DRAFT VERMONT CLIMATE ACTION PLAN

Vermont Climate Council

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Letter from the Vermont Climate Council

We adopt this initial Climate Action Plan under the Vermont Global Warming Solutions Act (GWSA) with feelings of both urgency and responsibility to do our part to mitigate climate change through transformation of how we use and source energy; to adapt our communities and built environment to the warming planet; to protect our natural and working lands from the damage created by climate change; and to support and enhance the resilience of Vermont's landscape and communities. Climate change represents an existential threat for people and the natural systems upon which we depend for our health and well-being. It is critical that we act to become more resilient and adaptive to climate change already underway and that we do more to reduce the emissions that have brought us to this point, in order to create a habitable future.

This initial Climate Action Plan represents one of the first public process in the State of Vermont to acknowledge and try purposefully to incorporate equity and the principles of a just transition in both its development and outcome – but we know we fell short. During our meetings and outreach, too few Vermonters had their voices lifted up to join the voices of those who have also participated in similar endeavors in the past. In our development of pathways, strategies, and actions, we faced challenges creating programs and policies organically in partnership with marginalized communities and individuals in Vermont and to envision new ways to ensure a just transition for all of us. As we continue forward, we have a strong desire to engage more Vermonters deeply and equitably in this transition, recognizing the historical and present harms and systemic injustices that are at work here in Vermont and elsewhere.

And yet, there is much in this initial Climate Action Plan to embrace and act upon now, and from which we must build going forward. The recommendations set forth aim to make real and lasting progress toward the significant greenhouse gas emissions reductions required by the GWSA and to strengthen Vermont's ability to adapt to a changing climate. Many essential, detailed ancillary reports represent new analyses that underpin our work and point the way forward. We adopted several concrete recommendations with broad consensus, designed to promote mitigation, adaptation, and resilience, and we look forward to implementation by the Legislature, state agencies, and our partners in climate action throughout the State. We also identified many areas that will require more conversation and will be the focus of further development at the Council in the years ahead. Just as we have acknowledged the need for the Council to better partner with marginalized communities and individuals in our work moving forward, we urge those involved in Plan implementation likewise to commit to meaningful, effective engagement with those on the front lines to make just transitions possible.

We are grateful for the dozens of devoted subcommittee members; the many committed participants, from members of the pubic to technical consultants, who attended our meetings and events; and the thousands of Vermonters who were able to engage with us in this process. Many of you spent countless hours helping us develop Vermont's initial Climate Action Plan – thank you.

The Council's work continues and is ongoing, as contemplated by the GWSA and demanded by the imperatives of climate change. The measure of these efforts will be in the ways our energy sources change, our natural and built environments adapt, and Vermonters engage in a just transition away from climate pollution and toward a cleaner and sustainable future.

Executive Summary

Vermont is committed to moving forward actions that set the state on the path to building a resilient and adaptive future that meets our statutory emission reduction requirements, as laid out in the Global Warming Solutions Act (GWSA). The Vermont Legislature passed Act 153, also known as the GWSA on September 22, 2020, creating the Vermont Climate Council (hereinafter the Council) and set forth specific greenhouse gas (GHG) reduction requirements for the State to achieve. The Act requires reductions in Vermont's GHG emissions tied to three time periods: 2025, 2030, and 2050. Vermont is required to reduce its GHG emissions by no less than 26% below 2005 GHG emission levels by January 1, 2025; by no less than 40% below 1990 GHG emission levels by January 1, 2030; and no less than 80% below 1990 GHG emission levels by January 1, 2050.

The 23-member Council, comprised of eight administration officials and 15 appointments from the legislature representing various sectors, is charged with:

- identification, analysis and evaluation of strategies and programs to reduce GHG emissions, to achieve the State's GHG reduction requirements, and to prepare the State's communities, infrastructure and economy to adapt to current and future effects of climate change;
- adoption of the Vermont Climate Action Plan by December 1, 2021, to be updated at least every 4 years, that sets forth specific initiative, programs and strategies that the State will pursue to reduce GHG emissions, achieve the reduction requirements, and build resilience in communities, infrastructure and the economy; and
- identification of accurate means to measure the state's GHG emissions and progress towards meeting the reduction requirements; effectiveness of initiatives, programs and strategies included in the Plan; the effect of climate change on wildlife, climate and natural resources of the State, and the State's existing resilience and progress towards improving resilience and adaptation.

To achieve the Council's mandate, the GWSA established four Subcommittees and charged them to assist with preparing the Climate Action Plan and carry out other duties which are spelled out in detail in their charges (See Appendix INSERT). The four Subcommittees specifically identified in the GWSA are: Rural Resilience and Adaptation; Cross-Sector Mitigation; Just Transitions; and Agriculture and Ecosystems. The GWSA also allowed the Council to create additional Subcommittees to advise the Council. To address the technical complexity and data needed for this effort, the Council also created a fifth Subcommittee: Science and Data.

The core function of the Subcommittees is to recommend draft initiatives, programs, and strategies for the Council to review, refine and compile into Vermont's Climate Action Plan. As outlined in the legislation, the Subcommittees collectively must further the following objectives:

- Prioritize the most cost-effective, technologically feasible, and equitable GHG emissions reduction pathways, adaptation and preparedness strategies;
- Provide for GHG emissions reductions that reflect the relative contribution of emissions from different sectors;

- Minimize negative impacts on marginalized and rural communities and individuals with low and moderate incomes;
- Ensure that all regions of the state benefit from GHG emissions reductions;
- Support economic sectors and regions of the state that face the greatest barriers to emissions reductions, especially rural and economically distressed regions and industries;
- Support industries, technology, and training that will allow workers and businesses in the state to benefit from GHG reduction solutions;
- Support the use of natural and working lands to reduce GHG, sequester carbon and increase resilience; and
- Maximize the state's involvement in interstate and regional initiatives and programs designed to reduce GHG emissions, and build upon state, national, and international partnerships and programs.

To ensure the Subcommittees had the right composition to accomplish their charges, recruitment focused on:

- Council members and some measure of balance across the three designations;
- Specific expertise necessary to create the work;
- Geographic balance;
- Sectorial balance; and
- Equity and representation of vulnerable populations.

The recommendations ultimately put forward in this Plan are the collective work of these subcommittees. These recommendations were reviewed and adopted by the Council over the period of several months and together represent the necessary actions needed to advance the objectives of the GWSA. The recommendations are organized around five areas:

- Emissions reductions;
- Building resilience and adaptation in Vermont's natural and working lands;
- Building resilience and adaptation in Vermont's communities and built environment;
- Enhancing carbon sequestration and storage; and
- Cross-cutting pathways.

In conjunction with developing the recommendations found within, the Just Transitions Subcommittee supported the work by ensuring that the strategies to reduce greenhouse gas emissions and build resilience to climate change impacts will benefit and support all residents of the State of Vermont fairly and equitably. The term "Just Transitions" encompasses both public policy and business action that address the impacts of the transition away from greenhouse gas emissions for jobs and livelihoods (the transition "out") and the generation of low or zero

greenhouse gas emission jobs and livelihoods of a sustainable society (the transition "in"). The Just Transitions Subcommittee designed six key principles to guide the recommendations of the Climate Council in development of the Climate Action Plan. These include:

I. Ensuring *Inclusive, Transparent, and Innovative Engagement* in the development of the plan and associated policies and program.

II. Creating *Accountable and Restorative* recommendations that recognize inequality and seek to resolve them using clearly identified strategies.

III. Moving at *The Speed of Trust* where candor and honesty are recognized as essential for public trust and preparing Vermonters for transition to a sustainable climate future.

IV. Incorporating *Solidarity* to create inclusionary spaces for all traditions and cultures, particularly for Indigenous communities, recognizing them as integral to a healthy and vibrant Vermont.

V. Prioritizing *The Most Impacted First* through recommendations that address the needs of impacted and frontline communities first, providing the greatest benefits of transitions to these communities.

VI. Developing *Supports for Workers, Families, and Communities* that consider and plan for potential impacts on workers, families and their communities based on the implementation of Vermont's Climate Action Plan

The Just Transitions Guiding Principles provide a framework for climate action to be utilized during the continued development and ongoing implementation of the Climate Action Plan. These principles set expectations for the Climate Council and its subcommittees to conduct their work, what recommendations they make and how investments, implementation and oversight of the plan must occur. The Guiding Principles have helped to shape the beginning of a process of community engagement, co-creation, and the prioritization of recommendations that speak to issues of equity and justice. The Climate Council has taken some important first steps, however, the Council has heard significant frustration around the timeline which has prevented adequate and inclusive engagement. Time and resource constraints have prevented a robust equity analysis and public engagement process. Both are essential to move away from a status quo that exacerbates inequities and places impacted communities at greater risk from climate change.

The Council acknowledges that to realize the transformative change that is needed, ongoing engagement with Vermonters will be needed to consider solutions and understand the barriers to implementation. This Fall, the Council engaged with a total of 1,602 Vermonters to discuss the development of the Climate Action Plan. Public events were held over a few weeks, an online survey was conducted, and public comments received through the online portal were summarized. Through these forums, Vermonters engaged in formulating the actions for inclusion in the Climate Action Plan, helping the Council consider how it will advance climate action in Vermont. Despite the engagement, the Council was challenged due to both the timeline and the ongoing pandemic. The velocity of the process influenced the participation level of groups that are likely to be more highly impacted by climate change including low-income communities, BIPOC communities, and disability advocacy groups in particular. The public engagement plan outlined additional opportunities for broader partner outreach and support that were not fully

realized during this phase due to the lack of time to build trust and respectfully coordinate with multiple partners.

Vermont's Climate Action Plan is a vital opportunity to build a stronger, healthier, more vibrant, and resilient future for Vermont, but it is only the first step. The work of the Climate Council is ongoing, and the Council has been clear that this is an initial plan. The timeline made it very challenging to address all the objectives identified in the Global Warming Solutions Act (GWSA) to the level of detail needed to advance them immediately. As such, there are several pathways for further work beyond December 1.

While the legislature and the Agency of Natural Resources will work to advance numerous actions put forward in this plan through legislative action and rulemaking, the Council will work to further advance areas work in several key areas, including but not limited to:

- Funding and financing options, with a specific emphasis on prioritizing the expenditure of the American Rescue Plan Act dollars to advance the implementation of this plan.
- Overseeing the rollout of the Climate Action Plan and a comprehensive public engagement strategy.
- Furthering the implementation of the Guiding Principles and the Scoring Rubric in the program design of priority actions.
- Organizing the subcommittees work to focus on next steps to further the resilience, adaptation, and sequestration actions prioritized in this plan.
- Prioritizing future technical analyses to inform future iterations of this plan.
- Advancing the measuring and assessing action tool contemplated in this plan.

To make progress on all these fronts, the Council will need to determine what the necessary organizational structure will be in the coming year. That said the work is imperative and enduring. As such, we envision a robust engagement from the Council for the foreseeable future to continue to work on behalf of Vermonters to realize the transformative change needed to meet both the challenges and opportunities of climate change.

Acknowledgements

Members of Council

Members of Subcommittees

State staff

Consultants

Using this Plan

This Climate Action Plan outlines the steps Vermont needs to take to impact meaningful climate action. This plan includes recommended actions for state, regional, local, private, and non-profit sector partners. It also includes actions that individual Vermonters can take, highlighting the

request the Council heard many times for a set of implementable actions at all levels of society and government.

This plan is organized around five areas:

- Emissions reductions;
- Building resilience and adaptation in Vermont's natural and working lands;
- Building resilience and adaptation in Vermont's communities and built environment;
- Enhancing carbon sequestration and storage; and
- Cross-cutting pathways.

These areas cover the broad scale change and shifts that are needed to reach the emissions reduction requirements established in the Global Warming Solutions Action (GWSA), as well as ensure that Vermont's communities and landscapes are resilient to the impacts of climate change. Each area identified above contains a set of pathways, strategies, and actions, that while not exhaustive, meet the intent of the emissions reduction requirements, and adaptation, resilience, and carbon sequestration goals of the GWSA.

Pathways are the high-level mean to achieving GHG emissions reduction or adaptation, resilience, and sequestration goals. The pathways identified in this plan illustrate the framework needed for climate action in Vermont. Under each pathway are a set of strategies that illustrate how we are going to get to a particular pathway. Within each strategy are a set of actions. Actions are the tasks that define the policy, program, project, initiative, and plans, that should be undertaken to meet the pathways and strategies. Actions and strategies were organized under pathways based on the prioritization process undertaken at a subcommittee level. See the graphic below for details on how to read the strategy and action tables.

The pathways for emissions reduction identify steps that need to be taken together to meet the GHG reduction requirements established in the GWSA. Achieving these requirements is a significant undertaking, requiring aggressive immediate and sustained efforts, and the set of actions included in that section must be taken as a whole to ensure Vermont both can meet its 2025 requirements, and be on the path to compliance with the 2030, and 2050 GHG reduction requirements. The Climate Council has identified a lead implementor, and timeline for implementation, to ensure a shared understanding of what will be needed to bring each recommendation to fruition.

The pathways for adaptation, resilience, and carbon sequestration include specific actions for implementors at the state, regional, and local level, but do not identify a lead implementor or timeline to implement by action. Unlike emissions reductions, requirements and benchmarks for progress related to resilience and adaptation were not as clearly laid out in the GWSA. A requirement was set for carbon sequestration and storage which requires the state to be net zero by 2050 but intermediate benchmarks to ensure we are on track to meet that requirement was not identified. The Climate Council acknowledges more work needs to be done to identify clear metrics and goals for those areas of work.

The release of this Climate Action Plan is a step in the Council's work to inform climate action in Vermont. This plan includes a section on implementation that should be used by legislators, state agencies, and other stakeholders to inform the work needed to fulfill the charge of the GWSA In parallel, the Council will continue to build out a framework for measuring and

assessing progress that government, non-profit, private sector, and municipal partners to track the impact of their actions, as well as supporting the Council in periodically assessing progress

and recommending changes in approach that will be needed to fully implement the GWSA..

How to read an action or strategy table

Lead implementer who will be working on this action. This is not inclusive of all necessary partners, but names the lead government agency, legislative body, non-profit, private sector partner, etc. who will take the lead and coordinating on this action. A lead implementer is only identified for the actions under the Emissions Reduction Pathways. Acronyms have been used to save space and are listed under Definitions and Acronyms.

For Emissions Reduction pathways, **impact** is an assessment of the actions' contribution to achieving 2025, 2030, and 2050 emissions reduction requirements. For all other pathways, impact is an assessment of the action on adaptation, resilience, and carbon sequestration goals. Actions were ranked as high, medium, and low and all actions included in the body of this plan were ranked either as high, or as actions that are needed to support high priority actions (enabling actions). For all other pathways, impact was assessed at the action level, but the plan includes a summary assessment of all actions under a strategy.

An **equity assessment** was conducted at the action or strategy level using the Guiding Principles for Just Transition Scoring Rubric developed by the Just Transitions Subcommittee. The equity assessment and scoring rubric can be viewed under Attachments.

Lead Implementer

Impact

Action or Strategy Details

Equity

Cost-Effectiveness

Timeline to Implement

Co-Benefits

Technical Feasibility

Each action describes the policy, program, or tool that is recommended to support the strategy and pathway. For Emissions Reduction Pathways, this is described for the action, for all other pathways, this is described at the strategy level for the group of actions under each strategy.

Actions under the Emissions Reduction Pathways include a detailed **timeline by which to implement.** Actions under other pathways do not include this as the assessment was done at the strategy level, and actions underneath may be implemented at different times.

For Emissions Reduction Pathways, **Cost-effectiveness** was assessed as the lifetime net cost per ton of GHG emissions avoided. For all other pathways, it refers to the relative lifetime net cost of the action compared to the desired outcome or impact.

Assessment of **co-benefits** at the action and strategy level included reviewing the impact on broader societal benefits as well as building resilience, adaptation, mitigation, and storing and sequestering carbon.

The assessment of **technical feasibility** speaks to the degree to which the required technologies are developed and reasonable available.

Climate Change in Vermont

CLIMATE CHANGE IN VERMONT

Lesley-Ann L. Dupigny-Giroux, Jason Shafer, Owen Pollio, Ken Jones

1.0 PREFACE

This section of the Climate Action Plan presents the drivers and processes of climate change in the Vermont by focusing on the natural hazards that affect multiple socioeconomic sectors and which directly influence on our resilience as a state. In presenting resilience through the dual lenses of inclusion and vulnerability (of peoples, the natural environment and human infrastructure), we honor Abenaki knowledges (Figure 1a) and all ways of knowing (Betts, 2021), as we seek to do no harm (Figure 1b).

For consistency with other state-level Climate Action Plans, this section used data and statistical methods developed in support of the Fifth National Climate Assessment (NCA5)[1] by the National Center for Environmental Information (NCEI), the Environmental Protection Agency (EPA) and the Northeast Regional Climate Center (NRCC). One such document is the 2021 Vermont State Climate Summary[2] which is included with permission as Appendix 1 and which will be released by NCEI by January 2022. County level climate projections of future thresholds were summarized from the NOAA Climate Explorer[3] and included in Appendix 1. Sectoral impacts of climate change across Vermont can be found in the 2021 Vermont Climate Assessment. Existing tools for monitoring and quantifying vulnerabilities will be woven throughout this section.

2.0 BACKGROUND

Across Vermont, natural hazards of varying intensity, duration and frequency occur. These include severe storms, winter storms, drought, flooding, wildfires, air pollution, ground-level ozone, temperature extremes, localized winds and biotic elements (insects and disease)[4] . Some of these hazards are ubiquitous, while others tend to occur at specific geographic locations.This poses varying exposure or risk and therefore, societal vulnerability. As climate change continues to be observed in Vermont, the characteristics of these hazards are also changing and this sets up cultural, socioeconomic and policy implications for Vermonters as individuals, municipalities, communities and indigenous peoples, as well as for the built and natural environments. Thus, climate change related impacts on our economic sectors are of central importance in this Climate Action Plan, as we lay out the inaugural framework for mitigating against and adapting to climate change, while building our resilience as a State.

2.1 **Geographies of vulnerability** (human, landscape, infrastructure)

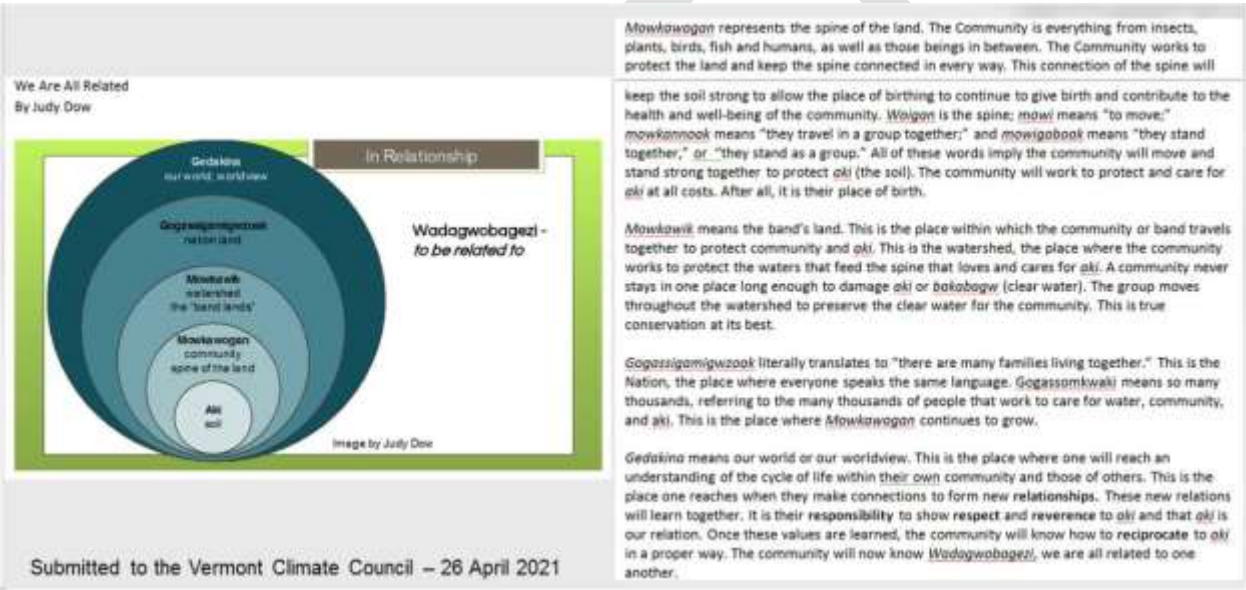
The topography or physical geography of Vermont is one of the most important factors in influencing the occurrence of natural hazards their impacts on human settlements, the location of our major roadways in steep, V-shaped valleys and our ability to increase resilience as a state. The north-south spine of the Green Mountains, along with the complex east-west valleys and the north-south ridges of the Taconic Mountains[5] affect the movement of localized winds and incidence of freezing rain conditions; produces enhanced orographic precipitation and the associated flooding events; control the incidence of pollution

[1] <https://www.globalchange.gov/nca5>
[2] https://statesummaries.ncics.org/chapter/vt/
[3] https://crt-climate-explorer.nemac.org/
[4] Dupigny-Giroux, 2002
[5] Dale, 1905

and stagnation events, as well as variations in freeze and frost dates[6].

Various online tools can be used to monitor Vermont's human and landscape vulnerability. The NOAA Climate Resilience Toolkit[7] offers a 5-step, risk-based management framework to achieve climate resilience. The Vermont Department of Health has summarized the Vermonters' vulnerability by geographic location as well as by climate hazards (Figure 4c) and offers the online Heat Vulnerability Index Mapping Tool[8] < for ongoing monitoring. Finally, the Forest Monitoring Cooperative has launched the Forest Ecosystem Monitoring Cooperative's "Monitoring northeastern forest indicators for signs of climate-drive change[9].

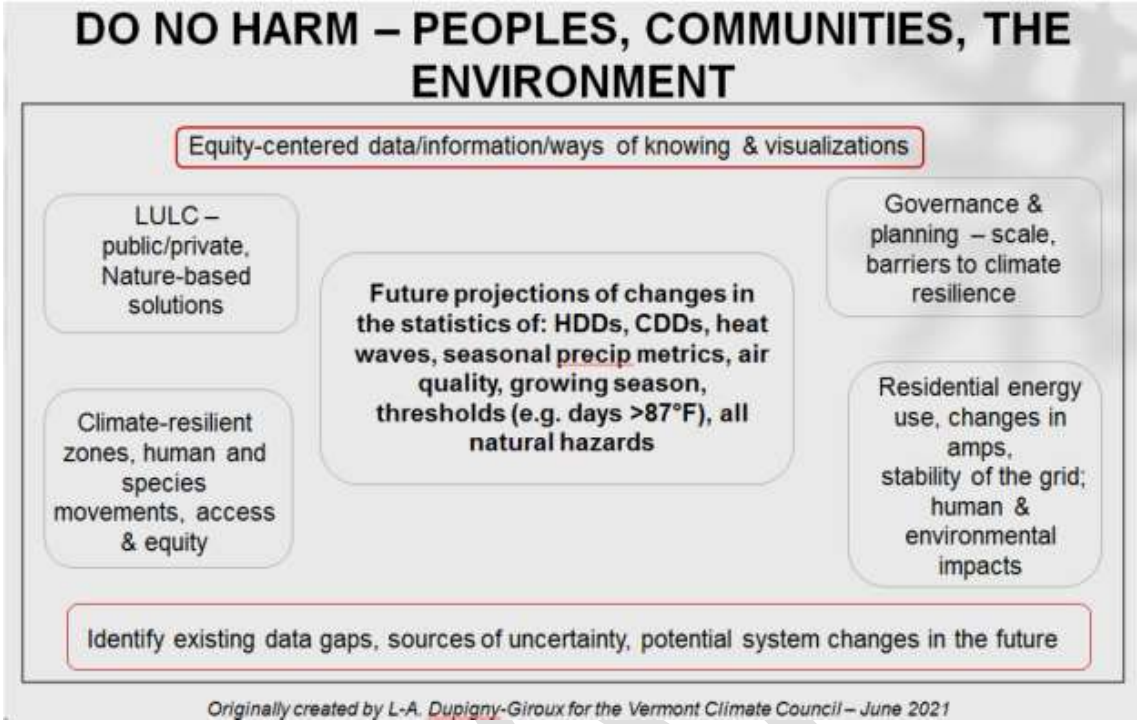
Figure 1a



Source: Diagram submitted to the Vermont Climate Council as frameworks to guide discussions and understanding of the relationship between humans and the Earth. 'We are all related' was created by Abenaki scholar and educator Judy Dow.

[6] https://www.weather.gov/btv/climoFreeze
[7] https://toolkit.climate.gov/
[8] https://ahs-vt.maps.arcgis.com/apps/MapSeries/index.html?appid=5bfd71bdeff242d4a8f0d2780369807a> and Vermont Social Vulnerability Mapping Tool at https://ahs-vt.maps.arcgis.com/apps/MapSeries/index.html?appid=ffea40ec90e94093b009d0ddb4a8b5c8
[9] https://www.uvm.edu/femc/cooperative/projects/climate_indicators

Figure 1b



Source: Diagram submitted to the Vermont Climate Council as frameworks to guide discussions and understanding of the relationship between humans and the Earth. 'Do no harm- Peoples, Communities, the Environment' by Lesley-Ann L. Dupigny-Giroux, after consultation with Abenaki elders and scholars.

3.0 UNDERSTANDING CLIMATE & CLIMATE CHANGE IN VERMONT

3.1 Wind and snowfall climatologies

High winds may occur from either large-scale weather systems, also known as gradient winds, or from localized thunderstorm wind gusts. The occurrence of high winds from large-scale weather systems (gradient winds) in Vermont shows a strong correlation with elevation. . Under certain meteorological situations, locally strong winds can be enhanced by terrain in nearby valleys (e.g., October 30, 2017 wind storm).

Vermont's distribution of snowfall also follows a strong correlation with elevation. This is due to the colder temperatures at higher elevations, and the influence of the mountains producing enhanced upward motions which lead to localized clouds and higher winter precipitation. Total snowfall ranges from around 70" a year in the deeper valleys to over 200" in the highest Green Mountains. Winter temperatures and precipitation are increasing, which will likely result in a greater number of winter storms featuring elevation-sensitive rain or snow accumulations. A comparison by the National Weather Service Burlington Forecast Office (NWSFO-BTV) of the average monthly snowfall received at long term stations during the cool season for the 1980-2010 vs. the 1990-2020 overlapping 30-year periods[10] , revealed that with the exception of January and April, total snowfall , decreased for the months of November, December (FIGURE 2f), February and March[11].

[10] https://www.weather.gov/btv/climoSnowfall>
[11] Banacos, 2011

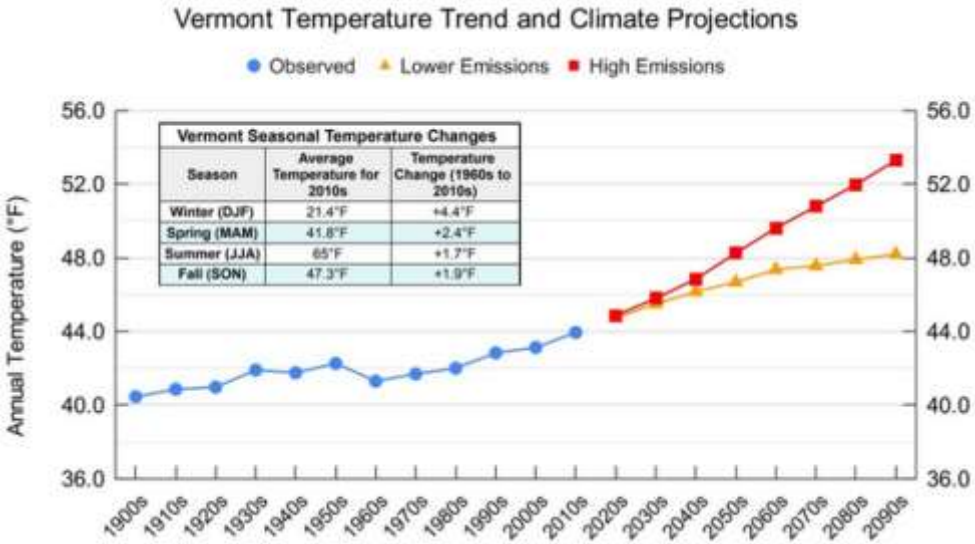
Wet snowfall occurs when partially melted snowflakes have water on their edges, making them sticky. Freezing rain occurs when rain falls into a shallow subfreezing layer of air and then freezes on contact to surfaces. These processes are more frequent at higher elevations, principally due to colder temperatures and higher precipitation accumulations. The greatest risks from wet snow and freezing rain icing show a strong correlation with elevation across Vermont. Thus, wet snow and freezing rain hazards are more likely to produce power outages at higher elevations (Figure 2e). However, intense ice storms can still occur in valleys, especially in deeper northern valleys near the international border when shallow cold air can recharge itself from Canadian source regions such as the ice storms of January 1998, and December 22, 2013.

