ANALYSIS & TARGETS

In order to adequately determine if the Central Vermont Region is on the right path to meeting it's 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 alternative heating 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 the region is now, where the region 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 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. 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 the region's overall progress towards achieving 90% of its regional energy used produced from renewable sources. As new or better data is provided or developed, these tables will be updated to reflect the changes.

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

In order to determine where we need to go with our energy future, it is important to know where we currently are. Included in this is an identification of the existing sources of energy generation. In general, energy can be divided into four basic categories where discussions can be focused. These include resource type, land use, transportation, and siting. While all four are related and interconnected, they all serve separate components that need to be addressed individually as well as collectively.

Resource Type

The 2016 State Comprehensive Energy Plan notes four primary resource types for energy that are used throughout the state. These include non-combustion based renewables (including wind, hydroelectric, and solar), combustion based renewables (including biomass), nuclear energy, and fossil fuels. Fossil fuels account for a majority of the energy used in the state with natural gas and petroleum products accounting for 62% of Vermont's total energy use[1].

Non-Combustion Based Renewables

Non-combustion based renewables includes all the typical sources of energy including wind, solar, hydroelectric, and woody biomass. Based on information from the Vermont Department of Public Service through the Energy Action Network's Community Energy Dashboard, there are approximately 1,300 sites in Central Vermont that are producing renewable energy across the four resource types. This accounts for approximately 118,500 megawatt hours of energy produced annually within Central Vermont. This amounts to approximately 3.5% of the annual energy consumption in Central Vermont. By comparison, data from the U.S. Energy Information Administration noted that in 2010 the State of Vermont was consuming approximately 147.6 trillion BTUs[2] of energy. Of that total, 6.5 trillion BTUs or roughly 4.3% were coming from renewable sources. Table One identifies the non-combustible based renewable resources.

TABLE ONE EXISTING REGIONAL RENEWABLE ENERGY GENERATION		
RESOURCE TYPE	**MEGAWATTS**	**MEGAWATT HOURS**
Solar	24	29,919
Wind	.14	486
Hydroelectric	25	88,467
Biomass	3	13,091
Other	0	0
Total Existing Regional Renewable Energy Generation	52.14	131,963

Notes:
1. Regional totals were aggregated from each municipal total therefore not all calculations will be consistent.
2. Information provided by the Department of Public Service .

1. 2016 Comprehensive Energy Plan – p.389.
2. BTU is the acronym for British Thermal Unit which is a unit of heat. It signifies the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit.

Combustion Based Renewables

Along with non-combustion based renewables are the combustion based renewable energy sources. This category is primarily dominated by methane gas which is produced from landfills. In particular, the Washington Electric Cooperative receives a majority of its energy generation from the Coventry Landfill in Coventry, Vermont. According to the Washington Electric Cooperative's data, in 2014 over 53% of their power came from the Coventry facility. Also included under this category are anaerobic digesters, biodiesel, combined heat and power, compost heat, and biomass.

Biomass is the most common form of combustible based renewable energy in Central Vermont. In its most popular form, biomass from wood products or byproducts such as wood pellets or wood chips are used for home heating. According to data from the U.S. Energy Information Administration, in 2015 one in six Vermont households used some form of biomass as their primary home heating source. According to the Energy Acton Network's Community Energy Dashboard, there are 26 combustion based renewable sites in Central Vermont producing approximately 21,024 megawatt hours of energy with almost 100% of this coming from the Moretown Landfill in the form of methane gas.

Nuclear Energy

The Central Vermont Region's energy portfolio has been significantly impacted by the decommissioning of the Vermont Yankee Nuclear Facility in Vernon, Vermont. This facility, which was shut down at the end of 2014 provided approximately 55% of the electrical generation capacity for the State of Vermont. In order to make up for the loss of this power source, the utility providers have turned to purchasing power from the New England grid which produces a majority of its power from natural gas fired utilities or other sources. Development of additional renewable resources in-state can help off-set this demand which could mean less power is being imported to meet existing and future demands.

Based on data from the Vermont Public Service Department, in 2011 the majority of energy being provided to Central Vermont from Green Mountain Power, Hardwick Electric Department, Northfield Electric Department, and Washington Electric Cooperative was from hydroelectric sources including Hydro Quebec. In fact nuclear energy as a source accounted for only about 10% of the energy generation for the service providers in Central Vermont. This would potentially lead to the conclusion that the closure of the Vermont Yankee Nuclear Facility impacted the State of Vermont as a whole, the direct impact to Central Vermont was not as significant.

Fossil Fuels

Fossil fuels are all non-renewable sources of energy that are generally carbon based and formed over millions of years from organic matter (including plants and animals) that were gradually buried under layers of rock. These fuels include natural gas, coal, and oil. Fossil fuels are typically refined for use as gasoline or other distillate fuels such as diesel fuel; home heating oil; or transported as natural gas.

In general, the majority of fossil fuel usage is attributed to home heating (including water) in the form of natural gas or home heating oil, or for transportation to fuel vehicles. It should be noted, however, that according to information from the U.S. Energy Information Administration, natural gas fired power plants are providing energy to Vermonters, however these plants are generally located outside of the state. Additional information regarding fossil fuels will be included in the discussion on transportation later in this document.

In order to further refine the existing energy picture within Central Vermont, the CVRPC calculated its current energy consumption for transportation, heating, and electric use. This included both commercial and residential heating information. This information is listed in Tables Two through Five.

TABLE TWO CURRENT REGIONAL TRANSPORTATION ENERGY USE	
DATA CATEGORY	**INFORMATION**
Total number of vehicles	45,584 vehicles
Average miles traveled per vehicle	12,500 miles
Total regional miles traveled	567,650,000 miles
Average gallons of fuel used per vehicle per year	576 gallons
Total regional gallons of fuel used per year	30,518,817
Transportation energy used per year (in Billions)	3,396 BTUs
Average regional cost per gallon of fuel	$2.31
Regional fuel costs per year	$70,488,465.00

Notes:
1. Regional totals were aggregated from each municipal total therefore not all calculations will be consistent.
2. Total vehicles provided by the American Community Survey.
3. Average miles traveled & Average gallons of fuel used per vehicle provided by VTrans.
4. Average cost per gallon of fuel provided by the CVRPC.
5. Information related to public transit is not included in this table.

TABLE THREE CURRENT REGIONAL RESIDENTIAL HEATING ENERGY USE				
FUEL SOURCE	**NUMBER OF HOUSEHOLDS**	**PERCENT OF HOUSEHOLDS**	**REGIONAL HEATED SQUARE FOOTAGE**	**REGIONAL BTUs (in Billions)**
Natural Gas	487	1.8%	679,396	41
Propane	5,496	20.4%	8,953,042	537
Electricity	1,206	4.5%	1,494,263	90
Fuel Oil	14,238	52.9%	24,431,228	1,466
Coal	66	.2%	132,664	8
Wood	5,031	18.7%	9,493,439	570
Other (includes solar)	392	1.5%	696,536	42
No Fuel	22	.1%	42,680	3
TOTAL	**26,938**	**100%**	**45,923,248**	**2,755**

Notes:
1. Regional totals were aggregated from each municipal total therefore not all calculations will be consistent.
2. Data provided by the American Community Survey.

TABLE FOUR CURRENT REGIONAL COMMERCIAL ENERGY USE		
COMMERCIAL	AVERAGE THERMAL ENERGY	COMMERCIAL THERMAL
2,642	699	1,847,355

Notes:
1. Regional totals were aggregated from each municipal total therefore not all calculations will be consistent.
2. Thermal energy use is expressed in Millions of BTUs.
3. Information provided by the Vermont Department of Labor and the Department of Public Service.

TABLE FIVE CURRENT REGIONAL ELECTRICITY USE	
USE SECTOR	CURRENT ELECTRICITY USE
Residential	241,268,280 kilowatt hours
Commercial & Industrial	353,116,751 kilowatt hours
TOTAL	**498,265,731 kilowatt hours**

Notes:
1. Regional totals were aggregated from each municipal total therefore not all calculations will be consistent.
2. Information provided by Efficiency Vermont.

