SECTION IV

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IV. TARGETS FOR ENERGY CONSERVATION, ENERGY USE, AND ELECTRICITY GENERATION

While Section III focuses on cataloguing the Northwest region's current energy demand and generation capacity, Section IV creates targets for regional energy conservation, use, and generation. The targets will guide the region toward achieving the state's and region's energy goals.

Achieving these energy goals will be challenging. Intensive conservation methods will need to be employed throughout the region in all sectors. Increased electrification of transportation and space heating will also be needed (combined with the subsequent decrease in fossil fuel use). But perhaps most importantly, total energy demand in the region will need to decrease despite population growth. The specifics of regional conservation and generation targets are covered in detail in Subsection B. Subsection A provides context for how regional targets were developed. Appendix H contains a comprehensive list of regional energy targets.

A. LEAP MODEL AND METHODOLOGY

To create targets for conservation and use, the NRPC teamed with VEIC. The VEIC staff used LEAP (Long-range Energy Alternatives Planning) software to create a model of the demand for and supply of total energy usage in Vermont and the region. LEAP software allows users to create complex models of systems with editable inputs from the large scale (such as population or vehicle miles traveled) to the small scale (the electrical demand of individual appliances). Because of the model's complexity, it is difficult to explain comprehensively. The following scenarios provide some background on the methodology and the inputs used to create both statewide and regional models in LEAP. Appendix A presents the full model results for the region and the state as well as a more thorough explanation of the model assumptions and methodology.

Targets for generation were developed by the Department of Public Service in partnership with the state regional planning commissions. Generation targets were based on estimates in the Vermont Comprehensive Energy Plan and the LEAP model. The Department of Public Service and regional planning commissions then took into considerations variables such as generation potential, population, and existing generation to develop targets for renewable generation.

ONE MODEL – TWO SCENARIOS

The model created in LEAP actually contains two scenarios. The first scenario—the reference scenario—contains inputs that reflect current energy use and generation trends. The second scenario is designed to achieve the goal of meeting 90% of Vermont's total energy demand with renewable sources. This scenario, called the 90 x 50 VEIC scenario, is adapted from the Vermont Total Energy Study (TES) Total Renewable Energy and Efficiency Standard (TREES) Local scenarios.[4] This scenario is a hybrid of the high and low biofuel cost scenarios used in the TES. More information regarding the TES can be found on the Department of Public Service website.[5] Both scenarios are based on projected energy demand.

FIGURE 4.1 PROJECTED ENERGY DEMAND AND FOSSIL FUEL USEAGE

Total electricity demand will double by 2050.

Fossil fuel useage projected to be near zero by 2050.

The model results show that, despite a growing population and economy, energy use will decline in the 90 x 50 VEIC scenario because of increased efficiency and conservation. Electricity use will increase with the intensified use of heat pumps as primary heating sources and the use of electric vehicles. Because those choices are powered by electricity, and electricity is three to four times more efficient compared to fossil fuels, overall energy use will decrease both regionally and statewide.

[4] Required by Act 170 of 2012 and by Act 89 of 2013, the intent of the TES according to the VT Public Service Dept. was "to identify the most promising policy and technology pathways to employ in order to reach Vermont's energy and greenhouse gas goals."

[5] Vermont Total Energy Study: http://publicservice.vermont.gov/publications-resources/publications/total_energy_study

The difference in total energy demand between the reference scenario and the 90 x 50 VEIC scenario is a key point. This difference, or "avoidance," estimates the amount of total energy demand that will need to be eliminated through conservation efforts to ensure that the state's and region's energy goals are met by 2050. The many challenges that will inhibit regional efforts to reach conservation and generation targets are covered in detail in Section VI.

LEAP INPUTS AND ASSUMPTIONS

Data used to construct the model was primarily drawn from the Public Service Department's Utility Facts 2013 and information available from the U.S. EIA, a federal entity associated with the U.S. Department of Energy that maintains official, federal energy statistics. Projections used in the model came from the Vermont TES, information from Vermont public utilities about their committed electricity supply, and stakeholder input.

