Chittenden County Regional ecos Plan

SUPPLEMENT 6:

ENERGY ANALYSIS, TARGETS, & METHODOLOGY

DRAFT: October 16, 2025

Chittenden County RPC

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INTRODUCTION

Supplement 6 is an appendix to the Chittenden County ECOS Regional Plan. Supplement 6 and the land use, transportation, and energy chapters of the main document all form the Chittenden County Regional Enhanced Energy Plan (EEP) as enabled by 24 V.S.A. §4352. Supplement 6 and the chapters mentioned above meet the requirements of the VT Public Service Department's (PSD) Energy Planning Standards which provides the EEP greater weight in the Vermont's Public Utility Commission's (PUC) Section 248 review process for siting energy infrastructure. This EEP includes all the required elements of an enhanced energy plan. The 2025 version of the EEP constitutes the first update of the EEP. During the first update an equity assessment, forest block evaluation and more current data/maps were added.

Part 1 of this supplement is a discussion of key trends and insights facing the energy sector.

Part 2 of this supplement assesses the potential equity impact of the policies related to land use, transportation, energy efficiency, and renewable energy generation.

Part 3 of this supplement includes estimates of existing energy consumption for the transportation, heating, and electric sectors.

Part 4 of this supplement estimates includes targets for future energy consumption by sector, renewable energy generation and energy transformation measures to demonstrate milestones along the way toward meeting 90% of total energy needs with renewable energy and achieving the Global Warming Solutions Act requirements for reducing greenhouse gas emissions. Future energy consumption and energy transportation measures are derived from PSD's Low Emissions Analysis Platform (LEAP) model as an indicative pathway for reaching the Global Warming Solutions Action (GWSA) emission reduction requirements.

Part 5 of this supplement evaluates whether forest blocks or habitat connectors should be treated as a possible constraint to meet the forest evaluation energy planning standard. Part 5 also contains renewable energy generation targets. The renewable energy generation targets are based on the PSD's generation scenario methodology. This uses mapping data for potential solar and wind energy resource areas as well as known and possible natural resource constraints. It also accounts for population and electricity demand as well as existing generation currently sited or permitted within the region's boundaries. The generation targets are technology-neutral, which means the region has the flexibility to meet the targets through the development of various renewable energy technologies (e.g. biomass, solar, wind, etc.).

PART 1: KEY TRENDS AND INSIGHTS

ENERGY COSTS

Vermont residents, businesses, and industries spend about $1.9 billion a year to pay for imported fossil fuels (2022 Energy Action Network (EAN) Annual Report). About 75% of this money immediately leaves the county and state. This outflow of energy dollars acts as a drain on the local economy. The inverse is true for electricity: about 70% of spending on electricity recirculates within the state economy (regardless of how renewable energy credits are traded). Developing local renewable energy generation systems will provide more jobs and economic stimulation within the state in addition to advancing other energy-related goals.

The price of energy is forecasted to continue increasing in the future, which will result in an additional burden on the county's residents and businesses, especially for low- or fixed-income households. Reducing energy consumption, and generating on-site renewable energy, can help mitigate increasing energy costs.

WEATHERIZATION AND ENERGY EFFICIENCY

Weatherizing homes has an immediate impact on people's lives and promotes energy efficiency and a cleaner environment. Weatherization includes air sealing and insulating the building envelope. A well weatherized building reduces energy costs and eliminates drafts, making the home more comfortable and energy bills less. Weatherization can put much-needed money back into people's pockets. As a critical anti-poverty program for low-income households, weatherization also promotes environmental justice and health equity. Programs such as those run by Vermont Gas and the Champlain Valley Office of Economic Opportunity reduce carbon emissions and assist in the removal of environmental hazards such as lead, asbestos, and vermiculite. These environmental hazards are typically found in older buildings located within Chittenden County's disadvantaged neighborhoods, as defined by the Federal Justice40 Initiative.

The 2022, CEP and the State Climate Action Plan (CAP) called for an ambitious target to weatherize 120,000 homes statewide by 2030. This would help meet carbon reduction goals and protect the health and financial security of Vermont's most impacted communities. According to the state's Low Emissions Analysis Platform (LEAP) model, Chittenden County would need to weatherize 43% of homes by 2030, and 60% of homes by 2050, to advance this weatherization goal.

According to the 2022 Vermont Energy Action Report, 31,338 homes have been weatherized statewide as of 2020. To meet the state's weatherization goal, the Energy Action Network estimates that Vermont's qualified weatherization workforce needs to grow from 770 people working in weatherization as field workers, office staff, and energy auditors, to 6,200 people by 2030.[lxxii] To meet the weatherization goal, the state must address the challenges that affect the weatherization workforce, including: shortages of skilled workers willing to work in uncomfortable conditions; wage competition with less-strenuous working conditions; fluctuations in funding/incentives for weatherization projects; and affordable housing. As noted in the Comprehensive Economic Development Strategy (CEDS), a workforce shortage in the weatherization industry creates challenges toward meeting these goals. Still, there is also an opportunity to address this by supporting reskilling and transitioning away from the fossil fuel industry.

Chittenden County has a long history of electrical and natural gas energy efficiency programs, dating back to 1990 through efficiency utilities such as BED, VGS and Efficiency VT. These programs, along with improvements in federal standards, have helped reduce per-household and per-employee energy consumption of electricity and natural gas, and provide significant energy savings and economic benefits to the state and county. Less energy consumption reduces energy bills.

Two programs that help Vermonters reduce energy consumption from heating and electricity in homes and businesses include the Home Performance with ENERGY STAR® guidelines, and building/renovating to the state's Building Energy Standard. In addition, the Affordable Heat Act of 2023 establishes a possible market mechanism. When implemented in 2026, it will incentivize the delivery of cleaner energy options, making them increasingly available and affordable for Vermonters. Ideally, this will accelerate weatherization and the switch to clean fuels in the thermal sector.

FUEL SWITCHING AND ELECTRIFICATION

Electric Grid Evolution | Vermont's energy future includes a transition to beneficial electrification in the heating and transportation sectors. Beneficial electrification is a term for replacing fossil fuel-powered appliances and vehicles with heat pumps, electric vehicles, energy storage, and smart appliances to reduce emissions and energy costs. However, increased electricity demand, coupled with renewable energy generation and storage, may create challenges for the electric grid and for homes.

Residences and businesses may require costly upgrades to electric service to ensure adequate amperage for increased-load electrical appliances like EV charging and cold climate heat pumps. Finally, the cost of electricity itself, which is relatively high in Vermont compared to other states, is another barrier to electrification. Innovative programs and educational resources can help keep low-income and BIPOC communities from facing inordinate burdens by the transition to electrification. In addition, Smart Grid technology, behavior change, price signaling (e.g., time-of-use rates), and load control technologies can help reduce peak demand and defer substation upgrades, resulting in substantial cost savings.

Transportation | Chittenden County is home to an international airport and a National Guard base. Transportation fuel consumption in the county includes gasoline, diesel, and compressed natural gas, as well as aviation gasoline and jet fuel.

As with the entire state, the county relies heavily on gasoline and diesel for transportation. However, gasoline usage for transportation has decreased due to improved fuel economy standards and the adoption of electric vehicles in the light duty sector. According to the Energy Information Administration, between 2014 and 2023, motor gasoline consumption decreased by about 10% (from 7,465 to 6,704 thousand barrels[1]).

To prepare for Vermont's CEP goal of electric/zero-emission vehicles accounting for 100% of light-duty vehicle sales by 2035, electric vehicle charging station equipment (EVSE) should be installed as part of new development or redevelopment to ensure charging is available. Most EV owners charge at home. However, public charging at key locations, and/or workplace charging, may offer benefits for businesses, employees, and customers. Although the CEP goal only references light-duty vehicle sales be electric/zero-emission, planning and education on electric heaty duty vehicles can help ensure this sector of the vehicle fleet also transitions to cleaner fuel sources.

Retrofitting existing residential multi-unit dwellings (MUDs) with EVSE and the necessary electric service amperage is imperative to ensure that electric vehicle adoption is equitable, and all drivers have adequate access to charging infrastructure. MUD residents in apartments and condominiums often have more challenges in gaining access to home EV charging due to parking issues and costs. Renters in MUDs have additional barriers to long-term investments in charging infrastructure for shorter-term housing. In addition, policies and pricing structures to encourage off-peak charging need to be considered to mitigate grid constraints associated with electric vehicle

[1] U.S. Energy Information Administration. (2023). *State Energy Data System – Vermont Profile, Crude Oil and Petroleum Products.* https://www.eia.gov/beta/states/states/vt/data/dashboard/crude-oil-petroleum

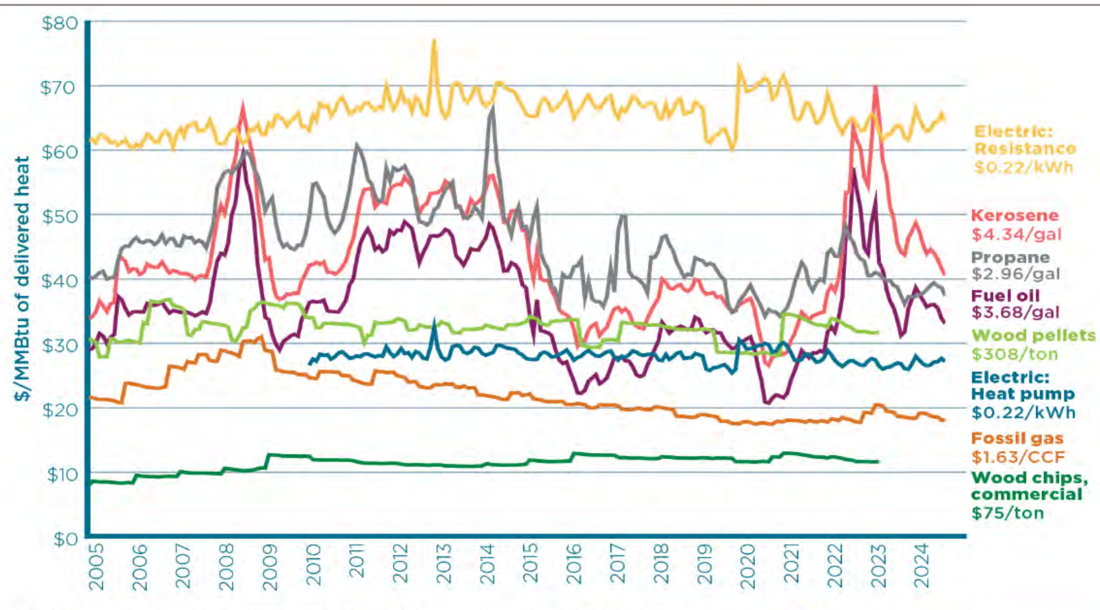
charging. Drive Electric Vermont provides technical assistance for installation of EV charging infrastructure at MUDs.

The 2023 Metropolitan Transportation Plan (MTP) anticipates increases in transit ridership, significant mode shift from driving to biking or walking, and the use of electric bikes (e-bikes) to reduce energy and emissions from transportation. See the MTP for additional information.

Heating | Like most of Vermont and the nation, Chittenden County relies heavily on fossil fuels for residential and commercial space heating, which is a significant contributor to greenhouse gas emissions. Promoting heat pumps (powered by a renewable electric grid), and sustainably harvested wood/biomass systems, biogas, and thermal energy networks (TENs), are key steps to meeting Vermont's Global Warming Solutions Act requirements, and 2022 Comprehensive Energy Plan goals.

Low-income, BIPOC, and renter households are likely to experience barriers and additional burdens when transitioning to heat pumps or other technologies, related to the upfront costs of retrofitting buildings. Incentive programs specifically designed for impacted or burdened populations can keep the transition to heat pumps equitable and accessible. However as noted in the 2024 Vermont Energy Action Network Annual Report (Figure 1), the cost of natural gas ($15.87 per MMBTU) is less than electric-powered air source heat pumps ($23.39 per MMBTU). Customers are not likely to save money on their energy bills by replacing existing natural gas heating systems with heat pumps. This impedes the state's ability to advance its energy and decarbonization goals.

FIGURE 1. COST COMPARISON OF HEATING FUEL OPTIONS OVER TIME (JUNE 2024 DOLLARS, INFLATION-ADJUSTED)



Sources: Fuel oil, propane, kerosene prices: VT Department of Public Service, Retail Prices of Heating Fuels, 2024. Fossil gas: VGS, 2024. Electricity: EIA, 2024. Wood chips, wood pellets: Biomass Energy Research Center, 2023. **Notes:** Electricity prices presented here are a statewide average but vary by utility territory. The reason propane is usually more expensive per MMBtu than fuel oil but less expensive on a per gallon basis is because propane has a lower energy content per gallon (66% of the energy of fuel oil per gallon). Prices reflect data availability at the time of publication: through June 2024. Prices shown are in June 2024 dollars, using the U.S. Bureau of Labor Statistics Consumer Price Index.

When buildings switch from fuel oil or propane to heat pumps, they will save customers money and protect them from price volatility (since the cost of electricity is less than fuel oil or propane, and less susceptible to price fluctuations). Even so, there may be structural challenges to fuel switching for some buildings, particularly for mobile homes, since the design of their underbelly utility systems requires more heating in winter (to prevent frozen pipes) than heat pump technology can currently achieve.

Establishing net-zero buildings and using heat pumps as primary fuel sources in new buildings will help the region meet its goal to shift the heating sector away from fossil fuels. Additionally, key partners in the energy transition are making progress towards becoming more renewable in the thermal sector:

- The City of Burlington is pursuing a district heating system from McNeil Generation Station's waste heat to be a source of renewable thermal energy for University of Vermont and University of Vermont Medical Center. When constructed, this heat source will replace natural gas demand and help the region meet its thermal energy targets. Additionally, the City has adopted a Net Zero Energy Roadmap to reduce and eliminate fossil fuel use from heating.
- VGS's comprehensive strategy for net-zero by 2050, with an immediate goal of reducing GHG emissions for customers by 30% by 2030, is critical to achieving the state's energy and climate goals. Expanding Renewable Natural Gas (RNG) to make up 20% of the supply mix by 2030 is also part of VGS's strategy. RNG is methane captured from off-gassing in landfills, wastewater treatment facilities, and manure piles to replace fossil natural gas. Burning this methane converts it to water and carbon dioxide, a much less potent greenhouse gas than methane itself. Finally, VGS is exploring networked geothermal for its customers, while prioritizing affordable housing in low-to-middle income communities. This will enhance equitability and limit undue burdens as lower income households transition away from fossil fuels.

