7.2 Energy

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A. Summary

Background

The Addison County Regional Planning Commission ("ACRPC") created this Plan, within the overall energy planning framework of the State, in order to plan for our future energy usage and infrastructure. This Plan addresses the Region's best interests in three key areas:

1. Economic needs and opportunities;
2. Environmental protection; and
3. Energy security.

Economic Needs, Threats and Opportunities

Energy costs have historically increased in both the State and the Region. As fossil fuels have become more difficult to obtain, the costs to extract and bring fuels to market has also risen. Energy producers have passed these costs on to the consumer. In the long term, assuming fossil fuels become scarcer, harder to find, and more expensive to extract, this trend could significantly impact Vermont and the Region. In April 2017, ACRPC estimated that residents of the Region spend approximately $43 million a year on gasoline for transportation (not including local businesses' expenses). While some of this money may be retained by local distributors, much of the money spent on gasoline leaves the Region, the State, and sometimes the Country. A similar scenario exists for other fossil fuel–dependent activities. Economic theory explains that money retained in a community multiplies in effect as it passes through the community from one business or person to another. Therefore, regions that retain even a fraction of the money spent each year on fossil fuel–related expenses should experience positive growth.

Electricity prices, and those of other energy sources, have historically risen. However, the cost to generate electricity locally is currently shrinking. Also, State incentive programs, like net metering, provide Vermonters with the ability to produce their own electricity and "zero-out" their costs, controlling the negative effects of inflation and eventually delivering cost savings to those individuals.

Industries that support small-scale solar and other renewable technologies (installers, distribution, sales, etc.) have created jobs in the state, including many in the Region. The Public Service Department's Vermont Clean Energy – 2015 Industry Report estimated that 2,519 "clean energy"– related business establishments existed in the State and employed approximately 16,000 in-state workers. That number grew in 2016 but has dropped since its high due to federal and state regulatory and incentive changes.

Slowing climate change can also save jobs. Many of Vermont's historic industries, such as the ski industry and others that depend on fall and winter tourism, rely on consistently cold temperatures during the winter months.

The Region also has very strong connections to its working landscape and its citizens making their living from the land. Recently, both the dairy industry and the forestry industry have suffered from economic challenges. ACRPC believes that responsible renewable generation projects or fuel sources may also stem from the Region's forests and agricultural lands, supporting those sectors of the economy.

This plan supports local residential, and thoughtfully sited commercial generation projects. It also supports the responsible and sustainable commercial growing and/or harvesting of the Region's renewable resources. In doing so, this plan seeks to harness the economic opportunities described above in order to promote long-term environmental and economic sustainability of the Region.

Environmental Protection

The burning of fossil fuels, driven by human energy needs over the past two centuries, has increased the amount of greenhouse gases in the Earth's atmosphere. Those gases, primarily CO_2, produced by combustion engines and power and heat generation processes, directly impact the earth's climate and many of its natural systems. Any fossil fuel that is burned for heat or to generate power produces emissions that contain both particulate matter and greenhouses gases. Gasoline used to power vehicles and the fuel oil or wood heating homes in the Region all produce emissions. The emissions produced by combustion include particulates, carbon dioxide, nitrogen and sulfur oxides, nitrous oxide and methane. Carbon dioxide, nitrous oxide and methane are greenhouse gases that contribute to global warming, while nitrogen and sulfur oxides lead to acid rain and acidification of water bodies.

Higher temperatures threaten the future of many of Vermont's indigenous species. Sugar maples and other northern hardwoods rely on cold winters to grow. Cold winters also protect Vermont from numerous invasive species that have been using the warmer temperatures to expand their range to the north. Burning fossil fuels significantly contributes to poor air quality and acid rain. While the Region's air quality largely remains excellent, its high-altitude habitats, including ponds and trees, do suffer from the impacts of acid rain. More frequent and substantial rainfall threatens water quality by destroying private and public infrastructure, like bridges and culverts. Climate change impacts alone justify energy conservation and the promotion of alternative, renewable fuel sources.

However, this does not mean that the Region should promote renewable energy production without considering other regional values. The Region's environment demands and deserves protection. Accordingly, ACRPC has and will continue to support siting policies for all energy transmission and generation projects in the Region to preserve the Region's resources and promote appropriately planned development.

Energy Security

Vermont currently relies upon other states and countries for a large portion of our energy needs. To address this issue, a State statute *(10 V.S.A. § 580(a))* has set a goal that by 2025, 25% of the energy consumed within the State will be produced in the State by renewable generation. Transportation energy is a clear example of the threats to both State and Regional energy security. Vermont imports all of the gasoline and diesel fuels that are required to operate passenger, commercial and agricultural vehicles in the State. While there are varying opinions about "peak oil," there is no debate that fossil fuels are a finite resource. The continuing reliance on a finite resource produced elsewhere, combined with the volatility of the fossil fuel market, will result in higher transportation costs with potentially far-reaching implications.

Our source of electrical energy is also a concern. Vermont currently obtains much of its electricity from hydroelectric facilities located out of State, primarily in Quebec. However, even these hydro resources raise concerns for some regarding their renewability and sustainability.

Although these hydro sources of electricity currently provide the region with low-cost generation, the construction of high-capacity transmission lines from Quebec to southern New England, currently in development, may create increased competition for electricity between Vermont and other, faster-growing states seeking electricity from renewable sources to fulfill their own energy portfolio standards. With increased demand, costs typically increase. Decreasing reliance on electricity from sources located outside Vermont will make both the State and the Region more energy secure.

Since 2004 ACRPC's Energy plan has incorporated the philosophy that the Region will reduce its energy usage by promoting conservation and efficiency, convert fossil fuel usage to renewably generated electrical resources, build renewable electrical generation and produce as much of the energy it consumes as practicable. ACRPC has engaged in a number of planning projects to support this philosophy. These projects include funding the local production of bio-fuels, planning for energy production on municipally owned properties, and engaging in local energy conservation education and outreach. ACRPC believes the Region has the potential to conserve more energy and to generate more energy. ACRPC has supported and will continue to support thoughtful renewable generation within the Region. However, ACRPC also recognizes that producing our own energy can come with negative aesthetic and local environmental costs. ACRPC chooses to plan for our energy future while promoting our economic well-being, preserving our environment and mitigating concerns about energy security.

Outline

This Plan includes the following sections:

1. Executive Summary
2. Introduction
3. Thermal Use, Targets and Strategies
4. Electrical Use, Targets and Strategies
5. Transportation Use, Targets and Strategies
6. Land Use - Generation and Transmission Use, Targets and Strategies
7. Conclusion

A brief summary of the function of each section follows:

Section 1, **Executive Summary**: this section provides an overview of the Plan and explains the content and function of each section.

Section 2, **Introduction**: this section offers background information regarding how this plan fits into the State of Vermont's energy planning efforts and why ACRPC chose to perform the work.

Section 3, **Thermal Use, Targets and Strategies:** ACRPC's "Thermal Uses, Targets and Strategies" focus on education and outreach to the people, businesses, organizations and municipalities of the Region that control thermal spaces. It analyzes current uses, applies targets to those uses to support the State's Energy Plan and provides Strategies in the form of Goals and Recommended Actions to achieve the targets. Based on ACRPC's estimates, which it developed in collaboration with Vermont Energy Investment Corporation (VEIC), the Region currently uses approximately 1.782 trillion BTUs to space heat residential units each year and about 0.739 trillion BTUs to space heat commercial, industrial, and institutional structures. The energy saved via conservation and improved efficiency for both residential and commercial/industrial space heating is targeted to equal approximately 1.214 trillion BTUs by 2050. Strategies include investing in improved thermal envelopes, new technology to provide heat more efficiently and conservation techniques.

Section 4, **Electric Use, Targets and Strategies**: ACRPC's "Electric Uses, Targets and Strategies" focus on educating users about, and incentivizing them to adopt, electrically efficient equipment and conservation measures and improving local energy storage capacity. It analyzes current uses, applies targets to those uses and provides Strategies in the form of Goals and Recommended Actions to achieve the targets. Regional electricity use totals roughly 0.91 trillion BTUs per year based on 2016 data available from Efficiency Vermont.

Section 5, **Transportation Use, Targets and Strategies:** ACRPC's "Transportation Uses, Targets and Strategies" focuses on facilitating the transition to electrification of the passenger vehicle fleet, improving ride-sharing capabilities, and using agricultural solutions to switch the heavy vehicle fleet to bio-diesel fuel. It analyzes current uses, applies targets to those uses to support the State's Energy Plan and provides Strategies in the form of Goals and

Recommended Actions to achieve the targets. Regional transportation energy use exceeds 1.975 trillion BTUs per year for approximated passenger vehicle fuel use[1]. Total regional transportation energy use is certainly greater due to farm and commercial vehicle use in the Region.

Section 6, **Land Use, Generation and Transmission Uses, Targets and Strategies**: ACRPC's "Land Use, Generation and Transmission Uses, Targets and Strategies" focus on planning land uses to reduce energy usage, including transportation, and on wisely siting energy generation and transmission resources. It includes a mapping exercise to analyze current uses, applies targets to those uses to support the State's Energy Plan and provides Strategies in the form of Goals and Recommended Actions to achieve those targets. As of October 2017, the Region annually generates 136,306.65 MWh of electricity through hydro, wind, solar, and biomass technologies. It had 60.91 MW of total generation capacity from all sources, according to renewable wind, solar and biomass data available from the Community Energy Dashboard (https://www.vtenergydashboard.org/) and Green Mountain Power, and hydro data available from the Low Impact Hydropower Institute (www.lowimpacthydro.org). Future energy generation and potential is extrapolated from data by the Department of Public Service ("PSD"), Community Hydro, and modeling documents developed by PSD. Regional energy production targets were then produced using a spreadsheet model created by Vermont's Northwest Regional Planning Commission in order to align with projected use and the goal of 90% renewable by 2050. Specific targets for new in-Region electricity generation by 2050 include the following: 87.5 MW (107,310 MWh) of solar generation, 19.3 MW (59,173.8 MWh) of wind generation, and 2 MW (7,008 MWh) of hydro generation (see Table 9)[2]. Although overall electrical consumption is forecast to remain approximately level, owing to a massive drop in consumption by the industrial sector, the shift to renewables requires more renewable generation. This model represents one generation mix to meet targets. While the generation targets identify renewable generation sources, they do not currently include biomass as a source of electric generation. Production estimates for biomass combined heat and power, biomass district heat, and methane generators are extremely site specific. As noted in this plan, ACRPC supports and encourages the use of sustainable biomass and biofuel generation as a renewable energy source for the Region.

A substantial part of the Region's effort to set renewable electricity generation goals involves the creation of regional energy generation maps in Section E. The regional energy generation maps are meant to guide the development of new solar, wind, and hydro energy generation facilities in the Region. A resource map was also created to identify potential wood resources in the Region that could be sustainably harvested and used for biomass generation. The maps provide a macro-scale look at different factors that impact the siting of renewable generation facilities, including generation potential and known and possible natural resource constraints. The maps demonstrate that on a macro-scale, the Region has the resources, including the land mass, to allow for sufficient renewable electricity generation to sustain our energy use, while avoiding undue adverse impacts upon known and possible constraints (These resources are

[1] Jonathan Dowds et al., "Vermont Energy Transportation Profile," (2017)

[2] The future projections for solar and wind were calculated by PSD, and future hydro data was taken from a study produced by PSD in collaboration with Community Hydro.

specifically identified in the Maps). The Maps may also be used in regulatory proceedings (Section 248), but should not be considered determinative. Each project will need to do its own site-specific mapping to ensure resources and constraints are accurately represented with respect to that project.

Section 7, **Conclusion**: The Conclusion focuses on specific Recommended Actions ACRPC can undertake to enact changes recommended in this plan. It extracts implementation steps from the Goals and Recommended Actions in each of the previous sections. The Conclusion also discusses the feasibility of meeting regional goals and enumerates challenges to the Plan's implementation.

Introduction

Background and Vermont State Energy Goals

Vermont began to plan for its energy needs after the energy crisis of the 1970s. The first comprehensive state energy plan was created in 1991 and the Vermont legislature subsequently required that plan be periodically updated. In the Vermont Comprehensive Energy Plan, last revised in 2015, the State of Vermont adopted several ambitious energy goals. The Vermont Comprehensive Energy Plan (2016), developed by the Vermont Department of Public Service ("PSD"), calls for the State to meet 90% of its total energy needs through renewable energy sources by 2050 (90 x 50 scenario). State statute also contains several goals pertaining to greenhouse gas emissions, energy generation, and energy efficiency including the following highlights:

Greenhouse gas reduction goals, See *10 V.S.A. § 578*

- It is the goal of the State to reduce greenhouse gas emissions... from the 1990 baseline by: 25% by 2012; 50% by 2028; and if practicable by using reasonable efforts 75% by 2050.

25 by 25 State goal, See *10 V.S.A. § 580*

- To produce 25% of energy consumed within the state through renewable energy by 2025.

Building efficiency goals; See *10 V.S.A. § 581*

- To substantially improve the energy fitness of at least 20% of the state's housing stock by 2017 (more than 60,000 housing units) and 25% of the state's housing stock by 2020 (approximately 80,000 housing units);
- To reduce annual fuel needs and fuel bills by an average of 25% in the housing units served;
- To reduce total fossil fuel consumption across all buildings by an additional 0.5% each year, leading to a total reduction of 6% annually by 2017 and 10% annually by 2025;
- To save Vermont families and businesses a total of $1.5 billion on their fuel bills over the lifetimes of the improvements and measures installed between 2008 and 2017;
- To increase weatherization services to low-income Vermonters by expanding the number of units weatherized, and/or the scope of services provided, as revenue becomes available in the home weatherization assistance trust fund.

Renewable energy goals; See *30 V.S.A. § 8001-8014*

- To support the development of in-State renewable energy resources;
- To include renewable energy plants in the State's energy portfolio.

Energy Units and Conversions

This plan uses multiple units of measurement to describe current and future energy use. Definitions and conversions for those units are described below.[3]

Power and Energy Unit Definitions	
BTU	A British thermal unit (BTU) is a measure of the heat content of fuels or energy sources.
kW	A kilowatt (kW) is a unit for measuring power that is equivalent to one thousand watts. It is often used to describe generation capacity.
kWh	A kilowatt- hour (kWh) is a measure of power usage as a function of time. For example, one kilowatt-hour is one hour of using electricity at a rate of 1,000 watts.
MW	A megawatt (MW) is a unit for measuring power that is equivalent to one thousand kilowatts. It is often used to describe generation capacity.
MWh	A megawatt- hour (MWh) is a measure of power usage as a function of time. For example, one megawatt-hour is one hour of using electricity at a rate of 1,000 kilowatts.
GW	A gigawatt (GW) is a unit for measuring power that is equivalent to one million kilowatts. It is often used to describe generation capacity.
GWh	A gigawatt-hour (GWh) is a measure of power usage as a function of time. For example, one gigawatt-hour is one hour of using electricity at a rate of one million kilowatts.

Energy Unit Conversions	
1 kWh of electricity	3,412 BTUs
1 MWh	1,000 kWh
1 MW	1,000 kW
1 GWh	1,000 MWh
1 trillion BTUs	10^{12} BTUs
1 gallon of heating oil	138,500 BTUs
1 cord of wood	20,000,000 BTUs

Purpose of the Plan

The Addison County Regional Planning and Development Commission developed the Region's first energy plan in 1980. That plan indicated that Addison County imported an

[3] Energy definitions and unit conversions were provided by the U.S Energy Information Administration.

estimated $16 million more in energy than it produced in 1977. The policies in that plan expressed concern about the future location of large-scale electric generation and transmission facilities in the Region. It supported the development of locally generated energy sources and pointed to their potential contribution to the Region's economy. The plan also recommended encouraging the concentration of new residential development near existing employment centers and discouraging a scattered pattern of residential development in the rural countryside, thus reducing gasoline consumption. ACRPC subsequently updated its Energy plan in 1994, 2005 and 2011. This Addison County Regional Energy Plan ("this Plan") was funded by the Vermont Department of Public Service ("PSD"). The Addison County Energy Plan constitutes one of eleven that that PSD has funded, one for each region of the State. By funding and completing in-depth energy planning within each region, PSD intends to enable Vermont to achieve state and regional energy goals—most notably, the goal to have renewable energy sources meet 90% of the state's total energy needs by 2050 (90 x 50 goal).

Although the energy picture often appears abstract and beyond the influence of local communities, sound regional and municipal planning can effectively guide certain types of energy decisions. The Region can move toward a position of sustainable energy use that will maintain a healthy environment and build a foundation for economic vitality. ACRPC and its member municipalities can promote appropriate land use patterns, participate in energy development decisions, facilitate alternative transportation options and encourage energy conservation strategies in the Region.

As of 2015, the Region used approximately 2,521 Billion BTU's of energy across all sectors. That constitutes a lot of energy. In order to contribute its share to the State of Vermont's goal of using 90% renewably generated energy by 2050, the Region and its citizens will need to make significant changes to the way we use and consume energy across all sectors.

Present and Future Electricity Generation and Usage

Vermont's supply of electricity currently comes from a combination of in-state and imported sources, with some of those sources classified as renewable and others non-renewable. The recent closing of the Vermont Yankee nuclear power plant in Vernon resulted in a sharp drop in electricity obtained from nuclear power and a significant decline in the amount of electricity generated from in-state facilities. Additional electricity to replace the nuclear-sourced energy has been obtained from regional markets in the northeast, primarily from natural gas powered generators. Hydroelectric energy, primarily from contracts with Hydro Quebec, is a significant source of electricity for the state, and woody biomass provides fuel to two generating facilities in northern Vermont. In-state wind and solar energy are beginning to provide a greater share of Vermont's electricity.

To realize the goal of obtaining 90 percent of all energy used in Vermont from renewable sources, and with significant growth in the demand for electricity anticipated, a transition in the make-up of the state's sources of electricity will have to occur. The Vermont

Energy Investment Corporation (VEIC) and the regional planning commissions made use of a program for energy policy analysis and climate change mitigation called Long Range Energy Alternatives Planning (LEAP) System to assess current and future energy usage to meet predicted supply and demand. The LEAP model was designed to compare the goal scenario (or 90x50), statewide and regionally, to a reference scenario that assumed a continuation of existing policies and practices. The 90x50 goal scenario illustrates the types of changes required across all sectors to go beyond the reference scenario and achieve the desired outcomes. This scenario also assumes that extensive electrification of heating systems and of passenger vehicles significantly reduces total energy demand because these end uses are three to four times more efficient than the fossil fuel combustion technologies they replace. The LEAP analysis anticipates some continued supply of electricity from New England nuclear facilities, but by 2050 nuclear will be the only electricity obtained from nonrenewable sources. Because of the large amount of generation required to meet the State's demand, the LEAP model assumes that by 2050, 50% of the electricity used in Vermont will be imported from other states and Canada.

Most of that imported electricity will come from hydroelectric facilities (probably from Hydro Quebec). Total new hydroelectric supply will amount to over 2,400 GWh annually. Hydroelectric generation (existing and projected new supply) will account for almost half of the state's electricity by 2050, with a significant amount imported.

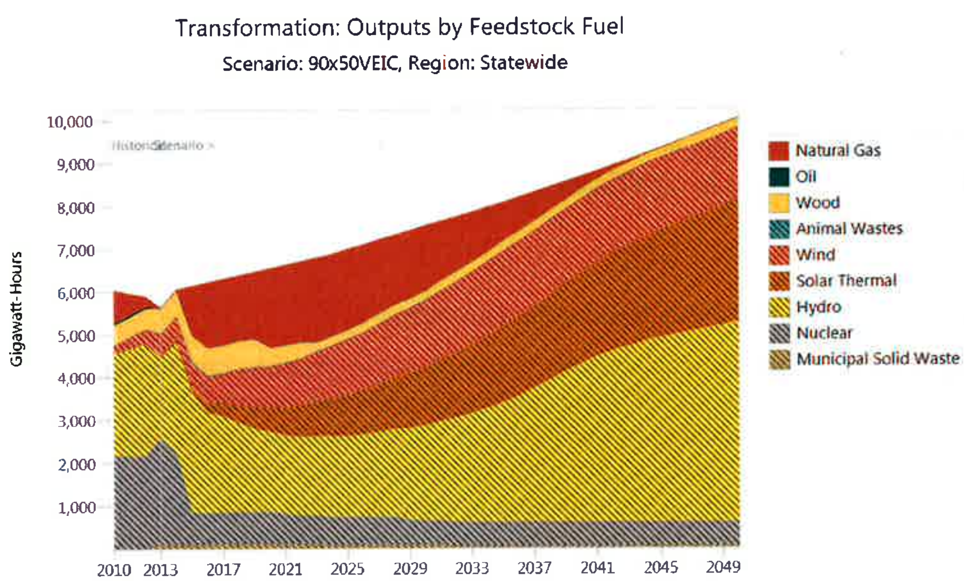


Figure 1: Vermont Electricity Consumption by Fuel Source 2010-2050[4]

[4] VEIC's LEAP Analysis results, 2012

The results of the LEAP model provide only one scenario of future energy use in the Region, which ensures that State and Regional energy goals are met. However, the model only provides projected Regional energy demand through assumed energy conservation and generation strategies. It does not provide details about how the Region may specifically attain the goals set by the model.