In the model, VEIC projects that the population of the state and the region will grow by 0.87% per year. This number was chosen based on population projections completed by the Vermont Agency of Commerce and Community Development. In the model, the number of persons per household was assumed to decrease from 2.4 in 2010 to 2.17 in 2050. This assumption was based on historical trends. The projected number of households is an important piece of the model; it is the basic unit in the model on which residential energy consumption is projected.

The commercial energy demand driver in the model is the square footage of commercial buildings. Data and projections about commercial building area were extracted from inputs for the TES. Industrial energy use was entered into the model using actual totals without a driver specified. Commercial and industrial demand calculated at the state level was then allocated to the regions by service-providing and goods-producing North American Industry Classification System (NAICS) codes, respectively.

Transportation energy use in the model is based on projections of vehicle miles traveled, which are available from VTrans for county-based totals. Although VMT have risen throughout most of American history, it peaked in Vermont in 2006 and has since slightly declined. Given this trend and Vermont's efforts to concentrate development and to support alternatives to single-occupant vehicles, the model assumes that VMT in the state and county will remain flat despite growth in population and economic activity.

The 90 x 50 VEIC scenario assumes that diesel used in heavy-duty vehicles is replaced with biodiesel. It also assumes that electricity will replace gasoline in passenger (i.e., light duty) vehicles and that electricity will provide an increasing amount of energy used for space heating, primarily through the use of cold climate heat pumps. The challenges associated with meeting these assumptions, including challenges related to infrastructure required to transition to biodiesel fuel sources, are outlined in Appendix A.

The supply side of the model was first calculated on a statewide basis. The reasons for this, according to VEIC, is that "no region is going to host a small share" of electricity generated by a larger source like the Seabrook Station Nuclear Power Plant in New Hampshire or Hydro-Québec. Instead, the electricity generation capacity of these large electricity suppliers is allocated according to the region's 2050 modeled electricity consumption. The resulting supply side focuses on "each region's 'share' of new (installed after 2015) in-state generation by 2050." The "share" data is meant to aid the Northwest region in attaining the 90 x 50 goal. However, it should be kept in mind that this "share" represents only one of the many paths the Northwest region may take to attain the 90 x 50 goal and does not necessarily set a mandatory target for the region to achieve.

B. REGIONAL LEAP MODEL

Because different fuels are measured in different units (e.g., gallons, cords, pounds, cubic feet), the results of the LEAP model can be difficult to compare. To help make comparisons between fuel types easier, the NRPC has decided to report the scenario results in a standard unit: BTUs. To provide some additional context, see Figure 3.1.

Results from the LEAP model show similar trends for both the state and the region. The following results focus on the region. When a significant difference exists between the state and regional model results, the difference will be addressed.

SPACE HEATING

Per the LEAP model results, the amount of energy used for single-family home space heating demand is expected to fall regionally between the present and 2050 (again, due to heat pumps). It is also due to increasing energy savings gained through weatherization retrofits of existing single-family structures and through the construction of new single-family homes that are compliant with the state's residential building energy standards (RBES).