Biomass in the form of cordwood and wood chips is one of the most affordable heating sources in Vermont. In addition, wood residuals (wood recovered from waste streams or timber processing) and low-grade wood (produced from chipping tops and branches from trees felled for other purposes) are used to generate electricity at Burlington's McNeil Plant.[2]

As noted elsewhere in this plan, biomass use must be balanced with the need to maintain ecological values and carbon sequestration and storage. Harvesting low-grade wood is sustainable when it does not exceed the net growth rate of low-grade wood in forests. The state's Net Available Low-Grade (NALG) wood has increased since 2010. While NALG may decrease in the short-term due to fluctuations in the rates of forest growth, and demand for low-grade wood, the long-term outlook allows for use of low-grade wood for heating and electricity generation at current or slightly higher levels (see Section 4, Energy Targets – Wood Fuel Capacity Analysis).

Carefully planned harvesting of mature trees through the practice of uneven-aged management will increase overall tree growth and carbon sequestration rates while restoring the health and diversity of Vermont's forests. It will also provide an important source of local and renewable fuel and building materials without pushing impacts elsewhere. This also supports carbon sequestration by provides economic value to retaining standing forests, rather than converting them to non-forest uses.[3] Finally, using thermal energy sourced from wood fuel creates an opportunity for jobs in the biomass and wood energy market in Vermont. (Of note, an aging forestry workforce is a concern in the forestry economy.[4]) Given this, CCRPC continues to support the use of low-grade wood, provided it is sourced through forest management practices that prioritize maintaining long-term ecological health, carbon sequestration and storage rates, and regenerative economic value from forests.

RENEWABLE ELECTRICITY GENERATION

Reliable, cost effective, and environmentally sustainable energy availability is critical to support the economy and natural resources of Chittenden County. As of 2022, Chittenden County generates 606,554 MWh annually of

[2] Kingsley, Eric, Innovative Natural Resource Solutions, LLC. "2023 Final Report on McNeil Forestry and Carbon Emissions and Sequestration" for Burlington Electric Department. https://burlingtonelectric.com/wp-content/uploads/McNeil-Carbon-6.2023.pdf

[3] Kosiba, A. (2023, February 20). An Introduction to Forest Carbon. *Northern Woodlands*.

[4] Vermont Sustainable Jobs Fund. (2022). *Vermont Forest Economy Career Guide*. https://www.vsjf.org/wp-content/uploads/2022/06/Vermont-Forest-Economy-Career-Guide_June-2022.pdf

renewable energy from a range of non-fossil fuel-based, renewable energy production sites owned by utilities, private parties, and municipalities. This is a 19% increase from 511,242 MWh in 2017.

The 2024 Vermont Energy Action Network's Annual Progress Report documents the power mix physically delivered to the state (based on contractual, or ownership entitlements), as shown in the pie chart below. While the power mix looks different after renewable energy credits are traded, either approach shows that Vermont's electricity consumption is about 91% carbon-free per 2022 data. See the annual report for further information.

Equitable Access to Renewables | The environmental and cost saving benefits of renewable energy generation are not always equally accessible. Impacted communities may be left out or burdened by renewable energy generation programs. Fewer people from these communities own their homes, while many live in multi-unit buildings that are not well-suited for installing their own systems. Community solar, in which benefits flow to multiple customer, can increase ownership access renewable energy generation. People who may not own a suitable site for solar energy generation effectively share the energy that comes from one site. Community solar also provides savings on electricity expenses, which is especially helpful for lower-income households. Community solar is also known as "group net-metering."

Peak Loads and Resilience | Residents and businesses value grid resilience. Vermont's weather and landscape patterns make the state vulnerable to power outages. Coupling distributed energy generation with battery storage systems and microgrids (groups of buildings that can operate in isolation when the grid is unavailable) will help improve grid resilience and improve electric efficiency by reducing transmission costs both into and out of the region. As the region electrifies its heating and transportation sectors with solar and wind generation sources, energy storage systems will be necessary to manage peak loads and turn intermittent sources into relatively consistent sources of energy. However, battery storage systems do come with the potential for unique fire hazards that pose a risk to public safety. Proper placement of energy storage in areas that will put the least amount of people and infrastructure at risk from fires is needed. Additionally, local emergency management leaders and first responders will need training on best practices for avoiding and responding to fire hazards from batteries.

Renewable Energy Standard | Act 56 of 2015 established a renewable energy standard (RES), which was updated in 2024 under Act 179 to require Vermont's electric utilities to source 63% of their retail electricity from renewable sources by 2025 and 100% by 2035. Figure 2 shows sources for the entire state's electric supply.

- Among the four electric utilities that operate within Chittenden County, Green Mountain Power's supply is now 100% carbon free. Currently 78% renewable, it will be 100% renewable by 2030. Burlington Electric Department's portfolio is also 100% renewable. Both utilities claim these achievements post-renewable energy credit sales (RECS). Vermont Electric Cooperative plans to meet or exceed its RES obligations by 2030. In 2022, GlobalFoundries was approved to operate its own electric utility subject to the RES. It is exploring substantial renewable energy and storage technologies located on campuses in Essex Junction and Williston.

FIGURE 2. VERMONT POST-REC ELECTRICITY PORTFOLIO

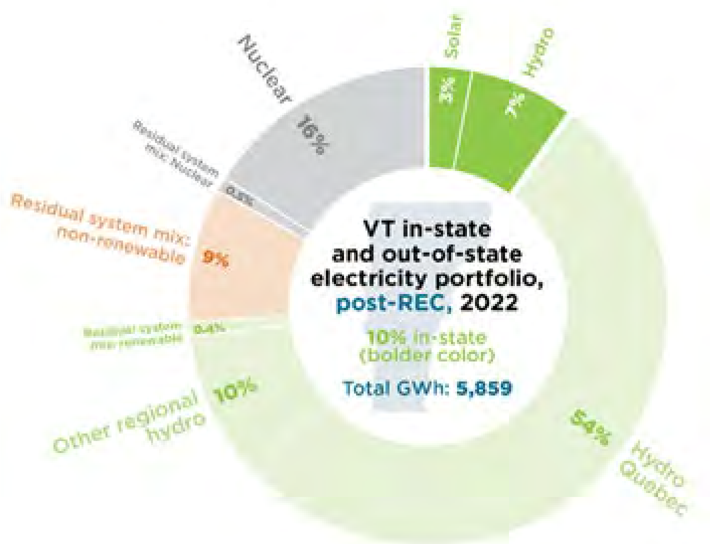
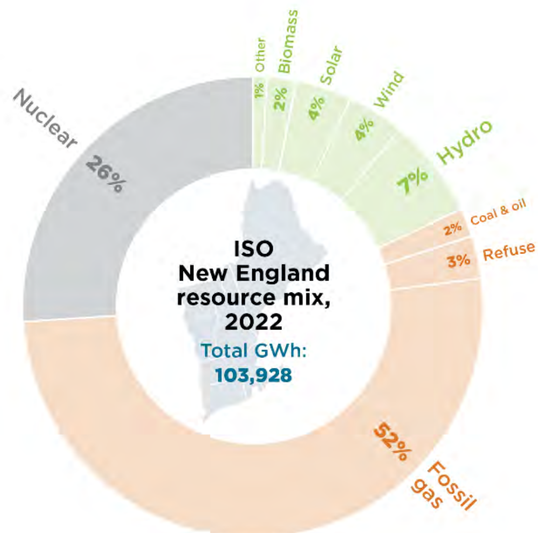


FIGURE 3. ISO-NE ELECTRICITY SOURCE MIX



Sources: Vermont Department of Public Service, 2022 Electric Utility Resource Survey; ISO-NE, Net Energy and Peak Load by Source Report, 2023.

- While the region's baseline electricity consumption overwhelmingly comes from carbon-free and even renewable sources, during peak demand times, energy from renewables is not sufficient. To meet demand, peak electricity is mostly provided by natural gas generation – a source of greenhouse gas emissions. Figure 3 shows the power sources for the regional electric grid (ISO-NE) on an annual basis, which is generally reflective of the mix on peak days.

The RES requires electric utilities to work with customers to reduce fossil fuel use and decrease carbon emissions from transportation and thermal heating. To do so, utilities offer customers new innovative programs and services. For example, electric utilities serving the region offer incentives for electric vehicles, charging equipment, and heat pumps to meet the statute and deliver innovation.

Vermont's rural nature offers challenges for the transmission and distribution of energy. It is important that Chittenden County's energy production, transmission, and distribution infrastructure is efficient, reliable, cost-effective, and environmentally responsible. The Vermont Electricity Power Company (VELCO) is Vermont's electricity transmission utility. VELCO's 2024 Long-range Transmission Plan notes that the regional transmission system serving west central Vermont adequately serves current needs, yet may require substantial upgrades in future years, particularly as more local electricity generation occurs. Several principal electricity distribution utilities serving the region, including Burlington Electric, Green Mountain Power, Washington Electric Coop, and Vermont Electric Cooperative, all have areas with significant system constraints where future system upgrades may be needed.

Finally, the cost of electricity is impacted by the distance it travels. When electricity is transmitted over long distances, a significant amount of electricity is lost. Locating generation near electric loads reduces transmission losses and may result in more cost-effective retail electricity rates.

ENERGY AND LAND-USE PLANNING

Compact Development Patterns | An impactful way to reduce greenhouse gas emissions is to enable more compact walkable neighborhoods in the region's areas planned for growth. Chittenden County, perhaps more than other regions of the state, can achieve great energy efficiency and GHG benefits because of development density and infill development goals. CCRPC has created a Climate Change and Land Use guide that highlights the benefits of compact development and the tools needed for municipalities to support it.

Energy Efficiency | Compact walkable neighborhoods encourage smaller building footprints with lower heating and cooling needs, promote efficient travel that is less dependent on cars, and provide more opportunities for walking, biking, and transit.

Building Energy Standards | Vermont has statewide building energy standards that set minimum energy efficiency requirements for new and renovated buildings. Buildings that comply with the standard are generally more comfortable and cost effective to heat and cool. The energy standards also help to advance the state's goals for reducing greenhouse gas emissions. However, Vermont's Act 44 Building Energy Code Study Committee Report notes that Vermont statute does not clearly state whether municipalities have the authority to enforce the standard. A 2025 report on the building energy code led by Energy Future Groups recommends that Vermont "transition to the Department of Fire Safety having the authority to administer compliance with the standard by 2030, and in the interim, leverage the skills of local Energy Professionals to support residential energy code compliance activities ."[5]

Conservation for Carbon | Compact development also decreases development pressure on Vermont's working and natural landscapes. This preserves land for carbon sequestration and storage.

Electric Load Efficiency | Dense population centers make distributed generation easier, because energy can be produced near significant numbers of customers and load. Additionally, the county's dense land use pattern may enable innovative energy solutions, such as district heating and microgrids.

Enhanced Energy Planning | In 2016, the Vermont Legislature enacted Act 174 to improve energy planning, and to give town and regional plans greater weight or "substantial deference" in Public Utility Commission (PUC) proceedings. As of 2025, Bolton, Burlington, Charlotte, Colchester, Essex Junction, Hinesburg, Huntington, Jericho, Richmond, Shelburne, South Burlington, Underhill, Westford, Williston, and Winooski have adopted enhanced energy plans. Enhanced energy plans may also help municipalities and the region qualify for funding to implement energy goals.

- **Development Constraints |** Act 174's enhanced energy planning standards involve identifying and mapping constraints to development. These constraints must be applied equally to renewable electricity generation projects, as well as other forms of development. CCRPC should coordinate with the Public Utility Commission (PUC) and the Agency of Natural Resources to better balance development of renewable energy generation to meet climate goals with potential adverse impacts on natural resources.

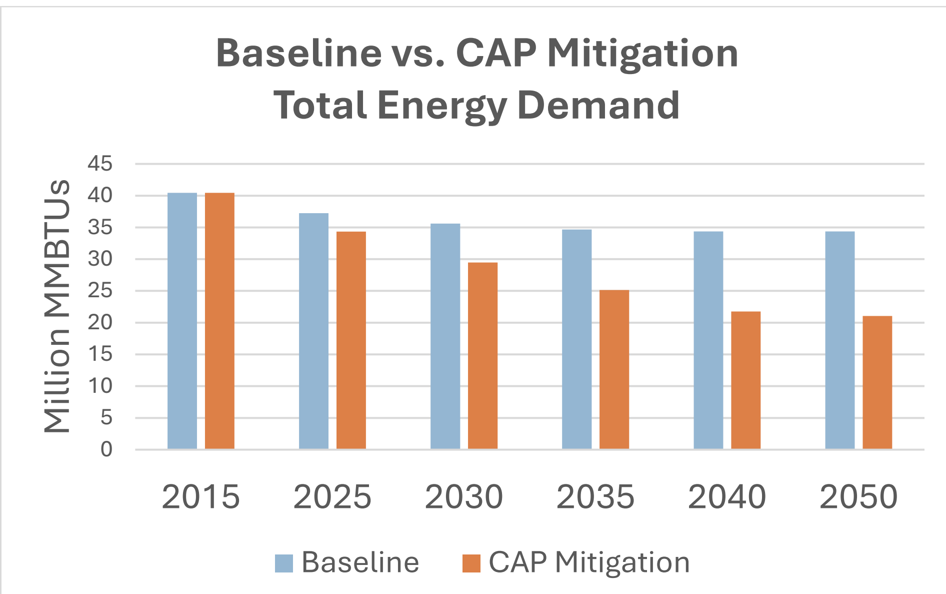
[5] Tyler, Z., Faesy, R., Energy Futures Group (2025) "Vermont Residential Energy Code Administration Plan" https://www.vapda.org/uploads/1/3/1/8/131894470/vt_energy_code_administration_plan_2025.06.30.pdf

ENERGY ANALYSIS AND TARGETS

Low Emissions Analysis Platform (LEAP) | The Department of Public Service contracted with Stockholm Environment Institute (SEI) and worked in coordination with the Agency of Natural Resources (ANR) to build a model to inform the development of the 2022 Comprehensive Energy Plan (CEP) and 2021 Climate Action Plan (CAP) including scenarios designed to show indicative pathways of how the state could achieve the GHG reduction requirements in the GWSA. This scenario is referred to as the “Central GWSA Mitigation” or “CAP Mitigation” scenario. A second (“Baseline”) scenario was also developed to estimate Vermont’s energy demand given business-as-usual conditions. The model was built with the Low Emissions Analysis Platform (LEAP), a software tool for energy system modeling and emissions accounting. The charts below represent the magnitude of change needed in the commercial, industrial, and transportation sectors to meet state energy and climate goals in Chittenden County. The targets needed to meet the energy planning standards are derived from the CAP scenario.

