Energy Supplement

- Policy Frameworks
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Policy Frameworks

Act 174 Enhanced Energy Planning:

During the 2016 legislative session, the State of Vermont passed Act 174, an act related to improving the siting of energy projects. Act 174 outlines a path whereby regions and municipalities could receive "substantial deference"[1] for applications that seek to receive a Certificate of Public Good before the Public Utility Commission (formerly the Public Service Board) if certain considerations were incorporated into a regional or municipal development plan. Act 174 provides an avenue for regions and municipalities to have increased input in Public Utility Commission determinations for Certificates of Public Good regarding renewable energy generation facilities. Otherwise, a plan will receive "due consideration" in the Section 248 review process. Act 174 is categorized as enhanced energy planning and goes beyond what is outlined in 24 VSA 117 Section §4348a and §4382 respectively (see below for contents; supplement for details). In general, the requirements of Act 174, updated in 2022 in line with the Climate Action Plan, work in conjunction with the existing statutory information required to be included in a regional plan's energy element (as described in 24 V.S.A. § 4348a(a)(3)). Furthermore, the standards outlined in Act 174 require regional and municipal plans to be consistent with the following State Goals and Policies:

- Greenhouse gas reduction requirements under 10 V.S.A. § 578(a)
  - 26% from 2005 levels by 2025
  - 40% from 1990 levels by 2030
  - 80% from 1990 levels by 2050
- The 25 x 25 goal for renewable energy under 10 V.S.A. § 580 (25% in-state renewables supply for all energy uses by 2025)
- Building efficiency goals under 10 V.S.A. § 581 (e.g., reduce fossil fuel consumption across all buildings by 10% by 2025)
- State energy policy under 30 V.S.A. § 202a and the recommendations for regional and municipal planning pertaining to the efficient use of energy and the siting and development of renewable energy resources contained in the State energy plans adopted pursuant to 30 V.S.A. §§ 202a and 202b
  - Includes meeting 90% of energy needs with renewable sources by 2050 (as well as intermediate targets and sector-specific targets)
- The distributed renewable generation and energy transformation categories of resources to meet the requirements of the Renewable Energy Standard under 30 V.S.A. §§ 8004 and 8005 (2024 Act 179 changed key tier requirements to reflect 100% renewable electricity by 2035 and created two new tiers: Tier 4 new regional renewable energy and Tier 5 on load growth)

This plan integrates and references the following:

- State Comprehensive Energy Plan (CEP) 2022

[1] According to Act 174 of 2016, "substantial deference" means that a land conservation measure or specific policy shall be applied in accordance with its terms unless there is a clear and convincing demonstration that other factors affecting the general good of the State outweigh the application of the measure or policy. The term shall not include consideration of whether the determination of energy compliance should or should not have been affirmative under 24 V.S.A. § 4352.

    - Low-Emissions Analysis Platform (LEAP) informs statewide targets, methodology update and target update (2022)
    - **Appendix B- Act 174 Standards:** The 2022 Comprehensive Energy Plan (CEP), published on January 14, 2022, includes several important updates to the Act 174 enhanced energy standards
- State Climate Action Plan (2021 and 2025 update) 10 V.S.A § 592
- Long Range Transmission Plan Update (VELCO) (2024) (especially solar optimization transmission and distribution resources constraints)
- Utility Integrated Resource Plans (Green Mountain Power, Washington Electric, Northfield Electric Department, and Hardwick Electric Department)

The Central Vermont Regional Planning Commission first received a Determination of Energy Compliance (DOEC) through the Vermont Public Utilities Commission (PUC) with the 2018 Regional Energy Plan adopted as an amendment and Appendix A-7 of the 2016 Regional Plan. Since then, 7 municipalities have received determinations of energy compliance via municipal enhanced energy plans including Barre Town, Northfield, Waterbury, Waitsfield, Middlesex, Plainfield, and Woodbury, 1 municipality has a Net Zero Action Plan (Montpelier), 6 are currently in the Enhanced Energy Planning process (including Worcester, East Montpelier, Marshfield, Moretown, Calais, and Williamstown), and at least 3 more municipalities had developed drafts which were interrupted by the pandemic (and while they have not yet submitted their plans for approval, do include targets, maps, and preferred siting language in their existing town plans). Municipal breakouts of the Regional analyses and targets-based State forecasting from the Low Emissions Analysis Platform (LEAP)[2], as well as municipal breakouts of the mapping products to support municipal planning and implementation, will be posted and hosted on the CVRPC website once this plan has been reviewed and approved (drafts will be made available to support the 5+ municipalities currently working on their enhanced energy plans).

Equity Framework
Energy burden is just one metric to consider when assessing potential impacts and needs. In Central Vermont, outages (frequency and duration), income, distribution utility, and fuel assistance uptake, are key recurring considerations throughout this plan and the region. New tools and metrics have been and continue to be developed at the State and Federal level with varying applicability to Vermont (inset below). CVRPC is committed to continuing to engage with these tools and resources and integrate them into future planning

Federal Indices/Programs*	State Definitions	State Indices/Tools
• Justice40+/- • Energy Justice Mapping Tool- Disadvantage Communities Reporter • Climate and Economic Justice Screening Tool • EPA-EJ screening and mapping tool ▪ Economic Innovation Group's Distressed Communities Index	As defined by Act 154, environmental justice populations are "any census block group in which: (A) the annual median household income is not more than 80% of the State median household income; (B) Person of	▪ Vermont Environmental Disparity Index and Environmental Risk ▪ Forthcoming Environmental Justice Communities Tool (S.248) ▪ Municipal Vulnerabilities Index

[2] a software tool for energy system modeling and emissions accounting, across residential, commercial, industrial, and transportation energy use

(DCI) Interactive Map: relative distress scores and economic distress characteristics ▪ DOE's Low-Income Energy Affordability Data (LEAD) Tool ▪ Social Vulnerability Index Score (relative health burden; GMP used as part of their scoring) ▪ EIG's Opportunity Zone Activity Map, Distressed Energy Community, Disadvantaged Community *some of these tools are no longer in use by the Federal Government	Color and Indigenous Peoples comprise at least 6% or more of the population; or (C) at least 1% or more of households have limited English proficiency."	(Climate Action Office) ▪ Vermont Community Index/Underserved Communities (AOA) ▪ Vermont Department of Health's vulnerability indicators

Most of these tools rely on American Community Survey data and the census tract resolution is often too coarse to be very useful. Using the Climate & Economic Justice Screening Tool (CJEST) associated with the Justice 40 campaign (which uses data from DOE's LEAD Score, the EPA's EJScreen, and ACS) only 1 Barre City Tract would qualify as disadvantaged in Central Vermont. Although the 36 burden indicators in the improved energy justice map viewer could be useful in the context of project prioritization at the state and perhaps at the regional level, they do not provide useful insights for municipal scale planning. These indicators are attached to eligibility for funding and technical assistance programs making them useful and important guardrails, albeit coarse ones. Community asset inventories, needs assessments, engagement, and related efforts will be necessary to drive frontline community identification for prioritization. An iterative process at the project scale is an effective strategy for ensuring that projects align with community needs and priorities, fostering more equitable outcomes and sustainable development in the long run. This approach allows for continuous feedback and adaptation, enabling stakeholders to respond to the evolving challenges and opportunities within the community.

Energy Burden (2019 Efficiency Vermont Report[3])

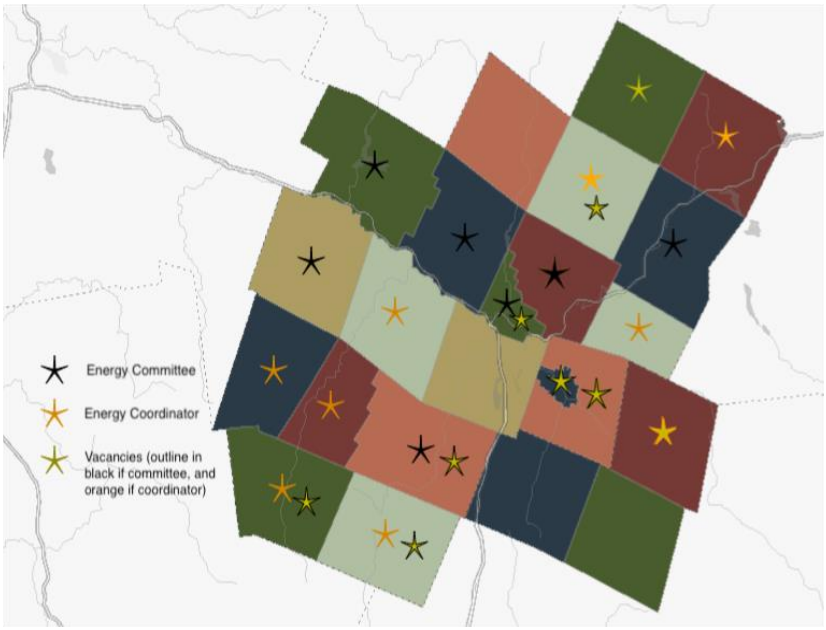
Town	Median Household Income	Electricity Spending	Thermal Spending	Transportation Spending	Total Spending	Total Energy Burden	Energy Burden Group
Barre City	$35,225	$1,110	$1,965	$2,227	**$5,302**	**15.1%**	Highest
Cabot	$43,864	$1,096	$2,081	$2,725	**$5,902**	**13.5%**	High
Plainfield	$48,529	$987	$2,222	$2,657	**$5,865**	**12.1%**	High
Worcester	$49,167	$1,085	$1,882	$2,757	**$5,724**	**11.6%**	High
Williamstown	$57,792	$1,221	$2,317	$2,584	**$6,122**	**10.6%**	Moderate
Washington	$56,696	$1,213	$2,062	$2,693	**$5,968**	**10.5%**	Moderate
Roxbury	$56,667	$1,059	$1,987	$2,703	**$5,749**	**10.1%**	Moderate

[3] The 2023 Report did update this data, however the update also changed methodology, especially for the transportation sector, which relied on national datasets with coarse resolution for our communities. Therefore, we prefer to use the 2019 Report which had a more bottom-up approach.

Berlin	$59,792	$1,161	$2,120	$2,585	**$5,866**	**9.8%**	Moderate
Marshfield	$60,833	$1,081	$2,050	$2,680	**$5,812**	**9.6%**	Moderate
Orange	$62,829	$1,094	$2,089	$2,692	**$5,874**	**9.3%**	Moderate
Waterbury	$65,750	$1,131	$2,426	$2,557	**$6,114**	**9.3%**	Moderate
Warren	$66,250	$1,101	$2,343	$2,608	**$6,052**	**9.1%**	Moderate
Barre Town	$70,521	$1,204	$2,396	$2,669	**$6,268**	**8.9%**	Low
East Montpelier	$67,844	$1,209	$2,131	$2,678	**$6,018**	**8.9%**	Low
Calais	$64,766	$964	$1,974	$2,747	**$5,685**	**8.8%**	Low
Moretown	$69,375	$1,135	$2,223	$2,707	**$6,065**	**8.7%**	Low
Woodbury	$63,438	$949	$1,839	$2,755	**$5,543**	**8.7%**	Low
Northfield	$67,750	$1,105	$2,099	$2,585	**$5,789**	**8.5%**	Low
Montpelier	$60,793	$957	$1,804	$2,288	**$5,049**	**8.3%**	Low
Middlesex	$74,188	$1,130	$2,191	$2,749	**$6,071**	**8.2%**	Low
Duxbury	$75,000	$1,074	$2,276	$2,752	**$6,103**	**8.1%**	Low
Fayston	$79,940	$1,080	$2,646	$2,681	**$6,407**	**8%**	Low
Waitsfield	$78,264	$1,189	$2,317	$2,660	**$6,166**	**7%**	Low

Climate Council Principles:

This plan also follows the guidelines established by the State of Vermont Climate Council's Guiding Principles for a Just Transition; energy planning, policies, and strategies were developed with these principles in mind.



PLACEHOLDER FIGURE: Town with Enhanced Energy Plans, Energy Committees and Coordinators

Central Vermont has 17 towns with Energy Committees and/or Coordinators and 3 towns with vacant or inactive Energy Committees or Coordinators (Figure). Energy Committees and Coordinators have varying roles:

- Advise town legislative and planning bodies concerning Town energy policy including enhanced energy planning, project development/review, etc.,
- Promote municipal energy efficiency and resilience, and lower energy costs,

- Develop municipal/community projects from renewable energy generation and storage projects to running WindowDressers Community Builds (see insert),
- Develop and implement community outreach, education, & neighbor: neighbor campaigns to provide residents and businesses with resources to reduce energy burdens, improve energy efficiency, and reduce greenhouse gas emissions.

CVRPC has noticed a significant increase in engagement with enhanced energy and other planning processes at the local, regional, and state levels in parallel with town participation in programs like the Municipal Energy Resilience Grant Program (Act 172), previously available federal incentives programs like through the IRA (Inflation Reduction Act), etc. as well as state incentive programs. Towns see a role for themselves in project development while feeling urgency to reduce municipal energy spending and community energy burdens while increasing community resilience in the face of global climate change

Methodology: Municipal Energy Use and Targets

Please refer to the Department of Public Service's 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. Lastly, up-to-date supplement can be found on the CVRPC webpage along with municipal breakouts for targets which will be published throughout the Summer of 2026 and updated as municipalities adjust for their own enhanced energy planning needs.

