

Energy

Appendix A: Plan Goals, Objectives, Actions, and Impact

Appendix A provides the complete list of recommended Goals, Objectives, and Actions to support the energy needs of the Region. It does not intend to serve as an exhaustive or exclusive list of proposals for facilitating the Region’s energy goals. However, it is indicative of the types of proposals that ACRPC supports, adoption of which the RPC would welcome. Following each of the proposed actions is a brief assessment of how their implementation may impact the three primary energy goals of this plan: the energy justice, climate change resilience, and energy security of the Region.

EJ: Environmental Justice

CCR: Climate Change Resilience

ES: Energy Security

GOAL 1: Build regional capacity for energy planning and public engagement to support the transition to renewable energy and improved energy efficiency.

Objective 1:

Educate consumers regarding efficiency and energy conservation.

- a. Regularly host a regional energy fair. **EJ:** Accessible programming for all income levels | **CCR:** Promotes low-carbon technologies | **ES:** Highlights local energy generation options

Objective 2:

Expand targeted ACRPC energy services for municipalities.

- a. Expand the regional staff position to focus on developing municipal energy projects and advising municipalities on regulations and enforcement. **EJ:** Reduces planning burden on under-resourced municipalities | **CCR:** Advances low-GHG projects | **ES:** Supports domestic energy development
- b. Work with municipalities to learn what types of energy projects are needed in each town. **EJ:** Planning capacity less dependent on local taxbase | **ES:** Planning support of domestic energy projects

GOAL 2:

Increase the Region’s thermal energy efficiency through municipal leadership and support for residential and commercial heating improvements to meet local and State targets of 90% renewable energy by 2050.

Objective 1:

Promote energy efficiency in municipal buildings.

- a. Work with towns to develop and implement MERP energy assessment recommendations, including facilitating access to grant or bond funding and group purchasing programs to reduce costs. **EJ:** Reduces municipal costs and taxpayer burden | **CCR:** Reduces GHG emissions and improves infrastructure | **ES:** Reduces imported fuel dependence
- b. Advocate for a state-wide, municipal utility tracking software to support ongoing evaluation of the costs and benefits of municipal energy efficiency and weatherization projects. **EJ:** Closes information gap between municipalities | **CCR:** Tracks progress toward emissions reductions

Objective 2:

Encourage local and sustainably harvested wood and efficient wood heating.

- a. Promote EPA III approved energy efficient wood stoves through education and outreach. **EJ:** Improves indoor/outdoor air quality | **CCR:** Reduces heating GHG emissions | **ES:** Uses domestically available fuel
- b. Promote sustainable timber harvest from regional and town forests, in accordance with Natural Resources goals, to provide local heating and electricity fuel sources, prioritizing access for low-income citizens. **EJ:** Reduces energy burden for low-income residents; improves air quality compared to older heating methods | **CCR:** Produces less GHG than fossil fuels | **ES:** Provides domestic fuel source and reduces imports

Objective 3:

Support weatherization efforts and optimize building design for energy conservation.

- a. Coordinate with CVOEO, Neighborworks, Efficiency Vermont, VEEP, and CEAC’s Energy Navigator program to encourage weatherization participation, including event support, grant assistance, project development, and education/outreach collaboration. **EJ:** Improves access to assistance programs for low-moderate income residents | **CCR:** Reduces fossil fuel demand and improves home resilience | **ES:** Reduces imported fuel dependence
- b. Promote the installation of air source and geothermal heat pumps. **EJ:** Improves air quality | **CCR:** Reduces heating GHG emissions | **ES:** Reduces imported fuel demand
- c. Support thermal energy network development and explore community-based utility models (municipal, neighborhood, cooperative) that build local capacity and resilience. **EJ:** Could reduce and stabilize low-income heating costs | **CCR:** Utilizes waste heat, reduces fossil fuel demand | **ES:** Reduces imported fuel dependence
- d. Encourage municipalities, businesses, organizations and homeowners to build to higher energy standards (RBES/CBES “Stretch energy code”) and work with willing local planning commissions to incorporate these standards into municipal plans and zoning regulations. **EJ:** Reduces energy costs and improves building safety/comfort; provides planning assistance to under-resourced municipalities | **CCR:** Reduces building sector GHG emissions; increases likelihood of GHG reduction success | **ES:** Reduces imported fuel demand; supports local energy solutions.



GOAL 3: Modernize the Region’s electrical systems and promote efficient energy use in buildings.

Objective 1:

Support energy conservation and efficient use of electricity in buildings.

- a. 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. **ES:** Reduces non-solar hour electricity demand
- b. Advocate for the availability of smart meter technology to help consumers understand and regulate their electricity usage. **EJ:** Helps consumers manage energy use and costs | **ES:** Reduces non-solar hour electricity demand

Objective 2:

Work with municipalities, electric utilities and community groups to modernize grid infrastructure and support the clean energy transition.

- a. Help the Region’s municipalities investigate and install, or purchase, cost-effective municipal solar and/or wind net-metered facilities to power municipal energy use. **EJ:** Reduces taxpayer energy burden | **CCR:** Reduces municipal GHG emissions | **ES:** Reduces imported fuel dependence
- b. Work with GMP to ensure that during the transition to distributed electric generation and increasing consumer reliance on electricity for power, that GMP improves the distribution and transmission grid and substations improves regularly to continue to provide cost effective, reliable service and opportunity for growth to all communities in the Region and eliminates the congestion currently occurring in the Addison Region. **CCR:** Reduces grid vulnerability and supports clean generation | **ES:** Supports local energy generation
- c. Advocate for appropriate cost allocation policies: globalizing costs for residential-scale distributed generation while requiring commercial/industrial generators to fund improvements necessary for their projects. **EJ:** Prevents undue burden on communities | **CCR:** Supports climate-friendly grid modernization | **ES:** Supports domestic energy supply

- d. Share info with VELCO, GMP and VECOOP to ensure that targets for renewable 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. Support grid upgrades where they will provide the greatest cost/benefit. **EJ:** Economic efficiency reduces energy burden | **CCR:** Improves climate adaptation resource efficiency | **ES:** Reduces cost and improves price stability
- e. Strongly encourage the Region’s electric utilities to adopt the new standards for digital substations from the National Electrical Manufacturers Association. **EJ:** Reduces price spikes during high demand | **CCR:** Supports renewable generation and grid resilience | **ES:** Improves regional energy security
- f. To reduce costs and promote local resilience, strongly encourage new renewable energy projects proposed for the Region to be designed from the outset so they can be connected to onsite or nearby strategically sited energy storage systems to avoid significant retrofitting in the future. **EJ:** Reduces future retrofit costs and stabilizes prices | **CCR:** Enables intermittent renewable integration | **ES:** Improves domestic energy system functioning
- g. Require newly installed generation systems to meet the following standards when relevant IEEE1547-2018, IEEE2800-2022, IEEE 2030-2011, and IEEE 2030.7-2017 for connection to the grid. **CCR:** Enables safe low-GHG technology deployment | **ES:** Improves utility-scale renewable functioning

GOAL 4: Reduce transportation energy consumption by transitioning to electric vehicles and promoting mode shift away from single-occupancy vehicles.

Objective 1:

Support the development of electric vehicle infrastructure and promote EV adoption.

- a. Plan for and install electric vehicle charging infrastructure on municipal property. **EJ:** Expands charging access for those unable to install at home | **CCR:** Accelerates transition to electric vehicles | **ES:** Enables use of domestic electricity
- b. Encourage major employers in the Region to install (additional) EV charging stations for employees. **EJ:** Expands charging access for those without home charging | **CCR:** Integrates EVs into commuting | **ES:** Reduces imported commute fuels
- c. Develop an EV Readiness report that includes strategic infrastructure improvement recommendations as well as assessments of municipal fleets. **CCR:** Identifies EV adoption progress and barriers | **ES:** Supports transportation infrastructure transition
- d. Promote the Drive Electric Vermont website and resources. **EJ:** Reduces information gaps about EV programs | **CCR:** Provides decarbonization information | **ES:** Informs about non-imported fuel options

Objective 2:

Reduce vehicle miles traveled and support the development of alternative transportation options.

- a. Support Walk-Bike Council of Addison County efforts to increase safe walking and biking access by facilitating complete streets infrastructure and helping municipalities secure funding for incremental bicycle and pedestrian improvements. **EJ:** Expands affordable transportation access and minimizes municipal costs | **CCR:** Reduces fossil fuel transportation demand | **ES:** Eliminates fuel use for active transportation



Four Hills Farm, Bristol

- b. Support public transit expansion by working with TVT to improve rural service access, encouraging municipal representation on transit boards, promoting park-and-ride and ride-sharing programs, and advocating for enhanced public transit access during planning proceedings. **EJ:** Expands affordable transportation access | **CCR:** Reduces single-occupancy vehicle fossil fuel demand | **ES:** Reduces imported transportation fuel demand
- c. Support employer programs to encourage telecommuting, carpooling, vanpooling, for employees' commute trips. **EJ:** Reduces energy burden for rural/extended commuters | **CCR:** Reduces employee fossil fuel demand | **ES:** Reduces imported fuel demand

GOAL 5: Transition medium and heavy-duty transportation to cleaner fuel alternatives.

Objective 1:

Support improvements to rail infrastructure and encourage cleaner fuels for large vehicle fleets.

- a. Support transportation goals for expanding passenger and freight rail service (see [Transportation Chapter](#)) to reduce vehicle miles traveled and fossil fuel consumption. **EJ:** Provides lower cost long-distance travel | **CCR:** Reduces light and heavy-duty vehicle GHG emissions | **ES:** Reduces imported transportation fuel demand
- b. Work with Clean Cities Coalition to encourage large vehicle fleets to switch to conventional natural gas use in situations in which switching to EVs or renewable natural gas is not feasible. **EJ:** Improves air and noise quality | **CCR:** Reduces GHG emissions compared to diesel

GOAL 6: Advance renewable electricity generation while protecting natural resources.

Objective 1:

Encourage municipal renewable energy generation.

- a. Analyze the feasibility and support the deployment of municipally owned, leased, or otherwise operated distributed generation facilities that are consistent with the *Regional Energy Project Siting and Design Standards*. **EJ:** Reduces energy-related tax burden | **CCR:** Reduces climate impact and hardens emergency facilities | **ES:** Reduces imported fuel reliance

- b. Support the development, implementation, and ongoing evaluation of Municipal Enhanced Energy Plans. **EJ:** Reduces undue community burden | **CCR:** Avoids undermining other climate goals | **ES:**

Objective 2:

Support responsible siting and development of renewable energy resources.

- a. Work closely with municipalities affected by proposed energy development projects to evaluate whether those projects are consistent with the *Regional Energy Project Siting and Design Standards*. **EJ:** Prevents unfair community impacts | **CCR:** Reduces opposition to clean energy | **ES:** Builds support for domestic generation
- b. Support the expansion of energy storage, microgrids, and other energy system infrastructure in locations and with designs that are consistent with the *Regional Energy Project Siting and Design Standards*. **EJ:** Addresses rural energy disruption frequency | **CCR:** Enables renewable balancing and weather resilience | **ES:** Improves domestic energy functionality

Objective 3:

Encourage compact settlement patterns and conserve forest land as renewable resources.

