Town of Barre

ENERGY PLAN 2020

~ ~ Notes ~ ~

TABLE OF CONTENTS

This page is intentionally left blank.

ANALYSIS & TARGETS

It is important to understand there must be a correlation between energy efficiencies and the mandate to switch energy sources to renewables. The renewable benchmarks do not come without increased costs and therefore conservation is imperative to lessen the financial burden. It is also critical that financial incentives continue and are kept at a pace that at a minimum incentivizes the direction mandated. Within we are only addressing laser point targets which exist today. We must however allow a broad-brush method in order to release the ingenuity and creativity needed to meet the mandate while taking all practical steps to ensure renewables have sound management which take place in such a manner that protects human health and the environment against the adverse effects of activity, processes, products or substances.

In order to adequately determine if the Town of Barre is on the right path to meeting its share of the state's goal of 90% of the energy used being produced by renewable sources, an identification and analysis of current energy use is necessary. To this end, the following questions have been identified to help determine current energy use and targets for moving forward.

I. *Does the plan estimate current energy use across transportation, heating, and electric sectors?*

II. *Does the plan establish 2025, 2035, and 2050 targets for thermal and electric efficiency improvements, and use of renewable energy for transportation, heating, and electricity?*

III. *Does the plan evaluate the amount of thermal-sector conservation, efficiency, and conversion to renewable fuels needed to achieve these targets?*

IV. *Does the plan evaluate transportation system changes and land use strategies needed to achieve these targets?*

V. *Does the plan evaluate electric-sector conservation and efficiency needed to achieve these targets?*

These five questions and their respective responses serve as the basis for identifying where Barre Town is now, where it needs to go, and how it will get there in terms of its energy future.

The information needed to answer the five questions listed above was procured from various sources. This includes information from the American Community Survey (as part of the residential 2017 U.S. Census), The Vermont Agency of Transportation, the Vermont Department of Labor, the Vermont Department of Public Service, Efficiency Vermont, the Vermont Energy Investment Corporation (VEIC), and the Central Vermont Regional Planning Commission. A significant portion of the data related to targets was provided by the VEIC through a process known as Long-Range Energy Alternatives Planning or LEAP by drawing on sources mentioned above. This modeling factors in a significant number of data points and has been used extensively throughout the world for energy planning such as this.

The data that is used throughout this section was developed using a bottom up approach as well as a top down approach. In some cases, data was provided at a regional level and thus was allocated to each municipality based on a methodology appropriate for that particular dataset. In other cases, information was provided at the municipal level and then aggregated to identify the regional total. While these two methods are generally the same in concept, these two processes may produce anomalies in the information. To that end, it is important to note that the data provided herein is only a starting point and should be used to establish a general direction, not a required outcome. This data is presented as a way to gauge Barre Town's overall progress towards achieving 90% of its energy used produced from renewable sources. As new or better data is provided or developed, these tables will be updated to reflect the changes.

Barre Town has two utilities that provide electricity to its residents, Green Mountain Power(GMP) and Washington Electric CO-OP (WEC). GMP services the majority of the Town. WEC electrical needs are met by utilizing 100% they say renewable energy. A portion of GMP's electricity comes from renewables. Because both electric utilities serve Barre Town their renewable energy "portfolio" should be considered towards overall progress in reaching 90%. However, we cannot guarantee their energy portfolio going forward.

Another important factor that should be considered is measures taken by the Town and its residents with regard to energy conservation. The easiest way to save energy is that which we don't use. Barre Town has invested considerable tax dollars to upgrade and make Town buildings more energy efficient. Likewise, residents have also, at considerable expense, made weatherization improvements themselves or taken advantage of weatherization programs.

While progress has been made weatherizing homes, there is much to be done. Much of Barre Town's housing is very old and as a result not energy efficient. Barre Town can't mandate home improvement projects that increase energy efficiency, however, we can and do support it and at the same time support expanding any program that improves the weatherization of homes not only in Barre Town but across the State. All new construction shall be constructed in accordance with State building energy standards if applicable. Builders and homeowners should be familiar with the State mandate.

I. Estimates of current energy use across transportation, heating, and electric sectors

Energy is an important component of Barre Town's vitality. Our energy plan is a guide to promote numerous benefits which include municipal cost savings, increased revenues, a strong economy, greater energy independence and security, local influence over energy facility siting, more efficient communities, healthier communities, a clean environment, and regional coordination and collaboration. State incentives may be available to communities that have energy plan.

To a large degree, energy costs are **NOT** controlled by a municipality; they are dictated by outside sources. The number one demand for energy use in Vermont is in transportation. Heating is second followed by electrical use. So, while Barre Town and its residents may not be able to control the cost of energy, they can always look toward conservation, behavior changes, and fuel switching as a way to cut cost and meet many of the benefits mentioned above.

Other methods of energy conservation can also be encouraged such as the use of renewable energy sources and increasing the energy efficiency of buildings. Promoting these methodologies can also lead to job creation for the local work force.

TRANSPORTATION

In many cases, energy use related to transportation is a significant component to the overall energy use within a municipality. Table One provides an overview of the current energy usage in Barre Town related to transportation.

TABLE ONE	
CURRENT RESIDENTIAL TRANSPORTATION ENERGY USE	
DATA CATEGORY	**INFORMATION**
Total number of vehicles	5,934 vehicles
Average miles traveled per vehicle	12,500 miles
Total regional miles traveled	74,175,000 miles
Average gallons of fuel used per vehicle per year	576 gallons
Total gallons of fuel used per year	3,987,903 gallons
Transportation energy used per year	480 billion BTUs
Average regional cost per gallon of fuel	$2.31/gal
Fuel costs per year	$9,212,056/yr.

Notes:

1. Total vehicles provided by the American Community Survey.
2. Average miles traveled & Average gallons of fuel used per vehicle provided by VTrans.
3. Average cost per gallon of fuel provided by the CVRPC.
4. Information related to public transit is not included in this table.

Identifying current levels of electricity use provides a baseline for a community to understand how much energy is being consumed. Electricity use does not take into account the source of the electricity generation. As such, electricity being consumed in Barre Town that is not renewable is governed by the utilities purchase power portfolio.

Barre Town's current electricity use is noted in Table Two.

TABLE TWO CURRENT ELECTRICITY USE	
USE SECTOR	**CURRENT ELECTRICITY USE**
Residential	20,360.6 megawatt hours
Commercial & Industrial	12,718.8 megawatt hours
TOTAL	**33,079.4 megawatt hours**

Notes:

1. Information provided by Efficiency Vermont

Home Heating

The residents of Barre Town depend upon, propane, electricity, fuel oil, and wood for their home heating needs with fuel oil being the most dominant. In many cases, the housing stock that exists was built when fuel oil was inexpensive, and systems were easy to maintain. Over the years, these systems have become less efficient and more costly to maintain Table Three provides a breakdown of the fuel sources used for residential heating in Barre Town while Table Four lists the current commercial energy use.

TABLE THREE CURRENT RESIDENTIAL HEATING ENERGY USE				
FUEL SOURCE	**NUMBER OF HOUSEHOLDS**	**PERCENT OF HOUSEHOLDS**	**HEATED SQUARE FOOTAGE**	**BTUs (in Billions)**
Propane	353	11.30%	658,350	39.5
Electricity	85	2.70%	156,870	9.4
Fuel Oil	2,236	71.40%	4,326,540	259.6
Coal	0	0.00%	0	0
Wood	398	12.70%	811,920	48.7
Other (includes solar)	60	1.90%	117,180	7
TOTAL	**3,132**	**100%**	**6,070,860**	**364.3**

Notes:

1. Data provided by the American Community Survey.

TABLE FOUR CURRENT COMMERCIAL ENERGY USE		
COMMERCIAL ESTABLISHMENTS	**AVERAGE THERMAL ENERGY USED PER ESTABLISHMENT**	**COMMERCIAL THERMAL ENERGY USED REGIONALLY**
131	0.8	105.3

Notes:

1. Thermal energy use is expressed in Billions of BTUs.
2, Information provided by the Vermont Department of Labor and Department of Public Service.

II. 2025, 2035, and 2050 targets for thermal and electric efficiency improvements, and use of renewable energy for transportation , heating, and electricity

To effectively identify efficiency improvements for Barre Town, the Central Vermont Regional Planning Commission has provided targets for efficiency improvements for each of the target years as percent reductions below 2014 levels. These improvements relate to residential, commercial, and overall building efficiency. The target number may seem to be skewed towards the later years, however there is an expectation that efficiencies will increase with technological advances and occur over time regardless of additional actions being taken. The targets are noted in Table Five.

TABLE FIVE TARGETS FOR THERMAL EFFICIENCY IMPROVEMENTS			
SECTOR TYPE	**2025**	**2035**	**2050**
Residential Thermal Efficiency	20%	42%	92%
Commercial Thermal Efficiency	22%	33%	61%

Notes:

1. Information derived from VEIC LEAP Modeling

In order for Barre Town to help support the state's goals of 90% of the energy used being derived from renewable sources by 2050, the Central Vermont Regional Planning Commission allocated megawatt hour targets for the years 2025, 2035, and 2050. This municipal target is based on an allocation from a region-wide target for renewable energy generation. Table Six notes Barre Town's targeted renewable energy use and Table Seven identifies the targets for renewable energy generation.

TABLE SIX
TARGETS FOR RENEWABLE ENERGY USE

SECTOR TYPE	2025	2035	2050
Transportation Renewables	9.60%	31.30%	90.20%
Heating Renewables	51.60%	66.20%	92.90%

Notes:

1. Information derived from VEIC LEAP Modeling

TABLE SEVEN
TARGETS FOR RENEWABLE ENERGY GENERATION

SECTOR TYPE	2025	2035	2050
Electricity Renewables (in megawatt hours)	12,749	20,398	50,995
Heating Renewables	51.60%	66.20%	92.90%

Notes:

1. Information provided by The Department of Public Service

In general, the Town of Barre supports the use of renewable energy systems, to the extent that it does not over burden the town with a disproportionate share of the State's renewable energy goals and provided that they fit into the goals of the Town Plan, taking into account noise, scenic vistas, location, negative impacts on residents, and represents an orderly development of renewable energy systems. The build out of renewable energy systems (solar and wind) within the town should proceed at the same rate as the rest of the region.

Some renewable energy sources in the town are represented by wind, solar, and wood. While renewables represent a chance to move away from fossil fuel sources, they are not without their own negatives such as aesthetics, noise, cost, reliability, and availability.

It is a long-standing practice within the town to have new utility lines and utility line extensions placed underground as opposed to above ground to minimize their overall visual impact and enhanced reliability. Therefore, any extension of 3-phase power lines should be underground.

Wind Turbines

Wind turbines are relatively expensive, can be high maintenance, have siting issues (works best at higher elevations, and on ridgelines), require significant property line setbacks, may cause noise issues, moving shadows, etc. with adjacent property owners, may negatively affect property values, and of course only works when there is sufficient wind speed. Turbines can be shut down due to excess wind speeds or at night to preserve and protect bats and migrating birds. Additionally, there has to be sufficient line capacity to move the power generated out onto the grid.

Aesthetics are a major concern, as Barre Town is geographically defined by 2 north/south ridges, with expansive views from both ridges to the east as well as the west.

Solar Energy

Solar energy is represented by both solar hot water heating systems (domestic hot water), and solar electricity (photovoltaics - PV). The most appropriate location for solar arrays is roof tops, existing impervious surfaces, or industrial/earth resource land (identified by the Town) not well suited for conventional development. Any new ground mounted solar array should utilize existing topography, development, or vegetation on site to break up the visual mass of the arrays. Renewables cannot be sited in predominately visible locations on hillsides or ridgelines and shall be sited to preserve open space.