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 & industrial electricity usage data is provided by Efficiency Vermont (both municipal and regional totals- see supplement), 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) (see supplement for specifics). Using the regionalized LEAP results provided by the Department of Public Service, 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 (update 2022). Targets include both a "business as usual" baseline and the CAP (Climate Action Plan) mitigation scenario targets. While a summary of results is included below and referenced throughout this chapter, a walkthrough of the methods, data sources, and interim steps are included in the supplement and accompanying tools and supporting resources hosted by the Department of Public Service. Furthermore, full details of the LEAP Model methods, data sources and assumptions may be found as Appendix D to the 2022 Comprehensive Energy Plan[4]. Municipal analyses and targets will be made available on the CVRPC website.

Residential Heating Energy Use and Cost Estimates

Current Regional Residential Heating Energy Use by Fuel Source

Residential Fuel Source	2020 ACS 5 Year Estimate				2015 ACS 5 Year Estimate			
	CVRPC Households	CVRPC % Households	CVRPC Square Footage Heated	CVRPC BTU (in Billions)	CVRPC Households	CVRPC % of Households	CVRPC Square Footage Heated	CVRPC BTU (in Billions)
Natural Gas & Propane	7,935	29%	12,927,060	776	5,983	22%	9,632,438	578
Electricity	1,534	6%	1,937,060	116	1,206	5%	1,494,263	90
Fuel Oil	13,376	49%	23,073,188	1,384	14,238	53%	24,431,228	1,466
Coal	15	<1%	29,352	1.8	66	<1%	132,664	8
Wood	3,875	14%	7,342,750	441	5,031	19%	9,493,439	570
Other (Solar +)	656	2%	1,117,591	67	392	2%	696,536	42
No Fuel	34	<1%	44,545	2.7	22	<1%	42,680	3
Total	**27,425**		**46,427,157**	**2788**	**26,938**		**45,923,248**	**2755**

Source: 2016-2020 5 Year American Community Survey; 2011-2015 ACS; DPO4, B25117, B25010

Data Considerations for underpinning data

- These estimates have been updated in the energy chapter to be based on 2024 ACS 5-year estimates which have large margins of error especially in rural areas and **only identify one primary heating fuel while many residents use two or more**
  - Municipal Consumption Tool Current Heat tabs updated with 2024 ACS 5 year data for occupation, fuel tenure, housing characteristics, etc. Commercial not updated (PSD provided 2022)
- Due to large margins of error, it is difficult to determine if there are indeed less than 1% of households still using coal and without fuel; it is difficult to interpret the categories of solar and other, solar may refer to passive or active solar heating, or given the rise since the last plan it's possible respondents have installed solar panels and have heat pumps and are misidentifying their fuel type
- Tables in the Energy Chapter are based on total occupied units, but there are many seasonal, recreation, and/or occasional use (2nd) homes across the region (2022 ACS 5-Year Average B25004 Vacancy Characteristics). The table below (see 6. Determine energy use for seasonal units) supplies an additional adder to take into consideration thermal use in these homes: 4,137 homes across the region account for approximately 97,201.5 additional MMBTUs of energy use

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[4] https://publicservice.vermont.gov/content/2022-cep-analysis-greenhouse-gas-emission-reduction-pathways-vermont

(conservatively). While thus far fewer low-temperature degree days in the winter have yet to result in reduced fuel consumption in the winter (without stable declining temperatures, residents may not adjust as naturally to cold temperatures), more frequent high-temperature degree days are associated with increased heat-related health issues (VDH Climate Dashboard) including Central Vermont where few have adopted air conditioning and the threshold for health impacts is lower (86 as compared to 90 in Burlington). The increased use of air conditioning in the region will need to be assessed in future updates, as we continue to experience increasingly extreme storms, loss of stable seasons, and overall warmer, wetter conditions associated with Climate Change.

2022 ACS- 5 year estimate Regional Residential Fuel Use by Type and Town

% of Fuel Use by Tenure	ORANGE						WASHINGTON					
	Owner Occupied		Renter Occupied		Total Occupied		Owner Occupied		Renter Occupied		Total Occupied	
	#	%	#	%	#	%	#	%	#	%	#	%
Utility gas	0	0.0%	0	0.0%	**0**	**0.0%**	16	3.2%	0	0.0%	**16**	**3.1%**
Bottled, tank, or LP gas	75	19.5%	4	10.5%	**79**	**18.7%**	109	22.1%	13	46.4%	**122**	**23.4%**
Electricity	0	0.0%	3	7.9%	**3**	**0.7%**	0	0.0%	0	0.0%	**0**	**0.0%**
Fuel oil, kerosene, etc.	204	53.1%	31	81.6%	**235**	**55.7%**	191	38.7%	3	10.7%	**194**	**37.2%**
Coal or coke	3	0.8%	0	0.0%	**3**	**0.7%**	0	0.0%	0	0.0%	**0**	**0.0%**
Wood	86	22.4%	0	0.0%	**86**	**20.4%**	169	34.2%	12	42.9%	**181**	**34.7%**
Other Fuel	16	4.2%	0	0.0%	**16**	**3.8%**	9	1.8%	0	0.0%	**9**	**1.7%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Total Occupied Housing Units	384		38		**422**		494		28		**522**	

% of Fuel Use by Tenure	WILLIAMSTOWN						BARRE CITY					
	Owner Occupied		Renter Occupied		Total Occupied		Owner Occupied		Renter Occupied		Total Occupied	
	#	%	#	%	#	%	#	%	#	%	#	%
Utility gas	0	0.0%	0	0.0%	**0**	**0.0%**	58	3.3%	144	7.1%	202	5.3%
Bottled, tank, or LP gas	326	26.7%	75	78.9%	**401**	**30.5%**	286	16.3%	562	27.6%	848	22.3%
Electricity	30	2.5%	0	0.0%	**30**	**2.3%**	45	2.6%	287	14.1%	332	8.7%
Fuel oil, kerosene, etc.	679	55.7%	20	21.1%	**699**	**53.2%**	1,187	67.6%	976	47.9%	2163	57.0%
Coal or coke	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	0	0.0%
Wood	160	13.1%	0	0.0%	**160**	**12.2%**	98	5.6%	48	2.4%	146	3.8%
Other Fuel	25	2.0%	0	0.0%	**25**	**1.9%**	72	4.1%	22	1.1%	94	2.5%
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	10	0.6%	0	0.0%	10	0.3%
Total Occupied Housing Units	1120		95		**1315**		1756		2039		3795	

% of Fuel Use by Tenure	BARRE TOWN						BERLIN					
	Owner Occupied		Renter Occupied		Total Occupied		Owner Occupied		Renter Occupied		Total Occupied	
	#	%	#	%	#	%	#	%	#	%	#	%
Utility gas	10	0.3%	0	0.0%	**10**	**0.3%**	10	1.0%	0	0.0%	**10**	**0.9%**
Bottled, tank, or LP gas	389	12.8%	76	14.4%	**465**	**13.0%**	219	22.9%	32	25.8%	**251**	**23.2%**

Electricity	82	2.7%	157	29.7%	**239**	**6.7%**	12	1.3%	4	3.2%	**16**	**1.5%**
Fuel oil, kerosene, etc.	2,146	70.4%	296	56.0%	**2442**	**68.3%**	614	64.1%	75	60.5%	**689**	**63.7%**
Coal or coke	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Wood	393	12.9%	0	0.0%	**393**	**11.0%**	88	9.2%	13	10.5%	**101**	**9.3%**
Other Fuel	27	0.9%	0	0.0%	**27**	**0.8%**	15	1.6%	0	0.0%	**15**	**1.4%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Total Occupied Housing Units	3047		529		3576		958		124		1082	

% of Fuel Use by Tenure	**CABOT**						**CALAIS**					
	Owner Occupied		**Renter Occupied**		**Total Occupied**		**Owner Occupied**		**Renter Occupied**		**Total Occupied**	
	#	%	#	%	#	%	#	%	#	%	#	%
Utility gas	0	0.0%	0	0.0%	**0**	**0.0%**	26	4.1%	0	0.0%	**26**	**3.6%**
Bottled, tank, or LP gas	108	21.1%	24	24.7%	**132**	**21.7%**	86	13.6%	52	57.8%	**138**	**19.1%**
Electricity	11	2.2%	10	10.3%	**21**	**3.5%**	0	0.0%	0	0.0%	**0**	**0.0%**
Fuel oil, kerosene, etc.	144	28.2%	35	36.1%	**179**	**29.4%**	193	30.5%	24	26.7%	**217**	**30.0%**
Coal or coke	2	0.4%	0	0.0%	**2**	**0.3%**	8	1.3%	0	0.0%	**8**	**1.1%**
Wood	181	35.4%	28	28.9%	**209**	**34.4%**	295	46.6%	14	15.6%	**309**	**42.7%**
Other Fuel	65	12.7%	0	0.0%	**65**	**10.7%**	25	3.9%	0	0.0%	**25**	**3.5%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Total Occupied Housing Units	511		97		**608**		633		90		**723**	

% of Fuel Use by Tenure	**DUXBURY**						**EAST MONTPELIER**					
	Owner Occupied		**Renter Occupied**		**Total Occupied**		**Owner Occupied**		**Renter Occupied**		**Total Occupied**	
	#	%	#	%	#	%	#	%	#	%	#	%
Utility gas	3	0.6%	0	0.0%	**3**	**0.5%**	0	0.0%	0	0.0%	**0**	**0.0%**
Bottled, tank, or LP gas	201	41.5%	42	50.0%	**243**	**42.8%**	319	32.5%	18	12.5%	**337**	**29.9%**
Electricity	0	0.0%	0	0.0%	**0**	**0.0%**	16	1.6%	14	9.7%	**30**	**2.7%**
Fuel oil, kerosene, etc.	150	31.0%	35	41.7%	**185**	**32.6%**	378	38.5%	107	74.3%	**485**	**43.0%**
Coal or coke	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Wood	130	26.9%	3	3.6%	**133**	**23.4%**	239	24.3%	5	3.5%	**244**	**21.7%**
Other Fuel	0	0.0%	4	4.8%	**4**	**0.7%**	31	3.2%	0	0.0%	**31**	**2.8%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Total Occupied Housing Units	484		84		**568**		983		144		**1127**	

% of Fuel Use by Tenure	FAYSTON						MARSHFIELD					
	Owner Occupied		Renter Occupied		Total Occupied		Owner Occupied		Renter Occupied		Total Occupied	
	#	%	#	%	#	%	#	%	#	%	#	%
Utility gas	4	1.0%	0	0.0%	**4**	**0.8%**	6	1.1%	0	0.0%	**6**	**1.0%**
Bottled, tank, or LP gas	254	60.5%	54	100.0%	**308**	**65.0%**	89	16.3%	5	7.6%	**94**	**15.4%**
Electricity	0	0.0%	0	0.0%	**0**	**0.0%**	15	2.8%	0	0.0%	**15**	**2.5%**
Fuel oil, kerosene, etc.	81	19.3%	0	0.0%	**81**	**17.1%**	207	38.0%	33	50.0%	**240**	**39.3%**
Coal or coke	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Wood	78	18.6%	0	0.0%	**78**	**16.5%**	198	36.3%	28	42.4%	**226**	**37.0%**
Other Fuel	3	0.7%	0	0.0%	**3**	**0.6%**	30	5.5%	0	0.0%	**30**	**4.9%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Total Occupied Housing Units	420		54		**474**		545		66		**611**	

% of Fuel Use by Tenure	MIDDLESEX						MONTPELIER					
	Owner Occupied		Renter Occupied		Total Occupied		Owner Occupied		Renter Occupied		Total Occupied	
	#	%	#	%	#	%	#	%	#	%	#	%
Utility gas	5	0.7%	0	0.0%	**5**	**0.7%**	47	2.2%	85	5.0%	**132**	**3.4%**
Bottled, tank, or LP gas	215	30.4%	8	25.0%	**223**	**30.1%**	363	16.9%	627	36.7%	**990**	**25.6%**
Electricity	5	0.7%	0	0.0%	**5**	**0.7%**	80	3.7%	173	10.1%	**253**	**6.6%**
Fuel oil, kerosene, etc.	291	41.1%	11	34.4%	**302**	**40.8%**	1,369	63.6%	723	42.4%	**2092**	**54.2%**
Coal or coke	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Wood	177	25.0%	13	40.6%	**190**	**25.7%**	251	11.7%	14	0.8%	**265**	**6.9%**
Other Fuel	15	2.1%	0	0.0%	**15**	**2.0%**	39	1.8%	66	3.9%	**105**	**2.7%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	5	0.2%	19	1.1%	**24**	**0.6%**
Total Occupied Housing Units	708		32		**740**		2154		1707		**3861**	