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

With the baseline information established for the region, the next step is to identify what targets need to be met in order for the region to achieve its share of the state's renewable energy goals. The 2016 State Comprehensive Energy Plan identifies target years of 2025, 2035, and 2050 as specific points to help measure progress. Using these same target years, the Central Vermont RPC has identified percentage targets for efficiency improvements regarding transportation, heating, and electricity. Tables Six identifies the percentage of existing residential and commercial buildings in Central Vermont that would need to be weatherized in each of the target years to meet the State's energy goals. These targets also assume that new structures be built based on state energy codes and therefore meet or exceed the needed efficiency standards.

Additionally, Table Six notes the electric efficiency needed for each target year to meet the renewable energy goals in the State's Comprehensive Energy Plan. The electric efficiency is an indication of how much efficiency is needed across all sectors. It is a comparison between anticipated electricity use for each target year versus the electricity use in the base year, which in this case, is 2010.

TABLE SIX REGIONAL 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.

TABLE SEVEN REGIONAL TARGETS FOR RENEWABLE ENERGY USE			
SECTOR TYPE	**2025**	**2035**	**2050**
Transportation Renewables	9.6%	31.3%	90.2%
Heating Renewables	52.3%	66.6%	92.5%

Notes:
1. Information derived from VEIC LEAP Modeling.

The information in Tables Six and Seven were developed using the Long-Range Energy Alternatives Planning (LEAP) Model as provided by the Vermont Energy Investment Corporation (VEIC). VEIC was contracted to provide modeling support for this project and developed the LEAP model for each Regional Planning Commission to reflect their share of the state totals. The percentages are weighted heavier in the later years which assumes increases in efficiencies and technological improvements that will establish these targets.

Additionally, the targets are not a cumulative total therefore each target year is taken independently and account for the previous target year's percentages as well. It is not meant to be in addition to the previous target year. For example, the residential thermal efficiency target for 2035 indicates that 42% of the residential units should be weatherized and efficient. This could be done through a combination of new construction or weatherization of existing structures. These are targets for a municipality to try and achieve and not a mandate on what they must accommodate.

A major factor that will impact these targets are market forces which are beyond the control of an individual municipality or region. With that in mind, the region (and therefore the municipalities) should work to ensure barriers don't exist that would adversely impact the ability to reach these targets. Section two of this plan related to implementation and pathways will discuss this in more detail.

TABLE EIGHT REGIONAL TARGETS FOR RENEWABLE ENERGY USE			
SECTOR TYPE	**2025**	**2035**	**2050**
Electricity Renewables (in megawatt hours)	104,620	167,404	418,531

Notes:
1. Information provided by The Department of Public Service

Table Eight notes the renewable electricity use for each of the target years and is expressed in megawatt hours. The identification of these targets by megawatt hour is a significant factor because it represents energy (megawatt hours) as opposed to power (megawatt). In this case, the megawatt hours identified denote the amount of renewable energy that should be consumed as part of the total energy being consumed by the target years. This information was generated base on data provided by the Department of Public Service and information developed by the Regional Planning Commission.

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

One important way for each region to support and work collectively to achieve the state's goal of 90% renewable energy generation by 2050 is through conversion and development of alternative fuels. Conversions to more efficient technologies such as cold climate heat pumps for residential heating or switching to electric vehicles will mean that less energy needs to be generated as efficiencies in technologies increase. If less energy needs to be generated, the energy being generated from renewable sources will provide more of the demand over time.

Table Nine outlines the thermal sector conversions to wood heat and heat pumps. For these tables residential and commercial uses are combined to indicate the total fuel switching needed.

TABLE NINE
REGIONAL THERMAL SECTOR CONVERSIONS
(RESIDENTIAL & COMMERCIAL)

SYSTEM TYPE	2025	2035	2050
New Efficient Wood Heat Systems	117	108	966
New Heat Pumps	2,792	7,198	13,630

Notes:
1. Regional totals were aggregated from each municipal total therefore not all calculations will be consistent.
2. Information derived from VEIC LEAP Modeling.
3. Heat pumps includes both space heating and hot water heating.

The information in Table Nine is derived from calculations based on information provided in the LEAP modeling data. As with other targets, the numbers identified for each target year represent the number of new systems needed to achieve the overall efficiency goals. It should be noted that Table Eight only highlights efficient wood burning systems and heat pumps. This is an indication that using these two technologies could account for all the changes needed in Central Vermont regarding conversions from fossil fuel based heating systems such as fuel oil or natural gas.

Other options for conversion of residential and commercial heating systems may be available that would satisfy the goals of the state's comprehensive energy plan. Wood systems are being highlighted due to the their renewable fuel and heat pumps are being highlighted since the 2016 State Comprehensive Energy Plan focuses on electrification therefore a high efficient electric heat pump would address the efficiency goals while having the electricity to power the system being generated from renewable sources.

Another system type that should be encouraged are geothermal heating and cooling. Geothermal systems use the consistent temperature of the earth to either provide heat or cooling to homes and businesses. Geothermal systems generally require an electric fan to force air through the system, however like with other systems, the increase in efficiency through technology and the electrification of the grid make systems like this a viable option to address conservation and conversion of systems.

One challenge that will need to be addressed regarding conversions and conservation efforts will be the tracking and monitoring of system upgrades or improvements that address efficiency or steps to increase weatherization of residential and commercial properties. While specific programs are set up to help track and score these changes, many homeowners and business owners make changes and upgrades as part of the normal lifecycle of a property. These systems are often upgraded without any formal acknowledgement of the possible efficiency improvements being made. In order to measure how the targets in Table Eight are being met (or not being met), a methodology should be developed to ensure the necessary information is gathered when changes occur. This will be addressed in the Pathways and Implementation Actions section.

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

Transportation

As noted in Table Two, the average vehicle miles traveled for residents in Central Vermont is approximately 12,500 miles per year. At an average cost of approximately $2.31 per gallon of fuel and an efficiency factor of approximately 22 miles per gallon of fuel, the average person living in Central Vermont is spending approximately $1,300 dollars on fuel each year. According to information from the American Automotive Association, the average cost of owning a vehicle can range from approximately $6,500 for a small sedan to $10,400 for an SUV[3]. By creating development patterns whereby uses are in closer proximity to where people live, work, or recreate, trips can be combined or alternative modes of transportation can be employed. This will reduce the vehicle miles traveled and therefore reduce the transportation costs to individuals.

Another option to consider when evaluating system changes is the conversion to electric or alternative fuel vehicles. Vehicles that are powered by renewable energy sources increase efficiency, reduce greenhouse gas emissions, and can reduce the need for fossil fuels. While switching to alternative fuel vehicles does not reduce the vehicle miles traveled, it does reduce the dependence on fossil fuels. These changes also require improvements to infrastructure such as grid capacity to transmit the electricity as well as an increase in the volume of charging stations to provide additional opportunities and locations for vehicle charging thus increasing the range of electric vehicles.

An evaluation of LEAP data and information from the American Community Survey identifies the number of vehicles needed to be switched from fossil fuels to renewable fuels. Specifically, conversion to electric vehicles and biodiesel vehicles was noted in the LEAP analysis in order to meet the needed reductions in energy related to transportation. Table Ten identifies the number of electric and biodiesel vehicles needed for each of the three target years in order to meet the energy reduction goals related to transportation as identified in the LEAP analysis.

TABLE TEN REGIONAL TRANSPORTATION FUEL SWITCHING TARGETS			
FUEL TYPE	**2025**	**2035**	**2050**
Electric Vehicles	3,902	26,954	53,809
Biodiesel Vehicles	6,801	12,603	20,438

Notes:
1. Information derived from VEIC LEAP Modeling.

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3. 2016 article from the American Automotive Group (AAA) http://newsroom.aaa.com/auto/your-driving-costs/. Costs include fuel, insurance, maintenance, registration, depreciation, and similar expenses associated with owning a vehicle and is based on driving 15,000 miles per year.