Solar Hot Water

Solar hot water systems require minimal space and can be located on roofs or ground mounted and could be located in all zones. Solar hot water systems are subject to setback requirements (same as any accessory building). Roof mounted arrays are subject to building height requirements and need to be sensitive to neighborhood aesthetics.

Solar arrays ideally require full sun and unobstructed southern exposure. Essentially all the solar heat generated is stored in a hot water pre-heater tank (think of it as a battery) and used on an as needed basis, which has the potential to reduce the morning and evening spikes in electrical demand required to produce hot water. Payback on the systems is fairly short term given that there are both state and federal rebates/incentives available. These systems would also be appropriate for heating swimming pools.

Photovoltaics (PV)

PV requires a much larger array of panels and may have a more visual impact on surrounding properties. Due to their larger size and system connection needs residential PV systems are more expensive to install than hot water systems. Even with the present state and federal incentives, payback can be up to 20 years. As with solar hot water, these systems can be roof mounted or ground mounted, and are subject to residential set back and height restrictions. Annual electricity production maybe negatively impacted by winter months snow covering the panels, and panel angle.

Wood

Wood is available as both firewood and pellets. Generally, firewood is produced in or within a few miles of Barre Town which minimizes transportation costs and supports a local economy. Firewood removal from forest land is also an important tool for forest, wildlife, and agricultural land management. Pellets used in Vermont are generally produced regionally, also minimizing transportation costs.

While using firewood for heat in stoves and inside boilers is a logical step to supplement fossil fuels, outside wood boilers have their own particular set of issues. Generally, the flue pipe (smokestack) is short and in certain meteorological conditions can cause significant ground level smoke plumes to the detriment of the neighbors or neighborhood. Outside wood boilers used in the summer solely for hot water production may create low lying smoke plumes which might impact neighbor's health and enjoyment of their property. Their use is best limited to winter heating.

The use of wood pellets for heat in stoves and inside boilers as a means to supplement fossil fuels has its own set of challenges. Pellets are delivered in the form of 40-pound plastic bags or loose when a silo is part of the boiler system. Unlike the use of a firewood system, the wood pellet system requires electricity as a means to power the auger and the blower. An uninterruptible power supply battery backup or an alternative connection to a separate battery can be used during power loss.

III. Evaluation of the amount of thermal-sector conservation, efficiency, and conversion to alternative heating fuels needed to achieve these targets

Barre Town has taken a proactive role in ensuring the facilities that it owns are evaluated and upgraded to improve thermal efficiency and/or to install more efficient heating sources. This process can help extend the life of existing facilities while maintaining high quality services. These conversions and conservation measures can also result in reduced operations costs which is beneficial to all residents. Specific examples include:

- The East Barre Fire Station has had lighting upgrades done (both interior and exterior), and the heating plant was converted from #2 heating oil to propane. The roof was replaced with an additional 1" of insulation added. Note – the added weight of adding more than 1" of insulation would have compromised the roof's structural integrity.

- The South Barre Fire Station has had lighting upgrades (interior and exterior) and building occupancy sensors installed. The heating plant has been converted from oil to propane, and the roof will be replaced in coming years. A building energy audit recommended that the outside concrete walls be weatherized/insulated. Work to be performed in 2021.

- The Town Office Building has been subject to several energy upgrades in the past. Weatherization and insulation of the front part (the oldest part) of the building has been completed, and an insulation project is under consideration for the new part of the building. Changes to the heating plant are also under consideration for the future. Some of the exterior lights have been converted to LED's. Circulator pumps, fin tube radiation valves, and the sprinkler air compressor pump will also be replaced soon.

- The Emergency Medical Service building has updated lights and the heating and hot water system is propane. An energy audit performed in 2018 has recommended insulating and air sealing the attic. Presently scheduled for 2020.

- The Department of Public Works (DPW) maintenance facility's roof was recently replaced and insulation added.

- DPW's truck garage is scheduled for window replacement in 2022.

- Barre Town Elementary School (BTMES) – The school has undertaken a series of energy saving and conservation efforts over the past few years as part of an ongoing program to make the school more energy efficient and to reduce the cost of operating the school's facilities:

  The schools heat and hot water is supplied by a wood chip fueled boiler during the winter months. The chip plants control panel was recently upgraded to Variable Frequency Drive programming which allows the circulator pumps to operate on a demand basis. Sections of the roofing membranes have been replaced resulting in a significant reduction in heat loss, as well as preventing water leakage into the building. Lighting throughout the school is systematically being replaced with LED lights and appropriate fixtures. And exterior lights were replaced with LED lighting. HVAC units replaced with more efficient units. Exterior windows and doors were replaced. Finally, the dishwasher in the kitchen was replaced with a more energy efficient one.

BTMES receives electricity credits from the solar project located on Town owned property in Websterville. Resulting in lower costs to operate the school as well as supporting the move to using renewables for electricity.

Going the next step and converting town owned heating systems from fossil fuel based to higher efficiency renewable energy-based systems may possibly benefit the Town of Barre. However, currently is not reasonably cost effective to make those conversions. Something to review and access in the future as the technologies evolve.

In order to address thermal sector conversions, Table Eight notes the number of new efficient wood heat systems and heat pumps needed in each target year to achieve the state's comprehensive energy goals. These include both residential and commercial heating systems.

TABLE EIGHT
THERMAL SECTOR CONVERSIONS
(RESIDENTIAL & COMMERCIAL)

SYSTEM TYPE	2025	2035	2050
New Efficient Wood Heat Systems	6	36	76
New Heat Pumps	320	818	1,555

Notes:

1. Information derived from VEIC LEAP Modeling
2. Heat pumps includes both space heating and hot water heating.

IV. Evaluation of transportation system changes and land use strategies needed to achieve these targets

As noted previously, energy for transportation is one of the major components of non-renewable energy use. Providing readily available, convenient, and accessible alternatives to single occupancy vehicles is one way to reduce these costs. Another way to reduce fossil fuel usage is to convert from strictly fossil based vehicles to either hybrids (using both gasoline and electric) to alternative fuel driven such as biodiesel, hydrogen, or electric vehicles. The information in this section will discuss the various options related to transportation and land uses. The downside to being a very rural state with jobs located in distant towns is that reducing vehicle miles traveled and occupancy rates in vehicles is problematic. Behavior change within the community will ultimately happen once there are practical alternatives through land use and company cultures. Support of communication reliability will also reduce transportation use by creating a community that can work from satellite locations and attract companies that rely on wireless connectivity.

Technology

Barre Town has and will continue to bring awareness to the practical opportunities in future development when it presents itself. The use of hybrid, plug-in, hydrogen, and biodiesel as alternative fuels to reduce the fossil fuel demand are explored during the purchasing process. As the range and power of these alternative fueled vehicles increases, the economics will work in favor of investing in the municipal fleet, perhaps even heavy-duty vehicles. Barre Town is challenged with having steep inclines and rural demands that will add to demands of an alternative fueled vehicle. The addition of charging stations will attract owners of alternative vehicles. However, the efficiency of batteries during frigid, cold winter months is drastically reduced. Also, seasonal dilemma's (mud season) on rural back roads are limiting factors when relying on such power.

Another technology not typically associated with transportation efficiency is the support of increased communications in the village centers and industrial park areas. The support of communication towers, repeaters, and boosters in these targeted areas of Barre Town will reduce commuter travel and create a stronger commercial economy. A reliable and strong connection will support residents in search of a telework-friendly home and will attract companies that rely on wireless connections for day-to-day activities.

Bicycles

Dramatic urbanization increases the need for compact transportation. Cities can plan or implement massive expansions of public transportation and of communal bicycle schemes and other efforts to make more people go by bike. The rural and hilly terrain of the Town has inspired more recreational use than demand use transportation.

The commuter rider desires the most direct route with few interruptions, whereas the recreational rider is riding for pleasure and a specific route has less importance.

The Town of Barre has constructed and continues to expand upon its bike paths. Although we coin the route as "bike paths" they are enjoyed as much by pedestrians. As the Town continues their expansions of these routes the Town should consider opening their use to a broader audience of compact commuters.

The planning and design of compact routes, whether they are improvements to existing highways, provisions including in new highways, or separate exclusive routes need to accommodate a broader range of commuters.

Several targets might include:

- Designating certain roadways as principal routes can be effective in discouraging compact traffic on otherwise hazardous roadways. The principal alternate routes must be generally hazard free in order to encourage the more serious rider to take the a less direct route.

- Some routes are physically separated from the highway and can be either within the highway right-of-way or within a separate right-of-way. If paths are less than 5 feet from highways, physical barriers such as fences or guardrail should be considered in order to divide the two distinct facilities.

- Most of the highways used by bicyclists do not have enough shoulder width to safely accommodate them. Highway sizing is not determined by Barre Town and limited by regulations in most cases. Most of those highways which do have wider shoulders do not have markings or signs delineating a preferred route.

The amount of road rage that occurs today in car to car incidents should be horse sense enough that education on road courtesies should be posted along roadsides which share space.

Pedestrians

Pedestrian walkways are an important and integral part of the transportation system.

- The construction of these facilities should be considered for the safety and convenience of pedestrian and vehicular traffic.

- These byways should be provided for in those areas where the volume of traffic warrants the cost and utilization of land for them.

Sidewalks are the most formal means of delineating walkways to separate pedestrian and vehicular traffic. They are generally needed in areas of moderate to high density development. These facilities are found in a wide variety of types as to width and surface materials and should be designed in accordance with acceptable standards to satisfy traffic volumes.

- Sidewalk improvements should be planned at the same time that road improvements or other construction projects are planned.

Footpaths are informal pedestrian walkways which may be utilized to move traffic between points or as nature trails and other recreational purposes. These paths generally have specific uses and are not necessarily associated with the need to separate pedestrian and vehicular traffic. Easements should be acquired or dedicated and maintained for the public use of these footpaths.

Shared use paths serve as part of a transportation circulation system and support multiple recreation opportunities, such as walking, bicycling, etc. Shared-use paths should always be designed to include pedestrians even if the primary anticipated users are bicyclists.

Public Transportation & Ride Public Transportation & Ride Shares

The State of Vermont currently operates several commuter or ride share parking lots in the area. There is one such lot located along South Barre Road (VT RT 14) in South Barre near the VT RT 63 intersection and another just west of East Barre along US RT 302. VTrans also provides ride share parking lots in the adjacent communities of Berlin, Montpelier, East Montpelier, Orange, and Williamstown. Ride share lots are a very low cost and effective way to achieve a reduction in vehicle miles traveled.

Green Mountain Transit currently operates a ride share pool and the Wheels Program for seniors. These types of programs greatly increase the mobility of Barre Town residents who are limited in their personal resources or access to family vehicles. This also reduces the demand of private vehicle use and its associated fossil fuel use.

One component of reducing fossil fuel-based energy used in the transportation sector is to convert or replace those vehicles with alternative fuel options such as hybrid (fossil fuel/electric), electric or biodiesel or emerging technologies such as hydrogen fuel. Table Nine identifies the targets for Barre Town to reduce its transportation energy consumption to a point that will help meet the state's comprehensive energy planning goals. Again, this information assumes efficiency and improved technologies will be included in the development of vehicular fuel technology.

TABLE NINE

TRANSPORTATION FUEL SWITCHING TARGETS

FUEL TYPE	2025	2035	2050
Electric Vehicles	510	3,522	7,031
Biodiesel Vehicles	889	1,647	2,671

Notes:

1. Information derived from VEIC LEAP Modeling (information is suspect because Barre Town's current vehicle inventory is 5,934 and the overall increase just in alternative fuel vehicles alone makes up a 61% increase in vehicles. Barre Town's population is not expected to grow at a pace to support these numbers).