% of Fuel Use by Tenure	MORETOWN						NORTHFIELD					
	Owner Occupied		Renter Occupied		Total Occupied		Owner Occupied		Renter Occupied		Total Occupied	
	619	%	102	%	#	%	1,351	%	455	%	#	%
Utility gas	3	0.5%	0	0.0%	**3**	**0.4%**	0	0.0%	32	7.0%	**32**	**1.8%**
Bottled, tank, or LP gas	267	43.1%	42	41.2%	**309**	**42.9%**	156	11.5%	45	9.9%	**201**	**11.1%**
Electricity	26	4.2%	38	37.3%	**64**	**8.9%**	28	2.1%	73	16.0%	**101**	**5.6%**

Fuel oil, kerosene, etc.	178	28.8%	16	15.7%	**194**	**26.9%**	910	67.4%	278	61.1%	**1188**	**65.8%**
Coal or coke	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Wood	119	19.2%	3	2.9%	**122**	**16.9%**	257	19.0%	0	0.0%	**257**	**14.2%**
Other Fuel	26	4.2%	3	2.9%	**29**	**4.0%**	0	0.0%	27	5.9%	**27**	**1.5%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Total Occupied Housing Units	619		102		**721**		1351		455		**1806**	

% of Fuel Use by Tenure	**PLAINFIELD**						**ROXBURY**					
	Owner Occupied		**Renter Occupied**		**Total Occupied**		**Owner Occupied**		**Renter Occupied**		**Total Occupied**	
	#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
Utility gas	0	0.0%	0	0.0%	**0**	**0.0%**	3	0.8%	0	0.0%	**3**	**0.7%**
Bottled, tank, or LP gas	85	22.8%	28	16.5%	**113**	**20.8%**	100	27.4%	8	12.5%	**108**	**25.2%**
Electricity	2	0.5%	22	12.9%	**24**	**4.4%**	0	0.0%	1	1.6%	**1**	**0.2%**
Fuel oil, kerosene, etc.	148	39.8%	103	60.6%	**251**	**46.3%**	161	44.1%	35	54.7%	**196**	**45.7%**
Coal or coke	0	0.0%	0	0.0%	**0**	**0.0%**	2	0.5%	0	0.0%	**2**	**0.5%**
Wood	114	30.6%	17	10.0%	**131**	**24.2%**	94	25.8%	14	21.9%	**108**	**25.2%**
Other Fuel	23	6.2%	0	0.0%	**23**	**4.2%**	5	1.4%	6	9.4%	**11**	**2.6%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Total Occupied Housing Units	372		170		**542**		365		64		**429**	

% of Fuel Use by Tenure	**WAITSFIELD**						**WARREN**					
	Owner Occupied		**Renter Occupied**		**Total Occupied**		**Owner Occupied**		**Renter Occupied**		**Total Occupied**	
	#	%	#	%	#	%	#	%	#	%	**#**	**%**
Utility gas	0	0.0%	22	10.5%	**22**	**2.6%**	17	2.7%	37	28.5%	**54**	**7.1%**
Bottled, tank, or LP gas	342	52.7%	90	43.1%	**432**	**50.3%**	366	58.5%	73	56.2%	**439**	**58.1%**
Electricity	76	11.7%	18	8.6%	**94**	**11.0%**	44	7.0%	0	0.0%	**44**	**5.8%**
Fuel oil, kerosene, etc.	167	25.7%	40	19.1%	**207**	**24.1%**	76	12.1%	11	8.5%	**87**	**11.5%**
Coal or coke	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Wood	54	8.3%	11	5.3%	**65**	**7.6%**	116	18.5%	0	0.0%	**116**	**15.3%**
Other Fuel	10	1.5%	28	13.4%	**38**	**4.4%**	7	1.1%	9	6.9%	**16**	**2.1%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Total Occupied Housing Units	649		209		**858**		626		130		**756**	

% of Fuel Use by Tenure	WATERBURY						WOODBURY					
	Owner Occupied		Renter Occupied		Total Occupied		Owner Occupied		Renter Occupied		Total Occupied	
	♯	%	♯	5	♯	%	♯	%	♯	%	♯	%
Utility gas	30	2.0%	17	2.5%	**47**	**2.2%**	0	0.0%	0	0.0%	**0**	**0.0%**
Bottled, tank, or LP gas	620	41.1%	345	51.0%	**965**	**44.2%**	46	17.4%	6	20.7%	**52**	**17.7%**
Electricity	64	4.2%	186	27.5%	**250**	**11.4%**	8	3.0%	0	0.0%	**8**	**2.7%**
Fuel oil, kerosene, etc.	667	44.2%	128	18.9%	**795**	**36.4%**	114	43.2%	6	20.7%	**120**	**41.0%**
Coal or coke	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Wood	96	6.4%	0	0.0%	**96**	**4.4%**	94	35.6%	17	58.6%	**111**	**37.9%**
Other Fuel	32	2.1%	0	0.0%	**32**	**1.5%**	2	0.8%	0	0.0%	**2**	**0.7%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	0	0.0%	0	0.0%	**0**	**0.0%**
Total Occupied Housing Units	1509		676		**2185**		264		29		**293**	

% of Fuel Use by Tenure	Worcester						REGION TOTAL					
	Owner Occupied		Renter Occupied		Total Occupied		Owner Occupied		Renter Occupied		**Regional Total**	
	♯	%	♯	%	♯	%	Totals	%	Totals	%	**Totals**	**%**
Utility gas	0	0.0%	0	0.0%	**0**	**0.0%**	238	1%	337	5%	**575**	**2%**
Bottled, tank, or LP gas	87	26.3%	23	28.8%	**110**	**26.8%**	5,108	25%	2,252	32%	**7,360**	**27%**
Electricity	4	1.2%	0	0.0%	**4**	**1.0%**	548	3%	986	14%	**1,534**	**6%**
Fuel oil, kerosene, etc.	100	30.2%	35	43.8%	**135**	**32.8%**	10,355	51%	3,021	43%	**13,376**	**49%**
Coal or coke	0	0.0%	0	0.0%	**0**	**0.0%**	15	0%	0	0%	**15**	**0%**
Wood	126	38.1%	22	27.5%	**148**	**36.0%**	3,613	18%	262	4%	**3,875**	**14%**
Other Fuel	14	4.2%	0	0.0%	**14**	**3.4%**	491	2%	165	2%	**656**	**2%**
No fuel used	0	0.0%	0	0.0%	**0**	**0.0%**	15	0%	19	0%	**34**	**0%**
Total Occupied Housing Units	331		80		**411**		20,383		7,042		**27,425**	

The following explains the series of steps that CVRPC has taken to calculate estimates of Residential Heating Energy use, square footage, and costs for the Central Vermont 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 Central Vermont Region. As 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.

1. **Data (ACS 2022 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.
    e. These data can be downloaded into an excel spreadsheet, CSV, or other file type. CVRPC did this by town and aggregated them in 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, 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 category since he last plan and in the future are new heat pumps and not new resistance heat.
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 stove, 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 a close 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 given new technology; thus we combine with other fuel.
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.

2. **Determine total square footage of housing by tenure:** For renter households, multiply the average household occupancy (e.g. 2.24 people) by **500 sq ft per person** (this number is a constant; it comes from the US Census Bureau's 2011 American Housing Survey and represents the national average size of a housing rental housing unit per occupant). For owner households, multiply the average occupancy by **800 sq ft per person** (from the same report). This provides an estimate—albeit, a very rough one—for the total square footage of occupied housing.
   Note: This is one of several areas where the methods could be improved in the future as these are only very broad estimates.

3. **Square Footage by Fuel Type:** In order to estimate the amount of space being heated by each fuel, the percentage of each fuel type was generated for owner- and renter-occupied households. Once the fuel use as percentages of total Renter and Owner households were calculated, the percentage for each fuel was multiplied by the total estimated square footage calculated in step 2.

4. **Energy Required for Heating:** This step is very simple. CVRPC used a basic estimate to take square footage and turn it into a calculation of the energy required for heating. The Department of Public Service cites a range of estimates for heat energy intensities per square foot from 45,000BTUs to 80,000BTUs for poorly insulated, leaky buildings for example pre-1940s housing units among others. Given the aging housing stock across the region, CVRPC used 60,000 BTUs as a generic estimate of the annual energy required to heat one square foot of housing annually in Vermont. In other words, all of the total square footages were multiplied by 60,000 BTUs/square feet.

   Note: In the future CVRPC might account for energy efficiency here, based on the number of buildings that have been weatherized or the percentage of buildings built in each decade (assuming that older buildings are less energy efficient in general when not weatherized). But for the purpose of consistency with initial calculations—the goal of which is to establish a general understanding of energy use in our regions—and without a good baseline of total homes weatherized, this method seems sufficient.

5. **Convert to units of fuel and determine cost:** The total Energy required for each fuel type was divided by the Energy generated from one unit of that fuel type. CVRPC used the following estimates of energy/unit and cost per unit estimates below (Units used divided by cost per Unit). Note, ACS does not account for wood pellet use, a conversion and cost estimate is included in the table below so that municipalities who wish to account for pellet use may do so.

Fuel Type	Standard Unit	BTUs	Cost	Total Regional Cost (Current Use)	Source (cost/unit)
Fuel Oil, kerosene, etc.	Gallon	140,000	$4.133	40,869,208.29	Vermont Average Residential-EIA (March 2024)
Bottled, tank, or LP gas (propane)	Gallon	91,000	$3.575	30,470,927.14	Vermont Average Residential-EIA (March 2024)
Coal or coke	Ton	19,590,000	$500	44,949.46	VT newspapers and quote VT&NH suppliers
Wood (seasoned)	Cord	20,000,000	$350	7,709,887.50	(275 green-450 kiln dried) VT newspapers

					and quoted VT suppliers
Wood Pellets	Ton	16,400,000	$405		Vermont wood/pick-up; Energy Co-op of VT
Electricity	Kilowatt hour	3,414	$0.2109	3,939,594.36	**VT State Energy Profile, US Energy Information Administration**
Other Fuel (includes solar)				4,142,353.99	
Regional Total Cost				$87,176,920.74	

6. **Determine energy use for seasonal units:** There is no corresponding ACS data on heating sources of vacation/second/seasonal homes, though for several of the towns in the Central Vermont region, these make up a significant portion of overall homes. The Department of Public Service guidelines suggest that on average, seasonal homes account for about 5% of the thermal energy used in a year-round home (for example a seasonal camp may not have a central heating system, but it still may use propane to heat the water, have a woodstove or fireplace for unseasonably cool nights, etc.). This guidance does not quite match the Central Vermont region as several communities with many seasonal residents use their properties throughout the winter specifically and/or for more than occasional use. Thus, for estimation purposes we assigned 10% to seasonal units in the towns on the eastern half of the region featuring many lakes with summer seasonal population influx, and 25% for those on the western half of the region proximate to the region's winter recreation areas. Here is the formula for calculating MMBTUs for seasonal units:

Number of seasonal units (ACS) x Average MMBTUs per Owner-Occupied Unit (110) x 0.1 (or 0.25) = Total MMBTUs Seasonal

Table Current Regional Residential Thermal Energy Adder (MMBTU) for Seasonal/Vacation Homes

	Seasonal/Vacation Homes	MMBTUs	% Use
Orange	36	396	0.1
Washington	55	605	0.1
Williamstown	73	803	0.1
Barre City	0	0	0.1
Barre Town	27	297	0.1
Berlin	57	627	0.1
Cabot	116	1276	0.1
Calais	117	1287	0.1
Duxbury	56	1540	0.25
East Montpelier	30	330	0.1
Fayston	565	15537.5	0.25
Marshfield	45	495	0.1
Middlesex	48	1320	0.25
Montpelier	88	968	0.1
Morteown	77	2117.5	0.25
Northfield	58	1595	0.25
Plainfield	19	209	0.1

Roxbury	124	3410	0.25
Waitsfield	233	6407.5	0.25
Warren	1735	47712.5	0.25
Waterbury	171	4702.5	0.25
Woodbury	341	3751	0.1
Worcester	66	1815	0.25
Totals	**4,137**	**97,201.5**	

7. **Final Data Combination:** Results were combined and displayed.

Methodology for Commercial Energy Use Estimates

This table uses a worksheet, Municipal Consumption, created by the Department of Public Service, which uses data from the Vermont Department of Labor's Economic and Labor Market Information web site: http://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, which are highly variable.

Transportation Use Estimates

This data was developed using the Department of Public Service's Municipal Consumption worksheet. The total number of vehicles comes from American Community Survey (ACS) 5-Year Estimates. Average annual VMTs, accounts for slightly longer-than-average commutes and more incidental trips in the rural and commuter parts of our region. Total vehicle miles travelled assumes an average fuel economy of 22 miles per gallon. Registered EVs was determined by the Vermont Energy Investment Corporation (Drive Electric) and uses a low midpoint between the Dept. of Public Service's average of 7,000 VMTs per EV annually and the average of 12,000 for ICE vehicles taking into account early trends in EV adoption including reducing trips in adverse weather and co-incidence of alternative transportation modes as well as the high % of our region who is retired and thus without a daily commute.