- a. Support housing goals for compact development, infill, village center growth, and shared utility infrastructure (see [Housing Section](#)) to reduce transportation energy demand and enable efficient energy systems. **EJ:** Reduces transportation costs and energy burden | **CCR:** Reduces transportation and heating fuel demand | **ES:** Reduces imported fuel dependence
- b. Discourage the conversion of forest blocks and other important ecosystems into exclusively energy generating sites. **EJ:** Maintains ecosystem services | **CCR:** Maintains CO² sequestration and storm buffering

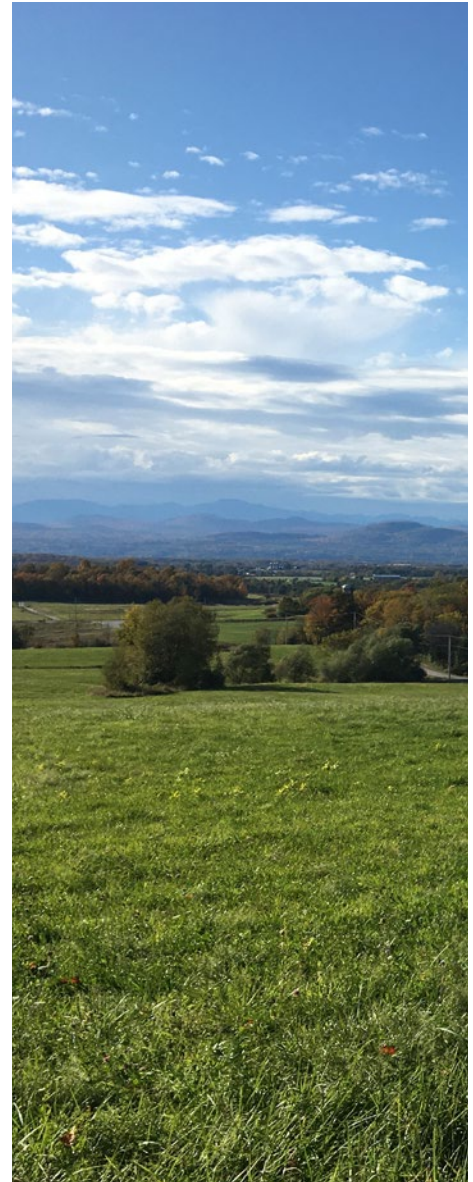
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Appendix B: Energy Units and Conversions

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

Table 17: Unit Conversions

Power and Energy Unit Definitions	
Btu	A British thermal unit (Btu) is a measure of the heat content of fuels or energy sources.
MMBtu	One million British thermal units (MMBtu).
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	1012 BTUs
1 gallon of heating oil	138,500 BTUs
1 cord of wood	20,000,000 BTUs



Appendix C: Comprehensive Energy Targets List

LEAP Targets

TOTAL ENERGY FUEL SWITCHING TARGETS

Table 18: Total Energy Demand Reduction Targets by Sector

Target Energy Demand Targets (Thousand MMBTUs)				
	2025	2035	2050	Change
Residential	1,332	946	731	(982)
Commercial	832	735	727	(263)
Industrial	1,068	1,101	1217	160
Total	3,232	2,782	2675	(1,085)

Table 19: Residential Total Fuel Switching Target

CAP Mitigation Total Regional Residential Sector Final Energy Demand (Thousand MMBTUs)				
Fuel	2015	2025	2035	2050
Electricity	345	311	413	482
Wood	394	317	173	79
Propane	302	225	107	40
Wood Pellets	98	30	22	18
Biodiesel	-	24	145	110
Heating Oil	525	389	71	-
Biogas	-	2	4	2
Natural Gas	50	35	11	1
Total	1,713	1,332	946	731

DRAFT 6-10-26 | Public Hearing

Table 20: Commercial Total Energy Fuel Switching Target

CAP Mitigation Total Regional Commercial Sector Final Energy Demand (Thousand MMBTUs)				
Fuel	2015	2025	2035	2050
Electricity	317	335	396	409
Gasoline	31	34	36	38
Kerosene	0	0	0	-
Wood	76	80	90	108
Ethanol	2	2	2	3
Solar	8	20	21	23
Heat	-	-	24	39
Propane	194	106	30	1
Residual Fuel Oil	5	2	2	2
Wood Pellets	-	4	12	19
Biodiesel	-	6	46	64
Heating Oil	220	105	23	-
Biogas	-	9	13	16
Natural Gas	138	127	40	6
Total	990	832	735	727

Table 21: Industrial Total Energy Fuel Switching Target

CAP Mitigation Total Regional Commercial Sector Final Energy Demand (Thousand MMBTUs)				
Fuel	2015	2025	2035	2050
Electricity	260	253	237	251
Natural Gas	302	339	270	95
Gasoline	26	24	25	27
Kerosene	1	1	1	1
Diesel	161	128	44	-
LPG	16	16	15	14
Wood	19	11	11	12
Biogas	-	38	150	411
Ethanol	2	2	3	3
Lubricants	9	6	7	7
Biodiesel	-	62	144	188
Residual Fuel Oil	9	6	6	6
Wood Waste Solids	5	1	1	1
Asphalt and Road Oil	248	181	189	200
Total	1,057	1,068	1,101	1,217

THERMAL EFFICIENCY AND FUEL SWITCHING TARGETS

Table 22: CAP Mitigation Regional Residential New Cold Climate Heat Pumps

Technology	2025	2035	2050
ASHP 2 Head	1,103	2,957	4,366
ASHP Central	1,715	4,631	6,804
ASHP HE	1,619	4,343	6,412
GSHP HE	200	537	792
Total	4,637	12,468	18,374

Table 23: Regional Residential New Retrofits (Number of Housing Units)

Technology	2025	2035	2050
Baseline Scenario	1,232	2,378	4,178
CAP Mitigation	3,356	7,253	11,734

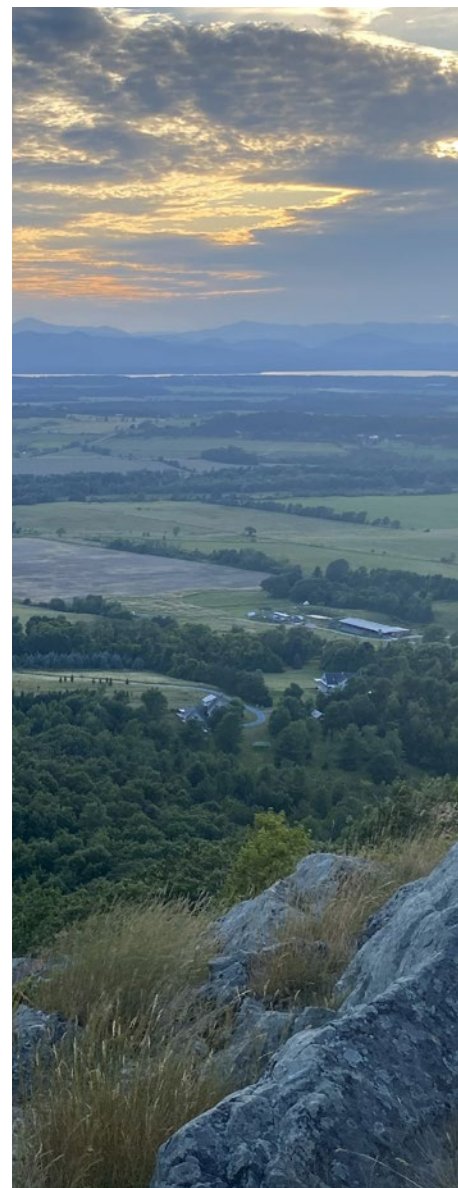
Table 24: Regional Residential New Heat Pump Water Heaters (Number of Units)

Scenario	2025	2035	2050
Baseline Scenario	246	250	257
CAP Mitigation	3,048	10,151	13,928

Commercial

Table 25: CAP Mitigation Regional Commercial New Cold Climate Heat Pumps

	2025	2035	2050
New CCHP	2,336	7,064	9,034



DRAFT 6-10-26 | Public Hearing

TRANSPORTATION TARGETS

Table 26: CAP Mitigation Regional Transportation Energy Demand (Thousand MMBTUs)

Fuel	Passenger Car			Light Truck			Medium Duty			Heavy Duty		
	2025	2035	2050	2025	2035	2050	2025	2035	2050	2025	2035	2050
Electricity	11	93	192	14	167	295	20	165	352	10	81	147
Natural Gas	-	-	-	-	-	-	-	-	-	-	-	-
Gasoline	416	202	26	1,050	477	64	147	98	26	0	0	0
Diesel	2	1	0	20	12	1	190	108	22	283	91	9
LPG				-	-	-	2	1	0	-	-	-
Ethanol	35	21	3	90	50	7	13	10	3	0	0	0
CNG	-	-	-	-	-	-	-	-	-	-	-	-
Biodiesel	0	0	0	1	1	0	13	14	5	20	12	2
Total	465	317	222	1,176	707	368	384	396	408	312	183	159

Table 27: CAP Mitigation Regional Non-Road Final Energy Demand (Thousand MMBTUs)

Fuel	2015	2025	2035	2050
Diesel	64	61	61	62
Biodiesel	2	4	8	14
Avgas	2	3	3	3
Jet Kerosene	83	82	69	48
Sustainable Aviation Fuel	-	1	16	37
Gasoline	22	20	21	21
Ethanol	2	2	2	3
Lubricants	18	14	14	14
Natural Gas	-	-	-	-
Total	193	187	192	202

Table 28: CAP Mitigation Regional EV and PHEV Stock (Number of Vehicles)

Vehicle Type		2025	2030	2050
Passenger Vehicle EV and PHEV Stock	Battery Electric	606	6,250	14,719
	Plug In Hybrid	115	88	20
	Total	721	6,338	14,739
Light Duty Truck EV and PHEV Stock	Battery Electric	622	8,705	17,753
	Plug In Hybrid	65	86	21
	Total	687	8,792	17,775

DRAFT 6-10-26 | Public Hearing

ENERGY EFFICIENCY TARGETS

Table 29 below represents total achievable Energy Efficiency (EE) savings through the implementation of improvements listed in Tables 32 and 33. Tables 30 and 31 show the benefits of these efficiency measures on the peak demand pressure on the grid.

