2020

Manchester Energy Plan

Town of Manchester, Vermont

Developed by the Manchester Planning & Zoning Office, Manchester Energy Committee, Manchester Planning Commission, & Bennington County Regional Commission.

5/19/2020

Adopted by the Manchester Selctboard

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Section 1 | Manchester's Energy Mission

The Town of Manchester is committed to working toward a sustainable energy future in a manner that minimizes environmental impacts and supports the local economy. The 2017 Town Plan includes the following energy mission: *Encourage and support the conservation of energy and the development of renewable energy resources in Manchester.* The purpose of this section of the Town Plan is to advance those objectives by promoting public awareness of energy issues, assessing current and projected future energy use and sources of energy, identifying conservation and efficiency opportunities, and by evaluating the potential for utilization of renewable energy resources to meet the town's energy goals. In keeping with this mission and in support of state identified energy goals, Manchester's energy goal is as follows: *Manchester will reduce the use of petroleum based fuel sources for heating and transportation while increasing the use of renewable sources, including electricity powered alternatives.*

Manchester Energy Goals

- Reduce dependence on non-renewable and imported energy sources.
- Promote energy conservation and efficiency in residential, commercial, and industrial structures and operations.
- Reduce energy consumption in all public buildings and operations.
- Facilitate wise development of sustainable local renewable energy resources.
- Support the local economy by reducing overall expenditures on energy while increasing investment in local energy businesses and products.

Vermont Energy Goals

- Obtain 90% of energy for all uses from renewable sources by 2050;
- Reduce statewide energy consumption by 30% by 2050;
- Reduce greenhouse gas emissions to 50% below 1990 levels by 2028 and 75% by 2050;
- Rely on in-state renewable energy sources to supply 25% of energy use by 2025;
- Improve the energy efficiency of 25% of homes by 2025;
- Meet the Vermont Renewable Energy Standard through renewable generation and energy transformation.

Electricity will need to play an increasingly important role to meet state and local energy goals. In general, electricity generation has occurred in large faraway fossil fuel based power plants, such as coal, oil, and natural gas based facilities. Furthermore, traditional electric-resistance heating systems are inefficient. Vermont currently obtains much of its electricity from nonrenewable energy sources, although a growing amount is derived from local and imported renewable sources, including hydro, wind, and solar. Electricity is used currently for lighting, telecommunications, appliances, and other equipment, while space heating, industrial processes, and transportation systems rely heavily on fossil fuel based technologies. The transportation sector in particular will need to very significantly reduce its dependence on fossil fuel based power, while increasing biological fuel based systems and converting to a more electric fleet. At the same time, new heat pump technologies that allow more efficient use of electricity to heat buildings will need to be widely deployed. In addition, solid and liquid biofuels – wood chips, and pellets, cord wood, and biodiesel in particular – will need to displace fossil fuel based energy for heating and transportation.

Meeting these energy goals will have multiple beneficial results for Manchester, including long-term costs savings, a more robust, resilient, and sustainable local economy, and a cleaner more resilient natural environment. By implementing this energy plan, Manchester will be working to do its part to reduce its pollutive effects, including its carbon footprint.

Section 1.1 | Act 174 & Enhanced Energy Planning

The Vermont Legislature approved Act 174 in 2016 to enhance regional and municipal energy planning and to establish a way for local communities to have more input on the siting of electric generation facilities. The act established standards that, if met by a regional or municipal plan, assure that greater weight ("substantial deference") be given to those plans in Section 248 proceedings before the Vermont Public Utility Commission regarding the siting of electric generation facilities. The standards require that plans include specific components organized into three broad categories:

1. **Analysis and Targets:** Assessment of current energy use and targets for future consumption.
2. **Pathways:** Identification of implementation actions and strategies to achieve future targets.
3. **Mapping:** Renewable energy resource maps and siting guidelines for renewable electric generation facilities.

This energy element of the Manchester Town Plan is consistent with the Act 174 planning standards and statewide policies and goals outlined in the 2016 Vermont Comprehensive Energy Plan (CEP). Attaining Vermont's energy goals (summarized in the sidebar on the previous page) requires action at the state, regional, and local levels. A regional energy plan was adopted in 2017 by the Bennington County Regional Commission (BCRC) and certified by the Vermont Department of Public Service. This enhanced energy plan element of the Manchester Town Plan draws from and is consistent with the regional goals and targets for efficiency, alternative energy use, and renewable energy development put forth in the regional plan.

Section 1.2 | State & Regional Energy Goals

The Vermont CEP, and related reports such as the Vermont Total Energy Study, establish benchmarks to help guide progress toward a sustainable future. A central goal of the plan is to attain ***90% of all energy used in Vermont from renewable sources by 2050 (90x50)***. Reaching this goal will require a significant reduction in total energy consumption over time, achieved through various conservation and efficiency measures, use of alternative fuels, development of renewable energy resources in the region, and increased imports of renewably generated electricity.

The BCRC worked with the Vermont Energy Investment Corporation (VEIC) to model levels of future energy use required to support attainment of state and regional goals in the Bennington County region (Figure 1.1). A leading finding of this analysis is that total energy consumption in the region will have to fall by nearly 50 percent by 2050. Energy conservation efforts combined with improved energy efficiency through technology upgrades and building weatherization will enable communities in Vermont to reduce energy consumption to sustainable levels into the future.

As already noted, a key aspect of improved efficiency will be a greater reliance on electricity to meet energy demands, especially in thermal and transportation sectors. By 2050, nearly half of all energy used in the region will be supplied through electricity, much of that from local generation (Figure 1.2). Electricity not only provides great efficiency gains over fossil fuel combustion, but also can be generated from renewable resources such as solar, wind, and hydro facilities. New electricity-driven technologies such as air and ground source heat pumps and electric vehicles will provide the efficiency needed to lower overall energy consumption while maintaining economic progress and supporting a high quality of life for residents.

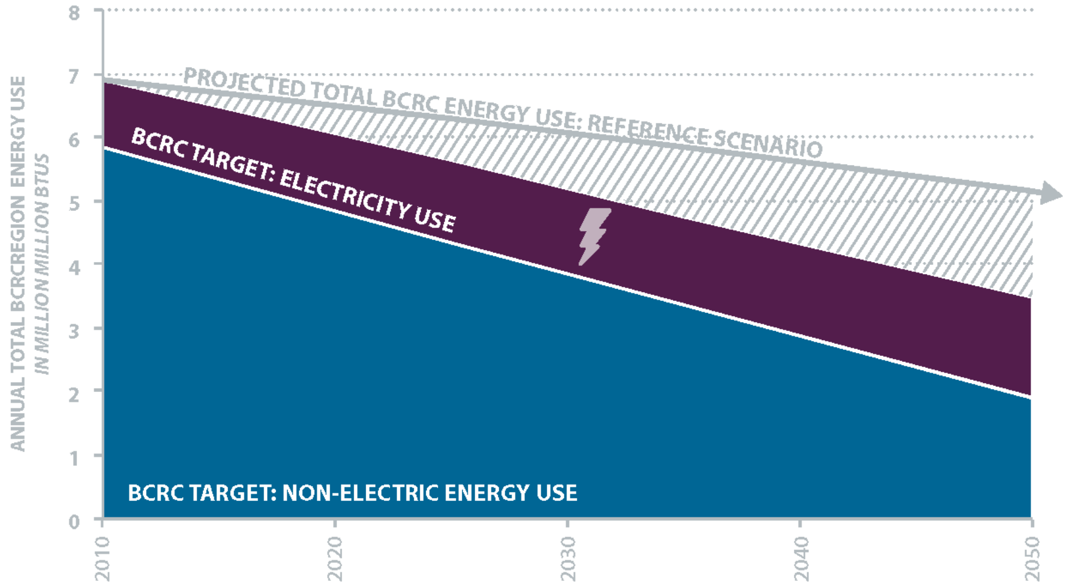


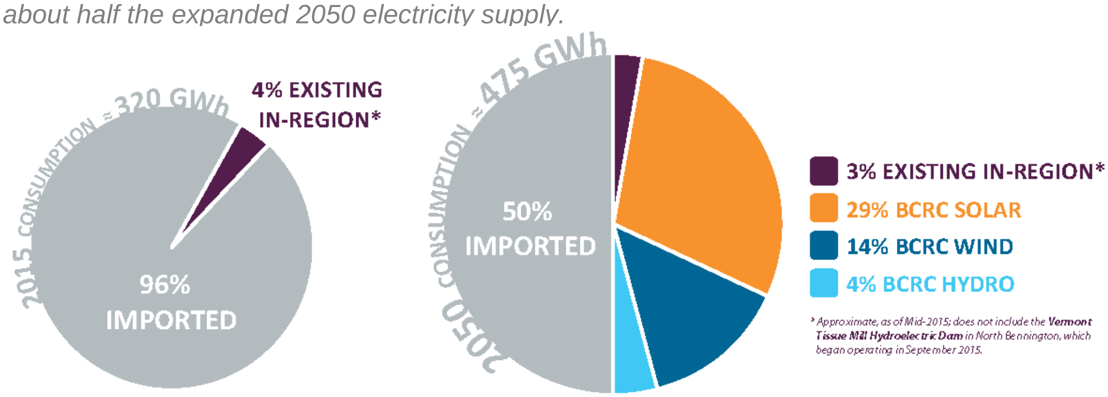
Figure 1.1 BCRC Region Energy Use Targets

According to LEAP Systems Model estimates, to achieve the state 90X50 energy goal, the BCRC region will need to dramatically reduce energy use by increasing efficiency and relying on electricity for many more purposes. The 'Reference Scenario' represents the likely energy use trend according to current energy efficiency programs and policies in place. Current policy is insufficient to meet energy use reduction goals.

Though this major shift in energy use is considerable, there are opportunities to lower costs and bolster the local economy through a transformation of the energy sector, where over $150 million per year currently is spent in the county on electricity and heating and transportation fuels. Nearly all this money currently flows out of the region and the state through the purchase and transport of imported fossil fuels and electricity. Reducing spending on energy and redirecting remaining funds to local energy businesses and jobs will better retain wealth in local communities.

Figure 1.2 Sources of Bennington Region Electricity, 2015 v. 2050

Electricity use will increase significantly by 2050, with in-region renewable generation equivalent to about half the expanded 2050 electricity supply.



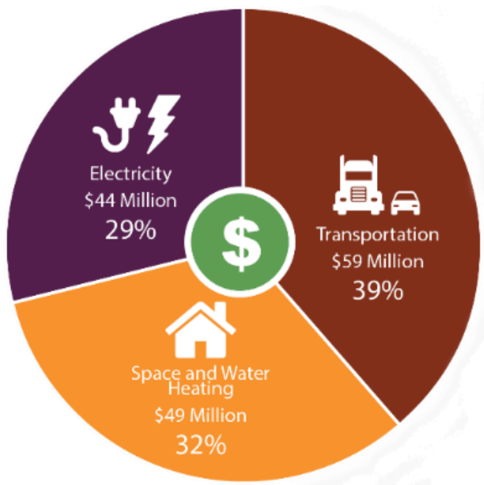


Figure 1.3
BCRC Region Energy Cost Estimates, 2015

More energy is used for transportation in the region than for any other purpose. Most electricity currently is used for lighting, appliances, cooling, and equipment (including technology and communications), but it is expected that electricity usage will soon overlap extensively into the thermal and transportation sectors.

Section 2 | Current & Projected Future Energy Use

It is important to understand the current amount of energy used for various purposes in Manchester, the sources of that energy, and how the amount and mix of energy demand may change over time as the town moves toward its short and long term energy goals. This section will analyze energy use across the electric, thermal, and transportation energy sectors and, using data from the Long Range Energy Alternatives Planning (LEAP) Systems Model, identify future targets for reduced energy consumption and fuel-switching for transportation, residential heating, industrial, and commercial applications. The LEAP modeling was completed by the Vermont Energy Investment Corporation (VEIC) using policies and assumptions contained in Vermont's Total Energy Study. Data and projections for Manchester are based on population, employment, and building stock data that includes Manchester Village.

Manchester includes a mix of residential, commercial, and institutional uses, as well as extensive rural open spaces. The town's 4,391 residents occupy just over 2,000 housing units, approximately 75 percent of which are single family homes. The town also includes over 600 housing units occupied seasonally. The town's economy is supported by a sizable commercial sector and several manufacturing businesses. All of these land uses and associated transportation systems result in considerable energy expenditures. According to the LEAP modeling data, Manchester will need to steadily reduce overall energy consumption to meet energy goals, with total energy demand falling to approximately 50 percent of current levels by 2050 (Figure 2.1).