Land Use

Early development of Barre Town occurred in village areas surrounding employment centers. These villages eventually developed their own names and post offices within the Town - Graniteville, Websterville, South Barre and East Barre. Within them are examples of early quarry workers homes, usually similarly constructed, such as on the east side along Cogswell Street in Upper Graniteville. Another popular house style is the Sears Roebuck and Montgomery Ward early version of pre-fabricated houses (available with plumbing and electrical if one chose to purchase the whole package) such as the house at 54 Brook Street in Websterville. The South Barre village has notable large wood framed houses thought to be custom built - one at the corner of Seager Lane and South Barre Road (VT RT 14) dating to 1803 and two side by side on the west side of VT RT 14 at 397 and 411 South Barre Road, one of which local lore relates was a safe haven offered as part of theUnderground Railroad which moved African American people to safety in the north.

Also, a part of village history is the traditional churches such as the East Barre Congregational Church and First Presbyterian Church in Graniteville. Traditional construction also remains for several grocery stores such as 34 Church Hill Road in upper Websterville, now the Millstone Hill Touring Center. Scattered throughout the town are barns that remain though the "farming" may have stopped some years ago – examples are the Swift barn on Swift Road, the Usle "Strawberry Grove" barn at 109 West Cobble Hill Road, and the Paquet Farm at 179 Morrison Road established in 1909 in the South Barre area.

The Barre Town Plan discusses the need to establish compact development patterns like these historic villages. This is noted for multiple reasons including minimizing the costs of infrastructure, creating opportunities for walkable communities, and increasing the population density needed for public transit. This village concept establishes a land use pattern that is still viable and desirable today and is supported by the Town Plan's goals.

V. Evaluate electric-sector conservation and efficiency needed to achieve these targets

Conservation and efficiency of electricity is a key component to achieving the state's comprehensive energy planning goals. Over time, advancements in technology will provide a degree of the needed efficiency and conservation measures to achieve these goals, but also, efforts can be taken now to ensure that Barre Town is on track to meet our conservation and efficiency targets. Table Ten outlines the electric efficiency improvements needed for each of the three target years. Additionally, information related to more proactiveways to achieve these efficiencies are also noted below.

TABLE TEN

TARGETS FOR ELECTRIC EFFICIENCY IMPROVEMENTS

SECTOR TYPE	2025	2035	2050
Electric Efficiency	1.50%	7.30%	15.20%

Notes:

1. Information derived from VEIC LEAP Modeling

Energy Conservation

The greatest impact on reducing dependence on fossil fuels, both domestic and foreign, is to decrease the overall demand for energy through conservation. Conservation also produces the most economic gain because it represents money not spent for energy. Basic conservation efforts involve little or no monetary investment, but most likely will involve changes in both culture behavior and lifestyle. Additional efforts require an investment in reducing the energy requirements of buildings.

While the Town of Barre cannot require energy conservation by citizens of the Town, the Town can certainly actively promote energy conservation measures. This can be achieved through zoning bylaws (as recommendations), encouragement and listing resources in the Town Newsletter, and on the Town website. The Town is also leading by example in making Town owned buildings more efficient. These improvements are highlighted on the Town website and in the newsletter. Barre Town actively reviews and participates in planning workshops and meetings to understand additional opportunities for efficiency support to include consideration in adopting stretch codes, financing resources, and planning manuals for residents.

Transportation

While public transportation; buses and trains provide minimal opportunity in Barre Town for energy conservation, better utilization of commuter ride share parking lots would help residents reduce the use of private motor vehicles. Many of these lots could be expanded in size in the future as demand grows. There is also the option of adding additional lots or utilizing existing business lots that have lower traffic volume. Note that any of these changes would be done at the discretion of VTrans and are not town driven outcomes. Although, we would be supportive of them.

A roundabout has been constructed in East Barre at the Intersection of Route 302 and 110 and use of roundabouts is encouraged to reduce stop and go traffic and reduce accidents and improve safety.

Another option for setting up a carpool can be found at www.connectingcommuters.org, which helps those seeking carpooling opportunities find car or van pooling partners. For carpool matching, van pools, and bus routes please call 800-685-7433 or visit their website.

Within the Town, development of multiple charging station locations will encourage the conversion from fossil fuel vehicles to plug-in hybrid and full electric alternatives. Businesses will be encouraged to make their electric vehicle charging stations available to the public.

Businesses are encouraged to utilize rail transport when available. The Town's Wilson Industrial Park (WIP) and areas of Quarry Hill, Websterville, and Graniteville have rail service connecting to Montpelier via the New England Central Railroad.

Street Lighting

Barre Town completed a public streetlight survey in 2012 of all lights that the Town pays for. It was a great opportunity to survey the lights in use and to make recommendations for additions or deletions to the streetlight inventory. The goal was to replace existing streetlights which were generally either mercury vapor, or high-pressure sodium, with LED lights. The changeover was conducted in cooperation with Green Mountain Power. Expected savings are around $10,000 per year for the Town. In all, there were 86 existing lights removed and 24 added for a net loss of 62.

Renewable Energy

As noted previously in Section II, renewable energy development throughout the state is necessary to meet the Vermont's renewable energy goals. This puts the source of generation closer to where it is needed. Table Eleven identifies the current renewable energy generation in Barre Town.

TABLE ELEVEN
EXISTING RENEWABLE ENERGY GENERATION

RESOURCE TYPE	MEGAWATTS	MEGAWATT HOURS
Solar	4.02	8,803.80
Wind	0.1	219
Hydroelectric	0	0
Biomass	0	0
GMP/WEC	TBD	TBD
Other		
Total Existing Renewable Energy Generation	4.12	9,022.80

Notes :

1. Information provided by the Department of Public Service.
2. Due to rounding, totals may not be accurate.

Siting

An analysis of existing land and renewable resource potential will help determine the amount of local renewable energy that could be developed within Barre Town. Table Twelve identifies the amount of renewable energy generation (in megawatt hours) that Barre Town would need to generate by 2050 to help meet our share of the Region's total renewable energy generation. This is the same information that is included in Table Seven.

TABLE TWELVE TARGETS FOR RENEWABLE ENERGY GENERATION			
SECTOR TYPE	**2025**	**2035**	**2050**
Total Renewable Generation Target (in megawatt hours)	12,749	20,398	50,995

Notes :

1. Information provided by the Department of Public Service.

These totals may be reduced by taking advantage of utility renewables.

To provide a comparison, the information in Table Thirteen includes an analysis of the renewable energy generation potential and will be complemented by information and maps that are in **Appendix B** of the plan. Table Thirteen notes the amount of generation that could occur if all the areas identified as prime or secondary resources were developed with renewable energy, specifically for solar and wind. By comparing the two tables, it becomes clear that there is adequate land area available for Barre Town to accommodate renewable energy generation that can meet their share of the region's renewable energy allocation.

Vermont's 2016 Comprehensive Energy Plan ("CEP") serves as the electrical energy plan in Vermont. The CEP recognizes that battery storage has an important role as the state integrates more renewable resources into the electrical grid. Page 229 of the CEP states that "energy storage is increasingly important as our reliance on intermittent resources increases," and goes on to comment on the "wide variety of purposes" it can serve, "from shaving electricity demand peaks and supporting grid voltage to providing backup power and "firming" the output of intermittent renewables." In other words, energy facilities like these are an effective tool to reduce utility costs and can facilitate the connection of distributed resources as required under Tier II of the RES (Renewable Energy Standard). To that end Barre Town has recently welcomed a 499kW battery storage project located within Wilson Industrial park. The battery storage facility will work closely with Green Mountain Power to optimize the use of the storage system to stack a number of different value streams. Its operational flexibility has the potential to help Vermont achieve several policy mandates, including expansion of renewable generation, addressing climate change risks, and modernizing an aging electrical grid.

Notes :

1. Information gathered from Public Service Board Case # (18-1658-PET).

TABLE THIRTEEN POTENTIAL RENEWABLE ENERGY GENERATION		
RESOURCE TYPE	**MEGAWATTS**	**MEGAWATT HOURS**
Rooftop Solar	3.79	4,644
Ground-mounted Solar	1,019.98	1,250,902
Wind	652.58	2,000,810
Hydroelectric	0	0
Biomass & Methane[1]	0	0
Battery Storage (unsure how to capture currently)		
Other	0	0
Total Potential Regional Renewable Energy Generation	1,676.35	3,256,356

Notes : 1. Information calculated by the CVRPC based on data provided by the Vermont Center for Geographic Information and efficiency factors provided by the Department of Public Service.

1. Biomass and methane are not restricted by resource locations and should be sited accordingly to provide maximum benefit to the greatest number of end users or to meet municipal needs. Siting will be more dependent on local regulatory controls and should be planned for accordingly.

One final factor to consider is efficiency of renewable resources and their ability to generate energy. These efficiency factors will allow Barre Town to utilize whatever renewable resource is most appropriate for the specific circumstances. Table Fourteen notes the efficiency factors for common types of renewable energy generation.

TABLE FOURTEEN RENEWABLE GENERATION OUTPUTS & CAPACITY FACTORS		
RESOURCE TYPE	**CAPACITY FACTOR**	**ANNUAL MEGAWATT HOUR OUTPUT PER INSTALLED MEGAWATT**
Solar	14% - 16%	1,300
Small Wind	20% - 25%	2,000
Utility Scale Wind	25% - 35%	2,600
Methane	60% - 90%	6,600
Biomass	60% - 80%	6,100
Small Hydroelectric	40% - 60%	4,400

Notes :

1. Information provided by the Vermont Department of Public Service.

Conclusion

As noted throughout this section, Barre Town face challenges similar to the rest of the state regarding its energy future including the need for conservation, renewable energy generation, development, and changing habits and attitudes towards renewable technology and land use choices. All of these components need to work together in order to ensure a collective and comprehensive approach to energy planning is initiated.

The State Comprehensive Energy Plan has set a goal of 90% renewable energy by the year 2050. This goal is achievable if all stakeholders including the state, the region, the municipalities, the energy developers, the private land owners, the special interest groups, and the interested citizens come together to discuss the issues and work collectively to identify the outcomes that to the best of its ability satisfy the Town's targets.

This plan primarily explores renewable energy related to the production of electricity and electrification of the grid. In addition to the resources noted herein, it's important to consider other forms or technologies that could contribute to our renewable energy future. With advancements in safety, efficiency, and technology, the Region's energy future could look vastly different in the next five or ten years. This will not only impact the generation of energy, but the delivery and infrastructure to support distribution of energy.

PATHWAYS & IMPLEMENTATION ACTIONS

The following goals and implementation actions outline the specific pathways for Barre Town to consider in order to effectively support the State of Vermont's goals that are outlined in the 2016 Comprehensive Energy Plan. These goals are intended to cover a variety of pathways that address land use and siting of developments (including renewable energy generation); efficiency of building construction and weatherization; and fuel switching from fossil-based fuels to more sustainable and renewable options.

A. Conservation and Efficiency

Policy A-1: Increase conservation of energy by individuals and organizations.