3.2 Temperature variability

Across Vermont, the 2010-2020 11-year period has been the warmest since records began in 1895, with the warmest winter and summer seasons occurring in the 2000-2020 period[12] . Vermont's average annual temperature has increased over 2°F from the 1970s to 2010s and over 3°F from the end of the last century (Figure 3a). The rate of warming has increased through the last 120 years, and is currently around +0.5°F a decade. While this rate of warming may seem relatively small compared to perceived daily temperature changes, the overall warming is having a number of notable effects, such as the lengthening of the growing season, less reliable winter snow cover, and shifting peak energy usage to the summertime. Seasonal temperature trends show the winter season warming nearly twice as fast, increasing over 4°F from the 1960s to the 2010s. Other observed seasonal shifts include an expanding warm season causing longer falls and winter to have more false starts, and increased intra-seasonal and inter-seasonal temperature variability (more fluctuation within seasons). Backward or false springs (during with snow and freezing rain can occur in April-June after the normal progression of warming temperatures[13] continue to be observed, even with the observation that freeze-free seasons are longer[14] .

[12] Runkle et al., 2021
[13] Dupigny-Giroux, 2009
[14] Runkle et al., 2021

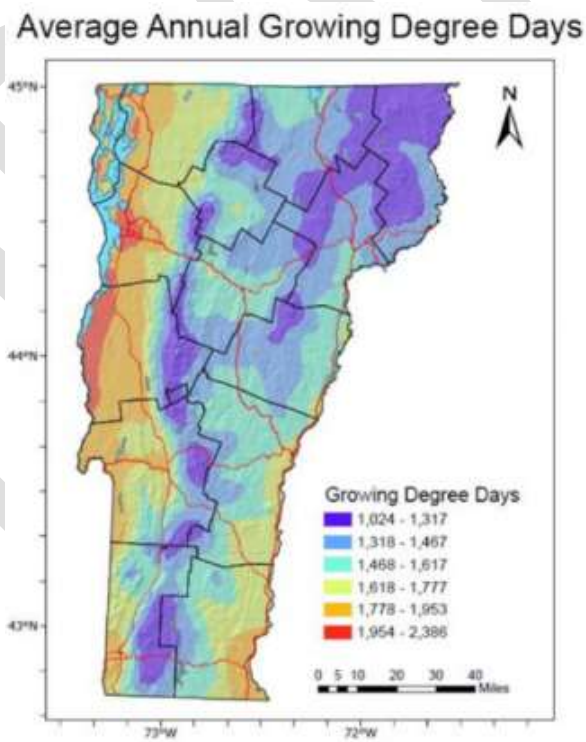
Figure 3a



Vermont Seasonal Temperature Changes		
Season	Average Temperature for 2010s	Temperature Change (1960s to 2010s)
Winter (DJF)	21.4°F	+4.4°F
Spring (MAM)	41.8°F	+2.4°F
Summer (JJA)	65°F	+1.7°F
Fall (SON)	47.3°F	+1.9°F

Decadal observed trends and climate projections of temperatures across Vermont under the low emissions scenario (RCP4.5 which represents moderate global emissions mitigation), and the high emissions scenario (RCP8.5, where emissions continue along current trends). Inset table based on data from NOAA's National Centers for Environmental Information.

Figure 2b



Average cumulative seasonal growing degree days (using a 50°F base). Based on a 5-km downscaled dataset from 1990-2019 following Shafer and Cronin (2021).

Growing degree days are used to determine arm season growing potential for various crops. Growing

degree days are highest in the warmest areas of Vermont (primarily west of the Green Mountains and in southern valleys), and lowest in the Northeast Kingdom and highest elevations. Growing degree days have increased by approximately 5 to 10% over the last 40 years, primarily as the warm season expands in the late summer to early fall (Figure 3b).

As Vermont's climate warms there has been an observable shift in temperature extremes. Heat waves are becoming more likely while cold waves are decreasing. Evidence for this from Burlington (Figure 4a) shows a steady decline in cold waves peaking around nearly 6 per year in the 1970s to less than 2 per year in the 2010s. Heat waves have generally increased from around 3 to 4 per year in the 1960s/1970s to over 7 per year in the 2010s. These changes will cause a shift in peak energy demand to more likely occur during the summer season, and increase heat exposure health risks to vulnerable populations.

Since the mid-2000s, a below average number of very cold nights (defined as nighttime temperatures of 0°F or less) has also been observed in winter, with a near to above average annual number of warm nights in the 2000-2020 period[15] The Vermont Department of Health[16] has documented the combined influence of warmer winters and longer warm seasons as contributing to both a more hospitable environment for blacklegged ticks, as well as their hosts, white-footed mice. Figure 5a captures the exponential increase in probable Lyme disease cases between 1990 and 2016, with Vermont and Maine being the states with the highest increases in actual reported case rates since 1991[17] (Figure 5b, c). The Department's climate and health pages[18] area resource for additional information on climate impacts on health, considerations for vulnerable populations[19] , potential impacts (e.g. on pollen, allergies, mold in buildings, waterborne and foodborne diseases) and the health benefits to be derived from climate change adaptation and mitigation.

3.3 Moisture variability

As Vermont's climate warms, the overall amount of precipitation is also increasing. Warmer temperatures produce increased evaporation of water vapor from nearby bodies of water, resulting in a greater potential for weather systems to produce higher amounts of precipitation. In general, increases in annual precipitation changes are relatively small, on the order of +0.5" to +1.0" a decade, with the greatest increases in precipitation occurring during the winter season.

Vermont's distribution of precipitation follows a strong correlation with elevation with the deeper valleys receiving less than 40" annually while, the highest peaks nearly reach 80" annually (FIGURE 2d). The interaction of weather systems with Vermont's terrain produces enhanced precipitation from airflow that is forced upward over mountains on their windwards sides, and precipitation suppression where the airflow is forced down the leeside. The Champlain Valley, for example, rests in the climatological rain shadow from the Adirondack Mountains of New York.

As noted in Runkle et al. 2021 (and shown on the Standardized Precipitation Index values on Figure 76), the year 1970 marked a shift towards annual average precipitation trending above the long term average, increasing by almost 6" since the drought decade of the 1960s. The wettest period since 1895 was observed in 2005-2014. Extreme precipitation (defined as greater than 2" over 24 hours) has also trended above the long-term average since 1995. These trends are reflected in the increases in stormflow between 1950-2006[20] (Figure 7 b), as well as the increasing magnitudes of the 1% (100-year return interval) storms across timescales from 1 hour (Figure 7c) to 1 day(Figure 7d). Such changes in recurrence intervals and other precipitation statistics should be factored into infrastructure planning, hydraulic studies and

[15] Runkle et al., 2021; see Appendix 1.
[16] https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_CH_WhitePaper.pdf
[17] EPA Change Indicators, 2021 https://www.epa.gov/climate-indicators/climate-change-indicators-lyme-disease
[18] https://www.healthvermont.gov/environment/climate
[19] https://www.healthvermont.gov/health-environment/climate-health/vulnerable-populations
[20] Hodgkins and Dudley, 2011

floodplain management in order to mitigate against ongoing loss, failure or disruption.

Vermont is marked by tremendous hydrologic variability over time and space. Temporally, fluctuations of importance can occur over very short time frames (e.g. in the transportation sector, heavy precipitation on the order of minutes to hours is of critical interest) up to weeks, months and years (which are important to the agricultural sector where moisture availability during key phenological stages of the planting, growing and harvesting seasons is paramount). Moisture extremes (droughts and floods) can and have occurred simultaneously across the state (e.g. flooding in Southern Vermont in July 2021, while the northern reaches were in moderate drought). In fact, Southern Vermont just experienced its wettest four summer months (June through September 2021) on record, with major localized flooding throughout the month of July and its most widespread major flooding event occurring on July 29, 2021 since Tropical Storm Irene, nearly 10 years earlier. The region was fortunate to experience only glancing blows from tropical systems Fred, Henri, and Ida thereafter. Both the flooding that did occur, and the catastrophic flooding that could have occurred but did not had the paths of major systems, confirm the need for climate adaptation and resilience even as the production of greenhouse gases must be reduced.

Apart from heavy precipitation, especially from slow-moving or stalled storms, flood-producing conditions include the presence of deep snow cover, frozen ground and ice-covered rivers (primarily in the cool season), with saturated soil, existing bankfull conditions, full reservoirs and complex topography.

Droughts followed by flooding in the same year is also a characteristic of Vermont, a pattern which has not changed over the last 100 years. For example, this flip-flop was observed in 1927 (where the November floods remain the flood of record for Northern Vermont) and more recently in August 2011 (where the flooding due to Tropical Storm Irene stands as the flood of record for Southern Vermont). The August 2011 drought was an example of a new type of drought called a flash drought, which is now observed more frequently in Vermont. Flash droughts[21] , as their name suggests, develop very quickly (weeks), typically in the spring/summer months, where the lack of precipitation and decreased soil moisture is often exacerbated by high daytime temperatures and low relative humidities in the air.

Apart from the newer flash droughts, traditional droughts tend to fall into staggered categories with meteorological (precipitation deficit) occurring first, followed by agricultural droughts (soil moisture deficit) and then hydrologic ones (when surface waters, lakes, groundwater and wells are affected over the course of months to years). As Figure 6 shows, it is possible to be in a meteorological drought (e.g. 1910s, 1930s), but not a longer term hydrologic drought. Recent droughts in Vermont and across New England suggest that this traditional sequence is changing. The year 2020 was a marker year when short term flash droughts over the summer were followed by record-setting streamflow and groundwater droughts in the fall[22] . This was significant because some of these records that were set or tied occurred on streams with 71, 89 and 90 years of records, dating back to the droughts of the 1930s. Across Vermont, evidence of this severe 2020-2021 hydrologic drought included the number and depth of new wells being drilled, and the fact the well drillers were still managing homeowner requests into the fall of 2021.

Hydropower generation is also subject to fluctuations in water levels. The Connecticut River is a heavily-managed river due to the presence of hydropower facilities at Wilder, Bellows Falls, Vernon, and Northfield, Massachusetts (which affects the flow of the river and erosion in Vernon, Vermont). It is also falls within the jurisdiction of both the states of Vermont and New Hampshire, with the river at and below the low-water mark on the western shore falling within the jurisdiction of the latter. To the extent climate change forecasts suggest intensification of the hydrologic cycle, this has implications for Connecticut River water quality and quantity that will require greater coordination between the states of Vermont and

[21] Otkin et al., 2019
[22] Lombard et al., 2020

New Hampshire, greater management of competing uses, and which could have significant downstream implications including the Long Island Sound Total Maximum Daily Load for nitrogen. This coordination could create new purpose for the Connecticut River Joint Commissions (see 10 V.S.A. § 1193).

Drought impacts on drinking water supplies as well as adequate water availability for key Vermont sectors such as hydropower, agriculture, forestry and other water-based recreation and tourism activities, represent a pressing need for building resilience to moisture extremes.

4.0 Economic impacts of climate change in Vermont

Due to the small geographic extent of Vermont as a state relative to the global economy, it is difficult to provide absolute attribution to the gradual, but certain climate changes that are occurring. Similarly, it is also difficult to tease out all of the specific economic impacts directly attributed to climate change. However, there are three categories of economic damage where the impacts are clear. These are structural damage, human health impacts and the disruption to production and supply chain within the business sector.

One partial measure of structural damage resulting from the increasing strength and frequency of storms is represented by FEMA-designated disaster declarations and the resulting payments. A review of FEMA designations between 2010 and 2019, shows that Vermont receives on average $9-30 million in assistance support. The range is based on either including or not including Irene-related damages that influence the ten year average significantly. However, FEMA only addresses short term catastrophic impacts and not the less destructive but still significant issues associated with increased precipitation and storms resulting in wet basements and tree damage. To get a handle on the size of these smaller scale impacts, it is instructive to review consumer expenditures as reported by the Census Bureau Consumer Expenditure Survey (CES). The CES includes a category for home maintenance, repair and insurance. For the northeastern states (Vermont specific data are not robust enough for reporting), the proportion of household income attributed to home maintenance, repair and insurance has increased from 1.88% to 2.15% between the 2003-4 and 2019-20 reports. This amounts to an average increase of $250 per household and for Vermont adds up to an additional $66 million in economic costs per year. It should be noted that, applying a similar approach to southern states in the US, with higher incidences of storm related damage due to hurricanes, tornadoes and tropical storms, yields an annual increase in maintenance, repair and insurance of $576 per household when comparing the 2003-4 data with 2019-20.

An examination of weather-driven insured losses by the Vermont Department of Financial Regulation over a ten year period (2010-2019) estimates that weather-driven factors resulted in approximately $558 MM of insured losses in Vermont across auto, homeowners, and farmowners policies[23] ; wind and hail hazards were the dominant perils associated with insured losses. Based on trends in reconstructed losses projected increases of insured losses of approximately 2-4% by 2050 relying principally projecting current trends forward. Storm systems and their accompanying perils were observed to become more intense over time as a result of the climate warming.

The impacts on residential properties parallel damage to commercial properties. In Vermont, the Grand list value Commercial and Industrial properties is about 12% of that of residential properties. If Commercial and Industrial properties suffer the same proportion of damage increases as do residential properties, the damage estimate increases by $8 million to a total property damage estimate of almost $75 million per year.

There are several examples of human health that are affected by climate change. While the human

[23] Shafer, J. C., and K. Cronin, 2021: An examination of weather perils and insured losses in Vermont. Vermont Department of Financial Regulation. 36 pp.

suffering associated with these human health impacts is important, it is still possible to assign dollar amounts to the increased health care services that result. In terms of the aforementioned exponential increase in probable and actual reported cases of Lyme disease and other tickborne illness, the Tick Borne Disease Working Group at the federal level estimates the dollar costs for Lyme disease at about $1.3 billion and because Vermont represents 1.5-2% of national cases, the dollar costs are $20-25 million per year. This value is in addition to the dramatic increases in anaplasmosis observed across the state. Prior to 2008, case of anaplasmosis were close to zero and that number increased to more than 200 in 2016. Finally, in terms of mosquito-borne diseases have been observed in Vermont for decades and include the West Nile Virus and Eastern Equine Encephalitis. A website focusing on mosquito-borne diseases puts national level economic damages in the billions of dollars.

Apart from vector-borne ailments, increasing temperatures pose economic effects due to water contamination impacts and those related to heat waves. In terms of the former, beach closures in Vermont are the result of a combination of increased water temperatures and increased nutrient loads. There is no dollar estimate that specifically informs the climate change component, but Vermont spends tens of millions of dollars each year to address water quality contaminants in our large lakes. Finally, in terms of heat waves, periods of extreme heat result in increases to the emergency room. Using the aforementioned threshold of 87°F as an extreme heat day since 2016, it should be noted that, prior to the year 2000, extreme heat days averaged about 6 per year resulting in dozens of emergency room visits. Models show these numbers increasing significantly with a resulting increase in emergency room visits. Perhaps more economically important than acute health events is the trend towards adding air conditioning to Vermont homes. One of the drivers behind an increase in the installation of heat pumps is the ability of a heat pump to also provide air conditioning services. The dollar cost for heat pump installation from 2019 to 2021 is estimated in this report to be $84 million or $27 million per year.

4.1 Vulnerabilities exposed by the COVID-19 pandemic

The ongoing SARS-CoV-2 (COVID-19) pandemic has acted as a compound stressor[24] or threat multiplier on communities and activities that were already vulnerable to natural hazards, climate change impacts and socioeconomic disruptions. In particular, 2020-2021 has been marked by climate migration and business disruptions.

The influx of out of state residents to Vermont during the COVID-19 pandemic, and others transitioning second homes into primary homes, provides a glimpse into what could be the leading edge of climate influenced, if not driven, migration to Vermont and the northeast. This has resulted in housing demand outstripping supply, leading to increased housing prices, decreased housing availability, and the exacerbation of housing fairness, equity and justice issues. Lack of infrastructure (chiefly community wastewater and water systems) makes compact settlement a challenge, thereby causing housing development to follow the path of least resistance, which is dispersed single-family home development on large lots along rural roads. This de facto development pattern will only exacerbate energy use patterns that will make achievement of many of the goals and objectives of the GWSA a challenge, and underscore the need to create an effective land use planning and regulation rubric that can achieve housing development and accessibility, compact settlement, smart growth, and just transitions policy imperatives.

News headlines in 2021 also report disruptions to the supply chain due to the COVID-19 pandemic. Prior to 2020 and continuing through the pandemic are transportation disruptions due to coastal storms. One of the most apparent sectors affected by climate change induced storms is for oil and gas production. Gulf of Mexico drilling platforms and coastal refineries are closed with increased frequency, each time causing a spike in petroleum and natural gas prices. Droughts cause a disruption in hydroelectricity generation

[24] Zscheischler et al., 2020

requiring electric utilities to purchase alternative, higher priced generation (and often with greater greenhouse gas emissions).

Agriculture is probably most susceptible to climate change. While Vermont may see longer growing seasons, most of our food comes from other parts of the world, many of which are subject to water restrictions due to drought. Shipping food on barges is often delayed during flooding events on the major river corridors.

5.0 Projections of future climate change

A warming and wetter climate has varying effects on different weather and climate hazards (Figure 8). Projected changes in temperature through 2050 show a high degree of confidence in temperatures increasing, resulting in a higher frequency of warmer temperatures and heat waves. On the other hand, the most extreme cold temperatures will likely decline in magnitude slightly as arctic warming tends to diminish the strength of wintertime arctic air masses. Overall annual precipitation will likely increase, although at a slower rate than temperature (moderate confidence). Extreme precipitation events, such as those with 2” or greater precipitation in a 24-hour period, will likely increase in frequency (moderate confidence).

Annual snowfall variability will likely remain high, with some wet winter seasons producing higher than average snowfall, as the climate remains cold enough to continue to support snowfall. However, the general trend is for more winter rain and reduced annual snowfall, especially in lower elevations and southern areas. Risks from power outages related to wet snowfall are expected to increase, as more winter storms will likely be closer to freezing where snowfall is wet or sticky in nature (moderate confidence).

Wind storms are expected to increase in intensity, but these will likely be related to unique meteorological storm types. Tropical Storms or Hurricanes, if they make landfall and move inland, will likely be able to maintain strength at higher latitudes from warming ocean temperatures, therefore increasing the risk for low-frequency but catastrophic storm impacts (e.g. Hurricane of 1938). On the other hand, gradient wind events from midlatitude storm systems across Canada or nor'easters may decline in frequency.

The projected frequency of ice storms and thunderstorms remain low confidence with competing meteorological risk factors for each. Low-end freezing rain icing events (those with ice accretion insufficient to produce power outages) are expected to increase, as warmer winter temperatures produce more winter storms with mixed precipitation types.

Overall risks to the power distribution grid have been shown to be increasing, more due to storm systems becoming more intense. A combination of weighing current trends, literature, and two climate simulations shows that overall power outage risks are projected to increase by approximately 5-10% through 2050, due to more frequent wet snowfall, and potentially stronger wind storms[25].

Vermont’s annual precipitation is projected to increase 1” to 2” through 2050 (Figure 9a). These rates of increase track closely to current precipitation rate changes over the last 30 to 40 years. Through 2100, the lower emissions scenario predicts approximately 4” greater annual precipitation, whereas the high emissions scenario predicts 9” greater annual precipitation. The spatial distribution precipitation change is relatively equal across Vermont counties. Extreme precipitation events will increase at a faster rate than annual precipitation increases, likely following current ratios of extreme events to annual precipitation rate changes.

Vermont’s annual temperatures are projected to increase over 2°F through 2050 on either the lower emission or high emissions scenarios (Figure 9b). These scenarios differ significantly through 2100, with the lower emissions scenario predicts 4°F of warming whereas the high emissions scenario predicts 9°F of

[25] Shafer and Cronin 2021

warming. The spatial distribution of warming is relatively equal across Vermont counties. With a warming climate comes a greater likelihood of higher temperatures. Extreme temperatures (as defined by a high temperature >= 90°F) are projected to double in frequency by 2050 through either the lower emission or high emissions scenario (Figure 9c). Vermont-wide average days above 90°F go from 4 days a year to 9 days a year by 2050. By 2100, however, there is significant variability, with the lower emissions scenario reaching 15 days a year, and the high emissions scenario projecting 45 days a year.

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APPENDIX 1

Vermont State Climate Summary (provided with NCEI permission)

Runkle, J., K.E. Kunkel, S. Champion, L.-A. Dupigny-Giroux, and J. Spaccio, 2017 (2021 revision): Vermont State Climate Summary, Supplemental Figures. NOAA Technical Report NESDIS 149-VT. NOAA/NESDIS, Silver Spring, MD, 26 pp.

CLIMATE CHANGE IN VERMONT

Lesley-Ann L. Dupigny-Giroux, Jason Shafer, Owen Pollio, Ken Jones

1.0 PREFACE

This section of the Climate Action Plan presents the drivers and processes of climate change in the Vermont by focusing on the natural hazards that affect multiple socioeconomic sectors and which directly influence on our resilience as a state. In presenting resilience through the dual lenses of inclusion and vulnerability (of peoples, the natural environment and human infrastructure), we honor Abenaki knowledges (Figure 1a) and all ways of knowing (Betts, 2021), as we seek to do no harm (Figure 1b).

For consistency with other state-level Climate Action Plans, this section used data and statistical methods developed in support of the Fifth National Climate Assessment (NCA5)[26] by the National Center for Environmental Information (NCEI), the Environmental Protection Agency (EPA) and the Northeast Regional Climate Center (NRCC). One such document is the 2021 Vermont State Climate Summary[27] which is included with permission as Appendix 1 and which will be released by NCEI by January 2022. County level climate projections of future thresholds were summarized from the NOAA Climate Explorer[28] and included in Appendix 1. Sectoral impacts of climate change across Vermont can be found in the 2021 Vermont Climate Assessment. Existing tools for monitoring and quantifying vulnerabilities will be woven throughout this section.

2.0 BACKGROUND

Across Vermont, natural hazards of varying intensity, duration and frequency occur. These include severe storms, winter storms, drought, flooding, wildfires, air pollution, ground-level ozone, temperature extremes, localized winds and biotic elements (insects and disease)[29] . Some of these hazards are ubiquitous, while others tend to occur at specific geographic locations.This poses varying exposure or risk and therefore, societal vulnerability. As climate change continues to be observed in Vermont, the characteristics of these hazards are also changing and this sets up cultural, socioeconomic and policy implications for Vermonters as individuals, municipalities, communities and indigenous peoples, as well as for the built and natural environments. Thus, climate change related impacts on our economic sectors are of central importance in this Climate Action Plan, as we lay out the inaugural framework for mitigating against and adapting to climate change, while building our resilience as a State.

[26] <https://www.globalchange.gov/nca5>
[27] https://statesummaries.ncics.org/chapter/vt/
[28] https://crt-climate-explorer.nemac.org/
[29] Dupigny-Giroux, 2002

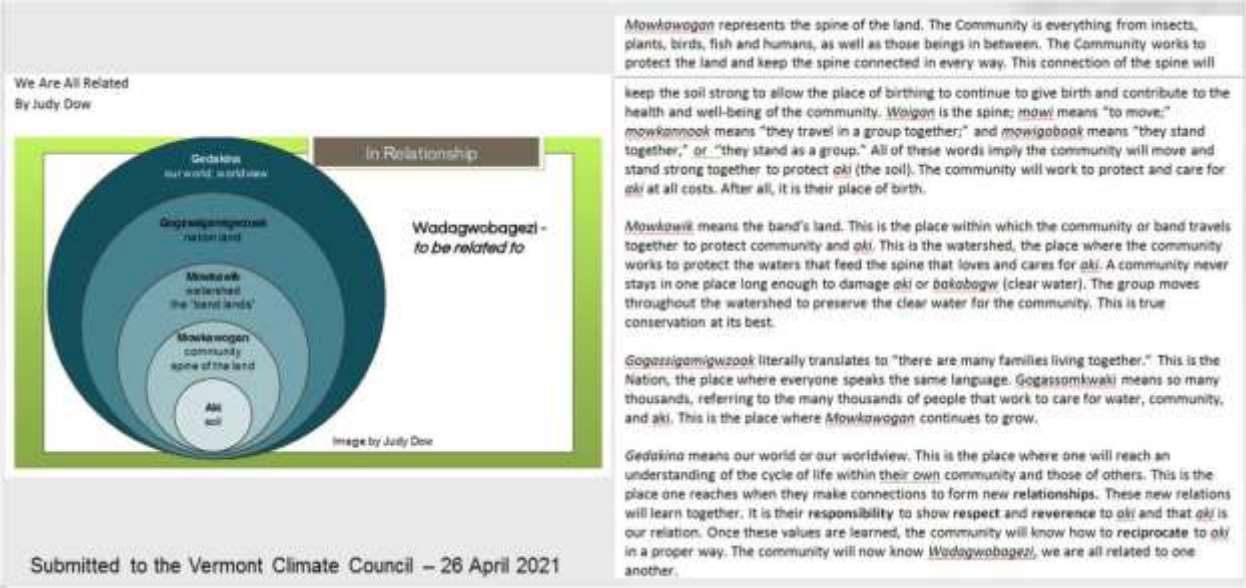
2.1 **Geographies of vulnerability** (human, landscape, infrastructure)

The topography or physical geography of Vermont is one of the most important factors in influencing the occurrence of natural hazards their impacts on human settlements, the location of our major roadways in steep, V-shaped valleys and our ability to increase resilience as a state. The north-south spine of the Green Mountains, along with the complex east-west valleys and the north-south ridges of the Taconic Mountains[30] affect the movement of localized winds and incidence of freezing rain conditions; produces enhanced orographic precipitation and the associated flooding events; control the incidence of pollution and stagnation events, as well as variations in freeze and frost dates[31].

Various online tools can be used to monitor Vermont's human and landscape vulnerability. The NOAA Climate Resilience Toolkit[32] offers a 5-step, risk-based management framework to achieve climate resilience. The Vermont Department of Health has summarized the Vermonters' vulnerability by geographic location as well as by climate hazards (Figure 4c) and offers the online Heat Vulnerability Index Mapping Tool[33] < for ongoing monitoring. Finally, the Forest Monitoring Cooperative has launched the Forest Ecosystem Monitoring Cooperative's "Monitoring northeastern forest indicators for signs of climate-drive change[34].