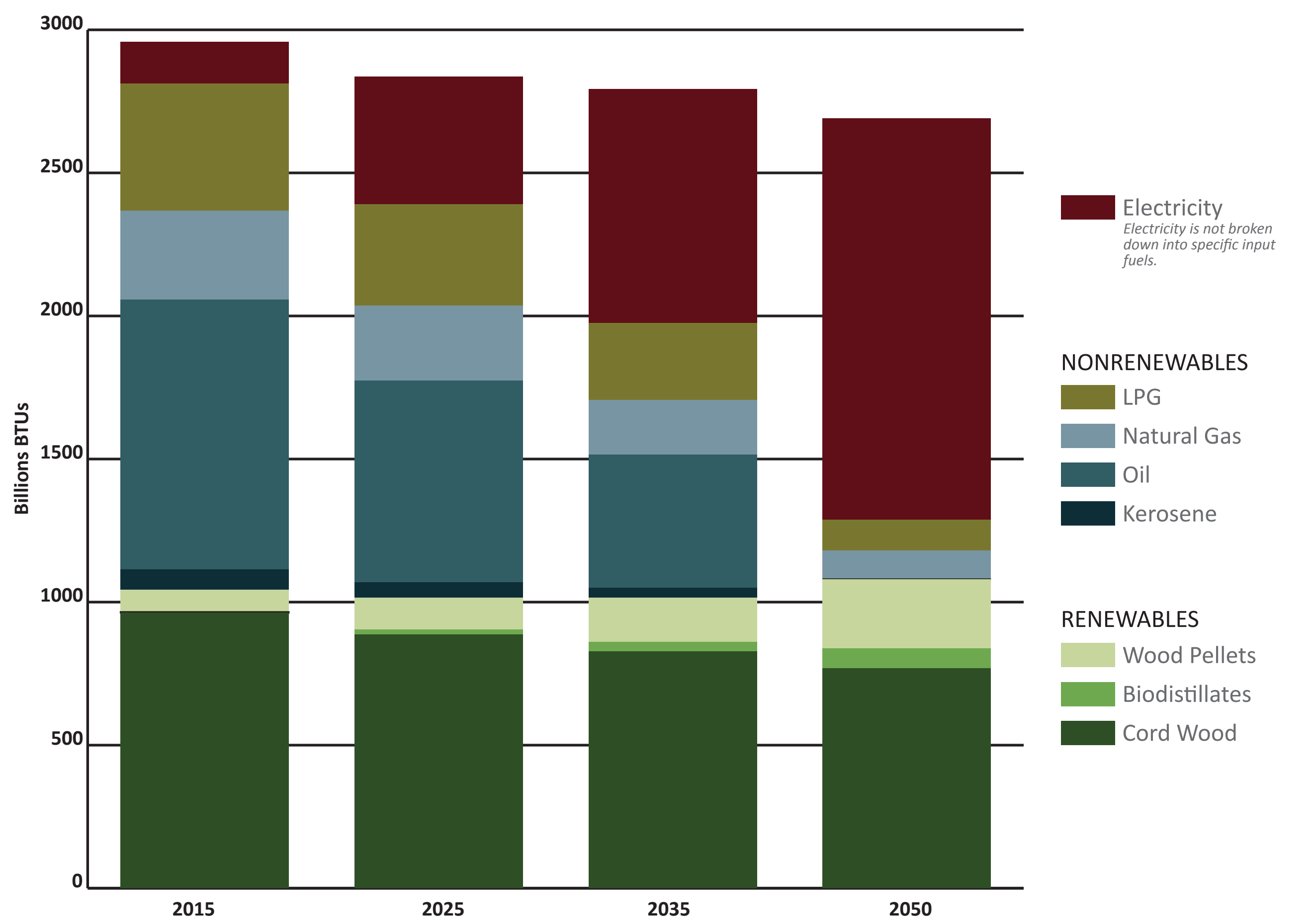
FIGURE 4.2 PROJECTED HEATING

Oil, Propane, and Kerosene are projected to be eliminated as single family home heating sources by 2050.

Total BTUs from wood heating projected to decrease by 3% between 2015 and 2050.

The model results also show a significant reduction in the use of fossil fuels (or in the case of some fossil fuels, complete elimination) as a single-family home heating source. The regional model shows the elimination of kerosene and fuel oil as heating sources by 2050. Liquid propane and even natural gas use are projected to drop during the model time frame.

FIGURE 4.3 LEAP PROJECTED REGIONAL SPACE HEATING ENERGY DEMAND



The model shows cord wood as continuing to provide a significant amount of BTUs for single-family home space heating in both 2015 and 2050 in the model. In 2050, the model shows cord wood providing about 29% of single-family home heating BTUs in the region. Wood pellet use grows considerably during the model time period from approximately 78 thousand million BTUs in 2015 to 241 thousand million BTUs in 2050. Despite this gain, pellets still only account for 9% of the total BTUs needed to meet model targets in 2050, a much smaller percentage than cord wood.