The most significant trends reflected in this transition, in addition to the steady reduction in total energy consumption, are the dramatic decreases in reliance on all fossil fuels, a significant growth in the use of renewable biodiesel fuel (primarily for heating and heavy vehicles and equipment), and an almost 50 percent increase in electricity consumption. While the use of woody biomass as a space heating fuel is not expected to increase significantly in absolute terms, the lower total energy consumption combined with improved building efficiency and the use of modern wood heating systems means that a much larger percentage of total energy demand will be met using this renewable fuel. The increased reliance on electricity, primarily for space heating and transportation, allows attainment of the much lower total energy demand through efficiency improvements. An assumption built into this model is that nearly all of the new electricity generation by 2050 will be derived from renewable sources.

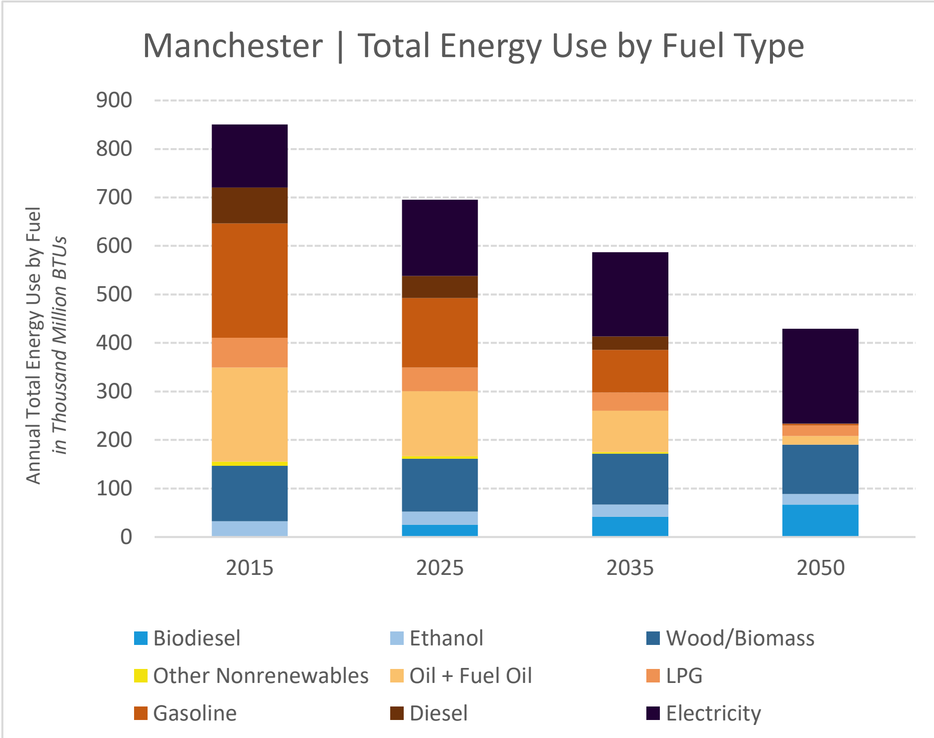


Figure 2.1 Manchester Total Energy Use by Fuel Type, 2015—2050.
Based on LEAP projections.

Section 2.1 | Residential Energy Use

Manchester's households consume energy for space and water heating (thermal applications), for electric lighting, appliances, and equipment, and for transportation. According to US Census (American Community Survey) data from 2015, over half of the households in Manchester are heated with petroleum oil and another one-third are heated using LP gas. Relatively few, therefore, are heated using some type of renewable fuel such as cord wood, pellets, or electric heat pumps (with some significant portion of the electricity derived from renewable generation sources). Even using more generalized regional LEAP modeling data, a significant majority of Manchester's current residential thermal energy demand is met using fossil fuels. Profound changes in total energy demand and in the fuel mix will be required to meet 2050 energy goals (Table 2.1 and Figure 2.2).

Forecasts for energy demand in the residential thermal sector all include significant efficiency gains, resulting in an overall decline in total energy consumption. As a result, the number of homes heating with cord wood, for example, remains about the same even though the amount of that fuel used drops significantly over time. Weatherization of existing homes will need to be a priority in Manchester, as close to half of all residential structures in town are at least 50 years old and likely are not well air-sealed or insulated. According to Efficiency Vermont data, only 37 homes in Manchester have completed registered energy star shell improvement projects.

Table 2.1 Manchester, VT - Total Residential Thermal Energy Demand By Fuel LEAP Model Data and Projections				
Fuel	**2015**	**2025**	**2035**	**2050**
Biodiesel (gallons)	11,983	64,274	116,564	198,268
Cord Wood (cords)	3,273	2,794	2,280	1,605
Wood pellets (tons)	396	556	640	724
Electric Resistance (kWh)	3,014,654	2,607,268	1,466,589	407,386
Heat Pump (kWh)	651,817	3,462,778	6,518,171	8,758,792
Kerosene (gallons)	65,896	46,333	27,800	-
LPG (gallons)	531,473	424,851	283,781	85,298
Oil (gallons)	914,401	652,710	380,916	-

The LEAP model also is premised on an assumption that liquid biofuels will become genuinely renewable (i.e., their net energy yield will improve dramatically over time as technology advances) and will be used to replace petroleum diesel as a primary fuel for many home heating systems. If that assumption is not borne out by real developments over time, it is likely that, for the town to stay on target toward meeting goals, many of those homes will have to switch to either electric heat pumps, wood pellets, or cord wood for their primary source of heat.

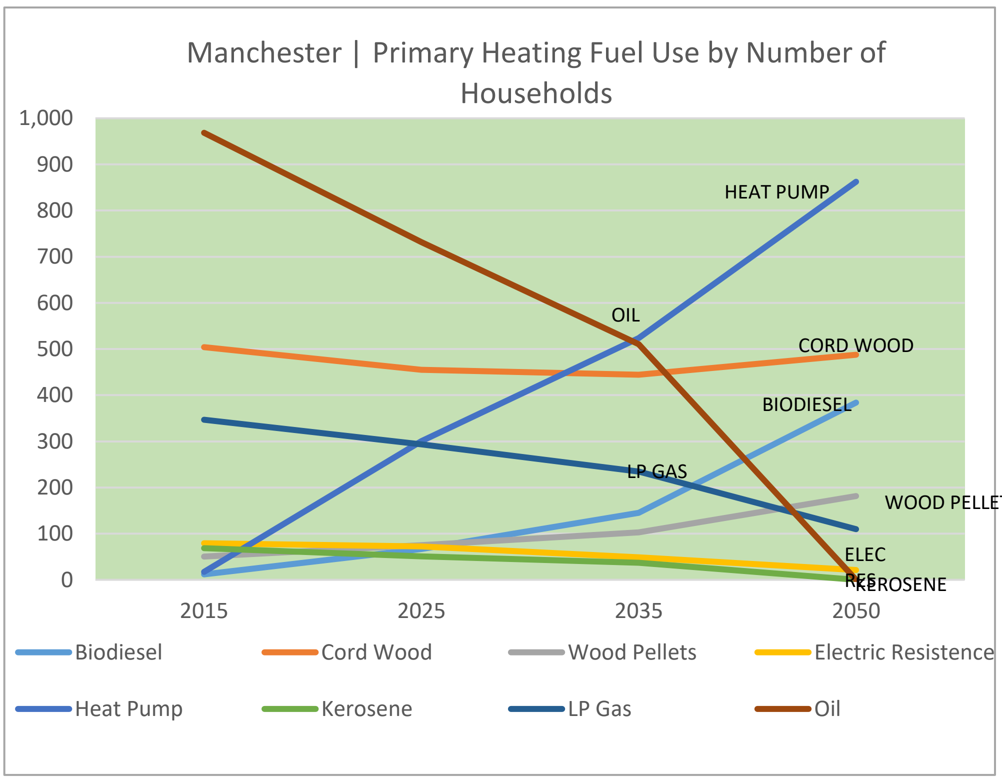


Figure 2.2 Heating Fuel Projections For Manchester Based on LEAP Model Data.

To achieve state and local energy goals, use of petroleum-based heating fuels should decline at a steady rate through 2035 and then more rapidly from 2035 through 2050 as they are replaced by biofuels and by electricity (heat pumps) generated from renewable energy resources. These projections are based on a fixed number of households – newly constructed households are expected to be fully weatherized and use renewable heating fuels. The number of homes using heat pumps as a primary heating source has been increased above LEAP projections by reducing the number relying on other renewable fuels by 20 percent. Weatherization and improvements in efficiency from new heating systems are projected to reduce total energy demand from this sector by over 50 percent.

Projections of residential electricity demand are complicated by the widespread integration of heat pumps (an electricity-driven technology for space and water heating that is much more efficient than older electric resistance heating systems) and electric vehicles (with considerable charging of batteries expected to occur at home-based EV charging ports). Average annual electricity consumption for a household in Manchester is approximately 8,200 kWh (just under 700 kWh per month), an amount that has fallen by over 600 kWh over the past several years as a result of energy efficiency initiatives such as the lighting and appliance incentive programs offered through Efficiency Vermont. Those efficiency improvements will need to be continued into the future, and will be especially important as town wide electricity demand in the residential thermal sector is expected to more than double to approximately 9 million kWh annually by 2050. Electricity usage for residential vehicles is projected to grow from its current negligible amount to over 6 million kWh over that same timeframe. It is important to remember that even though electricity consumption will increase dramatically, total energy consumption (all sources) will decline even more dramatically due to a variety of conservation and efficiency measures, including the far greater efficiency of electricity-driven heat pumps and vehicle motors.

Section 2.2 | Energy Use for Transportation

With transportation using more energy than any other sector, and the vast majority of that energy in form of nonrenewable petroleum fuels, it is clear that major changes must occur in the ways that people and goods are moved around the town and region. Reliance on personal light duty vehicles (LDVs, generally cars, pickup trucks, and SUVs) is widespread across the country and especially so in rural areas like southwestern Vermont. The independence and convenience provided by LDVs is considered essential to Manchester residents and businesses. Consequently, a variety of changes - in technology, alternative transportation modes, and land use patterns - will need to take place over time to maintain quality of life and economic vitality in Manchester.

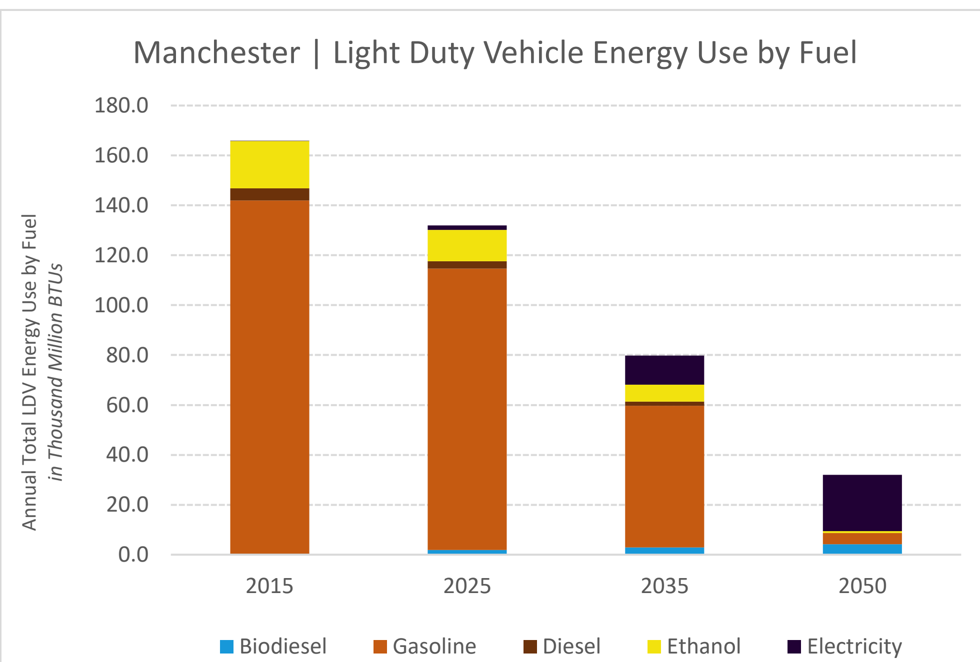


Figure 2.3 Vehicle Energy Use Projections by Fuel Type for Manchester.

Projected reduction in energy consumption in the transportation sector as highly efficient electric vehicles replace gasoline and diesel fueled vehicles. Estimates from LEAP model scenarios.

