SECTION V

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

While Section IV focuses on cataloguing the Northwest region's current energy demand and generation capacity, Section V 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

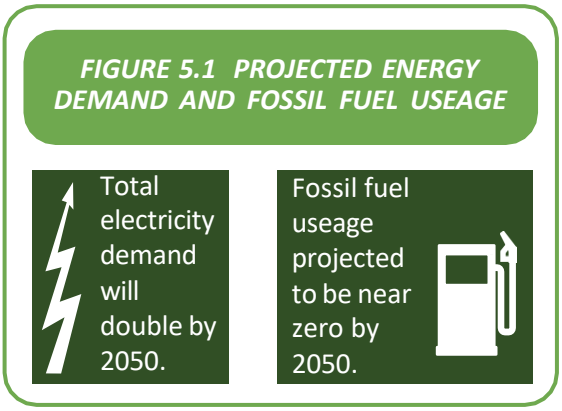
Energy targets were created by the Department of Public Service using the LEAP (Long-range Energy Alternatives Planning) software to create a model of the demand for and supply of total energy usage in Vermont and the region. LEAP software is a system that allows users to create complex models of future energy use. The LEAP model does not identify specific costs that would be incurred in the future. Instead, it compares 2050 costs among various scenarios, in order to achieve the least-cost alternative to meet legislative goals. The LEAP model also includes impacts that do not result in out-of-pocket costs, such as impacts of pollution. 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 Northwest Regional Planning Commission in partnership with the Department of Public Service.

ONE MODEL - TWO SCENARIOS

The model created in LEAP actually contains two scenarios. The first scenario—the reference scenario— models what we will achieve based on current trends. The second scenario is designed to achieve the goal of meeting Vermont's greenhouse gas reduction obligations under the Global Warming Solutions Act (GWSA). This scenario, called the "CAP Mitigation" scenario, is adapted from the Vermont Total Energy Study (TES) Total Renewable Energy and Efficiency Standard (TREES) Local scenarios.[3] More information regarding the TES can be found on the Department of Public Service website.[4]

FIGURE 5.1 PROJECTED ENERGY DEMAND AND FOSSIL FUEL USEAGE



To meet the GWSA goals, total energy use will need to decline despite a growing population and economy. 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.

[3] 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."

[4] 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 CAP Mitigation scenario is a key point. This difference represents the amount of total energy demand that will need to be eliminated to reach the state's and region's energy goals by 2050. The many challenges that could inhibit regional efforts to reach conservation and generation targets are covered in detail in Section VI.

LEAP INPUTS AND ASSUMPTIONS

This LEAP model was developed for the state Comprehensive Energy Plan and disaggregated for each regional planning commission accounting for share in population, housing units, industries, commercial floorspace, number of vehicles and presence of natural gas pipelines. More information on the LEAP modeling inputs and assumptions can be found in Appendix D of the 2022 Vermont Comprehensive Energy Plan. This disaggregated "share" represents only one of the many paths the Northwest region may take to attain its energy goals and does not necessarily set a mandatory target for the region to achieve.

FIGURE 5.2 THERMAL DIRECTIONAL GOALS

Significantly decrease use of fossil fuels.

Significantly increase number of regional residential cold climate heat pumps and heat pump hot water heaters.

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 4.1 (page 17).