It is important to note that Table Ten indicates the number of fossil fuel based vehicles that would need to be replaced with alternative fuel vehicles to meet the reduction goals for transportation energy by each target year. That is to say that of all the new vehicles on the road in 2025, approximately 10,700 of those vehicles would need to use alternative fuels as the primary fuel type. For reference, electric vehicles would be similar to a standard passenger vehicle currently using gasoline and biodiesel vehicles would be consistent with light or heavy duty trucks that currently run on standard diesel fuels.

Land Use

One key factor that impacts the amount of energy being used is land use. Land use directly impacts and influences our choices, especially as they relate to transportation. When land use patterns focus on density, compact development, or mixing of uses, the result can be an area that is walkable, bicycle friendly, or promote public transit use.

Land use planning and management can have a direct impact on how much energy is used and consumed in regard to transportation. As development density decreases (creating fewer lots or uses per acre), the impacts associated with that decrease in density will rise. This includes both costs and consumption of resources including energy to move people from place to place. As land uses are spread further from one another, more resources are required to link those uses together. This includes infrastructure such as roads or utilities; needs for emergency services such as police, fire, and ambulance, and increases in municipal service needs such as road maintenance.

In order to reduce the costs and needs for energy related to transportation and land uses, changes in land development will need to occur. One significant way that this can be addressed is through amendments to land development regulations such as zoning or subdivision. Changes to land development regulations that require pedestrian facilities such as sidewalks or multi-use paths to connect uses or activity centers is one technique that can be used to help create alternative transportation options in a community. Additionally, smaller changes could be implemented that can have larger impacts. Examples of this include reducing lot sizes, reducing parking requirements, adjusting setbacks, implementing traffic calming measures, or increasing building heights are all ways to maximize development potential within the framework of existing land development regulations.

If a municipality does not have land development regulations there are still avenues that can be explored from the non-regulatory side that would impact land development practices. For example, developing a capital plan for public utilities and services that is consistent with a municipal plan can identify and prioritize where public funds should be spent. This could include sidewalk connections, park & ride facilities, or water & wastewater services. Expansions to emergency services or road maintenance equipment can also be a way to signal intended growth. Receiving a state designation for a Downtown, Village Center, Growth Center, New Town Center, or New Neighborhood Development Area can provide the basis for non-regulatory growth management and the tools necessary to regulate development without a formally adopted set of regulations. Finally, having clear goals, policies, and action items identified in municipal plans will provide specific implementation that can impact how a community grows and therefore how the connection between land use and transportation is addressed on a municipal basis.

Currently, 19 of the 23 municipalities in the Central Vermont Region have some form of development regulation. Six of the 19 only have zoning regulations in place while the other 13 have zoning and subdivision regulations. Additionally, 12 of the municipalities have an active state designation and several municipalities have multiple designations. For example, the City of Montpelier has both a Downtown and a Growth Center designation, while the Town of Calais has three village centers that are designated including Adamant, East Calais, and Maple Corners.

While the techniques noted herein can help provide avenues for changes to support development density and create compact development patterns, a primary factor that will influence development density is adequate infrastructure to accommodate water and wastewater. Water and wastewater infrastructure is critical to provide a development pattern that includes density, mixed uses, and alternative transportation options. This is done by moving the supply and treatment of water and wastewater off-site therefore reducing the need for land to accommodate these facilities on-site. By doing so will create opportunities for smaller lots, density of development, increased building heights, and mixed uses. All of these are positive steps to reducing the need for infrastructure to accommodate single-occupancy vehicles such as parking areas, but also begins to support the critical mass that is necessary to support public transit.

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 Central Vermont is on track to meet their conservation and efficiency targets. Table Eleven outlines the electric efficiency improvements needed for each of the three target years. Additionally, information related to renewable energy generation, which is a necessary component in achieving these targets, is noted below.

TABLE ELEVEN
REGIONAL TARGETS FOR ELECTRIC EFFICIENCY IMPROVEMENTS

SECTOR TYPE	2025	2035	2050
Electric Efficiency	1.5%	7.3%	15.2%

Notes:
1. Information derived from VEIC LEAP Modeling.

Siting

A discussion of electric sector conversions and efficiencies should include information related to the ability to generate electricity through renewable means, but also to have a grid that can support the distribution of that electricity. An analysis of existing land and renewable resource potential will help determine what the capacity of the region is to generate and distribute local renewable energy. As noted previously, Table One identifies the current renewable generation for the region, while Table Twelve identifies the potential generation for the region.

TABLE TWELVE POTENTIAL REGIONAL RENEWABLE ENERGY GENERATION		
RESOURCE TYPE	**MEGAWATTS**	**MEGAWATT HOURS**
Rooftop Solar	40	49,268
Ground-mounted Solar	15,622	19,160,098
Wind	23,050	70,671,678
Hydroelectric	.01	28
Biomass & Methane[4]	n/a	n/a
Other	0	0
Total Potential Regional Renewable Energy Generation	38,713	89,881,072

Notes:
1. Regional totals were aggregated from each municipal total therefore not all calculations will be consistent.
2. 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.

Based on the information included in Table Twelve, the municipalities in Central Vermont have enough prime resource area that is not constrained to sufficiently accommodate the megawatt hour allocation and meet their share of the state's renewable energy goal. This means that the municipalities can reasonably identify additional constraints or preferred locations to align with their own land use planning goals if they so choose.

To better understand the relationship between megawatts and megawatt hours, the following conversions are used. It should be noted that some renewable generation types are more efficient at producing energy when they are actively in production. For example, the wind does not always blow and the sun is not always shining therefore a constant production of these resources may not be possible. On the other hand, methane generated from a landfill will be producing consistently for the a finite number of years therefore it's efficiency factor will be greater for the useful life of the facility. Table Thirteen outlines the various renewable technologies including their capacity factor and annual megawatt hour output per installed megawatt of capacity.

Table Thirteen reinforces the fact that multiple options of renewable energy generation exist and can be utilized at a regional and municipal level. For all of these generation types, understanding where the resources that support these sources are the best or preferred is critical. This information will be further discussed in the mapping section, however planning for the siting of renewable energy generation will ensure that, like any other land use, a municipality has made a concerted effort to ensure compatibility with other uses while accounting for possible future needs.

4. 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.

TABLE THIRTEEN 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, the Central Vermont Region faces challenges similar to the rest of the state regarding its energy future including the need for conservation, renewable energy 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 information provided in this section has shown that Central Vermont has the ability to shape its energy future within the spectrum of the avenues that it can control. The unknown component is whether or not the changes and development will occur and when. 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 satisfy the needs of the whole to the best of their ability.

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 the region 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 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[5]	MEASURE OF SUCCESS
1	Identify and maintain a directory of regional organizations that offer assistance in weatherization and make this information available to the Region's municipalities on a quarterly basis	CVRPC, Regional Partners	Medium 3 to 5 years	*TBD*	Directory is established and distributed
2	Develop information regarding energy efficiency, conservation, weatherization, and their benefits related to cost savings that can be distributed through multiple media formats. a. Work with regional partners to develop this information and update as appropriate. b. Distribute this information to municipalities for display or dissemination at a municipal level.	CVRPC, Regional Partners including Capstone Community Development, Efficiency Vermont, municipalities, and similar groups	Medium 3 to 5 years	*TBD*	Information developed and available for distribution

5. 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
3	Identify underserved populations such as low-income households and work with regional partners to encourage participation in programs such as the state Weatherization Assistance Program or similar initiatives.	CVRPC, Regional Partners as needed	Medium 3 to 5 years	*TBD*	Population segments identified and contacts established
4	Work with interested municipalities to form municipally supported Energy or Climate Action Committees to address local energy concerns and provide support as appropriate.	CVRPC, Regional Partners as needed	Medium 3 to 5 years	*TBD*	Committees formed
5	Continue to provide technical assistance to municipalities and encourage municipal bylaws that promote energy conservation and the development of renewable energy resources.	CVRPC, Regional Partners as needed	High On-going	*TBD*	Regulations updated to reflect energy specific requirements