Table 29: Regional Program Achievable Electric Energy Efficiency Savings (MWh)

		2025	2030	2035	2040	2050
Residential	Incremental Annual	76	79	86	83	93
Residential	Cumulative Annual	150	510	858	1,082	1,584
Non-Residential	Incremental Annual	76	69	69	68	79
Non-Residential	Cumulative Annual	152	498	765	747	690
Total	Incremental Annual	152	148	155	151	172
Total	Cumulative Annual	302	1,008	1,623	1,829	2,273

Table 30: Regional Program Achievable Electric Energy Summer Capacity (MWh)

		2025	2030	2035	2040	2050
Residential	Incremental Annual	0.006	0.005	0.006	0.006	0.007
Residential	Cumulative Annual	0.013	0.037	0.057	0.065	0.068
Non-Residential	Incremental Annual	0.013	0.011	0.011	0.010	0.012
Non-Residential	Cumulative Annual	0.026	0.082	0.126	0.120	0.105
Total	Incremental Annual	0.019	0.016	0.017	0.016	0.019
Total	Cumulative Annual	0.039	0.120	0.183	0.184	0.173

DRAFT 6-10-26 | Public Hearing

Table 31: Regional Program Achievable Electric Energy Efficiency Savings (MWh)

		2025	2030	2035	2040	2050
Residential	Incremental Annual	0.02	0.02	0.02	0.02	0.02
Residential	Cumulative Annual	0.03	0.10	0.17	0.22	0.33
Non-Residential	Incremental Annual	0.01	0.01	0.01	0.01	0.01
Total	Incremental Annual	0.03	0.03	0.03	0.03	0.03
Total	Cumulative Annual	0.05	0.18	0.29	0.33	0.43

Table 32: Regional Residential Incremental Annual MWh by End-Use

	2025	2030	2035	2040	2050
Appliances	286	250	301	295	403
Hot Water	205	191	222	192	221
HVAC Equipment	615	832	853	865	905
HVAC Shell	25	29	23	16	6
Lighting	91	5	7	6	7
Misc. Loads	127	100	132	110	135
Motors	8	8	10	8	9
Whole Building	71	86	78	80	79

Table 33: Regional Non-Residential Incremental Annual MWh by End-Use

	2025	2030	2035	2040	2050
Compressed Air	164	170	168	168	193
Plug Loads	36	60	65	63	74
Heating and Cooling	162	183	196	196	227
Ventilation And Circulation	152	189	216	229	261
Lighting	1,463	1,007	917	858	1,020
Refrigeration	268	306	328	341	389
Water Heat	83	110	117	110	130
Motors	75	73	72	72	83
Other	101	175	198	206	236

DRAFT 6-10-26 | Public Hearing

Appendix D: Energy Maps

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. The following maps are included:

1. **Existing Generation Facilities:** This map presents existing generation facilities greater than 15kW in capacity as well as existing transmission lines and 3-phase power lines in the Region.
2. **Known Constraints:** This map presents the established constraints on land development.
3. **Potential Constraints:** This map suggests where conditions would likely require mitigation, and thus which may prove a site unsuitable for development after site-specific study, based on state-wide or regional/local policies that are currently adopted or in effect.
4. **Wind Potential:** This map includes wind speed potential for the Region as well as proximity to 3-phase power lines. Known constraint areas are excluded.
5. **Ground Mount Solar Potential:** This map includes prime and base solar potential for the Region as well as proximity to 3-phase power lines. Known constraint areas are excluded.
6. **Unconstrained Prime Wind:** This map identifies areas with potential for wind development that have no constraints impacting them, including no intersection with habitat blocks as identified in [Chapter 1, Natural Resources: Maps 8 and 9](#).
7. **Unconstrained Prime Solar:** This map identifies areas with potential for solar development that





have no constraints impacting them, including no intersection with habitat blocks as identified in [Chapter 1, Natural Resources: Maps 8 and 9](#).

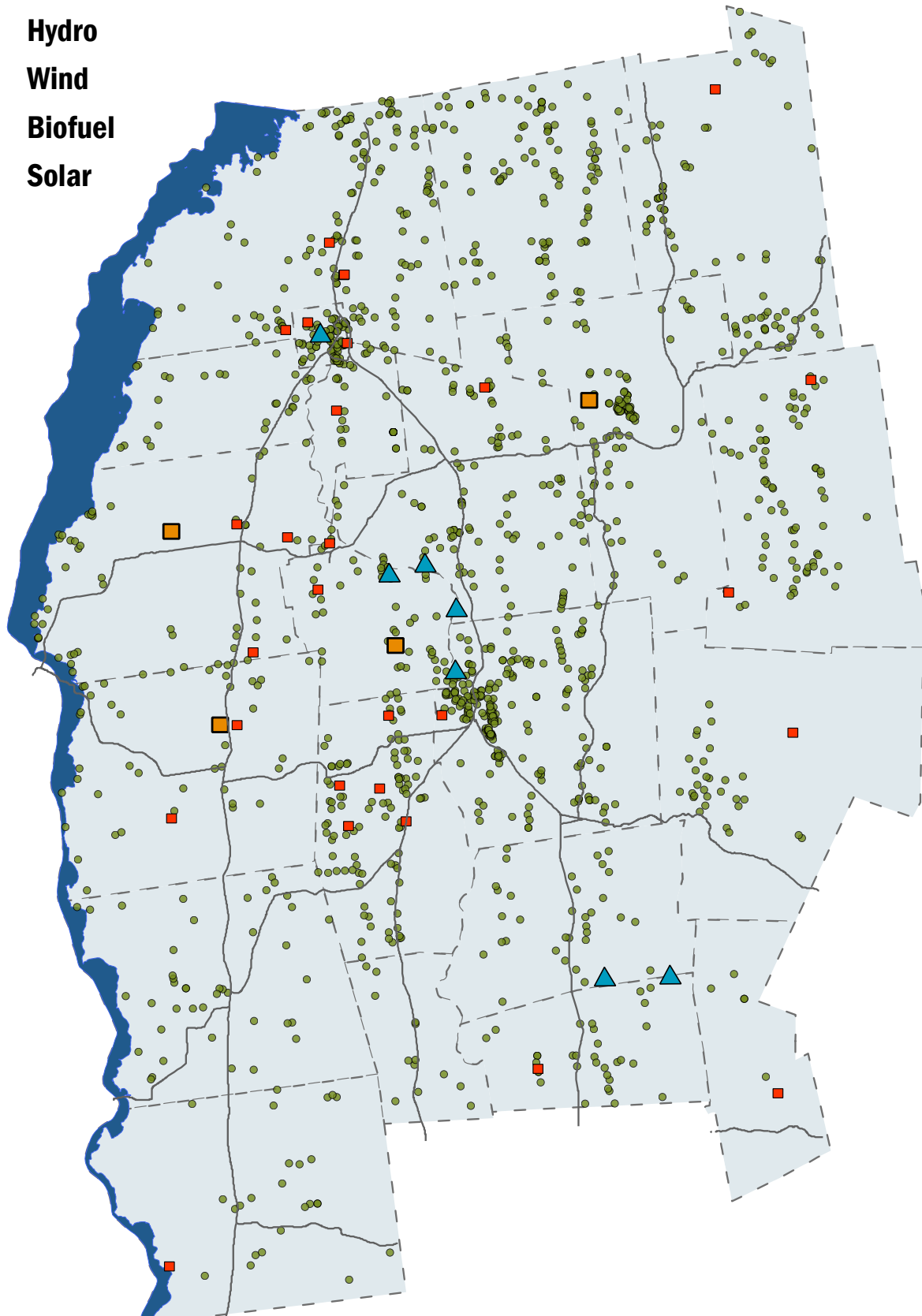
8. **Preferred Sites:** This map incorporates preferred locations for solar generation previously identified in Municipal Enhanced Energy Plans within the Region, rooftops in coordination with the State priority to develop generation in proximity to demand, and avoid green fields (gradient scale).
9. **Transmission Resources and Constraints:** This map demonstrates a key challenge for Addison County energy generation and electrification efforts with a depiction of the constrained electric distribution network in the Region.
10. **Transportation Infrastructure:** Comprised of three maps that include EV charger locations, public transportation lines and park and ride locations, and bike trail infrastructure.



Belden Falls Substation

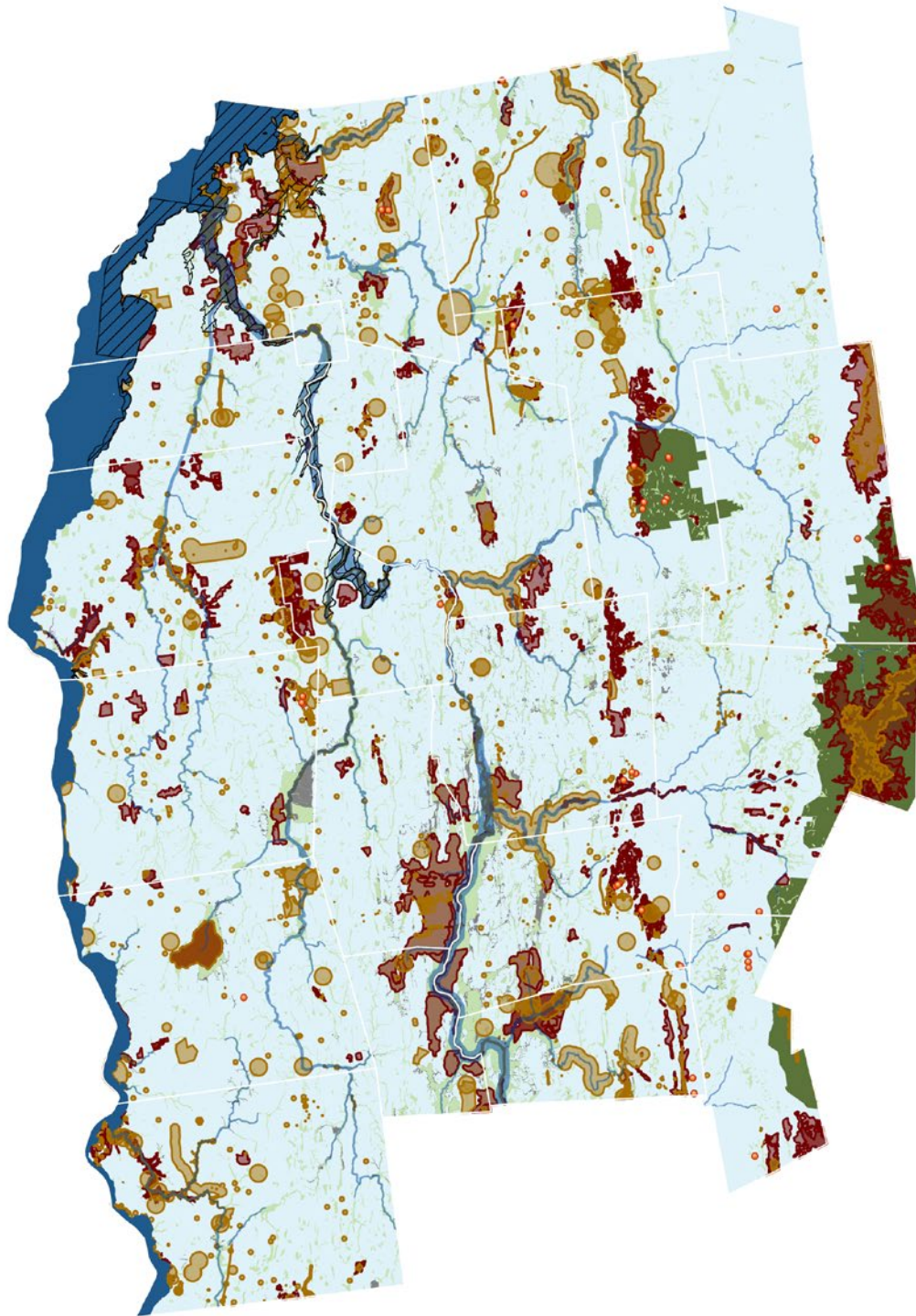
Map 1: Existing Generation Facilities

-  **Hydro**
-  **Wind**
-  **Biofuel**
-  **Solar**



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Map 2: Known Constraints



- | | | |
|---|--|---|
|  Confirmed Vernal Pool |  Rare, Threatened, and Endangered Species |  Class I Wetland |
|  FEMA Floodway |  Significant Natural Community |  Class II Wetland |
|  River Corridor | |  Advisory Wetland |
| | |  Wilderness Area |