FIGURE 5.3 CHANGE IN FUEL SOURCE - RESIDENTIAL THERMAL

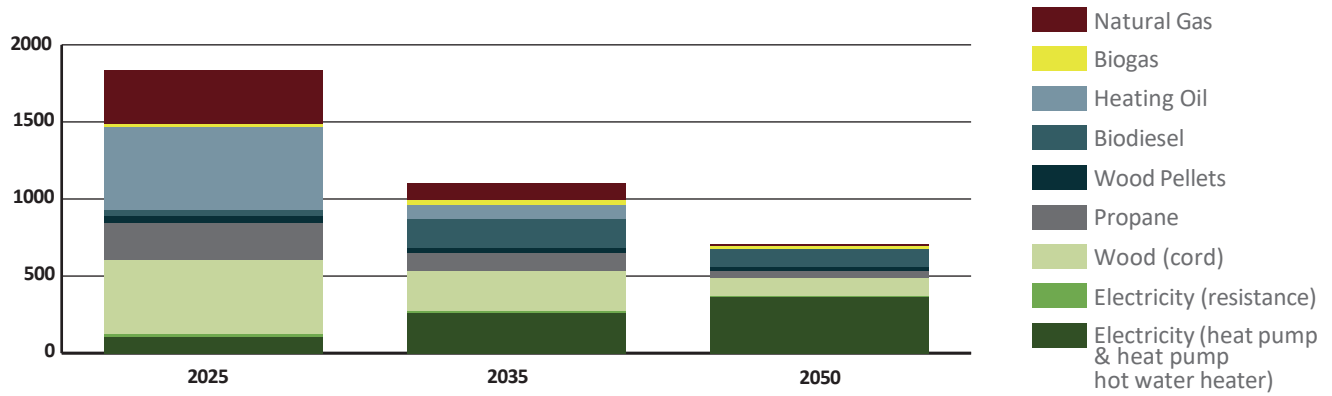
	2021	2050	Difference
Natural Gas	561	10	56x less
Propane	441	44	10x less
Electricity (*Heat Pump & Resistance*)	109	368	3.4x greater
Fuel Oil	947	92	10 x less
Wood (*Pellet & Cord*)	404	20	20x less
Biogas	0	115	-
Other	60	-	-

Source: *U.S. Census American Community Survey and 2023 Regional LEAP Modeling*

SPACE HEATING

To achieve the energy goals, according to the LEAP model, the amount of energy used for residential home space heating demand is expected to fall regionally between the present and 2050 (again, due in large part 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). Commercial and industrial retrofits and thermal efficiency upgrades can make a big impact on energy saving efforts.

FIGURE 5.4 CAP MITIGATION SCENARIO: RESIDENTIAL THERMAL ENERGY USE



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 residential home heating source. The regional model shows the elimination of fuel oil as a heating source by 2050. Liquid propane and natural gas use are projected to drop substantially during the model time frame.

While electricity use only needs to increase by roughly 3 times to meet residential demand, this represents a 23 times increase in the number of residential heat pumps needed. Heat pumps are most effective when residential properties are fully weatherized, therefore the rate of weatherization will need to dramatically increase as well, although this version of the model does not provide a specific target.

Industrial and commercial space heating demand is also estimated in the LEAP modeling. Due to the lack of existing data on commercial energy heating, it is difficult to accurately determine the scale of change necessary. However, it is clear that industrial and commercial uses will need to transition from fossil fuels to electricity to meet energy goals, including nearly eliminating natural gas usage. To support this transition, there will need to be a large increase in the number of commercial cold climate heat pumps. According to the LEAP model, in 2020 there was an estimated 250 commercial cold climate heat pumps. This would need to increase almost 70 times to 17,394 to meet the 2050 goal.

FIGURE 5.5 TOTAL RESIDENTIAL HEAT PUMPS

2020 (Est.)	1,162	
2025	7,000	**6x** more than 2020
2035	18,821	**16x** more than 2020
2050	27,736	**23x** more than 2020

***Source:** Efficiency Vermont, LEAP Modeling, CAP Mitigation Scenario*

FIGURE 5.6 COMMERCIAL DIRECTIONAL GOALS

Significantly decrease use of fossil fuels for commercial and industrial heating.