Electricity Use (actual values 2023 as last reported)

Efficiency Vermont has compiled three years of data, based on that provided (variously) by utilities serving the region.

TARGETS: 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 and then converted where appropriate with accepted measure conversions provided in the Analysis and Targets Aid Bottom Up tool. Residential targets use the mean MMBTUs for occupied households in the municipality, which were calculated by CVRPC. Commercial targets use the data from the Vermont Department of Labor. Data in this table represent the percentages of municipal households and commercial establishments that will need to be weatherized in the target years. The targets are cumulative. Targets assume a 6% increase in number of housing units/commercial establishments over each period. Weatherization projects are assumed to achieve an average of 25% reduction in MMBTUs for residential units and 20% for commercial establishments, although some weatherization projects can actually achieve deeper savings. As with thermal efficiency targets, these targets assume a 6% increase in number of housing units/commercial establishments over each period.

Summary of 2020-2023 Residential Weatherization (Efficiency Vermont projects include Home Performance with Energy Star, other weatherization projects, and residential new construction projects; their total savings include all measures)

	2020		2021		2022		2023	
Total Homes Weatherized (Capstone only)	**78**		**143**		**112**		**173**	
Performance with ENERGY STAR Projects (Efficiency VT)	**136**		**123**		**70**		**329**	
Weatherization Projects (Efficiency VT)	**40**		**46**		**57**		**143**	
Residential New Construction Projects	**8**		**21**		**25**		**54**	
Total kWh Saved (Capstone)	**526.28**		**49,639.31**		**38,114.35**		**106,643.73**	
Total MMBTUs Saved (Capstone)	**2,680.07**		**2,843.15**		**5,220.97**		**6,915.32**	
Total kWh Saved (Efficiency VT))*	**3,476,376**		**471,560**					
Thermal MMBTUs Saved (Efficiency VT)*	**13,800**		**32,206**		**31,520**			
Town Totals	**Capstone (Homes)**	**Efficiency Vermont (Projects)**	**Capstone (Homes)**	**Efficiency Vermont (Projects)**	**Capstone (Homes)**	**Efficiency Vermont (Projects)**	**Capstone (Homes)**	**Efficiency Vermont (Projects)**
Barre City	20	31	25	38	19	28	38	
Barre Town	10	7	14	1	11	4	11	
Berlin	3	4	3	2	12	3	8	
Cabot	1	4	2	3	6	2	8	
Calais	2	8	2	7	3	2	9	
Duxbury	0	0	0	4	1	5	1	
East Montpelier	5	6	2	3	3	5	6	
Fayston	1	3	0	3	2	5	0	
Marshfield	1	4	2	3	2	2	2	
Middlesex	2	5	0	5	1	5	5	
Montpelier	10	41	16	46	17	27	28	

Moretown	2	5	2	10	3	3	1	
Northfield	5	10	29	12	14	6	10	
Orange	2	0	3	0	2	0	6	
Plainfield	1	8	3	4	2	1	3	
Roxbury	2	3	0	2	1	1	1	
Waitsfield	1	6	2	2	0	9	0	
Warren	0	9	2	12	1	11	0	
Washington	1	0	3	3	0	4	4	
Waterbury	4	20	1	25	3	21	7	
Williamstown	4	7	28	3	4	2	14	
Woodbury	0	0	1	2	3	2	3	
Worcester	1	3	3	0	2	4	8	
Regional Total	**78**	**184**	**143**	**190**	**112**	**152**	**173**	

Capstone Weatherization Central Vermont 2020-2023

	2020	2020						2021	2021						2022	2022						2023	2023					
Town Totals	Total Homes	Multi Family Buildings	Multi Family Units	Single Family Homes	Occupants	kWh Savings	MMBTU Savings	Total Homes	Multi Family Buildings	Multi Family Units	Single Family Homes	Occupants	kWh Savings	MMBTU Savings	Total Homes	Multi Family Buildings	Multi Family Units	Single Family Homes	Occupants	kWh Savings	MMBTU Savings	Total Homes	Multi Family Buildings	Multi Family Units	Single Family Homes	Occupants	kWh Savings	MMBTU Savings
Barre City	20			20	44		530.75	25	9	4	21	37	3902.88	710.39	19	8	8	11	39	1865	586.17	38	7	11	27	69	8435.38	1519.96
Barre Town	10	8	3	7	18	145.5	837.31	14			14	34		433.98	11	5	8	3	17	8467	1040.36	11			11	23		361.96
Berlin	3			3	4		91.32	3			3	4		40.02	12	15	10	2	17	27650.35	366.88	8			8	22		307.24
Cabot	1			1	5		53.17	2			2	3		64.97	6			6	15		299.88	8			8	10		252.04
Calais	2			2	3		99.83	2			2	6		67.31	3			3	4		104.11	9	8	3	6	19	93766.02	781.62
Duxbury	0			0	0		0.00	0			0	0		0.00	1			1	1		42.51	1			1	1		13.07
East Montpelier	5			5	6		153.83	2			2	3		31.36	3			3	5		448.32	6			6	10		247.79
Fayston	1			1	1		8.15	0			0	0		0.00	2			2	2		106.66	0			0	0		0.00
Marshfield	1			1	5		90.71	2			2	4		24.43	2			2	4		53.14	2			2	2		57.67
Middlesex	2			2	2		110.84	0			0	0		0.00	1			1	1		9.47	5			5	7		241.58
Montpelier	10	4	5	5	13	380.78	82.12	16	15	6	10	27	1408	428.42	17	9	6	11	32	132	752.30	28	19	20	8	36	4090.33	1106.17
Moretown	2			2	2		42.55	2			2	3		44.51	3			3	4		261.37	1			1	3		17.10
Northfield	5			5	8		108.69	29	9	20	9	50	1330	196.57	14			14	39		486.82	10			10	24		461.47
Orange	2			2	5		37.92	3			3	9		42.40	2			2	5		71.84	6			6	12		275.08

Plainfield	1			1	2		18.87	3			3	6		104.90	2			2	5		83.93	3			3	4		127.20
Roxbury	2			2	4		77.70	0			0	0		0.00	1			1	5		32.18	1			1	1		69.65
Waitsfield	1			1	2		35.67	2			2	2		47.14	0			0	0		0.00	0			0	0		0.00
Warren	0			0	0		0.00	2			2	5		42.96	1			1	1		12.61	0			0	0		0.00
Washington	1			1	3		10.20	3			3	5		90.32	0			0	0		0.00	4			4	8		219.25
Waterbury	4			4	5		102.28	1			1	1		30.94	3			3	4		60.57	7			7	10		192.24
Williamstown	4			4	11		135.88	28	4	22	6	51	42998.43	165.70	4			4	11		215.52	14	3	3	11	36		430.90
Woodbury	0			0	0		0.00	1			1	4		38.70	3			3	5		153.77	3			3	8		51.26
Worcester	1			1	3		52.27	3			3	3		238.14	2			2	4		32.54	8	4	4	4	21	352	182.06
Regional Total	**78**	12	8	70	**146**	**526.28**	**2680.07**	**143**	37	52	91	**257**	**49639.31**	**2843.15**	**112**	37	32	80	**220**	**38114.35**	**5220.97**	**173**	41	41	132	**326**	**106643.73**	**6915.32**

Advanced Wood Heat Target Creation

The regional CAP LEAP targets provided by the Public Service Department include targets for heat pump and heat pump hot water heaters which model the state's general electrification policy with all other fuel types, other than biodiesel, decreasing dramatically. This was a significant issue for several of our communities, for whom cord wood heat is an important fuel source. The Central Vermont approach to the thermal sector, specifically for residential heat, incorporates the sustained use of wood (cord wood) (stand alone or in combination with heat pumps). This approach is integrated into the plan via:

- A high-efficiency cord wood target (to replace outdated inefficient cord wood stoves and boilers; cord wood as the preferred option where wood heating is chosen in new builds),
- promoting the use of high-efficiency cord wood stoves with heat pumps (we do not reduce the target for heat pumps),
- providing context on the use of wood heat across income-levels, the availability of cord wood including via wood pantries, the intersection with high frequency and duration of electric outages, and the significant reduction in energy use still achieved via wood heat stove conversion (especially when paired with heat pumps).

While up to 47% of Vermonters rely on wood heat as their primary or secondary heating fuel in their homes and state programs have supported advanced wood heat conversions in schools and commercial buildings, the state's electrification targets include a decline in wood heat use along with fossil fuels. CVRPC takes a different approach tailored to our needs, resources, and communities. CVRPC supports the transition from fossil fuel heating fuels using not only heat pumps, but also strongly supports the conversion of inefficient wood stoves to high efficiency cord wood stoves-our targets for the thermal sector reflect this commitment. This custom target still reduces air pollution emissions, reduces heating costs, the amount of wood fuel used, provides a pathway for those with frequent and long-duration electric outages, and provides an accessible option for many Vermonters.

There are clear geographic and demographic trends across the region regarding wood use; 34-43% of households use wood heating in the north part of our region, 15-26% in the less densely populated municipalities throughout the rest of the region and significantly fewer households use wood heating in our density centers (only 4-14%; see Table 9 in Supplement). In owner inhabited homes wood heating is relatively consistent across income levels. However, several characteristics make efficient wood heat a particularly important pathway for fixed and low-income residents in our region to reduce their costs and greenhouse gas emissions. Unlike heat pumps, for which potential savings or costs can vary significantly depending on utility territory among other factors, cost savings from the use of high efficiency wood stoves are often more straightforward. Furthermore, according to the State's Residential Fuel Assessment, over 1/3 of households using wood heat (as primary and secondary fuel) report that they, an immediate family member, or friend, cut or gathered the wood personally.

Current Wood Fuel Use in Occupied Housing Units by Town

	Owner Occupied		Renter Occupied		Total Occupied	
Orange	86	22.4%	0	0.0%	**86**	**20.4%**
Washington	169	34.2%	12	42.9%	**181**	**34.7%**
Williamstown	160	13.1%	0	0.0%	**160**	**12.2%**

Barre City	98	5.6%	48	2.4%	146	3.8%
Barre Town	393	12.9%	0	0.0%	**393**	**11.0%**
Berlin	88	9.2%	13	10.5%	**101**	**9.3%**
Cabot	181	35.4%	28	28.9%	**209**	**34.4%**
Calais	295	46.6%	14	15.6%	**309**	**42.7%**
Duxbury	130	26.9%	3	3.6%	**133**	**23.4%**
East Montpelier	239	24.3%	5	3.5%	**244**	**21.7%**
Fayston	78	18.6%	0	0.0%	**78**	**16.5%**
Marshfield	198	36.3%	28	42.4%	**226**	**37.0%**
Middlesex	177	25.0%	13	40.6%	**190**	**25.7%**
Montpelier	251	11.7%	14	0.8%	**265**	**6.9%**
Moretown	119	19.2%	3	2.9%	**122**	**16.9%**
Northfield	257	19.0%	0	0.0%	**257**	**14.2%**
Plainfield	114	30.6%	17	10.0%	**131**	**24.2%**
Roxbury	94	25.8%	14	21.9%	**108**	**25.2%**
Waitsfield	54	8.3%	11	5.3%	**65**	**7.6%**
Warren	116	18.5%	0	0.0%	**116**	**15.3%**
Waterbury	96	6.4%	0	0.0%	**96**	**4.4%**
Woodbury	94	35.6%	17	58.6%	**111**	**37.9%**
Worcester	126	38.1%	22	27.5%	**148**	**36.0%**

Source: 2022 ACS 5-year average B25117

Not all forms of advanced wood heat are equally in line with the state's goals for air quality, forest ecology, and energy (see Challenges starting page 196 2022 CEP, see the CEP for more on wood supply and current programs as well). CVRPC is thus focusing on the hyper-local benefits and opportunities presented via cord wood, while further consideration of wood pellets and chips would be needed before integration into preferred fuel types. Therefore CVRPC still feels advanced cord wood heat is important to include in our thermal energy transition because wood heat has an additional role to play in managing and reducing peak winter electrical loads, either stand-alone or in combination with heat pumps, wood stoves provide opportunities for homes, schools, and municipal buildings to avoid peak electric costs including during cold snaps. In addition to flexibility, advanced wood heat options can provide resilience benefits, as is included in the CEP and CAP.

<u>Method:</u>

Table 13 in the Energy Chapter provides a new target developed by CVRPC in recognition of the role cordwood heating plays in the region and can continue to do so as part of our energy policy and goals. These targets focus on the conversion of aged and/or inefficient woodstoves to high-efficiency replacements. These targets are based on:

- the constants used in current use estimates,
- Efficiency Vermont projects that advanced wood heat conversion reduces fuel use by approximately 1/3, which was further reduced to 2/3 when paired with weatherization and conversion of some wood heating use from the primary to secondary heating source (representing an average per household reduction from 5.69 cords per year to 1.9 cords).