Total Energy Demand | As the region strives to meet renewable energy and decarbonization goals, it will see a decrease in total energy demand (inclusive of the transportation sector), as buildings and vehicles become more efficient through weatherization and fuel switching. In addition, energy use will move away from fossil fuel consumption towards electricity from renewable sources (see chart below). Based on the comparison of total energy demand in the baseline scenario, and the CAP mitigation scenario, Chittenden County’s total energy demand will be 48% less in the year 2050 than it was in the year 2015, with the implementation of policies modeled in the CAP mitigation scenario.

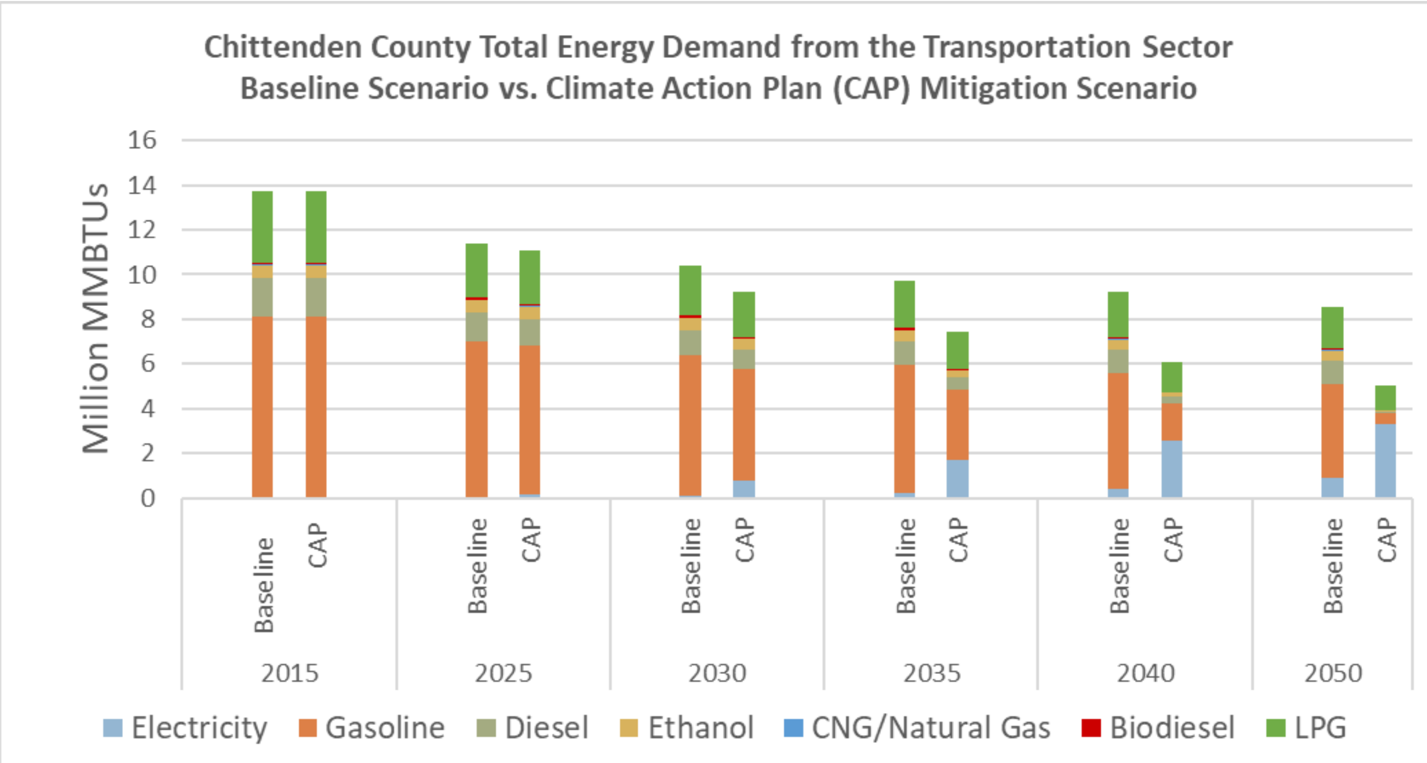
FIGURE 4: BASELINE VS. CAP MITIGATION TOTAL ENERGY DEMAND



Source: LEAP Data, October 2023

Transportation | The CEP includes a goal of having zero-emission vehicles account for 100% of light duty vehicle sales in Vermont by 2035, and calls for the transportation sector to meet 10% of energy needs from renewable energy by 2025 (45% by 2040). As the county transforms the transportation sector to meet these goals, electricity as a fuel source in the transportation sector will increase (see chart below). As a result, estimates suggest that Chittenden County will need 28,950 electric vehicles (EVs) by 2030, and 145,754 EVs by 2050 in the passenger and light duty sectors. In comparison, 3,183 EVs were registered in the county as of 2022.

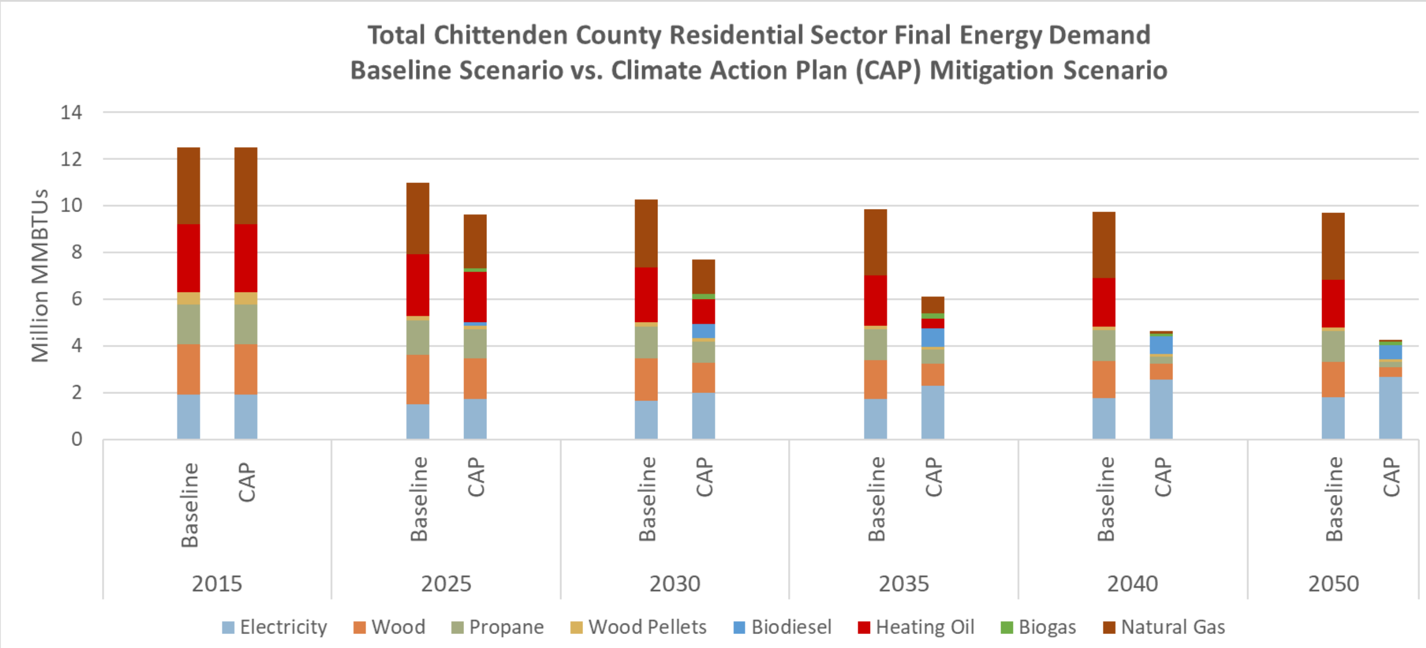
FIGURE 5: TOTAL ENERGY DEMAND FROM THE TRANSPORTATION SECTOR



Source: LEAP Data, October 2023

Heating | The use of energy for heating Chittenden County homes is projected to decrease by 64% from 2025 to 2050. Electricity demand will need to increase by 140% during this same time. Natural gas, fuel oil, and propane will virtually be eliminated, per the CAP scenario. Residential buildings will use less energy for space heating due to an increase in the percentage of weatherized buildings, and greater efficiency in heating technology.

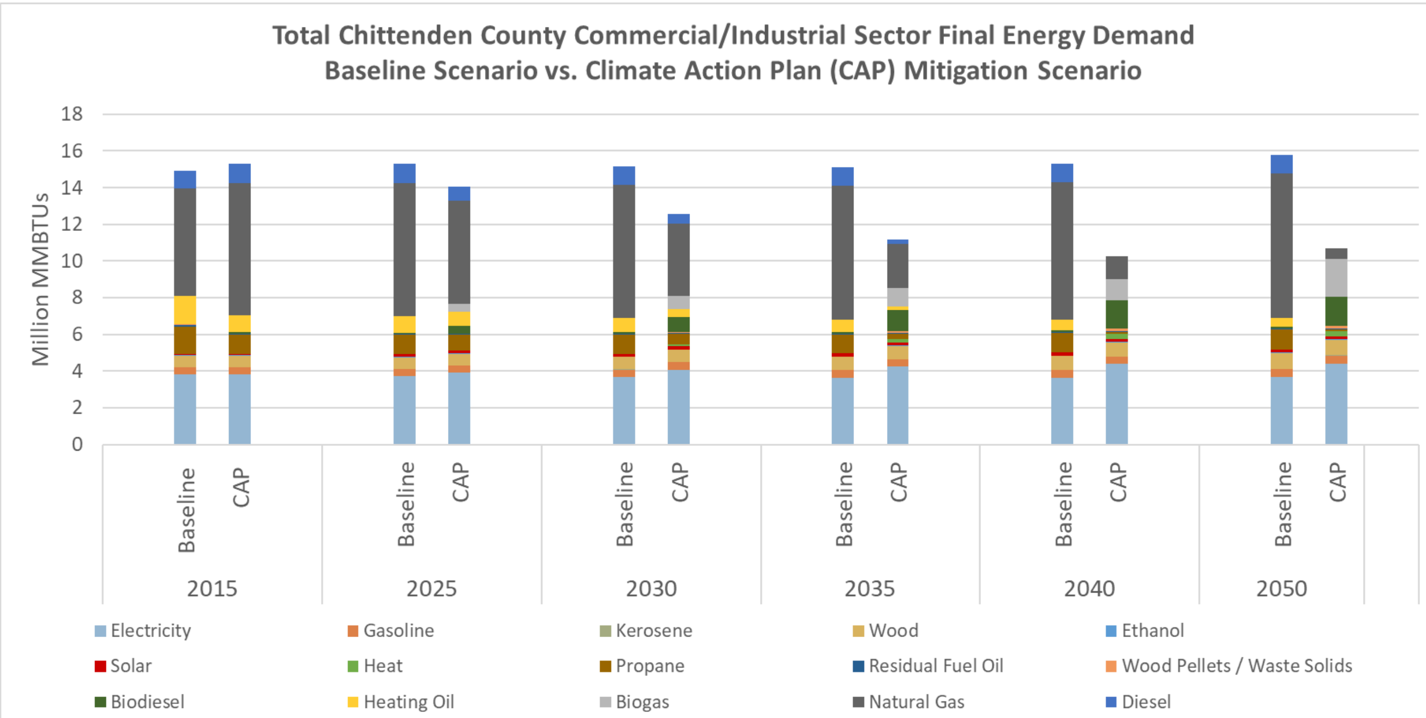
FIGURE 6: TOTAL CHITTENDEN COUNTY RESIDENTIAL SECTOR FINAL ENERGY DEMAND



Source: LEAP Data, October 2023

Industrial and Commercial Energy Use | Chittenden County's thermal energy demand in the commercial/industrial sector for year 2050 will need to be reduced by 24% from 2025 levels to meet future energy, carbon reduction, and renewable energy source goals. This will occur through weatherizing commercial buildings and using more-efficient heating technologies (e.g. cold climate heat pumps powered by renewable electrification). By 2050, the LEAP model targets that the region will have 64,790 new heat pumps installed in commercial buildings. Natural gas demand is estimated to decrease by 90% from 2025 to 2050 and the demand for heating oil and propane will be eliminated in the industrial/commercial sector.

FIGURE 7: TOTAL CHITTENDEN COUNTY COMMERCIAL/INDUSTRIAL SECTOR FINAL ENERGY DEMAND



Source: LEAP Data, October 2023

Electricity Generation Targets | CCRPC supports the generation of new renewable energy in the county to meet Vermont's Global Warming Solutions Act (GSWA), Climate Action Plan (CAP), and Comprehensive Energy Plan (CEP) goal of using 90% renewable energy by 2050, in a manner that is equitable, cost-effective, and respects the natural environment.