In total, wood sources account for approximately 37% of single-family home heating BTUs in 2050 according to the model. This represents a small increase from 2015 when wood sources were estimated to account for 35% of single-family home heating BTUs according to LEAP. Comparatively, electric heating sources account for a significant increase in terms of percentage of single-family home heating BTUS moving from about 5% of the single-family home heating BTUs in 2015 to 52% of the single-family home heating BTUs in 2050.

The NRPC has some concerns about continuing reliance on cord wood for space heating. These concerns—namely, sustainable harvesting and impacts on greenhouse gas emissions—are covered in Section VI.

Industrial and commercial space heating demand is not provided separately from total industrial and commercial energy demand in the LEAP model results. Heating is just one element of the total energy demand, so it is a little difficult to accurately provide data that reflects energy used for space heating instead of energy used for lighting, manufacturing processes, and other uses. However, a closer look at the data reveals that the energy, or BTUs, used by the commercial and industrial sectors is used primarily for space heating (natural gas, for instance, is used for space heating in the region, not generating electricity) and not for other types of uses (e.g., the electricity used for operating a machine).

In the model, the total demand for industrial and commercial energy includes reductions in natural gas use. Commercial demand also includes reductions in propane, oil, and residual fuel oil demand, with the latter two sources essentially eliminated from the fuel mix in 2050. Industrial demand for propane and residual fuel oil remains relatively constant throughout the model time frame. Demand for cord wood, another heating source, increases in terms of BTUs as well as overall percentage for both industrial and commercial sectors by 2050. This result was a surprise to the NRPC, as it is the opposite of the trend seen for single-family homes.

To meet the targets for wood and electricity thermal generation for single family home and commercial heating, there will need to be approximately 720 new high-efficiency wood systems installed and 11,603 new electric heat pumps systems installed in the region by 2050. Targets for 2025 and 2035, targets based on the LEAP model, are shown in Figure 4.4.

Weatherization is also a key element regional conservation of space heating energy. By utilizing LEAP data, and a model developed by the Vermont Department of Public Service, the NRPC establishes the following targets for weatherization within the region, shown in Figure 4.5.

FIGURE 4.4 THERMAL FUEL SWITCHING TARGETS (Residential and Commercial)

	2025	2035	2050
New Efficient Wood Heat Systems (in units)	46	89	720
New Heat Pumps (in units)	3203	6407	11603

FIGURE 4.5 REGIONAL WEATHERIZATION TARGETS

	2025	2035	2050
Total Residential Households	1,021	3,571	16,786
Percent of Regional Residential Households	4%	14%	57%
Total Commercial Establishments	284	392	823
Percent of Regional Commercial Establishments	24%	23%	64%

FIGURE 4.6 PROJECTED ENERGY NEEDS

Transportation energy projected to decrease by 58% by 2050.

Electricity and biodiesel are projected to provide 91% of total transportation energy needs by 2050.

Biodiesel will need to increase from 423,000 gallons in 2015 to 7.13 million gallons in 2050.