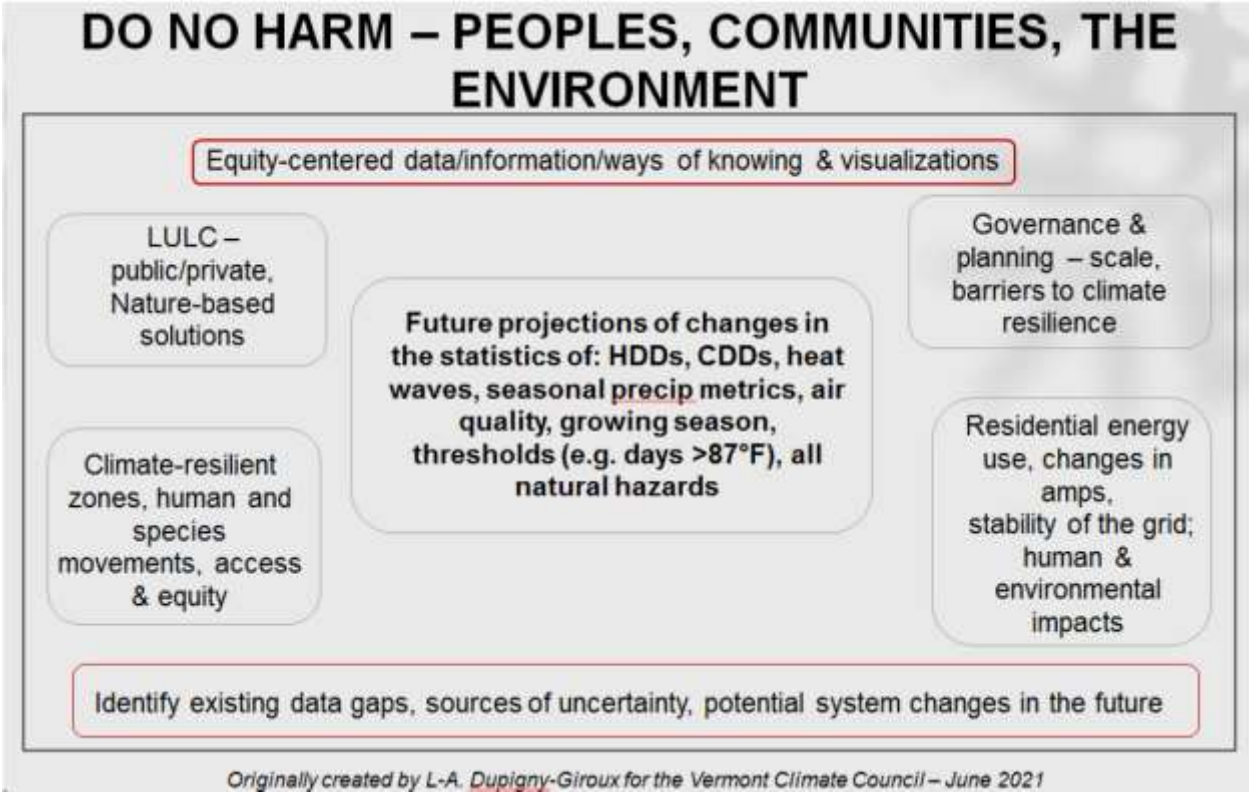
[30] Dale, 1905
[31] https://www.weather.gov/btv/climoFreeze
[32] https://toolkit.climate.gov/
[33] https://ahs-vt.maps.arcgis.com/apps/MapSeries/index.html?appid=5bfd71bdeff242d4a8f0d2780369807a> and Vermont Social Vulnerability Mapping Tool at https://ahs-vt.maps.arcgis.com/apps/MapSeries/index.html?appid=ffea40ec90e94093b009d0ddb4a8b5c8
[34] https://www.uvm.edu/femc/cooperative/projects/climate_indicators

Figure 3a



Source: Diagram submitted to the Vermont Climate Council as frameworks to guide discussions and understanding of the relationship between humans and the Earth. 'We are all related' was created by Abenaki scholar and educator Judy Dow.

Figure 1b



Source: Diagram submitted to the Vermont Climate Council as frameworks to guide discussions and understanding of the relationship between humans and the Earth. 'Do no harm- Peoples, Communities, the Environment' by Lesley-Ann L. Dupigny-Giroux, after consultation with Abenaki elders and scholars.

3.0 UNDERSTANDING CLIMATE & CLIMATE CHANGE IN VERMONT

3.1 Wind and snowfall climatologies

High winds may occur from either large-scale weather systems, also known as gradient winds, or from localized thunderstorm wind gusts. The occurrence of high winds from large-scale weather systems (gradient winds) in Vermont shows a strong correlation with elevation. . Under certain meteorological situations, locally strong winds can be enhanced by terrain in nearby valleys (e.g., October 30, 2017 wind storm).

Vermont's distribution of snowfall also follows a strong correlation with elevation. This is due to the colder temperatures at higher elevations, and the influence of the mountains producing enhanced upward motions which lead to localized clouds and higher winter precipitation. Total snowfall ranges from around 70" a year in the deeper valleys to over 200" in the highest Green Mountains. Winter temperatures and precipitation are increasing, which will likely result in a greater number of winter storms featuring elevation-sensitive rain or snow accumulations. A comparison by the National Weather Service Burlington Forecast Office (NWSFO-BTV) of the average monthly snowfall received at long term stations during the cool season for the 1980-2010 vs. the 1990-2020 overlapping 30-year periods[35] , revealed that with the exception of January and April, total snowfall , decreased for the months of November, December (FIGURE 2f), February and March[36].

Wet snowfall occurs when partially melted snowflakes have water on their edges, making them sticky. Freezing rain occurs when rain falls into a shallow subfreezing layer of air and then freezes on contact to surfaces. These processes are more frequent at higher elevations, principally due to colder temperatures and higher precipitation accumulations. The greatest risks from wet snow and freezing rain icing show a strong correlation with elevation across Vermont. Thus, wet snow and freezing rain hazards are more likely to produce power outages at higher elevations (Figure 2e). However, intense ice storms can still occur in valleys, especially in deeper northern valleys near the international border when shallow cold air can recharge itself from Canadian source regions such as the ice storms of January 1998, and December 22, 2013.

3.2 Temperature variability

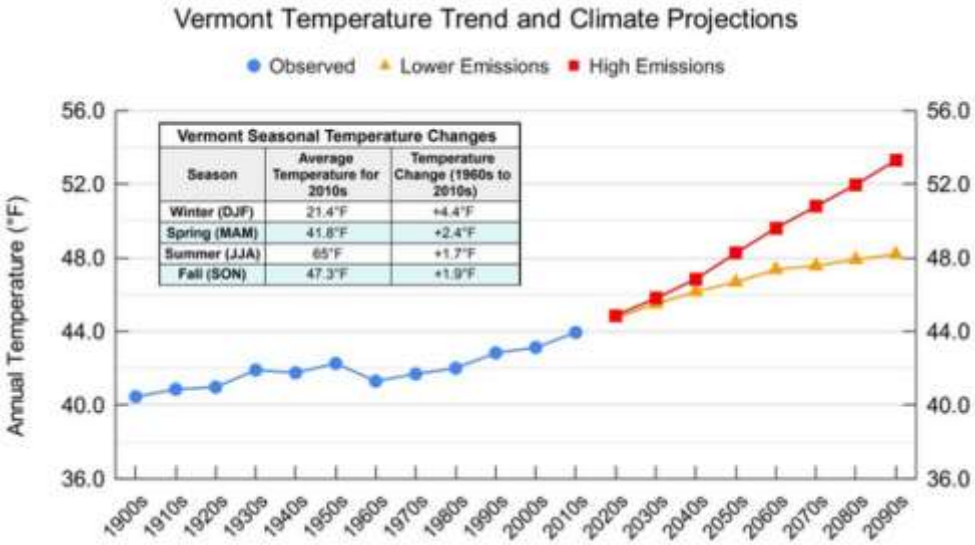
Across Vermont, the 2010-2020 11-year period has been the warmest since records began in 1895, with the warmest winter and summer seasons occurring in the 2000-2020 period[37] . Vermont's average annual temperature has increased over 2°F from the 1970s to 2010s and over 3°F from the end of the last century (Figure 3a). The rate of warming has increased through the last 120 years, and is currently around +0.5°F a decade. While this rate of warming may seem relatively small compared to perceived daily temperature changes, the overall warming is having a number of notable effects, such as the lengthening of the growing season, less reliable winter snow cover, and shifting peak energy usage to the summertime. Seasonal temperature trends show the winter season warming nearly twice as fast,

[35] https://www.weather.gov/btv/climoSnowfall>
[36] Banacos, 2011
[37] Runkle et al., 2021

increasing over 4°F from the 1960s to the 2010s. Other observed seasonal shifts include an expanding warm season causing longer falls and winter to have more false starts, and increased intra-seasonal and inter-seasonal temperature variability (more fluctuation within seasons). Backward or false springs (during with snow and freezing rain can occur in April-June after the normal progression of warming temperatures[38] continue to be observed, even with the observation that freeze-free seasons are longer[39] .

[38] Dupigny-Giroux, 2009
[39] Runkle et al., 2021

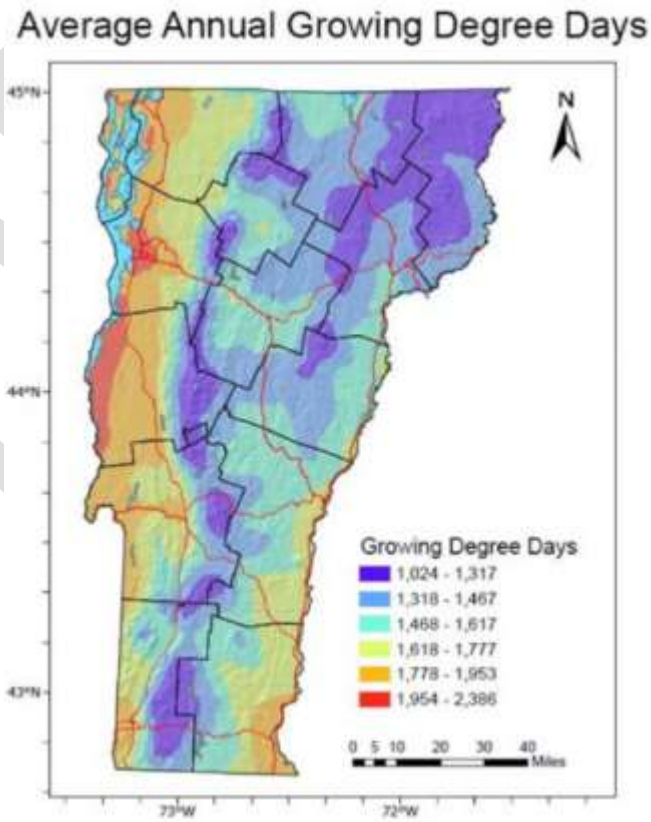
Figure 3a



Vermont Seasonal Temperature Changes		
Season	Average Temperature for 2010s	Temperature Change (1960s to 2010s)
Winter (DJF)	21.4°F	+4.4°F
Spring (MAM)	41.8°F	+2.4°F
Summer (JJA)	65°F	+1.7°F
Fall (SON)	47.3°F	+1.9°F

Decadal observed trends and climate projections of temperatures across Vermont under the low emissions scenario (RCP4.5 which represents moderate global emissions mitigation), and the high emissions scenario (RCP8.5, where emissions continue along current trends). Inset table based on data from NOAA's National Centers for Environmental Information.

Figure 4b



Average cumulative seasonal growing degree days (using a 50°F base). Based on a 5-km downscaled dataset from 1990-2019 following Shafer and Cronin (2021).

Growing degree days are used to determine arm season growing potential for various crops. Growing degree days are highest in the warmest areas of Vermont (primarily west of the Green Mountains and in southern valleys), and lowest in the Northeast Kingdom and highest elevations. Growing degree days have increased by approximately 5 to 10% over the last 40 years, primarily as the warm season expands in the late summer to early fall (Figure 3b).

As Vermont's climate warms there has been an observable shift in temperature extremes. Heat waves are becoming more likely while cold waves are decreasing. Evidence for this from Burlington (Figure 4a) shows a steady decline in cold waves peaking around nearly 6 per year in the 1970s to less than 2 per year in the 2010s. Heat waves have generally increased from around 3 to 4 per year in the 1960s/1970s to over 7 per year in the 2010s. These changes will cause a shift in peak energy demand to more likely occur during the summer season, and increase heat exposure health risks to vulnerable populations.

Since the mid-2000s, a below average number of very cold nights (defined as nighttime temperatures of 0°F or less) has also been observed in winter, with a near to above average annual number of warm nights in the 2000-2020 period[40] The Vermont Department of Health[41] has documented the combined influence of warmer winters and longer warm seasons as contributing to both a more hospitable environment for blacklegged ticks, as well as their hosts, white-footed mice. Figure 5a captures the exponential increase in probable Lyme disease cases between 1990 and 2016, with Vermont and Maine being the states with the highest increases in actual reported case rates since 1991[42] (Figure 5b, c). The Department's climate and health pages[43] area resource for additional information on climate impacts on health, considerations for vulnerable populations[44] , potential impacts (e.g. on pollen, allergies, mold in buildings, waterborne and foodborne diseases) and the health benefits to be derived from climate change adaptation and mitigation.

3.3 Moisture variability

As Vermont's climate warms, the overall amount of precipitation is also increasing. Warmer temperatures produce increased evaporation of water vapor from nearby bodies of water, resulting in a greater potential for weather systems to produce higher amounts of precipitation. In general, increases in annual precipitation changes are relatively small, on the order of +0.5" to +1.0" a decade, with the greatest increases in precipitation occurring during the winter season.

Vermont's distribution of precipitation follows a strong correlation with elevation with the deeper valleys receiving less than 40" annually while, the highest peaks nearly reach 80" annually (FIGURE 2d). The interaction of weather systems with Vermont's terrain produces enhanced precipitation from airflow that is forced upward over mountains on their windwards sides, and precipitation suppression where the airflow is forced down the leeside. The Champlain Valley, for example, rests in the climatological rain shadow from the Adirondack Mountains of New York.

[40] Runkle et al., 2021; see Appendix 1.
[41] https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_CH_WhitePaper.pdf
[42] EPA Change Indicators, 2021 https://www.epa.gov/climate-indicators/climate-change-indicators-lyme-disease
[43] https://www.healthvermont.gov/environment/climate
[44] https://www.healthvermont.gov/health-environment/climate-health/vulnerable-populations

As noted in Runkle et al. 2021 (and shown on the Standardized Precipitation Index values on Figure 76), the year 1970 marked a shift towards annual average precipitation trending above the long term average, increasing by almost 6" since the drought decade of the 1960s. The wettest period since 1895 was observed in 2005-2014. Extreme precipitation (defined as greater than 2" over 24 hours) has also trended above the long-term average since 1995. These trends are reflected in the increases in stormflow between 1950-2006[45] (Figure 7 b), as well as the increasing magnitudes of the 1% (100-year return interval) storms across timescales from 1 hour (Figure 7c) to 1 day(Figure 7d). Such changes in recurrence intervals and other precipitation statistics should be factored into infrastructure planning, hydraulic studies and floodplain management in order to mitigate against ongoing loss, failure or disruption.

Vermont is marked by tremendous hydrologic variability over time and space. Temporally, fluctuations of importance can occur over very short time frames (e.g. in the transportation sector, heavy precipitation on the order of minutes to hours is of critical interest) up to weeks, months and years (which are important to the agricultural sector where moisture availability during key phenological stages of the planting, growing and harvesting seasons is paramount). Moisture extremes (droughts and floods) can and have occurred simultaneously across the state (e.g. flooding in Southern Vermont in July 2021, while the northern reaches were in moderate drought). In fact, Southern Vermont just experienced its wettest four summer months (June through September 2021) on record, with major localized flooding throughout the month of July and its most widespread major flooding event occurring on July 29, 2021 since Tropical Storm Irene, nearly 10 years earlier. The region was fortunate to experience only glancing blows from tropical systems Fred, Henri, and Ida thereafter. Both the flooding that did occur, and the catastrophic flooding that could have occurred but did not had the paths of major systems, confirm the need for climate adaptation and resilience even as the production of greenhouse gases must be reduced.

Apart from heavy precipitation, especially from slow-moving or stalled storms, flood-producing conditions include the presence of deep snow cover, frozen ground and ice-covered rivers (primarily in the cool season), with saturated soil, existing bankfull conditions, full reservoirs and complex topography.

Droughts followed by flooding in the same year is also a characteristic of Vermont, a pattern which has not changed over the last 100 years. For example, this flip-flop was observed in 1927 (where the November floods remain the flood of record for Northern Vermont) and more recently in August 2011 (where the flooding due to Tropical Storm Irene stands as the flood of record for Southern Vermont). The August 2011 drought was an example of a new type of drought called a flash drought, which is now observed more frequently in Vermont. Flash droughts[46] , as their name suggests, develop very quickly (weeks), typically in the spring/summer months, where the lack of precipitation and decreased soil moisture is often exacerbated by high daytime temperatures and low relative humidities in the air.

[45] Hodgkins and Dudley, 2011
[46] Otkin et al., 2019

Apart from the newer flash droughts, traditional droughts tend to fall into staggered categories with meteorological (precipitation deficit) occurring first, followed by agricultural droughts (soil moisture deficit) and then hydrologic ones (when surface waters, lakes, groundwater and wells are affected over the course of months to years). As Figure 6 shows, it is possible to be in a meteorological drought (e.g. 1910s, 1930s), but not a longer term hydrologic drought. Recent droughts in Vermont and across New England suggest that this traditional sequence is changing. The year 2020 was a marker year when short term flash droughts over the summer were followed by record-setting streamflow and groundwater droughts in the fall[47] . This was significant because some of these records that were set or tied occurred on streams with 71, 89 and 90 years of records, dating back to the droughts of the 1930s. Across Vermont, evidence of this severe 2020-2021 hydrologic drought included the number and depth of new wells being drilled, and the fact the well drillers were still managing homeowner requests into the fall of 2021.

Hydropower generation is also subject to fluctuations in water levels. The Connecticut River is a heavily-managed river due to the presence of hydropower facilities at Wilder, Bellows Falls, Vernon, and Northfield, Massachusetts (which affects the flow of the river and erosion in Vernon, Vermont). It is also falls within the jurisdiction of both the states of Vermont and New Hampshire, with the river at and below the low-water mark on the western shore falling within the jurisdiction of the latter. To the extent climate change forecasts suggest intensification of the hydrologic cycle, this has implications for Connecticut River water quality and quantity that will require greater coordination between the states of Vermont and New Hampshire, greater management of competing uses, and which could have significant downstream implications including the Long Island Sound Total Maximum Daily Load for nitrogen. This coordination could create new purpose for the Connecticut River Joint Commissions (see 10 V.S.A. § 1193).

Drought impacts on drinking water supplies as well as adequate water availability for key Vermont sectors such as hydropower, agriculture, forestry and other water-based recreation and tourism activities, represent a pressing need for building resilience to moisture extremes.

4.0 Economic impacts of climate change in Vermont

Due to the small geographic extent of Vermont as a state relative to the global economy, it is difficult to provide absolute attribution to the gradual, but certain climate changes that are occurring. Similarly, it is also difficult to tease out all of the specific economic impacts directly attributed to climate change. However, there are three categories of economic damage where the impacts are clear. These are structural damage, human health impacts and the disruption to production and supply chain within the business sector.

One partial measure of structural damage resulting from the increasing strength and frequency of storms is represented by FEMA-designated disaster declarations and the resulting payments. A review of FEMA designations between 2010 and 2019, shows that Vermont receives on average $9-30 million in

[47] Lombard et al., 2020

assistance support. The range is based on either including or not including Irene-related damages that influence the ten year average significantly. However, FEMA only addresses short term catastrophic impacts and not the less destructive but still significant issues associated with increased precipitation and storms resulting in wet basements and tree damage. To get a handle on the size of these smaller scale impacts, it is instructive to review consumer expenditures as reported by the Census Bureau Consumer Expenditure Survey (CES). The CES includes a category for home maintenance, repair and insurance. For the northeastern states (Vermont specific data are not robust enough for reporting), the proportion of household income attributed to home maintenance, repair and insurance has increased from 1.88% to 2.15% between the 2003-4 and 2019-20 reports. This amounts to an average increase of $250 per household and for Vermont adds up to an additional $66 million in economic costs per year. It should be noted that, applying a similar approach to southern states in the US, with higher incidences of storm related damage due to hurricanes, tornadoes and tropical storms, yields an annual increase in maintenance, repair and insurance of $576 per household when comparing the 2003-4 data with 2019-20.

An examination of weather-driven insured losses by the Vermont Department of Financial Regulation over a ten year period (2010-2019) estimates that weather-driven factors resulted in approximately $558 MM of insured losses in Vermont across auto, homeowners, and farmowners policies[48] ; wind and hail hazards were the dominant perils associated with insured losses. Based on trends in reconstructed losses projected increases of insured losses of approximately 2-4% by 2050 relying principally projecting current trends forward. Storm systems and their accompanying perils were observed to become more intense over time as a result of the climate warming.

The impacts on residential properties parallel damage to commercial properties. In Vermont, the Grand list value Commercial and Industrial properties is about 12% of that of residential properties. If Commercial and Industrial properties suffer the same proportion of damage increases as do residential properties, the damage estimate increases by $8 million to a total property damage estimate of almost $75 million per year.

There are several examples of human health that are affected by climate change. While the human suffering associated with these human health impacts is important, it is still possible to assign dollar amounts to the increased health care services that result. In terms of the aforementioned exponential increase in probable and actual reported cases of Lyme disease and other tickborne illness, the Tick Borne Disease Working Group at the federal level estimates the dollar costs for Lyme disease at about $1.3 billion and because Vermont represents 1.5-2% of national cases, the dollar costs are $20-25 million per year. This value is in addition to the dramatic increases in anaplasmosis observed across the state. Prior to 2008, case of anaplasmosis were close to zero and that number increased to more than 200 in 2016. Finally, in terms of mosquito-borne diseases have been observed in Vermont for decades and include the West Nile Virus and Eastern Equine Encephalitis. A website focusing on mosquito-borne diseases puts national level economic damages in the billions of dollars.

[48] Shafer, J. C., and K. Cronin, 2021: An examination of weather perils and insured losses in Vermont. Vermont Department of Financial Regulation. 36 pp.

Apart from vector-borne ailments, increasing temperatures pose economic effects due to water contamination impacts and those related to heat waves. In terms of the former, beach closures in Vermont are the result of a combination of increased water temperatures and increased nutrient loads. There is no dollar estimate that specifically informs the climate change component, but Vermont spends tens of millions of dollars each year to address water quality contaminants in our large lakes. Finally, in terms of heat waves, periods of extreme heat result in increases to the emergency room. Using the aforementioned threshold of 87°F as an extreme heat day since 2016, it should be noted that, prior to the year 2000, extreme heat days averaged about 6 per year resulting in dozens of emergency room visits. Models show these numbers increasing significantly with a resulting increase in emergency room visits. Perhaps more economically important than acute health events is the trend towards adding air conditioning to Vermont homes. One of the drivers behind an increase in the installation of heat pumps is the ability of a heat pump to also provide air conditioning services. The dollar cost for heat pump installation from 2019 to 2021 is estimated in this report to be $84 million or $27 million per year.

4.1 Vulnerabilities exposed by the COVID-19 pandemic

The ongoing SARS-CoV-2 (COVID-19) pandemic has acted as a compound stressor[49] or threat multiplier on communities and activities that were already vulnerable to natural hazards, climate change impacts and socioeconomic disruptions. In particular, 2020-2021 has been marked by climate migration and business disruptions.

The influx of out of state residents to Vermont during the COVID-19 pandemic, and others transitioning second homes into primary homes, provides a glimpse into what could be the leading edge of climate influenced, if not driven, migration to Vermont and the northeast. This has resulted in housing demand outstripping supply, leading to increased housing prices, decreased housing availability, and the exacerbation of housing fairness, equity and justice issues. Lack of infrastructure (chiefly community wastewater and water systems) makes compact settlement a challenge, thereby causing housing development to follow the path of least resistance, which is dispersed single-family home development on large lots along rural roads. This de facto development pattern will only exacerbate energy use patterns that will make achievement of many of the goals and objectives of the GWSA a challenge, and underscore the need to create an effective land use planning and regulation rubric that can achieve housing development and accessibility, compact settlement, smart growth, and just transitions policy imperatives.

News headlines in 2021 also report disruptions to the supply chain due to the COVID-19 pandemic. Prior to 2020 and continuing through the pandemic are transportation disruptions due to coastal storms. One of the most apparent sectors affected by climate change induced storms is for oil and gas production. Gulf of Mexico drilling platforms and coastal refineries are closed with increased frequency, each time causing a spike in petroleum and natural gas prices. Droughts cause a disruption in hydroelectricity generation requiring electric utilities to purchase alternative, higher priced generation (and often with

[49] Zscheischler et al., 2020

greater greenhouse gas emissions).

Agriculture is probably most susceptible to climate change. While Vermont may see longer growing seasons, most of our food comes from other parts of the world, many of which are subject to water restrictions due to drought. Shipping food on barges is often delayed during flooding events on the major river corridors.

5.0 Projections of future climate change

A warming and wetter climate has varying effects on different weather and climate hazards (Figure 8). Projected changes in temperature through 2050 show a high degree of confidence in temperatures increasing, resulting in a higher frequency of warmer temperatures and heat waves. On the other hand, the most extreme cold temperatures will likely decline in magnitude slightly as arctic warming tends to diminish the strength of wintertime arctic air masses. Overall annual precipitation will likely increase, although at a slower rate than temperature (moderate confidence). Extreme precipitation events, such as those with 2" or greater precipitation in a 24-hour period, will likely increase in frequency (moderate confidence).

Annual snowfall variability will likely remain high, with some wet winter seasons producing higher than average snowfall, as the climate remains cold enough to continue to support snowfall. However, the general trend is for more winter rain and reduced annual snowfall, especially in lower elevations and southern areas. Risks from power outages related to wet snowfall are expected to increase, as more winter storms will likely be closer to freezing where snowfall is wet or sticky in nature (moderate confidence).

Wind storms are expected to increase in intensity, but these will likely be related to unique meteorological storm types. Tropical Storms or Hurricanes, if they make landfall and move inland, will likely be able to maintain strength at higher latitudes from warming ocean temperatures, therefore increasing the risk for low-frequency but catastrophic storm impacts (e.g. Hurricane of 1938). On the other hand, gradient wind events from midlatitude storm systems across Canada or nor'easters may decline in frequency.

The projected frequency of ice storms and thunderstorms remain low confidence with competing meteorological risk factors for each. Low-end freezing rain icing events (those with ice accretion insufficient to produce power outages) are expected to increase, as warmer winter temperatures produce more winter storms with mixed precipitation types.

Overall risks to the power distribution grid have been shown to be increasing, more due to storm systems becoming more intense. A combination of weighing current trends, literature, and two climate simulations shows that overall power outage risks are projected to increase by approximately 5-10% through 2050, due to more frequent wet snowfall, and potentially stronger wind storms[50].

[50] Shafer and Cronin 2021

Vermont's annual precipitation is projected to increase 1" to 2" through 2050 (Figure 9a). These rates of increase track closely to current precipitation rate changes over the last 30 to 40 years. Through 2100, the lower emissions scenario predicts approximately 4" greater annual precipitation, whereas the high emissions scenario predicts 9" greater annual precipitation. The spatial distribution precipitation change is relatively equal across Vermont counties. Extreme precipitation events will increase at a faster rate than annual precipitation increases, likely following current ratios of extreme events to annual precipitation rate changes.

Vermont's annual temperatures are projected to increase over 2°F through 2050 on either the lower emission or high emissions scenarios (Figure 9b). These scenarios differ significantly through 2100, with the lower emissions scenario predicts 4°F of warming whereas the high emissions scenario predicts 9°F of warming. The spatial distribution of warming is relatively equal across Vermont counties. With a warming climate comes a greater likelihood of higher temperatures. Extreme temperatures (as defined by a high temperature >= 90°F) are projected to double in frequency by 2050 through either the lower emission or high emissions scenario (Figure 9c). Vermont-wide average days above 90°F go from 4 days a year to 9 days a year by 2050. By 2100, however, there is significant variability, with the lower emissions scenario reaching 15 days a year, and the high emissions scenario projecting 45 days a year.

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CLIMATE CHANGE IN VERMONT

Lesley-Ann L. Dupigny-Giroux, Jason Shafer, Owen Pollio, Ken Jones

1.0 PREFACE

This section of the Climate Action Plan presents the drivers and processes of climate change in the Vermont by focusing on the natural hazards that affect multiple socioeconomic sectors and which directly influence on our resilience as a state. In presenting resilience through the dual lenses of inclusion and vulnerability (of peoples, the natural environment and human infrastructure), we honor Abenaki knowledges (Figure 1a) and all ways of knowing (Betts, 2021), as we seek to do no harm (Figure 1b).

For consistency with other state-level Climate Action Plans, this section used data and statistical methods developed in support of the Fifth National Climate Assessment (NCA5)[51] by the National Center for Environmental Information (NCEI), the Environmental Protection Agency (EPA) and the Northeast Regional Climate Center (NRCC). One such document is the 2021 Vermont State Climate Summary[52] which is included with permission as Appendix 1 and which will be released by NCEI by January 2022. County level climate projections of future thresholds were summarized from the NOAA Climate Explorer[53] and included in Appendix 1. Sectoral impacts of climate change across Vermont can be found in the 2021 Vermont Climate Assessment. Existing tools for monitoring and quantifying vulnerabilities will be woven throughout this section.

2.0 BACKGROUND

Across Vermont, natural hazards of varying intensity, duration and frequency occur. These include severe storms, winter storms, drought, flooding, wildfires, air pollution, ground-level ozone, temperature extremes, localized winds and biotic elements (insects and disease)[54] . Some of these hazards are ubiquitous, while others tend to occur at specific geographic locations.This poses varying exposure or risk and therefore, societal vulnerability. As climate change continues to be observed in Vermont, the characteristics of these hazards are also changing and this sets up cultural, socioeconomic and policy implications for Vermonters as individuals, municipalities, communities and indigenous peoples, as well as for the built and natural environments. Thus, climate change related impacts on our economic sectors are of central importance in this Climate Action Plan, as we lay out the inaugural framework for mitigating against and adapting to climate change, while building our resilience as a State.