In order to meet the projected energy consumption modeled by LEAP, PSD and the Northwest Regional Planning Commission (NWRPC) developed targets for new renewable energy generation (from wind and solar sources) for RPCs in the State. The targets were based upon the percentage of the population living in each region, and the percent of total prime and secondary renewable energy resource area in each region. The target for new hydroelectric energy generation was based on a study completed by Community Hydro and PSD, which examined undeveloped energy potential at established dams in Vermont. It does not include the potential identified along Otter Creek by the Middlebury Energy Committee. The table below illustrates the renewable energy generation targets created for each target year.

Table 1: Renewable Energy Generation Targets

Renewable Energy Generation Targets by Source and Year			
Year	New Hydro (GWh)	New Solar (GWh)	New Wind (GWh)
2025	2	36	19
2035	4	71	39
2050	7	107	59

Based on these targets, and the LEAP models projections for energy usage, ACRPC analyzed the outcome of regional energy generation in 2050. If assumed electric consumption is correct, and the targets are met in the region, 96% of the energy consumed in 2050 will be produced locally by renewable sources. See the table below.

Table 2: Regional Renewable Electricity Generation based on LEAP's predicted Electricty Consumption

Year	Projected Electric Consumption (LEAP) GWh	Total new energy generated based on targets above (GWh)	Renewable Energy currently produced in the Region (GWh)	Imported Energy (GWh)	% of Energy produced in the Region by renewable sources
2015	351	-	136.3	214.7	39%
2025	337.7	57	136.3	144.1	58%
2035	342.9	114	136.3	92.6	73%
2050	322.4	173	136.3	13.1	96%

However, the LEAP modeling's projection of future electricity use was based on an estimate of current electricity usage that is significantly higher than the actual electricity consumed in the Region (351 GWh vs 266 GWh). ACRPC discussed this concern with both VEIC and PSD, and decided to also create projected electricity consumption for target years based on current consumption and the general trend that electricity consumed in the Region would remain fairly constant through 2050. See the table below.

Table 3: Regional Renewable Electricty Generation based on LEAP trend for Electricty Consumption

Year	Projected Electric Consumption (LEAP trend and Efficiency VT) GWh	Total new energy generated based on targets above (GWh)	Renewable Energy currently produced in the Region (GWh)	Imported Energy (GWh)	% of Energy produced in the Region by renewable sources
2016[5]	266	-	136.3	129.7	51.3%
2025	266	57	136.3	72.7	73%
2035	266	114	136.3	15.7	94.1%
2050	266	173	136.3	0	116%

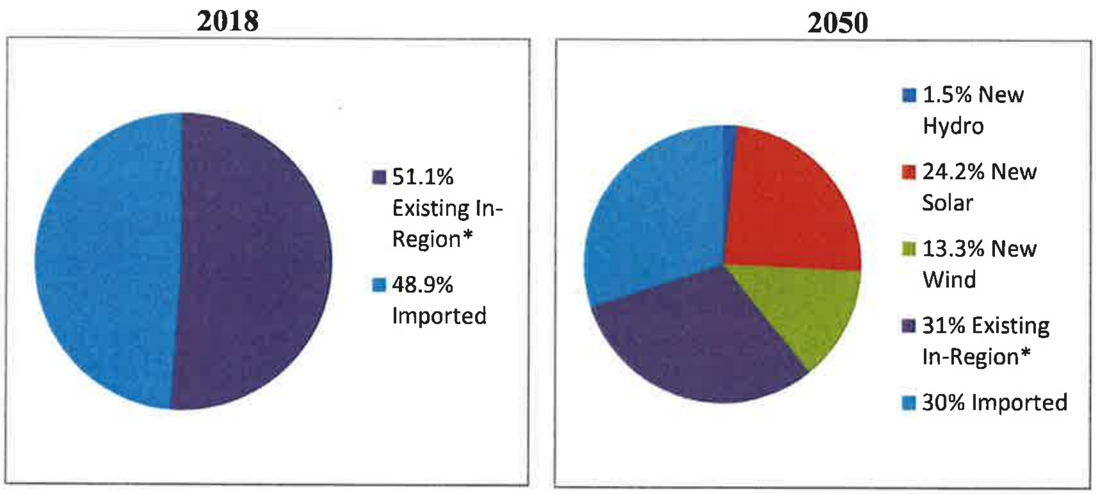
According to the analysis illustrated in the table above, if the Region meets the proposed targets and electric consumption remains constant through 2050, the Region will produce an excess of 16% of electricity from renewable sources. To further understand the targets and projected LEAP trends, please review section C of this plan starting on page 48.

Table 3 above does not include the predicted imported energy that Vermont will use from other states and Canada by 2050. If **50%** of the electricity consumed in the Region, (which according to the LEAP trend is predicted to be 133 GWh) was in fact imported from renewable sources outside of Vermont, 442.3 GWh of electricity would be available to the Region in 2050. The figure below illustrates the amount of electricity generated for usage broken down by source for the years 2018 and 2050.

[5] Efficiency Vermont data for electricity consumption in the Region for the years 2015 and 2016 were roughly the same.

Figure 2: Source of Addison Region Electricity

Imported vs. In-region, 2018 and 2050



**Existing in-region energy is approximate as of June 2018, data was collected from a variety of sources cited below. This figure assumes it will remain constant.*

ACRPC acknowledges that generating 442.3 GWh of electricity significantly exceeds the predicted demand of 266 GWh. ACRPC has therefore identified regional goals and strategies for energy conservation and renewable energy generation that support the attainment of Vermont's energy goals, while also considering the demand required by its residents and businesses. ACRPC has also identified specific implementable strategies appropriate to the Region to accomplish these goals. ACRPC will continue to revise these targets to accommodate Regional and State needs in future versions of this plan.

The modeling work completed by VEIC provided a framework for ACRPC to create specific strategies to help the Region achieve state energy goals. The modeling also assisted in the creation of regional maps prioritizing locations for the development of future renewable generation facilities in the Region. The maps also allowed ACRPC to calculate renewable generation existing in the region. The potential generation calculated from renewable sources is displayed below alongside the targets for 2050 and current renewable energy generation in the Region. The potential energy generation is a theoretical number calculated from the total available land mass in the Region after "Known Constraints" have been removed. ACRPC believes it grossly overstates potential. Nonetheless, it also demonstrates that we have the resources and land mass available to meet the Region's energy generation goals.

Table 4: Regional Renewable Energy Generation, Targets and Potential

Renewable Energy Generation Summary Table		
Current Renewable Generation Existing in the Region (GWh)	New Renewable Generation Targets for 2050 (GWh)	Potential Energy Generation in the Region (GWh)
136.3	173	312,065

Please see Section C and E below for more detailed information on current renewable generation, renewable generation targets and potential renewable generation.

While reading this document, it is important to keep in mind what the Regional Energy Plan will not do. Much like the Vermont Comprehensive Energy Plan, the Addison County Regional Energy Plan does not intend to directly address every specific energy-related issue within the Region. It does not discuss or provide recommendations regarding specific renewable energy generation projects that have been proposed in the Region. Although it provides a prospective vision of the mix of renewables that may be developed in the Region to attain state goals, the Regional Energy Plan does not specify the mix of renewable energy generation facilities that will actually be built or contracted by utilities serving the Region. In addition, this Plan does not provide direct information about the costs of implementing this Plan or the costs of failing to implement this Plan.

The energy landscape in Vermont has changed rapidly over the past 10 years. Climate change, policy changes, material cost, and quickly evolving technologies have all contributed to these changes. ACRPC anticipates that methods of generating, distributing, and conserving energy will continue to evolve over the next 30 to 40 years. This Plan should be revisited and revised, 3-5 years more frequently than other elements of the Addison County Regional Plan, to account for changes in federal and state policies and regulatory frameworks, and for changes in technology or environmental conditions due to climate change.

B. Thermal Use, Targets and Strategies

Thermal Uses

An estimate of current residential thermal energy demand in the Region, based on data from the 2011-2015 American Community Survey (ACS)[6], is shown in Table 5.

Table 5: Current Regional Residential Heating Energy Use

Fuel Source	Regional Fuel Use by Households (ACS 2011-2015)	Percentage of fuel use by Regional Households	Total Regional Square Footage Heated	Regional BTUs (in Billions)
Natural Gas	185	1.3%[7]	383,320	23
Propane	3214	22.4%	6,659,408	400
Electricity	358	2.5%	741,776	45
Fuel Oil	7474	52.1%	15,486,128	929
Coal	17	0.1%	35,224	2
Wood	2878	20.1%	5,963,216	358
Solar	22	0.2%	45,584	3
Other	185	1.3%	383,320	23
No Fuel	3	0.0%	6,216	0
Total	14336	100.0%	29,704,192	1,782

The data shows that in 2015 the majority of residences in the Region heated with fuel oil, (about 52%), followed by propane (22%) and wood (20%). Together these three heating sources account for about 95% of residential thermal heating fuel usage in the Region. Residential users are the biggest user group of energy in the Region. Next to transportation, the largest percent of energy used by residential customers is for space heating and cooling, and domestic water heating. In 2000, two-thirds of households in the Region used fuel oil to heat their homes. Nearly all the remaining households used either gas or wood. Since 2000 there has been a shift away from fuel oil, and to a lesser extent, wood (Dropping from 25% in 1980 to 20% as of 2015) towards propane gas. Also, just this year, Vermont Gas completed the installation of a controversial natural gas pipeline to Middlebury in the Region. Over the next several years, the pipeline is expected to expand residential service to the most densely populated areas of Middlebury, Vergennes, Bristol, Monkton, New Haven and parts of Ferrisburgh.

[6] All values in this chart are derived from the American Community Survey (ACS) from the U.S. Census Bureau.

[7] Since a natural gas pipeline did not exist in the Region until 2016, ACRPC believe the values concerning the number and percentages of households using natural gas constitute an error. ACRPC believes the natural gas numbers should be added to the propane values in the chart above.

Firewood is the least expensive fuel currently in the Region. Firewood is potentially renewable, carbon neutral, and for large parts of the Region, locally abundant. However, firewood is also heavy to move, generates smoke and particulates, to a degree dependent on the age and efficiency of the wood stove or furnace, and some people find the effort and process to be unacceptable or unfeasible.

Fuel oil, propane gas and non-renewable natural gas constitute fossil fuels. In order to meet State targets, their use will need to be largely eliminated by 2050. Making homes more thermally efficient is one way to reduce fossil fuel use. Another is to improve technology to make it work more efficiently. The third and best long-term solution is to replace the fuel source with technology using an alternative, renewable fuel source, like electricity produced through renewable generation. The cost of the change, both capital investment in new equipment and the operating cost of the fuels being used, constitute the major barrier to entry. While the Region has little control over the costs of energy, it can and does work to encourage conservation, efficiency and affordability for low income residents by providing lower local renewable generation costs.

Services available currently providing cost subsidies and/or promoting weatherization and efficiency include:

- The Champlain Valley Office of Economic Opportunity (CVOEO) provides fuel assistance to income-qualified residents either on a seasonal basis (call CVOEO at 800-479-6151) or on a crisis basis (call CVOEO Addison Community Action at 388-2285). The CVOEO website CVOEO.org describes additional fuel assistance programs available to Vermont residents;
- Efficiency Vermont has a number of programs to improve energy efficiency. It describes most on its home page at Efficiencyvermont.com. Current programs include:
    - energy audits;
    - incentives for Home Performance with Energy Star;
    - information on appliances, compact fluorescent and LED bulbs;
    - home heating help; and
    - Efficiency Vermont's reference library.
- Champlain Valley Weatherization Service, part of CVOEO, provides free weatherization services to income-qualified Addison County households;
- Neighborworks of Western Vermont also offers audits and subsidized weatherization services through their HEAT Squad program https://heatsquad.org/;
- Lastly, many of the Region's municipalities run services that supply firewood or other sources of heat to their residents.

Vermont also has residential energy standards. Officially called the "Residential Building Energy Standards" (RBES), the Residential Energy Code contains minimum standards of energy efficiency for all new residential construction in Vermont. The Vermont Residential Energy Code Handbook edition 4.1 March 1, 2015 includes two primary requirements:

1. A list of technical requirements that includes minimum standards for energy-efficient building components and construction practices; and
2. A certification requirement for reporting compliance. Upon completion, state law requires every Vermont builder to self-certify that the home complies with the RBES standards as built. The builder must complete and sign a certificate and submit it to the Town Clerk for filing. This must be on record before the Zoning Administrator issues a Certificate of Occupancy.

The Zoning Administrator's duty to distribute information about the Energy Codes provides an opportunity for all towns to communicate with homeowners regarding energy programs and conservation opportunities.[8]

The average household in the Region that heats with fuel oil uses about 700 gallons annually. At $2.90[9] per gallon, they would pay over $2,030 annually. The Region's residential users as a whole use about 5 million gallons or nearly $10 million worth of fuel oil annually. Not many years ago, prices were higher, and they spent considerably more.

Homeowners can reduce the energy consumed to heat their homes in a variety of ways. Shell improvements like upgraded insulation, air-sealing and window efficiency are important. New and upgraded heating systems tend to be far more efficient than older models, with cold climate heat pumps and geothermal systems topping the list. The Vermont Energy Dashboard provides a comprehensive list of resources available to homeowners seeking to reduce heat-related energy consumption (https://www.vtenergydashboard.org/resources#heat).

Estimates for commercial and industrial thermal energy use are more difficult to calculate. An estimate of total commercial energy use (thermal and electricity) is provided in Table 6 and based on data from the Vermont Department of Labor (VT DOL) and the Vermont Department of Public Service (PSD).

[8] Established under Act 89 passed in 2013.
[9] Fuel oil prices are estimated as of January 15, 2018.

Table 6: Current Regional Commercial Energy Use

	Commercial Establishments in Region (VT DOL)	Estimated Thermal Energy BTUs per Commercial Establishment (in Billions) (PSD)	Estimated Thermal Energy BTUs by Commercial Establishments in Region (in Billions)
Regional Commercial Energy Use	1019	0.725	739

While these are only estimates, they do indicate the substantial thermal energy use by commercial establishments in the Region and therefore the need for their participation in conservation and efficiency efforts.

Thermal Targets

Thermal targets for the Region include increasing weatherization of homes and commercial establishments, converting the use of old inefficient wood heating systems to new efficient systems, and switching to efficient heat pump systems. See Tables 7A – 7D below for target numbers corresponding to one scenario that could help us meet the 90 X 50 State goal.

Table 7: Thermal Targets

Table 7A. Residential Thermal Efficiency Targets	2025	2035	2050
Residential - Increased Efficiency and Conservation (% of municipal households to be weatherized)	3%	11%	55%

Table 7B. Commercial Thermal Efficiency Targets	2025	2035	2050
Commercial - Increased Efficiency and Conservation (% of commercial establishments to be weatherized)	17%	18%	51%

Table 7C. Thermal Fuel Switching Targets (Residential and Commercial) - Wood Systems	2025	2035	2050
New Efficient Wood Heat Systems (in units)	51	98	626

Table 7D. Thermal Fuel Switching Targets (Residential and Commercial) - Heat Pumps	2025	2035	2050
New Heat Pumps (in units)	1472	3558	7008

To hit the goal of 90% renewable energy use in the Region, targets have been established for each of the strategies noted above to reduce the energy needed for space-heating or change the type of fuel used for space-heating. In order to hit the 2050 targets, property owners in the Region will need to make significant improvements to their homes and businesses. Approximately half of the houses and businesses in the Region will need to be weatherized. In this scenario, the number of homes currently heating with wood that will need to invest in new wood-burning technology is relatively modest. By far the largest change will be achieved by converting houses currently heating with oil or propane (and some heating with wood) to cleanly generated electrical heat by installing efficient electric heat pumps. Electricity currently plays an insignificant part in heating the Region's homes. The 2015 Community Survey estimated only 2.5 percent (358 households) were heated with electricity (Table 5). This plan relies on renewably generated electricity becoming the dominant source of space heating to enable the Region to hit its greenhouse gas reduction targets.

Thermal Pathways to Implementation

Goals, Policies and Recommended Actions

Given the significant changes that the Region must make to meet the stated thermal targets, ACRPC promotes the following Goals, Policies and Recommended Actions for itself and its citizens.

Goal A.

Increase the Region's thermal energy efficiency and self-sufficiency by reducing both its energy use and carbon footprint to meet local and State targets of 90% renewable energy by 2050.

Policies and Recommended Actions

ACRPC's Recommended Actions for the Commission focuses on education and outreach to the people, businesses, organizations and municipalities of the Region that control thermal spaces. In conjunction with service providers, ACRPC proposes to help implement changes that improve the efficiency of heating structures and convert heating devices within those structures to use renewable sources of energy.

1. Promote thermal efficiency in the Region's municipal buildings:
    a. Help the Region's member municipalities conduct energy audits of all municipal buildings to identify weatherization retrofits and other strategies, and to incorporate the cost of the audit's recommendations into the municipal capital budget.

2. Encourage and promote local and sustainably harvested wood and efficient wood heating:
    a. Require outdoor wood boilers in the Region to comply with state efficiency and emission standards;
    b. Promote EPA III approved energy efficient wood stoves through education and outreach;
    c. Promote the management and use of town forests for sustainably harvested cordwood for low-income citizens;
    d. Support a regional energy fair;
    e. Work with forestry organizations to promote landowner education and sustainable forestry operations.

3. Encourage and support the Region's resident's efforts to weatherize their homes:
    a. Coordinate with CVOEO, Neighborworks of Western Vermont, Efficiency Vermont and other weatherization service providers to encourage the Region's residents to participate in weatherization programs.

4. Encourage proposed development to optimize design features and energy systems that conserve energy and use renewable sources:

a. Promote the installation of air source and geothermal heat pumps;
b. Promote compliance with existing residential and commercial building energy standards by educating and working with Zoning Administrators and encouraging them to distribute information about Vermont's Energy Codes to permit applicants and explain energy efficient options to builders and owners;
c. Encourage municipalities, businesses, organizations and homeowners to build to higher energy standards to increase efficiency and use renewable resources as heating or cooling sources (e.g. the Energy Star Home Program, the "Stretch Code" or passive solar homes such as PassivHaus);
d. Work with local planning commissions to incorporate additional energy standards into municipal plans and zoning regulations;
e. Work with existing energy providers in the Region (Fuel dealers, GMP and Vermont Gas) to encourage them to transition their business models to that of "energy service providers", offering efficiency improvements and a diverse range of renewable energy products.

C. Electrical Uses, Targets, and Strategies

Summary

Electrical energy constitutes a significant portion of the Region's current energy use. This Plan projects that the Region's energy use will shift from non-renewable fossil fuels to electric vehicles, electric heat pumps and other technologies using electrical power. It further projects that increasing supplies of electricity will come from locally distributed renewable generation sources. However, surprisingly, it also predicts the demand for electricity will remain relatively flat. This is because it anticipates substantial reductions in electric use because of efficiency and reduced demand in the commercial sector. The traditional pattern of electrical generation and supply will also change, driving changes in local energy delivery systems. This sub-chapter explores these changes and how they will impact the delivery system. It also sets targets for electric uses, and creates goals, policies and recommended actions to help the Region transition to a more renewable, less carbon-based electrical energy system.

For most of the last century, the US electrical generation and transmission grid has consisted of the following components. First, large central generation plants use fuels like nuclear fission, coal, or natural gas to create large amounts of energy to feed into the grid through transformers at high voltage, which can be shipped long distances over transmission lines. Upon reaching a consumer destination, sub-stations along the transmission line tap into the transmission line and use transformers once again to step down the electric voltage to a level at which it can be transferred to a local distribution system and then to customers.