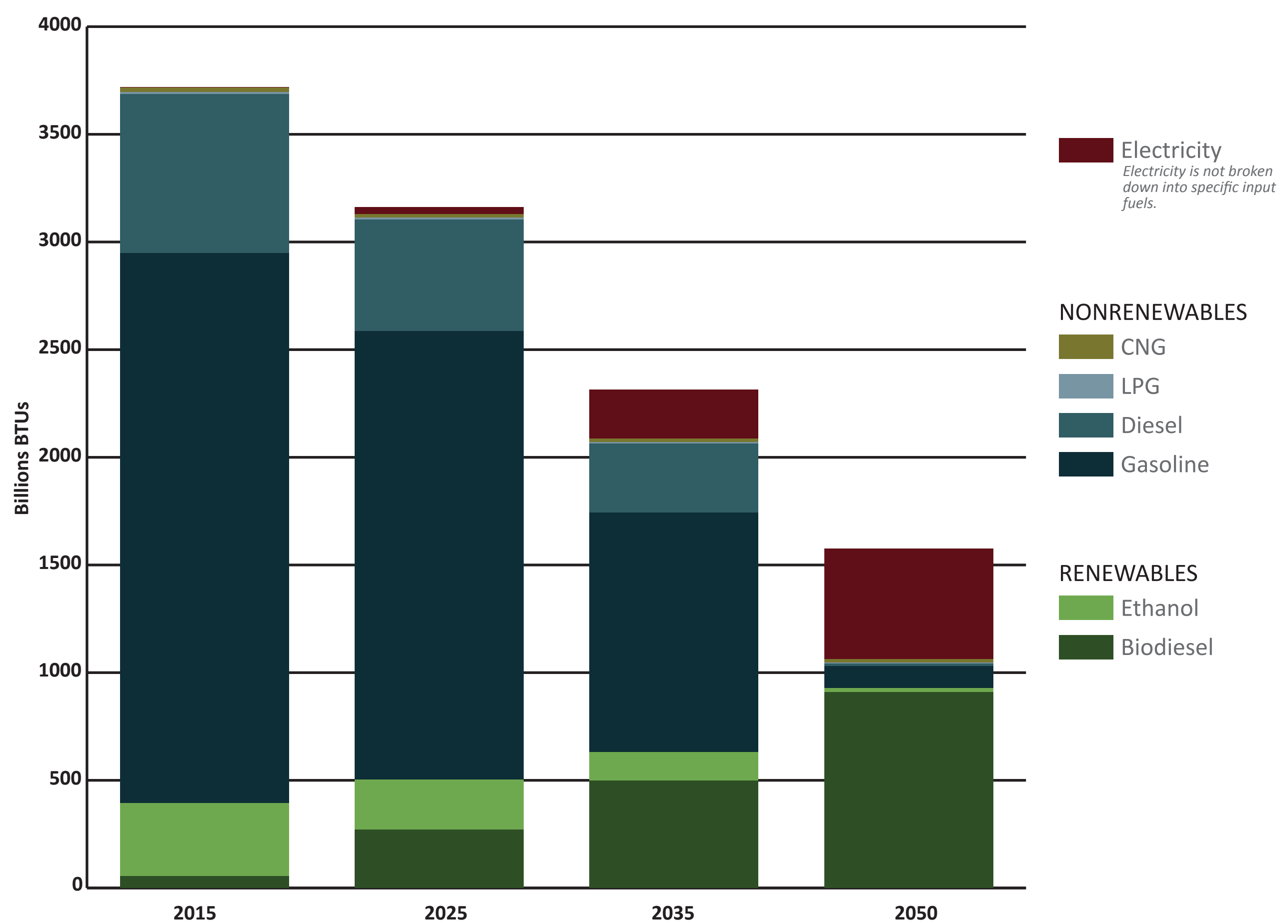
TRANSPORTATION

According to the LEAP model, transportation energy demand in the region falls significantly between 2015 and 2050. The demand decreases from approximately 3,719 billion BTUs to approximately 1,576 billion BTUs, a drop of about 58%. Gasoline, diesel, and ethanol demand equal 69%, 20%, and 9% of total transportation energy demand, respectively, in 2015. This demand decreases to 6%, <1%, and 1% of total transportation energy demand, respectively, in 2050. This is a drastic and ambitious shift in energy sources over time—arguably the biggest energy demand change in the model time frame. Per the model, the most considerable decreases in the use of gasoline and diesel energy sources occur between 2035 and 2050.

Electricity demand for transportation energy increases in a similarly dramatic fashion during the same time frame. In 2015, the model shows electricity demand at approximately 0.05% of transportation energy demand, increasing to approximately 33% by 2050.

Ethanol, compressed natural gas, and biodiesel are three other types of transportation energy sources that increase during the model time frame. Although the increases in demand for ethanol and compressed

FIGURE 4.7 LEAP PROJECTED REGIONAL TRANSPORTATION ENERGY DEMAND



natural gas are relatively modest, the growth in biodiesel demand is considerable (1.45% to 58% for transportation energy demand) and would mean an enormous increase in biodiesel gallons used in the region. This transition poses significant challenges, notably regarding the production and distribution (as well as the associated infrastructure) involved. These challenges are discussed in Section VI.