Fortunately, electric vehicle (EV) technologies have advanced significantly in recent years and these systems should replace internal combustion engines at an increasing rate in coming decades (Figure 2.3). By steadily transitioning the town's LDV fleet, Manchester residents, businesses, and government can improve transportation efficiency while keeping money in the local economy to support renewable electricity generation and local businesses in general. According to the LEAP analysis, Manchester can reduce the amount of energy used for transportation to 20 percent of current levels by 2050 while maintaining the number of miles driven by residents at a constant level. Electrification of the LDV fleet will account for much of this reduction in energy use through improved efficiency. By 2050, electric vehicles are expected to comprise close to 90 percent of the LDVs in Manchester (Figure 2.4), with biodiesel and ethanol fueling most of the rest of the light duty vehicles.

Figure 2.4 Electric Vehicle Targets for Manchester *(approximately 12 EVs were registered in the town in 2015 – LEAP data).*

There are three main kinds of EVs: full electric vehicles, plug-in hybrid (petroleum and electric) vehicles, and hybrid vehicles (in which batteries provide an assist to the internal combustion energy and are charged while driving). Full EVs have larger batteries and do not rely at all on petroleum diesel. With increasing efficiency and driving range, it is expected that most vehicles will be full-electric by 2050. EVs of any type have significantly greater fuel efficiency than that of internal combustion engine vehicles, leading to significant efficiency gains projected over time.

Although EVs certainly will play a major role in reducing energy use while allowing Manchester residents to continue to rely on personal vehicle travel, efficiency gains from EVs alone will not account for all the energy reduction needed to meet future transportation energy targets. Conservation through behavior changes such as carpooling, transit use, and increased reliance on walking and biking will be critical to reaching 2050 energy targets. Policies and programs that encourage compact mixed use development and implementation of bicycle and pedestrian friendly ("complete street") roadway design

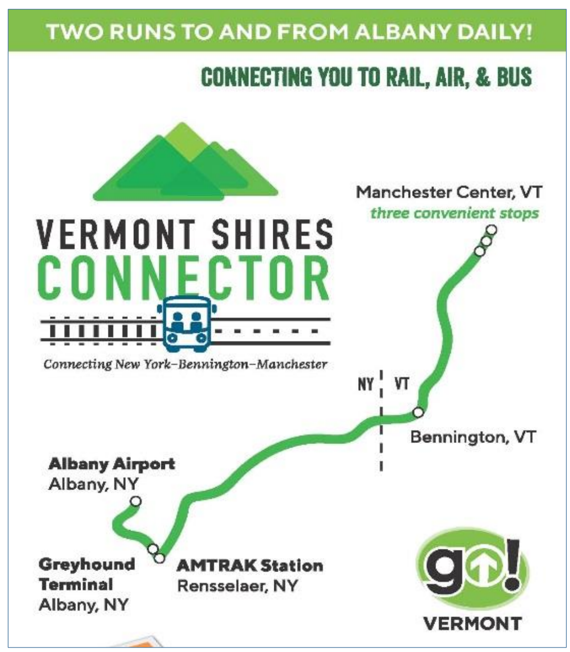


Figure 2.5 Vermont Shires Connector

This new intercity transit service is an example of the type of travel option that should be made increasingly available to residents in the future.

are necessary to shift the predominant transportation model to less on vehicles. Expansion of local and intercity bus systems, exemplified by the recent Vermont Translines shuttle between Manchester, Bennington, and transportation hubs in the Albany metro area is another example of the type of change that will be needed to allow residents to reduce reliance on personal vehicles while retaining the ability to conveniently access local, regional, and national destinations.

Benefits of AV Technology

Energy Conservation:

- Consistent acceleration deceleration resulting in improved fuel economy.
- AV operating in convoy leading to improved roadway capacity and increased passenger and cargo efficiencies.
- Reduced crash occurrences leading to lighter vehicles with better fuel economy and diminishing range issues associated with EV.

Land Use:

- Currently, one third of downtown land areas may be devoted to parking. AV could drop passengers off and drive away to satellite parking facilities, freeing up significant land in downtowns for greenspace or mixed commercial and residential uses.
- AV sharing programs may decrease car ownership and therefore the amount of land devoted to parking.
- AV sharing may also eliminate the need for parking altogether during peak hours, as the AV continuously travels to pick up and drop off passengers.

Another aspect of the changing transportation sector that may increase efficiency is the development of automated vehicle (AV) technologies. The eventual conversion of the fleet to autonomous vehicles will need to be planned for. AV technology has the potential to reduce energy and pollution costs associated with the transportation sector. At the same time it will affect traffic safety and congestion, and has the potential to affect land use patterns significantly. This AV conversion may be slower to come to rural areas such as Manchester, but it is already occurring with new on-board technologies that evaluate road conditions, terrain, and obstacles while a vehicle is in operation on the road. Town planning officials should be engaged in learning about these emerging AV technologies, and planning for them accordingly.

There are different levels of automation, from on board functions that assist the driver, to full automation in which the vehicle is fully capable of performing all driving functions without a driver (see Figure 2.6). In addition to AV technology for the light duty fleet, driverless transit could increase transit options in rural areas. Transit is typically cost prohibitive in low density areas, but not having to pay a driver will significantly reduce costs, perhaps better enabling shuttles to operate in rural areas such as ours. There are also emerging technologies for electric automated flight that could revolutionize regional travel options. Such vehicles could allow personal flights to metropolitan areas from rural towns such as Manchester, further decreasing the need for personal LDV use and ownership.

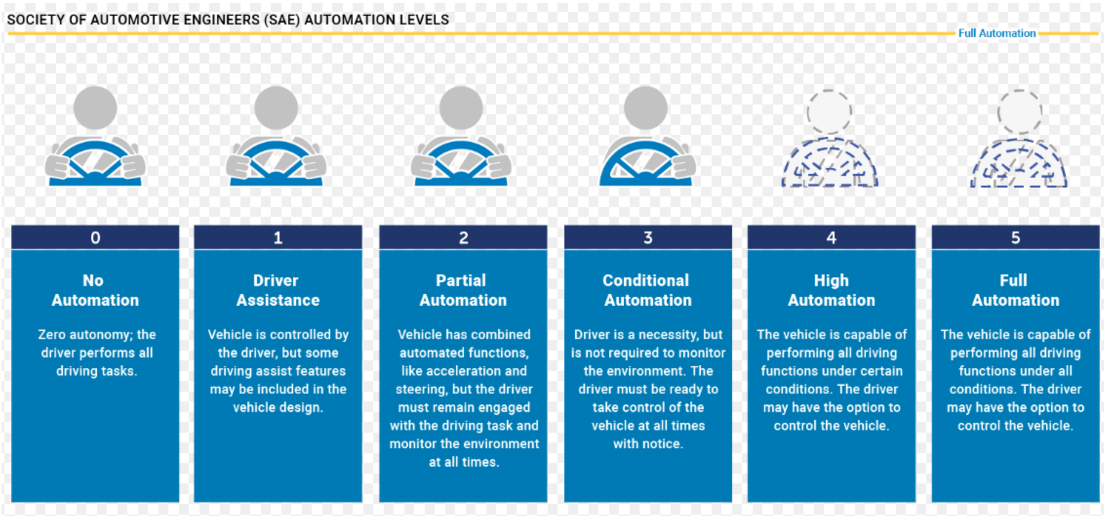


Figure 2.6 Vehicle Automation Levels. *Source: https://www.sae.org/*
Levels 1 and 2 are already common on the roadways of Vermont.

Section 2.3 | Commercial & Industrial Energy Use

Manchester is an important retail and service center for the region, with over 400 businesses and approximately 4,000 employees located in the town. Those businesses use a considerable amount of energy for space heating and cooling, operations, and transportation (for products, commuters, and customers). A particularly important consideration for Manchester and its economy is the energy demand for transportation for the many visitors who spend time in town and patronize local businesses throughout the year.

Commercial and industrial uses together account for more total energy demand than residential uses in Manchester (excluding transportation demand for each sector), and the decrease in consumption in these sectors is not expected to be as great as in the residential sector (Figure 2.7). Reliance on electricity in these sectors, already 50% greater than in the residential sector (Efficiency Vermont data), is expected to grow in importance due to use of heat pumps and electrification of manufacturing and other business functions. Reductions in fossil fuel use will occur in both sectors, although a significant amount of propane use will remain for certain commercial applications and residual fuel oil for some industrial applications.

The use of wood (biomass) in commercial and industrial uses is expected to grow substantially by 2050. An important opportunity for converting to wood chip and wood pellet based heating systems exists for nearly all commercial and industrial structures. Moreover, the clustering of these buildings in the downtown and in business parks makes district heating systems a viable and cost-effective option for many sites. It is important to note, however, that concentrations of wood burning systems could pose threats to air quality unless those systems are properly installed and maintained. Large-scale wood energy-based district heating systems may offer the ability to generate electricity in certain cases, especially where energy demand is relatively consistent year-round. The energy and environmental benefits of such systems are complemented by the economic benefits of reducing the amount of money spent on imported energy while supporting opportunities in regional wood fuel businesses.

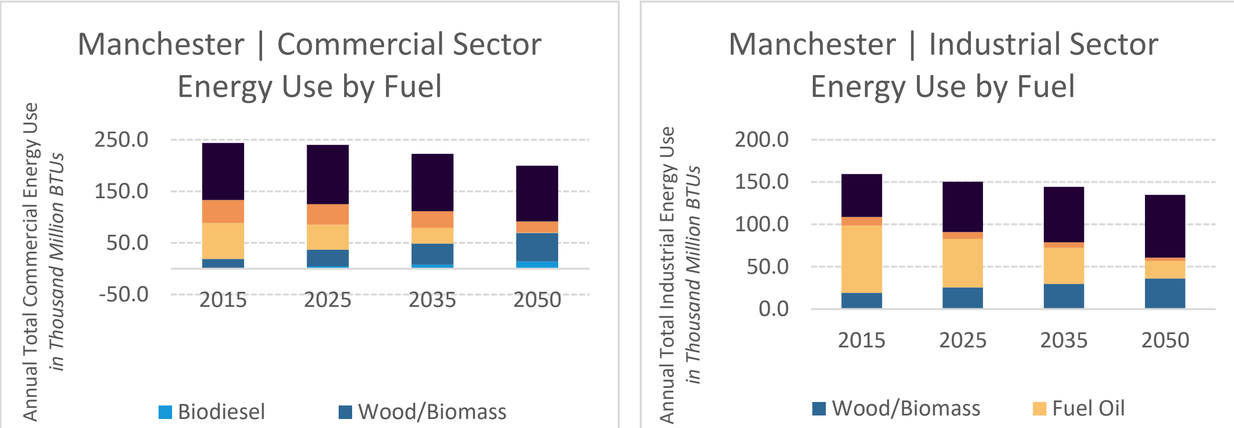


Figure 2.7 Nonresidential Projected Energy Use by Fuel in Manchester.

Commercial and industrial energy demand is expected to decline slightly over the next several decades, with an increase in efficient electrical systems and biomass heating replacing significant amounts of oil and propane.

Transportation is an essential component of all of the region's commercial and industrial enterprises. Commercial businesses require shipments of materials from suppliers for local sales, and industrial businesses receive raw materials and ship finished products to markets. A greater reliance on rail and public transit is anticipated and alternative fuels—electricity for light vehicles and biodiesel for heavy vehicles— will be used to power the private and commercial vehicle fleet. Tourism is a major component of the local economy and it will be necessary to ensure that those visitors have a way to reach the region and have sufficient mobility once here. Because electric vehicles are expected to play a large role in personal transportation, it will be important to ensure that sufficient charging stations are available at locations convenient for visitors as well as local residents.

In the commercial and industrial sector, biodiesel also may become an important fuel in the regional economy, and the ability to produce biodiesel fuels locally from oil seed crops offers significant opportunities for economic development through sustainable energy production. It will be important, however, to ensure the area's best agricultural soils are available for the production of food to meet an increasing demand for locally sourced foods. In summary, the energy demand forecasts through 2050 point to several key considerations and general approaches for addressing commercial and industrial sector needs:

- Continuation of conservation and efficiency programs to reduce overall energy demand.
- A focus on biomass-based heating systems and district heating system applications for clusters of commercial and industrial buildings.
- Use of combined heat and power (CHP) technologies (also known as cogeneration) whenever feasible.
- Greater reliance on electricity through use of heat pumps in smaller commercial buildings and electrification of industrial processes.
- Expanded public transportation options, including intercity and local connections.
- Development of EV-charging infrastructure and integration of local biodiesel production and use into the economy.