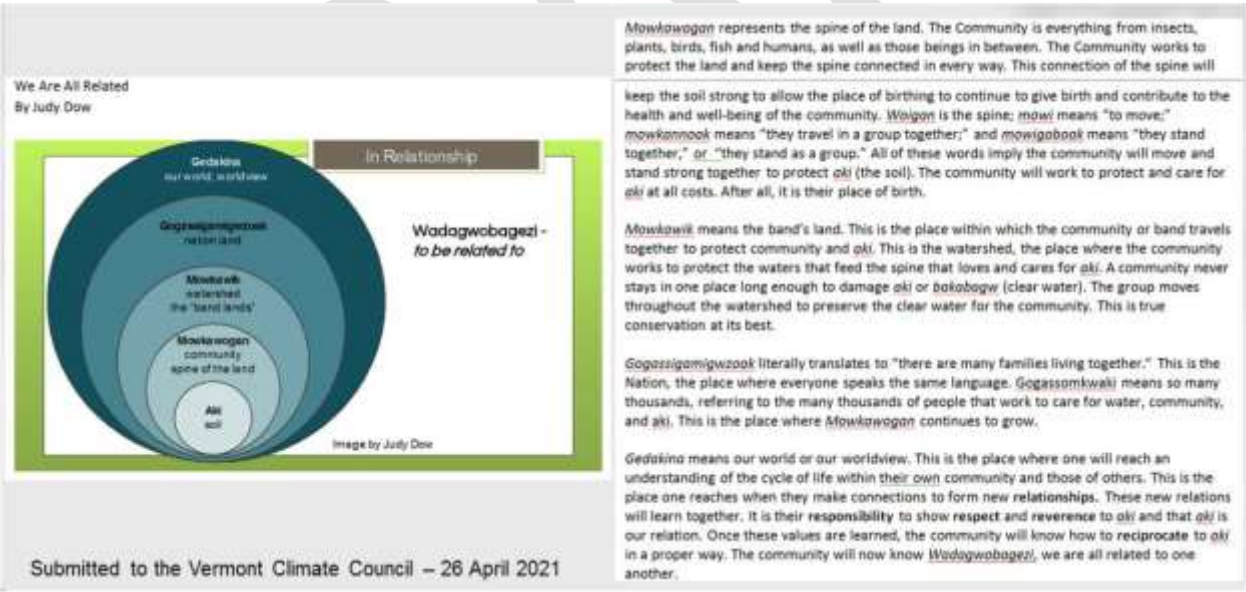
2.1 **Geographies of vulnerability** (human, landscape, infrastructure)

[51] <https://www.globalchange.gov/nca5>
[52] https://statesummaries.ncics.org/chapter/vt/
[53] https://crt-climate-explorer.nemac.org/
[54] Dupigny-Giroux, 2002

The topography or physical geography of Vermont is one of the most important factors in influencing the occurrence of natural hazards their impacts on human settlements, the location of our major roadways in steep, V-shaped valleys and our ability to increase resilience as a state. The north-south spine of the Green Mountains, along with the complex east-west valleys and the north-south ridges of the Taconic Mountains[55] affect the movement of localized winds and incidence of freezing rain conditions; produces enhanced orographic precipitation and the associated flooding events; control the incidence of pollution and stagnation events, as well as variations in freeze and frost dates[56].

Various online tools can be used to monitor Vermont's human and landscape vulnerability. The NOAA Climate Resilience Toolkit[57] offers a 5-step, risk-based management framework to achieve climate resilience. The Vermont Department of Health has summarized the Vermonters' vulnerability by geographic location as well as by climate hazards (Figure 4c) and offers the online Heat Vulnerability Index Mapping Tool[58] < for ongoing monitoring. Finally, the Forest Monitoring Cooperative has launched the Forest Ecosystem Monitoring Cooperative's "Monitoring northeastern forest indicators for signs of climate-drive change[59].

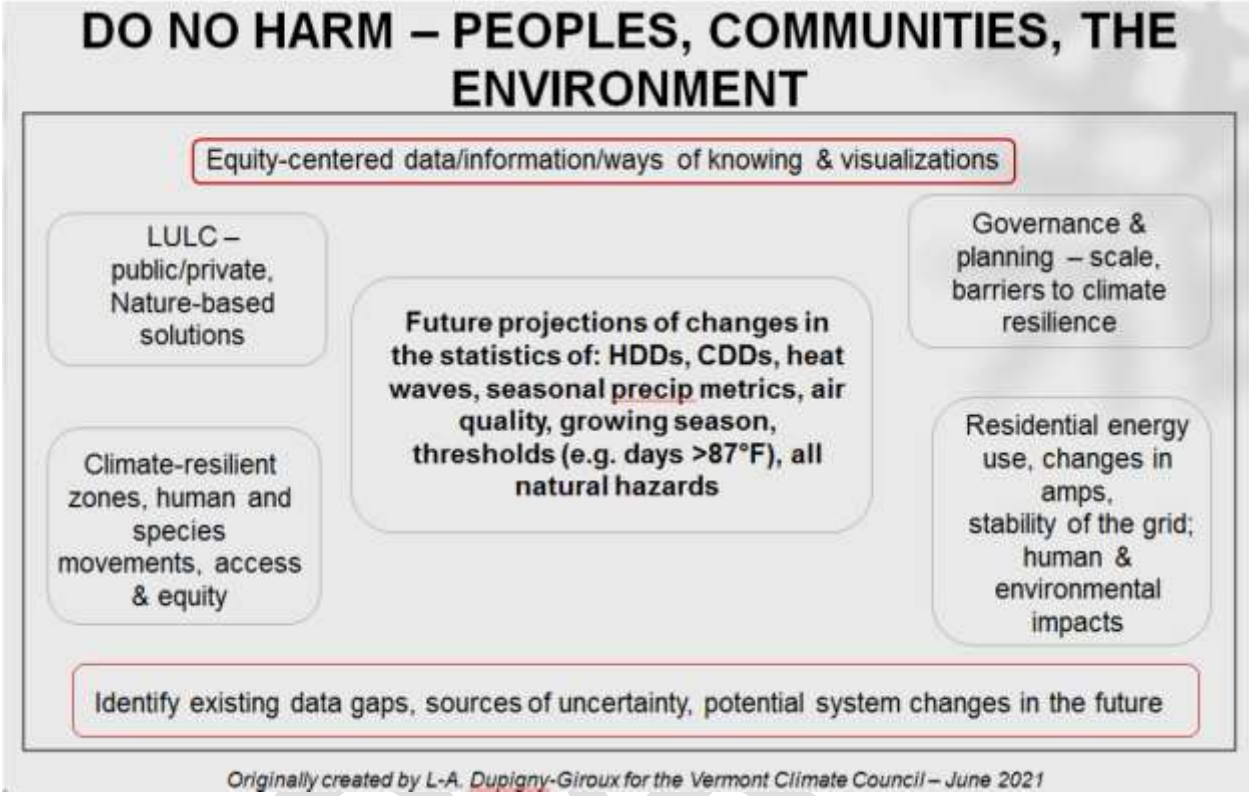
Figure 5a



Source: Diagram submitted to the Vermont Climate Council as frameworks to guide discussions and understanding of the relationship between humans and the Earth. 'We are all related' was created by Abenaki scholar and educator Judy Dow.

[55] Dale, 1905
[56] https://www.weather.gov/btv/climoFreeze
[57] https://toolkit.climate.gov/
[58] https://ahs-vt.maps.arcgis.com/apps/MapSeries/index.html?appid=5bfd71bdeff242d4a8f0d2780369807a> and Vermont Social Vulnerability Mapping Tool at https://ahs-vt.maps.arcgis.com/apps/MapSeries/index.html?appid=ffea40ec90e94093b009d0ddb4a8b5c8
[59] https://www.uvm.edu/femc/cooperative/projects/climate_indicators

Figure 1b



Source: Diagram submitted to the Vermont Climate Council as frameworks to guide discussions and understanding of the relationship between humans and the Earth. 'Do no harm- Peoples, Communities, the Environment' by Lesley-Ann L. Dupigny-Giroux, after consultation with Abenaki elders and scholars.

3.0 UNDERSTANDING CLIMATE & CLIMATE CHANGE IN VERMONT

3.1 Wind and snowfall climatologies

High winds may occur from either large-scale weather systems, also known as gradient winds, or from localized thunderstorm wind gusts. The occurrence of high winds from large-scale weather systems (gradient winds) in Vermont shows a strong correlation with elevation. . Under certain meteorological situations, locally strong winds can be enhanced by terrain in nearby valleys (e.g., October 30, 2017 wind storm).

Vermont's distribution of snowfall also follows a strong correlation with elevation. This is due to the colder temperatures at higher elevations, and the influence of the mountains producing enhanced upward motions which lead to localized clouds and higher winter precipitation. Total snowfall ranges from around 70" a year in the deeper valleys to over 200" in the highest Green Mountains. Winter temperatures and precipitation are increasing, which will likely result in a greater number of winter storms featuring elevation-sensitive rain or snow accumulations. A comparison by the National Weather Service Burlington Forecast Office (NWSFO-BTV) of the average monthly snowfall received at long term stations during the cool season for the 1980-2010 vs. the 1990-2020 overlapping 30-year periods[60] ,

[60] https://www.weather.gov/btv/climoSnowfall>

revealed that with the exception of January and April, total snowfall , decreased for the months of November, December (FIGURE 2f), February and March[61].

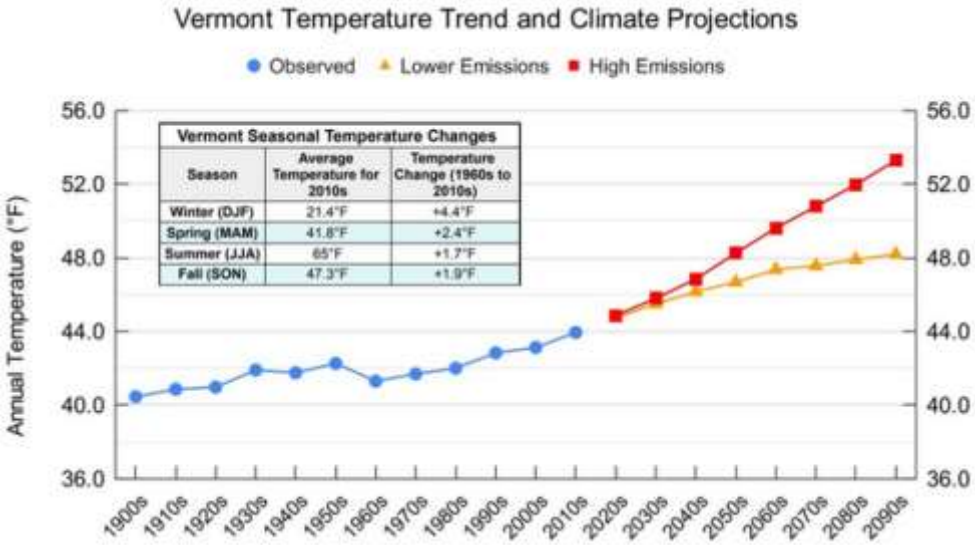
Wet snowfall occurs when partially melted snowflakes have water on their edges, making them sticky. Freezing rain occurs when rain falls into a shallow subfreezing layer of air and then freezes on contact to surfaces. These processes are more frequent at higher elevations, principally due to colder temperatures and higher precipitation accumulations. The greatest risks from wet snow and freezing rain icing show a strong correlation with elevation across Vermont. Thus, wet snow and freezing rain hazards are more likely to produce power outages at higher elevations (Figure 2e). However, intense ice storms can still occur in valleys, especially in deeper northern valleys near the international border when shallow cold air can recharge itself from Canadian source regions such as the ice storms of January 1998, and December 22, 2013.

3.2 Temperature variability

Across Vermont, the 2010-2020 11-year period has been the warmest since records began in 1895, with the warmest winter and summer seasons occurring in the 2000-2020 period[62] . Vermont's average annual temperature has increased over 2°F from the 1970s to 2010s and over 3°F from the end of the last century (Figure 3a). The rate of warming has increased through the last 120 years, and is currently around +0.5°F a decade. While this rate of warming may seem relatively small compared to perceived daily temperature changes, the overall warming is having a number of notable effects, such as the lengthening of the growing season, less reliable winter snow cover, and shifting peak energy usage to the summertime. Seasonal temperature trends show the winter season warming nearly twice as fast, increasing over 4°F from the 1960s to the 2010s. Other observed seasonal shifts include an expanding warm season causing longer falls and winter to have more false starts, and increased intra-seasonal and inter-seasonal temperature variability (more fluctuation within seasons). Backward or false springs (during with snow and freezing rain can occur in April-June after the normal progression of warming temperatures[63] continue to be observed, even with the observation that freeze-free seasons are longer[64] .

[61] Banacos, 2011
[62] Runkle et al., 2021
[63] Dupigny-Giroux, 2009
[64] Runkle et al., 2021

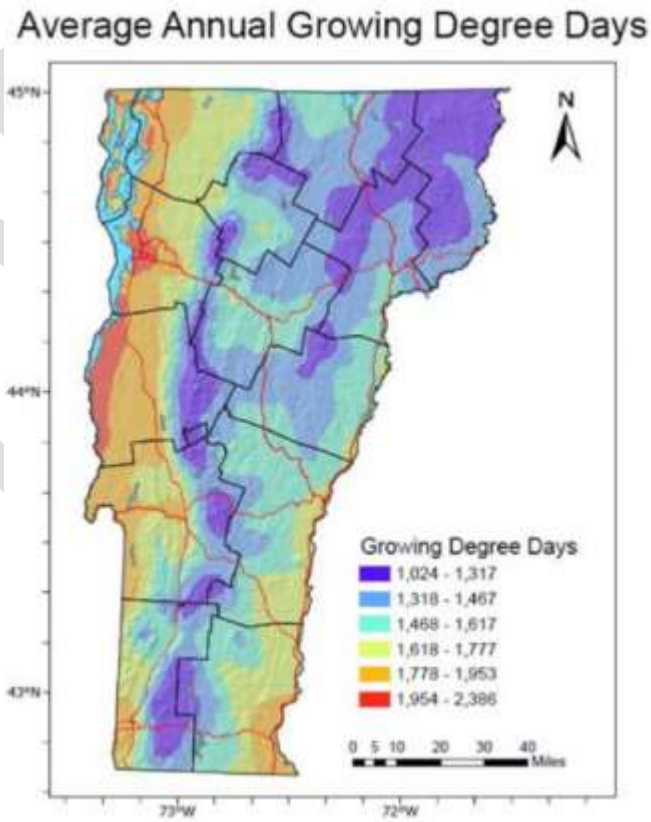
Figure 3a



Vermont Seasonal Temperature Changes		
Season	Average Temperature for 2010s	Temperature Change (1960s to 2010s)
Winter (DJF)	21.4°F	+4.4°F
Spring (MAM)	41.8°F	+2.4°F
Summer (JJA)	65°F	+1.7°F
Fall (SON)	47.3°F	+1.9°F

Decadal observed trends and climate projections of temperatures across Vermont under the low emissions scenario (RCP4.5 which represents moderate global emissions mitigation), and the high emissions scenario (RCP8.5, where emissions continue along current trends). Inset table based on data from NOAA's National Centers for Environmental Information.

Figure 6b



Average cumulative seasonal growing degree days (using a 50°F base). Based on a 5-km downscaled dataset from 1990-2019 following Shafer and Cronin (2021).

Growing degree days are used to determine arm season growing potential for various crops. Growing degree days are highest in the warmest areas of Vermont (primarily west of the Green Mountains and in southern valleys), and lowest in the Northeast Kingdom and highest elevations. Growing degree days have increased by approximately 5 to 10% over the last 40 years, primarily as the warm season expands in the late summer to early fall (Figure 3b).

As Vermont's climate warms there has been an observable shift in temperature extremes. Heat waves are becoming more likely while cold waves are decreasing. Evidence for this from Burlington (Figure 4a) shows a steady decline in cold waves peaking around nearly 6 per year in the 1970s to less than 2 per year in the 2010s. Heat waves have generally increased from around 3 to 4 per year in the 1960s/1970s to over 7 per year in the 2010s. These changes will cause a shift in peak energy demand to more likely occur during the summer season, and increase heat exposure health risks to vulnerable populations.

Since the mid-2000s, a below average number of very cold nights (defined as nighttime temperatures of 0°F or less) has also been observed in winter, with a near to above average annual number of warm nights in the 2000-2020 period[65] The Vermont Department of Health[66] has documented the combined influence of warmer winters and longer warm seasons as contributing to both a more hospitable environment for blacklegged ticks, as well as their hosts, white-footed mice. Figure 5a captures the exponential increase in probable Lyme disease cases between 1990 and 2016, with Vermont and Maine being the states with the highest increases in actual reported case rates since 1991[67] (Figure 5b, c). The Department's climate and health pages[68] area resource for additional information on climate impacts on health, considerations for vulnerable populations[69] , potential impacts (e.g. on pollen, allergies, mold in buildings, waterborne and foodborne diseases) and the health benefits to be derived from climate change adaptation and mitigation.

3.3 Moisture variability

As Vermont's climate warms, the overall amount of precipitation is also increasing. Warmer temperatures produce increased evaporation of water vapor from nearby bodies of water, resulting in a greater potential for weather systems to produce higher amounts of precipitation. In general, increases in annual precipitation changes are relatively small, on the order of +0.5" to +1.0" a decade, with the greatest increases in precipitation occurring during the winter season.

Vermont's distribution of precipitation follows a strong correlation with elevation with the deeper valleys receiving less than 40" annually while, the highest peaks nearly reach 80" annually (FIGURE 2d). The interaction of weather systems with Vermont's terrain produces enhanced precipitation from airflow that is forced upward over mountains on their windwards sides, and precipitation suppression where the airflow is forced down the leeside. The Champlain Valley, for example, rests in the climatological rain shadow from the Adirondack Mountains of New York.

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[65] Runkle et al., 2021; see Appendix 1.
[66] https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_CH_WhitePaper.pdf
[67] EPA Change Indicators, 2021 https://www.epa.gov/climate-indicators/climate-change-indicators-lyme-disease
[68] https://www.healthvermont.gov/environment/climate
[69] https://www.healthvermont.gov/health-environment/climate-health/vulnerable-populations

As noted in Runkle et al. 2021 (and shown on the Standardized Precipitation Index values on Figure 76), the year 1970 marked a shift towards annual average precipitation trending above the long term average, increasing by almost 6" since the drought decade of the 1960s. The wettest period since 1895 was observed in 2005-2014. Extreme precipitation (defined as greater than 2" over 24 hours) has also trended above the long-term average since 1995. These trends are reflected in the increases in stormflow between 1950-2006[70] (Figure 7 b), as well as the increasing magnitudes of the 1% (100-year return interval) storms across timescales from 1 hour (Figure 7c) to 1 day(Figure 7d). Such changes in recurrence intervals and other precipitation statistics should be factored into infrastructure planning, hydraulic studies and floodplain management in order to mitigate against ongoing loss, failure or disruption.

Vermont is marked by tremendous hydrologic variability over time and space. Temporally, fluctuations of importance can occur over very short time frames (e.g. in the transportation sector, heavy precipitation on the order of minutes to hours is of critical interest) up to weeks, months and years (which are important to the agricultural sector where moisture availability during key phenological stages of the planting, growing and harvesting seasons is paramount). Moisture extremes (droughts and floods) can and have occurred simultaneously across the state (e.g. flooding in Southern Vermont in July 2021, while the northern reaches were in moderate drought). In fact, Southern Vermont just experienced its wettest four summer months (June through September 2021) on record, with major localized flooding throughout the month of July and its most widespread major flooding event occurring on July 29, 2021 since Tropical Storm Irene, nearly 10 years earlier. The region was fortunate to experience only glancing blows from tropical systems Fred, Henri, and Ida thereafter. Both the flooding that did occur, and the catastrophic flooding that could have occurred but did not had the paths of major systems, confirm the need for climate adaptation and resilience even as the production of greenhouse gases must be reduced.

Apart from heavy precipitation, especially from slow-moving or stalled storms, flood-producing conditions include the presence of deep snow cover, frozen ground and ice-covered rivers (primarily in the cool season), with saturated soil, existing bankfull conditions, full reservoirs and complex topography.

Droughts followed by flooding in the same year is also a characteristic of Vermont, a pattern which has not changed over the last 100 years. For example, this flip-flop was observed in 1927 (where the November floods remain the flood of record for Northern Vermont) and more recently in August 2011 (where the flooding due to Tropical Storm Irene stands as the flood of record for Southern Vermont). The August 2011 drought was an example of a new type of drought called a flash drought, which is now observed more frequently in Vermont. Flash droughts[71] , as their name suggests, develop very quickly (weeks), typically in the spring/summer months, where the lack of precipitation and decreased soil moisture is often exacerbated by high daytime temperatures and low relative humidities in the air.

[70] Hodgkins and Dudley, 2011
[71] Otkin et al., 2019

Apart from the newer flash droughts, traditional droughts tend to fall into staggered categories with meteorological (precipitation deficit) occurring first, followed by agricultural droughts (soil moisture deficit) and then hydrologic ones (when surface waters, lakes, groundwater and wells are affected over the course of months to years). As Figure 6 shows, it is possible to be in a meteorological drought (e.g. 1910s, 1930s), but not a longer term hydrologic drought. Recent droughts in Vermont and across New England suggest that this traditional sequence is changing. The year 2020 was a marker year when short term flash droughts over the summer were followed by record-setting streamflow and groundwater droughts in the fall[72] . This was significant because some of these records that were set or tied occurred on streams with 71, 89 and 90 years of records, dating back to the droughts of the 1930s. Across Vermont, evidence of this severe 2020-2021 hydrologic drought included the number and depth of new wells being drilled, and the fact the well drillers were still managing homeowner requests into the fall of 2021.

Hydropower generation is also subject to fluctuations in water levels. The Connecticut River is a heavily-managed river due to the presence of hydropower facilities at Wilder, Bellows Falls, Vernon, and Northfield, Massachusetts (which affects the flow of the river and erosion in Vernon, Vermont). It is also falls within the jurisdiction of both the states of Vermont and New Hampshire, with the river at and below the low-water mark on the western shore falling within the jurisdiction of the latter. To the extent climate change forecasts suggest intensification of the hydrologic cycle, this has implications for Connecticut River water quality and quantity that will require greater coordination between the states of Vermont and New Hampshire, greater management of competing uses, and which could have significant downstream implications including the Long Island Sound Total Maximum Daily Load for nitrogen. This coordination could create new purpose for the Connecticut River Joint Commissions (see 10 V.S.A. § 1193).

Drought impacts on drinking water supplies as well as adequate water availability for key Vermont sectors such as hydropower, agriculture, forestry and other water-based recreation and tourism activities, represent a pressing need for building resilience to moisture extremes.

4.0 Economic impacts of climate change in Vermont

Due to the small geographic extent of Vermont as a state relative to the global economy, it is difficult to provide absolute attribution to the gradual, but certain climate changes that are occurring. Similarly, it is also difficult to tease out all of the specific economic impacts directly attributed to climate change. However, there are three categories of economic damage where the impacts are clear. These are structural damage, human health impacts and the disruption to production and supply chain within the business sector.

One partial measure of structural damage resulting from the increasing strength and frequency of storms is represented by FEMA-designated disaster declarations and the resulting payments. A review of FEMA designations between 2010 and 2019, shows that Vermont receives on average $9-30 million in

[72] Lombard et al., 2020

assistance support. The range is based on either including or not including Irene-related damages that influence the ten year average significantly. However, FEMA only addresses short term catastrophic impacts and not the less destructive but still significant issues associated with increased precipitation and storms resulting in wet basements and tree damage. To get a handle on the size of these smaller scale impacts, it is instructive to review consumer expenditures as reported by the Census Bureau Consumer Expenditure Survey (CES). The CES includes a category for home maintenance, repair and insurance. For the northeastern states (Vermont specific data are not robust enough for reporting), the proportion of household income attributed to home maintenance, repair and insurance has increased from 1.88% to 2.15% between the 2003-4 and 2019-20 reports. This amounts to an average increase of $250 per household and for Vermont adds up to an additional $66 million in economic costs per year. It should be noted that, applying a similar approach to southern states in the US, with higher incidences of storm related damage due to hurricanes, tornadoes and tropical storms, yields an annual increase in maintenance, repair and insurance of $576 per household when comparing the 2003-4 data with 2019-20.

An examination of weather-driven insured losses by the Vermont Department of Financial Regulation over a ten year period (2010-2019) estimates that weather-driven factors resulted in approximately $558 MM of insured losses in Vermont across auto, homeowners, and farmowners policies[73] ; wind and hail hazards were the dominant perils associated with insured losses. Based on trends in reconstructed losses projected increases of insured losses of approximately 2-4% by 2050 relying principally projecting current trends forward. Storm systems and their accompanying perils were observed to become more intense over time as a result of the climate warming.

The impacts on residential properties parallel damage to commercial properties. In Vermont, the Grand list value Commercial and Industrial properties is about 12% of that of residential properties. If Commercial and Industrial properties suffer the same proportion of damage increases as do residential properties, the damage estimate increases by $8 million to a total property damage estimate of almost $75 million per year.

There are several examples of human health that are affected by climate change. While the human suffering associated with these human health impacts is important, it is still possible to assign dollar amounts to the increased health care services that result. In terms of the aforementioned exponential increase in probable and actual reported cases of Lyme disease and other tickborne illness, the Tick Borne Disease Working Group at the federal level estimates the dollar costs for Lyme disease at about $1.3 billion and because Vermont represents 1.5-2% of national cases, the dollar costs are $20-25 million per year. This value is in addition to the dramatic increases in anaplasmosis observed across the state. Prior to 2008, case of anaplasmosis were close to zero and that number increased to more than 200 in 2016. Finally, in terms of mosquito-borne diseases have been observed in Vermont for decades and include the West Nile Virus and Eastern Equine Encephalitis. A website focusing on mosquito-borne diseases puts national level economic damages in the billions of dollars.

[73] Shafer, J. C., and K. Cronin, 2021: An examination of weather perils and insured losses in Vermont. Vermont Department of Financial Regulation. 36 pp.

Apart from vector-borne ailments, increasing temperatures pose economic effects due to water contamination impacts and those related to heat waves. In terms of the former, beach closures in Vermont are the result of a combination of increased water temperatures and increased nutrient loads. There is no dollar estimate that specifically informs the climate change component, but Vermont spends tens of millions of dollars each year to address water quality contaminants in our large lakes. Finally, in terms of heat waves, periods of extreme heat result in increases to the emergency room. Using the aforementioned threshold of 87°F as an extreme heat day since 2016, it should be noted that, prior to the year 2000, extreme heat days averaged about 6 per year resulting in dozens of emergency room visits. Models show these numbers increasing significantly with a resulting increase in emergency room visits. Perhaps more economically important than acute health events is the trend towards adding air conditioning to Vermont homes. One of the drivers behind an increase in the installation of heat pumps is the ability of a heat pump to also provide air conditioning services. The dollar cost for heat pump installation from 2019 to 2021 is estimated in this report to be $84 million or $27 million per year.

4.1 Vulnerabilities exposed by the COVID-19 pandemic

The ongoing SARS-CoV-2 (COVID-19) pandemic has acted as a compound stressor[74] or threat multiplier on communities and activities that were already vulnerable to natural hazards, climate change impacts and socioeconomic disruptions. In particular, 2020-2021 has been marked by climate migration and business disruptions.

The influx of out of state residents to Vermont during the COVID-19 pandemic, and others transitioning second homes into primary homes, provides a glimpse into what could be the leading edge of climate influenced, if not driven, migration to Vermont and the northeast. This has resulted in housing demand outstripping supply, leading to increased housing prices, decreased housing availability, and the exacerbation of housing fairness, equity and justice issues. Lack of infrastructure (chiefly community wastewater and water systems) makes compact settlement a challenge, thereby causing housing development to follow the path of least resistance, which is dispersed single-family home development on large lots along rural roads. This de facto development pattern will only exacerbate energy use patterns that will make achievement of many of the goals and objectives of the GWSA a challenge, and underscore the need to create an effective land use planning and regulation rubric that can achieve housing development and accessibility, compact settlement, smart growth, and just transitions policy imperatives.

News headlines in 2021 also report disruptions to the supply chain due to the COVID-19 pandemic. Prior to 2020 and continuing through the pandemic are transportation disruptions due to coastal storms. One of the most apparent sectors affected by climate change induced storms is for oil and gas production. Gulf of Mexico drilling platforms and coastal refineries are closed with increased frequency, each time causing a spike in petroleum and natural gas prices. Droughts cause a disruption in hydroelectricity generation requiring electric utilities to purchase alternative, higher priced generation (and often with

[74] Zscheischler et al., 2020

greater greenhouse gas emissions).