The reasons for the shift in demand for transportation energy sources are briefly addressed in previous sections. The model accounts for level VMT despite a growing regional population. This—combined with the increased efficiency of gasoline vehicles and the anticipated electrification of the passenger vehicle fleet—results in increased electricity demand for transportation, yet decreased demand for gasoline (because electric vehicles use energy much more efficiently than gasoline vehicles). Meanwhile, heavy vehicles are anticipated to transition from diesel fuels to biodiesel during the model time frame. To meet regional transportation BTU targets, the region should support policies that would result in the following number of electric and biodiesel vehicles (Figure 4.9).

FIGURE 4.8 PERCENTAGE OF TOTAL TRANSPORTATION ENERGY DEMAND

	2015	2025	2035	2050
Electricity	0.05%	1.01%	9.81%	32.55%
Gasoline	68.65%	65.84%	48.06%	6.47%
Diesel	19.90%	16.38%	13.83%	0.76%
LPG	0.24%	0.25%	0.30%	0.32%
Ethanol	9.17%	7.37%	5.79%	1.14%
CNG	0.54%	0.57%	0.73%	1.02%
Biodiesel	1.45%	8.57%	21.48%	57.74%

FIGURE 4.9 TRANSPORTATION FUEL SWITCHING TARGET - ELECTRIC AND BIODIESEL VEHICLES

	2025	2035	2050
Electric Vehicles	3,716	27,828	62,889
Biodiesel Vehicles	6,546	13,034	24,989

ELECTRICITY AND ELECTRICAL GENERATION

Electricity demand increases significantly in the region according to the LEAP model results. Electricity increases from 16% to 44% of total energy demand between 2010 and 2050. This is an increase from approximately 523 million kWh in 2010 to 1.06 billion kWh in 2050, which equates to approximately a doubling of electricity demand (Figure 4.10).

FIGURE 4.10 PROJECTED ENERGY CONSUMPTION

Total regional electricity consumption projected to increase by over 100% by 2050.

Figure 4.11 displays the projected sources of Vermont's electricity between 2010 and 2050 according to VEIC. Generation from renewable sources greatly expands during this time frame. Hydro generation continues to grow due to additional in-state generation. Hydro generation from Hydro-Québec used in both Vermont and the region stays relatively constant throughout the model time frame. Wind and solar generation also grow due to additional in-state generation. Nuclear electricity production shows the closure of the Vermont Yankee facility since 2010. The remaining nuclear electricity generation between 2010 and 2050 is from the Seabrook Station in New Hampshire. No new nuclear generation is anticipated. The use of fossil fuels for electricity consumed within Vermont is essentially zero by 2050.

REGIONAL GENERATION TARGETS

Based on the LEAP model and the Vermont Comprehensive Energy Plan, the Department of Public Service worked with regional planning commissions in Vermont to develop targets for new renewable generation. The solar and wind generation targets are based on the estimated needs to cover the region's energy use in 2050 within the context of the 90 x 50 goal. The hydro generation target is based on a study written by Community Hydro, a hydro advocacy organization. The study looks at generation potential at existing dam locations in the region that could be retrofitted to produce electricity.