Conservation of energy is a key component to achieving the State's goals of 90% energy derived from renewable sources by 2050. Conservation of energy in-turn will reduce the amount of energy (both renewable and non-renewable) needed to support the existing and future systems thus allowing small increases in generation to support more uses overall.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST[2]	MEASURE OF SUCCESS
1	Barre Town will encourage homeowners and businesses to replace or upgrade current outside lights with LED's or current technology.	Municipality	Medium 3 to 5 years	*TBD*	Increase in energy efficiency by homeowners and businesses
2	New construction of homes and businesses should utilize energy efficient lighting.	Municipality	Medium 3 to 5 years	*TBD*	Update local codes to require efficient lighting be utilized in new construction
3	Work with regional partners to identify programs or funding that supports efficiency and conservation initiatives and provide information to residents.	Municipality regional partners	High 1 to 3 years	*TBD*	Information distributed as appropriate

2. All implementation actions will require funding to support the efforts. In some cases, these costs will be associated with other programs or activities. For the purposes of this section, the "cost" column will indicate the funding that may be needed to support the identified implementation action. Costs are To Be Determined (TBD) as implementation actions are more specifically defined.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
4	Create an Energy Committee comprised of Town citizens and officials to explore ways to make homes and businesses more efficient in the use of energy.	Municipality	High 1 to 3 years	*TBD*	Local Energy Committee formed

Policy A-2: Promote energy efficiency in the design and construction of buildings.

Energy efficient building designs provide benefits to the owners and occupants by reducing the amount of energy needed to heat, cool, and maintain the mechanical systems within the building. Establishing and promoting energy efficiency in design and construction will ensure new buildings and building practices will be more efficient into the future.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Continue to inform the public through zoning of State Residential Energy Standards and the requirement that new construction meet those standards.	Municipality	High On-going	*TBD*	Information disseminated as needed
2	The Development Review Board will recommend developers (residential and commercial) to utilize energy efficient insulation, weatherization, heating, and lighting in all projects. Encourage structures to be built to take advantage of passive solar.	Municipality Development Review Board	Medium 3 to 5 years	*TBD*	New developments utilize energy efficient building materials
3	Encourage home and business owners to have a professional energy assessment performed by a certified home energy specialist or ENERGY STAR® contractor to determine both energy losses from the building and to have a plan developed to correct energy and heat loss deficiencies.	Municipality	High 5 to 10 years	*TBD*	Increase in number of assessments performed

Policy A-3: Identify ways to decrease the use of fossil fuels for eating.

Establishing alternative sources of renewable fuels for heating or conversions to heating. This will promote a more sustainable thermal energy future.

IMPLEMENTATION ACTION		RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Identify funding programs or partners that can assist with conversion of heating sources utilizing renewable based systems for homes and businesses.	Municipality, CVRPC, regional partners, state agencies	High 1 to 3 years	*TBD*	List of funding sources established & maintained
2	Identify technologies such as cold climate heat pumps, district heating, wood stoves or boilers that would be suitable for home and business conversions and educate users on their advantages.	Municipality, CVRPC, industry experts	High 1 to 3 years	*TBD*	Information sessions conducted bi- annually
3	Identify potential locations throughout the community that could benefit from district heating projects based on building density, proximity to resources such as biomass, or status as a use by right where applicable.	Municipality	Low	*TBD*	Locations identified and mapped

3. District heating is a system for distributing heat generated in a centralized location for two or more homes and/or buildings' heating requirements.

Policy A-4: Demonstrated municipal leadership regarding efficiency of municipal buildings.

Leading by example is the most effective way to show the municipality is committed to implementing the actions that will support a renewable energy future. Municipalities typically own multiple buildings that can benefit from energy efficiency measures. This could include replacing appliances in the Town Hall, adding solar panels to the town garage, or replacing outdated oil burning heating systems for high efficiency heat pumps.

IMPLEMENTATION ACTION		RESPONSIBILITY	PRIORITY/TIMELINE	COST	MEASURE OF SUCCESS
1	Barre Town will continue to evaluate and upgrade municipal buildings to ensure energy efficient practices are being utilized.	Municipality	High 1 to 5 years	*TBD*	Municipal buildings are upgraded regarding energy efficiency and weatherization
2	Identify municipal buildings or properties that could support renewable energy development to serve municipal facilities.	Municipality	High 1 to 3 years	TBD	Renewable energy projects installed as appropriate
3	Develop protocols for life-cycle analyses of municipal buildings and facilities to ensure costs for upgrades and improvements are planned.	Municipality	High On-going	*TBD*	System developed to evaluate buildings and facilities

B. Reducing Transportation Energy Demand, Single-Occupancy Vehicle Use, and Encouraging Renewable or Lower-Emission Energy Sources for Transportation

The State of Vermont currently operates several commuter or ride share parking lots in the area. There is one such lot located along South Barre Road (VT RT 14) in South Barre near VT RT 63 and another just west of East Barre along US RT 302. VTrans also provides ride share parking lots in the adjacent communities of Berlin, Montpelier, East Montpelier, Orange, and Williamstown. This leads to a reduction in vehicle miles traveled.

Green Mountain Transit (GMT) currently operates a ride share pool and the Wheels Program for seniors. These types of programs greatly increase the mobility of Barre Town residents who are limited in their personal resources or access to family vehicles. This also reduces the demand of private vehicle use and its associated fossil fuel use.

Policy B-1: Encourage increased use of transit.

Public transit offers communities the ability to move multiple persons utilizing existing roadway or railway infrastructure. Convenient, reliable and efficient public transit provides an alternative mode for individuals that might otherwise choose to drive alone. Public transit has the ability to reduce the need for parking, provide more walkability in communities, and reduce congestion on local roads. However, to achieve maximum results they must use sound management practices to ensure the most effective use of the service provided. An example of this would be to utilize vans instead of buses on low volume passenger routes to receive better fuel consumption.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Barre Town will work with GMT to continue its services and if possible, expand them in the future if demand warrants and funds becomes available. One such beneficial expansion to consider would be expanding bus service into South Barre.	Municipality, GMT, VTrans, CVRPC	Medium On-going	*TBD*	Public transit routes are expanded
2	Work with large employers to identify if public transit could be more effectively scheduled to provide service to these locations.	Municipality, business community, GMT, VTrans	Medium 3 to 5 years	*TBD*	Transit routes evaluated for proximity to large employers
3	Identify under-served populations to ensure transit options are available or will become available.	Municipality, GMT, VTrans, CVRPC, transportation providers	High On-going	*TBD*	Populations identified and transit services planned as identified by the Energy Committee

Policy B-2: Promote the shift away from single-occupancy vehicle trips.

Due to the rural and suburban nature of Barre Town, single-occupancy vehicle trips are a common occurrence. While many people rely on their vehicle to perform general day-to-day tasks, reducing the rate of these trips can improve congestion on local roads; reduce conflicts with vehicles and pedestrians; and provide more support for ride shares, public transit, or similar multi-occupancy trips.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Encourage developers to incorporate pedestrian and bike paths and park and ride facilities where applicable within or in proximity to new developments.	Municipality	Medium On-going	*TBD*	Municipal regulations updated to require bicycle and pedestrian infrastructure
2	Work with transit providers to identify possible future park & ride locations that will support areas with current or future development density.	Municipality, GMT, VTrans, CVRPC	Medium On-going	*TBD*	Potential park & ride locations identified
3	Work with utility companies to inventory and map infrastructure such as fiber optic cable to identify gaps that may prohibit information accessibility or telecommuting options.	Municipality, utility providers	High On-going	*TBD*	Identify gaps and prioritize needs
4	Conduct regular inventories of park & ride facilities to ensure adequate space exists to accommodate users.	Municipality, VTrans, CVRPC, GMT	Medium On-going	*TBD*	Inventories conducted and facilities evaluated
5	Pursue grant funding that can support any of the above noted Activities	Municipality	High On-going	*TBD*	Grants applied for or funds secured

Policy B-3: Promote the shift away from gas/diesel vehicles to electric or non-fossil fuel transportation options.

Reducing the dependency on fossil fuels and other non-renewable fuels is a key pathway to achieving the state's energy planning goals. Switching to renewable fuel-based vehicles will help reduce greenhouse gas emissions and promote cleaner fuel alternatives.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Identify businesses in the municipality that operate large fleets of vehicles to provide assistance evaluating the possibility of integrating electric or non-fossil fuel-based vehicles into their fleets.	Municipality, business community	Medium 3 to 5 years	*TBD*	Businesses inventoried and contacts established
2	Inventory existing locations of electric vehicle charging stations to identify where infrastructure gaps may exist or where needs could be met to provide greater access for electric vehicle owners	Municipality, Drive Electric Vermont	Medium Out-going	*TBD*	Inventory of locations mapped to identify potential gaps
3	Update municipal regulations to encourage new non-residential developments to include or provide accommodations for electric vehicle charging stations within the development.	Municipality	Medium 3 to 5 years	*TBD*	Regulations updated

Policy B-4: Facilitate the development of walking and biking (shared use)

Walking and biking provide valuable alternatives to motorized vehicle travel. Develop and ensure a safe, efficient, and convenient infrastructure exists to promote walking and biking. It is essential to the future growth and sustainability of Barre Town.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY TIMELINE	COST	MEASURE OF SUCCESS
1	Identify roads that would be conducive to bike travel that also fit into a master plan of creating interconnected bike routes.	Municipality	High 1 to 3 years	*TBD*	Roads identified
2	New bike paths should be planned with consideration for additional width, signing, and striping in order to facilitate sharing of the facility with bicycles, pedestrians, and joggers.	Municipality, VTrans	Medium 3 to 5 years	*TBD*	Planned paths accommodate multiple user groups
3	Parking areas for vehicles should be conveniently located along bike routes to accommodate both the recreational rider and the commuter; this is an important consideration given the steep grades which separate much of the Town as well as separating the Town from neighboring communities.	Municipality, VTrans	Medium On-going	*TBD*	Specific locations identified and prioritized
4	Specific consideration should be given to a parking area at the bottom of Richardson Road or one in the Cobble Hill area for scenic rural trips via bicycle.	Municipality	Medium 3 to 5 years	*TBD*	Sidewalks widened where appropriate
5	Pedestrian needs, including wider, raised sidewalks, should be incorporated into the reconstruction or relation of existing highways.	Municipality, VTrans	Medium On-going	*TBD*	Pedestrian facilities are incorporated into roadway projects
6	Conduct an analysis of pedestrian needs to identify which roadways should be prioritized to accommodate pedestrian facilities.	Municipality, VTrans	Medium On-going	*TBD*	Roadway analysis conducted

Policy B-5: Demonstrated municipal leadership with respect to efficiency of municipal transportation.

Leading by example is the most effective way for a municipality to convince its residents and business owners to comply with regulations or actions that may seem onerous or costly. Barre Town's actions can serve as an example to the community of their commitment to reducing energy demand.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Promote the use of energy efficient street lights in the community.	Municipality	High Out-going	TBD	Street lights are replaced as needed
2	Purchase the most energy efficient or alternative powered municipal vehicles that will, at the same time, perform the necessary functions of the department.	Municipality	High On-going	*TBD*	Municipal vehicles purchased as needed

C. **Patterns and Densities of Land Use Likely to Result in Conservation of Energy**

Policy C-1: Land use policies that demonstrate a commitment to reducing sprawl and minimizing low-density development

Land use policies that work to limit the proliferation of large lot development in favor of small lots in a compact area help communities address conditions that create sprawl, or the outward pattern of development that is characterized by auto-centric uses in an expanded geography. By limiting conditions that lead to sprawling development patterns, Barre Town has effectively supported energy independence.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Evaluate municipal regulations to ensure higher density development patterns are located within the very high density residential areas to maintain existing settlement patterns and do not inadvertently promote sprawling development.	Municipality	Medium On-going	*TBD*	Regulations are evaluated as needed and recommendations are included
2	Prioritize development and growth in areas where municipal water, sewer and roads are available.	Municipality	Medium On-going	*TBD*	Development areas are identified and prioritized
3	Growth should be done in ways that do not burden existing systems and cost of operating those systems on the taxpayer.	Municipality	Medium On-going	*TBD*	Growth patterns and areas are identified

Policy C-2: Strongly prioritize development in compact, mixed-use centers when feasible and appropriate or ways to make compact development more feasible.