While this model still describes most of the electric power system in the Region, things are rapidly changing with the addition of more locally distributed generation assets. Some local generation sources have existed since the beginnings of the grid, like the Region's hydroelectric facilities described in the sub-chapter addressing generation. Others, like residential solar or wind power, have only recently begun to proliferate in significant numbers. These small-scale electricity generation facilities are commonly referred to as distributed generation. They produce energy that, for the most part, is consumed locally. Benefits include lessening the need for costly new large generation facilities and transmission infrastructure. Also, the distributed and redundant nature of small-scale generation facilities can provide stability and resilience if integrated properly. However, the variable and intermittent power production of renewable generation sources, including the cumulative output of small generators and commercial-scale projects, adds a significant burden of design and management complexity to the grid. Changing weather patterns that include increasingly destructive storms and flooding call for an increased focus on resilience. One approach that addresses all of these issues involves the design and creation of microgrids. According to the U.S. Department of Energy (DoE) a microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both connected or "island-mode".

In the Region, the grid consists of transmission infrastructure feeding or passing through the Region, electric distribution infrastructure providing service to businesses and residents and a variety of local generation facilities, most of which are described in the sub-chapter dealing with generation.

Electricity Transmission Infrastructure

1. Transmission Lines

The Vermont Electric Power Company (VELCO), a private corporation, owns most of the bulk power transmission system in the Region and the State of Vermont. VELCO currently has a 345kV and a 115-kV electric transmission line in the Region that runs on a north-south route through the towns of Leicester, Salisbury, Middlebury and New Haven. The 345KV line ends at the New Haven substation. North of the New Haven Substation, the line divides into two 115kV lines: one travelling through New Haven and Monkton on its way to the Williston Substation and one travelling through New Haven, Waltham, Vergennes and Ferrisburgh on its way to the South Burlington sub-station. There are additional regional level transmission lines that serve parts of the Region. Generally, those lines feed power generated at the region's hydro-plants into the transmission grid or link substations with transmission lines.

Additionally, merchant power companies interested in shipping renewable power from the north, primarily carrying power from hydro or wind facilities in New York and Quebec or other Canadian provinces, have promulgated plans to build transmission lines within the Region. These lines are proposed to be built largely underwater in Lake Champlain and exit the Lake either in or South of the Region to feed into the grid. While this Plan conditionally supports those projects, it demands that they pay their fair share of local property taxes, compensate towns and citizens for the rights of way and services that they use and the impacts they create. They must demonstrate benefits to the Region beyond local property tax and minimal construction jobs, and compensation should be appropriate to the magnitude of the impacts they create. Finally, they must be built to the requirements contained later in this Plan in the sub-chapter addressing requirements for sub-stations, generation facilities and transmission corridors.

Power lines, electrical wiring and appliances all produce electric and magnetic fields. Electric and magnetic fields have different properties. Electric fields are produced by voltage and are easily shielded by conducting objects. Any appliance that is plugged in produces electric fields. Magnetic fields are produced by current and are not easily shielded. An appliance must be turned on and using power to produce a magnetic field. Electric fields reduce in strength logarithmically with increasing distance from the source.

Experts have long debated and researched the potential impacts of electric and magnetic fields on human health. Due to their greater strength, the debate has largely focused on the fields generated by transmission lines. In 2007, the World Health Organization (WHO) compiled research on the potential human health effects associated with electric and magnetic fields. The WHO concluded that exposure could not be declared entirely safe because of a weak association found between electric and magnetic field exposure and increased risk of leukemia, especially in children. WHO, as well as other organizations such as the National Institute of Environmental Sciences (NIEHS), encourages power industries to continue their current practice of siting power lines to reduce exposures. This can include burying transmission and distribution lines when possible, properly grounding and wiring lines by following current electrical codes, and even educating the public and the regulated community on risk and reduction of exposure[10].

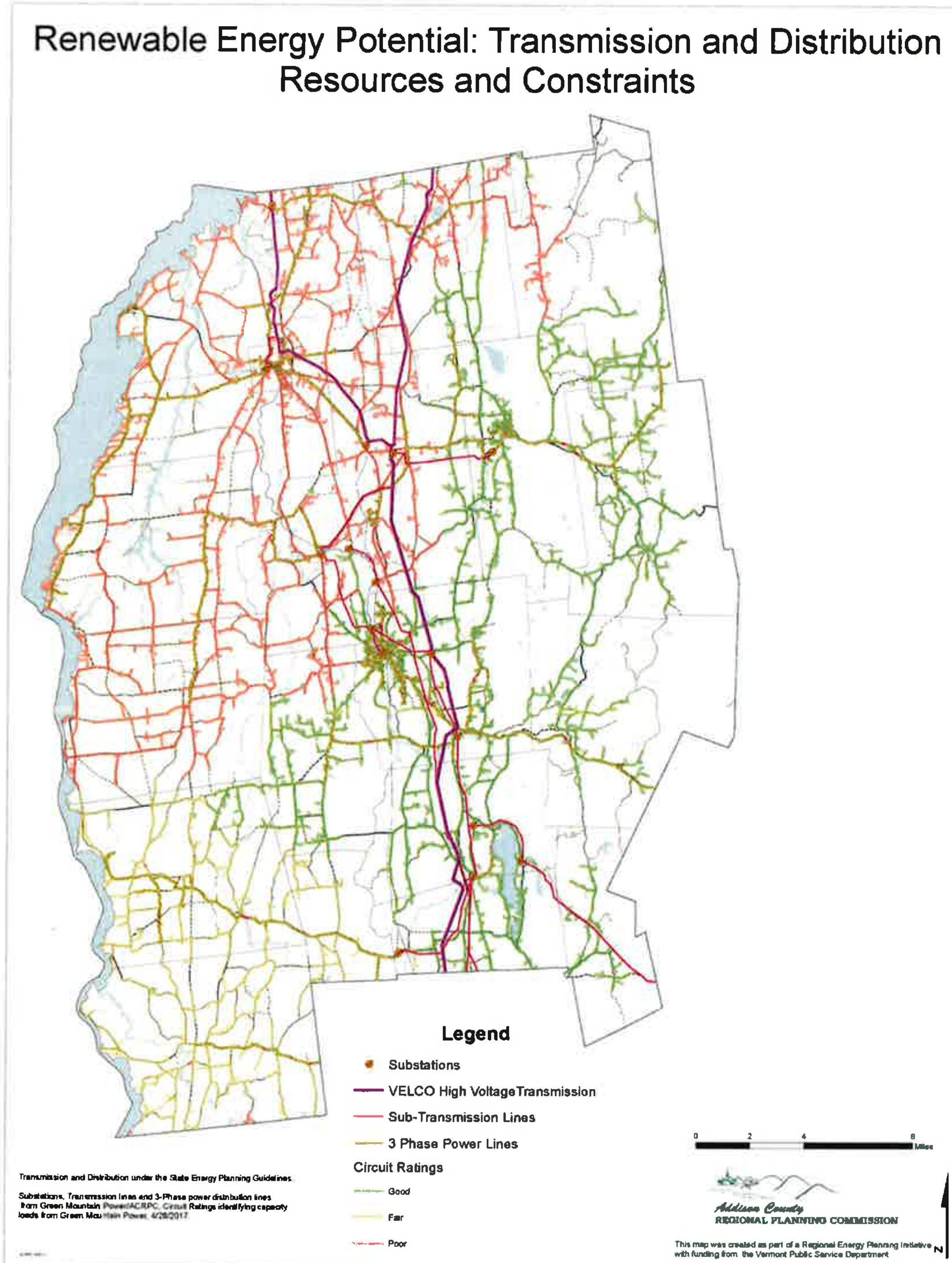
2. Substations

There are a number of substations throughout the Region. These facilities convert the electricity transmitted along the power grid to allow it to be carried on distribution lines to consumers. New or expanded substations proposed to be built shall also meet the requirements contained later in this plan in the sub-chapter addressing siting requirements for substations, generation facilities and transmission corridors.

3. Electric Distribution Infrastructure and Services

Green Mountain Power Corporation (GMP) provides and maintains electric utility service to nearly all customers in the Region. The small exception is that the Vermont Electric Cooperative (VEC) covers the northeastern corner of the Town of Starksboro. Generally, these lines are maintained and upgraded periodically, but have the capacity to support new projects. Local energy generation and distributed generation, however, are causing certain areas of the local distribution grid and its sub-stations to become constrained in their ability to deliver power 24/7. Map 1, showing constrained circuits in the Region, demonstrates this issue.

[10] Information from the World Health Organization was gathered from their website (http://www.who.int/peh-emf/en/)



Map 1. Renewable Energy Potential: Transmission and Distribution Resources and Constraints (2017)

Map 1

Recent growth in local solar generation facilities, largely within the northern portion of the Region, clearly shows constraints on the system. This plan supports capital investment in and the incremental improvement of local distribution infrastructure and substations to ensure the Region continues to enjoy reliable electric service and opportunity for economic growth. This plan also supports State policy requiring new commercial/industrial scale generation facilities to pay for any improvements to the distribution grid and sub-stations required to support their new facility. Similarly, it also supports each utility's duty to provide sufficient infrastructure to allow residential distributed generation.

4. Storage and Microgrids

The electricity grid is a complex system in which power supply and demand must be equal at any given moment. Constant adjustments to the supply are needed for predictable changes in demand, such as the daily patterns of human activity, as well as unexpected changes from equipment overloads and storms. Energy storage plays an important role in this balancing act and helps to create a more flexible and reliable grid system.

While the U.S. electric grid may not necessarily need more storage immediately, storage capacity will become more important as wind, solar, and other variable renewable energy resources continue to expand in the power mix. Studies have shown that the existing grid can accommodate an increase in variable generation[11] but a variety of scalable storage technologies must be developed to help us accommodate an even greater amount of renewable energy on the grid and assist us in reaching our 2050 goals.

In 2017, Green Mountain Power Corporation (GMP) proposed a 1 MW battery storage facility associated with its 5MW photovoltaic project in the Town of Panton, a facility now in place. It is in the process of developing and building a very similar project in Ferrisburgh. It appears that these developments will have the ability to effectively create microgrids and supply power locally for some limited period of time if the bulk transmission grid fails—effectively islanding. Additionally, the storage--a Tesla lithium ion battery bank--is able to store some of the output of the associated solar array and feed it back for local consumption in peak power periods, saving GMP and its ratepayers the cost of peak load demand power generation.

Electrical Use

Residential customers use just under 47 percent of the electricity sold in the Region. Commercial and Industrial customers represent about 53 percent of electricity sales. An estimate of electricity uses in the Region collected by Efficiency Vermont in 2016 is shown in Table 8 immediately below.

[11] National Renewable Energy Laboratory, "The Role of Energy Storage with Renewable Electricity Generation," (January 2010).

Table 8: Current Electricity Use

Use Sector	Current Electricity Use (Efficiency Vermont)
Residential (kWh)	123,901,781
Commercial and Industrial (kWh)	142,651,889
Total (kWh)	266,553,670

1. *Residential Use*

The average household in the Region uses about 640 kilowatt-hours of electricity monthly[12]. At a rate of 16¢ per kilowatt-hour[13], the average household electric bill is about $1,220 annually. The Region's 14,336 households therefore use more than $17 million worth of electricity every year.

Simple, inexpensive measures such as turning off lights in empty rooms or replacing light bulbs with new, more efficient bulbs can substantially reduce energy usage. Using timers or sensors to regulate lighting, heating or cooling in a home can also significantly decrease energy consumption. Other conservation measures that can have a profound impact on energy usage include improved insulation and weatherization of new and existing structures. New, more efficient appliances, motors and heat pumps can also help reduce electricity usage.

2. *Commercial and Industrial Use*

As shown above, commercial and Industrial electricity users in the Region used 142,651,889 kilowatt-hours (142 GWh) of electricity in 2016, the last year for which data is currently available, a little more than half of the electric energy used in the Region. The electricity used by the Region's businesses runs the pumps and motors that power its industrial processes and all of the associated lights, computers and appliances of its service and retail sectors. All of these businesses will need to invest in improved conservation and efficiency if the Region is to achieve the targets below.

[12] Efficiency Vermont, 2016

[13] GMP residential Rate as of January 2018 is 15.67 cents per KWh.

Energy Conservation and Efficiency Target

Like the thermal targets noted in Table 7, the Region will need to focus on efficiency and conservation to impact the amount of electricity that it uses. Since the electrical consumption in the Region is split almost evenly between residents (47%) and commercial and industrial entities (53%), the targets will require both individual home owners and commercial and industrial users to participate.

However, even with significant efficiency steps taken by businesses and residents, the Region's electrical usage will likely remain about the same. This is because many of the new technologies needed to reduce fossil fuel consumption, like heat pumps and electric cars, replace fossil fuel inputs with electricity. Importantly, this strategy of switching away from fossil fuels only works to reduce greenhouse gases if the electricity is generated renewably. Table 9 (below) shows that the Region must increase its efficiency and conservation by nearly 60% by 2050 to meet the proposed targets. Technological advances, such as better fuel or motor efficiency will help drive this change. However, this plan anticipates that the Region and its residents will also need to make significant capital investment in new technologies and efficiency to meet the targets.

Table 9: Electricity Efficiency Targets

Electricity Efficiency Targets	2025	2035	2050
Increase Efficiency and Conservation	10.8%	37.2%	59.2%

Efficiency Vermont is a statewide energy efficiency utility, the first of its kind in the nation. Efficiency Vermont helps consumers reduce energy costs by making homes and businesses more energy-efficient. It provides technical assistance and financial incentives to help Vermonters identify and pay for cost-effective approaches to energy-efficient building design, construction, renovation, equipment, lighting and appliances. Efficiency Vermont is funded by an energy efficiency surcharge on electric bills.

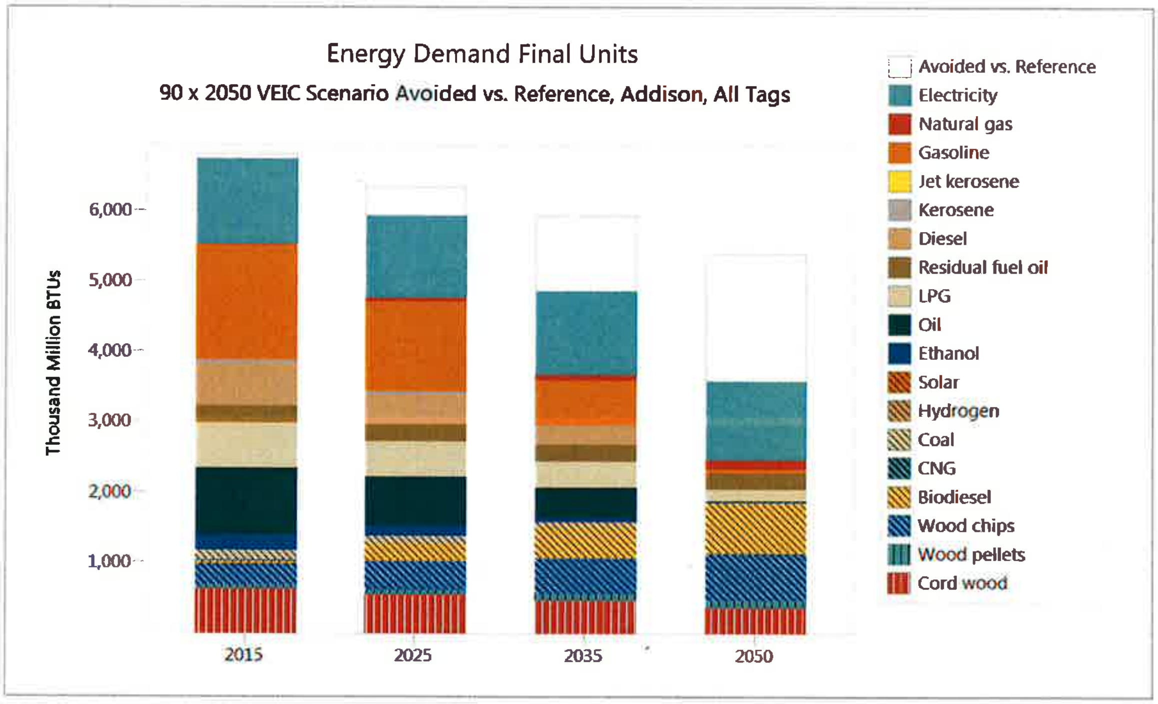
Some of Efficiency Vermont's programs include:

- Efficiency Excellence Network
- Heat Saver Loan Program
- Smart Thermostats
- LED Lighting Fixtures Program
- Home Performance with Energy Star
- Cold Climate Heat Pumps

Electrical Generation Future Demand and Targets

Electricity demand in the Region, which is currently 266,553.7 MWh, is projected to remain fairly constant according to demand trends that were produced by VEIC in conjunction with ACRPC (Figure 1). This is based on the assumption that current sources of energy demand will shift over time in each sector (transportation, residential, etc.). These consumption estimations are also based on the assumption that the Region is successfully on the path to the State's 90x50 renewable generation target.

Figure 3: Total Regional Energy Consumption



As Figure 1 above illustrates, VEIC's modeling estimates that the Region's overall energy demand will decrease substantially by 2050. The largest contributors to this deduction will be from conservation and efficiency improvements. Thermal conservation and more efficient equipment will shrink the amount of energy the Region uses by about one third ($1/3^{rd}$). This change is represented by the white space in Figure 3 above (See Section B for the projected targets and actions to improve thermal efficiency). Additionally, with the exception of natural gas, which is projected to rise slightly in use as it becomes available in the Region (the Red bar), VEIC's model projects that fossil fuel use in the Region will significantly decrease by 2050 (The orange green and beige bars). Fossil fuels will be replaced by increases in the use of biomass, wood chips and pellets (blue and red striped bars) for heating commercial and industrial spaces, biodiesel (yellow striped bar) for use in heavy equipment and electricity (light blue bar) in residential space heating and light vehicles.

Electric energy demand for the Region (light blue bar) is especially dynamic because different sectors see different changes. While changes will occur across all sectors, VEIC predicts that the commercial and industrial sectors will see significant reductions in electric usage because of their actions. At the same time, VEIC predicts the residential and transportation sectors will increase their electric usage as the Region switches to heat pumps to heat residential structures (See Table 7) and electricity to power light vehicles (See Table 12). As a net result of these changes, VEIC' predicts that the decrease in electrical usage in the commercial and industrial sectors will largely be offset by the increased electric usage in the residential and transportation sectors. Accordingly, it estimates the Region's electric consumption will remain relatively flat through 2050. Thus, the light blue bar representing electric usage in Figure 3 remains relatively the same size.

Figure 4: Regional Commercial Energy Consumption by Fuel

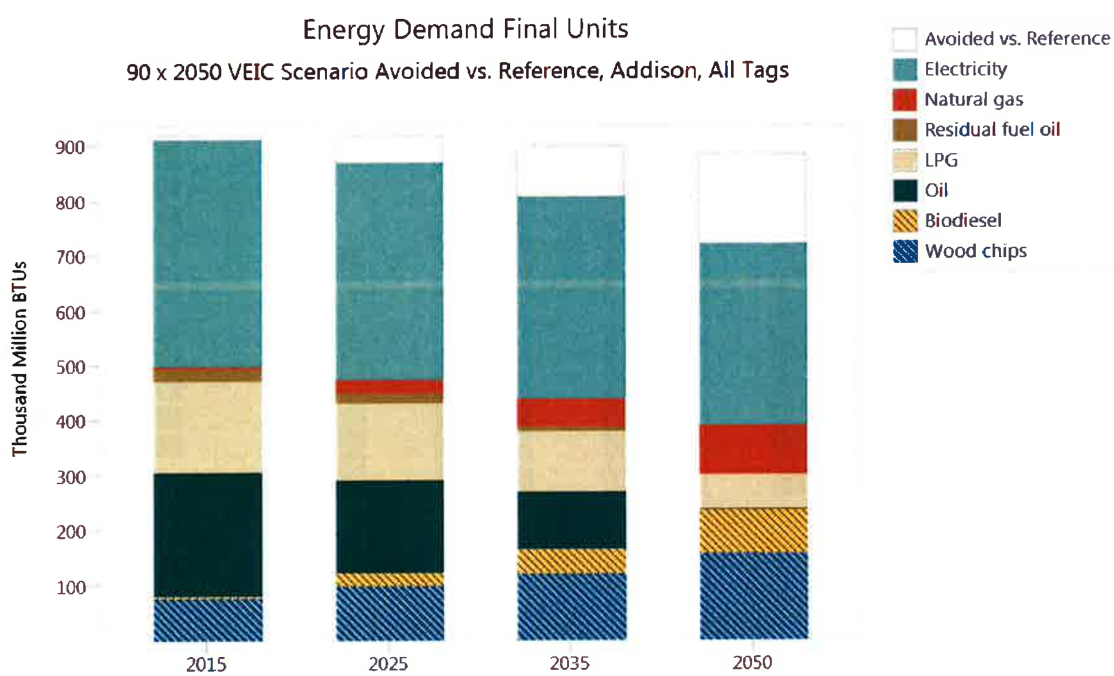


Figure 4 illustrates the projections for the Regional Commercial Energy Consumption, a subset of Figure 3. It depicts an overall reduction in total energy use. Efficiency savings are shown in white. It also depicts the following increases/decreases in fuel use:

a. Electricity use decreases because of efficiency gains;
b. Natural Gas use increases because of the new infrastructure available in the Region as it replaces other fossil fuel sources;
c. Residual fuel oil use decreases;
d. Liquid propane gas (LPG) use decreases;
e. Oil use decreases;
f. Bio-diesel use increases as it is adopted as a fuel for heavy commercial vehicles; and

g. Wood chips/pellet use for domestic heating and power plant fuel increases.