FIGURE 4.11 VERMONT PROJECTED ELECTRIC GENERATION SOURCES

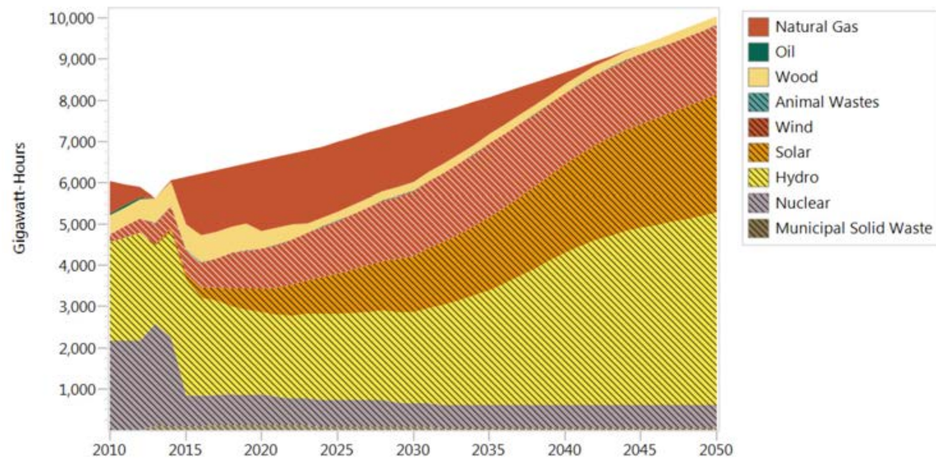


Figure 4.12 displays the regional targets for renewable generation. The targets envision a low wind/high solar mix of renewable generation in the region. There is a 19 MW target for new wind generation and a 208.5 MW for new solar generation by 2050. The hydro generation target is 10 MW by 2050 based on the Community Hydro study findings. Interim targets for 2025 and 2035 have also been created by NRPC. These targets display a linear progression to the 2050 generation targets.

The generation targets call for only the addition of renewable energy generation sources in the region and do not include using biomass as a source of electric generation. The reason biomass has been excluded is because the Vermont Comprehensive Energy Plan identifies limited opportunities for large-scale biomass electricity generation (such as McNeil generating plant in Burlington) in Vermont given the size, health, and composition of the state's forests.

FIGURE 4.12 GENERATION TARGETS

Year	New Wind (MW)	New Hydro (MW)	New Solar (MW)	Total New Generation (MWh)
2025	6.3	3.3	68.8	115,169.5
2035	12.5	6.6	137.6	230,338.9
2050	19.0	10.0	208.5	348,998.4

It is important to stress that the generation targets in Figure 4.12 represent only one possible way to derive 90% of total energy from renewable sources by 2050. The intent of the targets is to provide a sense of scale and a basis for discussion regarding the need for future electric generation, and about the siting of electric generation, in the region. Other electricity generation combinations may be possible. To guide the continuing conversation about the generation "mix," a regional MWh target has also been provided for each target year. This MWh target is based on the wind, solar, and hydro targets and each resources' capacity factor.

WIND GENERATION

The topic of wind generation within the region has become divisive within Vermont, and within the Northwest Region over the last several years. The NRPC remains committed to achieving the wind generation target of 19 MW of generation by 2050, but only through the construction of appropriately scaled wind generation facilities. Based upon the analysis in section V, NRPC generally does not have suitable locations for the construction of "industrial" or "commercial" wind facilities within the region and therefore finds this scale of development does not conform to this plan. For the purposes of this plan, NRPC will consider any wind facility with a tower height (excluding blades) in excess of 100 feet tall to be considered an "industrial" or "commercial" wind facility.

If a municipality through its local planning process identifies a preferred location(s) for an "industrial" or "commercial" wind facility within their boundaries, NRPC may consider amending this plan to account for this local preference. Coordination and consensus among neighboring municipalities will be a critical component of any process to amend the regional plan in this regard. Additionally, NRPC shall only consider such an amendment if the location, or locations, identified by the municipality do not include “known constraints” and mitigate impacts to “possible constraints” as identified in this plan.

REGIONAL MUNICIPAL ELECTRICITY GENERATION

The Department of Public Service “determination standards,” or the standards required to achieve “enhanced energy planning,” require that regional planning commissions develop targets for each municipality in the region. The NRPC has provided municipal renewable generation targets for solar generation, however wind targets have not been provided to municipalities and are instead considered a regional target. This is because of the limited amount of area in the region that is appropriate for wind generation per mapping completed by the NRPC (see Section V) and because of the NRPC’s position regarding the construction of “industrial” and “commercial” wind facilities in the region.