DRAFT 6-10-26 | Public Hearing

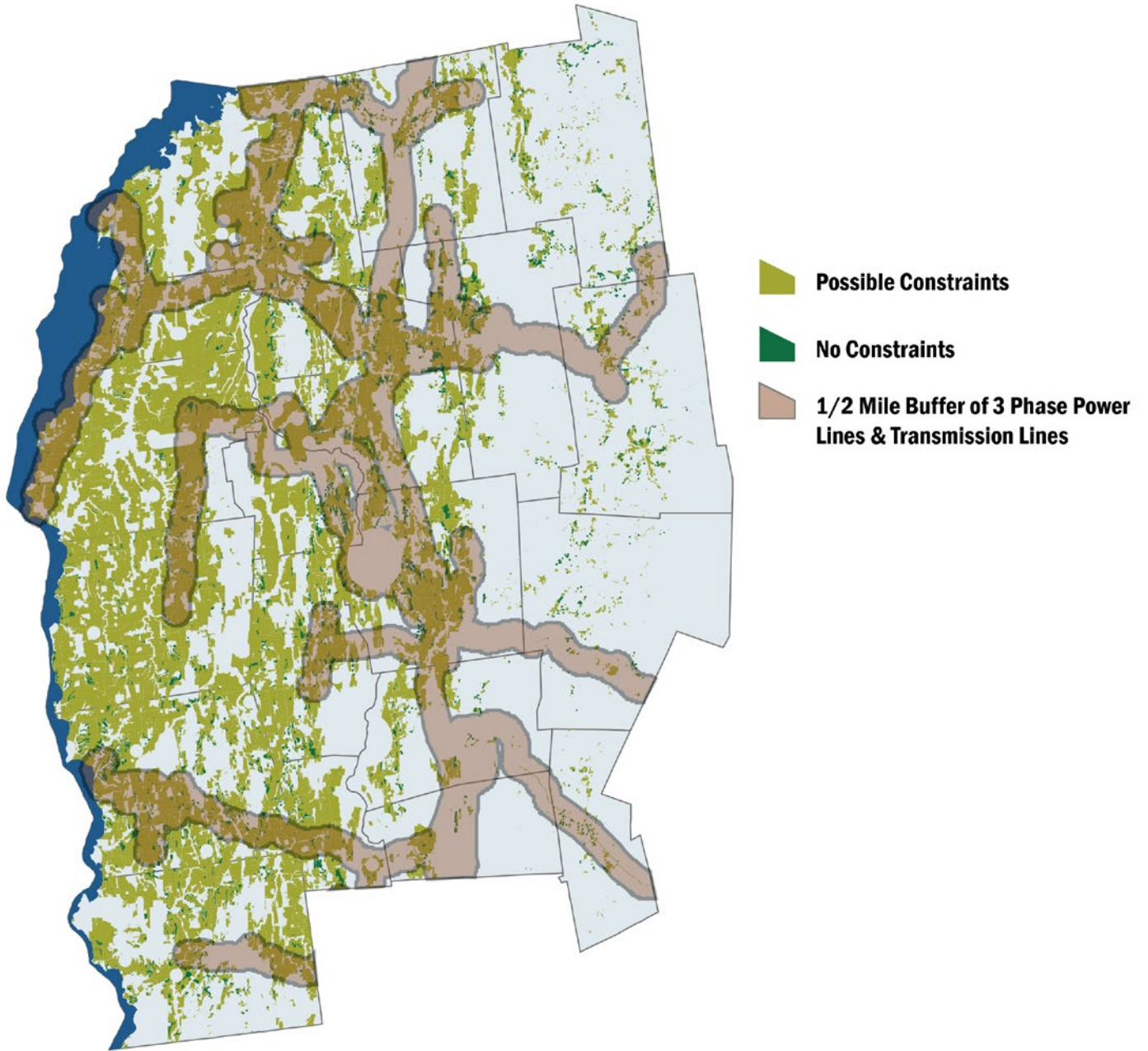
Map 3: Possible Constraints



- | | | | |
|--------------------------------|---|-------------------------------------|--|
| Unconfirmed Vernal Pool | Act 250 Agricultural Soil Mitigation Area | Highest Priority Connectivity Block | Highest Priority Surface Water and Riparian Area |
| FEMA Special Flood Hazard Area | Agriculturally Important Soils | Physical Landscape Diversity Block | Hydric Soils |
| Deer Wintering Area | Highest Priority Forest Block | | |

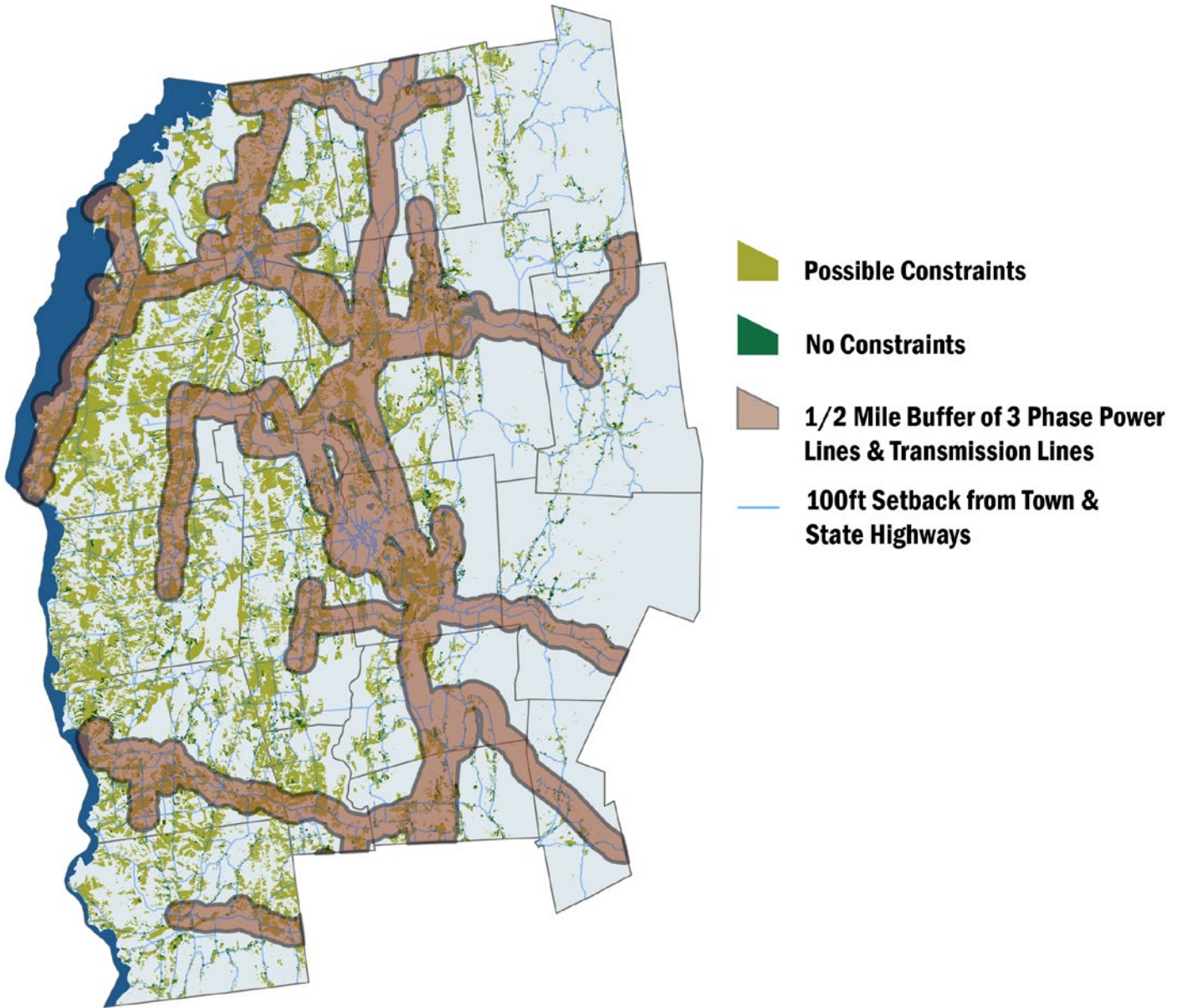
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Map 4: Wind Potential



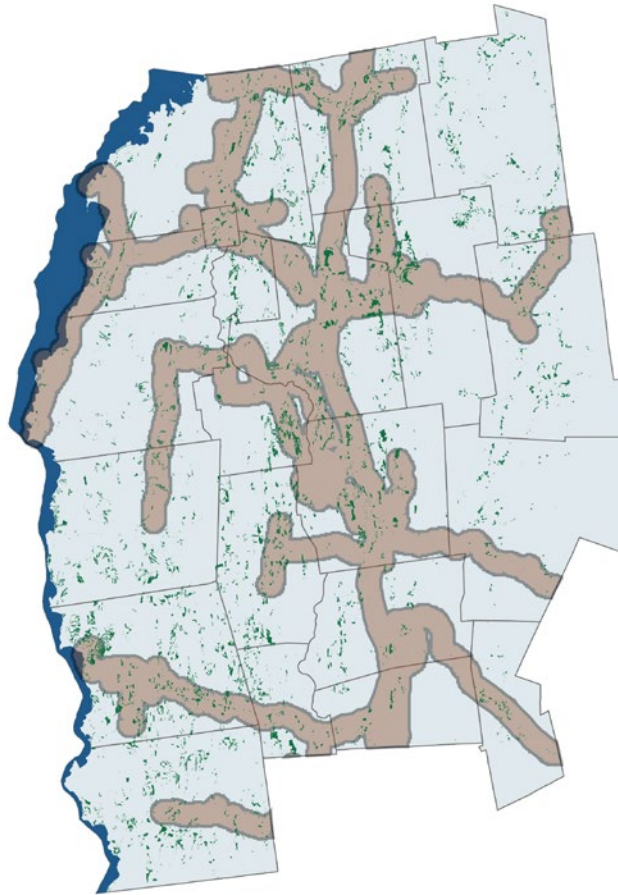
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Map 5: Ground Mount Solar Potential