The PSD's "determination standards", or the standards required to achieve "enhanced energy plans", require that regional plans establish 2025, 2035 and 2050 targets for renewable energy production. ACRPC worked with PSD guidelines, and the Northwest Regional Planning Commission, to produce targets for new renewable generation, based on the LEAP model and the 2016 Vermont Comprehensive Energy Plan (CEP). These targets are listed in Table 10 below.

Table 10: Renewable Electricity Generation Targets

Renewable Electricity Generation Targets	2025	2035	2050
New Solar (MWh)	36,412.3	71,897.7	107,310
New Hydro (MWh)	2,312.6	4,625.28	7,008
New Wind (MWh)	19,527.35	39,054.71	59,173.8
Total Renewable Generation Targets (MWh)	**57,252.29**	**114,504.59**	**173,491.8**

These generation targets represent only one possible pathway to derive 90% total energy from renewable sources by 2050. The purpose of these targets is only to provide an idea for planning the future electricity generation in our Region based on our estimated demand. Other potential electricity generation combinations do exist and could be better suited for our Region. **For instance, this model represents a generation mix which almost certainly would require industrial scale wind. Depending on individual municipalities' planning, this may not be practical, and a model with more solar and less wind generation would be more appropriate.**

The targets this analysis developed for new annual generation by 2050 total 173,492 MWh, and are broken out between the following generation sources: 107,310 MWh from 87.5 MW of new solar, 59,174 MWh from 19.3 MW of new wind, and 7,008 MWh from 2 MW of hydro (Table 10). The solar and wind generation targets are based on the estimated needs to cover the Region's energy use in 2050 within the context of the 90 by 50 goal. The new hydro generation is based on a study from Community Hydro and the PSD, and models enhancement of production from existing dam facilities, rather than new dam construction.

As summarized previously, on page 31 of this Plan and explained in more detail in Table 13 on page 69, the Region currently produces roughly 136,306.46 MWh of electricity annually with renewable generation. The target of annual new generation 173,492 MWh of electricity, added to the existing renewable generation of 136,306.65 MWh, equals 309,798.65 MWh (if we assume that the existing renewable sources continue to produce at their current level for the next 30 plus years). Since the models assume the Region's 2050 consumption will be roughly the same as it is now, 266,553.7 MWh, these targets roughly represent a 16% overshoot of the Region's projected need[14]. It is highly likely that the data and targets will change over the coming decades. If the reduction of industrial electrical demand were to prove overly optimistic, this additional generation might well be needed. On the other hand, if most targets were being met, the targets for generation could be adjusted down. Additionally, technological developments in the energy sector are progressing rapidly and many modeling assumptions may be adjusted along the way. ACRPC supports continuing work to expand the Region's renewable generation capacity in support of the 90 by 2050 goals. The Commission will continue to evaluate the impacts of new generation to determine both the feasibility of the targets, and how they relate to the Region's ongoing demand.

Electrical Pathways to Implementation

Goals, Policies and Recommended Actions

Given the significant changes that the Region and its residents and businesses will need to make in conservation and efficiency in order to make its targets, ACRPC promotes the following Goals, Policies and Recommended Actions for itself and its citizens.

Goal A.

Conserve renewable and non-renewable electrical energy resources.

Policies and Recommended Actions

1. Support energy conservation efforts and the efficient use of energy by installing efficient electric equipment:
    a. Help municipalities explore funding opportunities and capital budgeting to implement energy efficiency in all municipal buildings;
    b. Discourage the use of "always on" lighting in parking lots and other indoor and outdoor lighting in public places. Encourage the use of technology like motion sensors to light areas when needed;
    c. Plan for and install electric vehicle charging infrastructure on municipal property;
    d. Educate consumers regarding efficiency and energy conservation;
    e. Advocate for the availability of smart meter technology to help consumers understand and regulate their electricity usage.

2. Promote energy efficiency in all buildings, including retrofits and new construction:
    a. Promote improved compliance with the residential and commercial building energy standards by distributing code information to permit

[14] ACRPC looked at VT Community Energy Dashboard numbers and conducted the same analysis. Those numbers estimated we would overshoot the Region's needs by 34%. ACRPC chose to use VEIC's estimation in order to remain consistent with the rest of the State.

applicants and working closely with the Region's Zoning Administrators:

b. Encourage municipalities to consider requiring new construction to comply with the "stretch energy code" (http://publicservice.vermont.gov/sites/dps/files/documents/Energy_Efficiency/code_update/2015%20CBES%20Proposed%20Stretch_2015-2-3.pdf).

Goal B.

Shift energy use from non-renewable energy sources, like oil and gasoline, which emit greenhouse gasses and cause acid rain, to electricity from renewable sources using technologies like electric heat pumps and electric vehicles.

Policies and Recommended Actions

1. Work with municipalities, electric utilities and community groups to lead and support the transition:
    a. Help the Regions municipalities investigate and install, or purchase, cost-effective municipal solar and /or wind net-metered facilities to power municipal energy use;
    b. Help the Region's municipalities, their Energy Committees, and community groups, such as ACORN, install community funded and owned renewable energy projects, and allow local citizens to participate in the economic benefits of local energy generation;
    c. Work with utilities serving the Region to ensure that during the transition to distributed electric generation and increasing consumer reliance on electricity for power, that the distribution and transmission grid improves regularly to continue to provide cost effective, reliable service and opportunity for growth to all communities in the Region;
    d. Support utilities globalizing the cost of improving local distribution and sub-station infrastructure necessary to support residential scale distributed generation;
    e. Advocate for the retention of the current State policy that requires commercial and industrial generators to fund the cost of improvements to the distribution system necessary to accommodate their proposed projects;
    f. Share info with VELCO, GMP and VECOOP to ensure that targets for generation in the Region and across the state are optimized to enhance the cost effectiveness of the transmission and distribution system for the State of Vermont; and,
    g. Require systems 500 kW or greater to follow the IEEE1547 standard for connection to the grid.

D. Transportation Uses, Targets and Strategies

Summary

The largest portion of energy used in the Region is for transportation. Virtually all of it comes from petroleum products imported into the Region. In Vermont more than one-third of all energy consumed is for transportation, and 75% of that energy is consumed by passenger vehicles alone.[15]

As referenced throughout this plan, transportation's impact on the environment is first among all sectors in Vermont in terms of both energy use and greenhouse gas emissions. As such, transportation simultaneously presents a great challenge and opportunity. In pursuit of the goal of 90% renewables by 2050, the Vermont Comprehensive Energy Plan sets forth ambitious goals which include:

1. Reducing single occupancy vehicle (SOV) trips;
2. Increasing bicycle and pedestrian trips;
3. Increasing public transit and the number of park-and-ride locations and spaces;
4. Increasing the use of rail for freight and passengers; and
5. Promoting fuel transition from fossil fuels to cleanly generated renewable energy.

Achieving progress in these areas to the extent necessary to meet statewide goals requires significant planning and action at all levels of government. In the Region, we must reduce the need and demand for transportation and create new infrastructure required to reduce energy usage and increase the use of renewables. In particular, we need to continue to develop infrastructure supporting public transit, carpooling, biking, walking, and aiding the transition toward renewable fuels such as electricity and biodiesel.

According to the Census Bureau, Region residents owned 26,464 vehicles in 2015 or approximately .7 vehicles per person. That is up from around 24,000 vehicles in 2000 and 15,000 vehicles or .5 vehicles per person in 1980.

[15] Jonathan Dowds et al., "Vermont Energy Transportation Profile," (2017)

Table 11: Current Regional Transportation Energy Use

Transportation Data	Regional Data
Total # of Vehicles (ACS 2011-2015)	26,464
Average Annual Miles per Vehicle (VTrans 2017 Energy Profile)	11,680
Total Miles Traveled	309,099,502
Realized MPG (VTrans 2017 Energy Profile)	18.9
Total Gallons Use per Year	16,354,472
Transportation BTUs (Billion)	1,969
Average Cost per Gallon of Gasoline (RPC)	$2.63[16]
Gasoline Cost per Year	$43,012,261

Table 11, above, depicts the Region's fuel usage for passenger vehicles (it does not include heavy trucks or farm vehicles). Based upon the number of registered vehicles in the Region, assumed average vehicle miles travelled, gas mileage per vehicle and assumed gas prices at their current level, the table shows the Region's residents spend over $43 million dollars per year on residential vehicle trips. While some money will go to local gas stations, the majority of the cost per gallon leaves the local economy. Reducing vehicle miles by transforming local infrastructure to provide for other choices than single family vehicles can aid conservation and efficiency savings for individuals. Converting to different, locally produced generation sources of energy for transportation could help reinvest some that money locally.

Breaking the numbers down further, since we know the Region has 14,336 households (Census), this shows that on average, the Region's citizens average nearly two cars per household. If we divide the $43,000,000 dollars spent by the number of households, it shows the average household with two cars spends approximately $3,000 per year on just gasoline. Never mind other expenses associated with the cost of owning a vehicle. When one includes maintenance and depreciation on the vehicle, Triple AAA estimated that in 2014 the cost per year of owning a single vehicle was nearly $9,000. Since the average household has two cars, that adds up to an average of $18,000 per household, per year.

[16] Average price per gallon of gas (regular unleaded) as of February 2018 (AAA)

Transportation Targets

The costs quoted above should provide some incentive to move towards the proposed targets in Tables 12 A, 12 B and 12 C below.

Table 12: Transporation Targets

Table 12 A. Use of Renewables - Transportation	2025	2035	2050
Renewable Energy Use - Transportation	2.7%	18.2%	83.5%

Table 12 B. Transportation Fuel Switching Target - Electric Vehicles	2025	2035	2050
Electric Vehicles	2258	15,376	29,986

Table 12 C. Transportation Fuel Switching Target - Biodiesel Vehicles	2025	2035	2050
Biodiesel Vehicles	493	841	1208

As the Tables show, to meet the proposed targets, by 2050, assuming growth, nearly all residential vehicles in the Region will need to run on renewably generated electricity. Additionally, most commercial vehicles and farm equipment will need to switch from diesel to bio-diesel or electricity, if it is available for application in heavy commercial vehicles.

ACRPC's policies regarding transportation targets as they relate to reducing energy demand and single-occupancy vehicle use, and encouraging the use of renewable or lower-emission energy sources for transportation, are outlined below. These targets are consistent with those presented in the updated Addison County Regional Transportation Plan. For more detailed information on transportation related energy use goals and actions for Region, please see the Addison County Regional Transportation Plan by visiting our website or our office: (http://acrpc.org/programs-services/transportation/)

- Ridesharing/Carsharing/Ride-hailing section, pages 6-36 to 6-37;
- Public Transit, SOV trip reduction, park-and-rides, etc. pages 6-34 to 6-36;
- Pedestrian & Bicycle Facilities, pages 6-39 to 6-46;
- Energy Efficiency and Conservation section, pages 6-48 to 6-49; and,
- Electric Vehicles, page 6-50.

Transportation Pathways to Implementation

Goals, Policies and Recommended Actions

Given the significant changes that the Region will need to adopt to meet statewide targets, ACRPC promotes the following Goals, Policies and Recommended Actions for itself and its citizens.

Goal A.

Reduce reliance on nonrenewable fossil fuels, and shift reliance to renewable energy sources.

Policy and Recommended Actions

1. Create infrastructure and policies supporting electric vehicle use within the Region:
   a. Plan for and install electric vehicle charging infrastructure on municipal property;
   b. Incorporate EV ready standards into building code. (This can be as simple as requiring 220v outlets in garages);
   c. Encourage major employers in the Region, to install (additional) EV charging stations for employees;
   d. Identify strategic locations where EV charging stations should be added or expanded including existing service stations;
   e. Promote the Drive Electric Vermont website.

Goal B.

Maintain or reduce vehicle miles traveled per capita to 2011 levels by reducing the amount of single occupancy vehicle (SOV) commute trips.

Policies and Recommended Actions

1. Support regional efforts to increase access to safe, every day walking and cycling within and across municipal borders:
   a. Review municipal road standards to ensure that they reflect all "complete streets" principles applicable to our rural roads;
   b. Provide walking and biking paths connecting population densities with critical infrastructure, like in and between villages and elementary schools;
   c. Promote municipal membership on the *Walk-Bike Council of Addison County* to foster safe and accessible opportunities for walking and cycling as an alternative to SOVs;
   d. Help municipalities find and apply for funding sources for building walk/bike infrastructure;
   e. Help the Walk-Bicycle Council of Addison County work with municipal road foremen and select boards to plan for incremental development of critical bicycle infrastructure within their municipalities as road work is completed annually.

2. Support public transportation programs serving the Region. Bus routes, car and vanpools, and elderly and disabled services all fall under the umbrella of public transit:
   a. Work with ACTR (TVT) to explore creative approaches to expanding service in rural areas of the Region, including small capacity ride-share, ZipCar style micro-leases, and even self-driving EVs for a connecting service between small villages and major arterial corridors;
   b. Encourage additional municipal representatives on the Tri-Valley Transit ("TVT) Board[17] and the Addison County Transit Resources Regional Operating Committee ("AROC") to bring issues facing smaller, more isolated towns to the table;
   c. Support the use of a Park and Rides in the Region and encourage the Region's residents to consider ride-sharing programs;
   d. Help municipalities without park and rides to find a convenient location and apply for funding to create lots from Vermont's small park and ride program;
   e. Plan and advocate for enhanced access to public transit, particularly during relevant Act 250 proceedings;
   f. Promote better utilization of existing state and municipal park-and-ride lots;
   g. Work with ACTR to create better connectivity between public transit and park-and-ride locations. Support employer programs to encourage telecommuting, carpooling, vanpooling, for employees' commute trips;

Goal C.

Increase the use of rail for freight and passenger services.

Policy and Recommended Actions

1. Support improvements to the Western Rail Corridor that improve safety and the ability of the corridor to carry additional freight and passengers:
   a. Support Amtrak's expansion on the Ethan Allen line from Rutland to Burlington with stops in Middlebury and Vergennes;
   b. Support construction of a rail platform in Middlebury and completion of the rail station in Vergennes/Ferrisburgh;
   c. Encourage local businesses to explore the opportunity to use rail for freight.

Goal D.

Encourage citizens and businesses to transition from oil and gasoline to cleaner products and technologies and/or to renewable, non-fossil-fuel transportation options.

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[17] On July 1, 2018 Addison County Transit Resources, the transit provider in the Region merged with Stagecoach, the Transit provider for Windsor and Orange County. The new entity was re-named Tri-Valley Transit but kept the names ACTR and Stagecoach for its regional operating divisions.

Policy and Recommended Actions

1. Encourage options for cleaner fuel availability:

a. Work with Clean Cities Coalition to encourage large fleets to switch to natural gas use where transition to biodiesel is impractical;
b. Encourage use of renewable natural gas through Vermont Gas's forthcoming renewable natural gas green pricing program;
c. Support the agricultural industry as it investigates growing, processing and using biofuels for on farm and other commercial and heavy vehicle use.

E. Land Uses, Targets and Strategies

Summary

Land Use

The Region currently constitutes a largely rural area of working farms and forests, interspersed with small villages, rural residential single-family homes, and three larger growth centers where most of the commercial and industrial development in the Region lies. Because of its existing settlement patterns, many residents in the Region are probably more dependent on their cars, and the energy they use, than many Vermont residents. While the Region desires to retain its rural feel, it can adopt land use policies that encourage more densely settled areas that have the capacity to allow for more transportation alternatives within those areas, potentially saving energy and promoting healthier options, like walking or biking. As with other conservation goals, conserving energy by reducing the need for cars can be more cost effective for its citizens than fuel-switching to electric or other alternatively powered vehicles discussed in the previous chapter. Therefore, the Land Use Section of this Plan promotes greater density and housing options in the Region's villages. Other Land Use policies to limit energy use including the conservation of forest and farmland for biofuels and local food systems are listed in the Policy Section below.

Energy Infrastructure and Growth Patterns

Infrastructure such as electricity distribution lines, gas pipelines and sewer systems can lead to new or intensified development. Development is easier, less expensive and therefore more likely to occur in places served by infrastructure. So, decisions regarding infrastructure extensions or improvements should consider the impacts on growth and development patterns in the area.

In the Region, there are areas, especially in the mountain towns, that do not currently have access to electric lines. As with roads, whenever a distribution line is extended into a place that previously did not have service, over time additional development is likely to occur along the length of the line.

Current Energy Consumption and Fossil Fuels

1. Fuel oil and propane

There are a number of companies in the Region delivering propane and fuel oil to retail, commercial and industrial customers, used primarily for space heating and cooking. Most of these fuels are shipped into the region by truck. There is also a rail facility located in Leicester Junction where fuel is delivered and stored. Retail distribution of these fuels is available throughout the Region.

This plan supports phasing out the use of these fuels within the Region. However, it also recognizes that these businesses have been a very necessary part of the community for a long time. This Plan envisions supporting these businesses to transition to become energy service suppliers or some other ongoing type of business to minimize the negative impacts the transition may have.

2. *Gasoline*

Gasoline distribution in the Region is primarily through individual stations affiliated with major oil companies. In the Region's rural towns, many stations are small, locally-owned convenience stores with franchises. Along the major highways, gasoline stations are more likely to be corporate-owned chain stores.

This distribution network has historically served the Region well and fuel for gasoline engines is readily available. During the past 30 years, changes to the economic climate, consumer purchasing patterns and regulations on underground storage tanks have affected the gasoline distribution system. Smaller stores with limited sales volumes are finding it increasingly difficult to justify the expense associated with gas sales. Consequently, residents in more rural parts of the region have been gradually losing local access to fuel and must drive increasing distances for a fill up.

Like fuel oil and propane, this plan envisions reducing the Region's dependency upon gasoline and other petroleum-based fuels in favor of renewably generated electricity. However, it also recognizes that the distribution infrastructure for an effective transition to electric vehicles does not exist. One logical place to explore is transitioning the fuel distribution network to a network that can also supply electric vehicles. This Plan supports that transition. Building electric vehicle charging infrastructure should include all reasonable places for electric charging stations, including existing service stations.

There are health and safety risks associated with both the storage and transport of petroleum products in the Region. Throughout the past 30 years, electronically monitored, double-walled tanks have replaced older single-walled underground storage tanks. Unfortunately, many of these older tanks had already leaked and some of the region's groundwater has been contaminated. To date, the costs associated with groundwater contamination in the Region have been limited to small-scale clean up and supplying alternative drinking water supplies to homes affected. Given that most commercial tanks have been replaced, the possibility for large-scale widespread contamination has been substantially reduced. Small residential systems will continue to pose a localized threat.

Above ground storage and transport of highly flammable petroleum products also carry fire and explosion risks to communities. In the 1980s, transport of petroleum products to the Region shifted modes from a combination of Lake Champlain barge, rail and truck to primarily truck transport with limited rail use. A 2003 study of the Region's major highways indicated that more than three-fourths of all hazardous materials transported within the Region fall within the petroleum category. Additionally, all of the Region's local roads also have some risk associated with the transport of petroleum products to customers for heating and cooking fuels.