Compact development patterns create opportunities whereby land uses that support where people live, work, and recreate, are all within close proximity. This not only creates a greater sense of place, but it provides opportunities to walk, bike, or utilize public transit as the primary mode of transportation. Additionally, compact development patterns can promote conservation of energy through the redevelopment of underutilized spaces therefore including more energy efficient building designs.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Evaluate alternative land use regulations such as form-based codes and identify communities where similar regulations have been successfully implemented to determine effectiveness of creating desired development patterns	Municipality, CVRPC	Low 5 to 10 years	*TBD*	Evaluations completed
2	Evaluate existing regulations and amend as necessary to support and encourage infill development, redevelopment, adaptive reuse of existing buildings such as historic structures, and reuse of "brownfield" sites	Municipality, CVRPC	Medium 3 to 5 years	*TBD*	Regulations evaluated and recommendations made as appropriate
3	Inventory and map existing infrastructure such as water and wastewater to evaluate capacity and development potential.	Municipality	Medium 3 to 5 years	*TBD*	Infrastructure mapped and updated as needed
4	Review and amend regulations as appropriate to require creative design and clustering to minimize infrastructure costs and preserve open spaces.	Municipality	Medium 3 to 5 years	*TBD*	Regulations updated

MAPPING

D. Development and Siting of Renewable Energy Resources

Policy D-1: Evaluate generation from existing renewable energy generation including the identification of constraints, resource areas, and existing infrastructure by energy type.

Policy D-2: Evaluate generation from potential renewable energy generation including the identification of constraints, resource areas, and existing infrastructure by energy type.

The siting and generation of renewable resources is a critical part to identifying whether or not Barre Town can meet its share of the state's renewable energy goals by 2050. Furthermore, this analysis is important to determine where resources are available throughout the community to ensure the Town of Barre is not unduly burdened with supporting more than should be reasonably anticipated. Finally, this information better positions Barre Town to evaluate the renewable energy generation options that are available to meet these goals.

The Central Vermont Regional Planning Commission created maps for Barre Town that identifies resources related to solar, wind, hydroelectric, and woody biomass. Maps were also created to identify constraints that may limit the overall area of possible resource development within the town. The following information will address the evaluation of current and future generation potential within Barre Town.

Existing Renewable Energy Generation

As noted in the Analysis and Targets section, Table Eleven identifies the existing renewable generation for Barre Town. Information on existing generation is a representation of all projects that were issued a Certificate of Public Good by the Public Service Board through the end of 2016. Projects that are currently under review are not included in these numbers therefore additional renewable energy generation may be developed that will not be noted in the total generation represented in Table Eleven.

Potential Renewable Energy Generation

Table Thirteen in the Analysis and Targets section identifies potential generation of renewable energy for Barre Town. This information is based on mapping data provided by the Vermont Center for Geographic Information (VCGI) and the Department of Public Service. This information includes specific data related to prime resource areas for solar and wind development which is an indication of where the conditions are most ideal for generation of the specific resource. Also included with this data is information regarding constraints to be considered when evaluating areas for renewable energy development. Additional detail regarding known and possible constraints is discussed below.

Constraints [4,1]

As part of this effort, the Central Vermont Regional Planning Commission has identified information for each municipality related to renewable energy generation that includes an analysis and evaluation of resource areas within each municipality and how those resource areas are impacted by statewide and regionally identified constraints. In order to determine the impacts, an understanding of the constraints needs to be discussed.

4. Appendix A provides specific definitions for the known and possible constraints

For the purpose of this plan, constraints are separated into two main categories: known and possible. Known constraints are those areas were development of a renewable resource are very limited and therefore are not likely to occur. Known constraints that have been identified include:

- Vernal Pools (confirmed or unconfirmed)
- River Corridors as identified by the Vermont Department of Environmental Conservation
- Federal Emergency Management Agency Identified Floodways
- State-significant Natural Communities and Rare, Threatened, and Endangered Species
- National Wilderness Areas
- Class 1 and Class 2 Wetlands (as noted in the Vermont State Wetlands Inventory or Advisory Layers
- Regionally or Locally Identified Critical Resources

Similarly, the state has identified a list of possible constraints to be considered. Possible constraints identify areas where additional analysis will need to occur in order to determine if development of renewable energy resources is appropriate. In some cases, conditions may be prohibitive, but in others the conditions may be suitable for renewable energy development. The possible constraints include:

- Agricultural Soils
- Federal Emergency Management Agency Special Flood Hazard Areas
- Protected Lands (State fee lands and private conservation lands)
- Act 250 Agricultural Soil Mitigation Areas
- Deer Wintering Areas
- Vermont Agency of Natural Resources Conservation Design Highest Priority Forest Blocks
- Hydric Soils
- Regionally or Locally Identified Resources

In addition to the items listed above, the Regional Planning Commission, through its Regional Energy Committee, has identified additional constraints to be included for all the municipalities that were noted as being regionally significant. For the purposes of this mapping exercise, all of the regional constraints are considered possible constraints. This is due to the fact that the Regional Energy Committee determined that, like the statewide possible constraints, conditions could be such that developing renewable energy resources in these locations could occur but should be studied further at the municipal level to determine if the specific conditions regarding these locations are suitable. The possible regional constraints that were identified include:

- Elevations above 2,500 feet
- Slopes greater than 25%
- Municipally Owned Lands
- Lakeshore Protection Buffer Areas of 250 feet

Methodology

With all the known and possible constraints identified, this information was overlaid on the resource's maps for solar and wind resources. Where known constraints existed the resource, areas were deleted. Where possible constraints existed, the resource areas were shaded. The resulting areas included those lands where prime resources exist without any constraints and prime resource areas with possible constraints. The total area within these two categories served as the basis to determine the amount of resource that is available for potential development within Barre Town.

As noted in Table Thirteen of the Analysis and Targets section, based on the solar, wind, and hydroelectric potential within Barre Town, approximately 3,250,000 megawatt hours of energy could be produced, well above the town's allocation of 50,995 megawatt hours by 2050 as noted in Table Twelve. The potential energy generation for Barre Town increases when other sources of renewable energy generation such as biomass, biogas, and methane are included. No specific generation numbers are listed in Table Thirteen for these types of energy generation as their siting is not specifically tied to the availability of a resource, therefore calculating a potential for generation would be difficult.

Transmission Infrastructure

In addition to identifying and calculating possible generation of renewable energy based on resources and constraints, the mapping included in this plan also incorporates the existing three phase power infrastructure throughout the municipality. This is important to include because renewable energy generation needs three phase power to provide energy generation back to the grid. Without three phase power, renewable energy generation would be limited to scales necessary to serve uses in close proximity that would not require transmission infrastructure.

Similar to limits on three phase power are potential limitations on existing transmission infrastructure and the ability to transmit energy from its point of generation to the possible users. As noted previously, the mapping includes three phase power, but it also includes information on current transmission infrastructure. This is another component to consider when identifying where specific generation types should be located to ensure the transmission capacity exists within the grid or to identify areas where upgrades may be needed before development of renewable energy generation can occur. Based on the factors noted above, it may be appropriate for mapping to identify areas where significant energy loads are currently occurring or anticipated based on future land use and zoning.

Preferred & Unsuitable Siting Locations

Barre Town recognizes the preferred locations that have been identified by the State of Vermont. Additional preferred locations may be identified after an analysis of the needs with the community have been conducted. The state preferred locations include:

- Parking lots
- Gravel pits
- Brownfield sites
- Landfills
- Rooftop installations

There are several locations throughout Barre Town that have been identified as being unsuitable for development. In general, these areas have been identified due to their significance as supporting wildlife habitat. In these locations' development may be possible, however, the specific siting, scale, and amount of land disturbance will be a critical factor to consider. These areas include as show on the attached maps:

- Class 1 and 2 wetlands
- Vernal pools
- Deer Wintering
- Identified bear habitat

Finally, the Barre Town Municipal Energy Plan supports the development of renewable energy generation technology that will not adversely impact the built or natural environment or conflict with identified policies. Due to the diverse nature of Barre Town including urban and rural areas, there was no way to develop a consistent policy that would be equitable to all areas, therefore renewable energy generation types (both current and developed through future advances in technology or innovations in the industry) may be considered for application in Barre Town.

Local Mapping

To provide a more specific visual representation of resources and constraints, mapping was developed by the Central Vermont Regional Planning Commission that includes:

- Solar Resource Areas
- Wind Resource Areas
- Hydroelectric Resource Areas
- Known Constraints
- Possible Constraints
- Woody Biomass Resource Area

These maps should be used as a starting point to determine what areas may exhibit characteristics consistent with conditions that would support renewable energy development. More detailed review and analysis should be conducted to determine specific boundaries for resource areas or constraints. These maps can be found in Appendix B.

APPENDIX A

KNOWN & POSSIBLE CONSTRAINT DEFINITIONS & DESCRIPTIONS

The following is a list of the known, possible, and regional constraints that were used and referenced in the mapping section of this document. A definition of the constraint including source of the data is provided.

Known Constraints

Vernal Pools (confirmed and unconfirmed layers) –
Source: Vermont Fish and Wildlife, 2009 - present

Vernal pools are temporary pools of water that provide habitat for distinctive plants and animals. Data was collected remotely using color infrared aerial photo interpretation. “Potential” vernal pools were mapped and available for the purpose of confirming whether vernal pool habitat was present through site visits. This layer represents both those sites which have not yet been field-visited or verified as vernal pools, and those that have.

Department of Environmental Conservation (DEC) River Corridors –
Source: DEC Watershed Management District Rivers Program, January 2015

River corridors are delineated to provide for the least erosive meandering and floodplain geometry toward which a river will evolve over time. River corridor maps guide State actions to protect, restore and maintain naturally stable meanders and riparian areas to minimize erosion hazards. Land within and immediately abutting a river corridor may be at higher risk to fluvial erosion during floods.

River corridors encompass an area around and adjacent to the present channel where fluvial erosion, channel evolution and down-valley meander migration are most likely to occur. River corridor widths are calculated to represent the narrowest band of valley bottom and riparian land necessary to accommodate the least erosive channel and floodplain geometry that would be created and maintained naturally within a given valley setting.

Federal Emergency Management Agency (FEMA) Floodways –
Source: FEMA Floodway included in Zones AE – FEMA Map Service Center

These are areas subject to inundation by the 1-percent-annual-chance flood event determined by detailed methods. A "Regulatory Floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

State-significant Natural Communities and Rare, Threatened, and Endangered Species –
Source: Vermont Fish and Wildlife, National Heritage Inventory

The Vermont Fish and Wildlife Department's Natural Heritage Inventory (NHI) maintains a database of rare, threatened and endangered species and natural (plant) communities in Vermont. The Element Occurrence (EO) records that form the core of the Natural Heritage Inventory database include information on the location, status, characteristics, numbers, condition, and distribution of elements of biological diversity using established Natural Heritage Methodology developed by NatureServe and The Nature Conservancy.

An Element Occurrence (EO) is an area of land and/or water in which a species or natural community is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential

continued (or historical) presence and/or regular recurrence at a given location. For species Elements, the EO often corresponds with the local population, but when appropriate may be a portion of a population or a group of nearby populations (e.g., metapopulation).