Section 2.4 | Municipal Government Energy Use

The Town of Manchester relies on energy to provide services to the community. The town owns and operates buildings, vehicles and equipment, and is responsible for other services such as the provision of water, treatment and disposal of wastewater, and street lighting. The town already has taken steps to reduce its energy use through use of more efficient lighting and equipment in office buildings, replacement of streetlights with LED fixtures, and by pursuing other initiatives through Efficiency Vermont and other resources. Town Hall is fitted with smart thermostat technologies. *New town buildings and systems will be designed to take advantage of energy efficient measures. As repairs and improvements are made to existing buildings and systems, efficiency measures will be an integral part of those projects.*

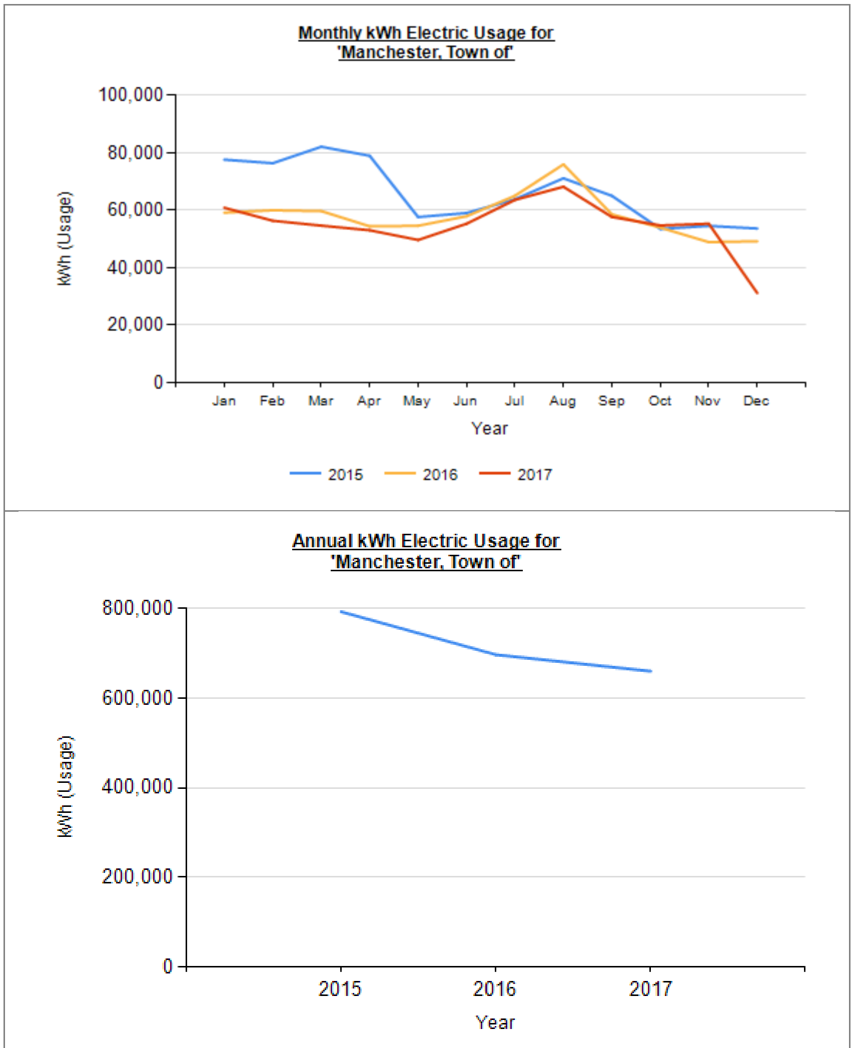


Figure 2.8 Electric usage for Town of Manchester utility accounts.
Efficiency Vermont obtained customer data from GMP to develop these graphs. The accuracy of the consumption data shown is completely dependent on the quality and availability of data provided the utility.

The town recently took advantage of a program coordinated by Efficiency Vermont whereby it replaced all of its old (mostly 150W high pressure sodium) streetlights with new energy efficient

LED streetlights. As part of this project, the town identified some streetlights as unnecessary and these were removed altogether. The new LED streetlights are much more energy efficient. The light from the LED units also is more "natural" and is distributed evenly, with very little wasted light or areas of overlapping illumination between adjacent lights. Green Mountain Power, also benefits from such efficiency upgrades by realizing comparable savings on the amount of electricity it must purchase. The town will continue to pursue opportunities for such conversion, and currently is replacing all the parking lot lights at town hall with state of the art, durable, downcasted LED lighting. *All planned future streetlights and streetlight replacements in the Town of Manchester will employ LED technology.*

The town has taken a leading role in improving transportation energy efficiency in the community by actively developing bicycle lanes, multi-use pathways, and sidewalks that connect the downtown, schools, neighborhoods, and recreation facilities. The town is currently seeking to conduct a scooping study on redeveloping the former OMYA railroad bed into a multiuse path that would extend the existing town recreation path connecting MEMS and Riley Rink all the way to North Road. Within the year, Depot Street is due to realize bike and pedestrian enhancements, including dedicated bike lanes, separation of sidewalks from the road, and increased crosswalks along this commercial corridor. In addition to this local infrastructure work, the town supported the "Shires Connector" link to regional intercity rail and other transportation hubs (see Figure 2.5). Additionally, the town revised its zoning bylaws to allow denser development within the downtown, while decreasing developable density within the rural areas unless development is clustered and protects open space. *In line with energy goals, the town will continue to support extension of bike and pedestrian pathways and to encourage dense development of its core.*

Another area in which the town can have significant impact is in its vehicle fleet. The town operates a sizeable fleet of vehicles and heavy equipment that use gasoline and diesel fuel. The Highway Department, with its dump trucks, pickup trucks, and array of heavy equipment is the largest user of transportation fuel in the local government. Consequently, its costs will rise more rapidly than any other department as gasoline and diesel fuel costs increase. The police Department also has a significant vehicle fleet. The Water and Wastewater Departments also rely on vehicles and heavy equipment. The use of hybrid SUVs and battery systems that allow for reduced idling might achieve significant fuel savings across town departments. As development and bike and pedestrian infrastructure expansion occurs in the downtown, limited police patrols may be conducted on foot or bicycle, further saving on fuel costs. *The town will seek to replace gasoline powered vehicles with electric and alternative fuel vehicles as the technology becomes available for specialized town uses.*

Section 2.5 | Local Renewable Energy Production

The vast majority of energy used in Manchester is imported from outside the town (and generally from outside the state and nation) in the form of gasoline, oil, propane, and electricity. Some of the imported electricity is generated from renewable sources, primarily electricity obtained from hydroelectric generating facilities in Quebec and Labrador via utility contracts with Hydro Quebec. Even imported renewable energy has environmental impacts, however, including damage to river and forest ecosystems from hydroelectric projects in Canada. On the other hand, the impacts of local energy sources can be regulated more directly and such energy sources are more secure over the long-term. Therefore, assessment of the potential for renewable energy development in Manchester is a critical component of this energy plan.

Some electricity generation currently occurs in Manchester, all of which is electricity generated from renewable sources including roughly two megawatts (2 MW) of solar capacity in small private and moderate-sized commercial photovoltaic systems. The recently approved 1.3 MW rooftop array at the WCW factory off Richville Road offers one of the largest rooftop solar projects in the state. One residential-scale 9.5 kW wind turbine has been erected in Manchester. Information about locally generated energy from renewable sources can be accessed from the Vermont Community Energy Dashboard's Energy Atlas. Data from the atlas currently show one wind and 69 solar installations in Manchester (see Figure 2.7).

Figure 2.9 Community Energy Dashboard Data for Manchester

Data displayed on the Energy Atlas for Manchester as of October 30, 2018, show 69 solar installations and one small scale wind turbine.

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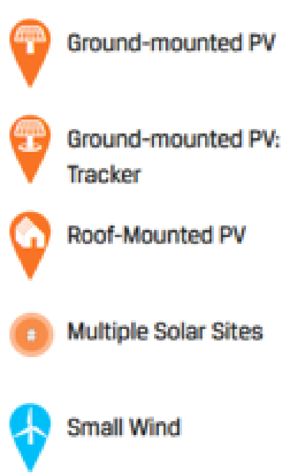
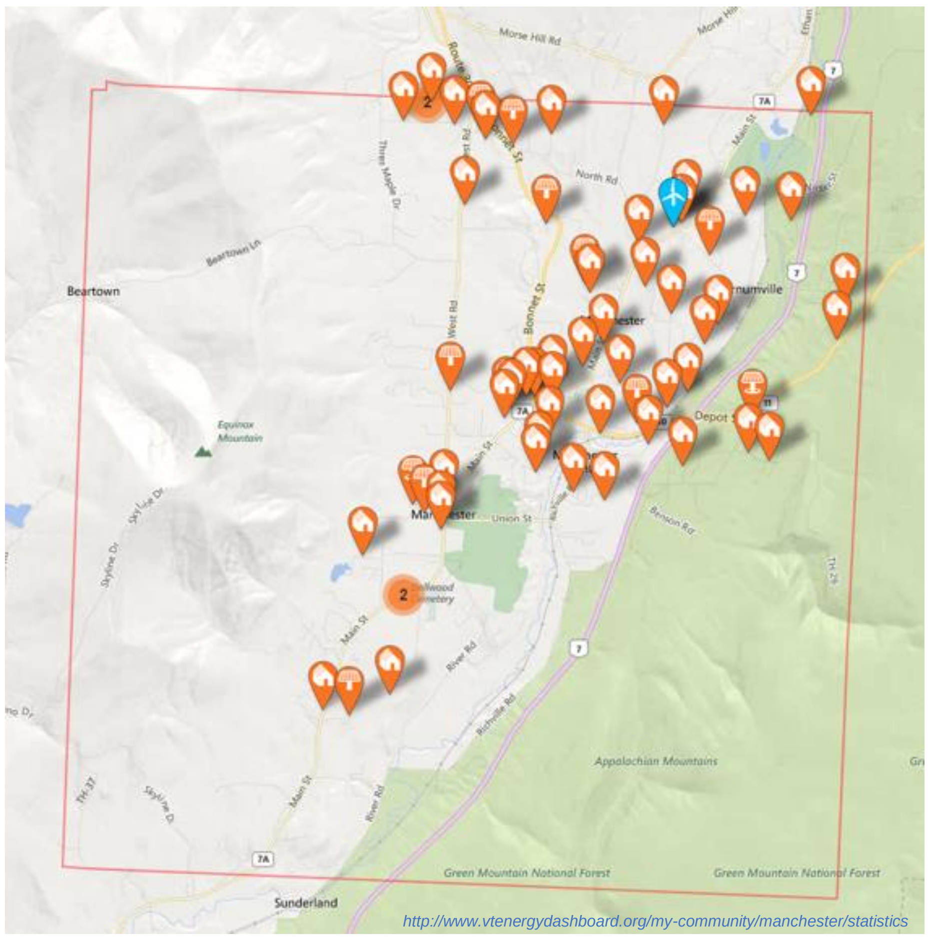




This plan includes geographic information system generated analyses and maps that show modeled solar and industrial wind potential (See Maps 1 and 3 on pages 28 and 30 of this plan). Map 1 reveals Manchester is not well suited for industrial scale wind production. All areas outside of a 1 kilometer residential buffer fall in the town's Forest & Conservation Zoning District, with very limited road infrastructure, abundant steep slopes, and habitat areas important to several rare, threatened or critical species. That, coupled with the scenic importance of these ridgeline areas to the town's visitor based economy and quality of life, leave little area suited for large scale wind generation in Manchester. Consequently, wind potential for small scale wind installations was also explored based on modeled wind speeds in Manchester (see Map 2 on page 29). The resulting map reveals some residential areas that may be well suited for installation of smaller scale wind turbines (100 kW capacity or less). Manchester will explore and encourage further local renewable energy production with solar and small scale wind, using information from these maps as starting points. There may also be limited potential for small scale hydroelectric installations in Manchester. These different potential energy systems will be discussed in the following energy strategies section of the plan.

Section 3 | Energy Strategies

A diverse array of targeted policies and actions will be required to effectively advance the town toward its conservation, efficiency, and renewable energy development goals and to support attainment of Vermont's goal of obtaining 90 percent of all energy used in the state from renewable sources by 2050. Some general strategies can be realized through cooperation with utilities, including the following:

- Support integration of advanced energy storage in the area.
- Support full integration of "smart grid" technology throughout the town and region and use of "smart rate" pricing plans.
- Cooperate with Green Mountain Power (electricity generation) and VELCO (electricity transmission) to ensure that areas planned for renewable energy generation are consistent with the capacity of the grid infrastructure and to ensure that any upgrades needed are implemented.