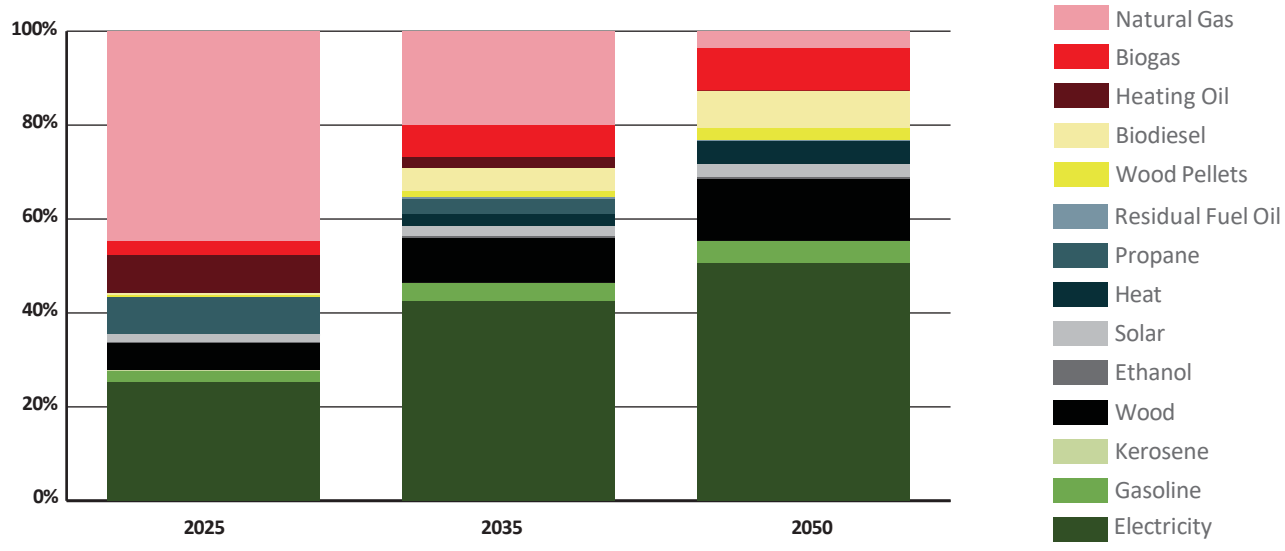
Significantly increase number of regional commercial cold climate heat pumps.

FIGURE 5.7 COMMERCIAL COLD CLIMATE HEAT PUMPS

2020	250
2025	4,497
2035	13,601
2050	17,394

Source: Efficiency Vermont, Regional LEAP Modeling, CAP Mitigation Scenari

FIGURE 5.8 CAP MITIGATION TOTAL REGIONAL INDUSTRIAL SECTOR FINAL ENERGY DEMAND (Thousand MMBTUs)



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 5.3.

TRANSPORTATION

The pace of reduction in gasoline vehicles will have to drastically increase in order to meet the 2050 goals. As part of this transition, adoption of electric vehicles will also need to increase. The region is achieving its goals for plug-in hybrid vehicles (PHEV) but adoption of fully electric vehicles (BEV) has lagged behind. While the average gas vehicle in Vermont has a fuel efficiency of 19 MPG, electric vehicles use far less energy, equivalent to 100 MPG. Therefore, transition to electric vehicles is also expected to reduce total energy use.

The LEAP modeling assumes vehicles miles traveled (VMT) will decrease by 10% by 2050. As VMT currently appears to be increasing statewide and carpooling is decreasing, these trends will need to be reversed to meet the 2050 goal.

FIGURE 5.9 TRANSPORTATION DIRECTIONAL GOALS

- ↓ Significantly decrease use of fossil fuels, such as gasoline and diesel.
- ↑ Significantly increase adoption of electric vehicles.
- ↓ Decrease average vehicle miles traveled.

FIGURE 5.10 TARGET: GASOLINE ENERGY USE

	Gasoline in Thousand MMBTU	% Change from Present Est.
2025	2,372	-25%
2035	1,883	-65%
2050	1,298	-95%

Source: *2023 Regional LEAP Modeling, CAP Mitigation Scenario*
Data Note: *Current est. include only household vehicles, this estimate may also include commercial or fleet vehicles*

FIGURE 5.11 TARGET: ELECTRIC VEHICLE - TOTAL REGISTRATIONS

	Plug-In Hybrid (PHEV)	Battery Electric Vehicle (BEV)	% Change from Present Est. (Total PHEV & BEV)
2025	290	1,939	162%
2035	276	23,427	2,382%
2050	66	51,071	5,902%

Source: *2023 Regional LEAP Modeling, CAP Mitigation Scenario*

Medium and heavy-duty trucks are also expected to transition primarily to electric energy from diesel. To meet regional transportation BTU targets, the region should support policies that would result in more electric vehicles and reduced vehicles miles travelled.