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	Partner with existing organizations to provide education and support to interested municipalities to establish "stretch codes"[6] for residential and commercial building standards.	CVRPC, state agencies	High 1 o 3 years	*TBD*	Codes established and adopted
2	Work with municipalities to develop local energy codes requiring or promoting energy efficient site design and renewable fuel use in new construction projects that require an Act 250 permit.	CVRPC	High 1 to 3 years	*TBD*	New regulations established as appropriate

6. Vermont has Residential Building Energy Standards (RBES) and Commercial Building Energy Standards (CBES). Stretch energy codes are those that achieve greater energy savings than the base RBES and CBES by including more stringent requirements for design and evaluation of energy efficiency.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
3	Identify or develop educational materials related to net-zero ready buildings[7] to be utilized by municipalities to inform their citizens about the efficiency of this design technique.	CVRPC	Medium 3 to 5 years	*TBD*	Materials developed and available for distribution
4	Identify community organizations or existing businesses to develop and disseminate information regarding the use of landscaping for energy efficiency including the importance of	CVRPC	Low 5 to 10 years	*TBD*	Groups identified and information developed
5	Identify information or develop new materials that promote the use of Vermont's residential building energy label/score to inform the community of the importance of energy efficiency in building design and construction.	CVRPC	Low 5 to 10 years	*TBD*	Materials developed and available for distribution

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

Reliance on fossil fuels such as oil, kerosene, or propane for heating is an unsustainable practice. Fossil fuels are non-renewable therefore they will eventually be depleted to a point where they are too expensive or too rare to be viable. Establishing alternative sources of renewable fuels for heating or conversions to heating from electric sources (which can be generated through renewable methods) 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 from fossil fuels to renewable based systems for homes and businesses.	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, ground source heat pumps, district heating[8], or high efficiency combustion wood stoves that would be suitable for home and business conversions and educate users on their advantages.	CVRPC, industry experts	High 1 to 3 years	*TBD*	Information sessions conducted bi-annually

7. A net-zero ready building is generally defined as a building whereby an equal or greater amount of energy used by a building is produced on site.
8. District heating is a system for distributing heat generated in a centralized location for two or more homes and/or buildings' heating requirements.

IMPLEMENTATION ACTION		RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
3	Identify potential locations throughout the region 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.	CVRPC, municipalities	Low 5 to 10 years	*TBD*	Locations identified and mapped
4	Work with interested municipalities to evaluate and amend as necessary local regulations to ensure district heating or similar centralized renewable generation facilities such as biogas or bio-digesters are permitted in appropriate locations.	CVRPC, municipalities	High 1 to 3 years	*TBD*	Local regulations updated as needed
5	Identify sources of renewable materials such as biomass, farm waste, or food waste (such as schools, restaurants, or food processors) to determine supply of alternative fuels that may be available for district heating or other heating alternatives for homes or businesses.	CVRPC, municipalities, business community	Medium 3 to 5 years	*TBD*	Locations identified and mapped

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

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.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Assist municipalities and regional partners including state agencies and the development community to identify incentives that encourage the inclusion of public transit in land development plans including reductions in parking requirements, reduced local permit fees, or similar incentives.	CVRPC, development community, regional partners, state agencies	High 1 to 3 years	*TBD*	Incentives identified and regulations updated as necessary
2	Work with regional partners including state agencies and the business community to identify incentives that encourage employers to support the use of public transit by their employees such as discounted transit fares, flexibility in work hours, or similar incentives.	CVRPC, business community, regional partners, state agencies	High 1 to 3 years	*TBD*	Incentives identified and presented as necessary
3	Work with Green Mountain Transit to identify future growth areas or development centers to ensure public transit will be accommodated in these locations including access to park & ride locations when appropriate.	CVRPC, municipalities, GMT	High 1 to 3 years	*TBD*	Areas identified and prioritized as appropriate
4	Work with public transit providers and other partners to identify underserved communities such as rural areas or low-income neighborhoods to identify transit opportunities in these locations.	CVRPC, regional partners, GMT	High 1 to 3 years	*TBD*	Service options identified for designated locations

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
5	Work with regional partners and municipalities to establish a comprehensive transportation plan that incorporates policies and implementation regarding the expansion of public transit that considers locations of park & ride facilities; public facilities such as schools and government buildings; or other activity centers and uses throughout the Region and identifies possible funding sources to support implementation.	CVRPC, VTrans, local & regional partners	High 1 to 3 years	*TBD*	Plan developed, areas prioritized, and funding options identified
6	Ensure the continued support of intermunicipal or interregional public transit options are maintained such as bus or rail service.	CVRPC	On-going	*TBD*	Services are maintained

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

Due to the rural nature of Central Vermont, 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	Promote the use of ride share programs within the region and maintain an active list of available services that can be distributed to the municipalities.	CVRPC	Medium On-going	*TBD*	List of providers developed and maintained
2	Work with regional partners such as VTrans to ensure inventories of park & ride locations and conditions are up-to-date. This may include occupancy studies or user surveys to assess specific needs.	CVRPC, VTrans	Medium On-going	*TBD*	Inventories completed and prioritized
3	Work with utility companies and municipalities to inventory and map infrastructure such as fiber optic cable to identify gaps that may prohibit information accessibility or telecommuting options.	CVRPC, utility providers	High On-going	*TBD*	Identify gaps and prioritize needs

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 electric or non-fossil fuel based vehicles will help reduce greenhouse gas emissions and promote cleaner fuel alternatives.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Work with municipalities to ensure land use regulations do not prohibit the installation of electric vehicle charging stations or similar alternative fuel technologies (such as bio-diesel) and identify model language that can be considered by municipalities to support these uses.	CVRPC, municipalities	Medium 3 to 5 years	*TBD*	Model regulations developed and approved by municipalities
2	Identify businesses in the region that operate large fleets of vehicles to provide assistance evaluating the possibility of integrating electric or non-fossil fuel based vehicles into their fleets.	CVRPC	Medium 3 to 5 years	*TBD*	Businesses inventoried and contacts established
3	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	CVRPC, Drive Electric Vermont	Medium On-going	*TBD*	Inventory of locations mapped to identify potential gaps
4	Work with industry advocates and municipalities to ensure open communications exist to disseminate information about alternative fuel vehicles (including financial, environmental, and sustainability benefits) on a routine basis. This may be done through regular meetings, special events, or other avenues as deemed appropriate.	CVRPC, industry representatives, lending institutions, state agencies	Low On-going	*TBD*	Contacts established and regularly engaged

Policy B-4: Facilitate the development of walking and biking infrastructure

Walking and biking provide valuable alternatives to motorized vehicle travel. Ensuring a safe, efficient, and convenient infrastructure exists to promote walking and biking is essential to the future growth and sustainability of the Region's municipalities.

IMPLEMENTATION ACTION		RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Evaluate local regulations and recommend changes that would require walking and biking infrastructure to be included in the land development process to establish a network of non-motorized facilities within each community as appropriate.	CVRPC, municipalities	Medium 3 to 5 years	*TBD*	Regulations evaluated and recommendations made
2	Develop model regulations to be evaluated by municipalities that require walking and biking infrastructure in downtowns, village centers, growth areas, or locations that propose high density development patterns.	CVRPC, municipalities	Medium 3 to 5 years	*TBD*	Model regulations developed
3	Provide regular updates and training to municipalities that discuss complete streets concepts and to effectively implement these facilities including sample language to be evaluated for inclusion in local regulations.	CVRPC, VTrans	Medium On-going	*TBD*	Regular reports to VTrans regarding trainings held
4	Work with its municipalities and regional partners to develop a walking and biking master plan that identifies priority projects, gaps in the infrastructure, and implementation strategies for incorporating facilities where appropriate.	CVRPC, municipalities, regional partners, state agencies, business community	Low 5 to 10 years	*TBD*	Plan developed and priority projects identified
5	Evaluate land use patterns to ensure walking and biking connections exist or are possible between key land uses such as schools, parks/greenways, commercial areas, or neighborhoods to help create walkable communities.	CVRPC	Low 5 to 10 years	*TBD*	Connections evaluated or established

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, the Region can more effectively support energy independence.