While data on wood heating is coarse, see detailed discussion above, this target uses current use as a starting point in 2025, and strives for 20% of households to convert per target year until 80% have verted in 2050. These numbers are broad enough to account for the unknown number of existing high-efficiency wood stoves. Updating these targets increases the demand for wood relative to the LEAP targets provided by the Department of Public Service for the target year 2050 but reflect a significantly lower estimation of demand in all previous years. CVRPC is working with the Department of Public Service and other partners to refine these LEAP targets to better reflect current use. And while these updates are not yet incorporated in the analysis, the proposed CVRPC wood targets for residential heating remains in line with a transition from fossil fuels and inefficient heating types (e.g. electric resistance) towards residential heating demand dominated by high-efficiency cold climate heat pumps and cordwood technologies.

Targets for Residential High Efficiency Wood Heat Conversions

	2025	2030	2035	2040	2050
Existing Wood (homes)	4000	3200	2400	1600	800
New High Efficiency Wood Heat (homes)	0	800	1600	2400	3200
% converted	0%	20%	40%	60%	80%
Total Cords Used	22730	19725	16691	13656	10621
Thousands MMBTUs	454.608	394.507	333.813	273.120	212.427

This would impact the State's trajectory of residential wood demand (crossed out below and replaced with CVRPC's targets (bolded below)), our target still achieves demand reductions via high efficiency cord wood stove conversions instead of solely converting wood heat to heat pumps.

CAP Mitigation Regional **Residential** Thermal Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	120	264	376	487	595	633
HP	1	136	231	322	413	453
HPWH	2	23	49	76	103	104
Electric Resistance	40	29	21	14	8	7
~~Wood (State default)~~	~~910~~	~~733~~	~~535~~	~~400~~	~~286~~	~~182~~
Wood (CVRPC)		**455**	**395**	**334**	**273**	**212**
Propane	475	375	273	183	101	67
Wood Pellets	225	69	57	50	45	42
Biodiesel	-	51	224	285	245	176
Heating Oil	1,140	827	404	140	-	-
Biogas	-	-	-	-	-	-
Natural Gas	-	-	-	-	-	-
Total	**2,870**	**2,318**	**1,869**	**1,544**	**1,272**	**1,100**

In the future CVRPC will work towards incorporating further adjustments to the targets associated with incorporating district heating, thermal energy networks, and geothermal.

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 & Targets Tool). The Energy Chapter thus emphasizes the thermal and transportation sector; although further efficiency targets are provided below. The Public Service Department provided regional estimates of electric energy savings associated with the implementation of efficiency programs based on the 2022 Energy Efficiency Market Potential Study for 2025-2050 (these targets are cumulative).Table A below shows possible electric energy efficiency savings (MWh), Tables D&E below include measures that can be used to achieve those savings, while Tables B&C show the co-benefits of these efficiency measures on reducing peak demand pressure (seasonal impacts).

Table A. Program Achievable Electric Energy Efficiency Savings (MWh)		**2025**	**2030**	**2035**	**2040**	**2050**
Residential	Incremental Annual	2,459	2,583	2,801	2,707	3,010
Residential	Cumulative Annual	4,861	16,566	27,893	35,147	51,456
Non-Residential	Incremental Annual	4,361	3,961	3,966	3,909	4,546
Non-Residential	Cumulative Annual	8,740	28,611	43,894	42,904	39,581
Total	Incremental Annual	6,820	6,544	6,767	6,616	7,556
Total	Cumulative Annual	13,601	45,177	71,787	78,052	91,037

Table B. Program Achievable Electric Energy Efficiency <u>Summer</u> Capacity Savings (MW)		**2025**	**2030**	**2035**	**2040**	**2050**
Residential	Incremental Annual	0.20	0.17	0.20	0.18	0.2
Residential	Cumulative Annual	0.42	1.22	1.86	2.11	2.2
Non-Residential	Incremental Annual	0.74	0.62	0.61	0.59	0.7
Non-Residential	Cumulative Annual	1.48	4.72	7.22	6.87	6.0
Total	Incremental Annual	0.94	0.79	0.81	0.77	0.3
Total	Cumulative Annual	1.90	5.93	9.08	8.97	6.2

Table C. Program Achievable Electric Energy Efficiency <u>Winter</u> Capacity Savings (MW)		**2025**	**2030**	**2035**	**2040**	**2050**
Res	Incremental Annual	0.49	0.52	0.56	0.54	0.6
Res	Cumulative Annual	0.97	3.32	5.68	7.27	10.8
Non-R	Incremental Annual	0.63	0.59	0.59	0.58	0.7
Non-R	Cumulative Annual	1.27	4.21	6.51	6.34	5.9
Total	Incremental Annual	1.13	1.11	1.14	1.12	1.3
Total	Cumulative Annual	2.23	7.54	12.19	13.61	16.6

Table D. Residential Incremental Annual MWH- by End-Use	2025	2030	2035	2040	2050
Appliances	493	431	519	507	694
Hot Water	352	328	383	330	381
HVAC Equipment	1060	1432	1469	1490	1,558
HVAC Shell	43	49	40	27	11
Lighting	156	9	12	10	12
Misc. Loads	219	173	227	190	233
Motor	14	13	17	14	16
Whole Building	122	147	135	138	137

Table E. Non-residential Incremental Annual MWH- by End-Use	2025	2030	2035	2040	2050
Compressed Air	282	292	289	289	333
Plug Loads	61	103	111	109	127
Heating and Cooling	279	316	337	338	390
Ventilation And Circulation	262	325	372	395	449
Lighting	2520	1733	1578	1477	1,756
Refrigeration	462	526	566	586	670
Water Heat	143	190	201	189	224
Motors	129	125	124	124	142
Other	175	302	341	355	406

Electricity use is expected to increase dramatically by 2050 so demand-side management and upgrades, such as hardwiring, lighting fixtures, appliances, and demand-management programs, is also an important part of this scenario, especially since electricity is replacing other fuel-burning thermal applications.

Fuel Switching Transportation Targets

Targets for switching from fossil fuel-based vehicles to EVs are the predominant focus for municipalities in the transportation sector. This target is calculated using the Regional LEAP data and disaggregated the regional target based on the municipal share of current vehicles (light duty only). The targets are cumulative.

This table displays a target for switching from fossil fuel-based vehicles to EVs. This target is calculated using the Regional LEAP data and disaggregated the regional target based on the municipal share of current vehicles (light duty only). The targets are cumulative.

EV Registrations by Town

County	EV Registration Jan. 2023			EV Registration Jan. 2024			Increase 2023-2024	
Municipality	AEV	PHEV	Total EVs	AEV	PHEV	Total EVs	Count	%

Washington County Total	569	487	1056	**896**	**580**	**1476**	**420**	**40%**
Barre City	53	55	108	88	73	161	53	49%
Barre Town	5	9	14	9	16	25	11	79%
Berlin	23	15	38	32	22	54	16	42%
Cabot	4	7	11	4	8	12	1	9%
Calais	20	19	39	33	20	53	14	36%
Duxbury	4	2	6	9	3	12	6	100%
East Montpelier	21	12	33	28	18	46	13	39%
Fayston	2	5	7	3	4	7	0	0%
Marshfield	12	11	23	18	14	32	9	39%
Middlesex	28	20	48	41	20	61	13	27%
Montpelier	164	150	314	257	151	408	94	30%
Moretown	29	7	36	38	17	55	19	53%
Northfield	20	20	40	36	22	58	18	45%
Plainfield	20	26	46	35	37	72	26	57%
Roxbury	2	1	3	4	0	4	1	33%
Waitsfield	41	26	67	66	31	97	30	45%
Warren	34	22	56	51	33	84	28	50%
Waterbury	75	69	144	126	81	207	63	44%
Woodbury	0	2	2	0	2	2	0	0%
Worcester	12	9	21	18	8	26	5	24%
Orange	3	0	3	5	1	6	3	100%
Washington	5	2	7	5	3	8	1	14%
Williamstown	11	8	19	15	12	27	8	42%
REGIONAL TOTAL	**588**	**497**	**1085**	**921**	**596**	**1517**	**432**	**40%**

…

Regional LEAP Targets

These are the original targets provided to CVRPC by the Department of Public Service; these were disaggregated from the State targets based on the table below.

Overview - LEAP Regionalization for Regional Planning Commission Enhanced Energy Planning

As part of the development of Vermont's Comprehensive Energy Plan (CEP) and Climate Action Plan (CAP), Stockholm Environment Institute (SEI) and Northeast States for Coordinated Air Use Management (NESCAUM) developed a scenario model of Vermont's energy consumption and emissions and used the model to construct pathways to meet statutory greenhouse gas (GHG) reduction obligations under the state's Global Warming Solutions Act (GWSA). The model was built using SEI's Low Emissions Analysis Platform (LEAP), a software tool for energy system modeling and emissions accounting. The model contains a representation of residential, commercial, industrial and transport energy use at a state level.

In order to support enhanced energy planning at the regional and municipal levels, the Department has undertaken an effort to "regionalize" final energy demand outputs from the statewide LEAP modeling for four core sectors: residential, commercial, industrial, and transportation. This workbook includes a simple disaggregation of those results for each of the regions based on key drivers of energy demand. This has been done for:

1. The **Baseline** (business-as-usual) scenario developed to estimate Vermont/regional energy demand under normal policy and programmatic conditions and
2. The **Central GWSA Mitigation ("CAP Mitigation")** scenario developed to meet the state's GHG reduction requirements.

Share of Statewide:	CVRPC	Source	Used for:
Population	10.2%	Generation Scenario Tool (for consistency)	Share of non-road transportation. Note: All transportation related natural gas demand was allocated to CCRPC
Housing Units	11.1%	Data submitted via RPCs in data template - almost all from the American Community Survey	Residential non-natural gas energy demand & technology adoption (total and thermal energy use, new CCHPs)
Commercial Floorspace	11.2%	Data submitted via RPCs in data template - almost all used SQ FT / Employee * Number of Employees Method; SQFT/Employee from Jim Sullivan (BCRC), Number of Employees from VDOL and/or Census	Commercial non-natural gas energy demand & technology adoption (total consumption, new CCHPs)
Passenger Cars	10.0%	DMV Registration Database	On-Road Transportation Energy Use (Passenger Car, Light Trucks, Medium and Heavy Duty).
Light Trucks	10.5%		

Medium Duty Vehicles	9.4%		Note: All transportation related natural gas demand was allocated to CCRPC
Heavy Duty Vehicles	9.8%		
NAICS Codes	8.9%	Census Data on NAICS Manufacturing Codes (31-33)	Industrial Data
Natural Gas - Residential	0.0%	VGS Historical Usage Data	Residential, Commercial, and Industrial Sector Natural Gas Usage
Natural Gas - Commercial	0.0%		
Natural Gas - Industrial	0.0%		

Resources

Full details of the LEAP Model methods, data sources and assumptions may be found as **Appendix D to the 2022 Comprehensive Energy Plan**: https://publicservice.vermont.gov/content/2022-cep-analysis-greenhouse-gas-emission-reduction-pathways-vermont

Appendix E to the Comprehensive Energy Plan also provides a summary of the report in Appendix D in slide format, although please note that some assumptions in the modelling were revised following the issuing the of the Comprehensive Energy Plan: https://publicservice.vermont.gov/sites/dps/files/documents/CEP_AppendixE_LEAPModelingSlides.pdf

The **Vermont Pathways Report** prepared for the Agency of Natural Resources also provides information on the analysis done using the model, including some of the revisions made after the CEP was publised (see Table 1 pg 1): https://climatechange.vermont.gov/sites/climatecouncilsandbox/files/2022-03/Pathways%20Analysis%20Report_Version%202.0.pdf

Baseline Total Regional **Residential** Sector Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	797	636	691	725	743	758
Wood	910	872	752	685	657	635
Propane	699	619	580	558	552	552
Wood Pellets	225	76	66	61	59	58
Biodiesel	-	-	-	-	-	-
Heating Oil	1,214	1,115	982	906	874	848
Biogas	-	-	-	-	-	-
Natural Gas	-	-	-	-	-	-
Total	**3,845**	**3,318**	**3,071**	**2,935**	**2,885**	**2,852**

CAP Mitigation Total Regional **Residential** Sector Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	797	719	837	955	1,071	1,114
Wood	910	733	535	400	286	182
Propane	699	520	378	248	125	93
Wood Pellets	225	69	57	50	45	42
Biodiesel	-	55	251	336	321	254
Heating Oil	1,214	898	453	165	-	-
Biogas	-	-	-	-	-	-
Natural Gas	-	-	-	-	-	-
Total	**3,845**	**2,994**	**2,511**	**2,154**	**1,849**	**1,683**

Baseline Regional **Residential** Thermal Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	120	184	236	269	284	293
HP	1	70	125	155	169	175
HPWH	2	2	2	2	2	2
Electric Resistance	40	34	30	27	26	26
Wood	910	872	752	685	657	635
Propane	475	442	402	380	373	372
Wood Pellets	225	76	66	61	59	58
Biodiesel	-	-	-	-	-	-
Heating Oil	1,140	1,040	906	830	797	771
Biogas	-	-	-	-	-	-
Natural Gas	-	-	-	-	-	-
Total	**2,870**	**2,614**	**2,363**	**2,224**	**2,170**	**2,129**

