# 11 DRAFT Cumulative Assessment of Action on Carbon Reduction for 2025 and 2030 requirements - Sectoral Reductions & Technology Pathways Analysis

The main text of this section is from the Executive Summary of the Vermont Pathways Analysis Report, prepared by technical consultants The Cadmus Group and Energy Futures Group (EFG). The report was delivered to the Agency of Natural Resources (ANR) on November 15, 2021. The Council and its subcommittees have not yet had the opportunity to fully review the report, pose final questions, and offer detailed revisions. Therefore, while we present the high-level executive summary here as part of the Climate Action Plan, we will wait to present the full and final report as an appendix until after that review and revision process has concluded, likely in December.

In the meantime, it is important to note that the sectoral reductions and technology pathways analysis presented in this Executive Summary are broadly consistent with those reviewed by subcommittees of the Council to date, providing a strong starting point for further analysis. The findings also broadly align with other independent analysis conducted for Vermont, including EAN's Emissions Reduction Pathways Model.[1]

Some of the policy recommendations in this CAP are directly connected to clear emissions reductions targets (for instance, the Clean Heat Standard, which is designed to meet the thermal sector's share of emissions reduction, or 34% of the needed total). Other policies can relatively easily be assessed for their emissions reduction impact, for instance the approximately 95,000 electric vehicles that would be made available to Vermont in the five years between model year 2026 and 2030 by virtue of participating in the Advanced Clean Cars II rule would likely result in about 10% of the needed GHG reductions by 2030. Meanwhile, some other policies and programs are more difficult to assess for their emissions reduction impact and will need to be designed and adapted over time to achieve key benchmarks, including actions and activity levels (or their equivalent), as modeled in the Vermont Pathways Analysis Report, in concert with other interconnected policies and programs. Beyond the emissions reductions estimates, the economic impacts of each of the recommendations will also require further analysis as more of the details of their implementation are developed.

[1] https://www.eanvt.org/ean-emissions-reductions-pathways-model/

It is very important to emphasize that passage of the identified policies and implementation or expansion of the identified programs alone will only meet Vermont's emissions reduction requirements if they are developed with clear tracking systems to ensure meeting modeled benchmarks, or their equivalent, over time. Specifically, the policies and programs must be designed, working in tandem with markets and consumer actions, to achieve the scale and pace of action outlined in this report, including the specific benchmarks for key actions and activities. If some benchmarks are not achieved—say, for instance, 166,000 electric vehicles registered by 2030—then other actions will need to be scaled up in order to make up for any shortfall and achieve an equivalent amount of emissions reductions. The full report presents a set of strategies, policies, programs, and actions that need to be implemented together, in coordination. Stated differently, the activity benchmarks highlighted in the report (i.e. number of EVs, heat pumps, heat pump water heaters, homes weatherized, etc.) should not be read as a menu of options to choose between. We will likely need all of them, or their equivalent, working in tandem at the scale and pace presented.

## Executive Summary

The *Vermont Pathways Analysis Report* was prepared by a team of decarbonization and energy planning professionals from The Cadmus Group and Energy Futures Group, under contract with the Agency of Natural Resources, to provide technical support to the Vermont Climate Council and its subcommittees and task groups as they prepare the CAP. This report provides analysis and detailed scenario modeling using the Low Emissions Analysis Platform (LEAP) model, presenting details on the pathways, strategies, policies, and actions that meet the requirements of the GWSA in across three time periods: 2025, 2030, and 2050. LEAP is an energy accounting framework-based tool that enables users to compare elements across user-defined scenarios that represent alternative future energy pathways. While not predictive, LEAP is beneficial for visualizing the scale and pace of transformation necessary to achieve emissions reductions. Results presented throughout this report are intended to inform the design of GWSA compliant policies.

To meet the GWSA requirements it is necessary to take deep, sustained, and flexible actions across all sectors. Policies, regulatory rules, public messaging, technical support, financing, incentive programs, training, education, and workforce development are all necessary to help drive the pace and scale of the actions needed to meet the requirements in each time period.