ELECTRICITY AND ELECTRICAL GENERATION

Electricity demand will increase significantly in the region under the "Cap Mitigation" scenario. Electricity increases from 20% to 39% of total energy demand between 2015 and 2050. As a result, while advances in energy efficiency are expected to reduce electrical energy usage through 2025, from 2025-2050 electrical use will increase again.

Current regulations require Vermont's utilities ensure electricity is 75% renewable by 2032. Further

increasing the percentage of renewable energy in the electricity supply will require interstate coordination to ensure reliability. There exists continued debate as to exact 2050 goals, but fossil fuels are unlikely to form a major part of the electric energy supply by 2050.

FIGURE 5.12 CAP SCENARIO: ENERGY USE FOR PASSENGER CAR & LIGHT DUTY TRUCKS

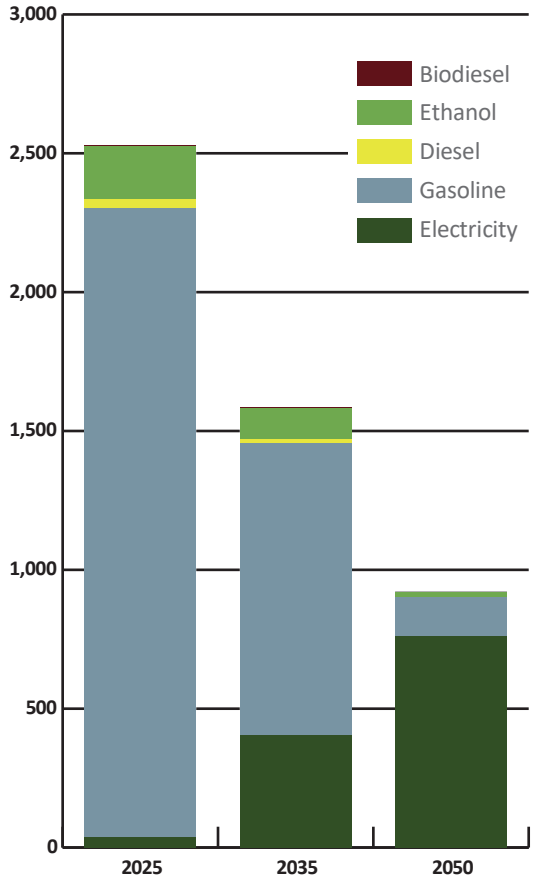
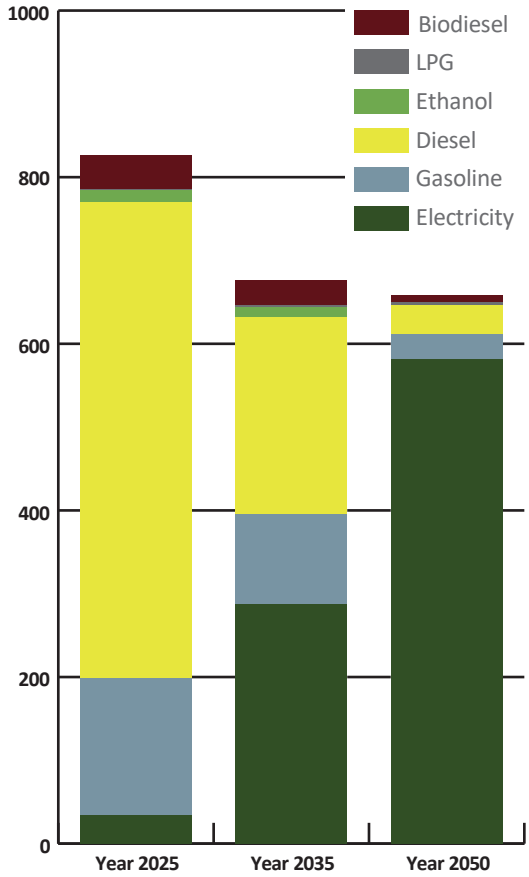