- Chittenden County needs to generate, at minimum, a total of 954,833 MWh (Megawatt hours) of energy annually (a 57% increase over 2022) to meet energy and climate goals set by the CAP and CEP. Table 20 sets progressive milestones to reach this goal, including the amount of additional generation that must be brought into production after accounting for existing renewables. These targets are based on the average of the county's share of statewide population and land area. This method attempts to balance siting energy generation close to where electricity is consumed, while ensuring homes are near employment, and built in compact patterns, with respect to development constraints. These also represent minimum targets; additional generation above targets will further advance the goals of the CAP and CEP.
- While the county has sufficient land to build new renewable electricity generation projects to reach the 2050 generation targets, this plan's in-region generation targets will warrant distribution and transmission system upgrades to export or store generation during periods of overproduction.

- The targets are technology neutral: they can be met with any mix of solar, wind, hydroelectric, biomass, or other sources of renewable electricity. CCRPC has completed an analysis of areas suitable for solar and wind energy generation to determine the region's ability to meet the 90% renewable by 2050, and decarbonization goals. Per the analysis, the region has sufficient land to meet its targets by relying on wind and solar energy generation.
- The PUC's current sound rule for wind generation makes developing new wind generation infeasible, because PUC Rule 5.700 imposes standards and requirements on wind energy, intended to minimize negative impacts of turbine sound on nearby properties, that have the effect of prohibiting its development. Keep in mind that the State has not yet studied the impact of the sound rules on wind generation projects. CCRPC supports regulatory changes to make wind power more viable for several reasons. First, it is complementary to solar in terms of its generation profile. Second, it can provide local low-cost electricity for Vermont rate payers. Host communities benefit from increased property taxes and jobs. Wind generation in Vermont can also reduce Vermont's strong dependence on external electricity providers, such as Hydro Quebec, to supply regional electric needs in an increasingly electrified world.
- CCRPC's renewable energy generation facility siting policies are detailed in Energy Action #6 of the main ECOS Plan and will inform CCRPC's preferred sites policy.

PART 2: EQUITY ASSESSMENT

The Department of Public Service's energy planning standards requires CCRPC to asses potential equity impacts of the land use, energy efficiency, renewable energy generation, and transportation policies to ensure the transitions required to meet Vermont's renewable energy goals and GHG requirements make energy more accessible and democratically managed for all Vermont communities.

To address the equity assessment requirement of the energy planning standards, this section outlines CCRPC's ongoing efforts to build our organization's capacity to address systemic racism and inequities in our communities. Furthermore, this section includes a discussion explaining the approach CCRPC utilized to acknowledge the ways in which equity can be strengthened in the ECOS Plan, especially how it relates to achieving renewable energy and climate goals.

In 2021, CCPRC hired The Creative Discourse Group to conduct an organizational equity assessment. In particular, the Creative Discourse Group made a recommendation to "Establish a process for conducting a mini-equity audit ahead of all key decisions and at the beginning of projects and initiatives." This recommendation is pertinent to the ECOS Plan update process as CCRPC Staff has applied an equity lens to reviewing ECOS Plan goal statements, key issues, strategies, and data using the self-assessment questions found in the Guiding Principles for Just Transition. Each energy related section was assessed to determine if the ECOS Plan language could be strengthened to better identify, understand, and address the impacts of energy and climate goals on impacted communities. If a deficiency existed, CCRPC staff wrote language to clearly define impacted communities and address existing or potential inequities/burdens. Examples include acknowledging that climate impacts of energy use are driven by the wealthy and privileged while impacts generally fall on the poor and those with less power (encapsulated in Chapter 6, Action 8: Just Transitions). Examples of solutions CCRPC will pursue to redress these historic power disparities include:

- **Chapter 6, Action 5(b): In-State Generation |** Support changes to the Renewable Energy Standard to prioritize in-state generation over electricity imports to avoid externalizing environmental and societal costs and benefits.
- **Chapter 6, Action 5(c): Expand Net-Metering Eligibility |** Increase the maximum size of net-metered projects, and establish a tiered system for net-metering rates in which utilities pay a lower rate to facilities over a certain size (such as 500kW), in order to increase net-metering participation and reduce the energy burden for public and non-profit entities without negatively affecting existing net-metering rates. Increase the maximum size of net-metered projects (currently 500kW) for public, non-profit, and community ownership entities, to encourage them to maximize development of renewable energy sources.
- **Chapter 6, Action 7: Affordability and Accessibility |** Support the affordability and accessibility of all climate resiliency and mitigation programs (AC, Weatherization, EVs, etc.). Encourage more education, guidance, and financial support for low-income Vermonters to participate in these programs.

The ECOS Plan also contains numerous sections where equity is the central theme, including the Equity & Regional Planning, Climate Change & Environmental Justice, and Community Engagement sections of the Introduction as well as the Civic Engagement and Social Connectedness Chapters. These sections serve as the backbone to the plan to ensure that all the ECOS Plan goals, strategies, and actions are implemented with an equity first approach. Additionally, CCRPC is drafting an Equity Action Plan to ensure that equity is embedded within all projects and to facilitate the assessment of impacts to marginalized communities.

CCRPC recognizes that these small changes are only first steps intended to guide a more fundamental shift in how our organization operates over the course of the current ECOS Plan and beyond. To this end, in 2022 CCRPC established a full-time Equity and Engagement Manager position and Community Engagement Advisory Committee

(CEAC) to ensure equitable processes and outcomes in our activities. The committee includes primarily community members with diverse lived experiences, interests, and expertise, as well as CCRPC Board members and CCRPC staff (non-voting members). Embedding the CEAC within the CCRPC structure will ensure that the voices and needs of marginalized people will be elevated in all programs and projects.

PART 3: CURRENT ENERGY DEMAND

The data below are from various data sources and represent actual current consumption and generation, rather than estimates from the Low Emissions Analysis Platform (LEAP) model found in the section on projected energy use.

Transportation Energy

Table 1 provides an overview of the passenger vehicle fleet composition by fuel source in Chittenden County. In 2023, Chittenden County was home to about 127,960 fossil fuel burning light duty vehicles. As of 2023, there were a total of 4,496 electric vehicles registered in Chittenden County, inclusive of both electric and plug-in hybrid vehicles. Chittenden County has seen a dramatic increase of electric vehicle ownership as more electric vehicle charging equipment has been installed, electric utilities and the State of Vermont have offered purchase incentives, and more electric vehicle models have become available for sale. As a result of the transition to electric vehicles, the County has seen the average amount of gallons of gasoline and diesel fuel decrease per vehicle and the average electricity per vehicle increase. This trend is shown in Table 2.

TABLE 1. CURRENT CHITTENDEN COUNTY TRANSPORTATION ENERGY USE

Current Chittenden County Total Transportation Energy Use by Vehicle Type		
	Total	**Percent**
Total pleasure cars or trucks	127,960	100.00%
Total Fossil Fuel Burning	127,77	97.5%
Electric Light Duty Vehicles	4,496	2.5%
All-Electric Vehicles	*2,643*	*1.4%*
Plug in Hybrid	*1,853*	*1.1%*
Sources: Efficiency Vermont RPC Report, June 2024; VT DMV (2023)		

TABLE 2. AVERAGE ENERGY USE PER VEHICLE BY FUEL TYPE

Average Energy Use per Vehicle by Fuel Type					
	2018	**2019**	**2020**	**2021**	**2022**
Avg. Gallons of Gasoline	491	458	399	413	421
Avg. Gallons of Diesel	3	2	2	2	2
Avg. Kilowatt-hours of Electricity	669	1,192	1,837	4,086	4,857
Source: Transportation Sustainability Tracking Tool; CCRPC (https://ccrpctranspstats.uvm.edu/)					

Thermal Energy

Table 3 and Table 4 on the next page describe how homes are heated in Chittenden County. Chittenden County is served by Vermont Gas and natural gas is available in most of the ECOS Plan's areas planned for growth. As such, over half of the homes are heated with natural gas. Areas outside the Vermont Gas service area rely on delivered fuels for space heating such as fuel oil, kerosene, or propane. About 24% of homes heat their homes with one of these fuel sources.

TABLE 3. CURRENT THERMAL ENERGY USE FROM NATURAL GAS (ECOS INDICATOR)

Current Thermal Energy Use from Natural Gas, 2022		
	Total	**Percent**
Homes Heating with Natural Gas*	39,898 (+/- 1,970)	56% (+/- 3%)
Residential Natural Gas Consumption (MMBtu)**	3,384,366	31%
Commercial/Industrial Natural Gas Consumption (MMBtu)**	7,386,332	69%
Total Chittenden County Natural Gas Consumption (MMBtu)**	10,770,698	100%
*Sources: *American Community Survey 1-year Estimate, 2021 Table B25040, **Vermont Gas*		

TABLE 4. CURRENT THERMAL ENERGY USE

Current Thermal Energy Use from Delivered Fuels and Wood, 2021				
	Total	**Margin of Error**	**Percent**	**% Margin of Error**
Homes heating with Fuel oil, Kerosene, etc.	9,927	+/- 1,586	14%	+/- 2%
Homes heating with Propane	7,153	+/- 1,243	10%	+/- 2%
Total Homes Heating with Delivered Fuels	17,080	+/- 2,015	24%	+/- 3%
Total Homes Heating with Wood	2,698	+/-961	4%	+/- 1%
Sources: American Community Survey 2021 1-Year Estimate, Table B25040				

WEATHERIZATION AND ENERGY EFFICIENCY PROJECTS

Reducing energy demand in both the thermal and electric sectors helps the region to meet the state's energy and climate goals. In particular, the state has a goal to weatherize 120,000 homes by 2030; for Chittenden County, the goal is to weatherize 31,865 homes (progress on this goal is tracked by the Vermont Energy Action Network's Dashboard). While there isn't a particular goal on reducing electricity demand, electric efficiency projects are one of best ways to reduce electric bills and manage load on the demand side. An example of efficiency projects include replacing appliances with energy efficient ones, installing LED light bulbs, and airsealing/weatherizing buildings to improve the thermal envelope. The best available data source for home weatherization and efficiency projects is through the State's efficiency utilities. In Chittenden County, there are three efficiency utilities. Burlington Electric Department operates as its own efficiency utility for customers within Burlington. Efficiency Vermont operates outside of the City of Burlington. VGS also operates as an efficiency utility focused on heating efficiency. Efficiency Vermont only monitors home weatherization programs done through the Home Performance with ENERGY STAR® (HPwES) program. HPwES is a comprehensive whole-house approach to diagnosing and addressing thermal and health/safety issues in the home to ensure a more energy efficient, comfortable, safe, and healthy home. A project is a collection of one or more energy efficient measures that have been implemented at a customer's physical location, such as replacing windows or adding a heat pump. Measures may include both electric and thermal efficiency improvements. A customer can be associated with one or more projects and in some cases, a project may be associated with multiple customers. Efficiency Vermont's data does not capture do-it-yourself projects or projects that do not go through the HPwES program. Table 5 on the next page indicates the number of energy efficiency projects completed. It is not intended to represent the number of homes weatherized.

TABLE 5. RECENT RESIDENTIAL ENERGY EFFICIENCY PROJECTS

Recent Residential Energy Efficiency Projects			
	2020	**2021**	**2022**
Total Residential Projects (includes projects below)*	3,322	3,524	3,314
Home Performance with ENERGY STAR® Projects	90	102	60
Other Weatherization Projects	198	57	67
Residential New Construction Projects*	36	78	84

Source: Efficiency Vermont RPC Report, June 2023; Burlington Electric Department
Burlington Electric Departments projects are not included because of differences in reporting.
***Comprehensive energy efficiency services to customers building new or gut-rehabbing single-family homes. This program maximizes energy efficiency, durability, and comfort through direct technical assistance, third party certification, incentives, and code compliance support. The RNC program is cosponsored with Vermont Gas Systems and Burlington Electric Department for homes in their service territories.*

ELECTRICITY

An estimate of current electricity consumption by residential and commercial/industrial sector in Chittenden County is shown in Table 6.

TABLE 6. CHITTENDEN COUNTY ELECTRICITY CONSUMPTION (ECOS INDICATOR)

Chittenden County Electricity Consumption	2022
Residential Electric Energy Use (MWh)	1,327,756
Commercial and Industrial Electric Energy Use (MWh)	469,417
Total Electric Energy Use (MWh)	1,797,173
Percent of State Electric Energy Use	32.1%

Source: Efficiency Vermont June 2023, Burlington Electric Department, Vermont Department of Public Service

Current Renewable Energy Generation

As shown in Table 7, Chittenden County's current renewable generation capacity is approximately 195 MW. This capacity results in approximately 593,122 MWh of electricity generation per year. Renewable electricity generation is sourced from solar, wind, hydroelectric, and biomass facilities located inside Chittenden County, including the McNeil Generating Station, half of the capacity of Georgia Mountain Community Wind, several hydroelectric dams on the Winooski River, and numerous distributed solar array and small-scale wind projects.

TABLE 7. EXISTING RENEWABLE ELECTRICITY GENERATION (ECOS INDICATOR)

Existing Renewable Electricity Generation			
	Sites	**Power (MW)**	**Energy (MWh)**
Solar*	4,847	94.7	124,477
Wind	32	5.54	14,207
Hydroelectric	6	33.0	144,343
Biomass (Wood)	4	50.6	310,095
Total**	**5,647**	**195.3**	**593,122**

Source: Vermont Department of Public Service Distributed Generation + Survey, January 2023 (with corrections by CCRPC. See Section 4 – Methodology for details).
**Includes ground-mounted and rooftop solar. There is no reliable dataset for existing rooftop solar alone.*
***The total existing renewable energy generation varies from the existing renewable energy generation reported in the renewable energy targets sections due to variations in the way the data is counted. These sites represent facilities that have been permitted and interconnected.*

PART 4: ENERGY TARGETS

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 section includes a simple disaggregation of those results for the residential, transportation, and commercial sectors based on key drivers of energy demand. The targets are derived from the **Central GWSA Mitigation ("CAP Mitigation")** scenario developed to meet the state's GHG reduction requirements. These targets show the direction and magnitude of change needed to meet local, regional, and state energy goals and are not intended to be used in a regulatory context.