More detail on many of the approaches listed and discussed here can be found in the 2017 *Bennington County Regional Energy Plan* (*Bennington County Regional Commission, March 2017*) and in *Guidance for Municipal Enhanced Energy Planning Standards* (*Vermont Department of Public Service, March 2017).* Additional information about the town's land use and transportation policies and recommended actions can be found in the land use and transportation sections of the *Manchester Town Plan, 2017*. Strategies for distinct energy sectors and institutional actors are discussed individually in the following pages.

Section 3.1 | Town Energy and Land Use Policy

Through the development of this energy component of the town plan, significant recent transportation improvements to Main Street and Depot Street in the downtown, and a comprehensive rezoning effort, the Town of Manchester has moved toward energy and land use policies that maximize energy efficiency and encourage renewable energy resource development and use. The following general strategies are reflected in the town's energy and land use policies:

- Encourage high density mixed-used development in the downtown and surrounding areas and low density development that does not require extensive infrastructure or services in rural areas.
- Actively support investments in the downtown and surrounding neighborhoods that bring new housing and essential businesses, as well as employment opportunities, into the walkable center of the community.
- Require development to be planned to take advantage of opportunities for utilization of solar energy.
- Require extension of the sidewalk network as part of new development within the town core.

- Support efforts of the Manchester Riverwalk and Bike Manchester, as well as the extension of multiuse recreation pathways connecting the downtown to outer residential and recreation areas.

The Town of Manchester actively seeks opportunities to support local renewable energy generation in the management of its physical plant and public infrastructure, and the procurement of equipment and facilities. On November 13, 2018, the Manchester selectboard approved a 25-year contract with Pig Pen Development, LLC, to make use of a new solar generation facility on a former gravel pit off of Bonnet Street. This net metering project will allow the town to save 7.5% on its electric bills regardless of prevailing electric utility rates. The arrangement will offset all of the electricity used in municipal buildings from fossil based, nuclear based, and large scale hydroelectric based sources to this locally sourced solar generation. This leaves building weatherization, conversion of heating systems, and conversion of the town's vehicle fleet and equipment to electric or liquid biofuel technologies as strategies to pursue. In 2013, the town conducted energy audits and has since moved toward implementing identified weatherization improvements in municipally owned buildings. Accordingly, the town is pursuing the following strategies:

- Reduced energy consumption resulting in return on investment should be accounted for in the town's capital planning process.
- Seek renewable alternatives to the propane system for heating the pool water at the town recreation center, particularly a geothermal heat pump system.
- Assess the potential for deploying ground or air source heat pumps for heating and cooling in all municipal buildings.
- Purchase more fuel efficient vehicles, including electric vehicles where practical. Hybrid sedans and SUVs might be particularly effective for the police department, as would new anti-idling technologies.
- All new lights purchased by the town will be LED, and all town-owned streetlights have been replaced with LED.

Section 3.2 | Residential Sector Energy Conservation & Efficiency

All zoning permits for new residential construction or renovation in Manchester include reference to the state mandated Residential Building Energy Standards. Furthermore, prior to issuing a certificate of compliance for any such permit the Residential Building Energy Standards certificate for the permitted work must be recorded in the town land records. In addition to these requirements, the town can help Manchester residents pursue energy conservation strategies by publicizing state and regional energy programs aimed to implement energy saving practices. *Through organizing periodic workshops and an annual energy fair, the town Energy Committee can publicize energy efficiency strategies and pursue policies and actions that will help achieve residential sector energy goals*, including the following:

- Promote use of the "Energy Star" or similar building performance rating system and related building practices that limit energy consumption in new and remodeled homes.
- Promote the use of Vermont's residential building energy label or score.
- Publicize energy education programs sponsored by Efficiency Vermont, and other organizations, that focus on residential energy savings.

- Publicize NeighborWorks of Western Vermont (NWWVT) “Heat Squad” home energy improvement programs, including low-cost audits and assistance with construction and financing.
- Support programs that provide funding for weatherization of the homes of lower-income residents, including the Weatherization Assistance Program offered through the Bennington Rutland Opportunity Council (BROC).
- Promote efforts to assist homeowners to switch to alternative space heating systems, including stoves and systems that burn wood and wood pellets, as well as air source heat pumps.
- Encourage home energy audits that allow homeowners to make home energy investment decisions by providing prioritized lists of improvements with costs and payback amounts and periods.
- Promote the use of heat pumps - highly efficient systems powered by electricity that can be generated from renewable energy sources.
- Promote the use of woody biomass fuels that can be sourced locally.
- Provide demonstrations of new energy efficient technologies.
- Educate the general public about how energy is harnessed and used.

Section 3.3 | Commercial and Industrial Sector Energy Conservation and Efficiency

Just as the Residential Building Energy Standards are referenced, all zoning permits for new or renovated commercial space include reference to the state mandated Commercial Building Energy Standards, and the Commercial Building Energy Standards certificate must be recorded in the land records before a certificate of compliance may be issued. Furthermore, the town will encourage developers of commercial properties to use the “Stretch Codes,” mandated through Act 250, in any new commercial construction regardless of whether an Act 250 permit is required.

The town can further promote improvements in the commercial and industrial energy sector by supporting Manchester forest products businesses, forest management businesses, and businesses involved in transporting and processing woody biomass for home, business, or institutional applications. As in the residential sector, air source heat pumps are an efficient and cost-effective way to reduce reliance on oil and propane fuels in many commercial and industrial applications. In addition, Manchester is well-suited for new geothermal heat pump systems—an option that may be particularly viable for new construction and larger commercial or industrial projects. Furthermore, the town can support development of businesses that provide geothermal systems and support (e.g., well drillers, excavators, and HVAC contractors) as well as coordination between those businesses and electrical contractors. *As within the residential sector, the town Energy Committee can further energy conservation within the commercial and industrial sectors by publicizing strategies at an annual energy fair or through periodic workshops.* Strategies publicized at such events should include the following:

- Encourage businesses to obtain feedstock for heating systems from local sources to support regional economic development and renewable energy goals.
- Promote the sale, installation, and service of heat pumps.

- Encourage business owners to work with Efficiency Vermont and energy service companies to assess the potential for converting all or part of their space heating and cooling to efficient air source heat pumps or clean and modern biomass systems.
- Encourage businesses to acquire the services of an energy auditor to assist in identifying measures to adjust operations and minimize energy use.
- Encourage employers to provide facilities to encourage bicycling, walking, and carpooling.
- Provide businesses information about electric vehicle charging stations and encourage them to install such facilities to support employees who would like to use electric vehicles for commuting.
- Publicize Efficiency Vermont incentive programs for businesses.
- Publicize the town's successful LED streetlight conversion and encourage commercial and institutional landowners to make similar changes on their external lighting.

Section 3.4 | Energy Conservation and Efficiency in the Transportation Sector

As already noted in this energy component of the Town Plan, the transportation sector accounts for significant energy usage in rural areas such as Manchester. Beyond the conversion of the local LDV fleet to electric, as discussed previously, other town transportation and land use policies and strategies will help contribute to conservation and efficiency in this sector. The town will continue to improve and expand the sidewalk network, on-road bike lanes, and off-road recreation pathways as identified in the Transportation and Recreation sections of the Town Plan. Compact development that is concentrated in the core of the town will continue to be required or encouraged by the *Manchester Land Use & Development Ordinance*. The town will work to ensure that local and state roadway construction and maintenance projects include accommodations for pedestrian and bicycle travel, incorporating "Complete Streets" principles whenever possible.

The town will continue to plan and implement modifications to local streets to make them more bicycle and pedestrian friendly and to present more attractive streetscapes for all residents and users of the transportation system. Safety improvements, gaps between important destinations, and other alternative transportation needs will be continually identified, and the town will continue to seek funding through the VTrans Bicycle – Pedestrian and Transportation Alternatives program, as well as from local funds and other sources, to plan and implement identified bicycle and pedestrian improvements. The town is currently working with VTrans on plans to improve the Manchester Park and Ride lot and provide coordinated service by Vermont Transit, Green Mountain Community Network (Green Mountain Express), and Marble Valley Regional Transit (The Bus) to the improved site. The town will pursue the following additional strategies:

- Install EV charging stations in town owned public parking lots.
- Require large new commercial, industrial, and multifamily development to provide EV charging stations at convenient locations.
- Require large new commercial, industrial, and multifamily development provide a location for a public transportation stop.

As within other sectors, the town Energy Committee can further energy conservation within the transportation sector by publicizing strategies at an annual energy fair or through periodic workshops. Such events should include the following:

- Highlight availability and location of EV infrastructure in the community.
- Publicize regional bus services and transfer locations.
- Promote electric vehicle use through cooperation with Drive Electric Vermont and other organizations.
- Encourage local auto dealers to supply electric and plug-in hybrid electric vehicles.
- Promote the Go Vermont website to support carpooling, ridesharing, and other opportunities.
- Include demonstration of liquid biofuel technology.

Section 3.5 | Local Food Systems

As has been pointed out already in this energy plan, transportation costs in rural settings such as Manchester's are relatively high. One way to reduce transportation costs is to locally source foods. In addition to reducing energy costs expended on the transport of food products, increasing the amount of food sourced locally or regionally and supporting more lands in agricultural production can help retain ecological functions provided by those lands as well as contribute to a resilient local and regional economy. *This theme of supporting local food production and consumption should be reflected in the annual energy fair hosted by the town energy committee.* This would be accomplished by including a local food systems program element for the annual fair. This element of the fair would promote local food producers in the local economy, with special focus on farm to table programming at local schools, and matching food producers with institutional and restaurant customers.

The town's land use policies also reflect promotion of local agriculture. New zoning enacted in June 2018 allows rural residential density bonuses for proposed development that includes significant open space protection. In the Rural Residential Zoning District, 50% of the subject lands must be protected as open space in order to gain the density bonuses. Furthermore, in the Rural Agricultural Zoning District, 70% of protected land must be made perpetually available for working lands uses (agricultural or forestry) in order to receive the density bonuses.

Section 3.6 | Institutional Energy Use

Although the town no longer operates a standalone school system, the town should encourage local schools to participate in the School Energy Management Program (SEMP) through the Vermont Department of Public Service. This can occur through engagement with the Taconic and Green School District, and local independent schools at the town sponsored annual energy fair. Furthermore, the energy committee could encourage Burr and Burton Academy to investigate development of a central biomass based heating system for its campus.

Local schools also should be encouraged to promote the use of school buses and walking and biking to school — including participation in the Safe Routes to Schools program, and the VTrans "Way to Go to School" program — to reduce reliance on single-passenger vehicle transport. The town can help by continuing its program of expansion of its sidewalk system, and continued bicycle and pedestrian enhancements to its road network through VTrans grant funding. The town's plans for improvements to parking and traffic circulation along Memorial Avenue and School Street as outlined in the recently adopted *Downtown Strategic Plan* will contribute significantly to this goal for the Manchester Elementary and Middle School, in particular.

How is Electricity Measured?
Understanding watts, megawatts, kilowatt-hours, and more

Watts are a measurement of power, describing the rate at which electricity is being used at a specific moment. For example, a 15-watt LED light bulb draws 15 watts of electricity at any moment when turned on.

Watt-hours are a measurement of energy, describing the total amount of electricity used over time. Watt-hours are a combination of how fast the electricity is used (watts) and the length of time it is used (hours). For example, a 15-watt light bulb, which draws 15 watts at any one moment, uses 15 watt-hours of electricity in the course of one hour.

Kilowatts and kilowatt-hours are useful for measuring amounts of electricity used by large appliances and by households. Kilowatt-hours are what show up on your electricity bill, describing how much electricity you have used. One kilowatt (kW) equals 1,000 watts, and one kilowatt-hour (kWh) is one hour of using electricity at a rate of 1,000 watts. New, energy-efficient refrigerators use about 300-400 kilowatt-hours per year. The typical American home uses about 7,200 kilowatt-hours of electricity each year [1].

Megawatts are used to measure the output of a power plant or the amount of electricity required by an entire city. One megawatt (MW) = 1,000 kilowatts = 1,000,000 watts. For example, a typical coal plant is about 600 MW in size.

Gigawatts measure the capacity of large power plants or of many plants. One gigawatt (GW) = 1,000 megawatts = 1 billion watts. In 2012, the total capacity of U.S. electricity generating plants was approximately 1,100 GW [2].