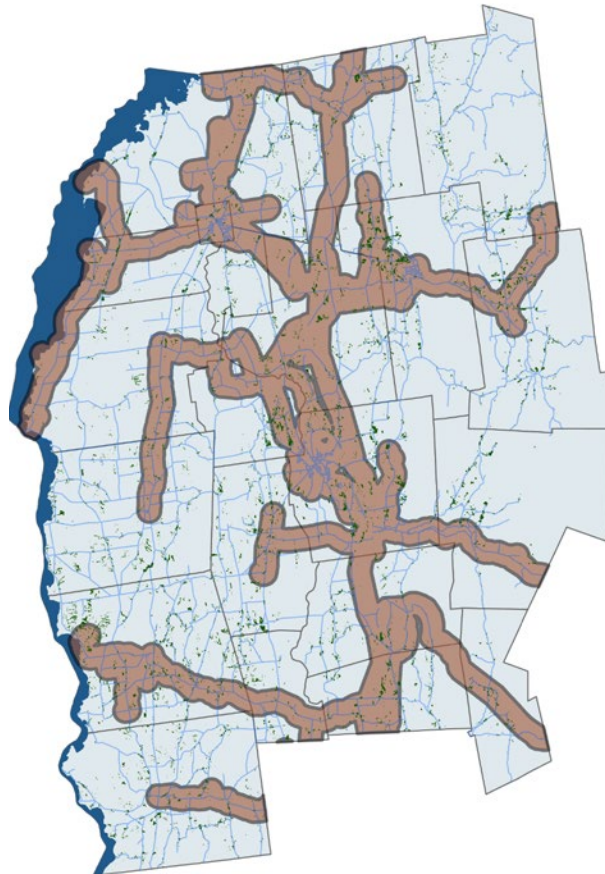
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Map 6: Unconstrained Prime Wind Energy



-  Unconstrained Prime Wind Locations
-  1/2 Mile Buffer of 3 Phase Power Lines & Transmission Lines

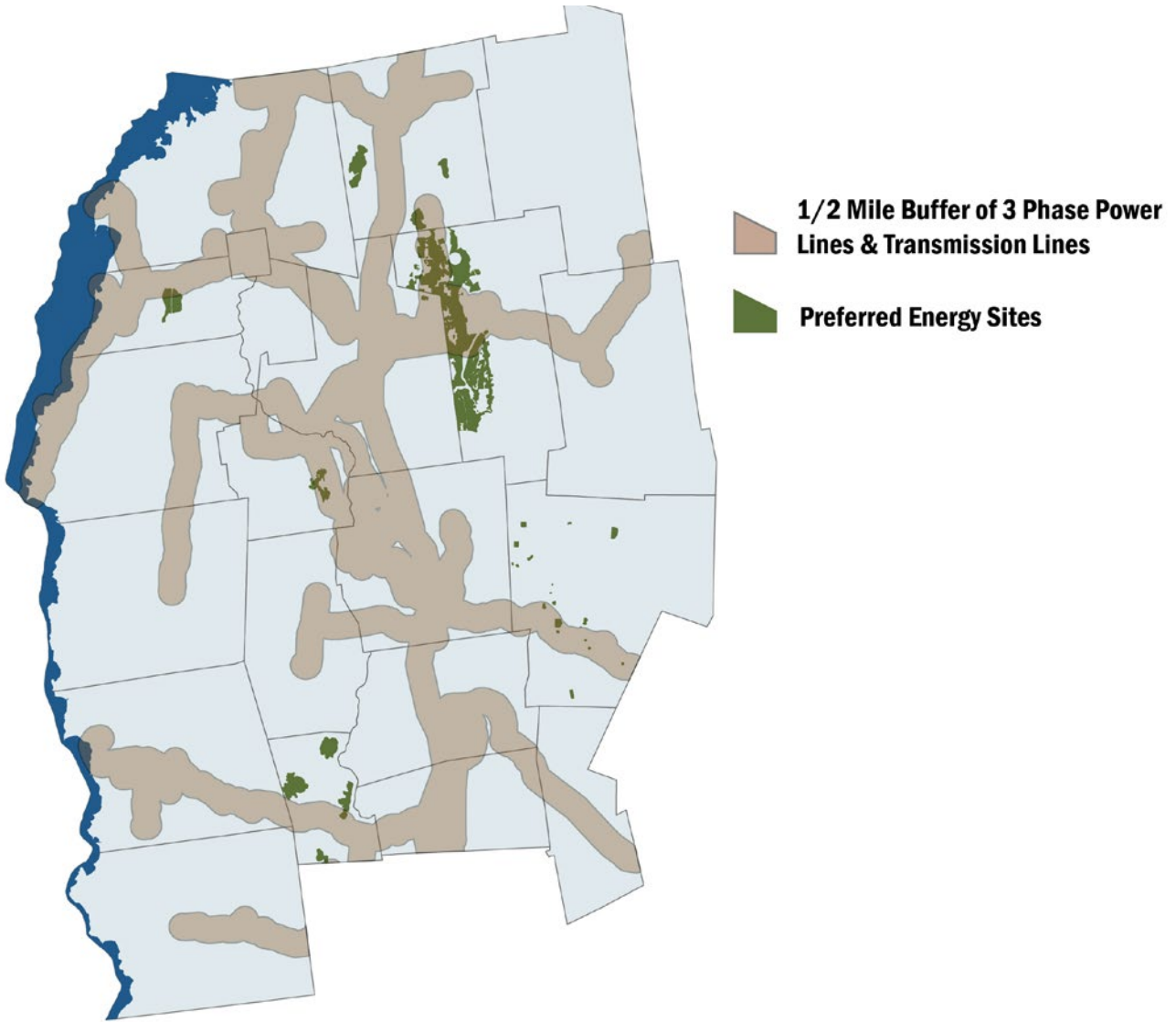
Map 7: Unconstrained Prime Ground Solar Energy



-  No Constraints
-  1/2 Mile Buffer of 3 Phase Power Lines & Transmission Lines
-  100ft Setback from Town & State Highways

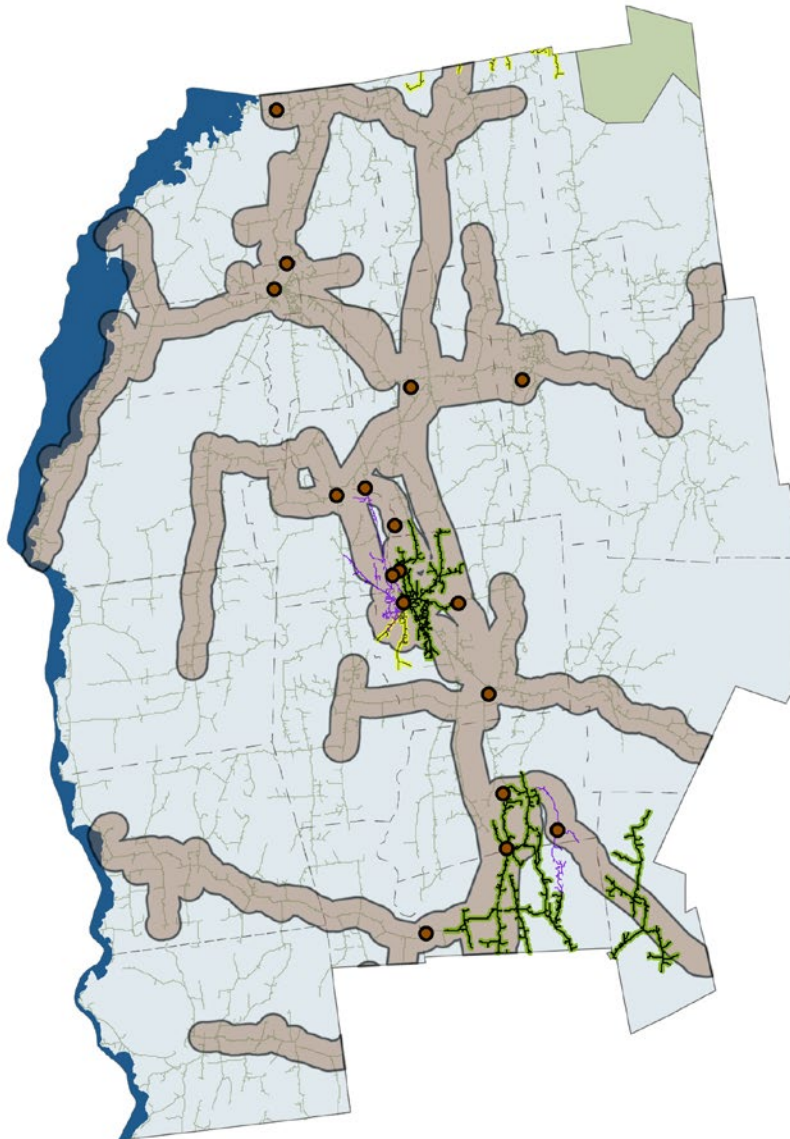
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Map 8: Preferred Sites







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Map 9: Transmission Resources and Constraints



-  **GMP Service Area**
-  **VELCO Service Area**
-  **1/2 Mile Buffer of 3 Phase Power Lines & Transmission Lines**
-  **Substations**