Agriculture is probably most susceptible to climate change. While Vermont may see longer growing seasons, most of our food comes from other parts of the world, many of which are subject to water restrictions due to drought. Shipping food on barges is often delayed during flooding events on the major river corridors.

5.0 Projections of future climate change

A warming and wetter climate has varying effects on different weather and climate hazards (Figure 8). Projected changes in temperature through 2050 show a high degree of confidence in temperatures increasing, resulting in a higher frequency of warmer temperatures and heat waves. On the other hand, the most extreme cold temperatures will likely decline in magnitude slightly as arctic warming tends to diminish the strength of wintertime arctic air masses. Overall annual precipitation will likely increase, although at a slower rate than temperature (moderate confidence). Extreme precipitation events, such as those with 2" or greater precipitation in a 24-hour period, will likely increase in frequency (moderate confidence).

Annual snowfall variability will likely remain high, with some wet winter seasons producing higher than average snowfall, as the climate remains cold enough to continue to support snowfall. However, the general trend is for more winter rain and reduced annual snowfall, especially in lower elevations and southern areas. Risks from power outages related to wet snowfall are expected to increase, as more winter storms will likely be closer to freezing where snowfall is wet or sticky in nature (moderate confidence).

Wind storms are expected to increase in intensity, but these will likely be related to unique meteorological storm types. Tropical Storms or Hurricanes, if they make landfall and move inland, will likely be able to maintain strength at higher latitudes from warming ocean temperatures, therefore increasing the risk for low-frequency but catastrophic storm impacts (e.g. Hurricane of 1938). On the other hand, gradient wind events from midlatitude storm systems across Canada or nor'easters may decline in frequency.

The projected frequency of ice storms and thunderstorms remain low confidence with competing meteorological risk factors for each. Low-end freezing rain icing events (those with ice accretion insufficient to produce power outages) are expected to increase, as warmer winter temperatures produce more winter storms with mixed precipitation types.

Overall risks to the power distribution grid have been shown to be increasing, more due to storm systems becoming more intense. A combination of weighing current trends, literature, and two climate simulations shows that overall power outage risks are projected to increase by approximately 5-10% through 2050, due to more frequent wet snowfall, and potentially stronger wind storms[75].

[75] Shafer and Cronin 2021

Vermont's annual precipitation is projected to increase 1" to 2" through 2050 (Figure 9a). These rates of increase track closely to current precipitation rate changes over the last 30 to 40 years. Through 2100, the lower emissions scenario predicts approximately 4" greater annual precipitation, whereas the high emissions scenario predicts 9" greater annual precipitation. The spatial distribution precipitation change is relatively equal across Vermont counties. Extreme precipitation events will increase at a faster rate than annual precipitation increases, likely following current ratios of extreme events to annual precipitation rate changes.

Vermont's annual temperatures are projected to increase over 2°F through 2050 on either the lower emission or high emissions scenarios (Figure 9b). These scenarios differ significantly through 2100, with the lower emissions scenario predicts 4°F of warming whereas the high emissions scenario predicts 9°F of warming. The spatial distribution of warming is relatively equal across Vermont counties. With a warming climate comes a greater likelihood of higher temperatures. Extreme temperatures (as defined by a high temperature >= 90°F) are projected to double in frequency by 2050 through either the lower emission or high emissions scenario (Figure 9c). Vermont-wide average days above 90°F go from 4 days a year to 9 days a year by 2050. By 2100, however, there is significant variability, with the lower emissions scenario reaching 15 days a year, and the high emissions scenario projecting 45 days a year.

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APPENDIX 1

Vermont State Climate Summary (provided with NCEI permission)

Runkle, J., K.E. Kunkel, S. Champion, L.-A. Dupigny-Giroux, and J. Spaccio, 2017 (2021 revision): Vermont State Climate Summary, Supplemental Figures. NOAA Technical Report NESDIS 149-VT. NOAA/NESDIS, Silver Spring, MD, 26 pp.

The Vermont Energy Economy & Opportunities Related to Climate Action

I. Current Vermont Context Regarding Energy & the Economy

In 2018, Vermont's Gross State Product included roughly $32 billion in economic transactions. Over the last decade, the cost of energy expenditures for Vermont households and businesses has averaged nearly $2.8 billion per year.

Figure 1. Vermont Average Annual Energy Consumption and Expenditures, 2009 - 2018

	Volume	**$ Spent**
Gasoline (gallons)	321,103,421	$ 938,120,000
Diesel (gallons)	64,716,958	$ 238,330,000
Fuel Oil (gallons)	129,851,400	$ 386,400,000
Propane (gallons)	105,638,400	$ 261,660,000
Natural Gas (bcf)	10.5	$ 104,760,000
Electricity (MWh)	5,530,000	$ 784,170,000
Wood[76]		$ 80,000,000
TOTAL		$ 2,793,440,000

Source: EIA

Of this total, an average of about $2 billion a year has been spent on fossil fuels (gasoline, diesel, fuel oil, propane, and natural gas) over the last decade. Vermont's current dependence on fossil fuels leads to high and unpredictable energy costs for Vermont households and businesses. As shown in Figure 2, gasoline and diesel have been much more expensive and price volatile as transportation fuels compared to electricity. Similarly, the two most expensive and price volatile primary heating options have long been propane and fuel oil (note: while resistance electric heat is more expensive than propane and fuel oil, Vermont building code does not allow it to be a primary heat source in new buildings). In comparison, heating with cold climate heat pumps and/or wood generally provides lower operating costs, with greater price stability.

Figure 2: Cost Comparison of Different Transportation Fuels Over Time

[76] Note: Data for wood is available on an irregular basis, so this figure represents the estimate for 2018 from the Department of Forests, Parks, and Recreation, not the EIA average from 2009 – 2018.

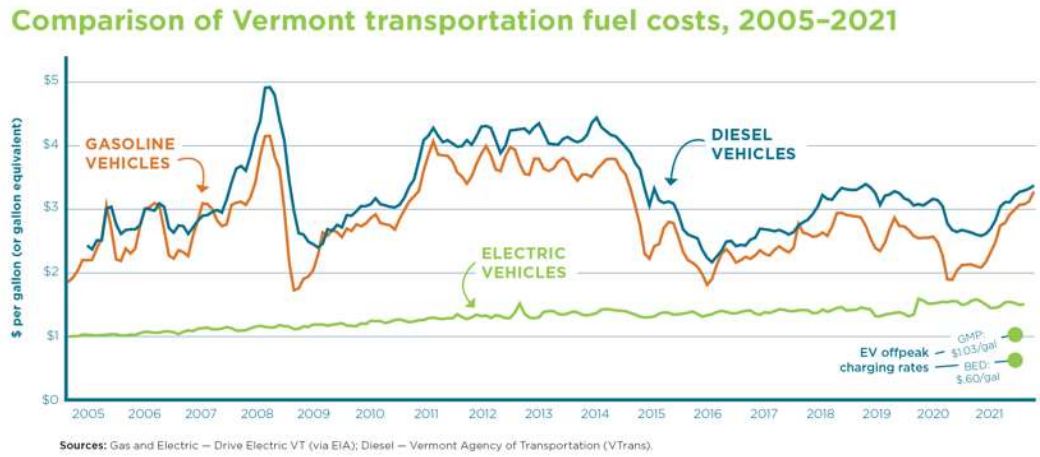
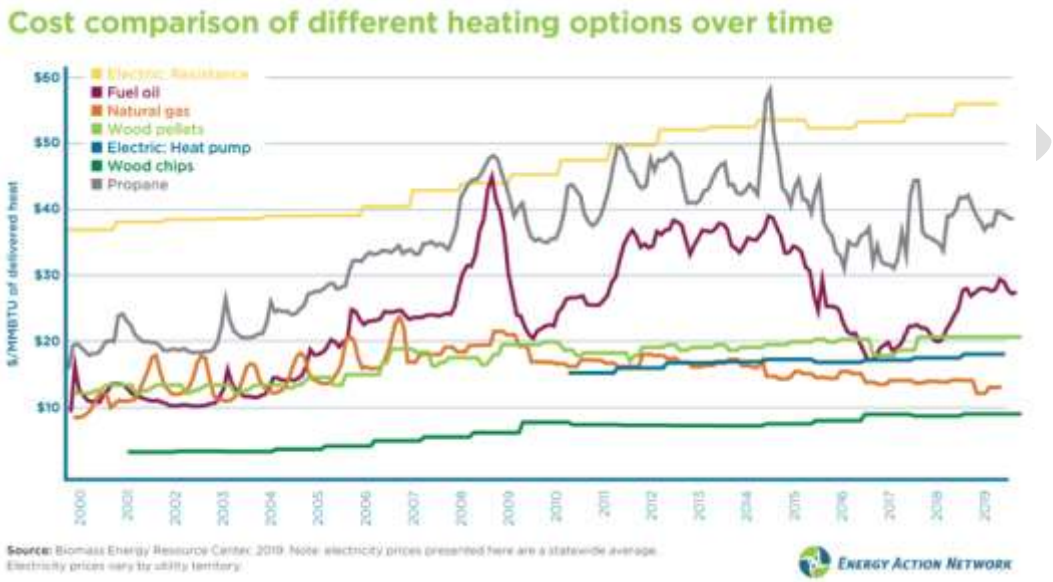


Figure 3. Cost Comparison of Different Heating Fuel Options Over Time



Not only do fossil fuel expenses represent a cost burden on Vermont consumers: they also generally create a drain on the Vermont economy. 100% of fossil fuels used in Vermont are imported. As commodities that have a relatively small amount of in-state labor represented in their overall price, much of the total amount Vermonters expend on fossil fuels (especially fuel oil, gasoline, and diesel) represents an outflow of dollars, with comparatively little value to the State economy in terms of local economic activity. In contrast, energy-related expenditures like weatherization, electricity purchases, and wood heating contribute more, per dollar spent, to local economic activity and Vermont-based jobs.

Figure 4: Local Economic Activity Related to Different Energy Sources in 2018

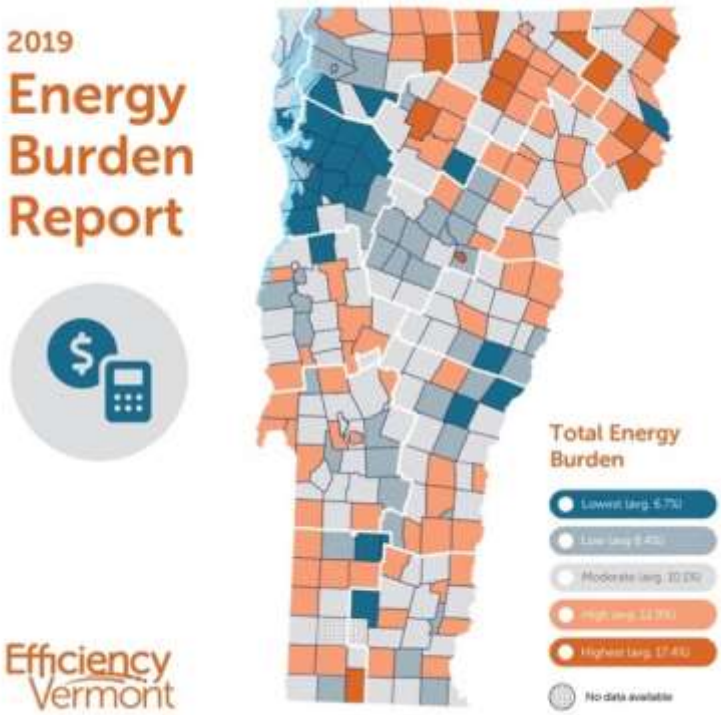
	Total sales (2018)[77]	Percent of retail price with local economic activity[78]	Vermont economic activity	Employment estimate[79]	Vermont compensation estimate
Fuel oil	$340 million	25%	$85 million	1,400[80]	$85 million
Propane[81]	$310 million	45%	$140 million		
Natural Gas	$115 million	50%	$60 million	135	$15 million
Electricity	$737 million	50%	$370 million	1,250	$140 million
Wood for thermal	$65 million	90%	$60 million	1,200[82]	$60 million
Wood for electric	$25 million	80%	$20 million		
Gasoline and diesel	$1021 million	30%	$300 million[83]	4,150	$165 million[84]

There are important demographic differences in energy use and energy cost burdens. On average, upper-income households consume more fossil fuels for transportation and heating, spending more on energy than lower-income households.[85] However, the share of income that lower-income households spend on energy – their energy burden – is higher than the share spent on energy by upper income households. This means that far too often, those who can least afford it are stuck with the highest energy burdens, from renters who have to heat with resistance electric heat because landlords have not upgraded heating systems, to lower-income Vermonters who often drive older vehicles that are more expensive to operate and maintain.

Another important difference is that rural households tend to spend more on transportation than urban households. Indeed, average total energy burden (spending on transportation and heating fuels as well as electricity, as a share of total income) varies by region, from a lowest average of 6.7% to a highest of 17.4%, in multiple Northeast Kingdom towns.

Figure 5. Total Energy Burden (Average) by Town

[77] Note: Total sales in 2018 were lower than the 10 year average (2009 – 2018), which was: fuel oil: $386 million, propane: $262 million, natural gas: $105 million, electricity: $784 million, gasoline: $938 million, and diesel: $238 million.
[78] The percent economic activity varies with the commodity price of fossil fuels. Higher commodity prices result in lower in-state percent activity. Note: these figures have been updated with additional information as of November, 2021 and differ from previous ACCD estimates.
[79] 2018 Quarterly Census of Employment and Wages
[80] Many Vermont fuel oil dealers also provide propane services. The employment figure includes both fuel oil and propane delivery services
[81] The propane figures may be high. The sales figure is taken from EIA but price estimates may be larger than actual, as described in the propane section of the longer economic chapter in the appendix.
[82] Includes a large number of self-employed, sole proprietors
[83] Include $110 million in Vermont transportation taxes
[84] Includes other services sold at gasoline stations
[85] See page 18, 2021 EAN Annual Progress Report for Vermont. https://www.eanvt.org/tracking-progress/annual-progress-report/2021-annual-progress-report/



II. Economic Opportunities Related to Climate Action:

Transitioning off of fossil fuels presents significant opportunities for Vermonters: lower energy costs; greater investment in the Vermont economy; and more and better paying local jobs.

The extent to which Vermonters can efficiently utilize electricity for transportation (electric vehicles) and heating (heat pumps for space and water heating) presents an opportunity to use an energy source that can now be used more economically and that can contribute more to the Vermont economy.[86] The same is true of wood heating. Other renewable fuels, such as B100 biodiesel or renewable natural gas can not necessarily be counted on to provide energy cost savings, even if they can provide GHG emissions reductions when replacing fossil fuels.

There are up-front costs related to equipment replacement or putting in supplemental heating systems that also have to be considered alongside fuel costs (i.e., capital vs. operating costs). However, with federal, state, and utility incentives, the up-front cost of electric or renewable options can often be lower than those for new fossil fuel equipment (though prices vary by model).

Historically, we have used fossil fuels mainly out of necessity: to get to work or school; to keep our homes and businesses warm; to mow our lawns or clear our driveways of snow. However,

[86] Note: potential savings related to use of heat pumps depends on a number of factors, including but not limited to: utility territory (i.e., differential electricity rates); the fuel it is displacing (i.e., savings potential is greater for fuel oil and propane users, perhaps not for natural gas users) variable efficiencies depending on temperature (i.e. heat pumps are less cost effective when temperatures drop below zero); and proper programming and use.

over the last decade it has become increasingly possible to do each of these things without needing fossil fuel. Whenever a vehicle, a heating system, or other piece of fossil fueled equipment reaches the end of its life, we now have proven and available electric technology or renewable alternatives ready to do the same job—oftentimes better and more affordably. In some cases, however, such as heavy duty applications, electric or renewable alternatives are not yet as advanced in terms of economic and technical feasibility.

Many opportunities are ready now. Take electric vehicles (EVs), for example. The Union of Concerned Scientists estimates that EVs, on average, can save rural Vermont drivers over $1,500 a year compared to gas vehicles.[87] On average, charging an EV costs about the equivalent of $1.50 a gallon in Vermont. However, depending on electric utility territory, if customers enroll in off-peak charging programs, charging an EV can cost even less: the equivalent of only $1.03 (Green Mountain Power territory) or even as low as $0.60 (Burlington Electric). That's a big difference when compared to gas prices that average $3.40 a gallon as of Novermber 2021, having spiked over 60% in the last year. EVs also cost less to maintain (no oil changes, for instance). Finally, with federal, state, utility, and other incentives, EVs—whether new or used—can cost less up-front than comparable gasoline models, though the extent to which this remains the case depends on continued and expanded incentives.[88]

Or take home heating. Home and building weatherization can significantly reduce heating costs while improving health and comfort. And heat pump systems and efficient wood heat—whether with efficient stoves or automated boilers and furnaces—both reduce greenhouse gas emissions and can save consumers money compared to fossil heat. It is important to note that potential savings or costs related to heat pumps do vary depending on utility territory and a host of other factors. Meanwhile, cost savings from use of efficient wood and pellet stoves are often more straightforward than cost savings from automated wood pellet boilers, which often depend on equipment purchase incentives to achieve price parity.

The energy transition will not and cannot happen overnight. Many Vermonters are tied to investments they made in fossil vehicles or heating systems, with no realistic choice but to keep using them in the near term. Instead, a cost-effective and practical approach is to focus on the next point of purchase: that time—whether one, five, or ten years away—when a piece of equipment reaches the end of its life and needs to be replaced anyway. When that situation comes, we should use multiple policy, program, and incentive-based tools to equitably help people choose clean transportation and heating options and discourage locking in decades more of fossil fuel dependence that we can no longer afford—for consumer protection, health, and climate reasons.

Delivering efficient and clean energy services can also be a major opportunity for local businesses that have historically sold fossil fuels and serviced heating equipment. There are some forward looking energy service providers (which used to call themselves fuel dealers) that are already shifting their business models to sell less fossil fuel by providing weatherization, wood pellet delivery, B100 biodiesel, and/or heat pump installation services. Similarly, VGS is expanding weatherization services and increasing the amount of renewable natural gas in their system.

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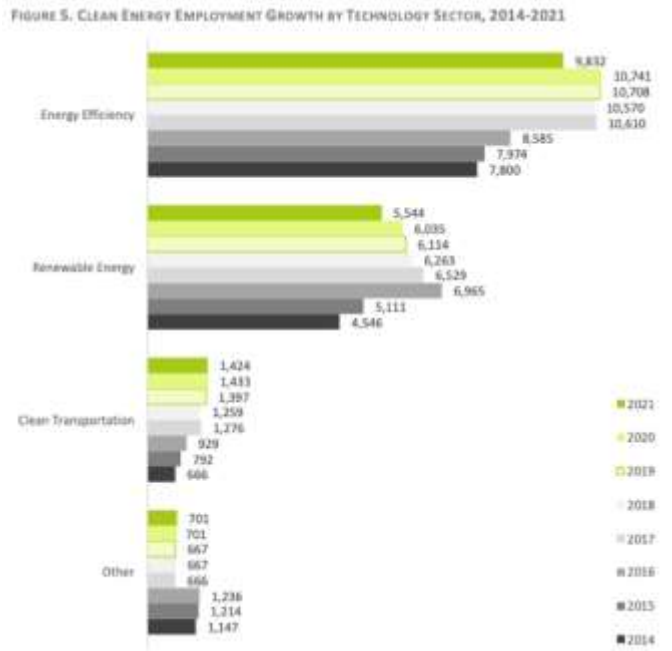
[87] https://www.ucsusa.org/about/news/rural-communities-could-benefit-most-electric-vehicles

[88] See the Drive Electric Vermont website to learn more

Indeed, the local fuel dealers and utilities who have historically provided fossil fuels have the opportunity to be part of the solution, creating new business models that better serve their customers, allowing fuel dealers to have more sustainable business futures.

While VELCO reports that our current transmission system is capable of handling high levels of electrification through 2030, significantly expanding the amount of transportation and thermal energy needs met by electricity will eventually necessitate new investments in our transmission and distribution system. The extent to which Vermont households and businesses save money via beneficial electrification of transportation and thermal energy use will depend in part on Vermont's ability to secure low-cost carbon-free electricity resources, as well as efficient and effective demand response and load management strategies.

Figure 6: Clean Energy Jobs by Sector, 2014 – 2021



The Clean Energy Industry Report has tracked Vermont employment in the clean energy sectors since 2014. As of 2020, clean energy jobs made up about 6% of total employment in Vermont.[89] Generally speaking, the median wage for clean energy jobs (approx. $27/hour) is much paying than the statewide median wage (approx. $19/hour).[90] Meeting our climate commitments via investments in energy efficiency and clean energy can be a win-win-win for Vermont consumers, the Vermont economy, and Vermont workers.

[89]https://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/CEDF/Reports/2021_VCEIR_FINAL.pdf

[90]https://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/CEDF/Reports/2020%20VCEIR%20Final.pdf

Vermont Climate Action Plan Requirements

The Vermont Global Warming Solutions Act of 2020

On September 22, 2020, the Vermont Legislature passed Act 153, the Vermont Global Warming Solutions Act of 2020 (GWSA) that created the Vermont Climate Council (hereinafter the Council) and set forth specific greenhouse gas (GHG) reduction requirements for the State to achieve.

The Council is charged with three tasks:

- identification, analysis and evaluation of strategies and programs to reduce GHG emissions, to achieve the State's GHG reduction requirements, and to prepare the State's communities, infrastructure and economy to adapt to current and future effects of climate change.
- adoption of the Vermont Climate Action Plan by December 1, 2021, to be updated at least every 4 years, that sets forth specific initiative, programs and strategies that the State will pursue to reduce GHG emissions, achieve the reduction requirements, and build resilience in communities, infrastructure and the economy; and
- identification of accurate means to measure the state's GHG emissions and progress towards meeting the reduction requirements; effectiveness of initiatives, programs and strategies included in the Plan; the effect of climate change on wildlife, climate and natural resources of the State, and the State's existing resilience and progress towards improving resilience and adaptation.

In carrying out its above tasks, the Council is charged with:

- Creating an inventory and assessing the efficacy, technical feasibility and cost effectiveness of all existing programs that impact greenhouse gas emissions;
- Identifying, evaluating, and analyzing new strategies and programs that are based upon emerging scientific and technical information;
- Identifying which strategies and programs will result in the largest greenhouse gas emissions reductions in the most cost-effective manner after analyses of the sources of greenhouse gas emissions;
- Identifying, analyzing, and evaluating public and private financing strategies to support the transition to a reduced greenhouse gas emissions economy and a more resilient State; and
- Evaluating and analyzing existing and new strategies and programs that build resilience, to prepare the State's communities, infrastructure, and economy to adapt to the current and anticipated effects

The Vermont Climate Action Plan–Required Content

The GWSA specifies that the Vermont Climate Action Plan shall include specific items,

including initiatives, programs, and strategies that will:

- Reduce GHG emissions from the transportation, buildings, regulated utility, industrial, commercial, and agricultural sectors;
- Encourage smart growth and related strategies;

- Achieve long-term sequestration and storage of carbon and promote best management practices to achieve climate mitigation, adaptation, and resilience on natural working lands;
- Achieve net zero emissions by 2050 across all sectors;
- Reduce energy burdens for rural and marginalized communities;
- Limit the use of chemicals, substances, or products that contribute to climate change; and
- Build and encourage climate adaptation and resilience of Vermont communities and natural systems.

Once the Plan is adopted, the Joint Fiscal Office of the Vermont General Assembly is required "to hire a consultant to prepare an analysis of the economic, budgetary and fiscal costs and benefits of the Plan."

GWSA Rule-making Requirement

If a plan is adopted, the Secretary of the Agency of Natural Resources is required to adopt rules consistent with the Vermont Climate Action Plan, as adopted, on or before December 1, 2022 and achieve the 2025 emission reductions requirements in the GWSA. Should a plan not be adopted by the Council, the Secretary is required to adopt rules to achieve the emissions reduction requirements in the GWSA by July, 2022.

The GWSA provides any person the right to sue the Secretary of the Agency of Natural. Resources (ANR) if rules are not adopted as required by the GWSA. It also authorizes any person to sue the Secretary by filing a lawsuit that alleges that the rules adopted by the Secretary failed to achieve the greenhouse gas emissions requirements pursuant to the GWSA.

The Vermont Climate Council--Additional Duties

In addition to the development adoption of the a Climate Action Plan, the Council is charged with recommending necessary legislation to the General Assembly concerning:

- Adopting of a market-based or alternative compliance mechanisms as part of the State's greenhouse gas emissions reduction strategies;
- changes to land use and development, including to chapter 151 of Act 153 and 30 V.S.A. § 248, to reduce greenhouse gas emissions and promote resilience in response to climate change;
- statutory authority necessary to implement the Plan; and
- any other matter the Council deems appropriate.

Emissions Reduction Requirements in the GWSA

The Act requires reductions in Vermont's GHG emissions tied to three time periods: 2025, 2030, and 2050. Pursuant to the State's membership in the United States Climate Alliance and commitment to implement policies to achieve the objectives of the 2016 Paris Agreement, Vermont is required to reduce its GHG emissions by no less than 26% below 2005 GHG emission levels by January 1, 2025.

Pursuant to the State's 2016 Comprehensive Energy Plan, Vermont is required to reduce its GHG emissions by no less than 40% below 1990 GHG emission levels by January 1, 2030 and no less than 80% below 1990 GHG emission levels by January 1, 2050.

Measurable resilience, adaptation and sequestration goals developed by the Council

In addition to the GHG emission reduction requirements set forth in the GWSA, the Climate Council is working to develop metrics to assess progress with respect to our actions around building resilience and adaptation and enhancing sequestration and storage. The Measuring and Assessing Progress section of this plan speaks to the development of a framework for assessing adaptation and resilience goals. In addition, the section of the plan for the carbon budget speaks to future work to consider carbon sequestration forecasting which will help determine how effective strategies and actions are at impacting our natural and working land's ability to sequester and store carbon.

Foundational Criteria

To meet both the requirements and objectives laid out in the Global Warming Solutions Act (GWSA) and detailed above, the Council developed a prioritization framework utilizing five foundational criteria: impact, cost-effectiveness, co-benefits, equity, and technical feasibility. These criteria speak directly to the priorities put forward in the GWSA while building upon the specific work to develop the Climate Action Plan (CAP) to inform high priority actions. The definitions for these criteria are applied differently based on whether evaluating actions related to cutting emissions (mitigation) verses actions related to building resilience, adaptation, and sequestering and storing carbon. As a result, the definitions have been broken out below. Application of equity in the prioritization of actions is not discussed here as the following section focuses on building equity into the CAP and specifically speaks to the application of the equity scoring rubric in refining and prioritizing actions.

Impact

Mitigation

Impact is the consideration of actions' contribution to achieving 2025, 2030, and 2050 emission reduction requirements. The gross GHG emissions reductions required by 2025 are 1.26 MMTCO2e below our most recent (2018) levels. 3.46 MMTCO2e of reductions are required by 2030.

- High impact recommendations are those that can reasonably be expected to get Vermont more than 10 percent of the way towards either our 2025 and/or 2030 emissions reduction requirements. High impact will also speak to enabling actions that are needed to advance actions that are high impact as defined here. A compelling case will need to be made that the enabling action is the only pathway to success of the high impact action.
- Moderate impact recommendations are those that can reasonably be expected to get Vermont between 2.5 percent and 10 percent of the way towards either our 2025 and/or 2030 emissions reduction requirements. Moderate impact will also speak to enabling actions that are needed to advance actions that are high impact as defined above. Rather than high enabling actions above, moderate enabling actions are supportive of the high impact action, rather than the only pathway.
- Low impact recommendations are those that can reasonably be expected to get Vermont less than 2.5 percent of the way towards our 2025 and/or 2030 emissions reduction requirements.

Resilience, adaptation, and sequestering and storing carbon

The assessment of impact for adaptation, resilience, and sequestration actions takes into consideration both the scale at which a particular action occurs and the effects (both short and long term) of that action.

- High impact actions are those actions that significantly improve the ability of [the built and/or natural environment and working lands OR people/vulnerable populations OR the economy] to adapt to or build resilience to climate change impacts. These actions may

also significantly increase the ability to sequester and store carbon. High impact actions are actions that would affect broad scale change at the municipal, regional, or statewide level.