National Wilderness Areas –
Source: United States Department of Agriculture Forest Service

A parcel of Forest Service land congressionally designated as wilderness.

Class 1 and Class 2 Wetlands –
Source: Vermont Significant Wetland Inventory (VSWI) and advisory layers

The State of Vermont protects wetlands which provide significant functions and values and also protects a buffer zone directly adjacent to significant wetlands. Wetlands in Vermont are classified as Class I, II, or III based on the significance of the functions and values they provide. Class I and Class II wetlands provide significant functions and values and are protected by the Vermont Wetland Rules. Any activity within a Class I or II wetland or buffer zone which is not exempt or considered an "allowed use" under the Vermont Wetland Rules requires a permit.

Class I wetlands have been determined to be, based on their functions and values, exceptional or irreplaceable in its contribution to Vermont's natural heritage and, therefore, merits the highest level of protection. All wetlands contiguous to wetlands shown on the VSWI maps are presumed to be Class II wetlands, unless identified as Class I or III wetlands, or unless determined otherwise by the Secretary or Panel pursuant to Section 8 of the Vermont Wetland Rules.

Possible Constraints

Agricultural Soils –
Source: Natural Resources Conservation Service (NRCS)

Primary agricultural soils" are defined as "soil map units with the best combination of physical and chemical characteristics that have a potential for growing food, feed, and forage crops, have sufficient moisture and drainage, plant nutrients or responsiveness to fertilizers, few limitations for cultivation or limitations which may be easily overcome, and an average slope that does not exceed 15 percent. Present uses may be cropland, pasture, regenerating forests, forestland, or other agricultural or silvicultural uses.

The soils must be of a size and location, relative to adjoining land uses, so that those soils will be capable, following removal of any identified limitations, of supporting or contributing to an economic or commercial agricultural operation. Unless contradicted by the qualifications stated above, primary agricultural soils include important farmland soils map units with a rating of prime, statewide, or local importance as defined by the Natural Resources Conservation Service of the United States Department of Agriculture.

FEMA Special Flood Hazard Areas -

The land area covered by the floodwaters of the base flood is the Special Flood Hazard Area (SFHA) on NFIP maps. The SFHA is the area where the National Flood Insurance Program's (NFIP's) floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies.

Protected Lands –

Include State fee land and private conservation lands. Other state level, non-profit and regional entities also contribute to this dataset. The Vermont Protected Lands Database is based on an updated version of the original Protected Lands Coding Scheme reflecting decisions made by the Protected Lands Database Work Group to plan for a sustainable update process for this important geospatial data layer.

Act 250 Ag Mitigation Parcels –
Source: Vermont Department of Agriculture

All projects reducing the potential of primary agricultural soils on a project tract are required to provide "suitable mitigation," either "onsite or offsite," which is dependent on the location of the project. This constraint layer includes all parcels in the Act 250 Ag Mitigation Program as of 2006.

Deer Wintering Areas(D W A) –
Source: Vermont Department of Fish and Wildlife

Deer winter habitat is critical to the long term survival of white-tailed deer (Odocoileus virginianus) in Vermont. Being near the northern extreme of the white-tailed deer's range, functional winter habitats are essential to maintain stable populations of deer in many years when and where yarding conditions occur. Consequently, deer wintering areas are considered under Act 250 and other local, state, and federal regulations that require the protection of important wildlife habitats. DWAs are generally characterized by rather dense softwood (conifer) cover, such as hemlock, balsam fir, red spruce, or white pine. Occasionally DWAs are found in mixed forest with a strong softwood component or even on found west facing hardwood slopes in conjunction with softwood cover. The DWA were mapped on mylar overlays on topographic maps and based on small scale aerial photos.

Vermont Conservation Design include the following Highest Priority Forest Blocks: Connectivity, Interior, and Physical Landscape Diversity –
Source: Vermont Department of Fish and Wildlife

The lands and waters identified in this constraint are the areas of the state that are of highest priority for maintaining ecological integrity. Together, these lands comprise a connected landscape of large and intact forested habitat, healthy aquatic and riparian systems, and a full range of physical features (bedrock, soils, elevation, slope, and aspect) on which plant and animal natural communities depend.

Hydric Soils –*Source: Natural Resources Conservation Service*

A hydric soil is a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part. This constraint layer includes soils that have hydric named components in the map unit.

Regional Constraints

Elevations above 2500 feet –
This constraint uses USGS contours over 2500 feet.

Lake Shore Protection Buffers (250 Foot and 800 Foot in Calais Only) –

For this constraint, CVRPC selected Vermont Hydrologic Dataset lakes and ponds greater than 10 acres and then buffered those by 250 feet and use the Town of Calais Land Use Regulations for shore lands in Calais.

Slopes Greater Than 25 % –

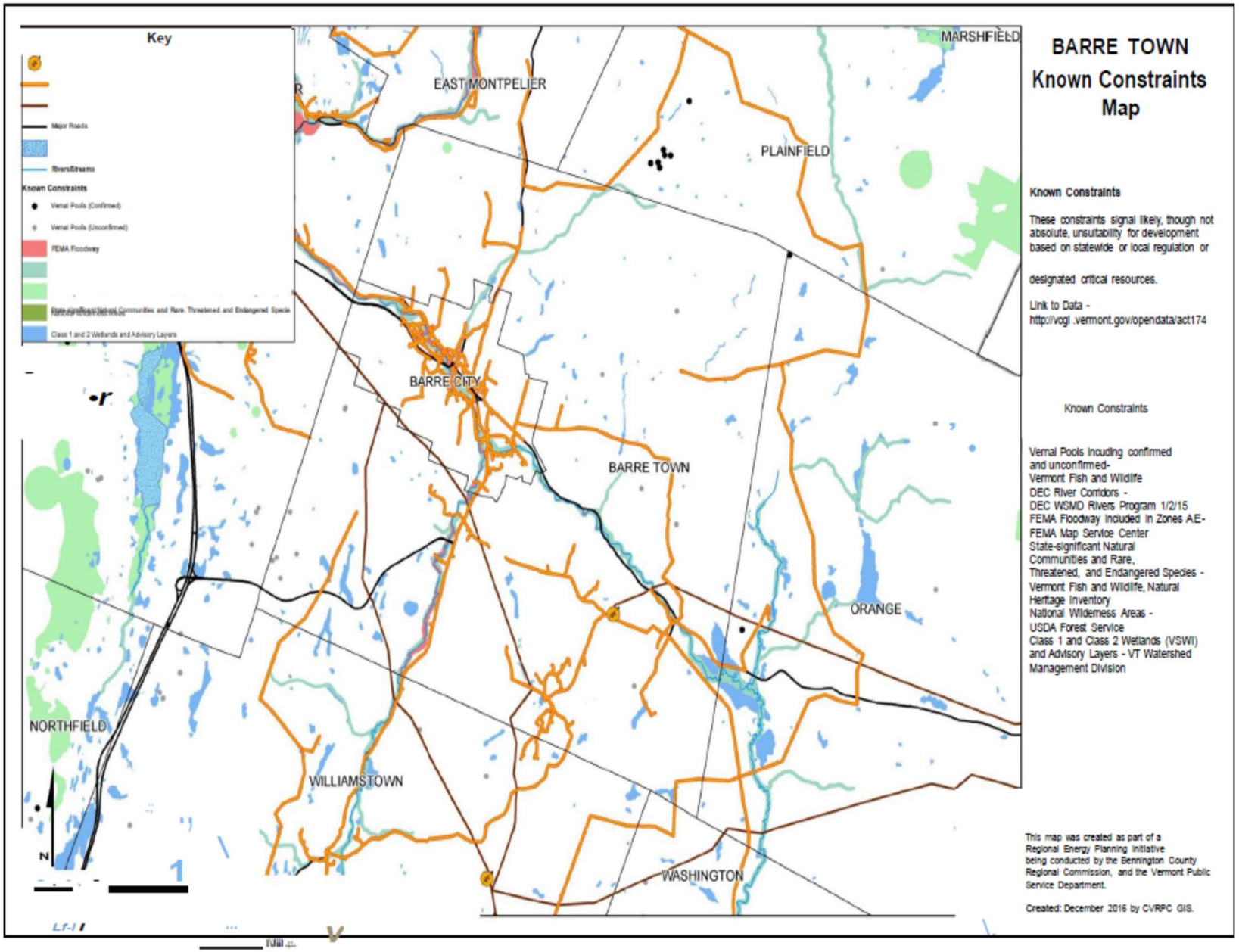
For this constraint, CVRPC performed a slope analysis using a 10 meter Digital Elevation Model.

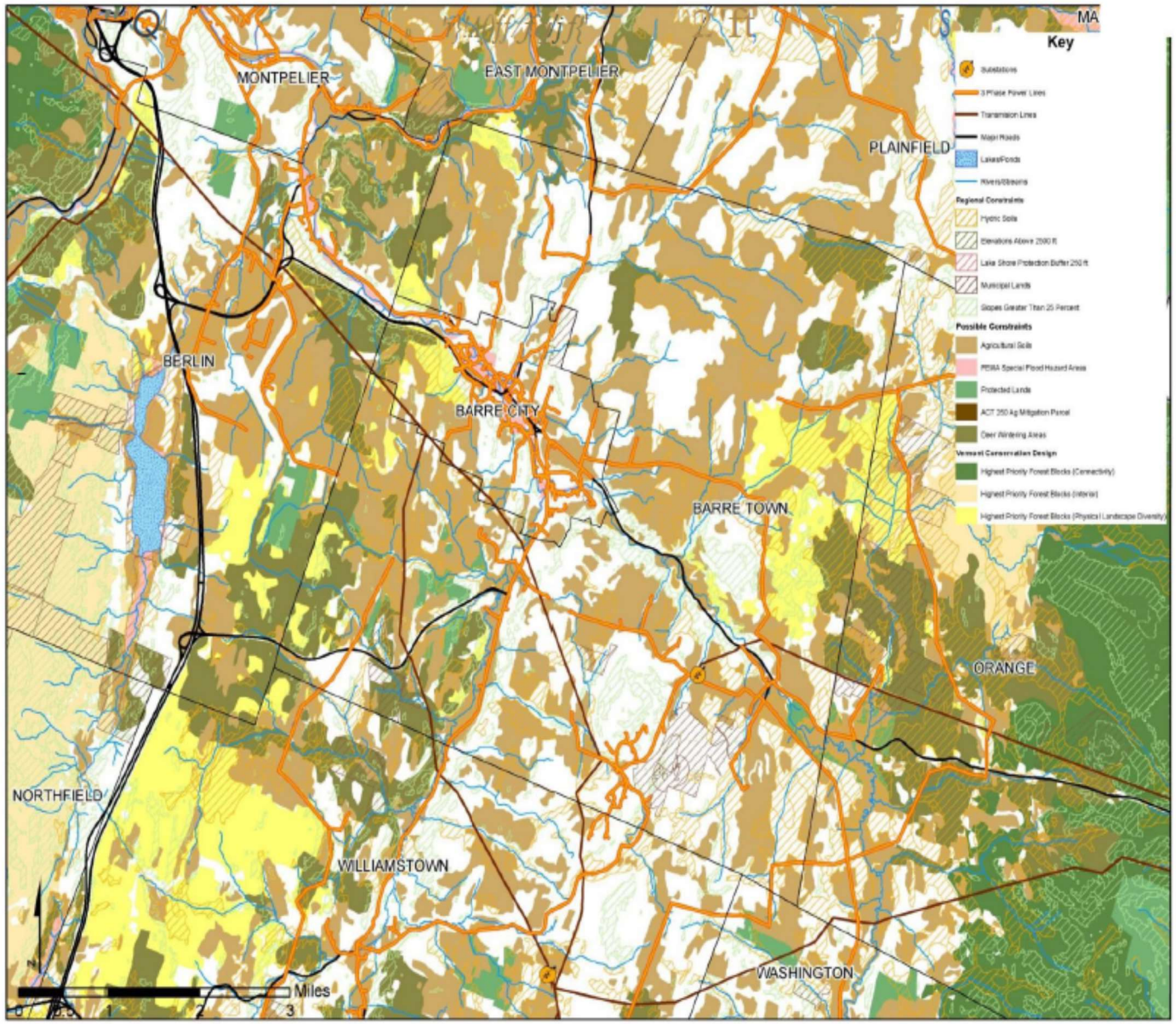
Municipal Lands –

For this constraint, CVRPC used the Vermont Center for Geographic Information's Protected Lands Database.