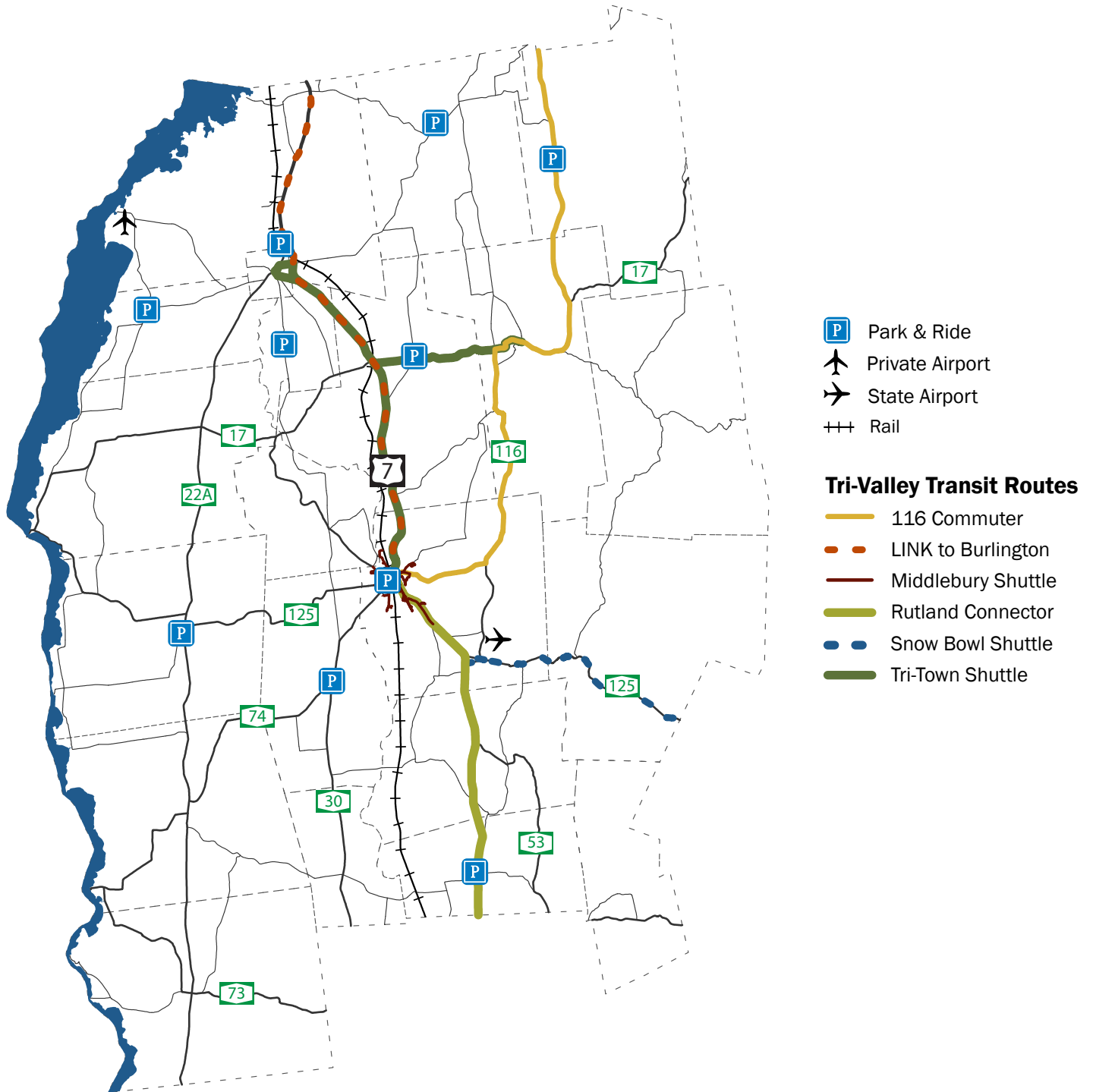
GMP Distribution Capacity

-  Due to system limitations, interconnections on this circuit may experience higher costs and delayed interconnections
-  Substation transformer with $\geq 20\%$ capacity remaining
-  Substation transformer with $< 20\%$ capacity remaining
-  Substation transformer with $< 10\%$ capacity remaining

DRAFT 6-10-26 | Public Hearing

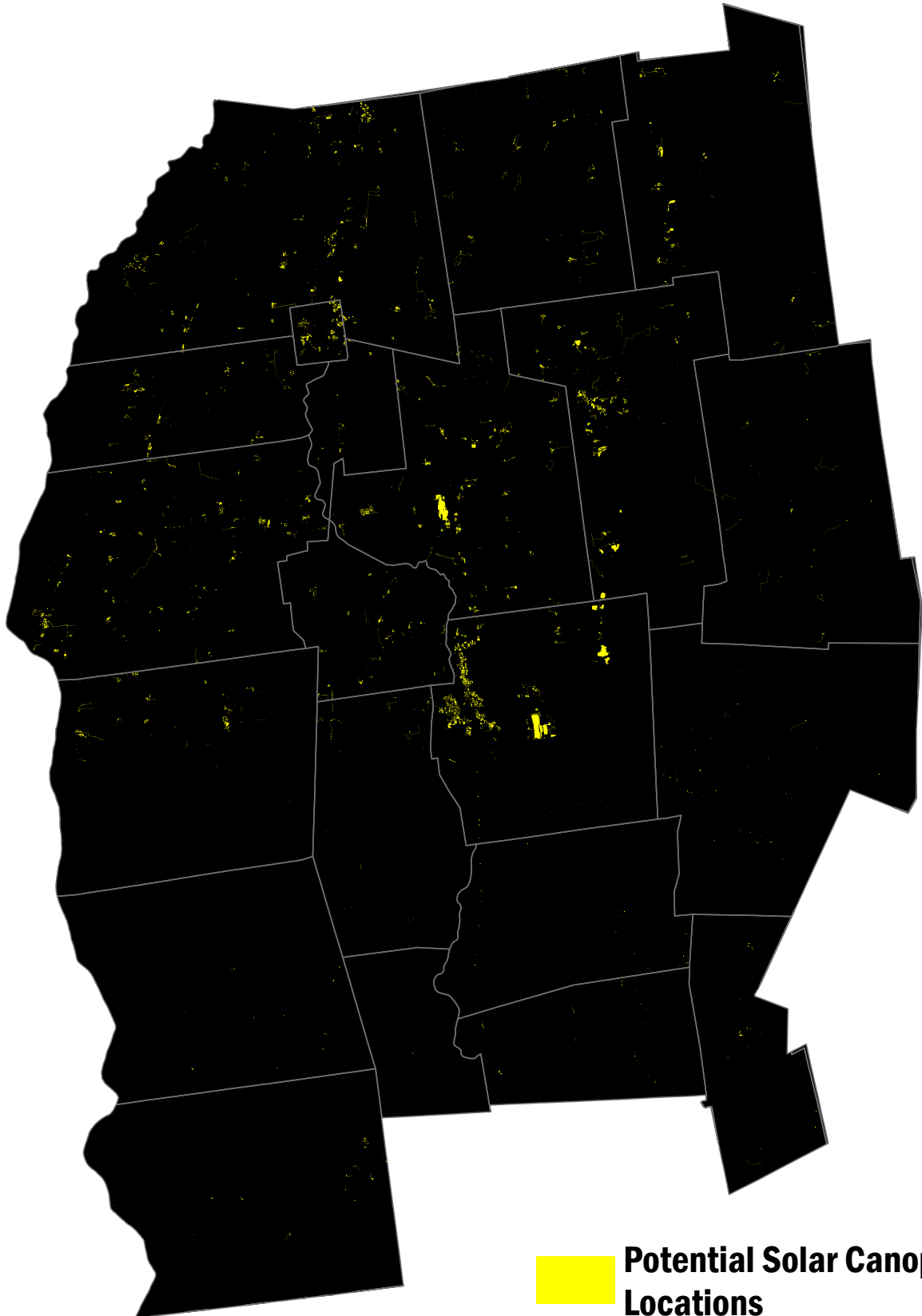
Map 10: Transportation Infrastructure

Comprised of three maps that include EV charger locations, public transportation lines and park and ride locations, and bike trail infrastructure (See Chapter 3)



DRAFT 6-10-26 | Public Hearing

Map 11: Potential Solar Canopy Locations



DRAFT 6-10-26 | Public Hearing

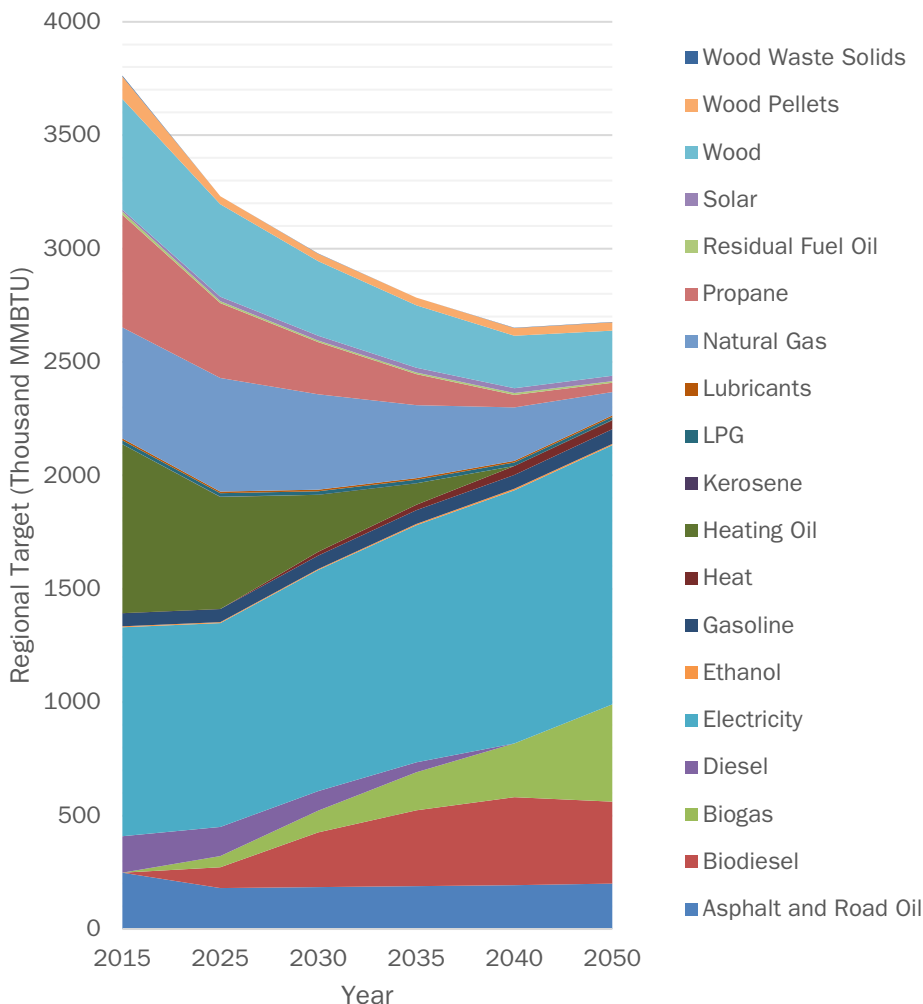
Appendix E: Target Generation Methodology

LEAP Model

Energy targets were created by the Department of Public Service (DPS) using the LEAP (Long-range Energy Alternatives Planning) software to create a model of the demand for and supply of total energy usage in Vermont and the Addison Region. Full details of the LEAP Model methods, data sources, and assumptions may be found as Appendix 103D to the 2022 Comprehensive Energy Plan. LEAP software is a system that allows users to create complex models of future energy use. The LEAP model does not identify specific costs that would be incurred in the future. Instead, it compares 2050 costs among various scenarios, in order to achieve the least-cost alternative to meet legislative goals. The LEAP model also includes impacts that do not result in out-of-pocket costs, such as impacts of pollution. Be-

Figure 10: Total Energy Use Based on LEAP Model

LEAP target data provided by the VT Public Service Department



cause of the model’s complexity, it is difficult to explain comprehensively. The following scenarios provide some background on the methodology and the inputs used to create both statewide and regional models in LEAP. **Appendix C** presents the full model results for the Region and the State and as well as a more thorough explanation of the model assumptions and methodology. Targets for generation within the Region were developed by ACRPC in partnership with the Department of Public Service based upon the needs projected in the LEAP model.