- Moderate impact actions are those actions that moderately improve the ability of [the built and/or natural environment and working lands OR people/vulnerable populations OR the economy] to adapt to or build resilience to climate change impacts. These actions may also moderately increase the ability to sequester and store carbon. Moderate impact actions are actions that would affect moderate scale change at the municipal, regional, or statewide level.
- Low impact actions are those actions that marginally improve the ability of [the built and/or natural environment and working lands OR people/vulnerable populations OR the economy] to adapt to or build resilience to climate change impacts. These actions may also slightly increase the ability to sequester and store carbon. Low impact actions are actions that would affect small scale change at the municipal, regional, or statewide level.

Cost-Effectiveness

To estimate costs and benefits in determining cost-effectiveness, the estimated benefits and costs are inclusive of direct and indirect benefits and costs to Vermont and Vermonters (i.e., "resource benefits and costs" for the State, including program implementation and management costs, not simply the "consumer costs and benefits"). Benefit-cost analysis estimated social and environmental "externalities", including health costs and benefits and a Social Cost of Carbon, reflecting the global damage-based assessment of the cost of Vermont's climate pollution, consistent with the Social Cost of Carbon report discussed in section INSERT. In many circumstances, additional benefit-cost tests are needed for further analyzing specific proposed policies and programs, including benefits and costs from a consumer and equity perspective or a public investment perspective.

Mitigation

Cost-effectiveness refers to the lifetime net cost per ton of GHG emissions avoided (acknowledging that some mitigation measures do not generate net costs and save money). Cost-effectiveness shall also be understood to account for lifetime or dynamic costs, not merely up-front or static costs. The following HIGH, MODERATE, and LOW definitions were used for prioritization:

- Highly cost-effective are actions that have a net savings per ton of GHG emissions reduced
- Moderately cost effective are actions that essentially break even per ton of GHG emissions reduced
- Least cost-effective actions are ones that will have a net cost per ton of GHG emissions reduced

Resilience, adaptation and sequestering and storing carbon

Cost-effectiveness for actions seeking to build resilience, further adaptation, and enhance sequestration and carbon storage refers to the relative lifetime net cost of the action compared to the desired outcome or impact. This definition only deals with the true cost to Vermonters and does not speak to the cost of avoided damages which we know is very important. By

incorporating the actions impact into how we evaluate cost-effectiveness, the most impactful actions can still be considered cost-effective overall even if they present significant upfront investments, indirectly getting at the cost of inaction.

The action first received an impact ranking of high, medium, and low using the definition discussed above. From there, the action's cost was considered as significant, moderate, or low. Significant was defined as an ongoing cost or a more than ten-year investment to Vermonters which needed to be raised from new revenues. Moderate was defined as on ongoing or more than ten-year investment from Vermonters that has an existing revenue source OR an action that needs a new revenue source for a short-term period (less than ten years). Low was defined as an action that has an existing revenue identified to utilize over a short-term period (less than ten years). Overall cost-effectiveness was compiled by considering the actions impact (high, medium, low) relative then to its cost (Significant, moderate, low). The cumulative summation of overall ranking will be as follows:

- High/Moderate, High/Low, Medium/low – HIGH
- High/Significant, Medium/Moderate, Low/Low – MEDIUM
- Medium/Significant, Low/Significant, Low/Moderate – LOW

Co-Benefits

Comprehensive climate policy will advance actions that work to mitigate climate pollution, while also building resilience, adaptation and storing and sequestering carbon. Actions must also seek to advance broader societal benefits such as public health, equity (specific focus on impacted communities), economic prosperity, biodiversity conservation, workforce opportunities and other benefits that improve the quality of life in Vermont broadly. Identifying actions that address co-benefits and elevating them is key to ensuring the collective plan is working for all Vermonters. Co-benefits was evaluated based on HIGH, MEDIUM, LOW RANKING using the following guidance:

- HIGH – an action that can easily be communicated with broad and varied benefits to Vermonters and Vermont itself.
- MEDIUM – an action that clearly addresses multiple climate action buckets (mitigation, resilience, adaptation, and sequestration/storage) but its broader societal benefits are harder to measure and speak to.
- LOW – an action that advances mitigation, resilience, adaptation, or sequestration/storage but does not clearly advance other benefits.

Technical Feasibility

This speaks to the degree to which the required technologies are developed and reasonably available. As this is called out in the GWSA, it is important to simply answer yes or no to ensure the action is implementable.

Cumulative Priority Ranking

The foundational criteria were used to develop an overall priority ranking for actions to be elevated in the CAP and to advance through an equity screening (detailed below). The definitions used for impact and cost-effectiveness were different for mitigation actions than resilience, adaptation and sequestration and storing carbon. As such, the overall prioritization

across the actions should not be compared amongst them. In addition, the equity scoring rubric was used to further refine high priority actions by transparently considering equity in the implementation of the action. Actions were then reconsidered based on the overall consideration of how equitable the action was and what could be further considered to make it more equitable in practice.

Actions that did not have a clear implementing authority and those that involve personal choices were screened out before prioritization so that the CAP could speak to their collective impact in one section (see INSERT). A stepwise approach was used to focus analysis on impact, cost-effectiveness co-benefits and technical feasibility to elevate high and a subset of medium priority actions to advance. The remaining actions and details of the analyses are all shown in the appendix (See INSERT). The overall priority ranking was assimilated as follows for HIGH and MEDIUM priorities (all other combinations will be LOW priorities). It is important to note that because impact is included in the definition for cost-effectiveness for resilience, adaptation and sequestration actions, the possibility of a low cost-effectiveness ranking is impossible if the impact ranking is high. However, this outcome is possible for emission reduction actions and therefore is represented on the chart below.

All HIGH priorities moved forward with an equity screening and consensus at the subcommittee was reached to advance a MEDIUM or LOW priority action. When considering MEDIUM or LOW priorities to elevate, specific consideration should be given to actions that have a particular focus on equitable solutions. Since the equity screening is to come after priorities are set, it is important to not lose actions that would make a significant impact in this space.

IMPACT	**COST-EFFECTIVENESS**	**CO-BENEFITS**	**TECHNICAL FEASIBILITY**	**OVERALL PRIORITIZATION**
HIGH	HIGH	HIGH	Yes	HIGH
HIGH	HIGH	MEDIUM	Yes	HIGH
HIGH	HIGH	LOW	Yes	MEDIUM
HIGH	MEDIUM	HIGH	Yes	HIGH
HIGH	MEDIUM	MEDIUM	Yes	HIGH
HIGH	LOW	MEDIUM	Yes	MEDIUM
MEDIUM	HIGH	HIGH	Yes	HIGH
MEDIUM	HIGH	MEDIUM	Yes	MEDIUM
MEDIUM	MEDIUM	HIGH	Yes	MEDIUM
MEDIUM	MEDIUM	MEDIUM	Yes	MEDIUM

Public Engagement

To realize the transformative change that is needed to implement the Global Warming Solutions Act, ongoing engagement with Vermonters will be needed to consider solutions and understand the barriers to implementing them. The Council and the subcommittees must comply with

Vermont's open meeting law. Vermont's open meeting law requires all meetings of public bodies to be open to the public at all times, unless a specific exception applies. The purpose of the law is to promote transparency, accountability, and better decision-making in government. Compliance with the open meeting law has been foundational in engaging with Vermonters in an ongoing basis through:

- Providing advance public notice of meeting and including meeting agendas;
- Discussing all business and taking all actions in open meeting, unless an exception in statute applies;
- Allowing members of the public to attend and participate in meetings; and
- Taking meeting minutes and make them available to the public.

This process, while beneficial, has allowed the participation of the relatively few Vermonters who had the time to engage this way. The Council also recognized the need early on to engage consultants to assist in laying the groundwork for a co-creation process with Vermonters in the development of the initial CAP. This was intended to build a framework for the continued and ongoing discussion with Vermonters around climate action in Vermont. Climate Access and RISE Consulting led that work and will continue to work with the Council as we roll out the initial Climate Action Plan. To do so, a public engagement plan was developed through discussion with the Council, subcommittees, three roundtables and stakeholder interviews. This plan, which can be found in the appendices (INSERT), focused on three phases of targeted engagement, the first of completed in Fall of 2021 is discussed here.

This Fall, we engaged with a total of 1,602 Vermonters to discuss the development of the Climate Action Plan. Public events were held between September 21 and October 12, 2021 and an online survey was conducted between September 20 and October 15, 2021. Additionally, The Agency of Natural Resources (ANR) summarized public comments submitted from July 2 and October 7, 2021. Climate Access and Rise Consulting interviewed stakeholders from a broad range of stakeholder groups to inform the public engagement plan and share concerns related to climate impacts and solutions to include in the Climate Action Plan.

The breakdown of participation via channel is as follows:

- Interviews & Roundtables: 37 participants
- Public Engagement Events: 521 total attendees
- Public Opinion Survey: 679 responses
- Public Comment Form: 365 comments

Looking across all input gathered via the range of channels, there are a number of themes that stand out. They include:

- Vermonters who participated want bold action on climate change. At each event, participants expressed strong support for solutions on scale with the challenge.
- There is great hope the Climate Action Plan will live up to what it is intended to achieve and significant concern that it will not.
- Top priorities for community members include tackling climate change through transportation improvements that provide access to cleaner vehicles and public transit, scaling weatherization efforts and efficiency upgrades for buildings and affordable, local sources of clean energy.

- Equity is a core concern. This came through at all events, via the survey and public comment portal. In particular, the impact of climate change and energy transition on youth, low-income Vermonters and BIPOC community members was expressed.
- The mental health impacts of climate change were raised as a key concern, particularly for youth.
- Accessibility of climate solutions. Vermonters want bold action yet wonder how solutions will be paid for and who will be able to afford and have access to them.
- Many who participated in the in person and online events are very interested in staying engaged in the process and appreciated being connected to other community members who feel strongly about the issue.

Through these forums, Vermonters also engaged in formulating the actions for inclusion in the Climate Action Plan, helping the Council consider how we will advance climate action in Vermont. The discussions focused on priorities, barriers and what was missing and are included in the full public engagement findings included in the appendices (INSERT). These considerations were used to further prioritize the suite of recommendations put forward.

We would be remised if we did not mention that public engagement was challenged due to both the timeline and the ongoing pandemic. The first of these gaps is the nature of the accelerated timeline for the release of the initial Climate Action Plan. The velocity of the process influenced the participation level of groups that are likely to be more highly impacted by climate change including low-income communities, BIPOC communities and disability advocacy groups in particular. The public engagement plan outlined additional opportunities for broader partner outreach and support that were not fully realized during this phase due to the lack of time to build trust and respectfully coordinate with multiple partners.

Additionally, there were public engagement challenges posed by the COVID-19 pandemic. The in-person events likely had lower attendance because of varying levels of physical access as well as comfort levels and public health concerns Vermonters may have had gathering in person during this time. Other accessibility gaps included the location of the in-person, which were held in open-air park settings to mitigate the risk of COVID transmission. This posed challenges for physical access, visibility, sound, weather conditions and transportation access to the meeting sites. In addition, three of the meetings were held on weeknight evenings which posed barriers for people with work, community, or family obligations between 5-7 pm. The online meetings may also have posed challenges for those with limited computer or internet access.

The Council will be considering next steps for public engagement as the plan is rolled out to ensure it is easily communicable and discussed in the framing of an iterative process. This will include a social media strategy, online events, an education and engagement platform, partner events and an evaluation. This plan will be ongoing and further refined with the Council.

Building Equity into the CAP and Ensuring a Just Transition

The Vermont Climate Council recognized early in the process the further work it needed to do – both internally and externally – to build equity into climate action in Vermont and Vermont's Climate Action Plan and ensure a just transition. To realize the transformative change that is needed to meet the objectives of the Global Warming Solutions Act (GWSA), Vermonters must be part of not only the solutions but in determining them, supporting all residents of the State fairly and equitably. Specifically, the Council took a three-pronged approach to incorporating and applying equity principles in policy and decision-making: holding space, organizational analysis, and engagement.

The act of holding space refers to the Council's commitment to start every Council meeting with a presentation or discussion related to equity. Rather than having one or a few specific trainings in the area, this has provided a continual opportunity to hear from experts in the field, working on the ground in Vermont and/or have facilitated conversations around what the work looks like in practice. This work will need to be continued as the State of Vermont and Vermonters work to implement the Climate Action Plan (CAP).

The Council also recognized that there is further work to do around the organizational structure of the Council. The formation of the Council itself, and the five subcommittees needed to develop the Climate Action Plan, took place at an astonishing speed and are imperfect. The systems needed to support the full work of the Climate Action Plan and represent the diversity in Vermont were developed in real time. As such, the hierarchy of the Council and its subcommittees created a system with imperfect power dynamics and under-represented sectors of Vermont's population. The Council itself is not representative of the BIPOC, low income and rural communities that are likely to be most vulnerable to the impacts of climate change, not is the Council representative of the economic sectors that will be most impacted by this transformation, such as the building trades. The Council cast a broader net when forming the subcommittees in order to bring more voices to the process, . The subcommittees, however, which are more representative, do not determine the final actions in the CAP but rather serve as advisory to the Council. The Council holds the decision-making power. In recognizing and appreciating this issue, the Council seeks to engage with the legislature going forward to consider new appointments to the Council and other tools, such as re-evaluating the State's per diem policy, to seek and create opportunities to add diversity to the Council.

The final approach to equity is co-creation of and broad-based public engagement in the development of the CAP and ultimately, its implementation. While detailed in the preceding section, the Council engagement efforts were significantly impacted by the aggressive timeline proscribed in the GWSA. That said, engagement cannot be a "point in time" effort in the development of the, but rather must be a commitment by the Council and its staff to work in an ongoing fashion to engage Vermonters in climate action. It is with this commitment, that the Council will continue to strive to do better in providing a platform for Vermonters to see themselves in this process.

Developing the Guiding Principles

The GWSA charges the Just Transitions Subcommittee with ensuring that strategies to reduce greenhouse gas emissions and build resilience to climate change impacts will benefit and support all residents of the State of Vermont fairly and equitably. The term "Just Transitions" encompasses both public policy and business action that address the impacts of the transition away from greenhouse gas emissions for jobs and livelihoods (the transition "out") and the generation of low or zero greenhouse gas emission jobs and livelihoods of a sustainable society (the transition "in").

The Just Transitions Subcommittee intentionally formed as a collaborative and diverse group of Vermonters, representing voices of indigenous, black, people of color, youth, people with low incomes, New Americans, labor unions, rural Vermonters and more. **The Subcommittee promoted proactively centering equity in the work of the Climate Council, rather than reactively measuring it**. To support this goal, the subcommittee created the *Guiding Principles for a Just Transition*. The Guiding Principles provide a framework for the Council and subcommittees to use in evaluating, adjusting and prioritizing recommendations that are outlined in the Vermont Climate Action Plan. By providing a checkpoint to ensure active discussion of equity concerns, the Guiding Principles are especially useful in climate policy areas where equity has not traditionally been considered. It is critical to provide an equity lens to incorporate the perspectives of historically marginalized, disadvantaged and underserved communities that are otherwise overlooked or neglected.

Defining "equity" is important for this process. (1) ***Distributive equity*** recognizes disparities in the allocation of resources, health outcomes, the inequities in living conditions and lack of political power place frontline / impacted communities; (2) ***Procedural equity*** includes equitable planning and implementation that requires communities have a meaningful opportunity to participate; (3) ***Contextual equity*** ensures that mitigation and adaption strategies take into account that low-income communities, black communities, indigenous communities and people of color, and people with disabilities, amongst others, are often more vulnerable to climate change; (4) ***Corrective equity*** ensures that mitigation and adaption strategies provide communities with clear processes to hold the state accountable to its commitments to pursue equity.

Vermont's Impacted & Frontline Communities

The Guiding Principles point out the significance in Vermont's climate work of recognizing Vermont's Impacted and Frontline Communities, defining these communities as those who:

- Are highly exposed to climate risks, such as health impacts, flooding, and extreme temperatures;
- Experience oppression and racism, are excluded from opportunities, or have less resources to adapt to climate and economic change;
- Bear the brunt of pollution and negative effects from today's fossil fuel and extractive economies; and
- Are more likely to experience a job transition as Vermont addresses climate change.

Studies show that low-income communities, indigenous peoples, black, and other communities of color are among those who are particularly vulnerable to the impacts of climate change. In addition, as industry and jobs transition away from greenhouse gas emissions and towards "greener" jobs and livelihoods, particular focus must be given to the labor sector. Finally, some

Vermonters may also be necessarily focused on achieving immediate goals of food, shelter, safety and health, which can impact ability to focus on long-term adaptation to climate and economic changes. Recognition of the disproportionate impact of climate upon frontline communities is essential to evaluating the impact of the transitions toward a carbon-free economy, and to emphasizing the goals of adaptation and resilience strategies. Consequently, the Guiding Principles encourage consideration of impacted and frontline communities in the development of recommendations and prioritization of resources to address climate change.

Guiding Principles for a Just Transition

The Just Transitions Subcommittee designed six key principles to guide the recommendations of the Climate Council in development of the Climate Action Plan. These include:

VII. Ensuring *Inclusive, Transparent, and Innovative Engagement* in the development of the plan and associated policies and program.

VIII. Creating *Accountable and Restorative* recommendations that recognize inequality and seek to resolve them using clearly identified strategies.

IX. Moving at *The Speed of Trust* where candor and honesty are recognized as essential for public trust and preparing Vermonters for transition to a sustainable climate future.

X. Incorporating *Solidarity* to create inclusionary spaces for all traditions and cultures, particularly for Indigenous communities, recognizing them as integral to a healthy and vibrant Vermont.

XI. Prioritizing *The Most Impacted First* through recommendations that address the needs of impacted and frontline communities first, providing the greatest benefits of transitions to these communities.

XII. Developing *Supports for Workers, Families, and Communities* that consider and plan for potential impacts on workers, families and their communities based on the implementation of Vermont's Climate Action Plan

Self-Assessment and Scoring Rubric

The Guiding Principles also include a process for assessing "equity and justice" which includes an explicit reflection and analysis of:

- Impacted and Frontline Communities;
- Analyzing Burdens and Benefits;
- Ensuring Equitable and Just Engagement;
- Funding and Data;
- Implementation and Outcomes

Moreover, a scoring rubric was developed to accompany a narrative response for each of the Assessment Questions. Each recommendation put forth by a subcommittee is scored on how applicable it is to the criterion of each prompt. The criterion include: *Frontline/Impacted Communities; Analyzing Burdens And Benefits; Ensuring Equitable & Just Engagement; Funding & Data; Implementation & Questions; Which Groups Derive Direct Benefits*. This rubric was designed to be used in the recommendation prioritization process and supported identifying strategies and actions that require additional equity and justice considerations before being advanced to implementation.

The full Guiding Principles document, along with the rubric can be found in (INSERT APPENDIX).

Coordination of the Climate Action Plan and Comprehensive Energy Plan

The development of the Climate Action Plan (CAP) has coincided with the development of Vermont's Comprehensive Energy Plan (CEP)[91]. As described earlier, the CAP is an Action Plan for greenhouse gas mitigation, sequestration, and adaptation strategies in the face of climate change. The CEP is a mechanism to implement statutory energy policy[92] based on a comprehensive analysis of challenges and opportunities in Vermont. While the CAP and the CEP have considerable areas of overlap, they remain distinct planning requirements, with different objectives. While the CEP must be consistent with and a key component of meeting the State's GHG requirements, it is not a climate change plan nor a comprehensive look at Vermont's non-energy GHG emissions or climate adaptation needs.

The CEP reviews energy system planning in ways that are beyond the scope of the GWSA. For example, it focuses on planning for reliability of the electric system given the pathways necessary to meet our climate goals. In addition, it must include recommendations for regional and municipal energy planning. In turn, the CAP looks at the impacts of climate change beyond the scope of the CEP, addressing resiliency in the natural and built environment, adaptation, sequestration, and non-energy mitigation.

That said, and as described in this plan, energy consumption drives a large majority of Vermont's greenhouse gas emissions; it is important that the process for the CAP and CEP aligned. Thus, the Public Service Department in its role developing the CEP and the Agency of Natural Resources in its role managing the Climate Council have closely coordinated these two required plans. Notably, public engagement efforts have been aligned, so that targeted outreach to both Vermonters and technical experts was not duplicated (See Chapter X public engagement). In addition, modeling (See Appendix X Modeling) was initiated for purposes of the CEP but reviewed, modified and adopted for the CAP, ensuring there is one set of energy-related assumptions on which the two plans were based upon. State Agency staff have diligently worked on both the CAP and the CEP.

The CEP is required to be consistent with the requirements of the GWSA and the CAP. At the same time, the CAP is required to be informed by the CEP. These requirements to closely coordinate the efforts – even if the resulting actions are not necessarily identical, the basis on which they are formed was efficient and practical – allow for clearer consideration of the issues rather than a debate of the facts.

[91] 30 V.S.A. §202b requires the Vermont Department of Public Service to lead development of the CEP at least every 6 years; the CAP is required at least every 4 years.
[92] 30 V.S.A. §202a most directly. Goals and policy objectives are littered throughout statute.

Scientific Underpinning of the Climate Action Plan

To help ensure that Council deliberations and CAP drafting was guided by evidence and peer-reviewed science, while employing credible, consistent, and transparent methods of assessment and analysis for Vermont, the Council created the Science & Data Sub-committee (SDSC). Although not directed by statute, the Council wanted a specific, fifth subcommittee to serve as a resource for the other four statutorily defined sub-committees. The section that follows contains the recommendations of the SDSC, and includes recommendations from the Agriculture & Ecosystems subcommittee related to the Carbon Budget.

Social Cost of Carbon

The Science and Data Sub-committee (SDSC) oversaw the development and presentation of material on the method and assumptions for estimating the Social Cost of Carbon for the Vermont CAP, as well as a review of the Vermont Department of Public Service's "Cost of Carbon Reductions" spreadsheet model[93]. The Climate Council approved the recommended SCC, underscoring the need for the economic analysis of climate action plans and mitigation scenarios to account for the value of avoided emissions.

The Social Cost of Carbon is an estimate of the value of economic, environmental, and health damages associated with a unit (typically a metric tonne) of emissions.[94] The SDSC adopted the Social Cost of Carbon findings from the report completed for the Climate Council Titled "*Social Cost of Carbon and Cost of Carbon Model Review Analyses and Recommendations to Support Vermont's Climate Council and Climate Action Plan*"[95] and recommended a the use of a stream of values that can be used to estimate the avoided damages of emissions associated with greenhouse gas mitigation measures. Specifically, the SDSC recommended, and the Council agreed that Vermont should:

1) Value greenhouse gas emissions costs (and avoided costs) by utilizing a global damage-based estimation of the Social Cost of Carbon, based on models developed for the New York Department of Environmental Conservation (NYDEC) by Resources for the Future. [96]

2) Recognize that the estimation of the Social Cost of Carbon is highly dependent on how costs and savings that occur in the future are valued in the present, as represented in

[93] A full description of the model can be found as part of the Public Service Department's Annual Energy Report.
[94] The National Academy of Sciences defines the Social Cost of Carbon as "an estimate, in dollars, of the present discounted value of the future damage caused by a metric ton increase in carbon dioxide (CO2) emissions into the atmosphere in that year or, equivalently, the benefits of reducing CO2 emissions by the same amount in that year."
[95] Energy Futures Group, August 14, 2021 (Revised August 31, 2021) https://aoa.vermont.gov/sites/aoa/files/Boards/VCC/SCC%20and%20Cost%20of%20Carbon%208-31%20DH%20revised.pdf
[96] Greenhouse Gas Emissions other than CO2 can and should appropriately value the cost of greenhouse gas emissions or benefit associated with mitigation of those emissions. The Energy Futures Group report presents Social Cost of Methane and a Social Cost of Nitrous Oxide values. Other gases, until better information can be developed, can and should be converted to Carbon Equivalent emissions.

a "discount rate",[97] and that the NYDEC guidelines offer a range of possible discount rates that value future damages and cost of those. Based on literature review conducted in the report, polling of the Science and Data Subcommittee and meeting attendees, as well as discussion of the whole Council, the Council determined it is reasonable to utilize the Social Cost of Carbon developed using the central discount rate of 2%. Because the value of the Social Cost of Carbon is highly dependent on the assumption for a discount rate, it was agreed that sensitivities to the economic analysis using Social Cost of Carbon's developed using discount rates of 1%-3% should be completed, illustrating a range of possible economic outcomes associated with different valuations of future costs and benefits of mitigation measures.

3) Plan for updating of the Social Cost of Carbon and discount rate on a regular basis, taking into account new research that may be published that impact Social Cost of Carbon and application of the discount rate.

The resulting Social Cost of Carbon Dioxide (and range of outcomes), which will be utilized in estimating the economic impact of this Climate Action Plan and its mitigation scenarios is provided in Exhibit X, below. As the Exhibit shows, a higher discount rate represents a lower valuation of costs the future relative to the present, and thus the Social Cost of Carbon is lower, while a lower discount rate values the future more highly and results in a higher Social Cost of Carbon (which in turn improves the economic benefit/cost analysis for mitigation measures).

97 A discount rate is a method to place a present value on costs or benefits that will occur at a future date.

U.S Social Cost of Carbon Dioxide by Discount Rate, Adjusted for New York State (2020$ per metric ton of CO2)

	Recommended Range of Discount Rates			
Emissions Year	3% Average	2% Average (Central Rate)	1% Average	0% Average
2020	51	121	406	2,130
2021	52	123	409	2,125
2022	53	124	411	2,119
2023	54	126	414	2,114
2024	55	128	416	2,108
2025	56	129	418	2,103
2026	57	131	421	2,098
2027	59	132	423	2,093
2028	60	134	426	2,088
2029	61	136	428	2,083
2030	62	137	430	2,077
2031	63	139	433	2,072
2032	64	141	435	2,067
2033	65	142	437	2,061
2034	66	144	440	2,056
2035	67	146	442	2,050
2036	69	147	444	2,045
2037	70	149	446	2,040
2038	71	151	449	2,035
2039	72	152	451	2,030
2040	73	154	453	2,024
2041	74	156	456	2,020
2042	75	158	459	2,015
2043	77	160	461	2,011
2044	78	162	464	2,006
2045	79	164	467	2,002
2046	80	166	469	1,995
2047	81	167	471	1,989
2048	82	169	472	1,983
2049	84	170	474	1,976
2050	85	172	476	1,970

See DEC (2020) "Establishing a Value of Carbon"

Source: *Appendix: Value of Carbon,* New York Department of Environmental Conservation, revised June 2021. https://www.dec.ny.gov/docs/administration_pdf/vocapprev.pdf.

With regard to the review of the Public Service Department's "Cost of Carbon Reductions" tool, which presented an initial cost-effectiveness comparison between selected technologies and/or policies on the basis of dollar per ton of Carbon Dioxide, the Technical Consultants found that the model has value for understanding the relative cost-effectiveness for near-term investment provided by several technological measures, as it was intended to be. However, a number of improvements were recommended. In addition, a greenhouse gas mitigation technology/policy supply curve will be developed in conjunction with ongoing modeling. The SDSC recommended that no further action by the Council was necessary with regard to the specific Cost of Carbon model evaluated, but that Vermont:

1) Continue to maintain and update the accounting for mitigation pathways to promote transparency and consistency in assumptions. This could come in the format of the "Cost of Carbon" model that the Department of Public Service creates, or through other reasonable means.

2) Initially through technical consultant and to be updated regularly by the State of Vermont, create a greenhouse gas mitigation technology/policy supply curve that estimates the relative net cost of mitigation policies and/or technologies per ton of greenhouse gas emissions saved.

The full Technical Report that provides recommendations on both of these issues is available on the Council's website.

Greenhouse Gas Inventory Review and Supplemental Accounting

The Vermont Greenhouse Gas Emissions Inventory, conducted by the Vermont Department of Environmental Conservation (DEC) within the Agency of Natural Resources (ANR), is published annually as required by Vermont statute 10 V.S.A. § 582. The Inventory establishes historic 1990 and 2005 baseline greenhouse gas (GHG) levels and tracks changes in emissions through time. The Inventory is vitally important as the primary means of determining progress toward Global Warming Solutions Act (GWSA) emissions reduction requirements.