CAP Mitigation Regional **Residential** Thermal Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	120	264	376	487	595	633
HP	1	136	231	322	413	453
HPWH	2	23	49	76	103	104
Electric Resistance	40	29	21	14	8	7
Wood	910	733	535	400	286	182
Propane	475	375	273	183	101	67
Wood Pellets	225	69	57	50	45	42
Biodiesel	-	51	224	285	245	176
Heating Oil	1,140	827	404	140	-	-
Biogas	-	-	-	-	-	-
Natural Gas	-	-	-	-	-	-
Total	**2,870**	**2,318**	**1,869**	**1,544**	**1,272**	**1,100**

Baseline Regional **Residential** New Cold Climate Heat Pumps						
Technology	**2020**	**2025**	**2030**	**2035**	**2040**	**2050**
ASHP 2 Head	397	1,200	2,278	2,911	3,218	3,381
ASHP Central	607	1,835	3,483	4,451	4,919	5,169
ASHP HE	583	1,763	3,346	4,275	4,725	4,964
GSHP HE	72	218	414	528	584	614
Total	**1,658**	**5,017**	**9,521**	**12,166**	**13,446**	**14,127**

CAP Mitigation Regional **Residential** New Cold Climate Heat Pumps						
Technology	**2020**	**2025**	**2030**	**2035**	**2040**	**2050**
ASHP 2 Head	423	2,549	4,686	6,836	8,995	10,093
ASHP Central	658	3,964	7,311	10,705	14,155	15,727
ASHP HE	622	3,743	6,882	10,039	13,210	14,821
GSHP HE	77	463	851	1,241	1,633	1,832
Total	**1,780**	**10,720**	**19,730**	**28,820**	**37,993**	**42,473**

Regional **Residential** New Retrofits (Number of Housing Units)						
Scenario	**2020**	**2025**	**2030**	**2035**	**2040**	**2050**
Baseline Scenario	1,378	2,847	4,205	5,496	6,833	9,658
CAP Mitigation	2,202	7,758	13,314	16,767	20,219	27,125

Regional **Residential** New Heat Pump Water Heaters (Number of Units)						
Scenario	**2020**	**2025**	**2030**	**2035**	**2040**	**2050**
Baseline Scenario	483	569	573	578	581	593
CAP Mitigation	483	7,046	15,213	23,465	31,809	32,196

Baseline Total Regional **Commercial** Sector Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	771	749	756	759	755	747
Gasoline	74	83	85	87	88	92
Kerosene	1	1	1	1	1	1
Wood	184	194	206	219	230	262
Ethanol	5	6	6	6	6	6
Solar	19	50	51	52	53	55
Heat	-	-	-	-	-	-
Propane	472	329	320	316	330	346
Residual Fuel Oil	12	5	5	5	5	5
Wood Pellets	-	-	-	-	-	-
Biodiesel	-	-	-	-	-	-
Heating Oil	535	309	268	233	203	161
Biogas	-	-	-	-	-	-
Natural Gas	-	-	-	-	-	-
Total	**2,073**	**1,723**	**1,697**	**1,677**	**1,672**	**1,675**

CAP Mitigation Total Regional **Commercial** Sector Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	771	816	890	963	1,007	995
Gasoline	74	83	85	87	88	92
Kerosene	1	1	0	0	-	-
Wood	184	194	206	219	230	262
Ethanol	5	6	6	6	6	6
Solar	19	50	51	52	53	55
Heat	-	-	38	57	96	96
Propane	472	258	164	74	4	2
Residual Fuel Oil	12	5	5	5	5	5
Wood Pellets	-	10	20	30	39	46
Biodiesel	-	16	74	111	150	156
Heating Oil	535	256	133	55	-	-
Biogas	-	-	-	-	-	-
Natural Gas	-	-	-	-	-	-
Total	**2,073**	**1,693**	**1,673**	**1,659**	**1,679**	**1,716**

Baseline Regional **Commercial** New Cold Climate Heat Pumps						
	2020	**2025**	**2030**	**2035**	**2040**	**2050**
New CCHP	316	960	1,827	2,333	2,580	2,710

CAP Mitigation Regional **Commercial** New Cold Climate Heat Pumps						
	2020	**2025**	**2030**	**2035**	**2040**	**2050**
New CCHP	316	5,682	11,298	17,184	21,120	21,977

Baseline Total Regional **Industrial** Sector Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	432	420	408	392	397	416
Natural Gas	-	-	-	-	-	-
Gasoline	43	41	42	42	43	45
Kerosene	1	2	2	2	2	2
Diesel	267	295	287	285	286	290
LPG	26	26	25	25	25	24
Wood	32	18	18	18	19	20
Biogas	-	-	-	-	-	-
Ethanol	3	3	3	4	4	4
Lubricants	15	11	11	11	11	12
Biodiesel	-	19	25	25	25	22
Residual Fuel Oil	15	9	9	10	10	10
Wood Waste Solids	8	1	2	2	2	2
Asphalt and Road Oil	411	301	307	313	319	332
Total	**1,253**	**1,146**	**1,139**	**1,129**	**1,143**	**1,179**

CAP Mitigation Total Regional **Industrial** Sector Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	432	420	408	392	397	416
Natural Gas	-	-	-	-	-	-
Gasoline	43	41	41	41	42	44
Kerosene	1	2	2	2	2	2
Diesel	267	212	143	72	-	-
LPG	26	26	25	25	25	24
Wood	32	18	18	18	19	20
Biogas	-	-	-	-	-	-
Ethanol	3	4	4	5	5	5
Lubricants	15	11	11	11	11	12
Biodiesel	-	102	169	238	312	312
Residual Fuel Oil	15	9	9	10	10	10
Wood Waste Solids	8	1	2	2	2	2
Asphalt and Road Oil	411	301	307	313	319	332
Total	**1,253**	**1,146**	**1,139**	**1,129**	**1,143**	**1,179**

Baseline Total Regional **Passenger Car** Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	1	15	28	60	116	228
Gasoline	1,059	782	704	634	545	376
Diesel	8	3	2	1	1	1
Ethanol	72	60	56	52	46	34
CNG	-	-	-	-	-	-
Biodiesel	0	0	0	0	0	0
Total	**1,139**	**861**	**790**	**748**	**708**	**639**

CAP Mitigation Total Regional **Passenger Car** Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	1	19	73	168	257	347
Gasoline	1,059	751	575	365	196	48
Diesel	8	3	2	1	1	0
Ethanol	72	64	55	38	23	5
CNG	-	-	-	-	-	-
Biodiesel	0	0	0	0	0	0
Total	**1,139**	**838**	**705**	**572**	**477**	**400**

Baseline Regional **Passenger Car EV and PHEV Stock** (Number of Vehicles)						
Vehicle Type	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Battery Electric	22	797	1,717	3,688	7,073	14,681
Plug In Hybrid	55	215	244	368	602	1,106
Total	**77**	**1,012**	**1,961**	**4,056**	**7,675**	**15,788**

CAP Mitigation Regional **Passenger Car EV and PHEV Stock** (Number of Vehicles)						
Vehicle Type	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Battery Electric	22	1,093	4,719	11,272	17,892	26,546
Plug In Hybrid	55	208	195	160	101	36
Total	**77**	**1,301**	**4,913**	**11,431**	**17,994**	**26,582**

Baseline Total Regional **Light Truck** Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	0	5	10	22	48	112
Natural Gas	-	-	-	-	-	-
Gasoline	2,306	2,066	1,820	1,625	1,442	1,192
Diesel	44	42	45	46	43	38
Ethanol	158	160	146	134	123	108
CNG	-	-	-	-	-	-
Biodiesel	1	3	4	4	4	3
Total	**2,509**	**2,275**	**2,024**	**1,832**	**1,660**	**1,453**

CAP Mitigation Total Regional **Light Truck** Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	0	25	138	313	455	552
Natural Gas	-	-	-	-	-	-
Gasoline	2,306	1,965	1,453	892	456	119
Diesel	44	38	32	22	10	3
Ethanol	158	169	139	94	53	14
CNG	1	0	0	0	0	0
Biodiesel	1	3	3	3	2	1
Total	**2,510**	**2,200**	**1,766**	**1,324**	**975**	**688**

Baseline Regional **Light Duty Truck EV and PHEV Stock** (Number of Vehicles)						
Vehicle Type	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Battery Electric	3	173	375	870	1,937	4,871
Plug In Hybrid	33	128	260	527	1,021	2,413
Total	**36**	**301**	**635**	**1,397**	**2,959**	**7,284**

CAP Mitigation Regional **Light Duty Truck EV and PHEV Stock** (Number of Vehicles)						
Vehicle Type	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Battery Electric	3	1,163	6,926	16,289	24,669	33,219
Plug In Hybrid	33	122	169	161	107	40
Total	**36**	**1,285**	**7,095**	**16,450**	**24,776**	**33,259**

Baseline Total Regional **Medium Duty** Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	-	0	0	1	1	1
Natural Gas	-	-	-	-	-	-
Gasoline	111	213	239	268	301	350
Diesel	168	278	302	325	347	379
LPG	1	3	4	5	6	8
Ethanol	8	17	19	22	26	32
Biodiesel	6	18	26	28	31	28
Total	**294**	**528**	**591**	**649**	**711**	**798**

CAP Mitigation Regional **Medium Duty** Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	-	26	101	217	330	463
Natural Gas	-	-	-	-	-	-
Gasoline	111	193	172	128	86	34
Diesel	168	249	210	142	82	28
LPG	1	3	3	2	1	0
Ethanol	8	17	17	14	10	4
Biodiesel	6	18	21	18	13	7
Total	**294**	**505**	**524**	**521**	**523**	**536**

Baseline Regional **Heavy Duty** Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	-	0	0	0	0	0
Natural Gas	-	-	-	-	-	-
Gasoline	0	0	0	0	0	0
Diesel	718	370	269	215	191	163
Ethanol	0	0	0	0	0	0
Biodiesel	24	24	23	19	17	12
Total	**742**	**394**	**292**	**233**	**208**	**176**

CAP Mitigation Regional **Heavy Duty** Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	-	12	47	99	145	181
Natural Gas	-	-	-	-	-	-
Gasoline	0	0	0	0	0	0
Diesel	718	347	210	111	57	12
Ethanol	0	0	0	0	0	0
Biodiesel	24	25	21	14	9	3
Total	**742**	**384**	**278**	**225**	**211**	**195**

Baseline Regional **Non-Road** Final Energy Demand (Thousand MMBTUs)						
Fuel	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Diesel	114	108	109	109	110	111
Biodiesel	4	7	9	10	10	8
Avgas	4	5	5	5	5	5
Jet Kerosene	148	148	149	150	151	152
Sustainable Aviation Fuel	-	-	-	-	-	-
Gasoline	40	36	37	37	37	37
Ethanol	3	3	3	3	3	4
Lubricants	31	24	24	24	25	25
Natural Gas	-	-	-	-	-	-
Total	**344**	**332**	**336**	**338**	**340**	**342**

CAP Mitigation Regional **Non-Road** Final Energy Demand (Thousand MMBTUs)						
Fuel	**201 5**	**202 5**	**203 0**	**203 5**	**204 0**	**205 0**
Diesel	114	108	109	109	110	111
Biodiesel	4	8	11	14	18	26
Avgas	4	5	5	5	5	5
Jet Kerosene	148	146	134	122	110	86
Sustainable Aviation Fuel	-	2	15	28	40	66
Gasoline	40	36	37	37	37	37
Ethanol	3	3	4	4	4	4
Lubricants	31	24	24	24	25	25
Natural Gas	-	-	-	-	-	-
Total	**344**	**333**	**338**	**343**	**349**	**360**

Baseline Regional **Greenhouse Gas Emissions** (Thousand Metric Tonnes CO2e)						
Sector	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Transportation	356	308	281	262	244	216
Residential	138	125	112	105	102	100
Commercial	77	51	48	45	44	43
Industrial	27	28	28	27	28	28
Electricity	28	29	22	19	28	51
Total	626	540	491	458	446	437

CAP Mitigation Regional **Greenhouse Gas Emissions** (Thousand Metric Tonnes CO2e)						
Sector	**2015**	**2025**	**2030**	**2035**	**2040**	**2050**
Transportation	356	292	224	148	88	37
Residential	138	102	60	30	10	7
Commercial	77	43	28	17	9	9
Industrial	27	22	17	12	6	7
Electricity	28	31	39	48	34	10
Total	626	490	368	255	147	70

Methodology: Municipal Energy Generation, Existing and Potential

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 Inventory which includes projects that have been submitted to the Public Utility Commission and are less than <5MW. CVRPC worked with both the Department of Public Service and Distribution Utilities (DUs) to conduct significant data cleaning of DU source data to address significant challenges in previous iterations including spelling errors, differences in notation and space, village and non-town names, incorrect zip codes, etc. while these may sound like minor inconveniences, it was impossible to attribute over 300 projects to either Barre City or Barre Town due to such issues which have now been resolved. The data however is still incomplete for smaller DUs.