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

To meet the GWSA goals, total energy use will need to decline despite a growing population and economy. Electricity use will increase with the intensified use of heat pumps as primary heating sources and the use of electric vehicles. Because those choices are powered by electricity, and electricity is three to four times more efficient compared to fossil fuels, overall energy use will decrease both regionally and statewide. The difference in total energy demand between the reference scenario and the CAP Mitigation scenario is a key point. This difference represents the amount of total energy demand that will need to be eliminated to reach the State’s and Region’s energy goals by 2050.

DRAFT 6-10-26 | Public Hearing

This LEAP model was developed for the state Comprehensive Energy Plan and disaggregated for each regional planning commission accounting for share in population, housing units, industries, commercial floorspace, number of vehicles, and presence of natural gas pipelines. More information on the LEAP modeling inputs and assumptions can be found in Appendix D of the 2022 Vermont Comprehensive Energy Plan. This disaggregated “share” represents only one of the many paths the Region may take to attain its energy goals and sets a mandatory aspirational target for the Region to achieve. The Regional Targets are further disaggregated to the municipal scale by ACRPC based on consumption in each sector (transportation, electric, thermal heating). While these estimates use best available data, they should not be considered a unit-by-unit audit of energy use. Rather, they serve as a starting point for better understanding our Region’s current energy use patterns, the cost drivers, and what we need to do to achieve long-range energy goals.

Because different fuels are measured in different units (e.g., gallons, cords, pounds, cubic feet), the results of the LEAP model can be difficult to compare. To help make comparisons between fuel types easier, ACRPC has decided to report the scenario results in a standard unit: BTUs.

Please refer to the DPS Act 174 Landing Page which has guidance for regions and municipalities and a host of tools used in the analyses that support this Plan. This supplement provides additional, not comprehensive, methodological information so as not to duplicate that which is already laid out by the State.

Vermont’s regional planning commissions have been tasked with developing reasonable estimates for local consumption across the transportation, heating, and electric energy sectors. While these estimates use best available data, they should not be considered a unit-by-unit audit of energy use. Rather, they serve as a starting point for better understanding our Region’s current energy use patterns, the cost drivers, and what we need to do to achieve long-range energy goals. Note, estimates and targets are frequently given in British Thermal Units (BTUs) and millions of BTUs (MMBTUs) in order to allow for comparison between different energy types.

Current residential and commercial and industrial electricity usage data is provided by Efficiency Vermont (both municipal and regional totals), Transportation and thermal sector data is estimated via the Municipal Consumption Tool, which pulls from a variety of sources including the Vermont Department of Public Service, American Community Survey, Vermont Department of Labor, the Vermont Department of Motor Vehicles, and DriveElectric (VEIC). Using the regionalized LEAP results provided by DPS, targets are established to provide milestones for thermal efficiency; renewable energy use; and conversion of thermal and transportation energy from fossil fuel based to renewable resources. These milestones are intended to help the Region measure progress towards the overall goals and are not identified as requirements. Regional LEAP targets were disaggregated using each municipality’s share of current regional energy use. Municipal disaggregation factors were calculated for transportation (Light Duty Vehicles), residential thermal, commercial thermal, residential electric, and commercial electric. Targets are established for the years 2025, 2035, and 2050 which coincide with the State Comprehensive Energy Plan (updated 2022). Targets include both a “business as usual” baseline and the CAP (Climate Action Plan) mitigation scenario targets. A summary of results is included below and referenced throughout this Appendix. Municipal analyses and targets are available on the ACRPC website. ACRPC can provide a copy of these resources upon request

RESIDENTIAL HEATING ENERGY USE AND COST ESTIMATES

The following explains the series of steps that ACRPC has taken to calculate estimates of residential heating energy use, square footage, and costs for the Addison Region. According to the Department of Public Service, residences in New England use somewhere about 45,000 to 80,000 BTUs of heat energy per square foot annually, averaging statewide at about 110 MMBTUs per residence per year for space and water heating. Space heating is by far the biggest use, and older building stock can require significantly more energy to heat.

Caveats:

- ✦ ACS data is based on random sampling over a multi-year period with large margins of error especially for rural communities like many in the Addison Region. As of the writing of this Plan, it remains the most consistent and comprehensive data available on residential heating.
- ✦ ACS data identifies only one primary source of heating. In reality, many residents use two or more resources.

Data (ACS 2022-2025 5-Year Estimates used)

- a. B25117 Tenure by House Heating Fuel
- b. B25010: Average Household Size of Occupied Units by Tenure
- c. DP04 Selected Housing Characteristics
- d. Total Housing Units

ACRPC downloaded the data sets referred above by town and aggregated them in Microsoft Excel tables

House heating fuel is categorized on the ACS questionnaire as follows:

Utility Gas: This category includes gas piped underground from a central system to serve the neighborhood. The only utility in Vermont that delivers gas in this manner (i.e. natural gas) is Vermont Gas, which serves a portion of our Region and its service area is well outside of our Region. A small number of ACS respondents indicated that they heated with “utility gas.” It is most likely that they confused this source with bottled, tank or LP gas. We therefore made adjustments to account for this error.

Bottled, Tank, or LP Gas: This category includes liquid propane gas stored in bottles or tanks that are refilled or exchanged when empty. This is the second most dominant heat source for owner- and renter-occupied homes.

Electricity: This category includes electricity that is generally supplied by means of above or underground electric power lines. Census data does not distinguish between types of electric heat (e.g. resistance vs. heat pumps). We assume that additional homes in this cate-

gory since the last plan and in the future are new heat pumps and not new resistance heat pumps.

Fuel Oil, Kerosene, etc.: This category includes fuel oil, kerosene, gasoline, alcohol, and other combustible liquids. This category (oil) is the leading source of heat in the Region overall, and for both owner- and renter-occupied homes.

Coal or Coke: This category includes coal or coke that is usually distributed by truck. Some households in our Region use anthracite in stoves, furnaces, and boilers. There are very few of these, if any, still in the Region, as the margin of error suggests potential to be zero.

Wood: This category includes purchased wood, wood cut by household members on their property or elsewhere, driftwood, sawmill or construction scraps, or the like. Wood is the third largest source of heat in the Region for owner-occupied homes, much of which is likely cordwood.

Solar Energy: This category includes heat provided by sunlight that is collected, stored, and actively distributed to most of the rooms. It is difficult to anticipate what residents mean when they select this option; consequently, we combined this estimate with the “other fuel” class.

Other Fuel: This category includes all other fuels not specified elsewhere. This category very likely consists of non-fossil fuel sources, but it is difficult to make further assumptions.

COMMERCIAL ESTIMATES

A worksheet, Municipal Consumption, created by the Department of Public Service, uses data from the Vermont Department of Labor’s Economic and Labor Market Information website: www.vtlmi.info. The worksheet determines the municipality’s share of the regional commercial building stock and applies assumptions from the Energy Information Institute’s Survey of Commercial Uses. The estimate does not include industrial uses that are highly variable.

TRANSPORTATION ESTIMATES

This data was developed using the Department of Public Service’s Municipal Consumption worksheet. The total number of vehicles comes from American Communi-

Table 35: Municipal Consumption Summary Disaggregation

Town	Transportation Percent of Region (MMBtu)	Thermal Residential Percent of Region	Thermal Commercial Percent of Region	Electric Commercial Percent of Region	Electric Residential Percent of Region	Total Electric
Addison	4.2%	4.3%	4.3%	3.0%	5.3%	4.1%
Bridport	3.8%	3.6%	3.6%	2.1%	4.0%	3.1%
Bristol	10.8%	10.4%	10.4%	7.2%	9.4%	8.3%
Cornwall	3.1%	3.4%	3.4%	0.4%	4.2%	2.3%
Ferrisburgh	8.5%	9.0%	9.0%	5.1%	10.3%	7.7%
Goshen	0.6%	0.6%	0.6%	0.1%	0.5%	0.3%
Leicester	3.5%	4.2%	4.2%	0.3%	3.5%	1.9%
Lincoln	4.2%	3.8%	3.8%	0.4%	3.7%	2.1%
Middlebury	16.0%	19.5%	19.5%	57.6%	15.8%	36.7%
Monkton	6.2%	5.0%	5.0%	0.5%	5.9%	3.2%
New Haven	6.1%	4.5%	4.5%	4.1%	5.2%	4.6%
Orwell	3.2%	3.5%	3.5%	1.2%	3.8%	2.5%
Panton	2.1%	1.9%	1.9%	1.0%	2.9%	2.0%
Ripton	1.7%	1.9%	1.9%	0.9%	1.7%	1.3%
Salisbury	3.6%	4.0%	4.0%	1.5%	4.0%	2.7%
Shoreham	3.9%	3.6%	3.6%	3.2%	4.0%	3.6%
Starksboro	5.9%	5.0%	5.0%	0.7%	4.9%	2.8%
Vergennes	7.4%	7.0%	7.0%	9.7%	5.5%	7.6%
Waltham	1.5%	1.2%	1.2%	0.2%	1.3%	0.8%
Weybridge	2.3%	2.1%	2.1%	0.5%	2.9%	1.7%
Whiting	1.3%	1.3%	1.3%	0.2%	1.3%	0.8%

ty Survey (ACS) 5-Year Estimates. Average annual VMTs account for slightly longer-than-average commutes and more incidental trips in the rural and commuter parts of the Region. Total vehicle miles traveled assumes an average fuel economy of 22 miles per gallon. Registered ICE (internal combustion engine) vehicles are assumed to travel 12,000 miles per year which is the mid-range of the provided estimate. Registered EVs were determined by the Vermont Energy Investment Corporation (Drive Electric) and use the low estimate provided by the DPS’s average of 9,000 VMTs per EV annually, taking into account early trends in EV adoption including reducing trips in adverse weather and use of alternative transportation modes, as well as the high percentage of our Region’s population that is retired and thus without a daily commute.

ELECTRICITY ESTIMATES

Efficiency Vermont provides an annual report with compiled data from the most recent three years, based on that provided by utilities serving the Region. ACRPC has compiled all of the annual reports from EVT into a single report providing data between 2015 and 2023.

Thermal Efficiency & Fuel Switching Targets (Residential & Commercial)

Targets for thermal efficiency of residential and commercial structures are based on a methodology developed by the regional Long-range Energy Alternatives Planning (LEAP) analysis carried out by the Department of Public Service and then disaggregated using municipal share of regional energy use determined via the Municipal Consumption Tool. See the Municipal Consumption Summary (live) tab in the Municipal Consumption Tool to see how each regional target was disaggregated to the municipal scale. See **Table 35**.