Notes and References:
[1] Assumes a typical U.S. household uses non-electric heating.
[2] SNL Financial. Historic & Future Power Plant Capacity.

Source | Union of Concerned Scientists
https://www.ucsusa.org/clean_energy/our-energy-choices/how-is-electricity-measured.html#.W9tKQy-ZNUM

Section 4 | Renewable Energy Development

Section 4.1 | Hydroelectric Generation

Although hydroelectric generation is the most efficient renewable source of electricity, the impacts to aquatic ecosystems are so problematic that it is highly unlikely that new dam construction will be undertaken in Vermont. Consequently, retrofitting existing dams with new turbine technologies or installation of new inline turbines are the only hydroelectric projects that are feasible for Manchester. Commercial-scale hydroelectric generation is limited in Manchester due to the limited number and suitability of existing dam sites. *The town supports efforts for environmentally responsible hydroelectric development; the most likely site being at* *the existing dam on the West Branch of the Batten Kill adjacent to the Town Green at the Kimball Grist Mill property.*

Recent hydroelectric development in Bennington County includes two facilities at existing dams, one on the Walloomsac River in Bennington and one on the Hoosic River in Pownal. These projects are complex because of the need for environmental assessment and remediation of the sediments behind the dams, and requirements intended to minimize additional impacts to the downstream aquatic ecosystems. Once completed, however, the facilities have offered approximately 1 MW of reliable and consistent renewable energy. Several smaller existing dams within the Bennington region have potential for redevelopment, all at capacities of less than 100 kW. One such dam is located in downtown Manchester the Kimball Grist Mill. The Town could sponsor an environmental and hydrologic potential study to assess the costs and benefits of pursing development of a small generating facility at this site.

In the 1890s the mill was generating electricity, but the dam has long been abandoned for this purpose. The Kimballs purchased and installed a Leffel hydrolic turbine in 1984, but never operated it. About 8 to 10 years ago and over the course of 3 to 4 years, Jim Hand and Steve Kimball chased the idea of generating electricity from the dam. The Vermont Agency of Natural Resources supported the project provided at least ½" of flow was maintained over the top of the dam during generation. Hand and Kimball initiated analysis of the system with some small improvements to discover its total output would be about 148,000 kilowatt hours per year.

The maker of the generator, the James Leffel & Co., is in Ohio and still operating. The Carthusian Monastery also has Leffel generators in its dam on Mount Equinox. A number of years ago, the Carthusians implemented upgrades proposed by Leffel enabling them to sell excess power to Burr and Burton Academy. At the same time that it proposed the Carthusian improvements, Leffel proposed upgrades to the Kimball system that would increase the potential output to 250,000 kilowatt hours per year. In order to make the Kimball project operational, the return flow requires reconfiguration to discharge underwater (currently it discharges above the water level of the mill pond). In conclusion, there is potential at the Kimball Grist Mill and the Manchester Energy Committee supports pursuit of making it operational.

The town rejects the idea of bringing upslope dams on Mount Equinox and Prospect Rock into production as too ecologically damaging. The Kimball Grist Mill is a different matter, the infrastructure is in place as foundation to the adjacent building and roundabout. Inline turbines in the municipal water mains leading from each of the municipal water storage tanks may offer potential for hydroelectric generation, but it is likely that Manchester's system lacks the vertical drop to make such a project feasible.

Section 4.2 | Solar Energy Generation

Solar radiation refers to the electromagnetic energy that emanates from the sun. We can harness that energy to produce heat or electricity via several different solar technologies. These technologies vary in their costs and appropriateness for different locations and applications (See Figure 3.1). Passive solar approaches use site design and building material choices to maximize the capture of heat and light from the sun. Active solar technologies use equipment to convert solar radiation into electricity or equipment that uses the solar radiation to heat water. These active systems vary in scale from very small panels to very large solar farms covering several square miles with over 500 megawatt capacity. *Both passive and active systems are encouraged for Manchester; however, large active solar installations should be limited to areas that will not degrade the scenic character of the town, adversely affect agricultural potential, nor harm ecologically sensitive resources.*

Net metering is the arrangement that utilities use to credit solar energy system owners for the electricity produced by their solar panels. With net metering, the owner of the solar panels only pays for the electricity used beyond what the solar panels generate. Community solar projects are group net metered solar energy installations between 15 kW and 150 kW in size, with shares in the facility sold to the site owner, neighbors, community members, nonprofit organizations, and local businesses. Energy users buy shares in proportion to their annual electrical usage. When construction is completed, power is fed directly into the grid, and a group net metering document is filed with the utility showing the allocation of shares among the various members. The utility then splits the output of the solar farm among the members in proportion to their share size, crediting their utility accounts. It is possible to go off the grid with a solar energy system that includes battery storage, but it will cost significantly more and is unnecessary for most residential applications with easy access to the power grid.

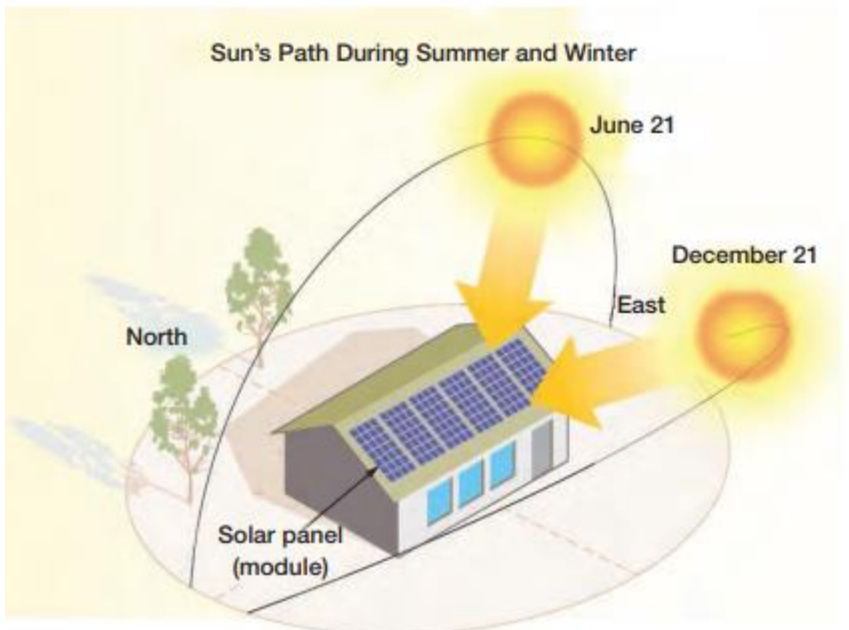


Figure 3.1. *In the Northern Hemisphere, a south-facing roof maximizes solar access for active solar systems.*

Source: U.S. Department of Energy

The Town of Manchester establishes the following general policies concerning solar energy development:

- *Small-scale (150 kW capacity or less) electricity generation from solar energy at homes, businesses, schools, and other institutions, is encouraged.*
- *The town supports the development of net metered solar projects.*
- *The town supports larger scale solar development (greater than 150 kW capacity) on **preferred sites** as defined in state statute or as described in this plan.*
- *Rooftop solar energy development, of any scale, is encouraged.*
- *Passive solar principles should be implemented in the course of all new development.*

New solar facilities shall be restricted to areas that do not adversely impact the community's traditional and planned patterns of growth, of a compact downtown surrounded by a rural countryside, including working farms and forest land. ***Preferred sites*** shall include rooftops; gravel pits, quarries, or other earth extraction sites; brownfields as defined by the state or federal government; abandoned impervious cover; and as canopies for functional parking areas. Locations that would significantly diminish the economic viability of the town's working landscape, should be excluded from consideration for solar development. Therefore, forested tracts should not be clearcut to provide for solar installations. Relatedly, the impact on soils of prime and statewide agricultural significance must be minimized during project planning and design. Similarly, the use of perimeter fencing around solar installations should be limited to avoid adversely impacting both aesthetics and wildlife. Alternative perimeter treatments, including natural vegetative screening, should be considered and used whenever possible.

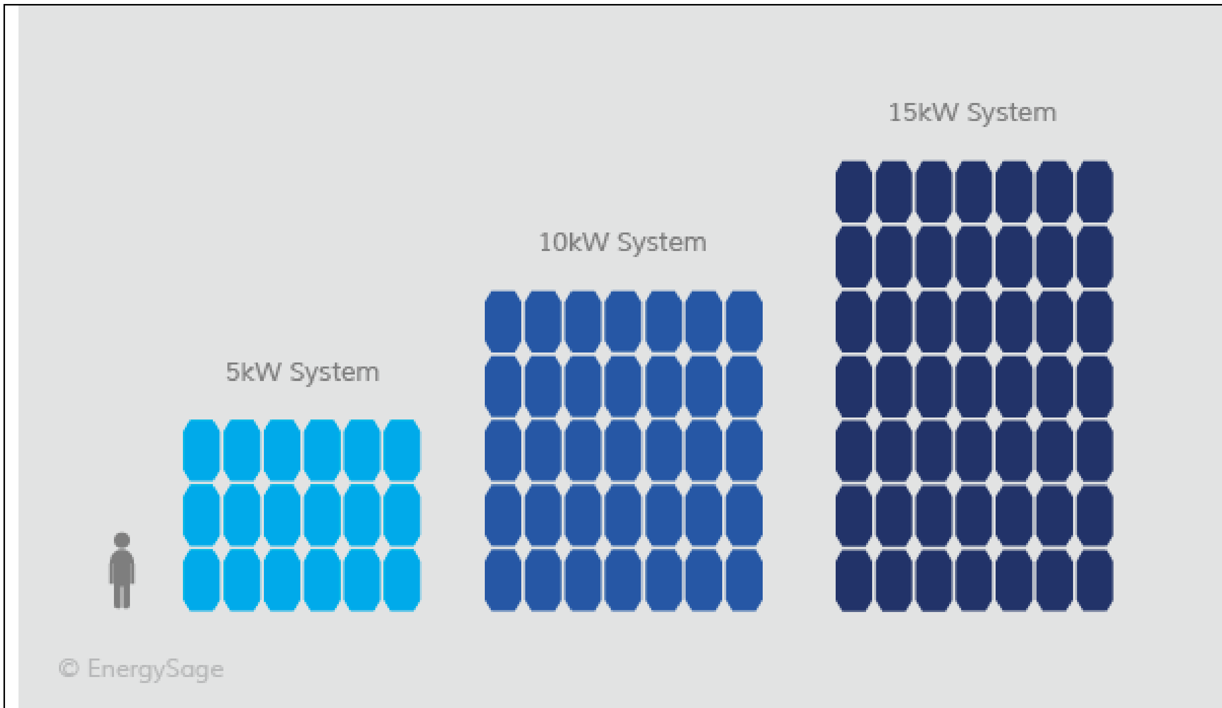


Figure 3.2. *How big is a solar installation? Systems will vary in size based on whether the photovoltaic cells are comprised of mono-crystalline or polycrystalline silicon. Monocrystalline cells are more efficient and therefore installations may take up less space.* *Source: EnergySage.com*

Solar facilities should not be sited in locations that adversely impact important scenic views. Specifically, solar sites should not adversely impact views from public roadways across open fields that have been identified for viewshed protection. Similarly, solar development adjacent to established scenic byways such as the Stone Valley Byway and the Shires of Vermont Byway, should be carefully sited to minimize adverse impacts to the byway. Solar installations must not visually impair prominent ridgelines or hillsides that can be seen from widespread public vantage points throughout Manchester. Finally, the architectural integrity of historic buildings should not be adversely impacted by solar installations, nor should visual gateways to historic districts be blocked by solar developments. Specifically, development of solar generating facilities shall be excluded from the following locations:

- Lands within FEMA-defined floodway and ANR-mapped river corridor.
- Class I or II wetlands.
- Rare, threatened, or endangered species habitat as mapped by the Vermont Agency of Natural Resources.

- Steep slopes (>20%) as defined in the *Manchester Land Use & Development Ordinance*.
- Surface waters and water resource buffer areas.
- Lands within the Forest Conservation zoning district.

Section 4.3 | Generation from Wind Resources

Wind is the result of the movement of air from an area of high pressure to an area of low pressure within the earth's atmosphere. Variable air pressure across the earth's surface results from the rotation of the earth on its axis, the warming of air by the sun, and the subsequent cooling of air as it rises or as the earth turns. Wind flow patterns are further modified by terrain, bodies of water, and vegetative and developed land cover. Wind can be harvested by wind turbine technologies. Turbines convert the kinetic energy of wind to mechanical power. That mechanical power can be directly used to grind grain or pump water as has been accomplished for centuries. Alternatively that mechanical power can be converted into electricity. The citing of wind turbines must take into account average daily wind speeds of a given area. Wind harvesting technologies, furthermore, must account for changing wind flow patterns in the immediate area of the wind turbine. Figure 3.3 shows modern electricity generating wind turbine size relative to residential, agricultural or commercial scale buildings.