3. *Natural Gas*

Vermont Gas has recently completed a 41-mile natural gas pipeline extension into the Region and continues to build out secondary distribution. The line serves or will serve commercial or residential customer's in up to 7 communities in the Region, including the three Regional employment centers of Vergennes, Middlebury and Bristol, the village areas in Monkton, New Haven and portions of Weybridge and Ferrisburgh. This pipeline has been a contentious issue for the Region. When proposed, the cost of fuels was significantly higher. However, many in the community objected to investment in new long-term infrastructure for a fossil fuel. After significant debate, the Addison County Regional Planning Commission supported the project with conditions. Those conditions were included in an MOU it executed with Vermont Gas. Conditions included provisions like service to the villages that the pipeline passed through to provide infrastructure to support planned, denser growth within those villages, training for the Region's first responders and working to incorporate renewable natural gas, made from composting agricultural waste, mainly cow manure and/or food waste into its fuel mix. Vermont Gas is working to make this opportunity available to the Region's farmers and food manufacturers.

Nonrenewable natural gas will serve as a short-term fuel for the Region. Whether consumers and businesses choose to convert to natural gas will be their own choice. ACRPC will continue to work with Vermont Gas to utilize the infrastructure it offers to promote economic development for manufacturing and to incorporate it into our farm economy to offer a renewable natural gas option.

Regional Renewable Energy Generation

The Region's energy supply is largely consistent with statewide patterns. This includes a number of alternative energy installations that tap local energy resources. The Region was historically developed with hydropower. The Middlebury River, New Haven River and Otter Creek powered the first mills in Middlebury, Bristol and Vergennes respectively. Several of these hydropower sites still exist and are discussed in the sub-section later in this chapter dealing with Hydropower. More recently, the relatively flat and open topography of the Champlain Valley in portions of the Region has attracted a number of large scale solar developments. Also, a growing number of homes have photovoltaic systems that supply a portion of their electrical energy. Finally, community members, either lacking good solar orientation or interested in a community system for other reasons, have created community energy systems where they have pooled resources with other like-minded citizens to develop an offsite community energy project. Thanks to Vermont's net-metering law, owners of these systems can purchase grid power when needed and sell excess power back to the grid during periods of high solar production up to the point at which their annual cost zeroes out. In order to qualify for net metering, an electrical utility customer must obtain a Certificate of Public Good (CPG) from the Public Utilities Commission ("PUC"), a process similar to an Act 250 land use permit. Projects that receive a CPG do not have to go through the local permit process.

Table 13: Total Existing Regional Renewable Generation

Renewable Generation Sources	Generation Capacity (MW)	Total Annual Generation (MWh)
Solar	34.75	41,792.8
Wind	0.4	961.78
Hydro	23.92	83,815.68
Biomass	2.38	9,736.39
Other	0.00	0.00
Total Existing Generation	60.91	136,306.65

As of October 2017, roughly 1,498 sites generate 136,306.65 MWh of solar, wind, hydro and bio-methane power annually within the Region (Table 13).[18] The discussion below encompasses all of the types of renewable generation potentially available to the Region's residents and how they might harness it to meet statewide generation targets for the community.

The following table displays a summary of renewable generation capacity in the Region organized by municipality as of May 2018. The data below comes from several sources and should be considered an estimate as new renewable generation sites may emerge, and existing sites may expand or close in the Region. Additionally, Map 2 shows the location of net metered generation sites in the Region. Sites generating greater than 15 kW have their capacities listed on the map. For other maps showing the location of the existing renewable generation facilities in the Region, please visit the Vermont Energy Dashboard's website (listed above).

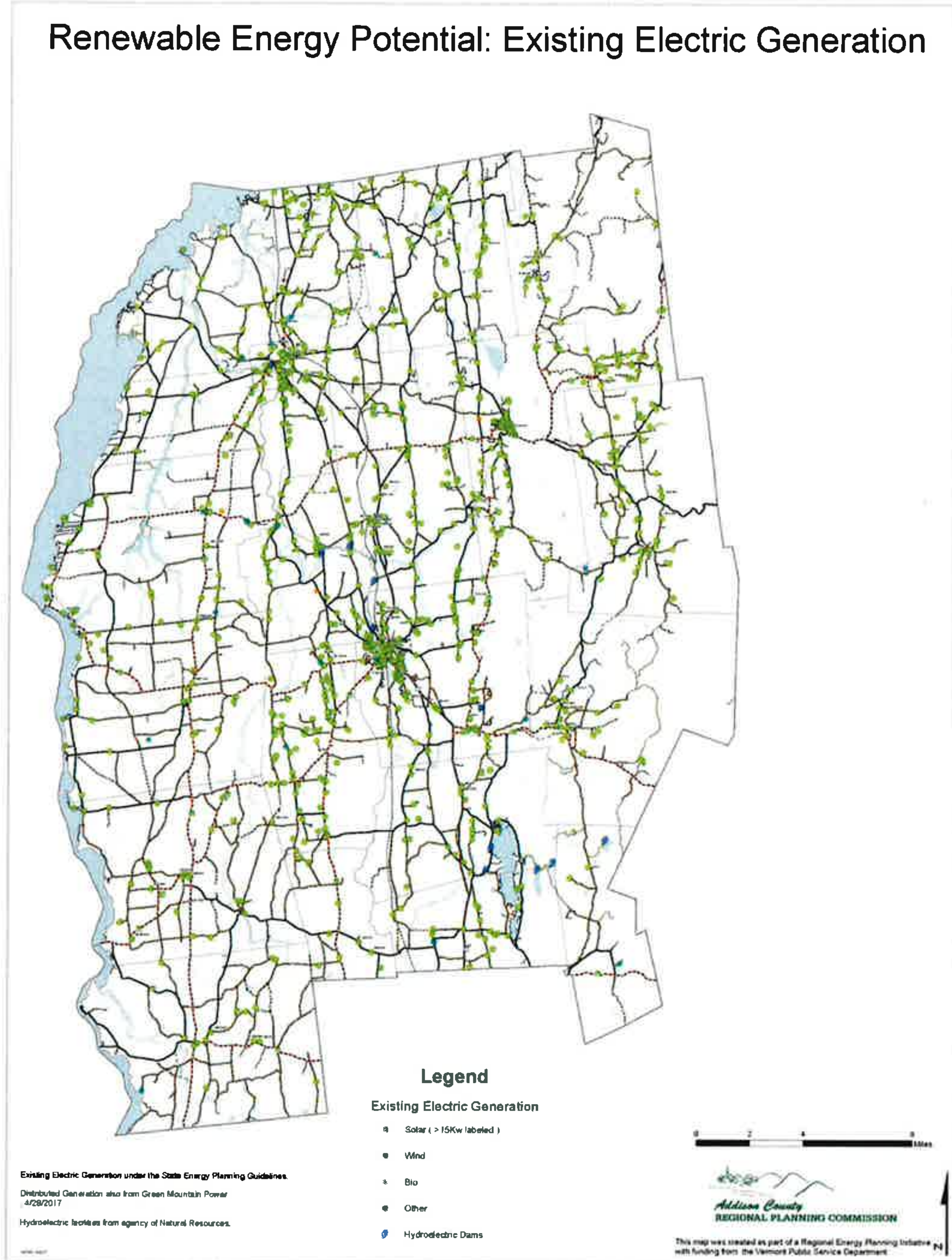
[18] Existing renewable generation data came from the Community Energy Dashboard (2017), Green Mountain Power (2018), Middlebury College (2018), and The Low Impact Hydropower Institute (2018).

Table 14: Total Existing Regional Renewable Generation Capacity by Municipality[19]

Municipality	Solar Sites	Solar Generation Capacity (MW)	Wind Sites	Wind Generation Capacity (MW)	Hydro Sites	Hydro Generation Capacity (MW)	Biomass Sites	Biomass Generation Capacity (MW)[20]
Addison	62	1.17	3	.028	0	0	1	.45
Bridport	45	2.5	2	.103	0	0	1	.68
Bristol	114	1.11	0	0	0	0	2	.45
Cornwall	89	.666	4	.033	0	0	0	0
Ferrisburgh	140	4.79	4	.044	0	0	0	0
Goshen	4	.024	1	.0014	0	0	0	0
Leicester	30	.328	1	.0138	1	2.2	0	0
Lincoln	93	.725	2	.01	0	0	0	0
Middlebury	235	5.71	1	.0095	1	2.25	1	.65
Monkton	102	1.0	0	0	0	0	0	0
New Haven	115	7.97	3	.015	1	5.85	0	0
Orwell	23	.826	1	.0095	0	0	0	0
Panton	30	6.05	0	0	0	0	0	0
Ripton	42	.216	1	.0095	0	0	0	0
Salisbury	31	.506	0	0	1	1.3	0	0
Shoreham	53	1.34	0	0	0	0	0	0
Starksboro	77	.628	1	.0025	0	0	0	0
Vergennes	71	1.63	2	.115	1	2.6	0	0
Waltham	39	.662	1	.0025	0	0	0	0
Weybridge	47	.243	2	.004	2	9.725	1	.15
Whiting	14	.699	0	0	0	0	0	0

[19] Existing renewable generation data came from the Community Energy Dashboard (2017), Green Mountain Power (2018), Middlebury College (2018) and The Low Impact Hydropower Institute (2018).

[20] This data only includes biomass used for electric generation or combined heat and power, for commercial or industrial use. It does not include biomass used solely for heat or electricity in individual homes or businesses.



Map 2. Renewable Energy Potential: Existing Electric Generation

Map 2

Solar Energy

Globally, the sun supplies energy to Earth at some 10,000 times the rate at which humankind currently uses energy. However, this energy is not distributed equally, geographically or temporally; the Region's location and climate mean our share of solar energy is less than the continental U.S. average, and considerably lower in the winter than in summer. However, the average monthly solar energy available to a fixed solar array tilted optimally for its latitude in the Region is still over 70% of that for its equivalent in Albuquerque, New Mexico—an excellent place for solar energy-- according to NASA data available at https://eosweb.larc.nasa.gov.

The Region's total electrical energy consumption currently stands at approximately 266,553,670 kWh (267 GWh) per year, according to Efficiency Vermont estimates (Table 8, page 29) If we already generate close to 90 GWh of that with renewable hydro (p.45), that leaves 177 GWh. This means that the Region could meet that entire remaining current energy demand with solar photovoltaic generation, using cumulative generation and usage averaged over the year, with about 136 MW of PV occupying around 1650 acres of the Region's 516,895 acres, or about one third of 1% of our land. (This rough calculation uses conservative empirical figures from our Region of about 1.3 GWh of annual production for a nominal 1 MW of photovoltaics, which occupy about 12 acres/MW. This is for fixed arrays using current technology.) Since this plan predicts total electrical consumption within the Region will remain relatively flat, on balance, it's clear that the solar resource alone is more than adequate for our entire current and future energy needs. That is if we were willing to devote a sufficient amount of land to it; according to Map 6 (p.63) the region has 12,459 acres of primary solar siting area, and an additional 118,405 acres of secondary solar siting area. However, the intermittent and seasonally variable nature of solar PV generation means that without significant advances in the technology and economics of energy storage, it could not be relied on as baseload generation. The diminished production of PV in winter months, coupled with peak heating demands (transitioning to electric heat pumps) makes this problem particularly acute.

Photovoltaics represent only one of several useful ways to harvest solar energy. The simplest use of sunlight is passive use for lighting and heating. Many of Vermont's one-room schoolhouses provide historic examples of how buildings can be oriented, and windows can be used to take advantage of passive solar energy for lighting and heating. Properly insulated buildings oriented so that their long axis is within 30 degrees of true south with unobstructed south facing windows can offset their space heating costs by 15 to 50 percent.[21] Taking this one step further floors and walls can be built of materials that will capture and store warmth from the sun. In many cases, passive solar buildings can be constructed at little or no extra cost, providing free heat and light – and substantial energy cost savings – for the life of the building. Solar water heating is another cost-effective solar application for buildings in the Region. Water heating is one of the largest energy costs for the Region's households. A

[21] Information from the *1997 Vermont Comprehensive Energy Plan*, prepared by the Vermont Department of Public Service.

water heating system that utilizes solar energy can reduce energy costs by up to 65 percent. A solar water heater cannot generally supply all the hot water needed year-round because of the climate and weather, so a back-up system is required.

New developments in photovoltaic cell (PV) technology, which converts solar energy into electricity, have led to PVs that are smaller, less expensive and more consumer-friendly – trends that should continue into the future. Although these technologies exist to convert solar energy into heat and electricity, at this point in time, it is impractical to supply all of the Region's energy with in-Region solar installations, for reasons cited above. However, use of solar energy for electricity and/or heat in individual homes and for charging electric vehicles is technologically feasible and ranges from solidly economical to marginally so.

Solar energy facilities ranging from 150 kW to 5 MW have been constructed within the Region with varying visual and other impacts. From that process the Region has learned how project siting standards and mitigation can work to integrate large solar developments with the Region's rural aesthetic character. The Section entitled, "Regional Standards for Siting Energy Generation and Transmission Projects" contains the standards the Region will apply when testifying regarding generation and/or transmission, and sub-station projects proposed for the Region.

A 2010 regional study to site solar facilities in municipalities in the Region can be found at the Addison County Regional Planning Commission's office (14 Seminary Street in Middlebury, Vermont). This study evaluates the potential for new photovoltaic electricity generation in Ferrisburgh and Middlebury, and provides recommendations for future research. The regional solar study can also be accessed online here:
http://acrpc.org/files/2012/04/COUNTY_FINAL_small.pdf

Biomass

1. Biomass Resources

Biomass consists of renewable organic materials, including forestry and agricultural crops and residues, scrap wood and food processing wastes, and municipal solid waste. All these products or waste products can be used as energy sources. The benefits of these resources are that they are local, affordable, sustainable and often waste materials. Some biomass materials, such as cordwood, have been traditionally burned to provide heat. However, these materials can also be used in other ways, such as producing gas that can then be burned to generate heat or power. The considerable energy savings and reduced electrical consumption from the grid modeled in this Plan clearly rest on commercial/industrial use of wood chip biomass energy.

The Agency of Agriculture, Food and Markets (AAFM) works in conjunction with the USDA Animal and Plant Health Inspection Service (APHIS) to protect Vermont from invasive insects that can harm Vermont forests and trees. This Plan understands the threat of invasive pests and supports the practices and strategies presented by the AAFM for managing biomass resources in a way that inhibits the spread of pests in daily operations.

Generally, AAFM believes that all biomass and cogeneration facilities should use technologies and procedures designed to limit the possibility of invasive species movement into un-impacted areas. Examples of this include screening of storage and processing areas, limitations on the length of time unprocessed material can remain on-site before use, chipping logs at the harvest site rather than at the facility, careful selection of harvest areas and species used, timing of harvests to target periods when pests are less likely to be mobile heat treatment, and other safeguarding practices. Any of these or other procedures should be employed as appropriate to help limit the introduction and spread of regulated (and unregulated but nonetheless potentially devastating) plant or insect pests.

2. Wood

Wood has historically been an important energy source in the Region. When colonial settlers arrived in the region, it was forested. Trees were felled to clear farmland and the byproducts of that clearing, including timber and potash, were a primary component of the region's early economy. The Region's residents used wood as their primary heat source into the 20^{th} century. As fossil fuels became available, one of the Region's primary energy sources, local wood, was largely replaced by imported oil.

During the oil embargo of the early 1970s, many of the region's residents returned to using wood as a renewable and cost-effective fuel. Most of this use was initially in the form of split or chunk wood for use in traditional woodstoves. However, once oil prices declined and residents were faced with the inconvenience of putting up wood several seasons in advance, many returned to the ease of oil heat. Several new residential wood heating alternatives have begun to be used in the Region over the past decade. In rural areas of the Region, outdoor wood furnaces have seen a rise in use allowing for much of the mess associated with indoor wood stoves to be left outside. Wood pellet burning stoves and furnaces have offered consumers another option. These stoves and furnaces use a processed wood pellet for fuel that can be automatically fed into the burner and delivered in bulk.

In addition to use for residential heating, wood is being used in Vermont to generate energy on a large scale. There are two wood chip fired electrical generation facilities located in Burlington and Ryegate. The McNeil Generating Station located in Burlington has a nominal capacity of 50 MW and has operated since 1984.

Between residential use and industrial-scale generating plants, there are a number of applications for wood as an energy source. Small-scale commercial electrical generation with wood fuel is possible and is most common at forest products manufacturing plants where waste material can be converted to energy. Over half of Vermont's mill waste is currently used as an energy source

Over 20 Vermont schools operate boilers fired by wood chips. This technology has the potential to co-generate electricity in addition to providing heat. The technology used in a number of these schools was developed by a local business, Chiptec. In the Region, Middlebury College has displaced one million gallons of oil per year—half the oil consumption of its heating plant—with local biomass in the form of wood chips.

The Region and Middlebury College foresters agree that each acre of the Region's forest might sustainably yield about one-third of a cord of firewood each year. The Region overall contains about 230,000 forested acres, equal to roughly 45% percent of the Region's overall land area of 516,895 acres. This rough calculation suggests that the Region's forest land might supply up to 76,000 cords per year — enough to serve as a heating source for nearly all of the Region's 14,336 households. If each house were assumed to burn 5 cords per year, that would amount to approximately 71,680 cords of wood. While the complete use of this resource is unlikely, it does illustrate the potential of using sustainably harvested wood to heat structures in the region.

In 2009 ACRPC, the Town of Bridport and the Bio Energy Resource Center (BERC) investigated whether the Region had sufficient biomass from both its farms and forests to support a local pellet mill facility. The result extensively studies sustainable yields of both wood and agricultural sources of fiber and concluded that the Region's forests, could not solely support a mill, but could if combined with other parts of the State. A link to that study is attached here.
http://acrpc.org/files/2012/04/BERC_Pellet-Mill_Report_2009.pdf.

The region's forest and farming resources are a renewable energy source that could be used sustainably for generations if properly managed. However, a number of issues associated with burning large quantities of wood have surfaced over the years, including increased air pollution levels and concerns about over harvesting of available wood sources. Biomass should be considered in the context of public health impacts in addition to whether supplies are sustainable and effective to meet short and long term demands for renewable heat source energy.

In general, wood products do not burn as cleanly as petroleum products and produce even more air pollutants when fires are contained within airtight stoves. However, newer wood stoves are required to burn more cleanly and many are now equipped with catalytic converters or other pollution control devices to remove pollution from wood smoke. New woodstoves for residential use are more energy efficient, produce less air pollution and are safer than older models. One theoretical benefit of burning wood is that there is little net production of carbon dioxide (CO2), a major greenhouse gas, because the CO2 generated during combustion of wood equals the CO2 consumed during the lifecycle of the tree. This logic necessarily requires that the resource is harvested sustainably, so that the baseline of conversion of CO2 to O2 through photosynthesis in the forest is maintained.

Concerns about over harvesting of forests have arisen in recent years in connection with large consumers of wood chips, such as wood fired electric generation plants. The economics of chip harvesting preclude the ability to effectively harvest in a selective manner and some public resistance has surfaced over even aged forest management techniques. Because of this resistance, the large-scale users of wood chips have taken an active approach to managing forests and have hired full-time foresters to ensure the harvesting is done in a sustainable manner for years to come with the least aesthetic impact possible.

Wood continues to be underutilized in the region as an energy source with far more biomass production grown in a single year than is harvested. The ability to market the former waste products from sawlog production allows wood to be grown much more as a crop, similar to grain, than ever before.

3. Bio-diesel

Biodiesel is an emerging technology for creating energy from biomass. Biodiesel is a fuel that can be manufactured from vegetable oils, animal fats, or recycled restaurant greases. The fats and oils are chemically reacted with an alcohol, such as methanol, to produce chemical compounds known as fatty acid methyl esters. Biodiesel is the name given to these esters when they are intended for use as fuel. Glycerol is produced as a byproduct. Biodiesel contains no petroleum, but it can be blended with petroleum products to create a biodiesel blend, which can be used to fuel unmodified diesel engines and to replace fuel oil for heating systems. If they become economically viable at scale, Biodiesel technologies could provide an opportunity for the Region's farmers to create new demand for locally grown crops. Since most farm equipment runs off diesel engines, biodiesel could also provide an alternative fuel supply for farm vehicles.

4. Biogas Power Generation

As discussed above, cow manure is another source of biomass in the Region. Other potential biomass resources in the region include food waste, cheese whey, slaughterhouse waste and brewery residuals.