The Science and Data Sub-committee (SDSC) of the Council has been responsible for reviewing the Inventory, including the summary report conducted by technical consultant Energy Futures Group (EFG) titled, "Greenhouse Gas Inventory Review: Vermont's Current Methods, Comparison with Accepted Practices, and Recommendations". To ensure that we achieve our State requirements, it is important that our tracking methods continue to be as transparent, accurate, and comprehensive as possible, building on good work that has been done to date. In accordance with the recommendations in the EFG report, the Vermont Climate Council and State of Vermont should:

1) Maintain and continue to update and improve the current sector-based (or in-boundary) GHG Inventory methodology, for consistency and alignment with the Intergovernmental Panel on Climate Change (IPCC), Environmental Protection Agency (EPA), and peer states, as appropriate.
2) Continue to report on gross emissions (i.e., sources of emissions, for compliance with the GWSA), while also working to improve how we track and report net emissions, including emissions sinks, via a separate carbon budget.
3) Include supplemental information and sensitivity analyses as part of future published GHG in-boundary inventories. Specifically, this should include (but not be limited to):
    a. Biogenic greenhouse gases

b. Additional analysis of global warming potential of greenhouse gases, including but not limited to a 20-year Global Warming Potential[98] (GWP20) in addition to GWP100.
c. Latest IPCC Assessment Report (AR) values (i.e., AR5 and eventually AR6, not just AR4).

4) Maintain Renewable Energy Credit[99] (REC) accounting as the basis for calculating electricity sector emissions (i.e., emissions from our purchase and consumption of electricity and associated RECs, as tracked through the New England Power Pool Generation Information System (NEPOOL GIS) and not exclusively from electricity generated within our borders) for VT's GHG emissions inventory. We concur with the EFG recommendation to use the most accurate REC values available for the region, perhaps using the REC settlement information compiled by the Massachusetts Department of Environmental Conservation.
5) Adopt key category analysis[100] for future inventories.

While Vermont continues to update the GHG Inventory, supplemental accounting and further research and data gathering is also called for. Specifically, the Vermont Climate Council and State of Vermont should gather information to:

a. Allow for supplemental upstream and/or lifecycle accounting of emissions related to the use of energy in Vermont, including those emissions that occur outside the boundaries of the state, as called for in section 578(a) of the GWSA. Note: this should include emissions related to *all* energy use (including but not limited to fuels used for transportation and heating), not just electricity.
b. Better understand and remedy any methodological gaps of emission inventory tools currently used by the State of Vermont to quantify greenhouse gas emissions for evaluating changes in the agriculture and related land use sectors and the tools' alignment with the Intergovernmental Panel on Climate Change (IPCC), Environmental Protection Agency (EPA), and peer state methodologies and approaches.

Future upstream and/or lifecycle accounting is envisioned to stand alongside—but not replace—the current in-boundary GHG inventory. This new and supplemental accounting would function as a decision aid, helping to ensure that Vermont achieves a fuller understanding of the emissions

[98] Global Warming Potential (GWP) is "a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO_2)."For more, see: https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

[99] A Renewable Energy Credit (sometimes also called a Renewable Energy Certificate), or REC, as defined in Vermont statute refers to, "all of the environmental attributes associated with a single unit of energy generated by a renewable source."

[100] The Intergovernmental Panel on Climate Change (IPCC) defines a key category as, "a category that is prioritized within the…inventory system because its estimate has a significant influence on [the] total inventory of greenhouse gases in terms of the absolute level, the trend, or the uncertainty in emissions and removals." For more, see: https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_4_Ch4_MethodChoice.pdf

that Vermont can fairly be understood to be responsible for and options for reducing such emissions (even if they occur out of state).

A better understanding of the role that supplemental accounting for upstream and/or lifecycle emissions related to energy usage may play in future updates to the Climate Action Plan (CAP) will be necessary going forward. Possible improvements related to Agricultural sector emissions tracking, both on a gross basis for purposes of the GHG Inventory and on a net basis, for purposes of the carbon budget, will also be a focus going forward.

Pathways

Pathways Overview

Addressing the climate crisis requires immediate and sustained investment in reducing greenhouse gas emissions and improving landscape-level resilience—and this presents a transformational opportunity for Vermont. To realize these opportunities and address the objectives of the Global Warming Solutions Act, the Climate Council organized their recommendations in a Climate Action Plan around five areas of action: 1) emissions reductions; 2) building resilience and adaptation in Vermont's natural and working lands; 3) building resilience and adaptation in Vermont's communities and built environment; 4) enhancing carbon sequestration and storage; and 5) cross-cutting pathways.

The recommendations are further organized in the following sections into tiers of pathways, strategies, and actions – with increasing levels of detail. A pathway is a high-level means of achieving GHG emissions reductions or adaptation, resilience, and sequestration goals. While written broadly, pathways are specific enough so that Vermont can assess whether progress has been made in achieving them. Under each pathway, a suite of strategies has been developed. These strategies are a statement of measurable activity, a benchmark, to be reached in pursuit of the pathway. Finally, actions have been identified as the "operational" tasks that the state, regional organizations, municipalities, non-governmental organizations, and Vermonters will undertake to meet the pathways and strategies. Actions were developed around existing, as well as new, policies, programs, projects, initiatives, plans, etc. The actions have been prioritized using the foundational criteria defined earlier in the plan. All the actions included here are a priority for implementation.

Pathways for Emission Reductions

The Global Warming Solutions Act defines "mitigation" as the reduction of greenhouse gas emissions caused by humans, as well as the preservation and enhancement of natural systems to sequester and store carbon, in order to stabilize and reduce greenhouse gas emissions in the atmosphere. The pathways included in this Chapter, when implemented, will constitute a significant step in Vermont's efforts to reduce emissions of greenhouse gases, and build upon ongoing work to mitigate climate change.

The proposed pathways have been organized by the inventory sector in which the emissions occur (emissions totals and percentages are from the most recent inventory, based on 2018 data):

- *Transportation* (39.7% of total emissions, 3.43 $MMTCO_2e$)
- *Buildings*, including residential and commercial fuel use, and emissions from natural gas distribution (33.9% of total emissions, 2.93 $MMTCO_2e$)
- *Electricity* generation (2.1% of total emissions, 0.18 $MMTCO_2e$)
- *Agriculture* (15.8% of total emissions, 1.37 $MMTCO_2e$)
- *Other Non-energy emissions*, including Industrial Processes and Waste (8.5% of total emissions, 0.73 $MMTCO_2e$)[101]

Greenhouse gas emissions from the transportation sector have consistently been higher than any other sector. The state has implemented law and policy aimed at requiring manufacturers to deliver for sale cleaner vehicles to the market, and the legislature has authorized and funded programs to incentivize the purchase and use of these vehicles in Vermont, as well as expand and accelerate other transportation solutions the reduce reliance on the single occupancy vehicle. The success of these policies and programs in driving innovation in the automobile industry to produce cleaner technologies, coupled with the recent development of more robust state vehicle purchase incentives and investments in electric vehicle charging stations has yielded a slow but steady increase in electric vehicles in the Vermont fleet. As of January, 2021 there were 4,360 plug-in hybrid or battery electric vehicles registered in Vermont.[102] However, modeling shows that our current rate of EV adoption and number of EVs on the road is not nearly enough to achieve the reductions in this sector required by the GWSA. For example, we will need approximately 170,000 light-duty electric vehicles in the Vermont fleet to meet our 2030 reduction requirements. The pathways and strategies in this sector represent a robust set of rules, programs, and policies that will accelerate EV adoption through a variety of approaches aimed at sparking market innovation and transformation in vehicle manufacturing, coordinating emission reductions and investments at the regional level, designing more robust vehicle purchase incentives that mitigate the high up-front costs of electric vehicles, creating more transportation options and helping ensure these choices are accessible to all Vermonters, no matter their income.

An essential component of the pathways to reduce emissions from the transportation sector is a regional, market-based cap and invest program for transportation fuels. Vermont is a member of the Transportation and Climate Initiative, along with 13 Northeast and mid-Atlantic states, and

[101] The Vermont Greenhouse Gas Emissions Inventory Update and Forecast for 2018 has not been finalized as of the adopted date of the CAP. Emissions data is subject to change in the final Inventory for 2018.
[102] https://www.driveelectricvt.com/Media/Default/docs/maps/vt_ev_registration_trends.pdf

has worked within this group to develop the Transportation and Climate Initiative Program (TCI-P), which would cap emissions from transportation fuel in the region and invest funds from the sale of carbon allowances to reduce emissions via the policies and programs put forward as actions included in this CAP. As of the date of the adoption of this CAP, the future of the TCI-P is uncertain, and it is not immediately clear how Vermont's adoption of the action to participate in the TCI-P would be implemented without partnership from other states in the region. Absent this clarity, the Council remains committed to this approach as a realistic and cost-effective way to meet the emission reduction requirements in the GWSA, and includes in this plan the action to join TCI-P when a viable regional market exists. Therefore, the Council maintains that there is an immediate requirement for legislative action to authorize the generation and collection of auction revenue from the sale of allowances in a transportation fuel cap and invest program, whether its TCI-P or a comparable approach, and to determine of how revenue will be allocated in accordance with the CAP and to ensure Vermonters' transition to the clean transportation and energy future is equitable, just, and accessible to all. This action will ensure that Vermont is fully prepared to expeditiously adopt and implement this type of critical program, or TCI-P, should it be viable in the future. In the interim, the Council will continue to explore and identify actions that can be taken to mitigate the gap in emissions reductions that would have been realized by the implementation of TCI-P regionally and in Vermont. These actions will be incorporated into future amendments to this CAP, and will meet the goals and requirements of the GWSA.

Acceleration of electric vehicle adoption is a cost-effective, and necessary approach to achieving emission reductions. The pathways also recognize that the importance of reducing Vehicle Miles Traveled (VMT). More research and planning are required to understand and implement strategies to help Vermonters reduce the number of miles they travel annually in single occupancy vehicles. This research will need to be led by VTrans and coordinated with cross-cutting efforts, such as improving the understanding of how land-use planning affect emissions and the development of new or revised Smart Growth policies.

Many of Vermont's residential and commercial building spaces are poorly insulated and heated using carbon intense fossil fuels. Given the duration and intensity of Vermont's cold-weather seasons, it is not surprising then that this sector is the second highest emitter of greenhouse gases in Vermont. Most homes were built before 1975, with a significant portion older than 1939[103]. Pathways to reducing emissions in this sector are two-fold: improving thermal efficiency of Vermont's buildings through weatherization and related activities and switching heating sources to lower carbon alternatives. These pathways need to be closely coordinated to achieve maximum efficiency and to overcome the equity and cost challenges associated with the necessary approaches. This work also incorporates an opportunity to keep more energy dollars in-state by replacing fossil fuel use with electricity for heating needs while also employing an increased workforce of weatherization and home heating technicians. Progress made, however, must align with policies and programs that prioritize those who struggle with the costs associated with housing and energy use.

Greenhouse gas emissions from the electricity sector in Vermont have been variable over time, but have been declining in recent years due to the adoption and implementation of the Renewable Energy Standard (RES) and utility commitments. As a result, contributions of

[103] Vermont Housing Needs Assessment, Vermont Housing Finance Agency ("VHFA Housing Needs Assessment"), February 2020, p. 2.

greenhouse gas emissions from the electricity sector are currently low. However, because pathways used to reduce emissions from other sectors will rely significantly on electrification, it is important that the low emissions levels in this sector be maintained and improved upon, even as the overall electricity load increases. This must be done while also keeping Vermont's electric supply reliable and affordable. Increased reliance on electricity to meet transportation and building heating needs also means ensuring resilient and adapted electric infrastructure, by upgrading distribution and transmission infrastructure, increasing load management and coordination capabilities, upgrading homes and businesses to enable the transition to electric technologies, and making distributed energy resource programs and services widely and equitably available to all Vermonters.

While gross emissions from the agricultural sector in Vermont account for approximately 16% of greenhouse gas emissions in the state, many Vermont farmers have already elevated climate change mitigation as a goal in managing their agricultural enterprises. Emissions from agriculture are technically a non-energy source of emissions, however reduction pathways are discussed separately from the non-energy emissions sector for the purposes of this Plan. Pathways in this sector include improving management practices, such as no-till or cover cropping, to prevent emissions of carbon currently stored in soils into the atmosphere, while also increasing the sequestration of carbon from the atmosphere through land use and management decisions on farms. Maintaining and improving soil health as a climate change mitigation strategy also has numerous co-benefits, such as resilience to extreme weather events and improved water quality. In fact, there is an opportunity to leverage existing water quality programming and funding to implement emission-reducing management tools, making pathways in this sector uniquely cost-effective.

Pathways in the final sector, other non-energy related emissions, address work needed to reduce greenhouse gas emissions from industrial processes and management of solid waste and wastewater. This sector represents around 8% of total emissions statewide, but many of the greenhouse gases emitted are gases other than CO_2 that have high global warming potential (GWP) but are short-lived in the atmosphere. Because of the short atmospheric lifetimes of these gases, prioritizing emission reductions from this sector is important for near term impacts. Emissions reductions already made from the solid waste sector will further benefit from the continued implementation of Vermont's Universal Recycling Law, and therefore have not been prioritized in this Plan. Pathways related to the treatment of wastewater, the use of high GWP refrigerants, and semiconductor manufacturing are, however, ripe for emission reductions in this sector.

There is no single pathway or strategy that will ensure the necessary transitions required to drastically reduce our emissions. Action will be taken on multiple fronts to reach the required emission reductions in the GWSA. Most importantly, the policies, programs, and rules outlined in each of the following sectors represent a coordinated approach to mitigating greenhouse gas emissions, emphasizing approaches that are equitable and seek to ensure accessibility for all Vermonters.

Transportation Pathways for Mitigation

Transportation – the movement of people and goods – is essential to the state's economy and Vermonter's quality of life. The state's rural character and low population density also means that Vermonters depend primarily on cars and trucks to get them where they need to go. Vermont's auto-reliant system is fueled almost singularly[104] with carbon-intensive gasoline and diesel, making transportation the largest source of climate pollution – equating to a full 40% of the state's greenhouse gas emissions. [105] The combination of our mostly rural nature, dispersed land use patterns and heavy reliance on fossil-fueled vehicles is a significant reason why Vermonters emit more greenhouse gasses per capita than any other state in New England. [106] This reality makes transforming the state's transportation system essential to meeting the emissions reduction requirements of the Global Warming Solutions Act. At the same time, creating a clean, efficient, multi-modal system will also have economic, environmental, equity and public health benefits.

Vermont's reliance on liquid fossil fuels is a significant drain on our economy. Vermonters collectively spend over $1 billion on fossil fuels for transportation. Approximately 70% of those dollars leave the state's economy every year.[107] In contrast, electricity purchases keep far more dollars in Vermont. Over 60% of every dollar spent on electricity stays here. [108] Moving to more efficient, electric vehicles will keep more of the money we collectively spend on transportation in the state's economy and in Vermonters' pockets.[109]

Transportation represents a significant equity issue in Vermont as well. [110] Lower-income and rural Vermonters spend a far greater proportion of their incomes on transportation related costs than more urban and upper income Vermonters. Transportation costs – primarily ownership, operation and maintenance of a vehicle – equate to 45% of total energy expenditures for the average Vermont household. This reality places a disproportionate economic burden on lower income Vermonters. [111]

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[104] https://vtrans.vermont.gov/sites/aot/files/planning/documents/planning/The%20Vermont%20Transportation%20Energy%20Profile_2019_Final.pdf
[MJ2]https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

[105] https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

[106] Page 11: https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_and_Forecast_1990-2016.pdf

[107] https://www.eanvt.org/wp-content/uploads/2021/06/EAN-APR2020-21_finalJune2.pdf

[108] EAN 2021 Progress Report: https://www.eanvt.org/wp-content/uploads/2021/06/EAN-APR2020-21_finalJune2.pdf

[109] https://www.ucsusa.org/sites/default/files/2020-11/rural-transportation-opportunities_0.pdf

[110] https://publicservice.vermont.gov/sites/dps/files/documents/Pubs_Plans_Reports/Legislative_Reports/2021%20Annual%20Energy%20Report%20Final.pdf

[111] https://www.efficiencyvermont.com/Media/Default/docs/white-papers/2019%20Vermont%20Energy%20Burden%20Report.pdf

Whether or not the current system serves people equally is another important equity issue. Many older Vermonters, youth, people living with disabilities, and low income Vermonters cannot drive, thus limiting their ability to access jobs, services and community amenities This has long been true but also underscored in the COVID-19 pandemic, when many low-income, frontline workers continued to report in-person to work, often relying on costly, inefficient vehicles. Research has also found that "possession of a driver's license and a car was a stronger predictor of leaving public assistance than even a high school diploma," which speaks to the importance of vehicle access and ownership as an important justice issue.[112] Creating a flexible and multi-modal transportation system for those who cannot drive, is an important step to improving access for these Vermonters.

The economic disparities and equity issues embedded in rural Vermont's current transportation system also present opportunities. Equitably accelerating the adoption of more efficient, electric vehicles, and increasing access by expanding transportation choices and creating compact communities where Vermonters can afford to live will have multiple co-benefits. Those benefits can include significantly reducing the high energy burdens and attendant costs that Vermonters currently carry; ensuring Vermonters of all incomes levels and demographics can access more clean, affordable transportation options; and – individually and collectively – improving public health outcomes by reducing exposure to the air pollutants caused by the burning of gasoline and diesel and expanding active modes of transportation. [113]

Together, the strategies identified below will not only improve health outcomes, but set Vermont on a course to dramatically reduce transportation-related carbon pollution, expand access to clean transportation options, and more equitably shift to a cleaner, more efficient, multi-modal transportation system. This is a two-pronged approach to make both vehicles and the transportation system more efficient by:

1. Replacing carbon intensive fuels (gas and diesel) with zero emission or low carbon fuels such as electricity (noting that for medium to heavy duty vehicles in particular, there may be a limited but important role for biofuels or hydrogen, especially in the near term).
2. Making both the vehicles and the transportation system more efficient and accessible; creating options for Vermonters to drive less or use alternatives to the single occupancy vehicle to get where they need to go, while also exapnding options for those who cannot drive.

Electrification is a critical short-term priority. Electric vehicles are more energy efficient than gas powered vehicles – costing far less per mile than a gas-powered vehicle to own and operate over time.[114] For rural Vermont drivers, the economic benefits of an electric vehicle will also be significant. A recent study estimated that a typical rural driver can save approximately $1,500 every year by switching from a conventional gasoline car to a comparable electric vehicle, which is even more significant over the life of the vehicle [115]

[112] https://www.sierraclub.org/sites/www.sierraclub.org/files/sce-authors/u2196/Arrive%20Together%20Transportation%20Access%20and%20Equity%20in%20Wisconsin.pdf
[113] https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_CH_Transportation-Health.pdf
[114] https://www.eanvt.org/wp-content/uploads/2021/06/EAN-APR2020-21_finalJune2.pdf
[115] https://www.ucsusa.org/about/news/rural-communities-could-benefit-most-electric-vehicles

Avoiding car trips, reducing car trip lengths and replacing car trips with clean and energy efficient transit, biking and walking options, carpool and rideshare programs and other non-vehicular strategies have economic, equity and public health benefits – while also having the potential to be important pollution reduction measures to achieve the 2050 requirements. These "vehicle miles traveled" reductions rely on compact community settlements and smart growth. This will require short- and long-term investments in key community infrastructure and affordable housing to create places where people want and can afford to live. More research is required to quantify, measure and better reflect the greenhouse gas emissions benefits of "transportation demand management" strategies but their value is clear, particularly as it relates to accessing employment and improved health outcomes..

When it comes to public health, the pollution associated with transportation disproportionately impacts disadvantaged communities, thus having unequal public health consequences and burdens – especially in places where there are high levels of traffic and congestion. Decades of advances in automobile emission control technologies have helped mitigate this, but communities located in or near high traffic areas still experience increased health risks due to emissions exposure to nitrogen oxides, sulfur dioxide, carbon monoxide, fine particulates, volatile organic compounds and ground-level ozone. Exposure to these pollutants results in many health effects, including cardiovascular impairment and disease and increased risk of cancer. In addition, they also result in environmental impacts such as acid rain and reduced visibility.[116]

Transitioning to a cleaner and more accessible transportation system can have real public health benefits. A recent analysis by the American Lung Association found that residents in every region of the U.S. stand to benefit from the elimination of on-road traffic pollution and clean, renewable electric generation. It is estimated that, by 2050, a cleaner transportation system could net Vermont over $73 million in value from avoided premature deaths, asthma attacks and work days lost. [117]

The pathways and actions described below will help put Vermont on a path to significant climate progress, respond to the diverse needs and interests of Vermonters and achieve many co-benefits associated with their implementation. At a high level, the pathways include:

- Electrification of the light duty sector (autos, SUVs and light duty trucks) and the charging infrastructure to support an efficient, integrated electric vehicle network.
- Electrification and lowering the carbon intensity of fuels in the heavy duty sector (mid sized and heavy duty trucks and busses). This also includes the charging infrastructure to support the electrification of medium-to-heavy duty vehicles.
- Reduction of vehicle miles traveled through the creation and utilization of multi-model transportation options, such as transit, micro-transit, rural ride-hailing, passenger rail, biking, walking, car and ridesharing etc. This includes the enabling environment – and infrastructure – to support it, which requires compact community settlements. More research is required to quantify, measure and better reflect the greenhouse gas emissions benefits of "transportation demand management" strategies but their value is clear,

[116] https://www.ucsusa.org/sites/default/files/attach/2019/06/Inequitable-Exposure-to-Vehicle-Pollution-Northeast-Mid-Atlantic-Region.pdf
[117] https://www.lung.org/getmedia/99cc945c-47f2-4ba9-ba59-14c311ca332a/electric-vehicle-report.pdf

particularly as it relates to accessing employment and improved health and equity outcomes.

The transformation of our current transportation system will evolve over time and the process will be iterative, but it must happen swiftly to achieve Vermont's required greenhouse gas emissions reductions. This will also rely on continuing to better understand the realities facing Vermonters and, through that enhanced understanding, develop better public engagement strategies, programs and policies to reflect their diverse needs and interests. Success will also be incumbent upon helping Vermonters avoid prolonged reliance on fossil fuels, either through vehicle electrification or by creating new efficient models for rural transit. That means the vehicle point of sale, purchase or lease is a critical moment. Policies, programs and public engagement approaches should be designed to help people, communities and businesses avoid locking into high-emitting fossil fueled vehicles that will be on the road for a decade or more.

The partnership and participation of all Vermonters in this transformation is essential. We have a strong foundation today upon which to build to ensure we leave no one behind as we work towards the necessary reductions in greenhouse gas emissions; improve access to multi-modal transportation options; and leverage advances in technology in cost-effective, equitable ways.

Pathway 1: Light Duty Electrification

The emissions benefits of switching from fossil fueled to electric powered vehicles are clear. Battery Electric vehicles (EVs) and Plug-in Hybrid light duty electric vehicles are well beyond the research and development stage, they are being manufactured across the globe and available for sale today in Vermont. Their deployment and use is supported by the state's current regulatory framework, federal leadership and the manufacturers' commitments. Vehicle types that are more suitable for the Vermont climate and landscape, like light-duty trucks and all-wheel drive vehicles, are becoming more readily available. Electric vehicles are an attractive alternative because they provide a similar level of transportation convenience as conventional vehicles, with the caveat that public charging availability needs to continue to grow. While EVs often cost significantly less to own and maintain over the lifetime of the vehicles, purchase or lease incentives are an important tool to reduce the often higher upfront costs of EVs. Catalyzing the dramatic acceleration of EV deployment will require a re-evaluation and expansion of purchase incentives and similar mechanisms to facilitate widespread adoption, especially among low- and moderate-income families.

1. Market-Driving Technology Forcing Regulatory Programs

Vermont first adopted California's Motor Vehicles Emission Standards, now known as Advanced Clean Cars (ACC), in the early 2000s pursuant to its authority under Section 177 of the Clean Air Act. The requirements of ACC are imposed directly on vehicle manufacturers and have pushed the industry to innovate and implement new technologies to meet the requirements of the rules and growing public demand. As these regulations are updated to require higher volumes of lower and no emitting vehicles be delivered to participating states, Vermont should amend its own rules to ensure the most stringent standards, identical to California's program, will apply to Vermont. Adoption of ACC II in Vermont will contribute to a broader acceleration of EV manufacturing and deployment as more manufacturers are required to embrace vehicle electrification and innovation, thereby ensuring a diversity of vehicle choices are available to Vermonters. The sooner a more mature market develops and economies of scale are achieved,

the more of this vehicle technology and types of vehicles are available on the market, helping to lower the upfront costs to consumers of EV ownership.

High (and consensus medium) Priority Actions

Lead Implementer: Agency of Natural Resources		
a.	**Action Details**: Adopt California's Advanced Clean Cars II (ACC II) Regulations (amending Vermont's existing Low and Zero Emission Vehicle Regulations) beginning no later than Model Year 2026. ACC II includes, as proposed, a 100% ZEV sales requirement by 2035, more stringent criteria pollutant emissions standards, a robust vehicle durability standard, warranty provisions, battery state of health standardization, battery labeling, and availability of repair information to independent repair shops.	**Impact** CAP modeling makes clear that vehicle electrification is one of highest pollution-reduction measures required to achieve the GWSA targets. CAP modeling indicates that approximately 170,000 EVs will need to be deployed by 2030 in order to achieve the state's emissions reduction requirement. Amending Vermont's Low and Zero Emission Vehicle regulations will be the primary driver in delivering electric vehicles to dealerships in Vermont. This program will allow for a faster transition to electric vehicles through increased availability than what would have occurred without amendments to the current program.
		Equity Vehicle manufacturers may have the ability to earn credits towards compliance with ACC II by implementing equity-focused projects. Vermonters will benefit from a more mature market delivering at economies of scale.. Increasing the availability and overall number of EVs generally will also help significantly drive down the cost of EVs over time and accelerate and expand the used EV market in Vermont, enabling increased consumer access to EVs.
		Cost-Effectiveness Electrifying the light duty fleet will be a relatively cost-effective approach to reducing greenhouse gas emissions. The adoption of ACC II is a low-cost action and a critical component of electrifying the light-duty fleet in Vermont.
	Timeline to Implement: Rules adopted no later than December 31, 2022	**Co-Benefits** - Reduction in criteria air pollutants

		- Lower vehicle maintenance and fuel costs - Enhanced vehicle consumer protection measures
		Technical Feasibility Yes

2. Light Duty Electric Vehicle Purchase Incentives

Vermont launched a point-of-sale EV purchase incentive program in 2019, and authorization of funding in subsequent years has allowed the program to continue to date. The incentive is administered by Vermont Energy Investment Corporation's Drive Electric Vermont (DEV) program and helps to reduce the upfront costs associated with EV ownership. Additional evaluation of the current program and consumer data research will inform necessary amendments to the current program in the form of incentive amounts, income eligibility, application to commercial and municipal fleets, and used EV purchases. Expanded and continued funding for upfront purchase incentives – with an important focus on helping lower-income, overburdened Vermonters to participate – will be critical to equitably increase EV adoption to the levels necessary to meet Vermont's greenhouse gas reduction requirements.