Because relatively small areas are needed for turbine foundation and infrastructure, wind turbine installations are largely compatible with various other land uses such as agriculture. However, noise from turbines can have adverse ecological, agricultural, and anthropomorphic effects. Consequently, for industrial scale wind turbine potential, a residential buffer of one kilometer is used in the GIS modeling to map areas for potential development in Manchester (See Map 1). As noted already, this excludes much of the town's land area from consideration for industrial scale wind development. Modern small wind turbines are relatively quiet, emitting sound that is barely discernable from ambient noise. Such smaller scale turbines (100 kW capacity or less) could be located throughout the town if specific sites have appropriate minimum prevailing wind speeds.

Concern for bird and bat mortality associated with wind turbines has resulted in significant research. A comprehensive study of bird collisions and wind turbines found avian mortality to be related to turbine cut-in speeds and turbine hub height with higher bird mortality associated with higher hub heights (SR Loss, T Will PP Marra. 2013. Estimates of bird collision mortality at wind facilities in the contiguous United States. *Biological Conservation*. 168:201-209). This research suggests that because Manchester is not well suited for industrial scale wind development, turbine hub height may be low enough that wind development in Manchester would not result in significant bird mortality. As for bat mortality associated with wind turbines, Vermont requires a minimum turbine cut-in speed that is estimated to avoid most bat collisions (J Lemaître et al. 2017. *Bat Mortality Caused by Wind Turbines: Review of Impacts and Mitigation Measures*. 10.13140/ RG.2.2.36392.67848). Various research based technologies are being developed to mitigate wildlife mortality associated with wind energy development. For example, AI software is being developed to detect raptors or large groups of approaching birds and adjust turbine controls accordingly. Another simple solution involves painting turbine blades colors that are less attractive to insects, which in turn attracts fewer birds and bats. In any case, most researchers agree that bird and bat mortalities associated with fossil fuel based energy development are significantly higher than wind energy associated mortality rates.

In Manchester aesthetic aspects of wind turbines and resulting changes of the visual landscape are of significant concern. Proposed wind development on Mt. Equinox generated strong public opposition a number of years ago for this reason. Having a visitor based economy, protection of Manchester's scenic landscape and particularly of the town's prominent and defining ridgelines is paramount. As revealed by the mapping exercise illustrated in Map 1, Manchester has limited potential for utility-scale (more than 100 kW) wind energy development, as areas with sufficient access to consistent wind are restricted primarily to higher elevations on Mount Equinox and adjacent ridgelines where severe environmental constraints limit the potential for development (Map 1). Because very few locations in Manchester have suitable wind resources for utility scale development, infrastructure availability, or are free from significant environmental constraints, no utility-scale (100 kW capacity or greater) wind energy facilities should be located in the town.

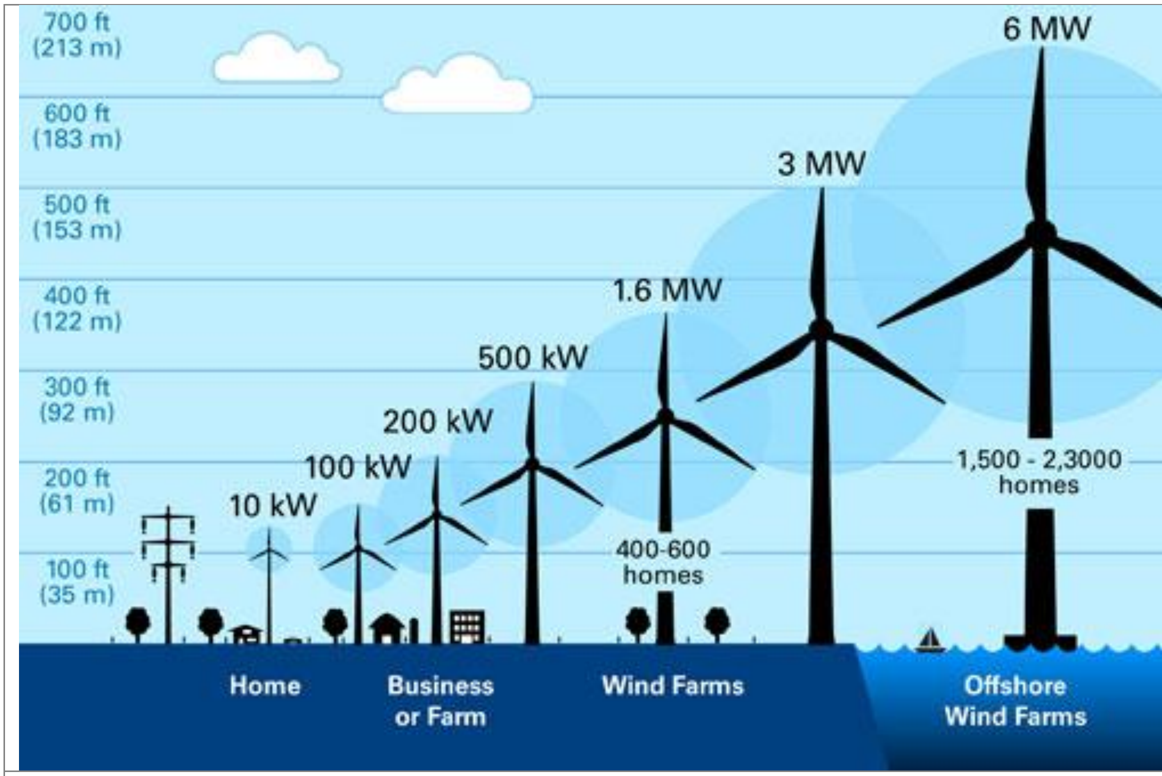


Figure 3.3. *Wind turbines can be different sizes. The bigger they are, the more electricity they can generate. That's because winds are stronger the higher you go, and the larger blades can capture more wind. But bigger isn't always better. Smaller turbines can be best for powering a house or part of a college campus.*

Source: http://energyclassroom.com/climb-a-turbine/

Smaller scale wind projects, including residential-scale turbines (10 kW or less) and turbines installed at farms, municipal properties, or school and business campuses (up to 100 kW) are encouraged in Manchester. Map 2 illustrates locations in Manchester where wind speeds may be adequate for a smaller-scale wind turbines. Other locations throughout the town may support small scale wind turbines, despite the average daily wind speeds falling below 10 miles per hour. Individual sites should be assessed for appropriate specific turbine technologies, and citing should occur to mitigate any adverse effects in terms of noise generation, wildlife, or ecosystem services.

Star Wind Turbines, a company headquartered just north of Manchester in East Dorset, is developing small scale turbines suitable for Vermont wind resources. These turbines with multi-blade design and low rotation speeds produce less noise and are thereby acceptable in residential areas and safer for birds and bats. These high efficiency, low maintenance, and less obtrusive turbine systems of between 5 and 45 kW could be well suited to sites throughout Manchester.

Section 4.4 | Biomass and Liquid Biofuels

In addition to solar, wind, and hydroelectric development, the town should support efforts to develop appropriate cost-effective biomass energy resources and help promote combined heat and power biomass projects. In this vein, the annual energy fair could promote responsible development of oil seed crops and liquid biofuels that could be produced and used to operate equipment and machinery on local farms. Such biofuels could potentially supply other businesses and the town with renewable fuels. Limiting the scope of production to that which can be used locally would help to reserve most arable lands for local food production. Indeed, as already discussed, local food systems development is another important element of reduced energy consumption throughout the Manchester community.

Concurrent with promotion of local oil seed and biomass technology, promotion of modern wood heating systems should also occur. Advanced wood heating offers an affordable, local, and renewable source of fuel with lower carbon emissions than fossil fuels. Although older wood heating systems were inefficient and had adverse air quality impacts, advanced wood heating systems are far more efficient and produce relatively little particulate matter. Advanced wood systems include cord wood, wood chip, and wood pellet systems. Kiln dried cord wood offers increased efficiency over air dried cord wood, and pellet stoves and boilers offer increased automation and convenience in addition to increased efficiency. In addition to helping reduce dependence on fossil fuels, promotion of locally derived and responsibly harvested wood biomass can lend to development of a more robust local forest economy that helps perpetuate healthy local forest ecosystems. Furthermore, the use of kiln dried cord wood is becoming more critical to prevent the further spread of invasive pests such as the Emerald Ash Borer.

Section 4.5 | Screening of Energy Generation Facilities

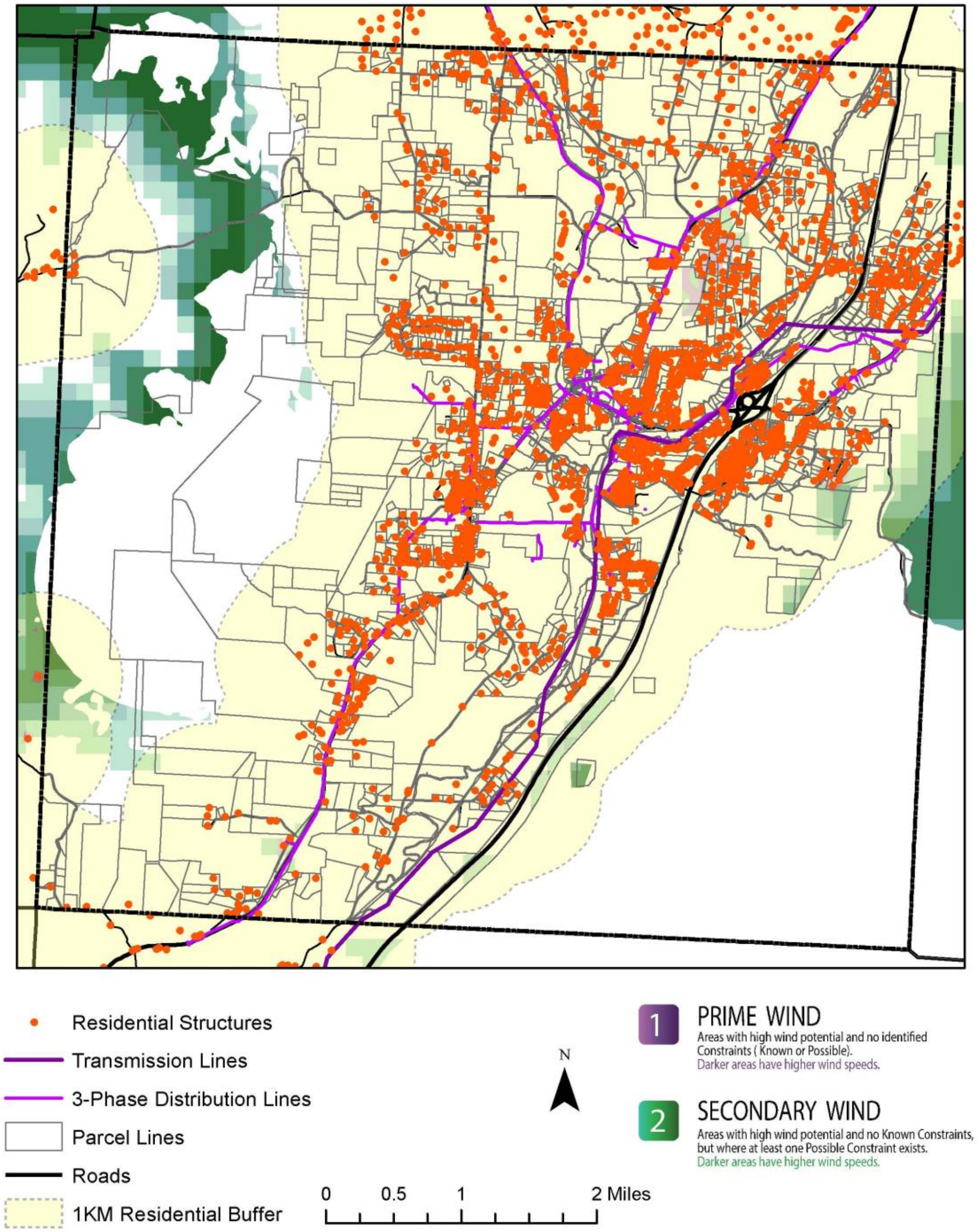
Energy generation facilities in Manchester should be limited in height and screened with natural growth or landscaping to mitigate potential adverse effects on neighboring property or scenic viewsheds, according to the following:

- The height of a ground mounted solar energy generating apparatus must not exceed 30 feet.
- The height of a ground mounted wind energy generating apparatus must not exceed 120 feet.
- An energy generating apparatus mounted on a building wall must not extend beyond the lowest portion of the roof.
- An energy generating apparatus mounted on a building roof must not extend more than 10 feet above the roof.
- The frontage of a site housing a solar energy generation facility must be screened by a landscaped or naturally occurring buffer that is at least 12 feet wide and contains an adequate mix of trees and shrubs, taking into account terrain, to screen the proposed facility. This screening requirement may be waived for solar facilities on lots without adequate area to provide such a buffer without shading the solar panels.