The LEAP model is an accounting framework that shows one possible path for Chittenden County to meet the state energy and decarbonization goals. These data are not intended to prescribe a future. Please note that these data are a starting point for Chittenden County to consider its energy future. This information should provide the framework for discussion about changes that will need to occur within Chittenden County to ensure that State energy and climate goals are met.

Full details of the LEAP Model methods, data sources and assumptions may be found as **Appendix D to the 2022 Comprehensive Energy Plan**. 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 published.

Transportation Energy Targets

The transportation energy targets for Chittenden County represent an ambitious electrification of the transportation sector to increase the amount of renewable energy used to power passenger vehicles and light, medium, and heavy-duty trucks. As indicated in Table 1, 3,183 electric light duty vehicles are registered as of 2022. To meet the 2025 target, electric vehicle registrations need to double (see Table 8). To meet the 2050 targets, electric vehicle registrations need to increase dramatically, and transportation energy from all fuel sources used in all vehicle types will need to decrease 47.5% from 2025 levels by 2050. This will primarily be achieved by converting to more efficient electric vehicles from fossil fuel vehicles. The LEAP model shows that to achieve this reduction, a majority of passenger vehicles must be all-electric. Generally, in the LEAP model it is assumed that all-electric vehicle adoption will be more aggressive compared to adoption of plug-in hybrid vehicles. Electrifying the transportation sector will also lead to a dramatic increase in electricity use to power vehicles and a significant decrease in gasoline consumption (see Table 9 on the next page).

TABLE 8. ELECTRIC VEHICLE TARGETS

Electric Vehicle (EV) and Plug-in Hybrid Electric Vehicle (PHEV) Stock – Number of Vehicles						
Passenger Car	**Vehicle Type**	**2025**	**2030**	**2035**	**2040**	**2050**
	Battery Electric	3,091	13,347	31,883	50,610	75,088
	Plug In Hybrid	588	551	451	287	103
	Total	**3,679**	**13,898**	**32,334**	**50,896**	**75,191**
Light Duty Truck	Battery Electric	2,468	14,695	34,559	52,337	70,478
	Plug In Hybrid	259	358	342	227	85
	Total	**2,727**	**15,053**	**34,901**	**52,564**	**70,563**
Source: LEAP Regionalization Results, October 2023						

TABLE 9. TRANSPORTATION ENERGY DEMAND

Chittenden County Total Energy Demand from Transportation Sector (Thousand MMBTUs)					
Fuel	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	178	771	1,714	2,555	3,323
Gasoline	6,639	5,018	3,154	1,677	448
Diesel	1,188	844	511	278	78
Ethanol	568	479	333	194	52
CNG/Natural Gas	21	17	11	6	2
Biodiesel	84	84	66	45	18
LPG	2,375	1,998	1,622	1,350	1,133
Total	11,053	9,210	7,410	6,105	5,054
Note: Energy demand for electric vehicle charging is captured solely under this table; it is not included in the residential or commercial electric targets.					

Thermal Energy Targets

RESIDENTIAL THERMAL

Total thermal energy use in Chittenden County homes is projected to decrease by 64% from 2025 to 2050. Electricity demand will increase by 140% between 2025 and 2050 to replace natural gas, fuel oil, and propane, which will be nearly eliminated. Residential buildings will use less energy for space heating due to an increase in the percentage of buildings that are weatherized and greater efficiency in heating technology. To achieve the projected energy savings, at least 60% of homes in Chittenden County need to be weatherized by 2050. Additionally, 101,654 new air-source or ground source heat pumps will need to be installed. Heat pumps are powered by electricity and are a more efficient way to heat a building compared to delivered fuels.

TABLE 10. RESIDENTIAL THERMAL ENERGY USE TARGETS

Regional Residential Thermal Energy Demand (Thousand MMBTUs)					
Fuel	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	631	899	1,165	1,424	1,515
Heat Pump	*326*	*552*	*771*	*989*	*1,084*
Heat Pump Water Heater	*55*	*118*	*182*	*246*	*249*
Electric Resistance	*69*	*50*	*34*	*20*	*16*
Wood	1,753	1,281	957	686	435
Propane	898	652	438	241	161
Wood Pellets	164	136	119	107	99
Biodiesel	122	536	681	587	422
Heating Oil	1,980	968	335	-	-
Biogas	157	224	235	88	154
Natural Gas	2,251	1,425	694	139	61
Total	**7,956**	**6,121**	**4,625**	**3,272**	**2,847**
Note: Energy demand for electric vehicle charging is not included in this table; rather, it is captured in the transportation energy targets in Table 10.					

TABLE 11. TARGETS FOR HEAT PUMPS IN THE RESIDENTIAL SECTOR

Residential Cold Climate Heat Pumps					
Technology	**2025**	**2030**	**2035**	**2040**	**2050**
Air Source Heat Pumps	24,549	45,187	66,008	87,025	97,270
Ground Source Heat Pumps	1,107	2,036	2,970	3,908	4,384
Total	**25,657**	**47,222**	**68,978**	**90,933**	**101,654**
Source: LEAP Regionalization Results, October 2023					

TABLE 12. TARGETS FOR WEATHERIZATION IN THE RESIDENTIAL SECTOR

Residential Weatherization Targets					
	2025	**2030**	**2035**	**2040**	**2050**
Homes Weatherized	18,568	31,865	40,129	48,393	64,921
Forecasted Housing Units*	84,284	88,581	93,174	98,090	109,006
Percent Weatherized	22%	36%	43%	49%	60%
**Regional housing unit forecast is the sum of municipal housing unit forecasts using 10-year historic growth rates. These projections are not necessarily aligned with regional and municipal housing targets discussed elsewhere in this plan.*					

TABLE 13. TOTAL ENERGY DEMAND IN THE RESIDENTIAL SECTOR

Total Energy Demand in the Residential Sector					
Fuel Source	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	1,720	2,004	2,286	2,562	2,666
Wood	1,753	1,281	957	686	435
Propane	1,245	904	594	300	222
Wood Pellets	164	136	119	107	99
Biodiesel	132	601	803	769	607
Heating Oil	2,150	1,084	396	0	0
Biogas	160	227	238	88	154
Natural Gas	2,287	1,448	704	139	61
Total	**9,612**	**7,686**	**6,098**	**4,652**	**4,244**
Source: LEAP Regionalization Results, October 2023					

Residential Final Energy Demand includes both thermal and electric appliance energy use, which includes space heating and cooling, water heating, cooking, refrigeration, lighting, and electric appliances. Final energy demand depends on the total number of households and energy-consuming devices, as well as the annual fuel requirements per household or per device. The LEAP model simulates these end uses within various types of buildings (different end uses / fuels are assumed based on the building type, tenure, urban/rural status). It is estimated that electricity demand will increase 55% between 2025 and 2050. Biodiesel and biogas also increase while natural gas use declines.

COMMERCIAL / INDUSTRIAL THERMAL

The 2023 LEAP Climate Action Plan mitigation scenario estimates that **total** energy demand in the commercial / industrial sector will see a 47% reduction between 2025 and 2050. This would be achieved primarily through weatherization on par with residential weatherization, and with the use of more efficient (and fossil-free) heating technologies, like cold climate heat pumps powered by renewable electrification. Improvements in commercial appliance efficiency, such as closed-door refrigerators in grocery stores and motion-sensitive lighting, can account for additional reductions.

TABLE 14. TARGETS FOR TOTAL COMMERCIAL/INDUSTRIAL THERMAL ENERGY USE

	Total Regional Commercial Sector Energy Demand, CAP Scenario (Thousand MMBTUs)					Total Regional Industrial Sector Energy Demand, CAP Scenario (Thousand MMBTUs)				
Fuel	**2025**	**2030**	**2035**	**2040**	**2050**	**2025**	**2030**	**2035**	**2040**	**2050**
Electricity	2,406	2,626	2,841	2,970	2,936	1,503	1,460	1,405	1,420	1,491
Gasoline	243	250	256	261	271	145	147	148	151	159
Kerosene	2	1	1	0	0	6	7	7	7	7
Wood*	571	608	646	679	772	68	69	72	74	75
Ethanol	17	17	18	18	19	13	14	16	18	19
Solar	147	150	154	157	163	N/R	N/R	N/R	N/R	N/R
District Heat	0	113	169	282	282	N/R	N/R	N/R	N/R	N/R
Propane	762	484	218	12	5	93	91	89	88	85
Residual Fuel Oil	14	14	14	15	15	33	34	34	35	36
Wood Pellets	28	59	88	114	136	N/R	N/R	N/R	N/R	N/R
Biodiesel	47	218	328	444	461	366	606	852	1,116	1,117
Heating Oil	756	393	162	0	0	N/R	N/R	N/R	N/R	N/R
Biogas	303	432	458	272	538	144	305	567	859	1,549
Natural Gas	4,334	2,747	1,354	432	214	1,280	1,196	1,018	829	359
Diesel	N/R	N/R	N/R	N/R	N/R	760	512	259	0	0
Other Petroleum	N/R	N/R	N/R	N/R	N/R	1,116	1,138	1,161	1,185	1,233
Total	**9,630**	**8,111**	**6,706**	**5,656**	**5,811**	**5,527**	**5,579**	**5,629**	**5,782**	**6,133**
Source: LEAP Regionalization Results, October 2023. "N/R" = Not Reported. *Includes Wood Waste Solids for Industrial Sector only.										

Regional-level LEAP data for commercial and industrial **thermal** energy use is not available, making it difficult to establish weatherization targets for the sector based on energy saved by weatherization. Instead, CCRPC used targets for the residential sector to estimate the number of commercial establishments weatherized.

TABLE 15. COMMERCIAL WEATHERIZATION TARGETS

Commercial Weatherization Targets					
	2025	**2030**	**2035**	**2040**	**2050**
Forecasted Establishments*	8,973	9,347	9,737	10,144	11,011
Percent Weatherized	22%	36%	43%	49%	60%
Establishments Weatherized	1,977	3,362	4,194	5,005	6,558
*Source: CCRPC Demographic & Employment Forecast by Economic Policy Research, March 2017					

By 2050, the LEAP model estimates that 64,790 new heat pumps will be installed in commercial buildings. As a result of this transformation in how commercial buildings are heated, natural gas demand is estimated to decrease by 90% from 2025 to 2050. Additionally, demand for heating oil will be eliminated and propane will be drastically reduced.

TABLE 16. TARGETS FOR COLD CLIMATE HEAT PUMPS IN THE COMMERCIAL SECTOR

CAP Mitigation Regional Commercial New Cold Climate Heat Pumps (CCHPs)					
	2025	**2030**	**2035**	**2040**	**2050**
New CCHPs	16,752	33,309	50,661	62,265	64,790
Source: LEAP Data, October 2023					

Almost all the changes in energy demand and fuel switching are associated with the commercial sector. The LEAP model included considerably less detail in the industrial sector due to the lack of available information. However, it is anticipated that diesel gas demand will shift to demand for biodiesel, and from natural gas to biogas in the industrial sector.

ELECTRIC EFFICIENCY TARGETS

Total electricity use is targeted to increase by 55% from 2025 to 2050 (Table 13). This will be driven primarily by electrification of the heating and transportation sectors. At the same time, total energy use will need to decrease, and electricity will become a larger proportion of the state's total energy use. Increasing the efficiency of electricity use through programs described in "Weatherization and Energy Efficiency Projects" above will be key to achieving these dual goals; projections of energy efficiency targets are included in Table 17 and Table 18. Note that cumulative commercial electrical efficiency is projected to drop from 2035 to 2050 because the savings from switching to LED lighting will taper off as this efficiency measure reaches market penetration.

TABLE 17. RESIDENTIAL ELECTRIC EFFICIENCY TARGETS

Residential Electric Efficiency Targets			
	2025	**2035**	**2050**
Forecasted Residences*	84,284	93,174	10,9006
Percent Upgraded with Efficient Electrical Equipment	6%	33%	50%
Total Cumulative Electricity Savings (MWh)	11,000	61,169	110,596
**Regional housing unit forecast is the sum of municipal housing unit forecasts using 10-year historic growth rates. These projections are not necessarily aligned with regional and municipal housing targets discussed elsewhere in this plan.*			

TABLE 18. COMMERCIAL ELECTRIC EFFICIENCY TARGETS

Commercial Electric Efficiency Targets			
	2025	**2035**	**2050**
Forecasted Establishments*	8,973	9,737	11,011
Percent Upgraded with Efficient Electrical Equipment	9%	42%	37%
Total Cumulative Electricity Savings (MWh)	24,587	120,048	99,165
*Source: CCRPC Demographic & Employment Forecast by Economic Policy Research, March 2017			

WOOD FUEL CAPACITY ANALYSIS

This section analyzes the level of wood fuel consumption that can be sustainably supported by the estimated supply of in-state biomass resources. This analysis is conducted on a statewide scale since there is no regional data available for wood fuel supply. However, Map 1 below shows potential areas of woody biomass in the region. According to these data, 138,658 acres of potential woody biomass exist in Chittenden County.

As shown in previous sections, wood (in the form of cordwood and pellets) is a significant heating fuel source for many homes and businesses, though LEAP modeling shows an overall decrease in wood heating over time. Since current wood fuel consumption levels have not been detrimental to air quality in the state or region, it is assumed that the reduced use of wood fuel expected in the LEAP modeling would only improve air quality.

Harvesting of low-grade wood for heating through cordwood or pellets is sustainable when it does not exceed the net growth rate of low-grade wood in forests. As shown in Table 19, the state's Net Available Low-Grade (NALG) wood has increased since 2010, despite the fact that growth in demand for low-grade wood increased while net average growth rates for forests decreased. Though impacts of climate change and other disturbances may be partial causes of this decreased forest growth rates, the dominant driver is the natural forest succession process as a generation of older trees are aging and growing slower, and have yet to be replaced by younger, faster-growing trees. See the 2018 Vermont Wood Fuel Supply Study for full explanations of these trends.