CVRPC added a column for municipality and aggregated projects by town, removing inactive projects, and splitting existing and proposed plants. Projects were split two ways, first into town tabs then by generation and storage, resource type, size, and sorted by DU; secondly all CVRPC projects were split by Generation and Storage, Size, Resource Type, and sorted for Town and DU. Distribution Utility Integrated Resource Plans where then skimmed for missing assets of all types, and furthermore for hydroelectric facilities, Federal Energy Regulatory Commission records and Low Impact Hydropower Institute records were compared, as were town plans and the State Comprehensive Energy Plan to identify additional plants. Projects were then split into Category I-III by size (e.g. Table X), and totals could be calculated including regional and municipal totals of generation by tech type and size, number of generation projects by tech type and size, municipal shares of regional totals, storage capacity by town and size, etc. Estimated annual MWh output per installed MW nameplate capacity were calculated using constants provided in the table below which are consistent with those used by the Public Service Department and in the Generation Scenarios Tool, except for hydroelectric which was taken directly from DU IRPs, FERC, and LIHI records.

As the Department of Public Service embarks on a data initiative, CVRPC is dedicated to supporting their efforts to address outstanding data integrity issues and improve the reliability and availability of a single consistent data source. Unfortunately, though hope was long held out, the Energy Action Dashboard was officially updated leaving aside the difficulty task of updating and hosting the much-beloved and crowd -sourced Energy Atlas that is unfortunately 7+ years out of date.

Table Existing Generation & Storage by Town

Existing Electric Infrastructure

Incremental Renewable Energy Target:

Distribution of the Incremental Renewable Energy Target Across Technology Types

The incremental renewable energy target is how much additional renewable energy generation is needed to meet our regional share of 25% of the State's energy use produced in-state. The limiting factor, when having this discussion is that different technologies and scales of technology have different land use and grid impacts for a given amount of installed capacity or energy production.

Incremental Renewable Energy Generation Target

	2025	2035	2050
Updated Targets	26,957MWh (18.8MW)	97,196 MWh (67.7 MW)	163,094 MWh (113.6MW)

Table 17 on page 107 of the regional plan reflects the distribution chosen for our region (50% ground-mount solar, 25% roof-top solar, 20% wind, 5% hydro) and the results of conversations exploring alternatives. One such alternative is discussed below:

An alternative in which the ground-mount and roof-top solar were reversed: While there is a regional preference to minimize land use impacts of ground-mount solar (and electric infrastructure in general), the general building condition and age across our region limits the feasibility of wide-spread roof-top solar without significant cost directly to residents (especially impacting the accessibility of renewables to low-income residents and residents with deferred home/building maintenance and/or limited-income). Additionally, roof-top and small-scale projects are less cost effective and can hasten costly grid infrastructure investment.

Using 50% ground-mount and 25% roof-top results in a small (1MW) overall reduction in the target from the alternative scenario considered with the inverse; two additional impacts are noted:

1. Lowers the overall number of municipalities where grid capacity issues related to rooftop solar are anticipated to be a concern. The number of towns with capacity or *headroom* concerns would drop from eight to four (Barre City, Montpelier, East Montpelier, and Waterbury are still flagged, while Duxbury, Calais, Middlesex, and Worcester are no longer flagged as a concern).
2. The other major impact is on land-use. Increasing our reliance on ground mount solar will double the footprint of ground-mount arrays from an estimated 217 acres to 434 acres (0.04% to 0.08% of our region)

Municipal Snap Shot of infrastructure limitations (transmission and distribution)

Municipal Customization:

Technology distribution of the incremental renewable energy target is customizable by towns. Scenarios are run for municipalities and individual preferences are input and checked to flag any issues regarding infrastructure capacity and/or with meeting the overall regional target. This ensures compatibility between the municipal and regional plans and ensures the next regional plan update is informed directly via ground-up, locally-specific considerations (the same goes for other targets).

More nuanced work is needed to balance conflicting priorities regarding cost (and to whom), land use impacts, historic and aesthetic considerations, technical conditions, and constraints presented by our existing infrastructure gaps. Ongoing energy planning at the municipal level will help us develop a clearer sense of where preferences and potential resource areas align, as well as the potential land use impacts of different scenarios. CVRPC is working with municipalities undertaking enhanced energy planning to identify preferred sites to the parcel level and ensure potential additional constraints are represented by a mapping layer so that both can be integrated into the regional plan.

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).

Renewable Energy Generation Outputs & Capacity Factors

Resource	**Capacity Factor**	**Annual MWh output per installed MW**
Ground Mount Solar	15%	1,314
Rooftop Solar	14.5%	1,270
Wind	22.5%	1,971
Utility Scale Wind	30%	2,628
Hydroelectric	50%	4,380
Natural Gas	75%	6,570
Biomass	70%	6,132

Source: Central Vermont Regional Planning Commission & Department of Public Service (Generations Scenarios Tool)

Connecting Incremental Energy Targets to Siting and Mapping:

Assumptions and Background:

- Generation targets for renewable energy sources were derived from the Generation Scenarios Tool and based on an assumption of 25% in-state generation
- We confirm that we have more than enough resource potential to meet these targets- this is estimated in, and converted to MW from, resource potential areas in acres which are updated in the Generation Scenarios Tool based on the most recent CVRPC mapping exercise
- The mapping analyses integrates CVRPC regional constraints with the state's known and possible constraints data, renewable wind and solar energy potential analyses, and rooftop solar analyses.

Resources:

- VCGI: https://vcgi.vermont.gov/data-release/act-174-statewide-energy-planning-data-updated-known-and-possible-constraints
- The Act 174 tab of the Planning Atlas: https://maps.vermont.gov/ACCD/Html5Viewer/index.html?viewer=PlanningAtlas&_gl=1*3umr0*_ga*MTQ1NDExNjgzMy4xNzI1OTAyMjg4*_ga_V9WQH77KLW*MTczODE4MjA4Ni44MC4wLjE3MzgxODIxMzkuMC4wLjA.
- A very short summary of the technical considerations included in these raw resource potential areas (wind and solar) can be found on pages 28-29 of the Act 174 Guidance Document.

https://publicservice.vermont.gov/sites/dps/files/documents/2024%20Guidance%20for%20Regional%20%26%20Municipal%20Enhanced%20Energy%20Planning%20Standards_0.pdf

State Energy Planning Data: Known and Possible Constraints; Calculating Renewable Energy Potential

Prime and base layers taking into consideration the State's known and possible constraints as well as draft ground-mounted solar, rooftop solar, and wind potential layers can be downloaded from the recently updated Act 174 tab of the Vermont Planning Atlas maintained by the Agency Of Commerce and Community Development (2022 updates https://vcgi.vermont.gov/data-release/act-174-statewide-energy-planning-data-updated-known-and-possible-constraints). While CVRPC did use these as a starting point, these layers had to be divided by town boundaries, redundancies between rooftop solar (and building footprints broadly) and ground mount had to be removed, etc. before additional considerations including regional possible constraints could be added and analyses conducted. CVRPC is working to integrate possible local constraints in next 2027 comprehensive Regional Plan Update.

CVRPC is in the process of developing a tool for municipalities to use during their own Enhanced Energy Planning processes to determine the potential impact of adding additional constraints or better yet, preferred sites to the maps. CVRPC is furthermore, committed to integrating mapping tools into the project review process and the project development process to support quick evaluations for discussions including highlighting areas with different numbers of possible constraints, working to identify preferred sites, mapping existing preferred site types and project characteristics, etc.

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 8 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 the formula below. Solar MWh of energy = (number of MW) * (8760 hours per year) * (0.15 capacity factor).

Calculating 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 formula below. Rooftop MW of capacity = (number of annual MW) ÷ ((0.145 capacity factor) * (8760 hours per year)). This was further curtailed by CVRPC to provide a conservative estimate as roof and condition could not be integrated at this point in analyses.

Calculating 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 the formula below. Wind MWh of energy = (number of MW) * (8760 hours per year) * (0.225 capacity factor)

Calculating Renewable Energy Generation Targets

Generations Scenarios Tool

Generations Scenario Tool was set to meeting the Region's incremental regional energy target via 50% Ground Mount Solar, 25% Rooftop Solar, 20% Wind, and 5% Hydro. Natural Gas is set to 0% as there is no natural gas infrastructure in the region and Vermont's primary supplier, VGS (Vermont Gas Systems), is not only not looking to expand their territory for natural gas but is also exploring work conversion into geothermal and other technologies. Furthermore, Biomass (for electricity generation) was set to 0% as after the Moretown Landfill closed it seems there is little appetite for a project in the region. Note that landfills are included as preferred sites though, and this could change in future analyses if a project is developed. These inputs were set to maximize rooftop solar as a key preferred site. The table below identifies regional targets for new renewable electric energy generation; in addition to the target for 2050, the table includes intermediate years to help track progress towards that goal.

Municipalization: Land: 20%, Existing Generation: 10%, Demand: 50%, Population: 20%
Table: Existing Renewable (MW), Multiplier (distribution across technology type), Incremental Regional Capacity Target (MW), Resource Available (MW), Prime Land Available (Acres), Acres Needed to Meet Target (Acres)

NOTE: while energy targets are provided in MWh, capacity targets are provided in MW-default outputs are provided here for consistency and comparison across regions. Values in orange exceed resources available although hydroelectric potentials are not yet well integrated into state planning tools and merit further consideration.

NOTA BENE: Resource and Land Available simply form an extreme upper bound, they are many times over the land needed to met the targets

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 (https://vcgi.vermont.gov/data-release/act-174-statewide-energy-planning-data-updated-known-and-possible-constraints).

Known Constraints

Vernal Pools (confirmed and unconfirmed layers) –

Source: Vermont Fish and Wildlife, 2009 - present

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

Department of Environmental Conservation (DEC) River Corridors –

Source: DEC Watershed Management District Rivers Program, January 2015

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

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

Federal Emergency Management Agency (FEMA) Floodways –

Source: FEMA Floodway included in Zones AE – FEMA Map Service Center

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

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

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

developed by NatureServe and The Nature Conservancy.
An Element Occurrence (EO) is an area of land and/or water in which a species or natural community is, or was, present. An EO should have practical conservation value for the Element as evidenced by potential (or historical) presence and/or regular recurrence at a given location. For species Elements, the EO often corresponds with the local population, but when appropriate may be a portion of a population or a group of nearby populations (e.g., metapopulation).

National Wilderness Areas –

Source: United States Department of Agriculture Forest Service

A parcel of Forest Service land congressionally designated as wilderness.

Class 1 and Class 2 Wetlands –

Source: Vermont Significant Wetland Inventory (VSWI) and advisory layers

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

Possible Constraints

Agricultural Soils –

Source: Natural Resources Conservation Service (NRCS)

“Primary agricultural soils” are defined as “soil map units with the best combination of physical and chemical characteristics that have a potential for growing food, feed, and forage crops, have sufficient moisture and drainage, plant nutrients or responsiveness to fertilizers, few limitations for cultivation or limitations which may be easily overcome, and an average slope that does not exceed 15 percent. Present uses may be cropland, pasture, regenerating forests, forestland, or other agricultural or silvicultural uses.
The soils must be of a size and location, relative to adjoining land uses, so that those soils will be capable, following removal of any identified limitations, of supporting or contributing to an economic or commercial agricultural operation. Unless contradicted by the qualifications stated above, primary agricultural soils include important farmland soils map units with a rating of prime, statewide, or local importance as defined by the Natural Resources Conservation Service of the United States Department of Agriculture.

FEMA Special Flood Hazard Areas -

The land area covered by the floodwaters of the base flood is the Special Flood Hazard Area (SFHA) on 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 –

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

Act 250 Ag Mitigation Parcels –

Source: Vermont Department of Agriculture

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

Deer Wintering Areas (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.