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
1	Evaluate municipal regulations to ensure higher density development patterns are located in regional and town centers to maintain existing settlement patterns and do not inadvertently promote sprawling development.	CVRPC, municipalities	Medium On-going	*TBD*	Regulations are evaluated as needed and recommendations are included
2	Assist municipalities to identify future growth areas that can accommodate development needs while meeting smart growth principles and respecting historic settlement patterns of compact villages, neighborhoods, and urban centers as appropriate.	CVRPC, municipalities	Medium On-going	*TBD*	Assistance provided and areas identified
3	Assist municipalities in preparing information necessary to acquire or maintain state designations including statutory requirements.	CVRPC, municipalities, ACCD	Low On-going	*TBD*	State designations are maintained or acquired
4	Work with municipalities and regional partners to inventory and map existing infrastructure such as water and wastewater to evaluate capacity and development potential.	CVRPC, municipalities	Medium 3 to 5 years	*TBD*	Infrastructure mapped and updated as needed
5	Work with communities to evaluate their land development regulations to ensure these regulations (including scale, massing, building height, and minimum lot size) are suitable to support density in appropriate locations and in proximity to needed infrastructure that is consistent with community character.	CVRPC	Low 5 to 10 years	*TBD*	Regulations evaluated and updated as appropriate

	IMPLEMENTATION ACTION	RESPONSIBILITY	PRIORITY/ TIMELINE	COST	MEASURE OF SUCCESS
6	Develop or make available model ordinances related to Planned Unit Developments, for review and consideration by municipalities as a way to establish compact development patterns outside of existing growth areas.	CVRPC	Low 5 to 10 years	*TBD*	Model regulations developed
7	Provide information related to available funding opportunities (including sources and programs) for municipal infrastructure projects or improvements that will promote or support development density or compact development patterns.	CVRPC, state agencies	High 1 to 3 years	*TBD*	Information on funding collected and distributed
8	Work with interested municipalities to create policies that incentivize development in designated growth areas with opportunities that could expedite land development reviews, permitting, or other regulatory processes as appropriate.	CVRPC, municipalities, state agencies	High 1 to 3 years	*TBD*	Regulations & processes updated as appropriate
9	Assist interested municipalities to review regulations and develop updates as appropriate that would support the development of micro-grid or community scale infrastructure for renewable energy generation.	CVRPC, municipalities	Medium 3 to 5 years	*TBD*	Regulations updated as appropriate

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	Provide information to municipalities regarding alternative land use regulations such as form-based codes and identify communities where similar regulations have been successfully implemented including rural or non-urban scale regulations.	CVRPC	Low 5 to 10 years	*TBD*	Workshops held bi-annually
2	Evaluate municipal regulations and recommend amendments that will support and encourage infill development, redevelopment, adaptive reuse of existing buildings such as historic structures, and reuse of "brownfield" sites	CVRPC, municipalities, regional partners	High 1 to 3 years	*TBD*	Regulations evaluated and recommendations made as appropriate
3	Provide information to municipalities on capital planning, public investment strategies, or state and federal programs that support infill development within core community areas.	CVRPC, state partners	High 1 to 3 years	*TBD*	Workshops or other informational sessions conducted
4	Evaluate roadways in existing villages, downtowns, or municipal activity centers to identify conflict points between motorized and non-motorized modes of travel and recommend options to promote walkable and bike friendly centers that encourage alternative transportation choices	CVRPC, VTrans, municipalities	Medium 3 to 5 years	*TBD*	Evaluations completed as needed and recommendations provided
5	Work with municipalities to identify priority development zones, growth areas, or locations where high demand for electric loads exist or are planned (such as industrial parks) to ensure current planning acknowledges future needs.	CVRPC, municipalities, state partners	High 1 to 3 years	*TBD*	Locations are identified and incentives established as appropriate

MAPPING

D. Development and Siting of Renewable Energy Resources

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

Policy D-2: Evaluate generation from potential renewable energy generation by municipality 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 the region 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 region to ensure no one municipality is unduly burdened with supporting more than should be reasonably anticipated. Finally, this information will better position the region and its municipalities to evaluate the renewable energy generation options that are available to meet these goals.

To this end, maps were created for Central Vermont at a regional and municipal level 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 Central Vermont. The following information will address the evaluation of current and future generation potential within the region.

Existing Renewable Energy Generation

As noted in the Analysis and Targets section, Table Eleven identifies the existing renewable generation for Central Vermont. 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 included in the total generation represented in Table Ten.

Potential Renewable Energy Generation

Table Twelve in the Analysis and Targets section identifies potential generation of renewable energy for Central Vermont. 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[8]

As part of this effort, the CVRPC has identified information related to renewable energy generation that includes an analysis and evaluation of resource areas within the region and how those resource areas are

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

impacted by statewide and regionally identified constraints. In order to determine the impacts, an understanding of the constraints needs to be discussed.

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 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 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

<u>Methodology</u>

With all the known and possible constraints identified, this information was overlaid on the resources 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 Central Vermont.

As noted in Table Twelve of the Analysis and Targets section, based on the solar, wind, and hydroelectric potential within Central Vermont, approximately 90,000,000 megawatt hours of energy could be produced, well above the region's allocation of 418,531 megawatt hours by 2050. The potential energy generation for Central Vermont increases when other sources of renewable energy generation such as biomass, biogas, and methane are included. No specific generation numbers are listed in Table Twelve 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 region. 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. Locations of high energy use were not included on the current mapping and this information should first be considered at a municipal level before being identified regionally. This process would be consistent with others herein that support municipal identification of energy planning needs to ensure consistency with local regulations and planning efforts.

Preferred & Unsuitable Siting Locations

Similar to the discussion regarding the identification of constraints at a regional scale, the Regional Energy Committee recommended that preferred and unsuitable areas would not be included on the mapping. Instead, the plan acknowledges and agrees with the statewide preferred locations including:

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

The Regional Energy Committee further concluded that the final determination and identification of suitable sites would be left to the individual municipalities as they develop and evaluate their needs, development patterns, and future land use goals. Similarly, unsuitable areas for development of renewable energy generation were not included on the regional maps and no specific examples beyond the constraint layers are noted. This would allow the municipalities to use local insight and knowledge to evaluate and establish the criteria for identifying locally preferred or unsuitable locations.

Finally, the Central Vermont Regional Energy Plan supports the development of renewable energy generation technology that will not adversely impact the built or natural environment or conflict with identified regional policies. Similar to constraint mapping, it was decided that the region should not limit the extent to which municipalities can plan for their energy future. Due to the diverse nature of Central Vermont including urban and rural areas, there was no way to develop a consistent regional policy that would be equitable to all the municipalities, therefore all renewable energy generation types (both current and developed through future advances in technology or innovations in the industry) may be considered for application in Central Vermont.

Municipal Information

As part of this effort, the Central Vermont Regional Planning Commission developed and distributed information to all 23 municipalities within the region related to Analysis & Targets and Mapping. This information was completed and distributed on April 28, 2017 using best available information. The CVRPC website was the mechanism for this information to be disseminated and including guidance and other resources for how to best use the information. This information is available at http://centralvtplanning.org/programs/energy/municipal-energy-planning/

Regional Mapping

To provide a more specific visual representation of resources and constraints, mapping was developed that includes:

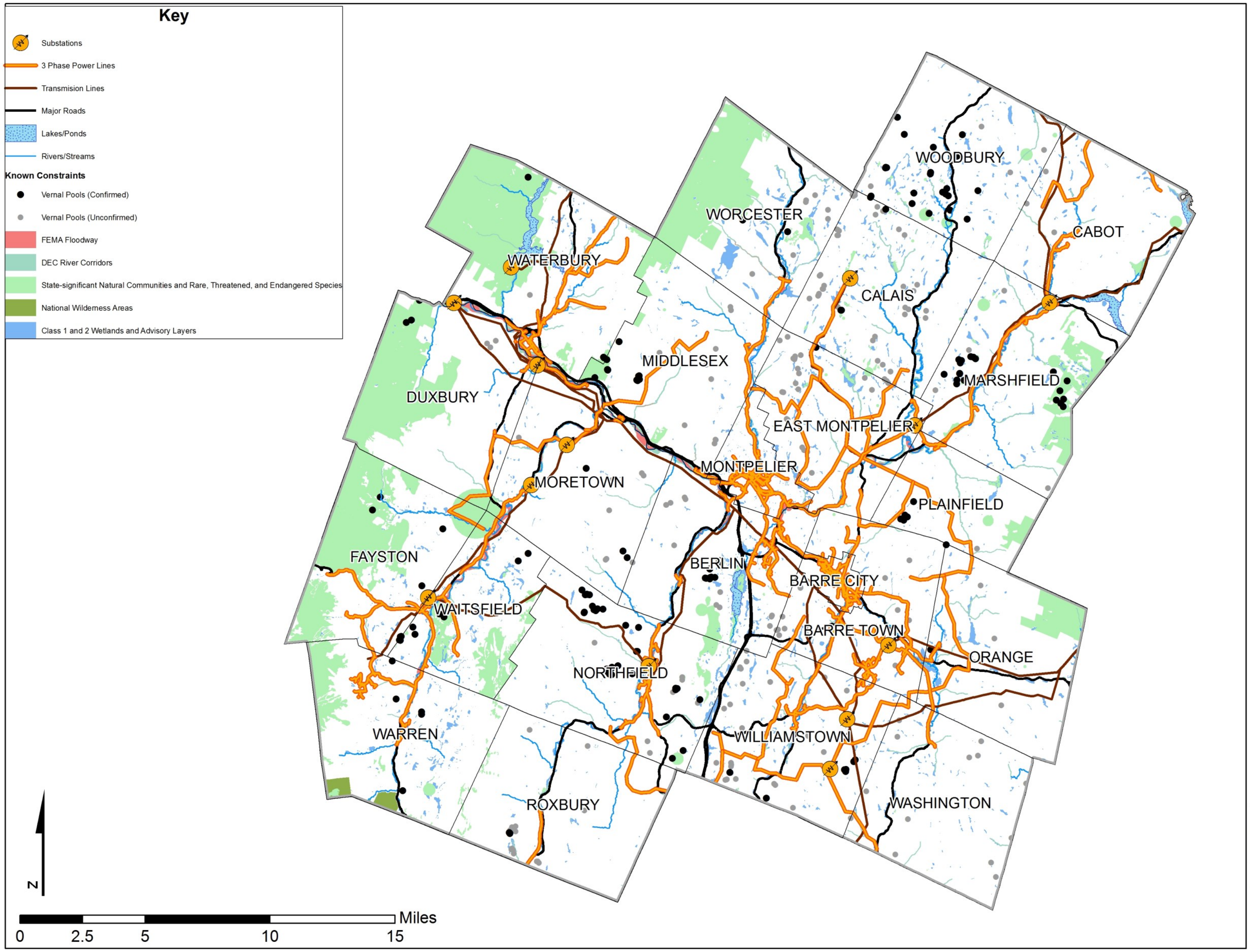
- Solar Resource Areas
- Wind Resource Areas
- Hydroelectric Resource Areas
- Known Constraints
- Possible Constraints
- Woody Biomass Resource Area

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 B

REGIONAL RESOURCE MAPS

Known Constraints Map



Known Constraints

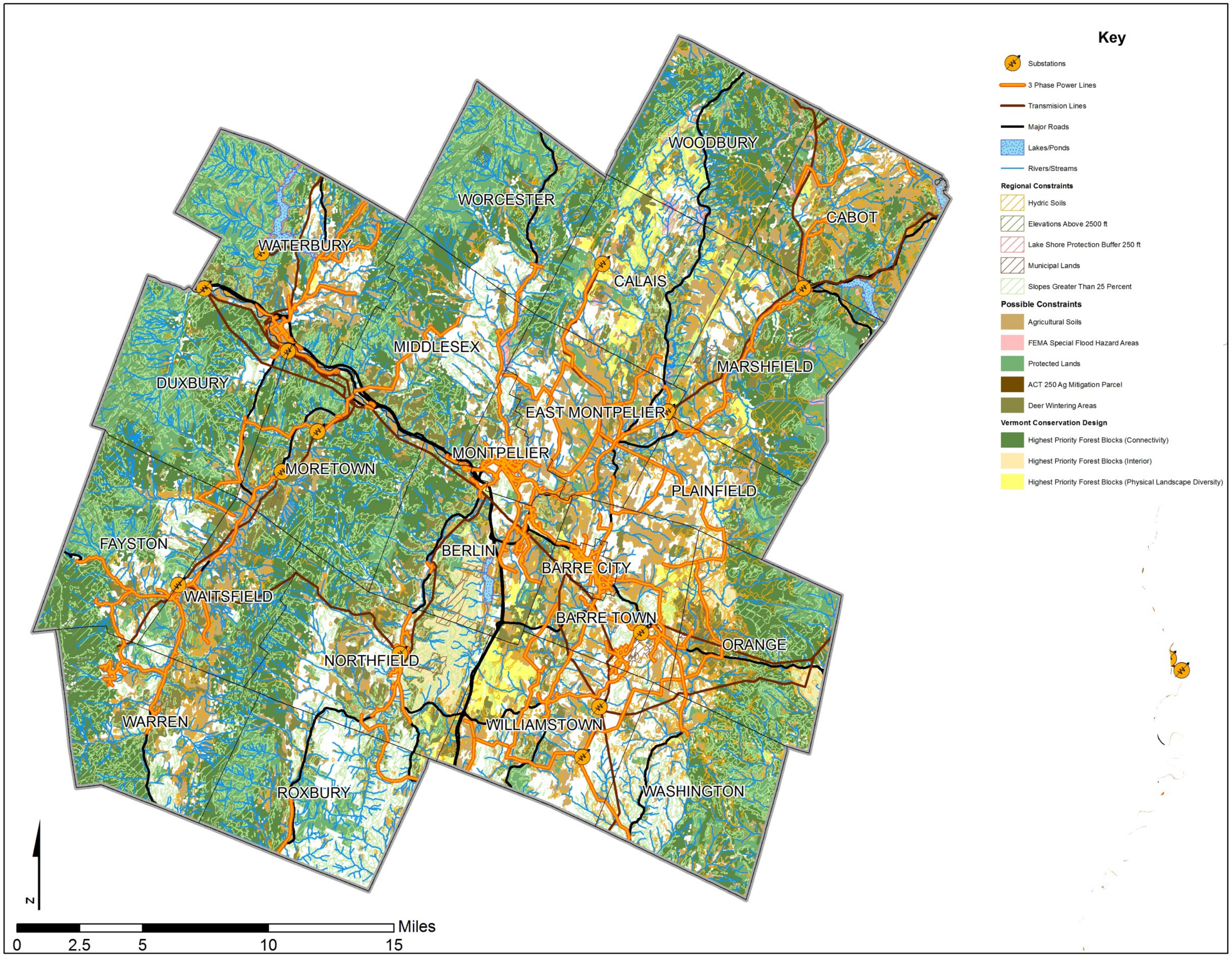
These constraints signal likely, though not absolute, unsuitability for development based on statewide or local regulation or designated critical resources.

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

Known Constraints
Vernal Pools incuding 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.



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.