Table 36: Conversion Factors

Resource	Acres/MW	Capacity Factor	MWh/MW
Solar	7	15.0%	1314
Rooftop Solar	1.5	14.5%	1270
Wind	40	22.5%	1971
Large Wind	10	30.0%	2628
Natural Gas	0.343	75.0%	6570
Biomass	6.375	70.0%	6132
Hydro	1	50.0%	4380

ELECTRICAL EFFICIENCY TARGETS

Efficiency and conservation measures are integrated into the thermal sector targets. Electricity efficiencies were embedded into the 20-year load forecast used in the updated LEAP model, thus are not an output of their own (and why the Public Service Department removed the Electric Sector tab of the updated Analysis and Targets Tool). Therefore, electric efficiency targets were provided separately in the EEU Potential Study Data Sheet and disaggregated to the regional scale using the recommended methodology. Municipal disaggregation uses the Total Electric percentage, which comes from the Municipal Consumption Tool and is applied to the EEU Potential sheet. These tools and materials are available upon request.

FUEL SWITCHING TRANSPORTATION TARGETS

Table 28 displays a target for switching from fossil fuel-based vehicles to EVs. This target is calculated using the Regional LEAP data and disaggregates the regional target based on the municipal share of current transportation consumption as estimated in the Municipal Consumption Sheet. The targets are cumulative.

Generation Targets

EXISTING RENEWABLE ENERGY GENERATION

Significant effort was made to aggregate the most comprehensive list of existing renewable energy generation sites possible for the region. The Department of Public Service periodically provides an updated Distributed Generation (DG) Inventory, which includes projects that

have been submitted to the Public Utility Commission and are less than <5MW. Unfortunately, crowd-sourced Energy Atlas data is unfortunately 7+ years out of date. Data from the most recent data set provided in the dashboard were cross referenced with the DG data provided by the PSD.

Capacity Factor is the ratio of actual electrical energy output over a given period of time to the theoretical maximum over that same period (the theoretical maximum energy output of a given installation being continuous operation at full nameplate capacity over the relevant time period).

GROUND-MOUNTED SOLAR ENERGY POTENTIAL

The methodology for estimating ground-mounted solar electricity potential is to divide the number of acres available as prime and base resources by 7 acres per MW for prime solar; 60 acres per MW is used for base solar to account for the presence of possible constraints that reduce the land usable for solar panels. The annual electricity production is then estimated using this formula: Solar MWh of energy = (number of MW) * (8760 hours per year) * (0.15 capacity factor).

ROOFTOP SOLAR ENERGY POTENTIAL

Rooftop solar potential data is sourced from the Vermont Center for Geographic Information (VCGI) dataset named Town Rooftop Solar Potential – Act 174 2022. As explained in the release notes, these estimates use a geographic information system (GIS) model of building footprints to determine the total surface area of rooftops suitable for solar photovoltaic panels (accounting for amount of solar radiation, slope, aspect, shading of nearby objects, and minimum size of rooftop viable for solar panels). Using published data for solar radiation, the VCGI data also estimates an annual solar energy production potential for each suitable rooftop, summarized by municipality, applying a capacity factor of 13.76% as published by the U.S. Environmental Protection Agency. The total system capacity in megawatts is then estimated using the following formula: Rooftop MW of capacity = (number of annual MW) * ((0.145 capacity factor) * (8760 hours per year)). This was further curtailed by ACRPC to provide a conservative estimate as roof and condition could not be integrated at this point in analyses.

WIND ENERGY POTENTIAL

The methodology for estimating wind electricity potential is to divide the number of acres available as prime and base resources by 25 acres per MW. There is no reduced land factor for base wind since possible constraints have a lesser impact on actual equipment siting due to the vertical nature of wind turbines. Then to estimate the amount of production using this formula. Wind MWh of energy = (number of MW) * (8760 hours per year) * (0.225 capacity factor).

CALCULATING RENEWABLE ENERGY GENERATION TARGETS

Municipalization is based on a weighted average of the following factors agreed upon by the ACRPC Energy Committee: Land Area: 20%, Existing Generation: 10%, Demand: 50%, Population: 20%. The target selected was the maximum available of 25% In-State Generation. All data used and targets generated can be found in the ACRPC Generation Scenarios Tool.

STATE KNOWN AND POSSIBLE CONSTRAINT DEFINITIONS AND DESCRIPTIONS

The following is a list of the known, possible, and regional constraints that were used and referenced in the mapping section of this document. A definition of the constraint including source of the data is provided. As discussed in the report, RPCs supported a coordinated effort by the Department of Public Service, VCGI, and ANR to aggregate these layers which are now available via the Act 174 tab of the DHCD Planning Atlas.

KNOWN CONSTRAINTS

Vernal Pools (confirmed and unconfirmed layers)

Source: Vermont Fish and Wildlife, 2009 - present. Vernal pools are temporary pools of water that provide habitat for distinctive plants and animals. Data was collected remotely using color infrared aerial photo interpretation. "Potential" vernal pools were mapped and available for the purpose of confirming whether vernal pool habitat was present through site visits. This layer represents both those sites which have not yet been field-visited or verified as vernal pools, and those that have.

Department of Environmental Conservation (DEC) River Corridors

Source: DEC Watershed Management District Rivers Program, January 2015. River corridors are delineated to provide for the least erosive meandering and floodplain geometry toward which a river will evolve over time. River corridor maps guide State actions to protect, restore, and maintain naturally stable meanders and riparian areas to minimize erosion hazards. Land within and immediately abutting a river corridor may be at higher risk to fluvial erosion during floods. River corridors encompass an area around and adjacent to the present channel where fluvial erosion, channel evolution, and down-valley meander migration are most likely to occur. River corridor widths are calculated to represent the narrowest band of valley bottom and riparian land necessary to accommodate the least erosive channel and floodplain geometry that would be created and maintained naturally within a given valley setting.

Federal Emergency Management Agency (FEMA) Floodways

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

State-significant Natural Communities and Rare, Threatened, and Endangered Species

Source: Vermont Fish and Wildlife, National Heritage Inventory. The Vermont Fish and Wildlife Department's Natural Heritage Inventory (NHI) maintain a database of rare, threatened, and endangered species and natural (plant) communities in Vermont. The Element Occurrence (EO) records that form the core of the Natural Heritage Inventory database include information on the location, status, characteristics, numbers, condition, and distribution of elements of biological diversity using established Natural Heritage Methodology developed by NatureServe and The Nature Conservancy. An EO is an area of land and/or water in which a species or natural community is, or was, present. An EO should

DRAFT 6-10-26 | Public Hearing

have practical conservation value for the Element as evidenced by potential (or historical) presence and/or regular recurrence at a given location. For species Elements, the EO often corresponds with the local population, but when appropriate, may be a portion of a population or a group of nearby populations (e.g., meta-population).

National Wilderness Areas

Source: United States Department of Agriculture Forest Service. A parcel of Forest Service land congressionally designated as wilderness. Class 1 and Class 2.

WETLANDS

Source: Vermont Significant Wetland Inventory (VSWI) and advisory layers. The State of Vermont protects wetlands which provide significant functions and values and also protects a buffer zone directly adjacent to significant wetlands. Wetlands in Vermont are classified as Class I, II, or III based on the significance of the functions and values they provide. Class I and Class II wetlands provide significant functions and values and are protected by the Vermont Wetland Rules. Any activity within a Class I or II wetland or buffer zone which is not exempt or considered an “allowed use” under the Vermont Wetland Rules requires a permit. Class I wetlands have been determined to be, based on their functions and values, exceptional or irreplaceable in its contribution to Vermont’s natural heritage and, therefore, merits the highest level of protection. All wetlands contiguous to wetlands shown on the VSWI maps are presumed to be Class II wetlands, unless identified as Class I or III wetlands, or unless determined otherwise by the Secretary or Panel pursuant to Section 8 of the Vermont Wetland Rules.

POSSIBLE CONSTRAINTS

Agricultural Soils

Source: Natural Resources Conservation Service (NRCS) “Primary agricultural soils” are defined as “soil map units with the best combination of physical and chemical characteristics that have a potential for growing food, feed, and forage crops, have sufficient moisture and drainage, plant nutrients or responsiveness to fertilizers, few limitations for cultivation or limitations which may be easily overcome, and an average slope

that does not exceed 15%.” Present uses may be cropland, pasture, regenerating forests, forestland, or other agricultural or silvicultural uses. The soils must be of a size and location, relative to adjoining land uses, so that those soils will be capable, following removal of any identified limitations, of supporting or contributing to an economic or commercial agricultural operation. Unless contradicted by the qualifications stated above, primary agricultural soils include important farmland soils map units with a rating of prime, statewide, or local importance as defined by the Natural Resources Conservation Service of the United States Department of Agriculture.

FEMA Special Flood Hazard Areas

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

Protected Lands

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

Act 250 Ag Mitigation Parcels

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

Deer Wintering Areas (DWA)

Source: Vermont Department of Fish and Wildlife. Deer winter habitat is critical to the long-term survival of white-tailed deer (*Odocoileus virginianus*) in Vermont.

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

Vermont Conservation Design include the following Highest Priority Forest Blocks

Connectivity, Interior, and Physical Landscape Diversity

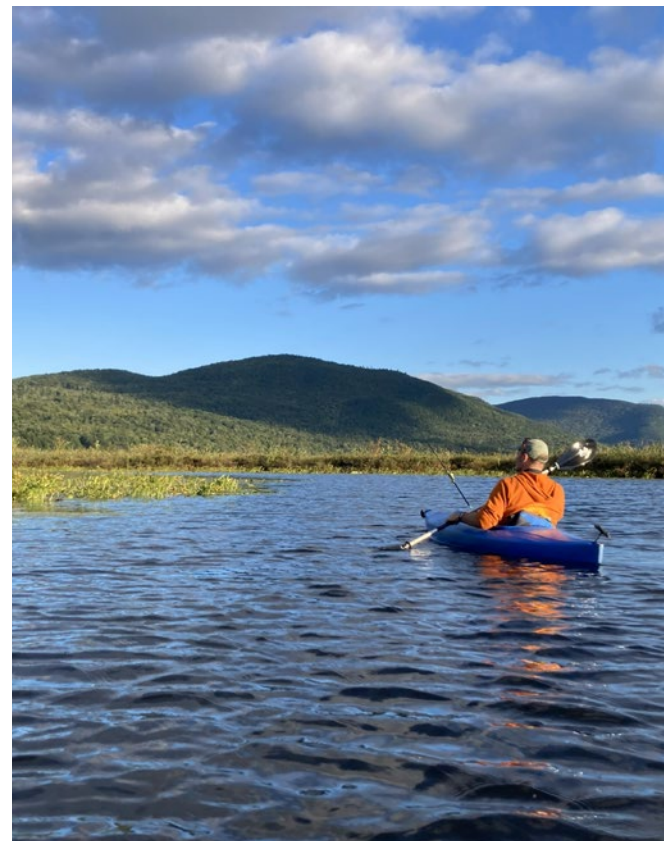
Source: Vermont Department of Fish and Wildlife. The lands and waters identified in this constraint are the areas of the state that are of highest priority for maintaining ecological integrity. Together, these lands comprise a connected landscape of large and intact forested habitat, healthy aquatic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

Hydric Soils

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



Limstone Bluff Cedar-Pine Forest



Canoeing on Bristol Pond

DRAFT 6-10-26 | Public Hearing