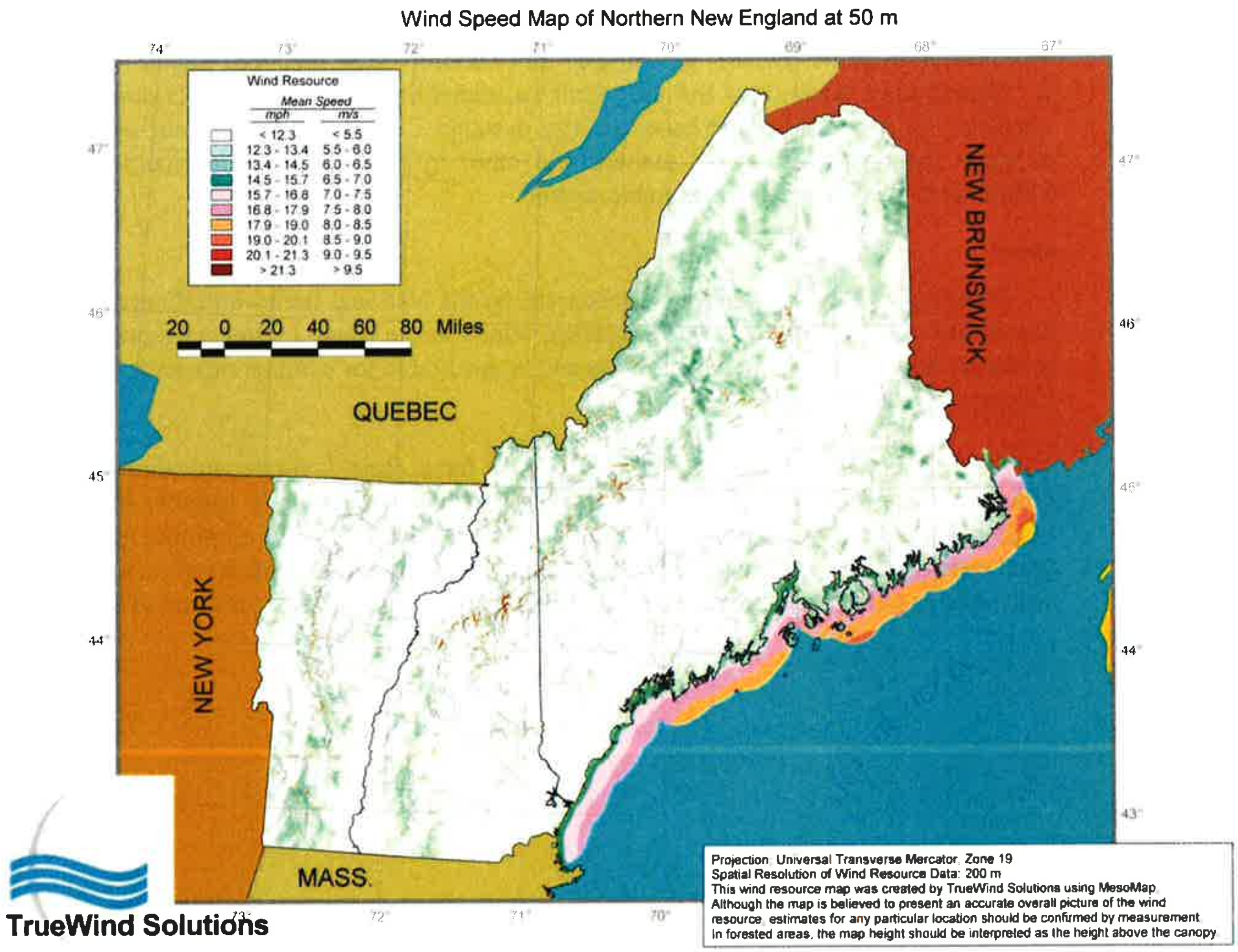
During the energy crisis of the late 1970s, the Foster Brothers Farm in Middlebury started producing electricity from cow manure. This electricity was used to provide power for the farm and the excess could be sold back into the power grid. To produce the electricity, an anaerobic digester uses bacteria to break down the manure into methane gas. The methane gas is used as a source of fuel for an internal combustion engine connected to an electrical generator. Methane produced from other sources, such as landfills or composting of food waste, could also be used to produce power in the same manner. As of this Plan, a number of the larger farms in the Region have invested in biodigesters to produce energy from methane generated by manure and food waste. Most then convert the gas to electricity to power the farm. They also use the heat generated in the digestion process and use the composted manure as bedding, producing a number of useful byproducts. One farm has recently invested with Middlebury College and Vermont Gas in using methane for heating. In 2012 ACRPC worked with Integrated Energy Systems to produce a study looking at the vehicle market for a biogas project proposed to serve Middlebury College and the potential of also using a portion of the gas created for fuel for large commercial vehicle fleets. The bio-gas project to heat the college is moving forward, but without the vehicle fleet fueling station. A link to that study of biogas and its potential is here:
http://acrpc.org/files/2012/04/COUNTY_FINAL_small.pdf

Some have expressed concern that we would be better off reducing food waste by using food before it spoils, through gleaning or other conservation practices, rather than recycling it. Others have questioned the long-term sustainability of the large-scale dairy operations necessary to support manure-based energy systems. However, in the near term, this plan supports the continued use of manure and other by-products of its agricultural and food industries to produce clean, renewable power.

Wind

Mapping of New England wind resources by the National Renewable Energy Laboratory shows that most of the Region has average winds in the Class 1 category (speeds below 12 miles per hour). This is the lowest class and is unsuitable for commercial-scale wind power (See map 3 below).

A small portion of the Region—appears to have class 3 winds and above (around 12 miles/hour at 100 meters above the ground), considered marginally suitable for large-scale wind installations. However, the entire Region is likely capable of producing significant wind energy at the smaller scales of individual or multiple-home wind turbines. Experience with wind installations in the Region and surrounding communities confirms this.



Map 3. Wind Speed Map of Northern New England at 50m[22]

Map 3

Wind power can be harnessed for both large and small-scale power generation. In recent years, several studies have shown that Vermont's wind resource is abundant enough to meet a significant portion of the state's electric energy needs. Ridgelines provide the best location for wind generation facilities, with elevations between 2,000 and 3,500 feet above sea level being ideal for maximum power production. In the Region, locations primarily in the towns of Starksboro, Lincoln and Ripton, were identified as having a Wind Power Class of 3 or greater, making large-scale generation feasible. However, much of the land in this area lies in the Green Mountain National Forest, and a significant portion of that has been designated as

[22] TrueWind Solutions, "Wind Energy Resource Maps of New England," available through Massachusetts Technology Collaborative at:
http://www.mass.gov/anf/docs/itd/services/massgis/wind-finalreport-northernnewengland.pdf

Wilderness area. This Plan opposes any commercial development within the "Known Constrained" areas located on Map 4, including the wilderness area discussed above.

Beyond prohibiting wind in areas mapped with "Known Constraints" (See Map 4) and supporting the current State policy that any commercial renewable developer pay for the total cost of their projects, including the transmission infrastructure improvements required to the grid to accommodate or serve their project, this Plan does not set any further restrictions with regard to commercial or industrial scale wind generation. Instead, it will incorporate and support the wind policies of its member municipalities as contained within their plans.

Small wind turbines, designed for individual residential or business use, usually generate under 15 kW. They have two or three blades usually with a diameter of eight to 24 feet. They are often mounted on a guyed monopole or a freestanding lattice tower ranging in height from about 80 to 120 feet. Turbines need to be 40 to 60 feet above nearby trees or other obstructions for optimum efficiency. Small to mid-sized turbines operate at lower wind speeds and can be more flexibly located. This Plan supports small residential scale wind development, provided the applicant provides sufficient setbacks to property lines and sites the facilities pursuant to the guidelines contained in the PSD's handbook for residential wind siting, "Siting a Wind Turbine on Your Property".

Geothermal Energy

Energy trickles from Earth's interior to the surface at a modest average rate of about 350 watts per acre, far less than the solar input. For the Region, far from major geological activity, that number is almost certainly significantly lower. In addition, solar energy warms the Earth, especially in the summer, and some of that energy is stored as heat in the upper layers of soil and rock. Year-round, soil temperatures just a few yards deep in Vermont average around 45°F to 50°F year-round. Unlike the case in seismically active areas like Iceland or even Yellowstone in Wyoming, this temperature is too low for direct (conductive) heating. It can however, help with summer cooling, and there are simple designs to affect that, with, for instance, fan-driven air circulation through buried outside duct pipes, or attic and whole house fans pulling cooler air up from basement spaces.

Latent Heat--The Special Case of Heat Pumps

Air to Air cold climate heat pumps are becoming quite popular in the Region, and for good reason. They are actually able to make more energy available for heating and cooling than they consume; they perform this quasi-magical feat in the same way that an ordinary refrigerator does, by using an energy source called the latent heat of vaporization and the latent heat of condensation of a chemical refrigerant. In reality, they do not create or harvest heat so much as move it from one space to another. A refrigerator removes heat from its inside to its outside using an evaporator on the inside converting the refrigerant to a gas, and a condenser on its outside turning the refrigerant from a gas back to a liquid. The evaporation phase absorbs heat from its surroundings and the condensation phase releases heat to its surroundings. In the case of a cold climate heat pump in heating mode, the condenser is inside and the evaporator is outside, so heat is removed from the air outside and delivered to the air inside. It can also perform as an extremely efficient air conditioner, evaporating refrigerant in the interior and condensing it on the outside. Cold climate heat pumps generally available for residential use tend to be economic down to around 12-15 degrees below 0° F using common refrigerants, so a secondary heating system is required for very cold periods. That may be a fossil fuel fired system, wood heat, or electric resistance heat, though widespread use of the latter can cause winter peak generation issues for electric utilities. Special air to air heat pumps using CO_2 as a refrigerant are useable down to around -30°F, but are not effective in reverse mode as air conditioners.

Distinct from air to air heat pumps, so called geothermal heat pumps can be more accurately referred to as ground source heat pumps. Rather than moving heat to or from outside air, they exchange heat with the ground or groundwater. There exist a wide variety of design types, including direct-coupled, closed loop and open loop. Open loop systems, which generally use an "open loop" of pumped groundwater to exchange heat with the refrigerant loop are most popular in the Northeast because of the relatively high availability of groundwater. The economics of this kind of system are best with relatively shallow and high flow drilled wells; they often can utilize a building's potable water well meeting those conditions. The initial cost of these types of system is higher than other HVAC systems, and they are best suited to new construction. On the other hand, they are typically more efficient than even air to air systems because the temperature differential between the inside and the ground or groundwater, is significantly less than the differential for air to air systems, and the payback is generally well under a decade. To date, few property owners in the Region have installed ground source heat pump systems, but their number can be expected to grow.

Hydropower

The Region possesses some relatively significant hydro resources. Hydropower has been used as an energy resource in the Region since colonial settlers built the first mills along the region's streams. Throughout the 1800s most of the region's industrial activity was focused around locations with access to hydropower, such as the Marble Works in Middlebury. Some of those same locations are still being used to generate power today.

There are seven hydropower generation facilities operating in the Region, five of which are located on Otter Creek. One other facility is powered by Sucker Brook from the Sugar Hill Reservoir in Leicester and the Goshen Dam in the town of Goshen. In Salisbury, there is a facility that generates hydropower from the Leicester River. All of these facilities are owned by Green Mountain Power (GMP).

There are two basic types of hydroelectric facilities: run-of-the-river and ponding facilities. Run-of-the-river plants hinder the flow of water only minimally, with the volume entering the powerhouse equaling the amount leaving the plant immediately. Ponding systems store water behind a dam to be released through the turbines on demand. Most of the hydropower plants in the region are run-of-the-river facilities. However, the Sugar Hill generator in Goshen can store water in a reservoir and release it on demand.

The size of these facilities ranges from the Sucker Brook facility (or Silver Lake Project), which produces less than 7,000 MWh annually to Huntington Falls, which generates more than 22,000 MWh. Altogether the region's hydro plants currently produce close to 85,000 megawatt hours of electricity annually. That figure represents approximately 33 percent of the electricity consumed in the Region annually.

The environmental impacts associated with hydropower, the Region's main source of electricity generation, can be significant. The physical character of a power-producing stream is usually markedly changed upstream, downstream and at the dam location. Water chemistry and biology are also altered. Even run-of-river plants can still cause impacts on the riverine system. At a minimum there is often a dam limiting the mobility of fish and blocking passage to spawning areas. The level of water in the reservoirs used in ponding systems can fluctuate greatly, causing shoreline erosion and degrading plant communities and animal habitat. However, properly scaled and managed hydro systems can significantly reduce impacts and present fewer negative environmental impacts relative to other energy sources. Partly because of the questions of environmental impact, the development of hydropower facilities, even smaller projects, can be impeded by an extremely difficult and expensive permitting process, especially at the federal level.

Energy Storage

As the Region permits commercial or industrial scale generation in its jurisdiction, the Region should also advocate to include an associated storage facility to supplement the power generated to improve its short-term resiliency and replace expensive peak power purchases. Battery storage, while expensive, is decreasing in price, both at the industrial and the consumer level, and can provide similar benefits at both. There is a brief description of storage at the commercial level in the subsection on Electrical Infrastructure on page 25. At the homeowner level viable offerings such as the Tesla Powerwall have made an appearance. In fact, GMP offers a Powerwall and software to homeowners for a reasonable one-time purchase or a $15/month payment plan with an agreement to let GMP draw power from the unit, aggregated with others, during peak demand periods. In the event of an outage, the homeowner has backup power capable of several hours of typical use.

Emerging Technology

As new technologies, such as hydrogen fuel cells, become viable, ACRPC will be open to learning about and distributing information on the wise use of those resources for sustainable economic development.

Renewable Generation Resource Mapping

As part of its efforts to discover energy generation potential within the Region, ACRPC created a series of maps depicting generation resources and also potential constraints. These maps show data as required by the Department of Public Service Determination Standards and are a required element of enhanced energy planning. The maps show areas that are potentially appropriate or inappropriate locations for future renewable generation facilities. The maps are a planning tool only and may not precisely indicate locations where siting a facility is acceptable. When proposing a generation facility, applicants must verify the presence or absence of the natural resources and other specific characteristics of the site as a part of the application.

Map 1 depicts the current transmission and distribution resources and constraints within the Region (page 27). Construction of new transmission facilities to support renewable energy generation can be a substantial driver for the total cost of the power the facility will generate. Knowing what infrastructure is available, and where, is an important planning component for renewable power development. Map 3 on page 54, depicts the places with the best potential wind speed for development in New England.

The map displaying "Known Constraints" (Map 4) within this plan on page 60 depicts natural resource layers that preclude renewable energy development. These "Known Constraints" depict places where, because of the natural resources located in the area, it would be prohibitive to secure a permit for energy development. A full description of each type of known constraint included on Map 4 is located in Table 15.

Map 5, entitled "Possible Constraints" depicts places where natural resources exist, but may not prohibit development. A full description of each type of possible constraint included on Map 5 is located in Table 16. Forest blocks are an example of a possible constraint (page 62). A lot of forest resources exist within the Region. However, they may or may not prevent wind or solar development.

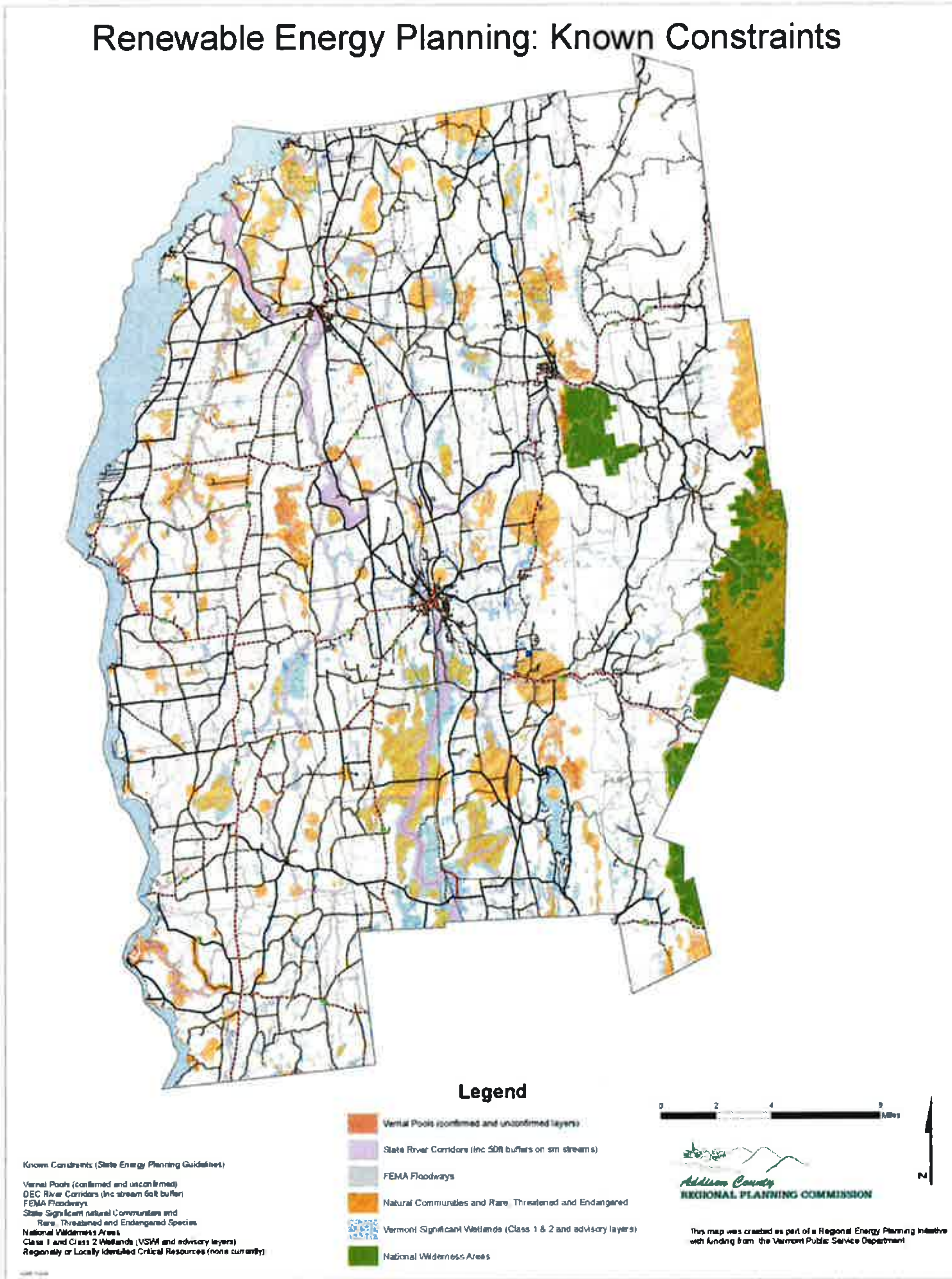
The remaining maps show the location of where solar resources exist, and where wind resources and biomass resources exist in quantities that would support generation. These maps are depicted below as Map 6, Solar Resources, Map 7 Biomass Resources and Map 8, Wind Resources (pages 63-65). These maps depict where resources exist and where no known natural resource constraints exist. They also depict baseline resources, not necessarily the "best" resources in the area. For example, the Wind Resource Map depicts where the wind blows at the minimum velocity necessary to support wind power and where no known natural resource constraints exist. As noted in the wind discussion above, while many places may meet the minimum criteria for wind development, the best area in the Region is probably the spine of the Green Mountains, which appears to have class 3 winds (around 12 miles/hour at 100 meters above the ground) and is considered to be marginally suitable for larger-scale wind installations. Accordingly, users are cautioned to read the maps in this context.