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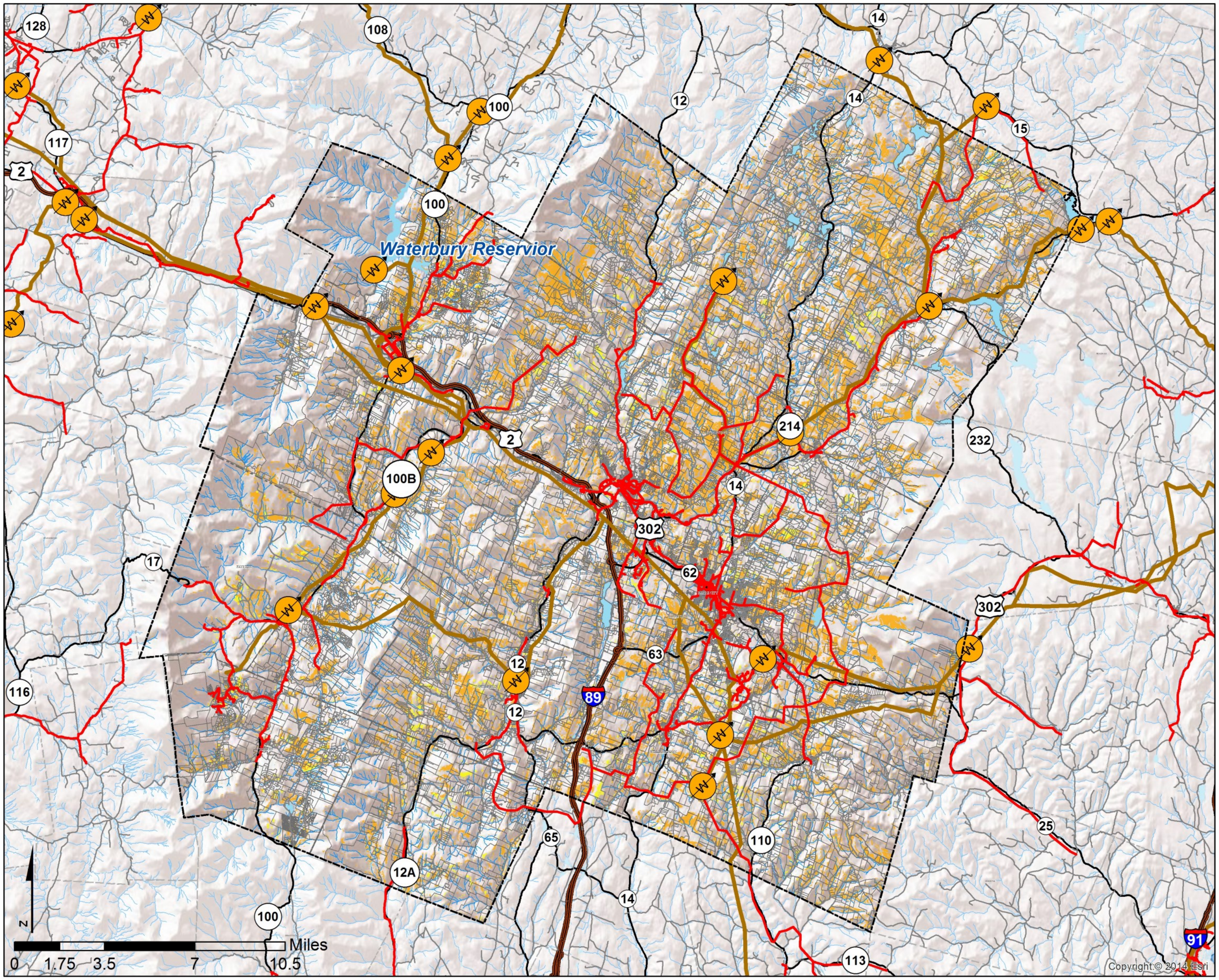
Solar Resources Map



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

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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

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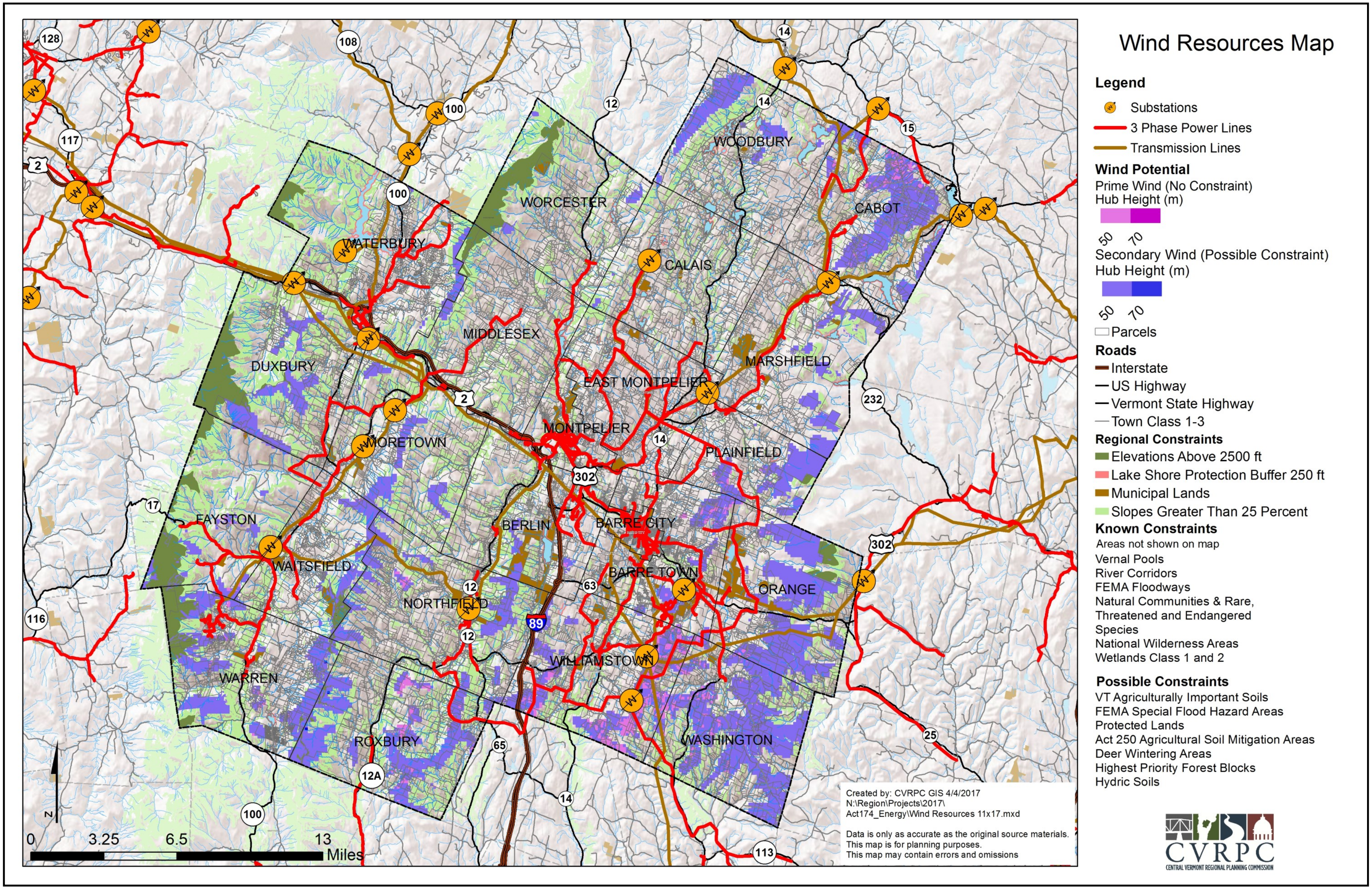
Wind Resources Map
Legend
Substations
3 Phase Power Lines
Transmission Lines
Wind Potential
Prime Wind (No Constraint)
Hub Height (m)
50 70
Secondary Wind (Possible Constraint)
Hub Height (m)
50 70
Parcels
Roads
Interstate
US Highway
Vermont State Highway
Town Class 1-3
Regional Constraints
Elevations 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
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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
CVRPC
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WOODBURY
CABOT
WORCESTER
CALAIS
WATERBURY
MIDDLESEX
MARSHFIELD
DUXBURY
EAST MONTPELIER
MONTPELIER
MORETOWN
PLAINFIELD
FAYSTON
BERLIN
BARRE CITY
WAITSFIELD
BARRE TOWN
ORANGE
NORTHFIELD
WILLIAMSTOWN
WARREN
ROXBURY
WASHINGTON
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Data is only as accurate as the original source materials.
This map is for planning purposes.
This map may contain errors and omissions
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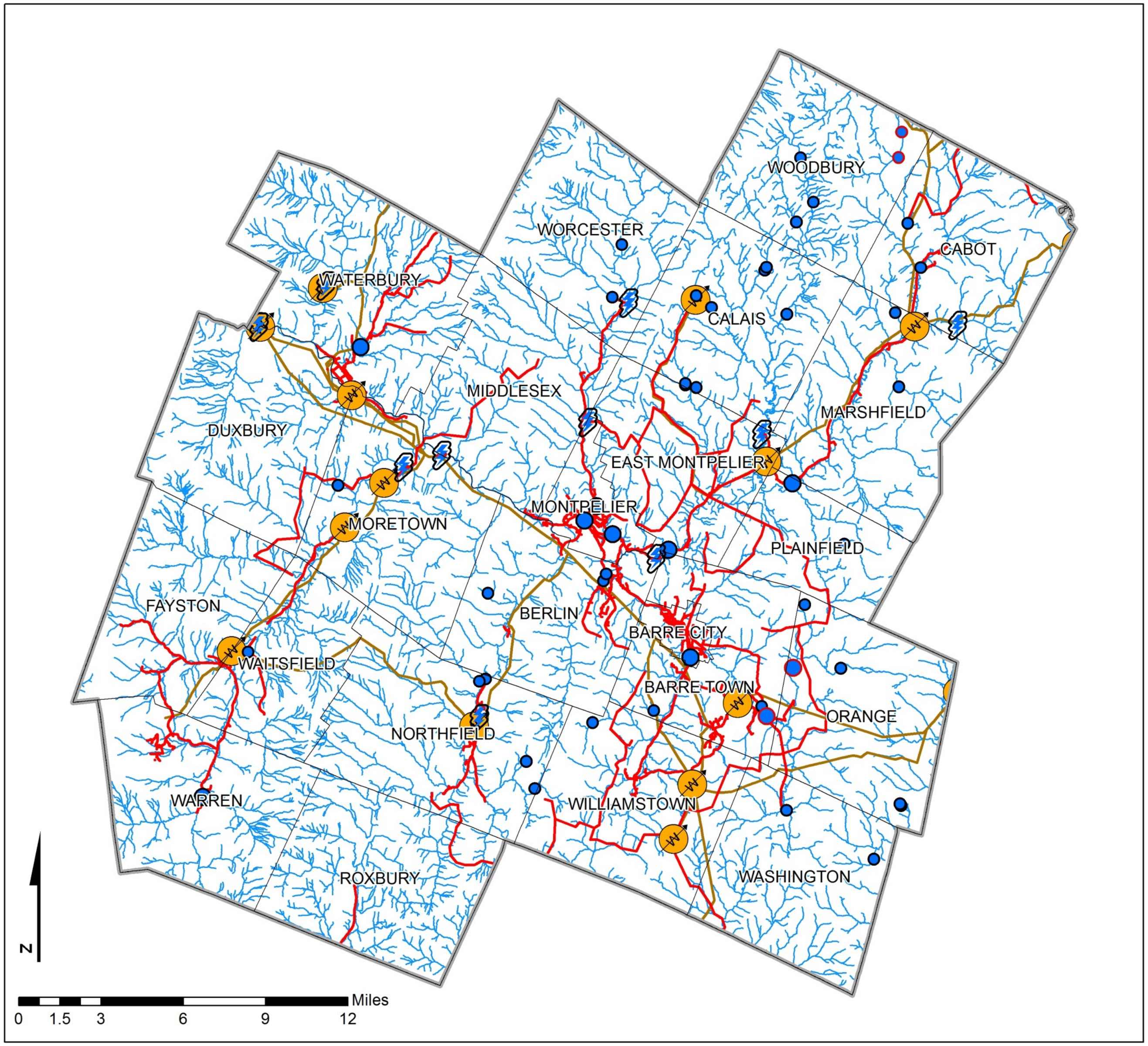
Hydroelectric Resources Map