Section 4.6 | Preferred Site Designation Requests

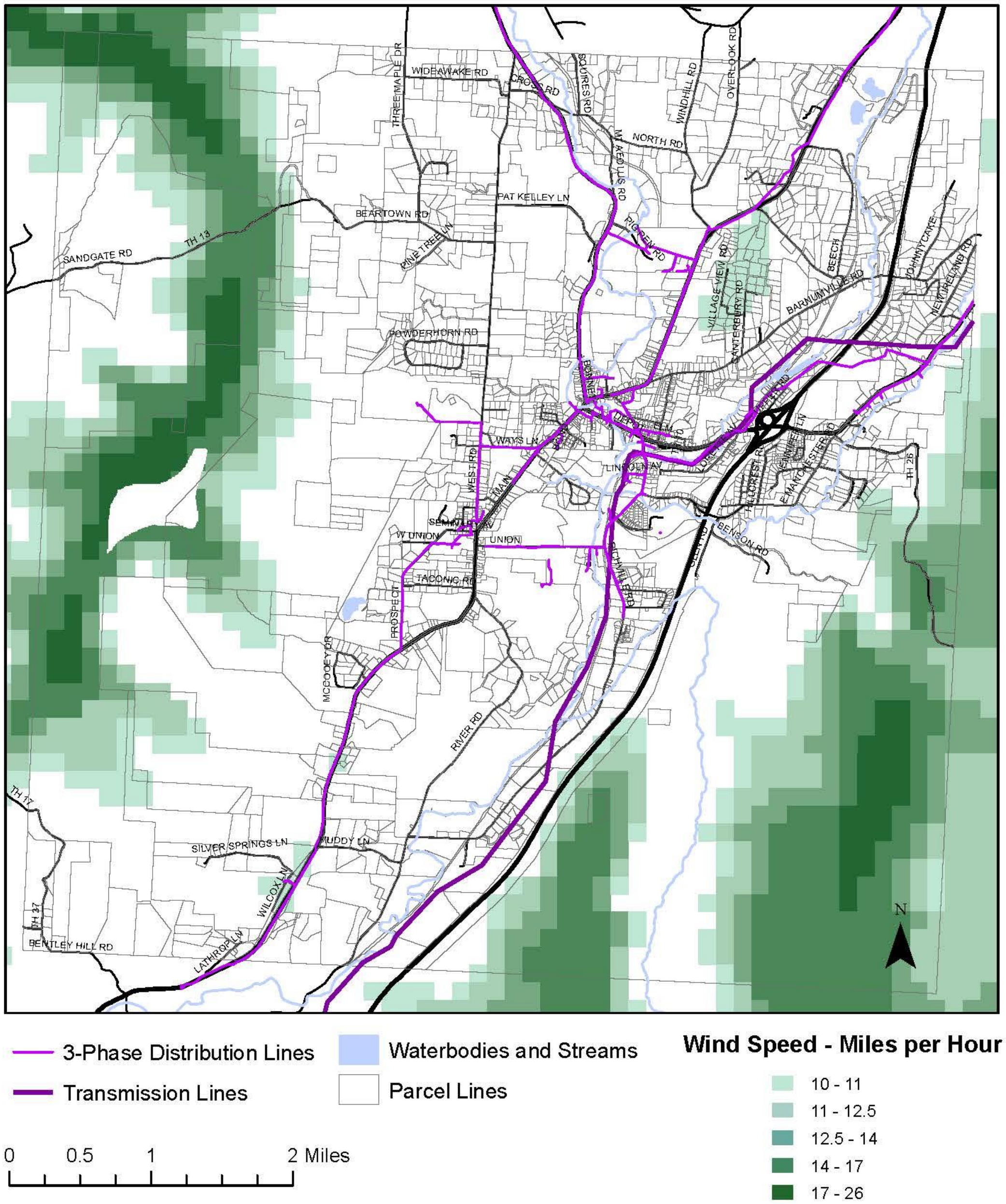
This plan does not identify sites as “preferred” for renewable energy generation development. Rather, proposed net-metered solar arrays requiring “preferred site” designation in order to proceed through the Public Utility Commission (PUC) process, must submit an application to the Town of Manchester using the *Preferred Site Scorecard* available from the Manchester Planning & Zoning Office.

Map 1. Industrial Scale Wind Resources in Manchester



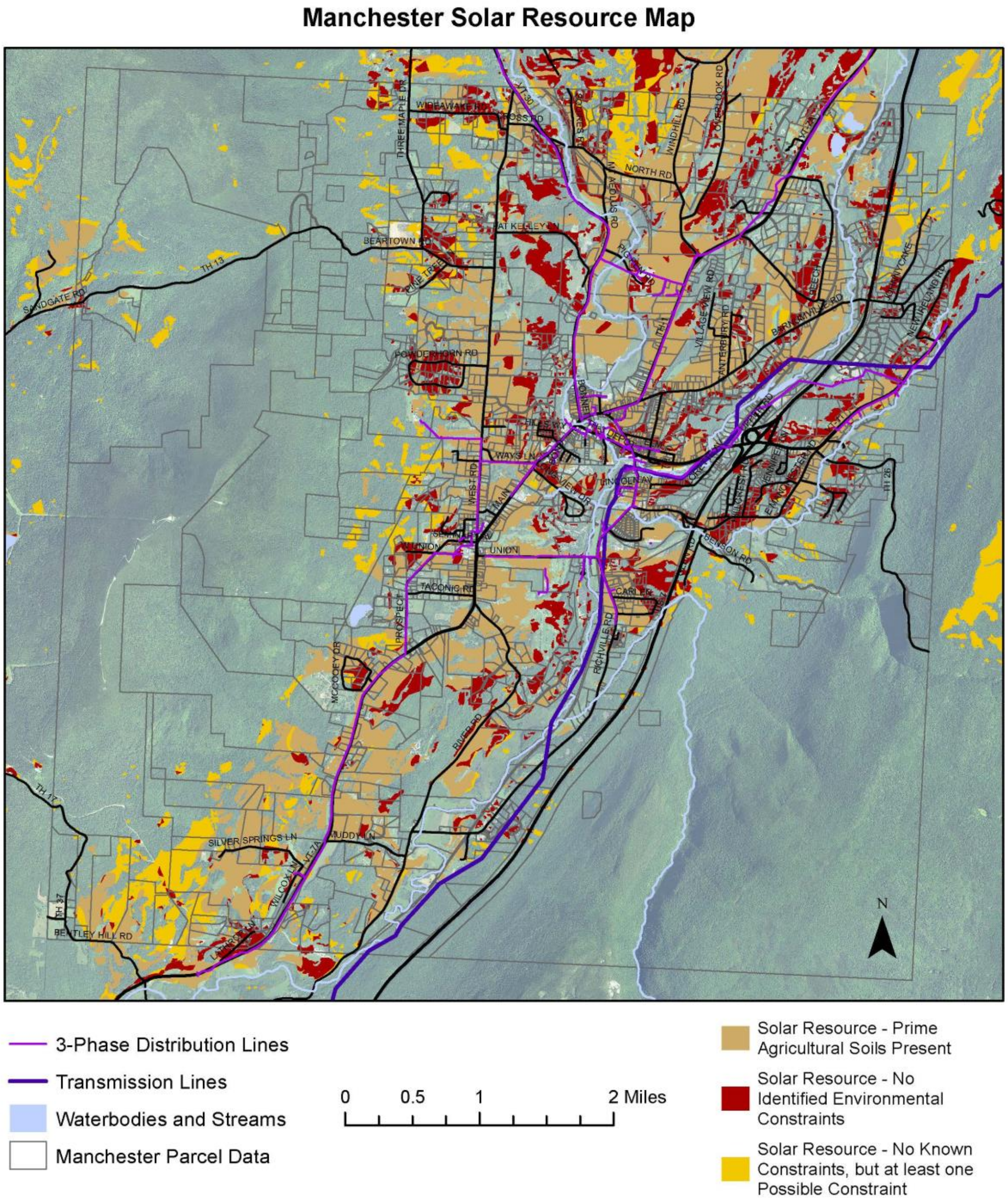
This map is for planning purposes, to inform a siting process, and to suggest areas for further investigation. Locally identified constraints are not shown. This map alone should not be used for determining the suitability of a given site for wind energy development. *For details on the mapping process and environmental constraints, see methods box on page 30.*

Map 2. Residential Scale Wind Resources in Manchester



This map reveals limited area suitable for residential scale energy development along Richville Road in the southern part of town, and in the Canterbury area between Barnumville Road and Main Street. Most modeled wind resources fall within the forested slopes of the Green Mountain National Forest.

Map 3. Solar Resources in Manchester



This map is for planning purposes, to inform a siting process, and to suggest areas for further investigation. Locally identified constraints are not shown. This map alone should not be used for determining the suitability of a given site for solar energy development. *For details on the mapping process and environmental constraints, see methods box on page 30.*

Methods: Mapping Renewable Energy Resources and Constraints

The wind and solar energy resource maps (Maps 1 and 3) were developed by first using data from the Vermont Center for Geographic Information to assess approximate locations where solar and wind energy resources are sufficient to potentially support development. If there were no identified constraints to development, these areas were mapped as "prime" resource areas.

The presence of environmentally and culturally sensitive areas, identified by Vermont state agencies and the Bennington County Regional Commission, were then identified and noted in the analysis. Those "constrained" areas include:

KNOWN CONSTRAINTS - Conditions that preclude development

"Known Constraints" are ecological and physical conditions that would prevent the development of renewable energy infrastructure. Known Constraints have been "masked" out of the resource maps. In other words, any location where a Known Constraint exists appears blank, as do areas where wind and solar resources are likely to be poor. **Known Constraints** include:

1. **Vernal Pools.** Seasonal wetlands that provide conditions for various species' habitats. (Mapping includes a 50 foot buffer around all Vernal pools.)
2. **ANR-mapped River Corridors.** Rivers and land adjacent to rivers necessary to maintain the natural movement, or meandering, of a river.
3. **FEMA DFIRM Floodways.** Areas most likely to be impacted by base floods (1% annual likelihood) where development is limited.
4. **State-Significant Natural Communities and Rare, Threatened, and Endangered Species.** Areas that include rare species or a valuable educational scientific resource as identified by ANR.
5. **National Wilderness Areas.** Federally owned land that is preserved in natural condition.
6. **Class 1 and 2 Wetlands.** All identified Class 1 and 2 Wetlands

POSSIBLE CONSTRAINTS - Conditions that could (but not necessarily) preclude development

"Possible Constraints" include ecological and physical conditions that would likely complicate, and *possibly* prevent, the development of renewable energy infrastructure. Possible Constraints overlapping the mapped solar and wind resource areas are shown as "Secondary Resource" areas. **Possible Constraints** include:

1. **Agriculturally Significant Soils.** All soils rated as agriculturally important, including "Prime" agricultural soils and soils of statewide or local importance.
2. **FEMA-mapped Special Flood Hazard Areas.** All zones with a 0.2% chance or higher of flooding annually.
3. **Protected Lands.** All state owned lands and privately owned conserved lands.
4. **Deer Wintering Areas (DWAs).** Identified deer winter habitat area.
5. **Vermont Conservation Design Highest Priority Forest Blocks.** Unfragmented natural areas with high ecological and habitat value.
6. **Hydric Soils.** Areas where soils are saturated for some part of the year, leading to biological conditions similar to wetlands.

The resulting maps, Map 1 and Map 3, are useful for planning purposes, to inform a siting process, and to suggest areas for further investigation. Locally identified constraints are not shown on these maps. ***Therefore, the maps alone should not be used for determining the suitability of a given site for solar or wind energy development, except that parcels or sites identified as "preferred" by the Town of Manchester may indicate sites ideal for wind or solar development.***