residential	$5,266	$5,541	$3,502	$14,309
Commercial & Industrial	$1,723	$5,850	$7,295	$14,868

Table B.9: Energy Generation in Ryegate

Category	Sub Category	CPG Number	Electricity Type	Utility/ Operator	Capacity kW	Annual Production MWh
Hydro	Hydropower		Grid	GMP	5,000	27,000
Solar	Ground-mounted PV	5308	Net-Metered	GMP	13	15.9
Solar	Roof-Mounted PV	3003	Net Metered	WEC	5.7	7.0
Solar	Roof-Mounted PV	1420	Net Metered	GMP	7.9	9.7
Solar	Roof-Mounted PV	876	Net Metered	GMP	5.5	6.7
Solar	Roof-Mounted PV	1683	Net Metered	GMP	5.7	7.0
Solar	Roof-Mounted PV	5092	Net Metered	WEC	4.2	5.2
Solar	Roof-Mounted PV	3276	Net Metered	GMP	4	5.2
Biomass	Woodchip		Grid	Catamount Energy/Suez Energy North America	167,627	154,785
					172,673	181,842

Source: Vermont Renewable Energy Atlas

Figure B.4: Electric Utility Services Territories in Ryegate



Warning- This Data is for planning purposes only and does not replace a survey and/or engineering study. Because this map is developed from various scale sources, there may be some discrepancies between data layers.

Green: Green Mountain Power

Red: Washington Electric Coop

RECENT LEGISLATION AFFECTING RENEWABLE GENERATION

Two major legislative initiatives will drive the development and use of renewable energy in the coming years: Act 56 and Act 99.

Act 56: This initiative establishes a 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 credits (RECs) from any plant, as long as the plant's energy can be delivered in New England.

Tier II: 1% 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. Utilities can meet this requirement by renewable energy or 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, or incentives to purchase EVs.

Act 99: Net-metering – an arrangement by which utility customers receive a payment for energy they generate that exceeds what they use – has been very popular in Vermont. Net metering applications are capped at 500 kW. 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. Previously solar generators received a "solar adder" for net metering. Act 99 eliminates the solar adder and replaces it with a series of adjustments for siting solar on 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 rule tends to incentivize small developments away from open fields and other undeveloped areas.