Key

- Substations
- 3 Phase Power Lines
- Transmission Lines
- Major Roads
- Lakes/Ponds
- Rivers/Streams
- Dams not on National Wild and Scenic Rivers
- Dams on National Wild and Scenic Rivers

Potential Hydroelectric Facilities

Potential Hydroelectric Facilities

- < 50 kW Capacity
- > 50 kW Capacity
- High Hazard with < 50 kW Capacity
- High Hazard with > 50 kW Capacity

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.
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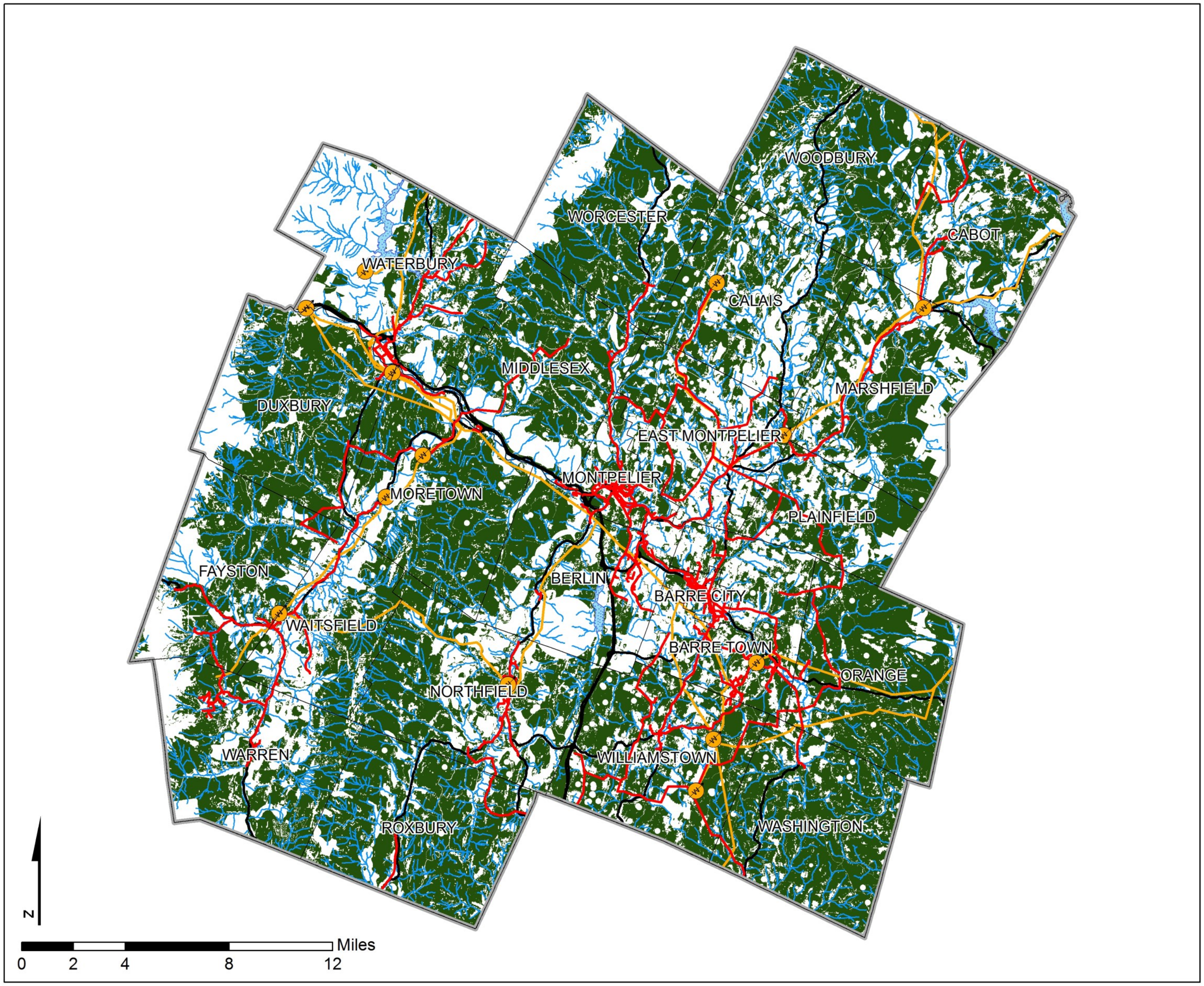
CENTRAL VERMONT REGIONAL PLANNING COMMISSION

Woody Biomass Resources Map



Key

- Substations
- 3 Phase Power Lines
- Transmission Lines
- Major Roads
- Lakes/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.

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