In passing the GWSA, the Vermont Legislature acknowledged that acting to address climate change is essential for Vermont's future. Indeed, multiple rationales and justifications support reducing emissions and meeting GWSA requirements:

- **Economic** – In comparison to the baseline or "business as usual," by 2050 the mitigation scenario modeled in LEAP offers $3.2 billion of net benefits.[2] The mitigation scenario avoids $16.3 billion of fossil fuel costs and $3.8 billion of avoided economic, health, and environmental damages,[3] for a combined total savings of $20.1 billion.

  The present value of additional costs for the mitigation scenario are $16.9 billion above the baseline for investments in more efficient buildings and heating systems, electric vehicles (EVs) and EV charging infrastructure, practices to reduce the emissions of greenhouse gases (GHGs) from agriculture and industrial processes, and investments in increased renewable electric generating stations and transmission and distribution systems.

  When the savings from fossil fuels and avoided damages are combined with the additional costs and investments required to reduce emissions, the net economic benefits between now and 2050 are projected to be approximately $3.2 billion, which is roughly equivalent to one year of Vermont's spending on all energy sources.

[2] These results are the net present value benefits in 2019 dollars, using a 2% discount rate, for the mitigation scenario compared to the baseline from 2015 through 2050.

[3] Based on a social cost of greenhouse gases estimated using a damage-based approach starting at a level equivalent to $122 per metric tonne of carbon dioxide equivalent.

- **Social Equity** – Vermont has taken important steps in recognizing the importance of addressing the "energy burden," or the total spending on energy for transportation and housing, for low- and moderate-income households. Many strategies and actions that reduce emissions can also reduce this energy burden, and can be supported by programs, education, outreach, and job opportunities that are targeted toward potentially underserved or marginalized segments of the population. Actions that reduce a household's energy use and emissions can also improve the longevity and affordability of the building, and can improve indoor air quality, safety, and comfort, thereby providing health and well-being benefits. Affordable and clean transportation alternatives, such as electric vehicles and improving bike and pedestrian infrastructure, also supports improved health and well-being while reducing emissions.
- **Environment** – By meeting the GWSA requirements, Vermont will reduce emissions by 26% below 2005 levels by 2025, 40% below 1990 levels by 2030, and 80% below 1990 levels by 2050, accompanied by sufficient sequestration for Vermont to be net zero after 2050. These levels of reduction are consistent with scientific and political consensus on what is required to avoid potentially catastrophic impacts from climate change. Even with reductions that meet the GWSA requirements, Vermont and the rest of the world will face increased damages and disruptions from climate change for decades to come. However, the nature and scale of the threat if the GWSA requirements are not met by Vermont and other jurisdictions are much greater and threaten the health, stability, and well-being of the entire planet.
- **Technical/Institutional** – Meeting the GWSA requirements relies and builds upon technical solutions and organizations that exist in Vermont today. Advances across many industries, both directly related to energy and related to advanced computing, communications, material sciences, and control systems have enabled the development of a full palette of affordable and clean solutions for meeting every sector's energy service needs. Vermont's utilities, private fuel dealers, private businesses, financers, and public and non-profit organizations can grow and evolve to meet the challenges of deploying modern energy technologies.
- **Legal** – Unlike a policy target or goal, the GWSA establishes emissions reductions as requirements with potential legal recourse if the state fails to keep pace. Recognizing that emissions reductions are contingent on individual decision-making and private investments that are not directly controlled by the state, there is nevertheless a legal requirement for the state to develop and enact a plan for reducing emissions in a historic manner. Success will depend on using the leverage of policies, public messaging, leading by example, regulations, and investment of public funds to catalyze and support the myriad of private decisions required to meet the requirements.

### *Sector Overview*

To meet the GWSA requirements it is necessary to catalyze actions that will reduce emissions from each of the major sectors that currently contribute to GHGs. The mitigation scenario modeling conducted by the Project Team for this report is not predictive or prescriptive about exactly how the emissions reductions will be achieved over the coming decades, but it provides valuable information on the scale and pace of changes that need to be considered in each sector. A brief synopsis of the type and scale of action needed in each sector is outlined below.