The maps contained in this plan are also available in a searchable format at ACRPC's website . The "scalability" of the digital version of the maps makes them a much more valuable tool for those desiring to understand resources or constraints within a small area of the Region.
(http://54.172.27.91/public/energysiting/regional_maps_sm/)

Mapping Constraints

Table 15: Mapping Known Constraints

Solar, Wind and Biomass Maps - Known Constraints		
Constraint	**Description**	**Source**
Confirmed and unconfirmed vernal pools	There is a 600-foot buffer around confirmed or unconfirmed vernal pools.	ANR
State Significant Natural Communities and Rare, Threatened, and Endangered Species	Rankings S1 through S3 were used as constraints. These include all of the rare and uncommon rankings within the file. For more information on the specific rankings, explore the methodology for the shapefile.	VCGI
River corridors	Only mapped River Corridors were depicted. It does not include 50-foot buffer for streams with a drainage area less than 2 square miles.	VCGI
National wilderness areas	Parcels of Forest Service land congressionally designated as wilderness.	VCGI
FEMA Floodways	FEMA Floodways display 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.	VCGI/ ACRPC
Class 1 and Class 2 Wetlands	Vermont Significant Wetland Inventory (VSWI) identified class I or II wetlands. These wetlands provide significant functions and values that 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.	VCGI



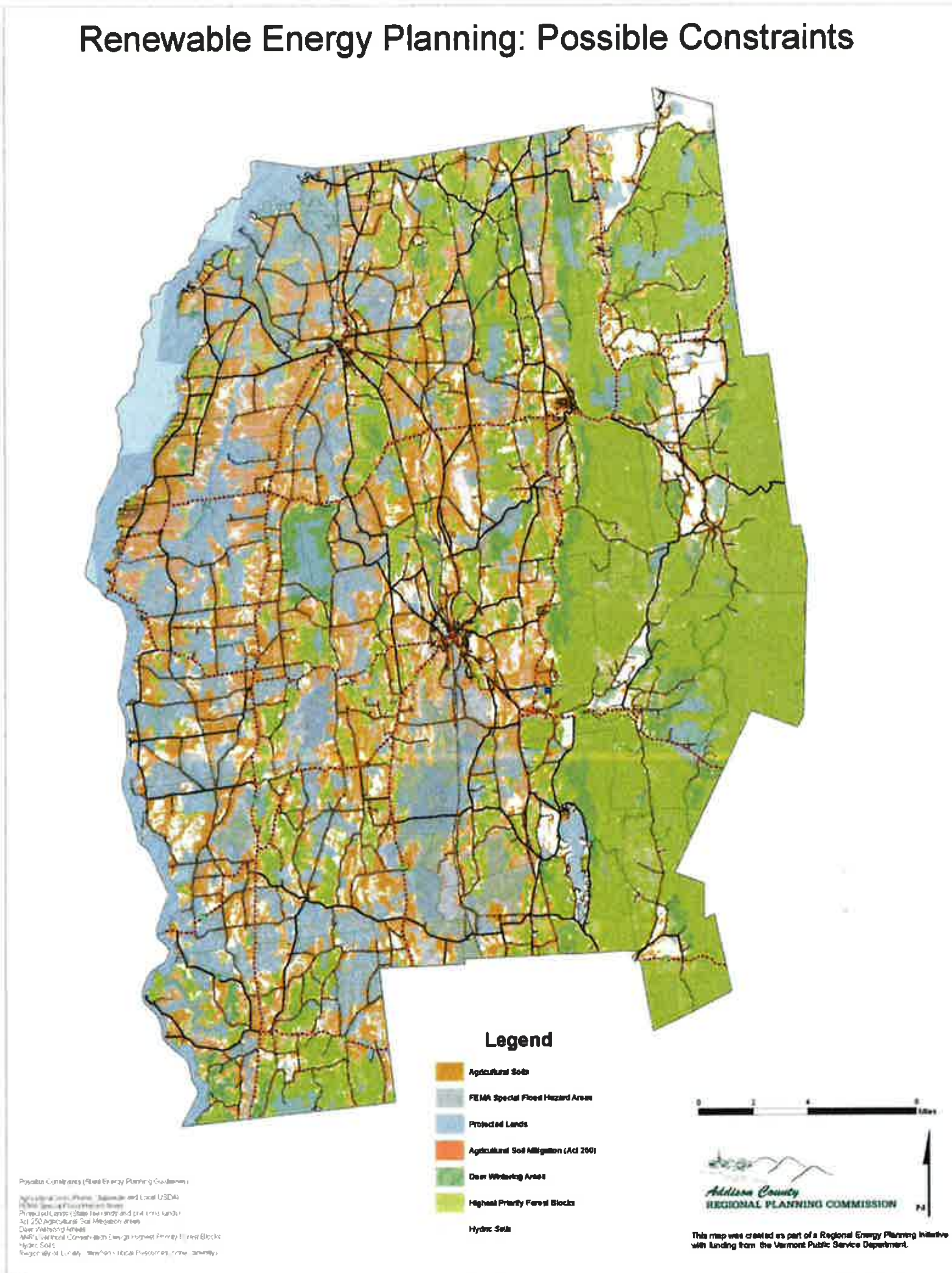
Map 4. Renewable Energy Planning: Known Constraints (2017)

<u>Map 4</u>

Table 16: Mapping Possible Constraints

Solar, Wind and Biomass Maps - Possible Constraints		
Constraint	**Description**	**Source**
Protected lands	This constraint includes public lands held by agencies with conservation or natural resource oriented missions, municipal natural resource holdings (ex. Town forests), public boating and fishing access areas, public and private educational institution holdings with natural resource uses and protections, publicly owned rights on private lands, parcels owned in fee simple by non-profit organizations dedicated to conserving land or resources, and private parcels with conservation easements held by non-profit organizations.	VCGI
Deer wintering areas	Deer wintering habitat as identified by the Vermont Agency of Natural Resources.	ANR
Hydric soils	Hydric soils as identified by the US Department of Agriculture.[23]	VCGI
Agricultural soils	Local, statewide, and prime agricultural soils are considered.	VCGI
Act 250 Agricultural Soil Mitigation Areas	Sites conserved as a condition of an Act 250 permit.	VCGI
FEMA Flood Insurance Rate Map (FIRM) special flood hazard areas	Special flood hazard areas as digitized by the ACRPC were used (just the 100-year flood plain; 500-year floodplain not mapped).	ACRPC
Vermont Conservation Design Highest Priority Forest Blocks	The lands and waters identified here 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.	ANR

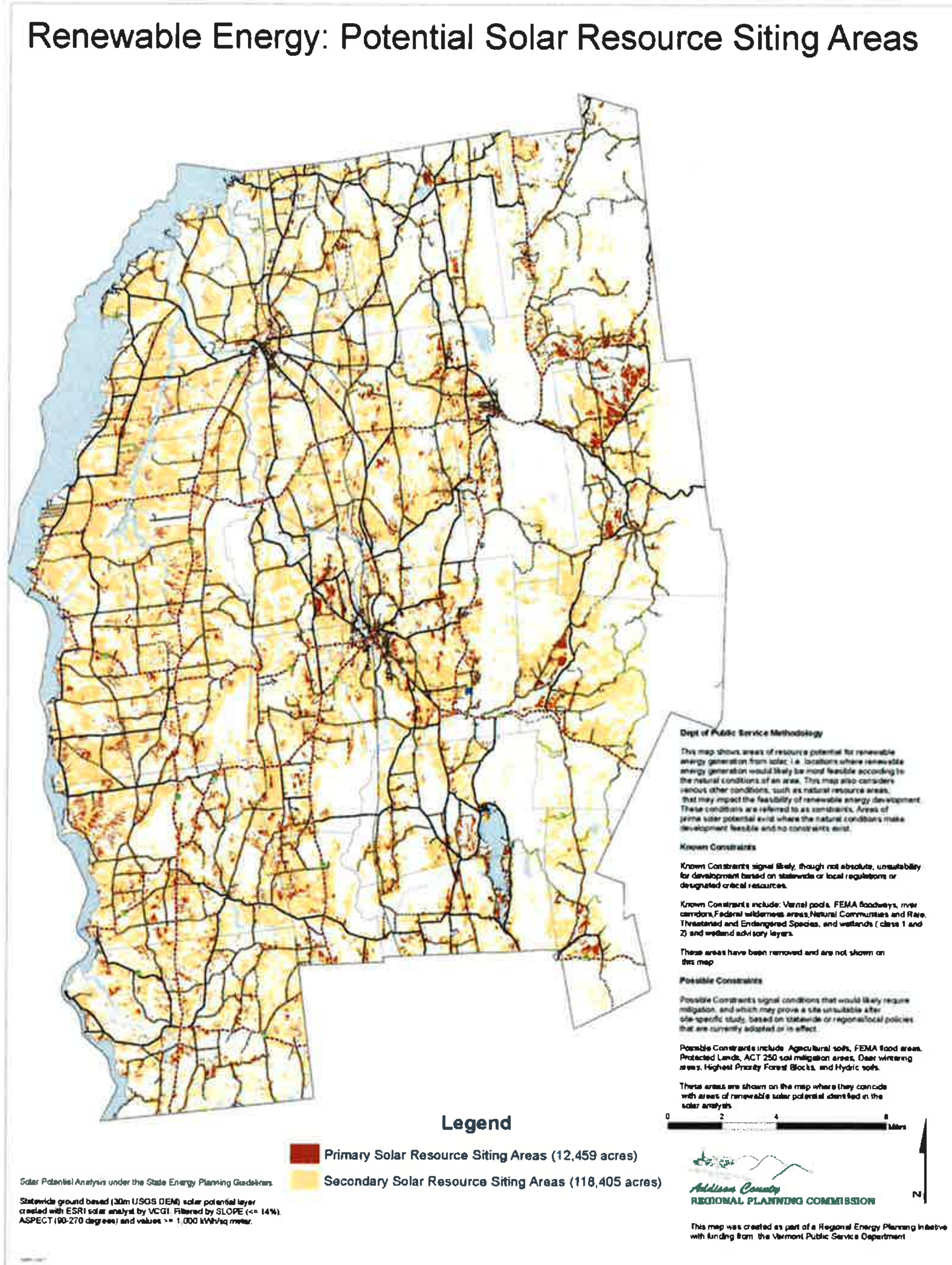
[23] The U. S. Department of Agriculture defines hydric soils as any soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part.



Map 5. Renewable Energy Planning: Possible Constraints (2017)

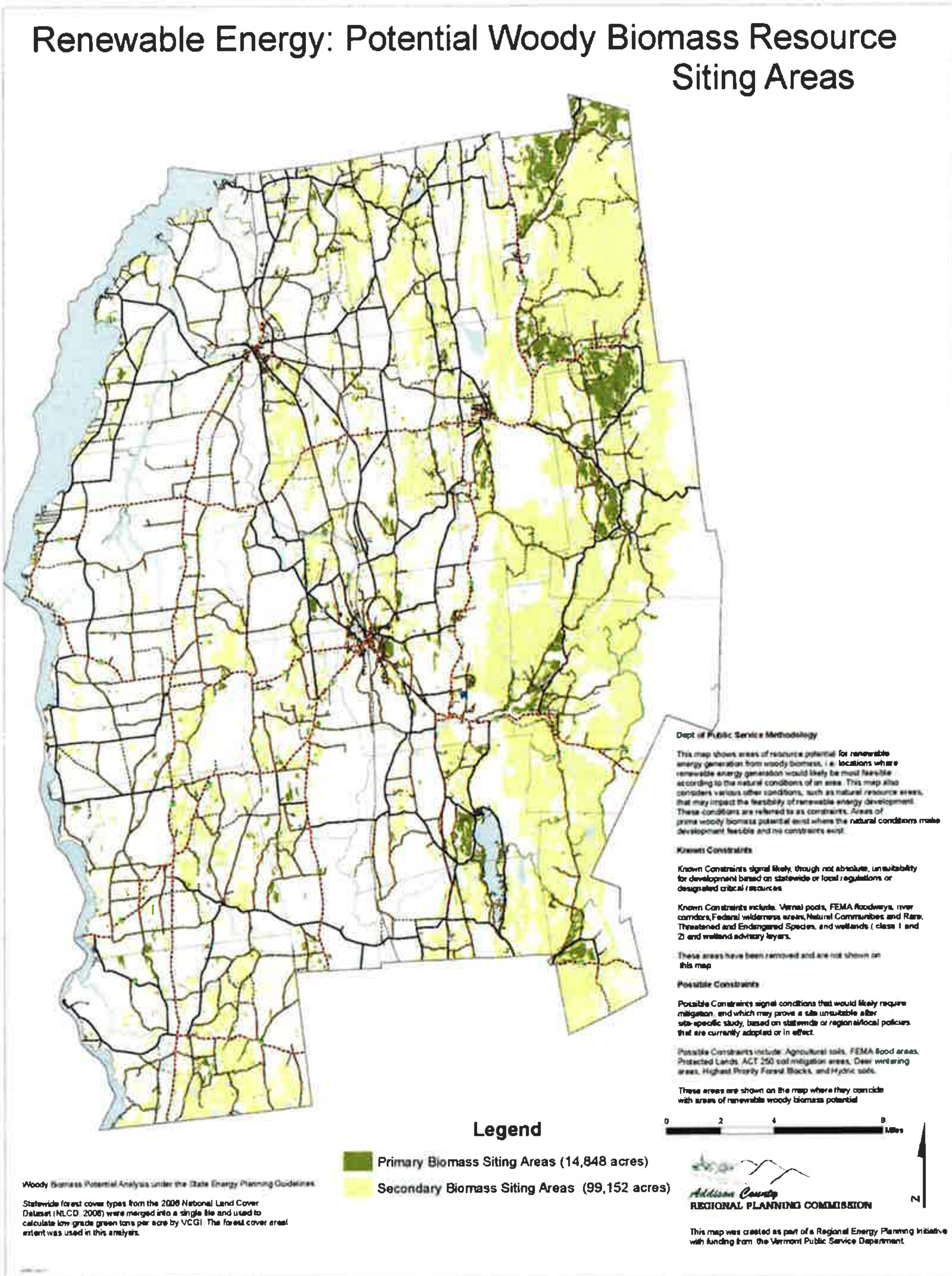
<u>**Map 5**</u>

Mapping Potential Resource Siting Areas



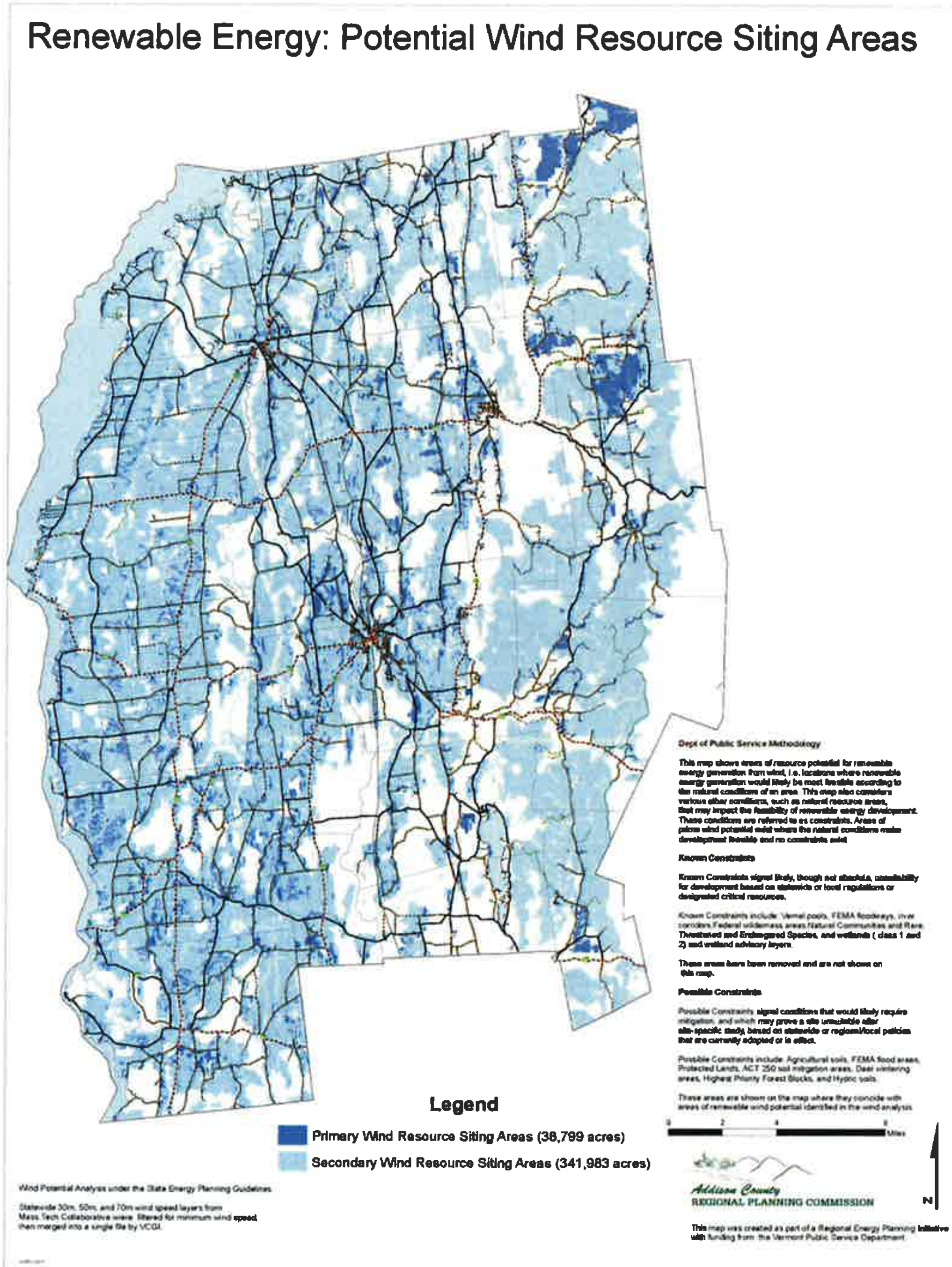
Map 6. Renewable Energy: Potential Solar Resource Siting Areas (2017)

Map 6



Map 7. Renewable Energy: Potential Woody Biomass Resource Siting Areas (2017)

<u>**Map 7**</u>



Map 8. Renewable Energy: Potential Wind Resource Siting Areas (2017)

Map 8

At the end of the mapping exercise, ACRPC calculated the amount of renewable resource generation the Region could theoretically produce based upon the maps and some assumed values for the amount of land it took to produce specified amounts of solar and wind energy. The results of this analysis are depicted in Table 17, Renewable Generation Potential. As the Table demonstrates, the amount of renewable generation potential is substantial, especially when compared to existing generation in the Region, displayed in Table 13 (page 45).

Table 17: Renewable Generation Potential[24]

Renewable Generation Sources	MW	Annual MWh
Rooftop Solar	99	121,414
Ground-mounted Solar	16,358.1	20,061,549
Wind	95,195.6	291,869,740
Hydro	3.6	12,614[25]
Other	0	0
Total Renewable Generation Potential	111,655	312,065,317

The table below identifies the total resource potential for renewable energy generation from woody biomass (acres of land), i.e., locations where renewable energy generation would likely be most feasible according to the natural conditions of an area. This resource was mapped with the consideration for various other conditions, such as natural resource areas, that may impact the feasibility of renewable energy development. These conditions are referred to as constraints.

Table 18: Woody Biomass Resource Potential

Renewable Generation Source	Total Acres
Woody Biomass	114,000.68

The following table displays a summary of renewable generation potential in the Region organized by municipality.

[24] All figures concerning Renewable Generation Potential in this Plan include areas with possible resource constraints and areas that are commercially feasible, but not necessarily ideal for development. As such, ACRPC believes Tables 17, 18 and 19 dramatically overstate the generation potential of the Region.

[25] Renewable hydro potential is based on a study conducted by Community Hydro, which evaluated generation potential at existing dam locations in the region that could be retrofitted to produce electricity. Information was also provided by the Middlebury Energy Committee.