Regional Constraints and Discussion

Forest Blocks

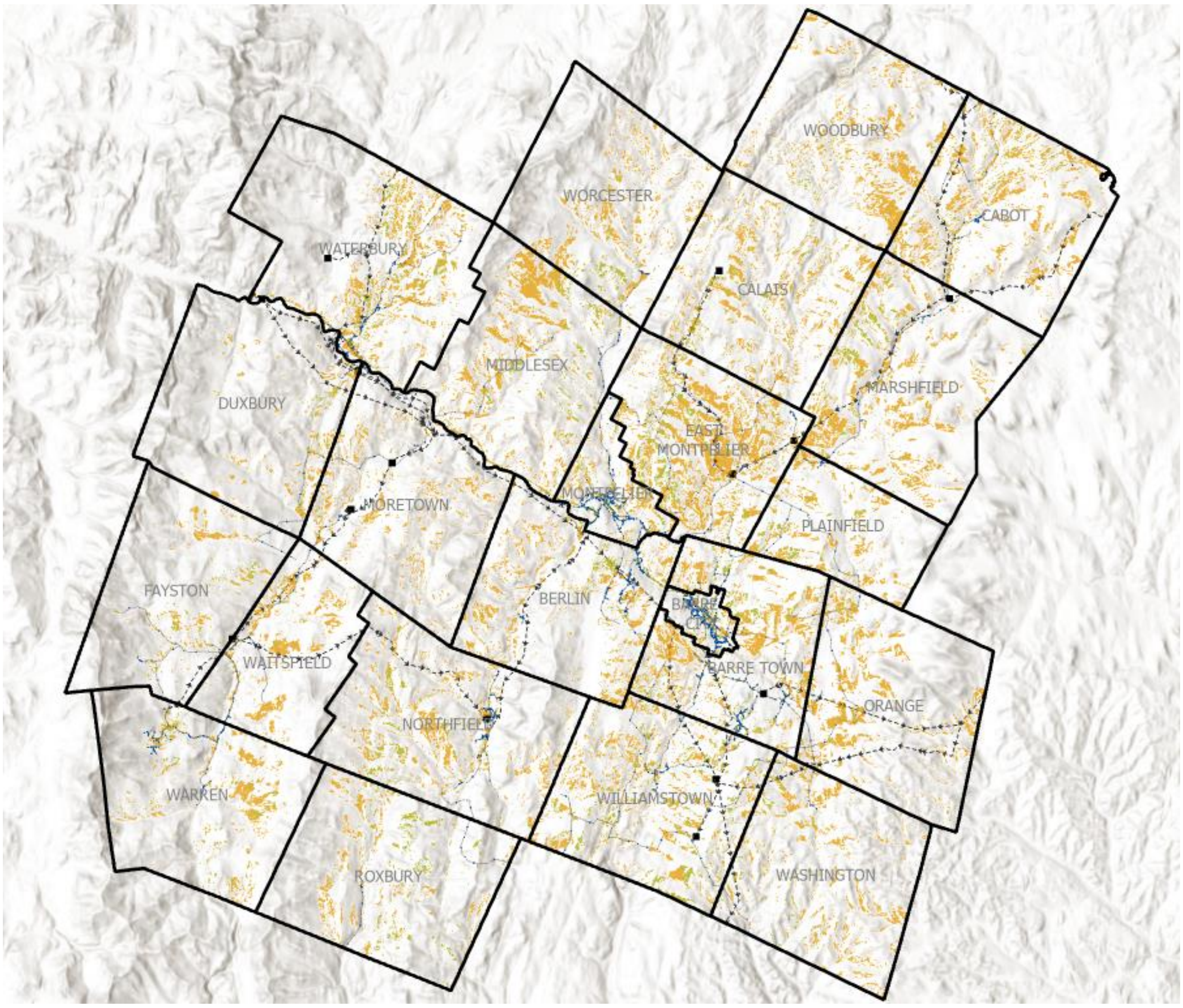
Mapping Resource Potential Areas- Solar & Wind

The following draft maps have been provided for the purposes of the Regional Plan Committee meeting and will be further formatted and refined for the plan.

Solar Potential Resource Areas:

Base Solar

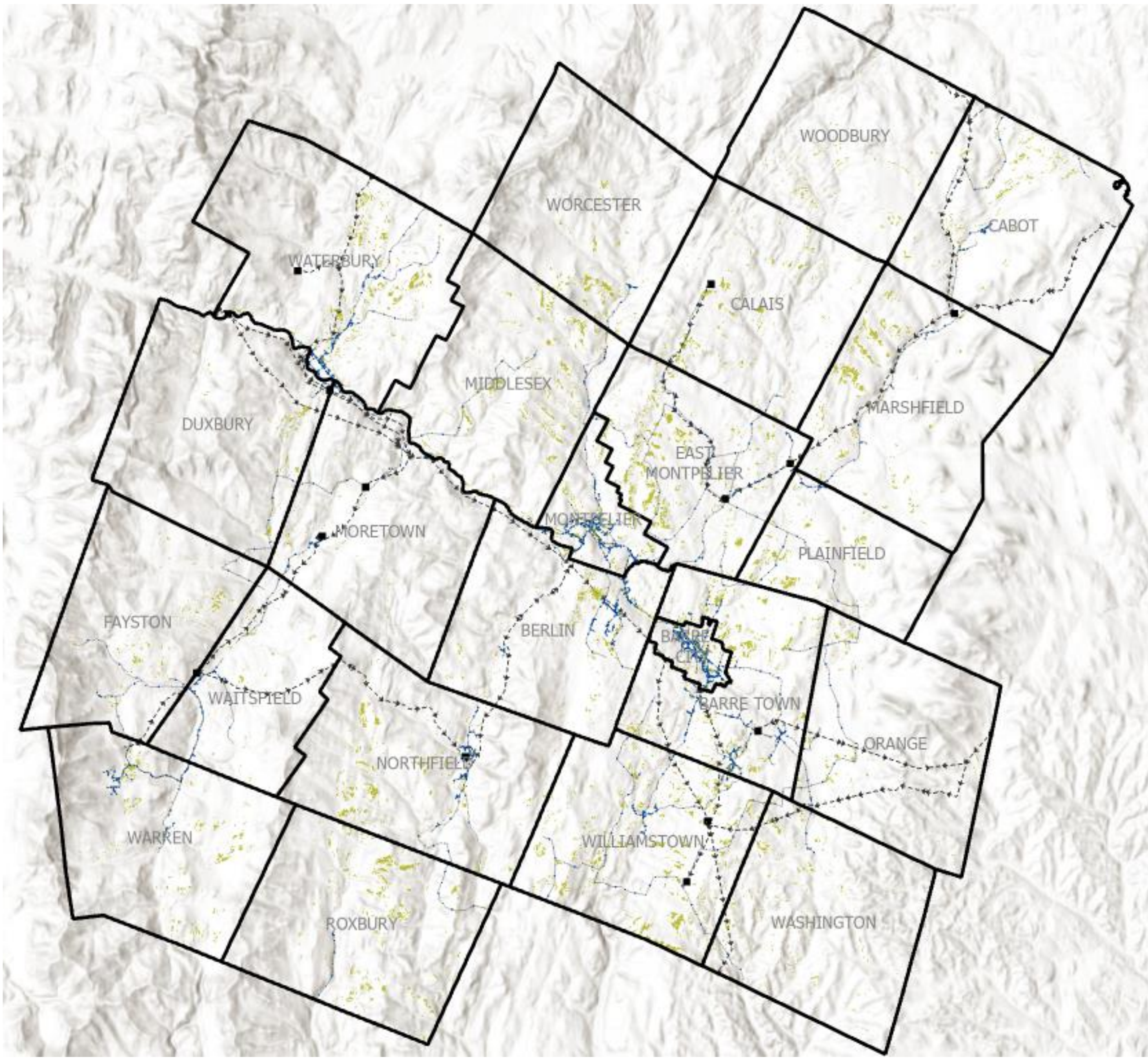
The following maps show solar potential resource areas. The orange areas represent base solar- those areas that have no state known constraints, no RPC constraints, but have one or more state possible constraints



While not clearly visible at this scale, black hashed lines represent transmission lines, blue lines are three-phase power, and black boxes show substations. Information about the grid is important because it demonstrates the variability of infrastructure from one town to the next.

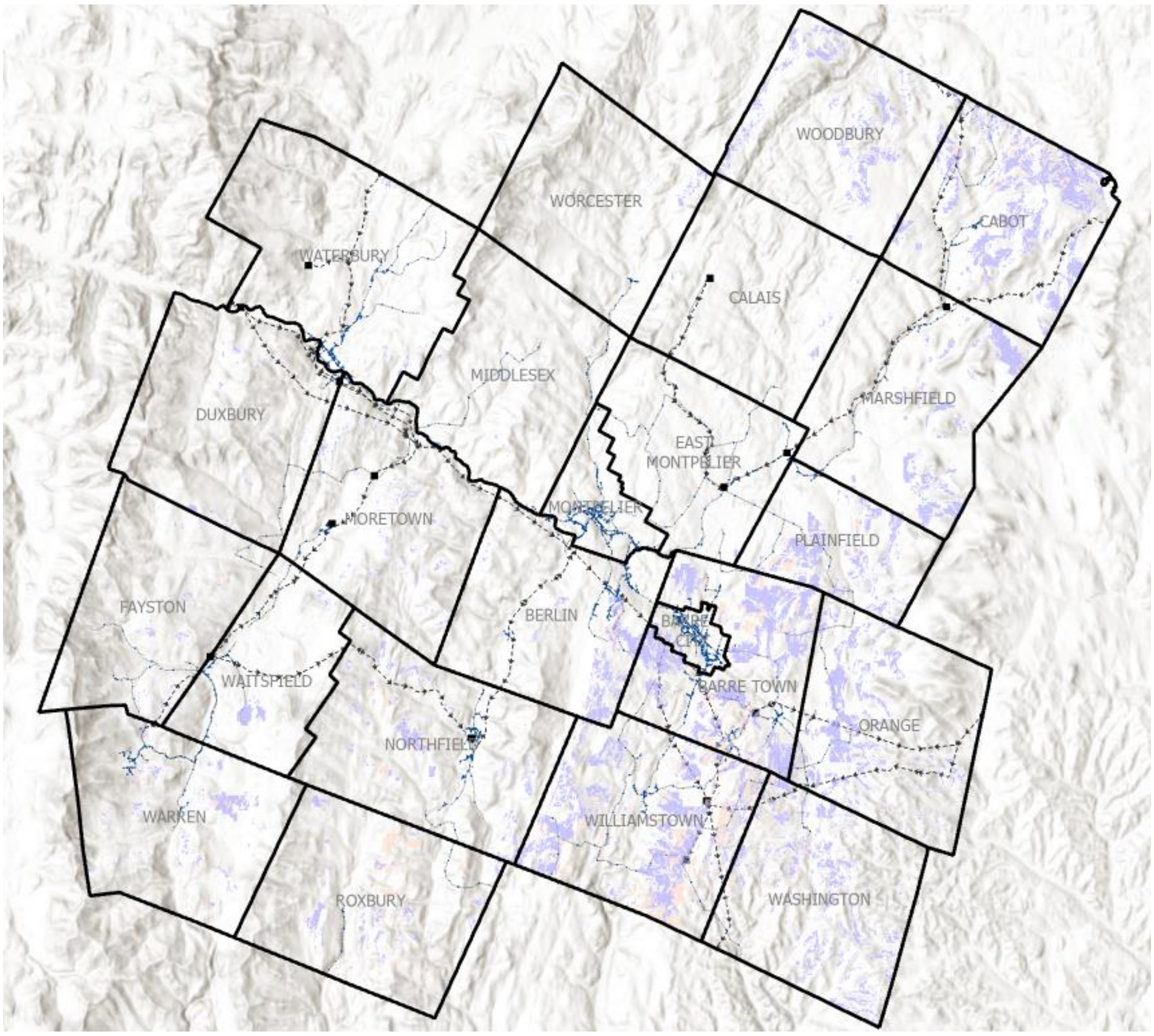
Prime Solar

The following map shows areas designated as prime solar in green. Areas defined as prime solar have no state known constraints, state possible constraints, nor RPC constraints (see map below showing just green)



Wind POTENTIAL RESOURCE AREAS:

This map identifies wind resource potential areas. Based on technical requirements and topography, prime wind, represented in pink, removes all state known and possible constraints as well as RPC constraints. Base wind, represented in purple, has no state known constraints nor RPC constraints but has one or more possible state constraints.



Potential Vs Targets

Region-wide	Prime Solar (Acres)	Base Solar (Acres)	Prime Wind (Acres)	Base Wind (Acres)
Resource Potential Areas (Acres)				
Possible (MW)				
Targets (MW)	*		*	
Targets (Acres)	**		**	

*The targets will shift here based on the distribution across different technology types above.

**The Public Service Department's constants for acres/MW for the technology types were used for consistency. These constants signficiantly over estimate the acres needed and recommendations to amend these using Vermont specific data have been made and well-received. For ground mount this typically includes the array footprints plus the temporary staging area, buffer for shade management, etc.

While this analysis seems to indicate that there is ample space to reach our targets, in practice there are issues related to fragmentation and proximity to users that practically restricts our resources. The following makes maps more useful for siting renewable energy generation:

- Locate investment in proximity to demand and to existing infrastructure (proximity to intentional growth areas and distribution and transmission lines;
- Removing parcels that cannot support distributed energy generation at scale to consider location of 500kW+ sized projects for further discussion with communities.

Approaching resources through these filters links scale and demand is a manner that the unfiltered maps neglect. The above recommendation is intended to provide a framework for identifying where this scale of projects could go preemptively so they are right-sized and appropriate for our communities, and we draw down some of that investment into our energy infrastructure where it is needed and supported. Only 23 projects out of the region's 2463 and counting renewable energy generation projects are 500kW and more, yet these 23 projects contribute 1/3 of our region's total nameplate generation. CVRPC anticipates that as the state continues to electrify and move towards 25% of demand produced by in-state renewable energy generation, it is important to consider and direct where these larger-scale projects may be located and how they fit into local and regional visioning of our communities.

Preliminary Analyses for consideration in next update.