### Transportation

The mitigation scenario for meeting the GWSA requirements relies heavily on electrification of the vehicle fleet. EVs produce fewer emissions than conventional gasoline and diesel cars and trucks because they are more efficient and use a cleaner fuel. A global and national transition toward EVs is underway, but Vermont will need to be on the leading edge of adoption to meet the GWSA requirements. The prospects for rapid adoption and transformation of vehicle fleet are aided by favorable performance and economics for EVs. Over time, EVs can provide individual customers with financial savings and a lower total cost for operations. Nevertheless, higher up-front costs (before incentives) are a near-term barrier, and care must be taken to ensure equitable access to clean transportation options.

While investments in reduced transportation demand management, biofuels, and alternative modes of transportation also contribute to reduced emissions, most of the savings are realized through the benefits of fleet electrification. By 2025 the mitigation scenario includes 43,000 EVs on the road, with EVs accounting for 40% of vehicle sales and 8% of the statewide total vehicle miles traveled (VMT). By 2030, the mitigation scenario includes 166,000 EVs on the road, with EVs accounting for more than 80% of vehicle sales and 29% of the statewide total VMT.

The challenges to undertaking a transition at this pace and scale include increasing public and private infrastructure for vehicle charging and the availability of EVs based on manufacturing capacity and Vermont's ability to present as an attractive market for EV sales. Revenues to assist with the transition in the transportation sector are expected to come from federal resources and from participation in the regional Transportation Climate Initiative (TCI).

### Buildings

In the building sector, the mitigation scenario relies on a combination of policies, strategies, and actions to reduce emissions. Modernizing the energy performance of Vermont's buildings means improving their thermal performance by insulating and air sealing to reduce the heating and cooling loads. It also involves taking advantage of the opportunity to improve the efficiency of heating systems by replacing conventional combustion-based equipment with modern and efficient cold-climate heat pumps. To further reduce emissions, buildings with more efficient thermal shells and heating equipment can also use electricity or biofuels, which create less emissions than conventional fossil fuels such as heating oil, propane, or natural gas. As building heating loads are increasingly electrified, electric system costs can be met through flexible load management and by coordinating multiple loads within and across large numbers of buildings.

Advanced flexible load management can include thermal and battery storage, which offer resilience and back-up power benefits.

The mitigation scenario includes more than 78,000 heat pump installations by 2025 and 142,000 heat pump installations by 2030. In many cases, the opportunities for enhanced building energy performance and reduced emissions will save customers' money. An example of the savings for an individual Vermont customer using propane is to use heat pumps, weatherization, and biofuels. Financing, incentives to overcome up-front-cost barriers, education, and outreach are all necessary to promote the pace of adoption necessary to meet emission reduction requirements.

In the mitigation scenario an additional 90,000 housing units are weatherized by 2030, with a focus on serving low- and moderate-income households including those in rental units and mobile homes. The challenge of increasing the pace of delivery for weatherization services is discussed later in the report.

A Clean Heat Standard (CHS) is a market based, flexible, and technology neutral approach to reduce emissions across all residential, commercial, and industrial buildings. As a performance-based standard, the CHS would require providers of heating fuels to procure a specified level of clean heat credits each year. Initiatives to improve the performance of rental properties and to set net zero standards for new construction also contribute to emissions reductions. Federal funds, both existing funds through historical programs funding weatherization and new funds related to infrastructure and climate objectives, will be essential complements to private and state-level investments in the building sector.

### Non-Energy

While more than three-quarters (76%) of Vermont's GHG emissions are attributed to energy use, there are significant non-energy emissions from agriculture and industrial processes. In Vermont's 2018 Greenhouse Gas Inventory,[4] non-energy emissions accounted for 24% of the total emissions, mostly from gases (such as methane and fluorinated gases) that have much higher impacts than carbon dioxide on warming for each physical unit of gas released.