TABLE 19. VERMONT WOOD FUEL SUPPLY ANALYSIS

Vermont Wood Fuel Supply Analysis		
	2010	**2018**
Average Forest Net Annual Growth Rate	2.10%	1.75%
Current Market Demand for Low-grade wood (Green Tons)	1,265,194	1,738,631
Total NALG Wood (Green Tons)	894,893	939,989
Source: Excerpts from 2018 Vermont Wood Fuel Supply Study, Table 2		

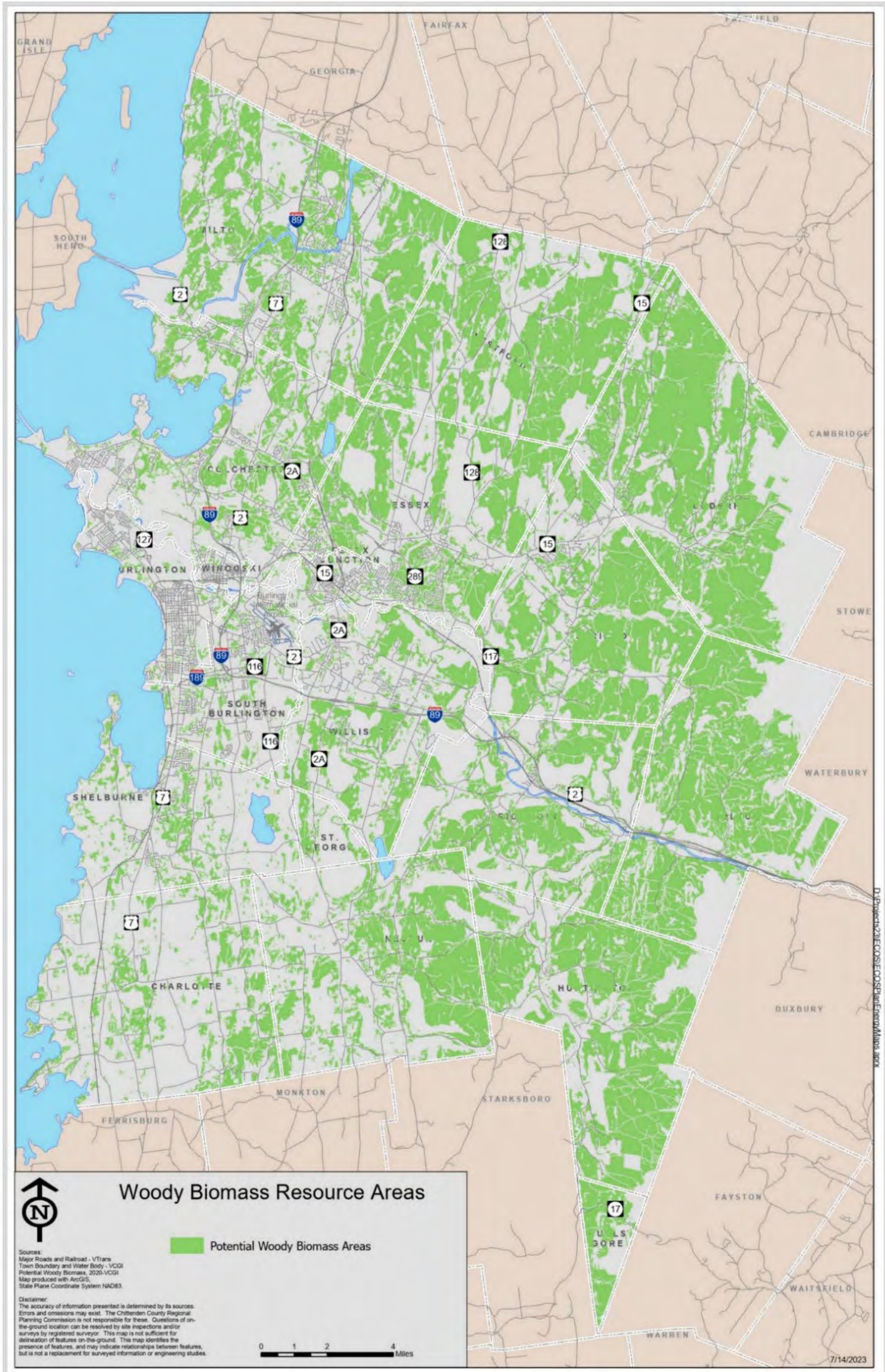
Table 19 assumes that current market demand for low-grade wood will continue at similar rates to the present. However, LEAP modeling in Section 3 of this Supplement anticipates a significant decrease in the use of cordwood and wood pellets for both residential and commercial heating. Given this, NALG will likely increase or remain steady even if forest growth rates and harvest of low-grade wood decrease as expected.

In a scenario where low-grade wood harvesting continues at current rates while forest growth decreases as expected, the demand for low-grade wood may begin to approach the amount available in forests soon after 2050. However, the forestry industry has begun implementing new practices for uneven-aged management that seek to restore the age / canopy diversity of forests, often by cutting 1-acre patches within 10-acre plots once every 10 years. This effectively regenerates the entire forest progressively over 100 years. This systems-wide approach to forest management also involves greater use of low-grade wood compared to practices from the prior century, which focused on sawlogs and pulpwood; therefore, NALG may increase compared to the present.

Maintaining a larger proportion of trees under 100 years old will also increase carbon sequestration rates, much of which will remain in the soil. This also supports the local forest economy and provides important revenue for retaining land as forest rather than converting it to agriculture or other uses. The alternative of letting forests naturally revert to mixed-age growth will still result in some carbon releases as dead wood decomposes; furthermore, it would also take far longer to reach conditions that resemble those prior to clearing in the 1800s.

In conclusion, comparing LEAP modeling with the state's wood fuel supply analysis indicates that there will be more than sufficient supply of wood fuel to meet the state's (and the county's) energy use goals. In fact, the state's forests could support harvest at current or increased levels through at least 2050, perhaps with positive outcomes on natural systems and carbon sequestration or storage in forests. Beyond 2050, more sophisticated modeling would be needed to determine the effect of various forest management practices on low-grade wood supply, but eventually a regime of uneven-aged management would restore a consistent level of NALG from forests.

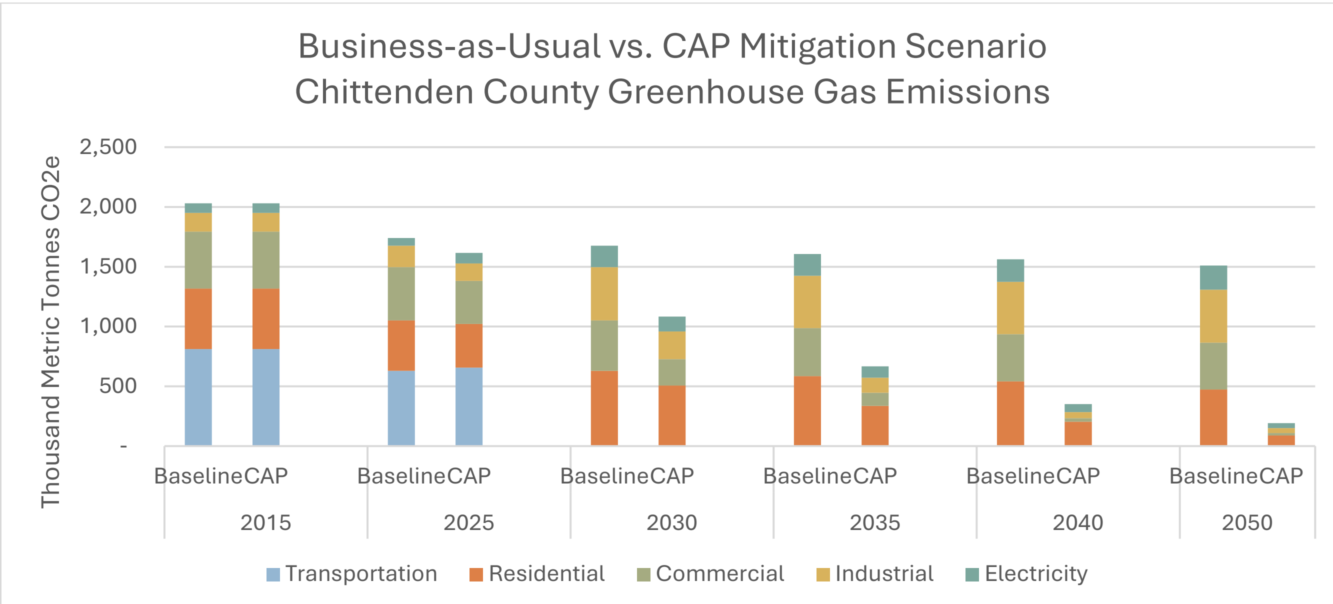
MAP 1. WOODY BIOMASS RESOURCE AREAS



Greenhouse Gas Emissions

Greenhouse gas emissions for each Sector (Transportation, Residential, Commercial, and Industrial) are shown below for two LEAP scenarios The business-as-usual scenario represents emissions from energy demand under normal policy and programmatic conditions. The CAP mitigation scenario represents emissions to meet the state's GHG requirements for Year 2050.

FIGURE 8. CHITTENDEN COUNTY GREENHOUSE GAS EMISSIONS; BUSINESS-AS-USUAL VS. CAP MITIGATION SCENARIO



Source: LEAP Data, October 2023

Renewable Electricity Generation Targets and Potential

Total in-state electricity consumption is estimated to be nearly 12 million MWh in 2050 (Table 20). To understand Chittenden County's share of in-state renewable energy generation potential, the Department of Public Service provided a planning tool that enables consideration of the impacts on land use and grid capacity. The Generation Scenarios tool uses mapping data for potential solar and wind energy resource areas, and known and possible natural resource constraints, as inputs. It also accounts for population, electricity demand, and existing generation currently sited or permitted within the region's boundaries. The generation targets are technology-neutral, which means the region has the flexibility to meet the targets through the development of various renewable energy technologies (e.g. biomass, solar, wind, etc.).

The 2016 Comprehensive Energy Plan (CEP) anticipated maintaining the ratio of in-state generation of renewable electricity at 50% or even increasing it. However, the PSD's Generation Scenarios tool includes scenarios in which 10%, 20%, or 25% of the state's electricity is supplied by in-state generators, which are more consistent with the Renewable Energy Standard requirements updated in 2024 by Act 179. CCRPC's Energy Subcommittee that guided the development of this plan decided to remain consistent with the 2018 ECOS Plan and continue to plan for 50% of electricity demand generated within the state.

To advance the state's energy goals, Chittenden County needs to produce at least a total of 954,833 MWh by 2050, which is 16% of the state's production, to ensure the State's population center is doing its part to generate locally produced renewable energy. The target is based on the average of Chittenden County's share of the state's land area (5.8%) and its share of the state's population (26.2%). Once the total targets for renewable energy generation were estimated, the existing renewable energy generation was subtracted from the total. The remaining amount is the new generation that must be sited within the county to meet the targets. It is important to note that these targets are necessary to meet the Department of Public Service's energy planning standards for regional plans to demonstrate the magnitude of additional renewable energy needed in the region. Enforcement is not associated with these targets so they should be considered as goal posts towards advancing the State's goal of generating 90% of its electricity from renewable sources.

TABLE 20. RENEWABLE ELECTRICITY GENERATION TARGETS

Renewable Electricity Generation Targets	2032	2040	2050
State Projected Electricity Demand	8,111,649	10,731,860	11,943,816
In-State Generation Target	4,055,825	5,365,930	5,971,908
State Imported Generation	50%	50%	50%
Chittenden County Total Target	648,475	857,945	954,833
2023 Renewables Generation	593,122	593,122	593,122
New Generation Needed	55,354	264,823	361,711
Note: The Department of Public Service reports 593,122 MWh for the County. See "Calculating Existing Generation Targets" for an explanation on why CCRPC reports a different number. Sources: Department of Public Service, CCRPC			

Chittenden County has sufficient energy resource area to meet the above generation targets. Solar and wind potential acreage (shown in Table 21) are based on a mapping exercise completed by the Vermont Center for Geographic Information (VCGI), with modifications by CCRPC. The wind potential data is from the Massachusetts Technology Collaborative and is a model of predicted wind energy potential based on wind speed models. The solar energy potential data identifies potential areas where optimal solar radiation is available based on east, west, and south facing aspect and slopes less than 14%.

Environmental and regulatory constraints are also accounted for in the analysis of wind and solar potential. Primary or 'prime' areas are locations with high energy potential that are free from state and local known constraints. Secondary or 'base' areas are locations with high energy potential that are free from state and local known constraints but include a presence of state or local possible constraints. See the Constraints and Unsuitability Methodology below for an explanation of how CCRPC defined constraints in the region and for the list of constraints that were included in the analysis.

To determine the amount of renewable energy potential from the wind and solar acreage described above, conversion factors estimating density of energy production per acre of land were applied to the base and prime areas to estimate the amount of capacity available for meeting Chittenden County's targets. See the "Calculating Existing Generation and Generation Potential" section for more information.

TABLE 21. LAND AVAILABLE FOR WIND AND SOLAR GENERATION

Land Available for Wind and Solar Generation		
	Prime Potential	**Base Potential**
Solar	6,864 acres (2% of county)	63,766 acres (19% of county)
Wind	8,350 acres (2% of county)	106,320 acres (31% of county)
Sources: VCGI, CCRPC and the Department of Public Service		

Table 22 describes the various technologies available for Chittenden County to meet the renewable energy targets. These include rooftop solar, ground mounted solar, wind turbines, biomass, methane from landfills and sewage treatment plants, and hydroelectric energy. The renewable energy generation targets can be met through any combination of technologies. However, given the regulatory complexities of siting new hydropower, this plan only identifies existing hydropower sites where equipment could be upgraded or expanded to provide additional generation. Similarly, there is a sentiment that current sound regulations on wind generation facilities in Vermont effectively prevent new installations. Because estimating the power generated from the use of biomass for heating or co-generation is site-specific, only the number of acres of woody biomass was included below. However, it is unclear whether the state forestry industry could support additional biomass-powered electric plants.