Solar generation targets have been established based on municipal population and based on the availability of solar resources in the municipality established by the mapping completed by the NRPC. The municipal targets are not a mandate, but are a planning tool. They present one scenario in which NRPC and municipalities can achieve local, regional and state energy goals. A MWh target for each municipality has been provided to help each municipality have a conversation about the desired mix of renewable generation.

FIGURE 4.13 MUNICIPAL GENERATION TARGETS

Municipality	Solar Target 2025	Solar Target 2035	Solar Target 2050	MWh Target 2025	MWh Target 2035	MWh Target 2050
Northwest Region	68.8	137.6	208.5	115,169.5	230,338.9	348,998.4
Franklin County						
Bakersfield	2.7	5.3	8.1	4,262.5	8,525.0	12,916.6
Berkshire	6.4	12.8	19.4	8,806.2	17,612.4	26,685.4
Enosburgh	5.1	10.1	15.4	7,188.4	14,376.8	21,783.1
Fairfax	5.7	11.3	17.2	7,931.5	15,862.9	24,034.8
Fairfield	3.3	6.5	9.9	5,035.4	10,070.9	15,258.9
Fletcher	2.5	5.0	7.5	4,008.6	8,017.1	12,147.2
Franklin	4.5	9.0	13.6	6,507.4	13,014.8	19,719.4
Georgia	6.0	12.1	18.3	8,360.3	16,720.7	25,334.3
Highgate	3.9	7.8	11.8	5,746.5	11,493.0	17,413.6
Montgomery	1.7	3.4	5.2	3,073.3	6,146.5	9,312.9
Richford	2.7	5.4	8.2	4,276.2	8,552.3	12,958.1
Saint Albans City	1.7	3.3	5.0	2,984.8	5,969.5	9,044.7
Saint Albans Town	5.4	10.7	16.2	7,524.9	15,049.9	22,802.8
Sheldon	2.4	4.9	7.4	3,948.2	7,896.4	11,964.2
Swanton	5.9	11.8	17.9	9,408.3	18,816.7	28,510.1
Grand Isle County						
Alburgh	2.8	5.5	8.4	4,371.9	8,743.9	13,248.3
Grand Isle	2.2	4.4	6.6	3,650.3	7,300.7	11,061.6
Isle La Motte	0.8	1.6	2.5	1,969.0	3,938.0	5,966.6
North Hero	1.1	2.2	3.3	2,316.8	4,633.6	7,020.5
South Hero	2.2	4.3	6.5	3,606.1	7,212.1	10,927.4

RENEWABLE ENERGY CREDITS (REC)

The generation targets do not take into consideration renewable energy credits (RECs). RECs are legally created when a renewable energy generation facility is constructed. RECs can then either be "retired" by their owner or sold within the New England regional market. There is a contentious discussion in Vermont about the current REC system and whether or not the current system should continue to be used. This discussion is outside the scope of this plan. This is due, at least in part, to changes that are currently occurring in regards to the disposition of RECs, particularly for net-metering projects.

For the purposes of this plan, all new solar, wind, or hydro generation in the region shall be considered to be progress toward the regional generation targets. This is regardless of whether to RECs are retired in state or sold out of state.

FIGURE 4.14 CAPACITY FACTOR - NOT ALL GENERATION IS EQUAL

This section provides targets for new renewable generation from solar, wind, and hydro sources. However, there may be a preference for one kind of renewable energy generation vs. another type of renewable generation within the region. It is possible (but not simple) to "swap" one generation type for another (for example, the region could decrease the amount of solar in favor of more wind).

It is important to recognize the different types of renewable energy are not equal, and each have a different "capacity factor" (actual output over time). For example, a solar generation system with a capacity of 100 MW, in practice it won't produce energy at that level all the time because the sun is not available for 24 hours a day, 365 days a year. Solar in Vermont is generally considered to have a capacity factor of 14%. Wind generation in VT, on the other hand, has a capacity factor of roughly 35%, because winds are more consistent source of energy than the sun. This means that if a reigon or community was determined to reduce the number of wind generation needed to reach targeted by the LEAP model, significantly more solar would be needed to make up the lost capacity.

Capacity factors also exist for hydro (40%) and biomass generation facilities (47%).