FIGURE 5.13 CAP SCENARIO: ENERGY USE FOR MEDIUM & HEAVY-DUTY TRUCKS

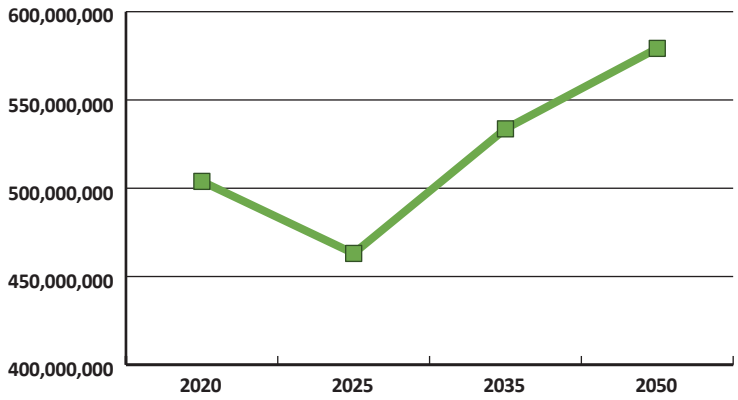


REGIONAL GENERATION TARGETS

Based on the 2050 energy goals 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 generation targets are based on the estimated needs to cover the 50% of the region's energy use in 2050. It is expected that the other 50% of energy would be generated out-of-state.

Figure 5.15 displays the regional targets for new renewable generation. The targets envision a high solar mix of renewable generation in the region. 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.

FIGURE 5.14 TOTAL ELECTRICAL ENERGY USE: CHANGE FROM 2020 TO 2050



It is important to stress that the generation targets in Figure 5.15 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.

FIGURE 5.15 RENEWABLE GENERATION TARGETS

	2025	2035	2050
Solar	15.0	65.0	140.1
Wind	0.2	0.9	1.9
Hydro	0.4	1.9	4.0
Biodigesters	0.2	1.0	2.1
MWH Total (in MWH)	23,396	101,384	218,365

Source: NRPC Targets based on Department of Public Service Renewable Generation Scenarios Tool

HYDRO GENERATION

The 2050 hydro generation target of 4 MW was developed based on two assumptions. First, based on the 2008 state study of possible additional capacity in existing dam sites, the region could add 750 kW of hydro. The remainder of the 3.25 MW could come from a number of small run-of-the-river systems. Run-of-the-river systems are flexible lower impact systems that generate electricity, small sites can have an average of 100 kW in generation. New traditional hydro sites were not included in the estimate.

BIODIGESTER GENERATION

Biodigesters take waste product from farms or food production and use anaerobic digestion to turn this waste into byproducts into methane gas and other byproducts that can generate electricity. Based on current technology, biodigesters are best financially suited for farms of 500 or more cows, of which there are currently 19 in the region. Assuming an average150 kw project and that not every farm will have a biodigester, the total assumption is 2.1 MW.

WIND GENERATION

Based upon the analysis in Section V, the Northwest Region 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 The NRPC remains committed to achieving new wind generation by 2050, but only through the construction of appropriately scaled wind generation facilities. 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. Based on these constraints, the NRPC has set a wind generation target of 2 MW to be achieved through small-scale wind.

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.

SOLAR GENERATION

The remainder of the regional energy generation is expected to come from solar, an additional 140.1 MW, which equates to around 980 acres of solar [Once we have an updated prime solar acreage we will add it here- expected to be about 4% of prime solar land].

REGIONAL MUNICIPAL ELECTRICITY GENERATION

Department of Public Service standards for enhanced energy plans require that regional planning commissions develop targets for each municipality in the region. The NRPC is developing solar, hydro and biodigester targets

for municipalities. 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 VI) and because of the NRPC's position regarding the construction of "industrial" and "commercial" wind facilities in the region as noted above.

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 is due, at least in part, to changes that are currently occurring in regards to the disposition of RECs, particularly for net-metering projects. This discussion is outside the scope of this plan.

For the purposes of this plan, all new renewable generation in the region shall be considered to be progress toward the regional generation targets. Regardless of whether RECs are sold or retired, this plan encourages the development and production of renewable energy in the region.

FIGURE 5.16 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 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 region 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%).