Given these considerations, CCRPC anticipates meeting its incremental renewable electricity generation targets primarily through solar (90%), likely split evenly between ground-mounted (45%) and rooftop installations (45%), with a small portion of generation sourced from wind power (10%) if made feasible by regulatory changes. However, as noted in the suitability policies of Chapter 6, Action 6(b) of the main ECOS Plan, previously developed sites are preferred for renewable energy generation, and development of rooftop solar should be maximized.

TABLE 22. PROJECTED RENEWABLE ELECTRICITY GENERATION POTENTIAL

Projected Renewable Electricity Generation Potential*		
	Power (MW)*	Energy (MWh)*
Rooftop Solar	776	935,184
Ground-Mounted Solar** – Prime	981	1,288,455
Ground-Mounted Solar** – Base	1,215	1,595,968
Wind – Prime	209	411,429
Wind – Base	2,658	5,238,911
Hydroelectric***	See Existing Generation Map	N/A
Potential Biomass Area****	138,658 acres	Unknown
Methane	Unknown	Unknown
Other	Unknown	Unknown

Sources: VCGI, CCRPC and the Department of Public Service

*See "Calculating Existing Generation and Generation Potential" for details on how resource areas were converted to power and energy. Conversions may not be exact due to rounding of municipal-level data, which were summed to obtain the county-level data.

**Ground-mounted solar potential reports how much land could be developed with solar based on its aspect and elevation and removes space taken up by roofs and roadways, but not other impervious surfaces like parking lots. Therefore, rooftop solar potential can be added to ground-mounted solar potential, though parking lot canopy solar installations would be included within ground-mounted solar potential.

***Creation of hydroelectric facilities is unlikely due to Vermont's natural resource regulations.

****Biomass acreage is sourced from VCGI's VT Potential Woody Biomass Areas. However, CCRPC did not project potential power or energy from biomass area due to difficulties in modeling.

PART 5: METHODOLOGY

Calculating Existing Generation and Generation Potential

EXISTING ELECTRIC ENERGY GENERATION

Data on generation sites, power and energy generation are available from the Department of Public Service. The database reports sites and capacity (power) from Certificates of Public Good filed in each municipality. CCRPC modified the data provided by PSD due to errors in how certain facilities were reported. Specifically, the PSD data omitted the Gorge #18 hydroelectric dam in South Burlington / Colchester, and also counted all of the Georgia Mountain Community Wind project within the Town of Milton / Chittenden County RPC rather than dividing the facility evenly with the Town of Georgia / Northwest RPC. CCRPC also corrected existing generation reporting at the municipal level for the Winooski 1 hydroelectric dam (which should be divided between the Cities of Burlington and Winooski) and the Essex #19 dam (which should be divided between the City of Essex Junction and the Town of Williston).

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 = (MW of capacity) * (8760 hours per year) * (0.15 capacity factor)

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 = (MW of capacity) * (8760 hours per year) * (0.225 capacity factor)

ROOFTOP SOLAR ENERGY POTENTIAL

Rooftop solar potential data is sourced from the Vermont Center for Geographic Information (VCGI) dataset named *Town Rooftop Solar Potential – Act 174 2022*. As explained in the release notes, these estimates use a geographic information system (GIS) model of building footprints to determine the total surface area of rooftops suitable for solar photovoltaic panels (accounting for amount of solar radiation, slope, aspect, shading of nearby objects, and minimum size of rooftop viable for solar panels). Using published data for solar radiation, the VCGI data also estimates an annual solar energy production potential for each suitable rooftop, summarized by municipality, and applies 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 MWh) ÷ ((0.145 capacity factor) * (8760 hours per year))

Calculating Renewable Energy Generation Targets

REGIONAL RENEWABLE ELECTRICITY GENERATION TARGET

For the 2018 ECOS Plan, CCRPC established a range (low target and high target) for renewable energy generation under the assumption that 50% of statewide annual electricity demand (in megawatt-hours or MWh) would be produced in-state. The low scenario was based on the county's share of land area available statewide for ground-mount solar and wind energy production (the only two technologies considered at the time). The high scenario was based on the county's share of the total state population. The 2018 Plan identified sufficient land for solar and wind development to meet this demand under either scenario, then allocated this regional target to each of the county's municipalities through a similar process.

In 2024, The Department of Public Service provided a planning tool that enabled consideration of the grid and land use impacts of a scenario in which 10%, 20%, or 25% of the state's electricity is supplied by in-state generators. A 50% option was included in prior versions of the tool but was later removed. This reflects the policy change in the 2022 Vermont Comprehensive Energy Plan (CEP) compared to the 2016 CEP based on at least two factors. First, Act 179 of 2024 changed Vermont's Renewable Energy Standard to require that under RES Categories 2 and 3, a minimum of 20%-32% of electric utilities' renewable portfolios must come from in-state distributed generation sources. Second, the 2021 VELCO Long-Range Transmission Plan (LRTP) indicated that additional distributed generation would be limited by current and future constraints in the transmission and distribution grid.

The LRTP and CEP both note that given the RES requirements and grid constraints, continued development of new in-state distributed generation would require costly upgrades to grid infrastructure which would be borne by ratepayers. The costs of these upgrades are approximated using PSD's Generation Scenarios Tool, summarized in Table 24. Both plans also noted that the current net-metering system is not the least-cost means of providing renewable energy compared to utility-scale installations. Therefore, both distributed and utility-scale generation would be necessary to achieve 50% in-state generation.

However, both plans highlight the need to evaluate the cost and reliability tradeoffs between increased in-state generation and increased electricity imports, which also would require costly transmission system upgrades. Furthermore, both plans acknowledge that having a higher share of in-state generation would provide greater economic benefit to Vermonters. CCRPC supports efforts by utilities and the Public Utility Commission to study this issue further and consider not only the total cost of grid upgrades to ratepayers, but also the benefits of reducing the state's reliance on external entities for electricity and allowing generation to be located proximal to load centers. This would give Vermont greater control over grid reliability and pricing and would allow the state to ensure a more equitable distribution of the environmental benefits and burdens of electricity production as required under 3 V.S.A. Chapter 72 (Environmental Justice).

Given the above, this ECOS plan continues to plan for 50% of electricity demand to be generated within the state. For Chittenden County this means that the regional share is 16%, which is the average of the county's portion of the state's population (26.2%) and land area (5.8%). This regional share, which represents the **total** regional electricity generation target, is applied to three milestone years (2032, 2040, and 2050) as shown in Table 23.

The **incremental** regional electricity generation target is the amount of new electricity that must be generated to meet the total target after subtracting production from existing facilities. Based on data provided by the PSD as of 1/31/2023, Chittenden County annually produces 593,122 MWh of electricity from renewable sources; the resulting incremental regional targets by milestone year are shown in Table 23. The county's existing generation already exceeds its share of the state's modeled electric demand in 2050 assuming 25% in-state generation (477,417 MWh, which is 16% of 11,943,817 MWh). This is another reason CCRPC models 50% in-state generation in this plan.

The existing renewable energy generation for the County is the sum of each municipality's total existing renewable energy generation sited within the municipalities' borders. If a facility is located on the border between two jurisdictions, the generation is split between each jurisdiction; for example, two of the four turbines in the Georgia Mountain Community Wind project are located within the Town of Milton; therefore, half the facility's production is counted for the Town of Milton and the Chittenden County region; the other half is counted for the Town of Georgia and the Northwest region.

Note that the targets are expressed in terms of total annual electricity use in megawatt-hours (MWh). The modeling does not account for daily and seasonal fluctuations in demand as well as supply from intermittent sources like solar and wind. Therefore, in reality a higher total capacity (in megawatts or MW) among generation facilities will be required than the minimum required to produce the total regional electric generation target. However, this would be difficult to model even if there was certainty about fluctuations in demand and the types of technologies available.

MUNICIPAL RENEWABLE ELECTRICITY GENERATION TARGETS

To better understand how the region can achieve its 2050 renewable energy generation targets, CCRPC used a tool provided by the PSD to determine generation targets for each municipality in its region as a portion of the region's overall target. The total municipal electric generation targets were calculated by multiplying the regional target by the municipality's share of the county total of three equally weighted factors: population, current electricity consumption, and land area available for renewable energy production. As with the regional target, the incremental municipal targets are obtained by subtracting existing generation facilities located within a municipality's borders.

As seen in Table 23, a ✓ in the "Incremental Targets by Year" columns indicates that a municipality has met or exceeded the target with existing renewable energy generation within the boundaries of the jurisdiction. Production beyond these targets furthers progress towards the regional target and reduces the incremental targets for all other municipalities. The excess generation of municipalities above the 2050 target is distributed equally to all other municipalities until the municipal target is reached or the excess generation is fully allocated.

The renewable electricity generation targets are solely intended to represent the scenario necessary to achieve our energy goals. They should not be interpreted as requirements to meet a certain level of production (since there is no enforcement or penalty), and local renewable energy production in excess of the targets is encouraged to reduce our reliance on imported energy.

The targets are technology neutral, meaning that they can be met with any mix of technologies. It is important to note that a municipality may choose to meet its target through a variety of different renewable energy technology types (e.g., wind, hydro, or biomass). Some municipalities may be able to achieve their targets with a single technology; for example, South Burlington's 2022 Climate Action Plan states that it is possible and recommended to meet its targets exclusively through rooftop solar. This is not possible for every municipality, and regardless, actual renewable generation facilities developed in any municipality will likely include a variety of technologies. Regardless, as shown in Table 25, every municipality and the region as a whole has more than sufficient land area available for renewable electricity facilities to meet the regional target through one or more technologies.

Although the Town of Essex and City of Essex Junction are now separate municipalities, Efficiency Vermont still only reports electricity demand data for the Town of Essex including the City. Therefore, the PSD and CCRPC approximated usage for each municipality by dividing the total usage proportionally by population. Furthermore, the consumption figures (and thus the renewable generation targets) for both Essex Town and Essex Junction include that of GlobalFoundries (a microchip manufacturer located in Essex Junction). GlobalFoundries (GF) uses approximately 400,000 MWh of electricity annually (representing about 8% of the consumption of the entire state of Vermont) and is also the state's largest for-profit employer. GF has become its own electric utility (GF Power LLC) to procure and provide power to the GF facility in Essex Junction. While Essex Town and Essex Junction theoretically can still meet their renewable generation targets given their available land resources, even factoring for the consumption of GF, it is expected that this will be offset at a regional and statewide level through generation facilities in many locations, rather than solely within these municipalities. Additionally, beginning in the early fall of 2026, GF Power will procure its own power consistent with the RES requirements. GlobalFoundries is currently exploring renewable energy and storage technologies that can be sited on its campuses to meet some of its energy needs consistent with the RES. Doing so would support the state and regional goals of locating generation close to load, minimize the need for transmission upgrades, and utilize existing developed land where possible as well as minimize aesthetic and natural resource impacts.

Though there is more than enough land suitable for renewable electricity generation to meet these targets, Table 24 shows that this would require upgrades to several municipal-level distribution systems by 2050. In addition, the region has only about 61,620 MWh remaining in transmission capacity, so a significant upgrade to the regional transmission system would be required by 2040. CCRPC is committed to coordinating with utilities and the PSD to meet energy and grid resilience goals. CCRPC will track progress towards meeting the renewable energy targets and will revisit the targets when the ECOS Plan is updated to ensure that the targets align with current population, land available for renewable generation, and electricity consumption data.

TABLE 23. MUNICIPAL RENEWABLE ENERGY GENERATION TARGETS

Municipality	Weighting Factors			Total Targets by Year (MWh)			Existing Renewables (MWh)	Incremental Targets by Year (MWh)		
	2020 Population	2021 Electricity Use (MWh)	Acres Available	2032	2040	2050		2032	2040	2050
Bolton	1,301	7,911	4,111	591	591	591	591	✓	✓	✓
Buel's Gore	29	301	1,908	5	5	5	5	✓	✓	✓
Burlington	44,743	317,617	4,658	334,091	334,091	334,091	334,091	✓	✓	✓
Charlotte	3,783	21,586	30,115	15,448	38,226	48,762	9,429	6,019	28,797	39,333
Colchester	17,524	128,420	8,832	20,902	46,257	57,985	14,202	6,700	32,055	43,783
Essex Town	11,504	344,140	10,650	23,387	68,240	88,986	11,535	11,853	56,705	77,451
Essex Junction	10,590	316,798	1,087	31,320	55,027	65,992	25,055	6,265	29,972	40,937
Hinesburg	4,698	38,387	16,307	9,064	23,406	30,041	5,274	3,790	18,133	24,767
Huntington	1,934	7,486	8,214	2,158	4,375	5,401	1,573	586	2,803	3,828
Jericho	5,104	23,333	9,452	9,174	14,111	16,394	7,869	1,305	6,242	8,526
Milton	10,723	77,239	20,484	86,418	86,418	86,418	86,418	✓	✓	✓
Richmond	4,167	19,706	7,033	6,064	8,646	9,841	5,382	682	3,265	4,459
Shelburne	7,717	56,692	15,324	12,278	29,465	37,415	7,736	4,542	21,729	29,679
South Burlington	20,292	200,330	6,162	33,895	59,795	71,775	27,051	6,844	32,744	44,724
St. George	794	3,209	2,122	801	801	801	801	✓	✓	✓
Underhill	3,129	11,999	15,758	5,367	16,281	21,330	2,483	2,884	13,798	18,847
Westford	2,062	8,677	9,123	2,255	5,778	7,408	1,324	931	4,454	6,084
Williston	10,103	120,456	15,025	36,695	47,869	53,037	33,743	2,953	14,126	19,294
Winooski	7,997	42,856	543	18,561	18,561	18,561	18,561	✓	✓	✓
Chittenden County	**168,194**	**1,747,141**	**186,906**	**648,475**	**857,945**	**954,833**	**593,122**	**55,354**	**264,823**	**361,711**

Sources: VT Department of Public Service, VCGI, and CCRPC.