Table 19: Renewable Generation Potential by Municipality

Municipality	Rooftop Solar (MW)	Ground-mounted Solar (MW)	Wind (MW)	Hydro (MW)[26]	Woody Biomass (acres)	Total (MW)
Addison	1	1,559.63	7,273	0	702.5	8833.63
Bridport	6	1,456	6,598.5	0	2520.3	8060.5
Bristol	10	638	3,949.5	0	1,046 .9	4597.5
Cornwall	1	848	3,649	0	2,338.9	4498
Ferrisburgh	7	1,410	7,584	0	3,072.3	9001
Goshen	0	320	3,936	0	7,408.97	4256
Leicester	1	426	1,146.5	0	3,613.3	1573.5
Lincoln	1	750	6,916.8	0	14,760.32	7667.8
Middlebury	44	1,032.6	5,559.8	1.6	5,375.51	12,243
Monkton	1	644.4	3,917.3	0	7,498.45	4562.7
New Haven	5	1,229.5	5,464.8	0	4,476.79	6699.3
Orwell	1	1,149.1	4,961.8	0	6,126.75	6111.9
Panton	0	569.4	3,160.3	0	699.85	3729.7
Ripton	0	828	7,683.3	0	14,552.96	8511.3
Salisbury	2	531.1	2,706.5	2	4,367.45	3241.6
Shoreham	1	1,313.7	5,885.2	0	35,28.07	7199.9
Starksboro	1	504	9,406.8	0	19,141.52	9911.8
Vergennes	14	79.8	542.3	0	66.8	636.1
Waltham	1	235	1,624.5	0	1,682	1860.5
Weybridge	1	431	1,877.5	0	1,207.5	2309.5
Whiting	1	402.5	1,352.75	0	398.5	1756.25

Table 17 shows that the Region has the theoretical capability of producing 312 million megawatt hours of renewable electrical power. While that number is only theoretical and is certainly more than ever could practically be built, it dwarfs the 173 Thousand megawatt hours of renewable electrical generation the Region's targets set for 2050 (See table 10) or the 2050 Regional electrical energy demand of 266 Thousand megawatt hours projected in 2050. Since the Region has the luxury of having significantly more area for generation potential than it needs to meet its renewable generation goals, ACRPC has chosen to use the following Regional land use standards to help guide the location of energy projects in areas it, and its member municipalities, deem acceptable and to prohibit them in other areas. ACRPC and its members shall apply these standards on a case by case basis as applications

[26] Renewable hydro potential is based on a study conducted by Community Hydro, which evaluated generation potential at existing dam locations in the region that could be retrofitted to produce electricity. Information was also provided by the Middlebury Energy Committee.

come before the Public Utilities Commission. Accordingly, these policies shall reduce the total area of generation potential noted above. However, neither ACRPC nor its member municipalities may apply these standards so strictly so as to eliminate their ability to meet the generation targets set for either the Region or the municipality as identified in Table 10 on page 33.

Table 20: Renewable Energy Generation Targets (MWh)

Municipality	2025	2035	2050
Addison	2,126.431	4,252.862	6,443.73
Bridport	2,761.965	5,523.929	8,369.59
Bristol	4,463.138	8,926.276	13,524.66
Cornwall	2,242.885	4,485.769	6,796.62
Ferrisburgh	3,567.98	7,135.96	10,812.06
Goshen	728.5707	1,457.141	2,207.79
Leicester	2,845.646	3,378.65	8,623.17
Lincoln	3,476.943	6,953.885	10,536.19
Middlebury	8,318.369	16,636.74	25,207.18
Monkton	2,637.941	5,275.882	7,993.76
New Haven	2,959.028	5,918.055	8,966.75
Orwell	2,727.615	5,455.23	8,265.50
Panton	1,164.227	2,328.454	3,527.96
Ripton	1,424.531	2,849.062	4,316.76
Salisbury	2,968.066	8,248.77	12,498.14
Shoreham	3,526.585	7,053.169	10,686.62
Starksboro	4,009.682	8,019.363	12,150.55
Vergennes	2,161.741	4,323.482	6,550.73
Waltham	708.5034	1,417.007	2,146.98
Weybridge	1,486.528	2,973.056	4,504.63
Whiting	945.9219	1,891.844	2,866.43
TOTAL	**57,252.30**	**114,504.59**	**173,491.8**

Regional Standards for Siting Energy Generation and Transmission Projects

The Addison County Regional Planning Commission supports responsibly sited and developed renewable energy projects within its boundaries. It desires to maintain the working landscape, adopted conservation and habitat protection measures and scenic rural views important to its tourism economy and rural cultural aesthetic. Not all industrial or community scale generation or transmission projects proposed can meet this standard. In order to not unduly impact the community values and aesthetics of the Region this Plan intends to protect, projects must meet the following Regional Standards in order to be considered "orderly development" supported by this Plan:

SOLAR

A. Siting:

Where a project is placed in the landscape constitutes the most critical element in the aesthetic siting of a project. Poor siting cannot be adequately mitigated. Accordingly, all energy generation and transmission projects proposed in the Region must evaluate and address the proposed site's aesthetic impact on the surrounding landscape.

Good sites have one or more of the following characteristics:

- Building and roof-mounted systems;
- Systems located in close proximity to existing larger scale, commercial, industrial or agricultural buildings;
- Proximity to existing hedgerows or other topographical features that naturally screen the proposed array from view from at least two sides;
- Reuse of former impacted property or brownfields that have qualified for and are listed in the State of Vermont Brownfield program.
- Sites designated as "preferred" areas by member municipalities.

Poor Sites have one or more of the following characteristics:

- No natural screening;
- Topography that causes the arrays to be visible against the skyline from common vantage points like roads or neighborhoods;
- A location in proximity to and interfering with a significant viewshed. The Addison County Regional Plan has chosen not to include any viewsheds at the Regional level. However, it recognizes that many of its member municipalities have defined locally significant viewsheds. Where that has occurred, this Plan should be read to incorporate those significant local viewsheds;
- The removal of productive agricultural land from agricultural use;
- Sites that require public investment in transmission and distribution infrastructure in order to function properly;
- Mass and Scale: The historical working landscape that defines the Region is dominated by viewsheds across open fields to wooded hillsides and eventually the Green Mountains or Lake Champlain and the Adirondacks. Rural structures like

barns fit into the landscape because their scale and mass generally do not impact large tracts of otherwise open land. Industrial scale solar arrays may need to be limited in mass and scale, and/or have their mass and scale broken by screening to fit in with the landscape in any given municipality. The Addison County Regional Plan has chosen not to include any cap on the size of solar facilities.

However, this Plan recognizes that many of its member municipalities have capped the size of solar arrays to fit within the aesthetic context of that municipality. Where that has occurred, this Plan incorporates and supports those municipal caps in size.

B. <u>Mitigation methods:</u>

In addition to properly siting a project, solar developers must take appropriate measures from the list below to reduce the impact of the project:

- Locate the structures on the site to keep them from being "skylined" above the horizon from public and private vantage points;
- Shorter panels may be more appropriate in certain spaces than taller panels to keep the project lower on the landscape;
- At a minimum, all solar arrays must observe the setback restrictions contained in Act 56 governing solar installations. However, developers are encouraged to increase setbacks to at least those listed in the Municipal Zoning Regulations within the Zoning District in which it lies;
- Use the existing topography, development or vegetation on the site to screen and/or break the mass of the array;
- In the absence of existing natural vegetation, the commercial development must be screened by native plantings beneficial to wildlife and pollinators that will grow to a sufficient height and depth to provide effective screening within a period of 5 years. Partial screening to break the mass of the site and to protect public and private views of the project may be appropriate;
- When installing pollinator plantings other than for screening purposes, the development should follow the voluntary pollinator-friendly solar standards as defined by the Solar Site Pollinator Habitat Planning & Assessment Form available on the UVM website at: https://www.uvm.edu/sites/default/files/Agriculture/Pollinator_Solar_Scorecard_FORM.pdf
- The siting of solar equipment shall minimize view blockage for surrounding properties. As an example, a landowner may not site an array on his or her property in a location calculated to diminish the visual impact of the array from his or her residence but places the array immediately within their neighbor's or the public's viewshed. Locating solar equipment in a manner designed to reduce impacts on neighbors or public viewsheds constitutes reasonable mitigation;
- Use black or earth tone materials (panels, supports fences) that blend into the landscape instead of metallic or other brighter colors).

WIND:

A. Siting:

Where a project is placed in the landscape constitutes the most critical element in the aesthetic siting of a project. Poor siting cannot be adequately mitigated. Accordingly, all energy generation and transmission projects proposed in the Region must evaluate and address the proposed site's aesthetic impact on the surrounding landscape.

Good sites have one or more of the following characteristics:

- Systems located in close proximity to existing larger scale, commercial, industrial or agricultural buildings;
- Proximity to existing transmission system to minimize the new infrastructure required to serve the project;
- Reuse of former impacted property or brownfields that have qualified for and are listed in the State of Vermont Brownfield program.
- Significant isolation distances from existing residential uses to allow the noise from the turbine to dissipate to a level of at least the State decibel standard before it reaches the property line.
- Sites designated as "preferred" areas by member municipalities.

Poor Sites have one or more of the following characteristics:

- A location in proximity to and interfering with a significant viewshed. The Addison County Regional Plan has chosen not to include any viewsheds at the Regional level. However, it recognizes that many of its member municipalities have defined locally significant viewsheds. Where that has occurred, this Plan should be read to incorporate those significant local viewsheds.
- Sites that require public investment in transmission and distribution infrastructure in order to function properly.

B. Mitigation methods:

In addition to properly siting a project, wind developers must take appropriate measures from the list below to reduce the impact of the project:

- At a minimum, all wind turbines must observe setback restrictions such that if a tower falls, the entire structure will land on property owned or controlled by the tower's owner. Developers are encouraged to increase setbacks to mitigate noise and shadowing impacts.
- Use white or other colored materials (tower, hub blades) and earth tones for ground infrastructure or fences that blend into the landscape instead of metallic or other brighter colors).

TRANSMISSION:

A. Siting:

Good sites have one or more of the following characteristics:

- Systems located in close proximity to existing larger scale, commercial, industrial or agricultural buildings;
- Proximity to existing hedgerows or other topographical features that naturally screen the proposed corridor from view from at least two sides;
- Shared or neighboring ROW with other transmission or transportation infrastructure

Poor Sites have one or more of the following characteristics:

- No natural screening;
- Topography that causes the lines to be visible against the skyline from common vantage points like roads or neighborhoods;
- A location in proximity to and interfering with a significant viewshed. The Addison County Regional Plan has chosen not to include any viewsheds at the Regional level. However, it recognizes that many of its member municipalities have defined locally significant viewsheds. Where that has occurred, this Plan should be read to incorporate those significant local viewsheds;
- The removal of productive agricultural land from agricultural use;
- Height and Scale: The historical working landscape that defines the Region is dominated by viewsheds across open fields to wooded hillsides and eventually the Green Mountains or Lake Champlain and the Adirondacks. Rural structures like barns fit into the landscape because their scale and mass generally do not impact large tracts of otherwise open land. Industrial scale transmission lines may need to be limited in height and scale, and/or have their height and scale broken by screening to fit in with the landscape in any given municipality. At the Regional level, Commercial transmission projects with tower heights greater than 72 feet are higher than the tree line and nearly all other structure within the Region. They cannot be adequately screened or mitigated to blend into the Region's landscape and are therefore must be designed to travel underground or to limit the total height of the structures to 72 feet.

B. Mitigation methods:

In addition to properly siting a project, transmission developers must take appropriate measures from the list below to reduce the impact of the project:

- Consider burying the transmission infrastructure in sensitive areas;
- Locate the structures on the site to keep them from being "skylined" above the horizon from public and private vantage points;
- Shorter towers may be more appropriate in certain spaces than taller towers to keep the project lower on the landscape;
- Developers are encouraged to increase setbacks away from public roads to reduce the views of the infrastructure;

- Use the existing topography, development or vegetation to screen and/or break the mass of the transmission facility;
- In the absence of existing natural vegetation, the commercial development must be screened by native plantings beneficial to wildlife and pollinators that will grow to a sufficient height and depth to provide effective screening within a period of 5 years. Partial screening to break the mass of the site and to protect public and private views of the project may be appropriate;
- Use black or earth tone materials that blend into the landscape instead of metallic or other brighter colors.

SUBSTATIONS

A. Siting:

Where a project is placed in the landscape constitutes the most critical element in the aesthetic siting of a project. Poor siting cannot be adequately mitigated. Accordingly, all energy generation and transmission projects proposed in the Region must evaluate and address the proposed site's aesthetic impact on the surrounding landscape.

Good sites have one or more of the following characteristics:

- Systems located in close proximity to existing larger scale, commercial, industrial or agricultural buildings;
- Proximity to existing hedgerows or other topographical features that naturally screen the proposed array from view from at least two sides;
- Reuse of former impacted property or brownfields that have qualified for and are listed in the State of Vermont Brownfield program;

Poor Sites have one or more of the following characteristics:

- No natural screening;
- Topography that causes the sub-station to be visible against the skyline from common vantage points like roads or neighborhoods;
- A location in proximity to and interfering with a significant viewshed. The Addison County Regional Plan has chosen not to include any viewsheds at the Regional level. However, it recognizes that many of its member municipalities have defined locally significant viewsheds. Where that has occurred, this Plan should be read to incorporate those significant local viewsheds;
- The removal of productive agricultural land from agricultural use;
- Mass and Scale: The historical working landscape that defines the Region is dominated by viewsheds across open fields to wooded hillsides and eventually the Green Mountains or Lake Champlain and the Adirondacks. Rural structures like barns fit into the landscape because their scale and mass generally do not impact large tracts of otherwise open land. Industrial scale substations may need to be limited in mass and scale, and/or have their mass and scale broken by screening to fit in with the landscape in any given municipality.

B. Mitigation methods:

In addition to properly siting a project, substation developers must take appropriate measures from the list below to reduce the visual of the project:

- Locate the structures on the site to keep them from being "skylined" above the horizon from public and private vantage points;
- Shorter structures may be more appropriate in certain spaces than taller structures to keep the project lower on the landscape;
- Developers shall meet setbacks equal to those listed in the Municipal Zoning Regulations within the Zoning District in which it lies;
- Use the existing topography, development or vegetation on the site to screen and/or break the mass of the substation;
- In the absence of existing natural vegetation, the substation must be screened by native plantings beneficial to wildlife and pollinators that will grow to a sufficient height and depth to provide effective screening within a period of 5 years. Partial screening to break the mass of the site and to protect public and private views of the project may be appropriate;
- Practice a "good neighbor policy". Site the sub-station so that it creates no greater burden on neighboring property owners or public infrastructure than it does on the property on which it is sited;
- Use black or earth tone materials (panels, supports fences) that blend into the landscape instead of metallic or other brighter colors).

Projects found to have poor siting characteristics pursuant to the Regional Standards contained in Section 1 above and/or other poor siting characteristics that a municipality clearly defines in their plan, including, but not limited to mass and scale, that cannot be mitigated by the mitigation methods contained in the policy, violate the municipalities' and the Region's standards regarding orderly development.

As noted previously, neither the Region nor any member municipality may apply the siting standards so strictly so as to eliminate the opportunity to meet the electrical generation targets for the Region or any given municipality.

Finally, the siting policy above identifies the attributes of "good" sites for development. Generally, these "good" sites include the description of "preferred" areas as defined by Public Utilities Commission Rule 5.100 governing net metered sites. "Preferred" sites as defined by Rule 5.100 entitle solar developers to additional financial compensation per kWh of power produced from a site meeting the definition of "preferred" sites. ACRPC's plan does not locate or define "preferred" sites for the purposes of Rule 5.100. However, since the areas it encourages for development as "good" in many cases are the same types of sites as the "preferred areas" as defined by Rule 5.100, ACRPC intends the policies will work harmoniously. This Plan also recognizes areas member municipalities designate "preferred" as appropriate sites for development.

DECOMSSIONING AND RESTORATION:

All projects shall be decommissioned at the end of their useful life pursuant to the requirements contained in Rule 5.900 of the Vermont Public Utility Commission rules. In the Region, the requirements of section 5.904 (A) shall apply to commercial scale solar installations greater than 100 kW.

Land Use, Generation and Transmission Pathways to Implementation

Goals, Policies and Recommended Actions

Given the significant changes, noted above, that the Region will need to adopt to generate and transport renewable energy and resources in order to meet statewide targets, ACRPC promotes the following Goals, Policies and Recommended Actions for itself and its citizens.

Goal A.

Plan for increased electric demand in partnership with Green Mountain Power and Efficiency Vermont.

Policies and Recommended Actions

1. Lead by example. Encourage the use of renewable energy production in town buildings, schools and residences:
    a. Investigate and support the installation of additional municipal solar and/or wind net-metering facilities that are compliant with the standards enumerated in this plan to off-set municipal electric use.

2. Support the development and siting of renewable energy resources in the Region that are in conformance with the goals, strategies, and mapping outlined in this Plan.
    a. Support responsibly sited and responsibly developed renewable energy projects, which shall include solar panels, wind turbines and all associated supporting infrastructure;
    b. Work closely with the Municipal Planning Commissions and Select boards from municipalities impacted by proposed energy development projects within the Region;
    c. Investigate and support installation of community-owned renewable energy project(s) that are compliant with the standards enumerated in this plan to allow the Region's citizens to participate in the economic benefits of local energy production;
    d. Expand regional and local energy storage and promote local microgrids to improve energy resiliency and efficiency;
    e. Support local on-farm or residential scale renewable distributed generation projects;
    f. Encourage GMP to develop distribution systems to support increased local, residential generation;
    g. Support and retain current State policy requiring developers of proposed commercial generation projects to fund all upgrades to the distribution system necessary to support their projects;

3. Favor the development of generation utilities in identified preferred locations over the development on other sites.

Goal B.

Promote Land Use planning that supports reducing energy usage and conserving resources

Policies and Recommended Actions

1. Encourage settlement patterns that reduce travel requirements for work, services, and recreation by helping member municipalities to create plans and zoning that:
    a. Encourage development of compact neighborhoods within the Region's Neighborhood Commercial, High Density Residential and Medium Density Residential Planning Areas;
    b. Support general stores and other businesses in municipal village areas;
    c. Allow infilling of existing large-lot development where higher density development is desirable and appropriate;
    d. Provide opportunities for appropriate home occupations and telecommuting;
    e. Support continued improvements in broadband connectivity and encourage telecommuting;
    f. Encourage applications to State Designated Downtown, Village Center and New Neighborhood programs to support infill growth and economic development.
2. Continue to encourage and support local food systems and farmers' markets
3. Conserve forest land as a renewable energy resource and promote the responsible and efficient use of wood for biomass energy production.
4. Conserve viable agricultural lands for potential use in local food system production, and/or potential use in raising biofuel crops.

F. Conclusion

This Plan contains a broad vision for the Region's energy usage. It envisions how the Region can transition away from fossil fuels and toward more locally produced renewable power generation. As such, the vision will need the work of many hands to implement. Significant parts of the vision extend beyond things within the control of ACRPC.

Since the amount of unconstrained land with potential for siting renewable generation assets far exceeds the amount necessary to meet the stated generation targets for the Region, the Region should be able to attain its energy generation goals while protecting important natural and scenic resources. However, since all Region's goals and strategies rely heavily on the choices of individual consumers and businesses in the Region, ACRPC will not be able to achieve the goals it sets for the Region solely through its own actions. ACRPC will collaborate and aid the efforts of other organizations to increase conservation, efficiency and renewable generation in the Region.

Other challenges include:

- Environmental constraints that prohibit the development of new generation, especially hydro generation;
- The need to balance "baseload" and "intermittent" electricity generation to ensure grid reliability and challenges related to the infrastructural capacity of the regional grid;
- Insufficient biofuel or ethanol technologies and research;
- Limits on the quantity of sustainably harvested wood the Region can produce for heating;
- The limits of regional planning commissions' jurisdiction to implement the Plan;
- Individual preferences and liberties;
- Local economic and environmental costs;
- Equity issues related to how the costs of the changes necessary to implement these goals will be shared among various stakeholders;
- Collective reliance on resources beyond the Region's and nation's control;
- Capital costs of technology and lack of individual incentives to invest in new technology and conservation.

Despite the challenges noted above, ACRPC believes it must plan for the Region's energy future. This Plan emphasizes the work and actions that all need to do to reduce our reliance on burning fossil fuels, which contribute to climate change. It also quantifies the energy security and economic opportunities generating local renewable power creates.

Recommended Actions

The Addison County Regional Planning Commission shall incorporate the following actions into its annual work plans, and, as funding permits, shall work to implement each action.

1. Maintain the Energy Section of the Addison County Regional Plan to provide education, data and mapping for those desiring to conserve or generate electricity within the Region;
2. Participate in Section 248 reviews of energy projects in the Region;
3. Work with Addison County Economic Development Corporation and member municipalities to support local energy generation as an economic development tool for the Region;
4. Work with local officials to draft municipal plans and regulations that support land use patterns promoting energy efficiency, appropriately sited and scaled renewable generation and the conservation of the Region's air quality, water quality and natural resources;
5. Work with local and state entities to plan the Region's transportation system to promote complete streets, resiliency and alternative transportation infrastructure in a context sensitive to the rural nature of the Region;
6. Work with partner organizations to promote educational opportunities with respect to the need for and opportunities available for thermal and motor-based conservation and efficiency.