APPENDIX B

MUNICIPAL RESOURCE MAPS


Key
Major Roads
Rivers/Streams
Known Constraints
Vernal Pools (Confirmed)
Vernal Pools (Unconfirmed)
FEMA Floodway
Class 1 and 2 Wetlands and Advisory Layers
EAST MONTPELIER
MARSHFIELD
PLAINFIELD
BARRE CITY
BARRE TOWN
ORANGE
NORTHFIELD
WILLIAMSTOWN
WASHINGTON
N
1
BARRE TOWN
Known Constraints Map
Known Constraints
These constraints signal likely, though not absolute, unsuitability for development based on statewide or local regulation or designated critical resources.
Link to Data - http://vcgi .vermont.gov/opendata/act174
Known Constraints
Vernal Pools including confirmed and unconfirmed- Vermont Fish and Wildlife
DEC River Corridors - DEC WSMD Rivers Program 1/2/15
FEMA Floodway included in Zones AE- FEMA Map Service Center
State-significant Natural Communities and Rare, Threatened, and Endangered Species - Vermont Fish and Wildlife, Natural Heritage Inventory
National Wilderness Areas - USDA Forest Service
Class 1 and Class 2 Wetlands (VSWI) and Advisory Layers - VT Watershed Management Division
This map was created as part of a Regional Energy Planning Initiative being conducted by the Bennington County Regional Commission, and the Vermont Public Service Department.
Created: December 2016 by CVRPC GIS.



BARRE TOWN

Possible Constraints Map

Possible Constraints

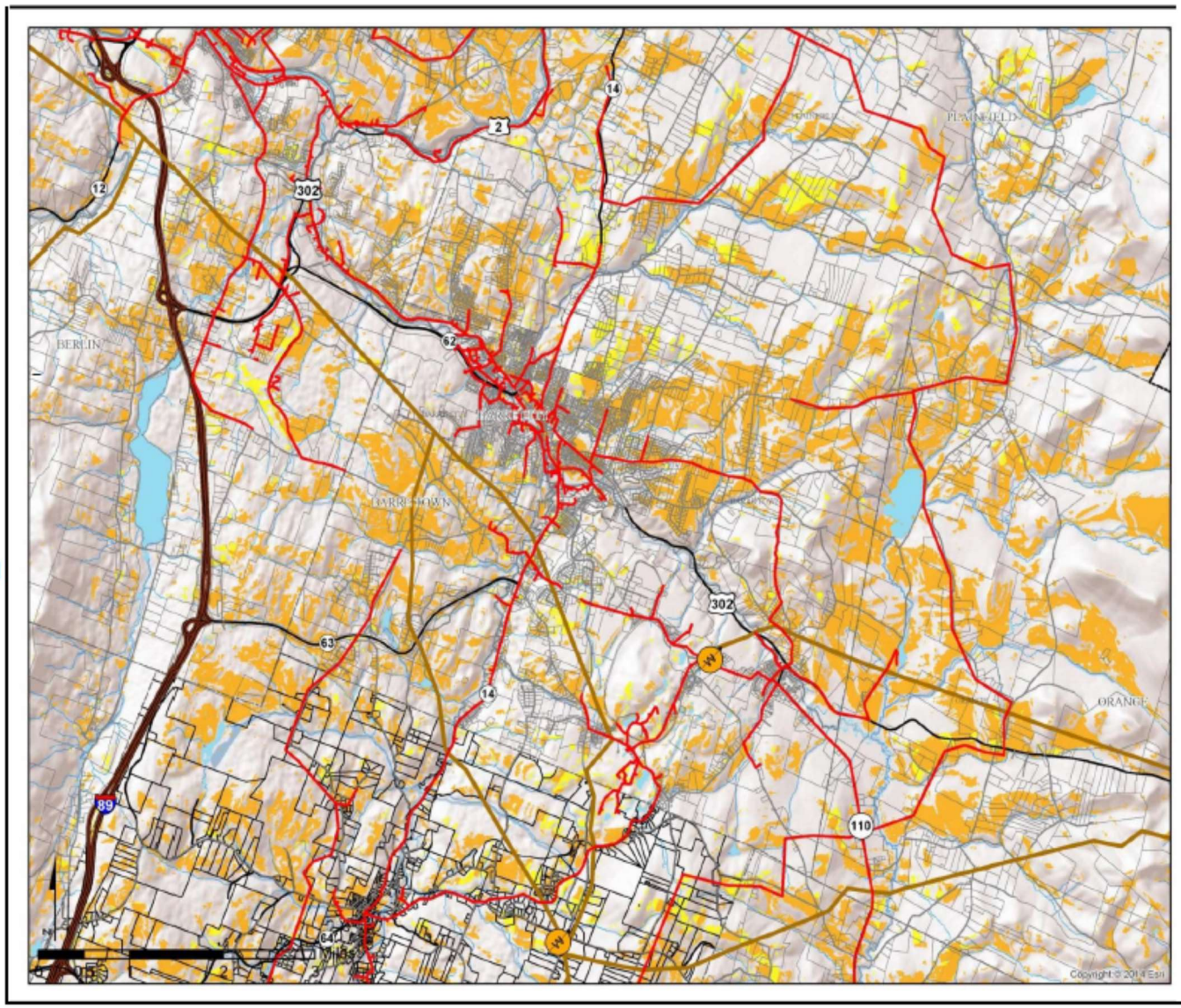
These constraints signals conditions that would likely require mitigation, and which may prove a site unsuitable after site-specific study, based on statewide or regional/ local policies that are currently adopted or in effect.

Link to Data- http://vcgi.vermont.gov /opendata/act174

Possible Constraints Data Sources
Agricultural Soils include local, prime and statewide classifications - NRCS
FEMA Special Flood Hazard Areas include Zones A and AE - FEMA Map Service Center
Protected Lands- include State fee lands and private conservation lands - VCGI
Act 250 Ag Mitigation Parcels include parcel as of 2006 - VT Dept. of Ag
Deer Wintering Areas- VT Fish and Wildlife
Vermont Conservation Design include the following Highest Priority Forest Blocks: Connectivity, Interior, and Physical Landscape Diversity) - VT Fish and Wildlife
Hydric Soils include soils that have hydric named components in the map unit - NRCS

This map was created as part of a Regional Energy Planning Initiative being conducted by the Bennington County Regional Commission, and the Vermont Public Service Department.

Created: December 2016 by CVRPC GIS.



BARRE TOWN

Solar Resources Map

Legend
- Substations
- 3 Phase Power Lines
- Distribution Lines

Solar Potential
- Prime (No Constraint)
- Secondary (Possible Constraint)

Parcels

Roads
- Interstate
- US Highway
- Vermont State Highway
- Town Class 1-3

Known Constraints

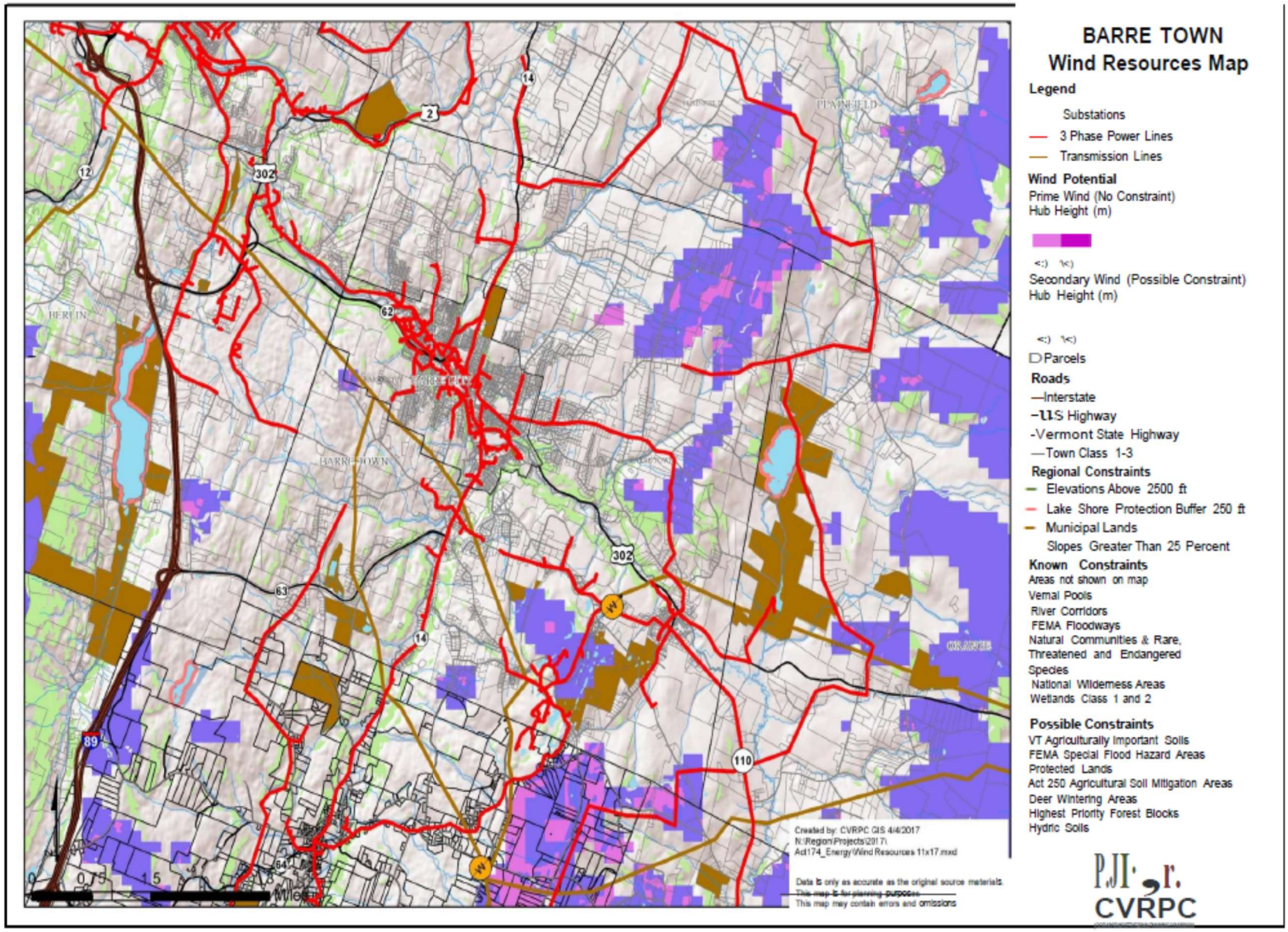
Areas not shown on map
- Vernal Pools
- River Corridors
- FEMA Floodways
- Natural Communities & Rare, Threatened and Endangered Species
- National Wilderness Areas
- Wetlands Class 1 and 2