Incremental municipal generation targets were calculated as a portion of the regional incremental target using a weighted average of each municipality's share of the region's population, electricity usage, and land available for renewables generation. If a municipality already produces more renewable energy than its 2050 target (indicated by a ✓) the excess is distributed equally to all other municipalities until their target is reached or the excess generation is fully allocated. Total municipal targets were set as the sum of the 2050 incremental target and any existing generation within the municipality. Finally, targets for each milestone year are set in reference to the 2050 target and the regional targets for those years.

TABLE 24. GRID CONSTRAINTS BY MUNICIPALITY

Municipality	Incremental Targets by Year (MWh)			Incremental Capacity Target (MW)			Distribution Headroom (MW)			
	2032	2040	2050	2032	2040	2050	2023	2032	2040	2050
Bolton	0	0	0	0.0	0.0	0.0	6.7	6.7	6.7	6.7
Buel's Gore	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Burlington	0	0	0	0.0	0.0	0.0	154.8	154.8	154.8	154.8
Charlotte	6,019	28,797	39,333	3.4	16.0	21.9	30.3	26.9	14.3	8.4
Colchester	6,700	32,055	43,783	4.3	20.7	28.3	139.6	135.3	118.9	111.3
Essex Town	11,853	56,705	77,451	5.8	27.8	38.0	125.4	119.6	97.6	87.4
Essex Junction	6,265	29,972	40,937	4.0	19.2	26.3				
Hinesburg	3,790	18,133	24,767	2.6	12.2	16.7	15.4	12.8	3.2	-1.3
Huntington	586	2,803	3,828	1.1	5.5	7.5	2.2	1.1	-3.3	-5.3
Jericho	1,305	6,242	8,526	1.7	8.2	11.1	7.1	5.4	-1.0	-4.0
Milton	0	0	0	0.0	0.0	0.0	50.3	50.3	50.3	50.3
Richmond	682	3,265	4,459	1.4	6.8	9.2	11.7	10.2	4.9	2.4
Shelburne	4,542	21,729	29,679	3.0	14.5	19.8	52.4	49.4	37.9	32.6
South Burlington	6,844	32,744	44,724	5.4	25.6	35.0	194.3	189.0	168.7	159.4
St. George	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Underhill	2,884	13,798	18,847	2.0	9.6	13.2	3.8	1.8	-5.9	-9.4
Westford	931	4,454	6,084	1.1	5.2	7.1	2.0	0.9	-3.2	-5.1
Williston	2,953	14,126	19,294	4.0	19.2	26.2	166.0	161.9	146.8	139.8
Winooski	0	0	0	0.0	0.0	0.0	21.2	21.2	21.2	21.2
County Total	**55,354**	**264,823**	**361,711**	**39.8**	**190.5**	**260.2**	**790.1**	**750.3**	**599.6**	**529.9**
County Transmission Headroom:							**44.0**	**4.2**	**-146.5**	**-216.2**

TABLE 25. TOTAL ENERGY POTENTIAL BY TECHNOLOGY (MWH)

Target Year: 2050	Incremental Target (MWh)	All Resources	Prime Solar	Base Solar	Rooftop Solar	Prime Wind	Base Wind
Bolton	0	198,508	22,846	26,199	4,893	3,813	140,757
Buel's Gore	0	92,825	1,400	2,331	40	2,466	86,587
Burlington	0	375,174	68,654	28,592	134,171	39,549	104,208
Charlotte	39,333	1,282,682	37,410	261,930	27,277	14,614	941,451
Colchester	43,783	506,911	106,100	103,383	102,344	30,307	164,778
Essex Town	77,451	531,649	123,917	161,003	78,063	5,585	163,080
Essex Junction	40,937	104,163	20,604	21,492	61,399	44	625
Hinesburg	24,767	806,148	127,264	115,657	22,767	44,925	495,536
Huntington	3,828	404,412	53,335	49,240	8,777	24,635	268,425
Jericho	8,526	479,434	98,931	90,922	31,457	19,765	238,359
Milton	0	993,340	143,088	183,614	61,594	51,798	553,246
Richmond	4,459	350,180	50,394	50,927	17,307	18,015	213,538
Shelburne	29,679	757,919	91,661	114,535	50,525	66,534	434,663
South Burlington	44,724	418,645	23,659	49,455	158,788	15,370	171,374
St. George	0	104,517	10,147	10,703	3,126	9,814	70,727
Underhill	18,847	772,077	124,266	112,835	14,531	16,686	503,760
Westford	6,084	456,482	122,720	97,594	11,994	21,500	202,674
Williston	19,294	776,661	41,723	110,204	122,471	23,083	479,179
Winooski	0	58,219	20,336	5,354	23,658	2,925	5,945
County Total	**361,711**	**9,469,947**	**1,288,455**	**1,595,968**	**935,184**	**411,429**	**5,238,911**

Sources: VT Department of Public Service, VCGI, and CCRPC.

This table shows the potential energy that could be generated using the full land / rooftop extent of each renewable technology (and all technologies combined). Green cells indicate that there is sufficient area to meet targets solely with a given technology, while red cells indicate there is not enough to use that technology alone. Using the Town of Charlotte as an example, the town has sufficient resource area to meet the 2050 incremental target; however, it could only meet a portion of its target through rooftop solar alone.

Constraints and Unsuitability Methodology

NATURAL RESOURCE CONSTRAINTS

The Department of Public Service's energy planning standards establish known and possible constraints to identify potential areas for the development and siting of renewable energy, storage, transmission, and distribution resources and areas that are unsuitable for siting those resources. Constraints are grouped into the following categories: state known constraints, local known constraints, state possible constraints, and local possible constraints. Development should be located to avoid state and local known constraints, and to minimize impacts to state and local possible constraints.

The state/local known and possible constraints and their associated policies constitute the land conservation measures that might be given substantial deference by the Public Utilities Commission in the Section 248 process for permitting renewable energy generation. The accompanying policies for local and state constraints are discussed in the Plan Methodology section and Chapters 2, 3, 4, 5, and 6 of the ECOS Plan.

Areas that represent known state/local known constraints are removed from wind and solar energy resource areas to estimate the amount of primary or 'prime' energy resource available for siting renewable energy generation and associated infrastructure. Prime energy resource areas are areas that a free from both local and state known and possible constraints.

Areas that represent possible state/local constraints are NOT removed from wind and solar energy resource areas. Instead, they are included with wind and solar energy resources areas to constitute secondary or 'base' energy resource areas. Base energy resource areas are areas with high solar and wind potential and a presence of state/local possible constraints. See Table 26 below for the list of state known and possible constraints.

While the first Chittenden County enhanced regional plan was being developed in 2017-2018, CCRPC went through a process with municipalities and the Long Range Planning Energy Subcommittee to identify local natural resource constraints that might be given substantial deference in the context of particular project review under Section 248. While there was some overlap between the constraints identified by each municipality, no constraints emerged as being universal restrictions to development across the county. Therefore, no regional natural resource constraints were added.

These local constraints are included in the ECOS Plan due to their importance at the local level. For a local constraint to be identified, supporting text in an adopted municipal plan or municipal land use regulation such as zoning regulations or subdivision regulations must align with the classification of known or possible constraints below. To be consistent with the energy planning standards, constraints must be equally restrictive of all development, not just renewable energy development.

The local constraints identified in this plan are not an exhaustive list of every development constraint. Therefore, CCRPC will continue to work with municipalities to complete or update energy plans. CCRPC will also continue to review municipal plans through CCRPC's *Guidelines and Standards for Confirmation of Municipal Planning Processes and Approval of Municipal Plans*. CCRPC will check to ensure that any local policies don't preclude municipalities from meeting their energy generation targets and complying with the state energy goals.

Known Constraints | Zoning districts or resource areas where development is unsuitable or prohibited with no exceptions. Typically, phrases such as "development *shall not* take place" are used to denote these areas.

Possible Constraints | Zoning districts or resource areas such as those in which:

- Development is not completely prohibited, but impacts of development should be "minimized", "avoided," "limited," "avoided *where possible,*" mitigated or similar.

- Development is allowed only following conditional use review.
- The goals of the zoning district are such that large-scale energy development may not be appropriate, such as scenic overlay districts.

TABLE 26. LOCAL / STATE KNOWN AND POSSIBLE CONSTRAINTS*

Bolton	Burlington	Charlotte	Colchester
Known Constraints: • Surface Water Setbacks • Wetland Buffers • Slopes 25% or more **Possible Constraints:** • Conservation District • Forest District • Slopes 15% to 25% • Town Owned Land	**Known Constraints:** None identified **Possible Constraints:** • Official Map Features/View Corridors • Burlington Country Club property • City-owned parks and Centennial Woods	**Known Constraints:** None identified **Possible Constraints:** • Shoreland Setback and Buffer Area • Surface Waters, Wetlands, and Buffer areas • Land in Active Agriculture • Slopes greater than 15% • Special Natural Areas • Wildlife Habitat • Water Supply Protection & Groundwater Recharge Areas • Historic Districts, Site, and Structures • Scenic Views	**Known Constraints:** • Slopes 20% or greater • Wetlands and Surface Water Buffers • Shoreland Overlay District • Water Protection Overlay District **Possible Constraints:** None identified

Essex	Hinesburg	Huntington	Jericho
Known Constraints: • Slopes over 20% **Possible Constraints:** • Scenic Resource Protection Overlay District • Resource Preservation District – Industrial • Slopes 15%-20%	**Known Constraints:** • Slopes over 25% **Possible Constraints:** • Slopes 15-25% • Core Wildlife Habitat • Wildlife Corridors / Linkages	**Known Constraints:** • Slopes over 25% **Possible Constraints:** • Slopes 15%-25% • Wetland Buffers, as defined by Huntington Land Use Regulations • Wetlands, as identified in the 2013 Science to Action report • Conservation District	**Known Constraints:** • Well Protection Area Overlay District • Natural Resource Overlay District – Primary Conservation Areas **Possible Constraints:** • Natural Resource Overlay District – Secondary Conservation Areas

Richmond	South Burlington	Underhill	Westford
Known Constraints: • Slopes equal to or greater than 35% **Possible Constraints:** • Slopes 20% - 35% • Science to Action Contiguous Habitat Units & Wildlife Travel Corridors • Ridgelines over 900 feet elevation • Conserved Lands	**Known Constraints:** • Very Steep Slopes greater than 25% • Class II Wetlands and Buffers • River Corridors • Floodplain Overlay District – Zone 0.2% B2 **Possible Constraints:** • Slopes 15% to 25% • Habitat Block and Corridor Overlay District • SEQ Natural Resource Protection Area • Floodplain Overlay District – Zone 0.2% B1	**Known Constraints:** • Areas above 1,500 ft. Elevation **Possible Constraints:** • Slopes 15% or greater • Mt. Mansfield Scenic Preservation District • Wetlands and associated buffers, • Surface Waters and buffers	**Known Constraints:** • Slopes 25% or greater • Deer Wintering Areas • Ledge Outcropping • Flood Hazard Overlay • Water Resources Overlay **Possible Constraints:** None identified

Williston	State	
Known Constraints: • Water Protection Buffers • Slopes 30% or greater **Possible Constraints:** • Slopes 15% -30% • Conservation Areas/Natural Communities • Primary Viewshed Areas • Tier 1 Significant Wildlife Habitat Areas	**Known Constraints** • FEMA Floodways • DEC River Corridors • National Wilderness Areas • State-significant Natural Communities and Rare, Threatened, and Endangered Species • Confirmed Vernal Pools Class 1 and 2 wetlands (VSWI and advisory layers)	**Possible Constraints** • Potential Vernal Pools • Agricultural Soils + Hydric Soils • Act 250 Ag. Soil Mitigation Areas • FEMA Special Flood Hazard Areas • VT Conservation Design Highest Priority: o Interior Forest Blocks o Connectivity Blocks o Physical Landscape Blocks o Surface Water and Riparian Area • Protected Lands (State fee lands and private conservation lands) • Deer Wintering Areas

* Not every constraint to development in Chittenden County is reflected in the regional energy planning process. Some municipalities did not request any local constraints. CCRPC did not receive requests from Essex Junction, Buel's Gore, St. George, or Winooski. In the case of Winooski, it was determined that local constraints were not needed as the local constraints were sufficiently addressed by the state's constraints.

SUITABILITY METHODOLOGY

Constraints represent areas in which development, including energy generation, is restricted. However, areas in which development is generally appropriate still have different levels of *suitability* for different types and scales of renewable energy generation. This may be due to conflicts between energy generation and other types of planned development, or infrastructure capacity issues. Therefore, we have incorporated considerations of scale into our Siting and Suitability Policies in Chapter 6 of the main ECOS Plan.

FOREST BLOCK EVALUATION

The energy planning standards require an evaluation of whether forest blocks or habitat connectors should be treated as a possible constraint. CCRPC conducted an overlay analysis of all state/local known and possible constraints included in this plan with the Agency of Natural Resources' Vermont Conservation Design / BioFinder dataset. CCRPC's analysis included both the "highest priority" and "priority" layers, and used data for interior forest blocks to meet the definition of "forest block" in 24 V.S.A. § 4303(34), while connectivity blocks and surface water & riparian areas were used to meet the definition of "habitat connectors" in 24 V.S.A. § 4303(36). CCRPC determined that most of these areas are treated as possible constraints already in the ECOS Plan due to the inclusion of local constraints with some exceptions in Westford, Jericho, Richmond, and Huntington (see white hatched areas on Map 2). Although the state/local constraints are combined into one color, each individual natural resource constraint is associated with an accompanying policy either directing development away from the natural resource or calling for mitigation. To ensure regional consistency and compliance with 24 V.S.A. § 4348A(2)(C), Chapter 2 of the main ECOS Plan identifies regionally important forest blocks as Vermont Conservation Design's highest priority and priority forest blocks, and Chapter 5 includes policy statements discouraging development from fragmenting these significant habitats.

MAP 2. FOREST BLOCK EVALUATION