In the mitigation scenario, non-energy emissions are reduced by 11% by 2025, 20% by 2030, and 38% by 2050. In the agriculture sector, management practices can reduce emissions, most importantly methane emissions, from enteric fermentation and manure management. The sequestration of carbon by agricultural soils can also be promoted through alternative cropping and tillage patterns. Reducing methane emissions was recently identified as an international priority at the 26th Conference of the Parties at Glasgow Scotland,[5] and Vermont can benefit from increased attention and funding directed toward the reduction of methane emissions, demonstrating how natural and working lands can be managed to reduce direct emissions and

[4] Vermont Department of Environmental Conservation. May 2021. *Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990–2017*. https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

[5] BBC News. November 2, 2021. "COP26: US and EU Announce Global Pledge to Slash Methane." https://www.bbc.com/news/world-59137828

increase sequestration. Meeting the GWSA requirement of net zero carbon emissions by 2050 requires steps to protect and maintain the landscape's capacity for sequestration. Even after meeting the reductions in gross emissions for the GWSA requirements, achieving a net zero requirement after 2050 will require Vermont to maintain sequestration rates of roughly 2 million metric tonnes of carbon dioxide equivalent (MMTCO2e) per year.

In Vermont, the non-energy emissions from industrial processes are primarily related to the use of substitutes for ozone depleting substances (ODS) as refrigerants and to the leakage of these gases (which have global warming impacts). In the mitigation scenario, emissions from ODS substitutes are reduced by more than 40% by 2030, based on the adoption of alternative refrigerants and enhanced refrigerant management and recycling. The direct non-energy emissions of fluorinated gases with high global warming impacts from semiconductor manufacturing are also reduced in the mitigation scenario, with an 8% decline by 2030.

### Electricity

The mitigation scenario relies heavily on the use of clean electricity in efficient buildings and transportation to offset the use of fossil fuels. Vermont has already made significant progress in shifting its electricity portfolio to clean resources, and the mitigation scenario includes continuing to increase renewable electricity, from 75% in 2032 to 100% by 2050. As the transportation and buildings sectors electrify, there will be significant increases in total electricity consumption. In the mitigation scenario, demand for electricity increases by 16% from 5.5 terawatt hours (TWh) in 2020 to 6.4 TWh in 2025, and by 43% to 7.9 TWh by 2030. By 2050 the total annual electricity demand in the mitigation scenario is more than 12 TWh. To meet these increased electricity demands, the mitigation scenario includes significant expansions in offshore wind, onshore wind, and solar generation, with Vermont continuing its reliance on electricity from the regional electric grid as well as generating resources in the state.

As electric demand grows and the uses of electricity are expanded, it is essential to address potential barriers that can prevent equitable access to the electric services and end uses that help to reduce emissions. Assuring equitable access to clean energy will entail consideration of the adequacy of electric service for individual housing units to support conversions to electric heat pumps and EV charging. Coordinated and flexible load management is a critical strategy to reduce the overall costs for new electric generation, transmission, and distribution infrastructure needs as electrification proceeds.

### *Meeting the Global Climate Imperative*

This report identifies and provides analytical support for the strategies, policies, and actions for each sector that, when combined in the mitigation scenario, enable Vermont to meet the GWSA emission reduction requirements. Vermont, in isolation, cannot solve or abate the looming potential threats of climate change. No single jurisdiction or country can do that. Nevertheless, Vermont can adopt a CAP and take actions across all sectors of our economy to do our part to reduce emissions, demonstrating the social, technical, and economic feasibility of transformative solutions. The mitigation scenario analyzed in this report identifies key questions, milestones, and guideposts to inform this journey. This report and our analyses are not predictive or

prescriptive about exactly how Vermont will meet the requirements of the GWSA. There is still a great deal of planning and work ahead.

The *Vermont Pathways Analysis Report* and the supporting analyses indicate that meeting the GWSA requirements will not be easy, but it is possible based on technologies, market trends, and resources that exist today. Efforts in every sector will need to be increased far beyond what has been done in the past. It will be critical to provide ongoing tracking, reporting, and evaluating of the impacts for meeting requirements so that strategies and actions can be adapted in response to changing conditions. The report and analyses can be used and useful for decades to come as Vermont strives and adapts to meet the climate challenge by reducing emissions at a scale that meets the GWSA requirements and in a manner that benefits its citizens, its economy, and its natural and built environment.