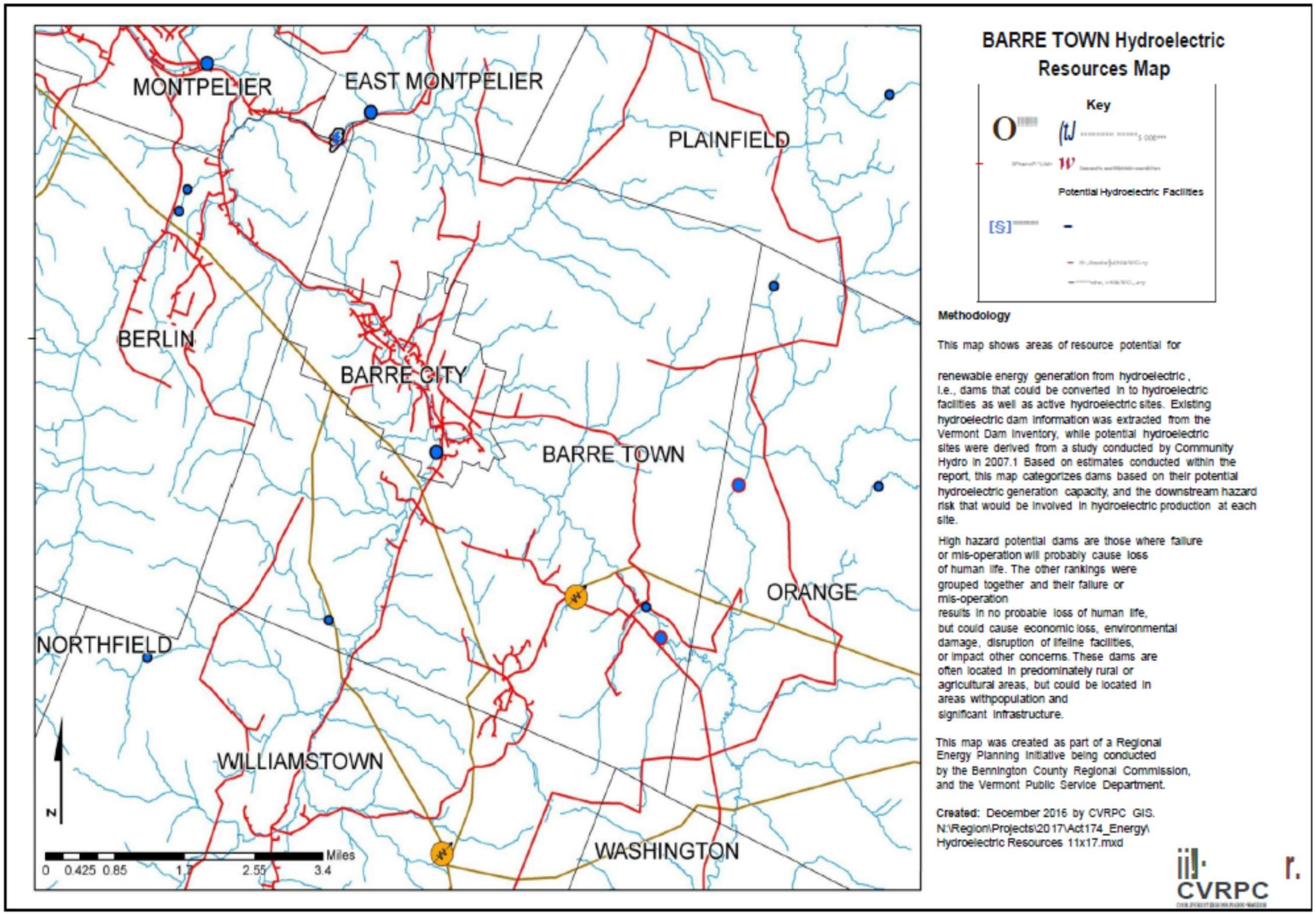
Possible Constraints
- VT Agriculturally Important Soils
- FEMA Special Flood Hazard Areas
- Protected Lands
- Act 250 Agricultural Soil Mitigation Areas
- Deer Wintering Areas
- Highest Priority Forest Blocks
- Hydric Soils
- Elevations Above 2500Ft
- Lake Shore Protection Buffer 250 Ft
- Municipal Lands
- Slopes Greater Than 25 Percent

Created by: CVRPC GIS 4/4/2017
N:\Region\Projects\2017\Act174_Energy\Solar Resources 11X17

Data is only as accurate as the original source materials.
This map is for planning purposes.
This map may contain errors and omissions

CVRPC


BARRE TOWN
Wind Resources Map
Legend
Substations
3 Phase Power Lines
Transmission Lines
Wind Potential
Prime Wind (No Constraint)
Hub Height (m)
Secondary Wind (Possible Constraint)
Hub Height (m)
Parcels
Roads
Interstate
US Highway
Vermont State Highway
Town Class 1-3
Regional Constraints
Elevations Above 2500 ft
Lake Shore Protection Buffer 250 ft
Municipal Lands
Slopes Greater Than 25 Percent
Known Constraints
Areas not shown on map
Vernal Pools
River Corridors
FEMA Floodways
Natural Communities & Rare, Threatened and Endangered Species
National Wilderness Areas
Wetlands Class 1 and 2
Possible Constraints
VT Agriculturally Important Soils
FEMA Special Flood Hazard Areas
Protected Lands
Act 250 Agricultural Soil Mitigation Areas
Deer Wintering Areas
Highest Priority Forest Blocks
Hydric Soils
Created by: CVRPC GIS 4/4/2017
N:\Region\Projects\2017\
Act174_Energy\Wind Resources 11x17.mxd
Data is only as accurate as the original source materials.
This map is for planning purposes.
This map may contain errors and omissions
CVRPC



BARRE TOWN Hydroelectric Resources Map

Key

Potential Hydroelectric Facilities

Methodology

This map shows areas of resource potential for

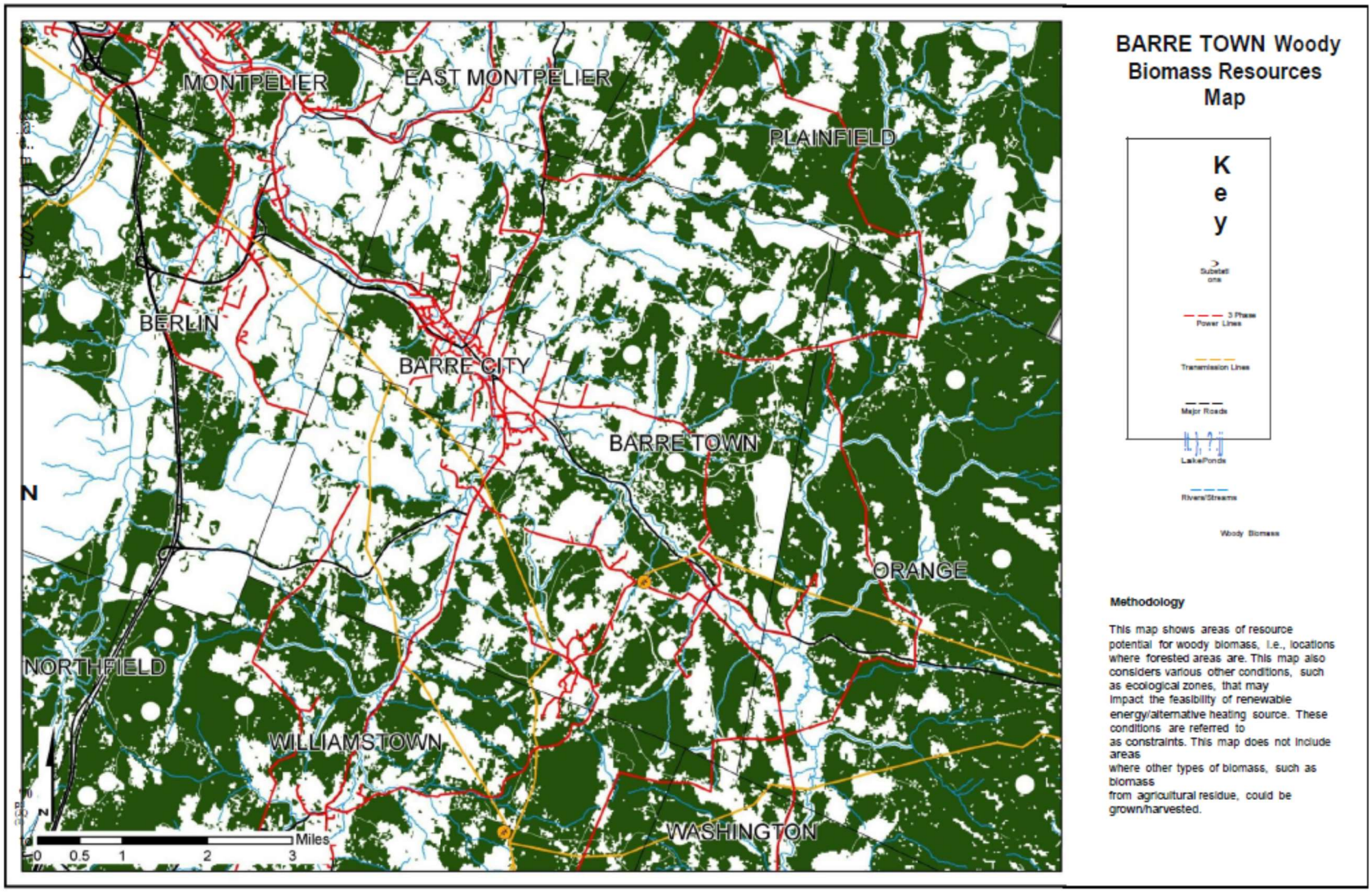
renewable energy generation from hydroelectric , i.e., dams that could be converted in to hydroelectric facilities as well as active hydroelectric sites. Existing hydroelectric dam information was extracted from the Vermont Dam Inventory, while potential hydroelectric sites were derived from a study conducted by Community Hydro in 2007.1 Based on estimates conducted within the report, this map categorizes dams based on their potential hydroelectric generation capacity, and the downstream hazard risk that would be involved in hydroelectric production at each site.

High hazard potential dams are those where failure or mis-operation will probably cause loss of human life. The other rankings were grouped together and their failure or mis-operation results in no probable loss of human life, but could cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. These dams are often located in predominately rural or agricultural areas, but could be located in areas withpopulation and significant infrastructure.

This map was created as part of a Regional Energy Planning Initiative being conducted by the Bennington County Regional Commission, and the Vermont Public Service Department.

Created: December 2016 by CVRPC GIS.
N:\Region\Projects\2017\Act174_Energy\Hydroelectric Resources 11x17.mxd

CVRPC


MONTPELIER
EAST MONTPELIER
PLAINFIELD
BERLIN
BARRE CITY
BARRE TOWN
ORANGE
NORTHFIELD
WILLIAMSTOWN
WASHINGTON
N
0 0.5 1 2 3
Miles
BARRE TOWN Woody Biomass Resources Map
Key
Substation
3 Phase Power Lines
Transmission Lines
Major Roads
Lake/Ponds
Rivers/Streams
Woody Biomass
Methodology
This map shows areas of resource potential for woody biomass, i.e., locations where forested areas are. This map also considers various other conditions, such as ecological zones, that may impact the feasibility of renewable energy/alternative heating source. These conditions are referred to as constraints. This map does not include areas where other types of biomass, such as biomass from agricultural residue, could be grown/harvested.
This map was created as part of a Regional Energy Planning Initiative being conducted by the Bennington County Regional Commission, and the Vermont Public Service Department.
Created: December 2016 by CVRPC GIS.