High (and consensus medium) Priority Actions

Lead Implementer: Legislature, Agency of Transportation		
a.	**Action Details:** Expand and redesign Point of Sale Purchase Incentives for new and used Electric Vehicles and E-bikes. Specifically: determine the appropriate per vehicle incentive amount and dramatically increase number of incentives issued while cost-effectively driving uptake; apply incentives to used EV purchases, determine the dollar amounts and makeup of purchase incentive needed to achieve EV deployment and equity goals (if incentives are tiered, create income tiers instead of vehicle price tiers); expand eligibility for commercial and municipal fleet EV purchases. Create and pilot small-scale rural transit programs that utilize EVs. Legislative action to incentivize EV purchases should not be limited by other policies that disincentivize EV adoption. For example, road user fees for EV drivers should not be imposed until new annual registrations of EVs exceeds 15%, pursuant to the recommendation of the PUC in the 2019 Report on Promoting the Ownership and Use of Electric Vehicles in Vermont.[118] That said, a long-term sustainable	**Impact** CAP modeling indicates that approximately 170,000 EVs will need to be deployed by 2030 in order to achieve the state's emissions reduction requirements. Incentivizing EV purchases will be critical towards meeting EV deployment requirements to achieve emissions reductions. **Equity** The program will prioritize low and moderate-income families, as it does now. This goal and implementing program elements will be examined, adjusted and potentially increased as needed in the future to ensure broad, equitable access and participation. **Cost-Effectiveness** Modeling shows that electrifying the light duty fleet is a cost-effective approach to reducing greenhouse gas emissions. Additional investigation will be required during program redevelopment to help determine the incentive amounts necessary to drive EV adoption at the rates required. Even with relatively high incentive amounts per vehicle,

[118] "https://www.driveelectricvt.com/Media/Default/docs/Vermont_PUC_Electric_Vehicle_Report_June2019.pdf

	transportation system funding solution is required, as gas tax revenues diminish as more fuel-efficient and electric vehicles are deployed. The impending Agency of Transportation "Electric and Highly Fuel-Efficient Vehicle Road Usage Charge Study" should provide a basis for informing what that longer term funding solution could be.	those costs will be gradually recouped by consumers through lower fuel and maintenance costs over time.
	Timeline to Implement: Continue the current incentive funding authorized in the 2021 Transportation Bill (T-Bill), concurrently analyze its effectiveness, using consumer and other data to scale the program – and the income-tiered program benefits -- with consideration of the anticipated future need-based EV deployment and equity goals. Use this analysis to strategically expand investments in future T-Bills.	**Co-Benefits**: - Reduction in criteria air pollutants - Lower vehicle maintenance and fuel costs for consumers - Keeps significantly more dollars spent on vehicle fuel in-state - Improve access to cost-effective transportation for low-income families
		Technical Feasibility Yes
b.	**Action Details:** Continue to fund and expand Replace Your Ride, Mileage Smart, and micro-transit pilot programs in future state budgets and T-Bills. Amend program eligibility and parameters as data and analysis requires.	**Impact** CAP modeling indicates that approximately 170,000 EVs will need to be deployed by 2030 in order to achieve the state's emissions reduction requirements. Although these programs are not limited to battery electric vehicle deployment, they are a helpful tool in facilitating adoption of more fuel-efficient vehicles while also furthering equity goals.
		Equity These programs prioritize and/or limit eligibility to low-income individuals and families. These programs also improve access to more fuel-efficient vehicles for low-income families, helping to reduce household energy burdens.
		Cost-Effectiveness Electrifying the light duty fleet is a relatively cost-effective approach to reducing greenhouse gas emissions. Additional investigation will be required during program review to help determine the incentive amounts necessary to drive EV or fuel-efficient vehicle adoption at the rates required. Even with relatively

		high incentive amounts per vehicle, those costs will be gradually recouped by consumers through lower fuel and/or maintenance costs over time.
	Timeline to Implement: Immediately	**Co-Benefits** - Owning, operating and maintaining an EV costs less than a conventional vehicle and leads to savings on transportation, a significant household expense. - Air quality benefits associated with retirement of old vehicle (Replace Your Ride only) - Helps meet critical transportation needs of those in poverty (Mileage Smart)
		Technical Feasibility Yes
Lead Implementer: Legislature and the Vermont Department of Taxes		
c.	**Action Details:** Design and implement a vehicle efficiency price adjustment that's linked to the "purchase and use" tax for new vehicles within a vehicle class. The program will help incentivize the purchase of more efficient new vehicles (electric vehicles in particular) and disincentivize purchase of less efficient vehicles The program should be designed to mitigate potential impacts to low-income purchasers and business and commercial users who require certain vehicles and where no cost-effective, comparable electric or clean vehicle options are available. Program development should consider and weigh how it complements current EV purchase incentive programs so as to avoid duplicative or unnecessary incentives. This program should be revenue neutral and revenues should go exclusively to rebates within the program.	**Impact** CAP modeling indicates that approximately 170,000 EVs will need to be deployed by 2030 in order to achieve the state's emissions reduction requirements. Although this vehicle price adjustment program would not be exclusive to EVs, adding an additional price signal to further incentivize the purchase of high efficiency or electric vehicles would help to speed the transition to EVs and more fuel-efficient vehicles in Vermont.
		Equity The program is limited to new car purchases and can be designed to exempt certain income levels and purchasers who require a certain class of vehicle for business and commercial use for which there may be no cost-effective, comparable, available alternative. Also, higher income earning Vermonters are the primary purchasers of new vehicles. This program's singular focus on new vehicle purchases is intended to help address equity considerations. For Vermonters who require new vehicles for business use, it will be important to consider and

		potentially exempt any purchase for such purposes from the program.
		Cost-Effectiveness Electrifying the light duty fleet is a relatively cost-effective approach to reducing greenhouse gas emissions. Additional investigation will be required during program development to help determine the amounts necessary to drive EV adoption at the rates required and not unnecessarily compete or duplicate other programs, such as EV purchase incentives. Even with relatively high price adjustment amounts per vehicle, those costs will be gradually recouped by consumers through lower fuel and maintenance costs over time.
	Timeline to Implement: Upon adoption of purchase and use price adjustment.	**Co-Benefits** - Reduction in criteria air pollutants. - Lower vehicle maintenance and fuel costs for consumers. - Keeps dollars spent on fuel in-state.
		Technical Feasibility Yes

3. Public Investment in Electric Vehicle Supply Equipment (EVSE)

The Vermont Agency of Transportation has worked hard towards the goal of deploying a Level 3 (DCFC) charger within 30-miles of every Vermont resident, helping to lay an important foundation of EV infrastructure. However, there is much more to do to build an integrated, seamless system. A lack of availability of public charging remains recognized as a deterrent to consumers in making vehicle purchase choices. This is sometimes referred to as "range anxiety." While most charging occurs at home or at work, longer trips often require fast (DCFC) and reasonably priced charging adjacent to highway corridors and within walking distance of services – and those options need to increasingly be made available. Vermont is already leading the nation in its per-capita EVSE deployment efforts through the work of an existing inter-agency team but there is more to do to create a cohesive, strong, integrated charging network that serves both rural Vermont and Vermonters living in multi-family and more urban environments. State government's role in this effort should be to continue to lead EVSE deployment efforts, help municipalities, electric utilities, non-profits and the private sector determine the optimum location and type of EVSE, and financially support purchase and installation of EVSE until it becomes mainstream. In particular, expanding workplace, multi-family housing and rental unit charging and the infrastructure needed to support it (which often lack garages or parking adequate for at home charging) must also remain a significant priority. Efforts must include addressing these charging needs with the understanding that public/private partnerships and the role of the utilities in EVSE charging will complement and support greater deployment of and

benefits from expanding EVSE charging infrastructure across the state. Future discussions surrounding EV charging and rate design will also need to be informed by research and recommendations of the Electric and Highly Fuel-Efficient Vehicle Road Usage Charge Study, recognizing that transportation funding through gas tax revenues will decline as more drivers fuel their vehicles with electricity.

High (and consensus medium) Priority Actions

Lead Implementer: Legislature; Interagency EVSE Working Group (ACCD, VTrans, ANR, VDH, PSD)		
a.	**Action Details:** Continue to fund and support build-out of DCFC and Level 2 EVSE based on the EVSE Deployment Plan under development by Drive Electric Vermont pursuant to the Agency of Transportation's Multipronged Vehicle Electrification Strategy and continue to coordinate regional efforts. Incorporate prioritization of multi-family and workplace charging and associated infrastructure availability into programs to be guided by equity principles and environmental justice mapping tools. Current funding includes VW Environmental Mitigation Trust and other funding available in the 2021 Transportation Bill. Available federal funding may be used as well as potential TCI-P revenue.	**Impact** CAP modeling indicates that approximately 170,000 EVs will need to be deployed by 2030 in order to achieve the state's emissions reduction requirements. Charging infrastructure is a critical component in enabling EV adoption to increase consumer confidence and to reduce range anxiety. Dramatic increases in EV adoption rates will require significant additional buildout of public and workplace charging to enable the transition to electric vehicles.
		Equity The state will work with local public and private partners to improve EVSE accessibility for multi-family properties, rental property dwellers, and Vermonters living in rural areas.
		Cost-Effectiveness Electrifying the light duty fleet is a relatively cost-effective approach to reducing greenhouse gas emissions. Deployment of EVSE is a critical component of achieving these cost-effective reductions and installation of additional EVSE is a critical enabling factor in advancing electrification of the light-duty vehicle fleet.

	Timeline to Implement: Immediately.	**Co-Benefits** - Cost of charging will be kept low through focus on home charging, especially multi-unit dwelling properties. - Day time employee charging may be beneficial to electric load management. - Enabling action for light-duty fleet electrification and associated air pollutant and health benefits. - Utility load control benefits to balance and benefit the grid and ratepayers.
		Technical Feasibility Yes
Lead Implementer: Legislature; Public Utilities Commission		
a.	**Action Details:** Direct the PUC to consider and develop beneficial EV charging rates to incentivize EV adoption through lower fuel costs. Additional investigation and coordination with utilities is needed to inform the rate design and to ensure that the rate promotes and enables managed charging and the benefits a flexible EV load can bring to the grid. Discussion with utilities is also critical to inform the details of the rate itself and to incorporate lessons learned from existing EV specific rates. Further investigation into alternative demand charge designs for low utilization charging locations is necessary to help mitigate the barrier presented by demand charges to DCFC installations in low utilization rural areas for the near future.	**Impact** Implementing beneficial EV charging rates would be another financial incentive to help spur EV adoption. Setting EV specific charging rates that are lower than normal residential rates and based upon shared savings to incentivize EV adoption through even lower vehicle fuel costs as well as promote the ability of utilities to manage EV charging to lower the cost for all ratepayers. The flexibility that managed EV charging allows provides grid benefits that positively impact Vermont ratepayers.
		Equity EV specific charging rates would be available to all Vermonters and, if based upon shared savings for load control, lower costs for all customers. Having this additional financial incentive to help reduce overall vehicle costs for the consumer would be another factor to help overcome the currently higher upfront cost of EVs and allow for greater access to the EV market for everyone.
		Cost-Effectiveness Adoption of a beneficial EV rate design would be

		another, and more enduring, financial incentive that would help to increase EV adoption and through shared savings and load control help achieve cost savings for participants and all ratepayers.
	Timeline to Implement: Upon issuance of PUC order.	**Co-Benefits** - Promotes managed EV charging which provides load flexibility that benefits all Vermont ratepayers. - Vehicle electrification reduces emissions of criteria air pollutants which has associated health benefits.
		Technical Feasibility Yes

4. Join the Transportation and Climate Initiative Program (TCI-P) when regional market viability exists

For over a decade, Vermont has been a member of the Transportation and Climate Initiative, a regional collaboration of 13 Northeast and Mid-Atlantic states and the District of Columbia that seeks to improve the transportation system, develop the clean energy economy and equitably reduce carbon emissions from the transportation sector. The TCI jurisdictions are: Connecticut, Delaware, the District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, Vermont, and Virginia. In December 2020, Massachusetts, Connecticut, Rhode Island, and the District of Columbia announced that they will be the first jurisdictions to launch the Transportation & Climate Initiative Program (TCI-P), a multi-state cap and invest, market-based program that reduces air pollution while investing $300 million per year in cleaner transportation choices and healthier communities. It is important to note that the TCI-Program (TCI-P) is different than the Transportation and Climate Initiative (TCI). The TCI-P is the program which resulted from the 10+ year collaboration among the 13 Northeast and Mid-Atlantic states and would be the mechanism that would – through the cap – reduce approximately 26% of transportation climate pollution across participating jurisdictions by 2032 and raise approximately $20 million in annual revenue for Vermont. Vermont's participation in TCI-P – critically, paired with a complementary legislative policy action to drive strategic investments, foster a more equitable process and ensure greater equity outcomes – is an important tool to reduce transportation emissions and raise needed revenues to investment in actions detailed in this Light-Duty Vehicle Electrification Pathway. As of the date of the adoption of this CAP, the regional implementation timeline of the TCI-P remains uncertain. This action, however, remains in the CAP as it represents a critical component of the transportation emission reduction strategy. Vermont should "remain at the table" in continuing to find a path forward for implementation and participation in TCI-P. When a viable regional market exists, Vermont will be ready to act swiftly and join TCI-P as a participating jurisdiction. At the same time, the Council is expanding the action included in this strategy to recognize additional parallel work required to pursue a

comparable cap and invest program for transportation fuels, both in Vermont and regionally, or other policies or programs that reduce emissions and drive similar outcomes as anticipated in participation in TCI-P. In order to allow timely and efficient implementation of this action, the legislature should enact 1) law that gives ANR the authority to collect revenue generated from the sale of allowances used towards compliance in a cap and invest program for transportation fuels, and 2) establishes a process, policies and criteria that guide the allocation of the aforementioned revenue consistent with the equity principles and actions adopted in the CAP. Federal infrastructure funds will soon become available to states for clean transportation investments. Rather than reducing the need for TCI-P or a comparable program, this federal spending will make TCI-P even more critical as a source of state or local matching funds (typically a 20% match) for federal grant programs available through the Infrastructure Investment & Jobs Act (November 2021) and potentially under the Build Back Better Act should it be passed by Congress and signed into law.

High (and consensus medium) Priority Actions

Lead Implementer: Agency of Natural Resources; Legislature		
a.	**Action Details:** Vermont joins TCI-P when regional market viability exists as a participating jurisdiction through adoption of the TCI-P Model Rule. Regulated entities (Fuel suppliers) will need to purchase and surrender CO2 allowances equal to the amount of fuel that they deliver for sale in Vermont. Allowances will be purchased at auction and Vermont will have agency over how auction proceeds are spent, investing in actions that prioritize and benefit disadvantaged communities and reduce emissions. Other policies and programs to meet required reductions in the transportation sector will be evaluated parallel to TCI-P and adopted as and if needed, such as a comparable transportation cap and invest program, a clean transportation standard or expanded vehicle efficiency price adjuster. The Legislature gives ANR authority to generate revenue via the allowance actions of a transportation fuel cap and invest program, and enacts a complementary policy that goes further to ensure equity outcomes (establish an expanded equity board, direct a minimum/significant investment in low income, rural, overburdened and underserved communities, e.g. 50%) and have funds go to transportation related or efficient	**Impact** TCI-P is an umbrella program, the proceeds of which will fund the actions in this Pathway and others in the CAP. **Equity** The TCI-P MOU requires a 35 percent minimum investment in low income, overburdened communities and the creation of an Equity Advisory Body. To go further to ensure better process and equity outcomes, there is also a bill being drafted for introduction in the 2022 legislative session that will require a yearly review by a broad stakeholder group and substantially more TCI-P revenues directed to low income, rural, historically disadvantaged communities. **Cost-Effectiveness** Revenue from TCI-P can be used to implement the actions outlined in this Pathway. Electrifying the fleet is a relatively cost-effective approach to reducing greenhouse gas emissions.

	transportation enabling investments. Consider a firewalled fund.	
	Timeline to Implement: Immediately.	**Co-Benefits** - Emissions reductions achieved through a coordinated regional approach. - Incentivizes regulated entities to lower carbon intensity of fuel delivered for sale. - Improving public health outcomes.
		Technical Feasibility Yes

5. Educate drivers on benefits of electrification and other transportation options to reduce vehicle miles traveled (VMT)

A critical component of the transition to electric vehicles is to implement timely and targeted education about not only the environmental and public health benefits of driving an electric vehicle, but the difference in maintenance and fueling requirements, charging infrastructure utilization (at home and publicly accessible), cost savings, and how to reduce the need to use single-occupancy transportation options. Incorporating this information and training into student driver education courses, and making training available to already licensed drivers, will help drivers be more confident and prepared in their choice to purchase and drive an EV. This component to initial and ongoing driver education and outreach efforts would be complimentary and would not be included in testing required to obtain vehicle operating licenses or other credentials associated with operation of motor vehicles.

High (and consensus medium) Priority Actions

Lead Implementer: Agency of Natural Resources, Agency of Education, Legislature		
a.	**Action Details:** Fund implementation and further enhancement of a complimentary unit within Vermont's driver education curriculum to educate student drivers about electric and high efficiency transportation options, as well as how to reduce VMT via use of other transportation options, as well as increase funding for EV education and buyer assistance support currently being offered by Drive Electric Vermont.	**Impact** CAP modeling indicates that approximately 170,000 EVs will need to be deployed by 2030 in order to achieve the state's emissions reduction requirement for 2030. Adequate and effective new and existing driver education will lead to increased uptake in EV deployment necessary to reduce emissions.
		Equity Education opportunities will be made available at no cost and will be integrated into existing driver education requirements for ease of access. EV education, information and buyer assistance support – including via Drive Electric Vermont or otherwise – will be translated to ensure non-English speakers can access the information.
		Cost-Effectiveness Because many education opportunities for driver training are already being deployed, an EV component of the existing curriculum could be added with minimal costs. The

		Drive Electric Vermont infrastructure and network also offers a solid foundation upon which to build.
	Timeline to Implement: Immediately.	**Co-Benefits** - Reduction in criteria air pollutants. - Lower vehicle maintenance and fuel costs for consumers. - Keeps dollars spent on fuel in-state.
		Technical Feasibility Yes

Pathway 2: Heavy Duty Electrification

Medium and heavy-duty trucks and buses contribute 14%of transportation emissions in Vermont. Reducing diesel emissions, such as particulate matter and nitrogen oxides has known health benefits. Medium and heavy-duty vehicle technology has been deployed internationally, and while there are challenges associated with replacing diesel power with electric, certain applications are being further developed and implemented. The purchase price of these vehicle types remains high compared to the upfront cost of conventional vehicles. Vermont has funded and implemented medium and heavy-duty electric vehicle pilot programs, including school and transit bus deployments and upcoming deployments of electric waste haulers, electric utility vehicles, and delivery vehicles. Vermont works closely with other states to coordinate a regional and national approach to deployment of medium and heavy-duty electric vehicles, as well as efforts to address excessive idling, research and development, and investigation of less carbon intensive and renewable fuels such biofuels. Note that this pathway includes not only deployment of electric vehicle technology, but also the development and future deployment of hydrogen fuel-cell vehicle technology, which is viewed as another fuel-switching pathway for medium and heavy-duty vehicles.

1. Market Driving, Technology-Forcing Regulatory Programs

Vermont's regulation of emissions from medium and heavy-duty vehicles has been limited compared to the regulation of light-duty vehicle emissions. Recent proposals and newly adopted regulatory programs from California have presented an opportunity to continue our coordination with other states to reduce emissions from medium and heavy-duty vehicles. The rules outlined below encompass a comprehensive rule package to reduce greenhouse gas emissions through electrification and cleaner engine standards and increase efficiency and engineering of medium to heavy duty trucks to cause lower emissions of greenhouse gases and traditional air pollutants. The state should pursue available funding and use to mitigate the high upfront costs of medium and heavy-duty electric vehicles and hydrogen fuel-cell technology development.

High (and consensus medium) Priority Actions

Lead Implementer: Agency of Natural Resources		
a.	**Action Details:** Adopt California Air Resources Board Advanced Clean Trucks Rule (an increasing percent ZEV sales requirement for manufacturers), Low NOx Omnibus Rule (includes a more stringent NOx emission standard and	**Impact** CAP modeling indicates that approximately 50,000 medium and heavy-duty EVs will need to be deployed by 2030 in order to achieve the state's emissions reduction requirement for 2030.
		Equity Reductions in these emissions through electrification would benefit communities that are disproportionately impacted by poor air quality related to transportation emissions.

	lengthened useful life and warranty), and Phase II GHG Rule for Truck Trailers beginning no later than Model Year 2025. Fund incentives for medium and heavy-duty electric fleet purchases.	**Cost-Effectiveness** This is a technology forcing regulation, and therefore the costs of compliance directly impacts manufacturers of MHD vehicles. Also, because manufacturers do not receive compliance credit for a vehicle until it is placed in service, manufacturers will need to support dealers and fleets in Vermont to make purchase and operation of these vehicles feasible in order to meet their compliance obligation.
	Timeline to Implement Immediately.	**Co-Benefits** - Reduction in criteria air pollutants. - Lower vehicle maintenance and fuel costs for owners and operators. - Keeps more dollars spent on fuel in-state.
		Technical Feasibility Yes

2. Electrify medium and heavy-duty vehicle auxiliary systems

Many medium and heavy-duty vehicles in Vermont are equipped with auxiliary systems that run off of the combustion engine power, and therefore increase the vehicle's emissions when they are in operation. While fully electric options for some of these specialty vehicles are becoming available on the market, retrofitting existing vehicles that still have a long remaining useful life to electric auxiliary systems will be an important step towards meeting our emissions reduction requirements in the short term and while the medium and heavy-duty electrification transformation takes place.

High (and consensus medium) Priority Actions

Lead Implementer: Legislature, Agency of Natural Resources		
a.	**Action Details** Fund programs that incentivize electric auxiliary systems, such as (but not limited to) hybrid-electric bucket trucks and electric transport refrigeration units and programs that incentivize installation of electrified parking spaces in truck loading/unloading zones.	**Impact** CAP modeling indicates that approximately 50,000 medium and heavy-duty EVs will need to be deployed by 2030 in order to achieve the state's emissions reduction requirements. Electrifying vehicle auxiliary systems can be a bridge towards electrification while conventional vehicles are still being used, but with electric auxiliary power.
		Equity Reductions in these emissions through electrification would benefit communities that are disproportionately impacted by poor air quality.
		Cost-Effectiveness While the upfront cost of fully electric medium and heavy-duty vehicles will be a barrier to early adoption, mitigating emissions from auxiliary power systems can be a cost-effective way to achieve emissions reductions while the transition to fully electric vehicles in this sector occurs.
	Timeline to Implement Immediately.	**Co-Benefits** - Reduction in criteria air pollutants

		- Lower vehicle maintenance and fuel costs for owners/operators - Keeps dollars spent on fuel in-state
		Technical Feasibility Yes

3. Join the Transportation and Climate Initiative Program (TCI-P) when regional market viability exists

For a detailed description of this Strategy, please see Pathway 1: Light Duty Electrification, Strategy (4), above. Vermont's participation in TCI-P or a comparable program -- critically, paired with a complementary policy to drive strategic investments, foster a more equitable process and ensure greater equity outcomes – is an important tool to reduce transportation emissions and raise needed revenues to investment in actions detailed in this Heavy-Duty Vehicle Electrification Pathway.

High (and consensus medium) Priority Actions

Lead Implementer: Agency of Natural Resources; Legislature		
a.	**Action Details:** See Action Details in Pathway 1, Strategy 4.	**Impact** See Impacts from Pathway 1, Strategy 4.
		Equity See Equity from Pathway 1, Strategy 4.
		Cost-Effectiveness See Cost-effectiveness from Pathway 1, Strategy 4.
	Timeline to Implement: Immediately.	**Co-Benefits** - See Co-benefits from Pathway 1, Strategy 4.
		Technical Feasibility Yes

Pathway 3 Reduction in Vehicle Miles Traveled (VMT)

While the quantitative emissions reductions benefits of reducing VMT requires additional modeling, it can be assumed that reducing the number and length of car trips is possible by growing state and local investment in transit, micro-transit, rail, bike and pedestrian infrastructure, and other transportation services beyond the single occupancy vehicle will have a beneficial impact on emissions. These transportation modes also have known public health, equity and other co-benefits. Increasing the use of these modes is contingent on several factors including service that mimics the convenience of driving, and is safe, reliable, and feasible for users who cannot drive, including people living with a disability. Use of these modes tends to be most feasible in urban and village areas where the land use density is adequate and is less feasible in dispersed rural contexts. Long term reduction of transportation emissions is also contingent on the commitment at the local, regional and state levels of supporting the state's smart growth land use goals through infrastructure investment.

1. Increase state, regional and local capacity to plan for VMT reduction and implement sustainable transportation strategies.

High (and consensus medium) Priority Actions

Lead Implementer: Legislature, Vermont Agency of Transportation, regional and local partners		
a.	**Action Details**: Require VTrans to create a S*tate Sustainable Transportation Implementation Plan*, including: • The GHG reduction cost effectiveness of Smart Growth strategies which could reduce VMT in the Vermont context and how that compares to other GHG reduction strategies which Vermont could deploy. • Understanding and quantifying the effect of Smart Growth on VMT in Vermont • Establishing of State VMT targets • The level of investment across modes needed to contribute towards long & short-term emissions, equity and other goals. This could include funding to grow existing programs & increase availability and use of transit, micro-transit and other transportation choices. • Continuing to fund and provide technical assistance to RPCs and municipalities through the Transportation Planning Initiative. In addition to the current program's priorities, transportation sustainability will be incorporated as a goal within Regional Transportation Plans and Municipal Plans and in order for evaluation and inclusion of affordable and effective methos of reducing GHG emissions from transportation such as expanding transit service, building bike and pedestrian facilities, locating EV charging equipment and more. The *State Plan* shall evaluate and incorporate if founds to be feasible, affordable, and effective at reducing GHG emissions: - Free fares for users of public transit. Encourage Public Transit Provider Boards of Directors to continue to offer fare-free transit to all public transit users following the conclusion of the	**Impact VMT** The state currently lacks information regarding how land use affects transportation emissions and the transportation investment necessary to reduce emissions by shortening trips, reducing single occupancy vehicle trips and increasing transit options and other services, and the associated infrastructure. More research and better metrics will be required. It is possible and the State should seek to quantify, measure and adjust programs and policies to realize potentially essential pollution reduction benefits needed to achieve 2050 emissions reduction requirements. **Equity** Transit and other services and modes that replace vehicle trips are essential to the those that can't afford to own or operate a vehicle. **Cost-Effectiveness** VMT reduction measures are relatively cost-ineffective compared to other transportation emission reduction pathways in contrast to vehicle electrification, but the long-term growth of non-single occupancy vehicle transportation and the associated land use patterns will result in numerous economic, social and environmental benefits and potentially significant essential pollution reduction benefits over time.

	SFY22 fare free programming funded by the Legislature. - A multi-year plan to increase the availability and use of transit and micro-transit, based on industry recommended deployment standards for route deployment, to achieve a more robust, integrated public transportation system following the conclusion of the SFY22 fare free programming funded by the Legislature. - Expanding and improving Amtrak/rail and inter-city bus service - Actions to enhance the delivery of the State's Complete Streets legislation, maintain and expand transportation trails, and continue to advance the implementation of the 2021 Bicycle & Pedestrian Strategic Plan and other bike/ped funding programs.	
	Timeline to Implement: Immediately	**Co-Benefits** • Increased equity in transportation options. • Improved public health outcomes from active transportation. • Air quality and other environmental benefits
		Technical Feasibility Yes

Pathway 4 Lower the carbon intensity of fuels

While Vermont is working to electrify vehicles to achieve emission reduction requirements, combustion vehicles and equipment, especially in the heavy-duty vehicle sector, will remain on and off Vermont roads for years to come. Production and deployment of combustion vehicles is likely to continue until at least 2035 for the light duty sector and may continue for additional years for heavy duty vehicles and equipment. Many heavy-duty vehicles have long “useful” lives, meaning they could continue to be operated for decades after electrification options are available and feasible. Therefore, increasing efficiency of combustion vehicles and equipment, and lowering the carbon intensity of the fuels that these vehicles use, remains a critical component of the State’s near-term strategy to reduce emissions in the transportation sector. Lower carbon fuels, like biodiesel, could play an important role, especially in the near-term, to reduce emissions from combustion vehicle use while developments and additional deployments of medium to heavy duty electric vehicles are made.

1. Join the Transportation and Climate Initiative Program when regional market viability exists

For a detailed description of this Strategy, please see Pathway 1: Light Duty Electrification, Strategy (4), above. TCI-P requires fuel suppliers that deliver gasoline and diesel fuel for final sale in Vermont to purchase carbon allowances available for sale at auction and surrender those credits equal to the emissions from the fuel delivered for sale. The number of allowances available for sale on the regional market is capped, and reduced over time, to achieve regional emission reductions. One way for a fuel supplier to reduce their compliance obligation is to supply lower carbon intense fuels for sale in participating jurisdictions.

High (and consensus medium) Priority Actions

Lead Implementer: Agency of Natural Resources; Legislature		
a.	**Action Details:** See Action Details for Pathway 1, Strategy 4.	**Impact** See Impacts details for Pathway 1, Strategy 4.
		Equity See Equity details for Pathway 1, Strategy 4.
		Cost-Effectiveness See Cost-effectiveness for Pathway 1, Strategy 4.
	Timeline to Implement: Immediately.	**Co-Benefits** - See Co-benefits for Pathway 1, Strategy 4.
		Technical Feasibility Yes

Buildings & Thermal Pathways for Mitigation

Vermont's buildings pose both a challenge and opportunity to equitably meeting Global Warming Solutions Act (GWSA) emission reduction goals. The state's housing stock is dominated by homes built before 1975, with over a quarter of them built before 1939.[119] Thermal energy use for these buildings produces over a third of the state's GHG emissions and represents roughly 35 percent of our energy expenditures.[120] Commercial and industrial buildings produced nearly 14% of the state's GHG emissions in 2017.[121] Importing fuel to heat our buildings is a significant drain on Vermont's economy. It also exposes Vermont families and businesses to substantial global fuel-price volatility, and disproportionately burdens lower-income Vermonters with energy related expenses.[122]

Replacing carbon intensive fossil fueled heating sources with available, lower carbon alternatives will significantly mitigate these challenges and contribute to Vermont meeting its climate goals. It will also stimulate Vermont's economy because more of the money Vermonters spend on heating will stay in state. According to the Energy Information Administration (EIA), in 2018, Vermont spent over $769 million on fossil fuels for heating. The Vermont Agency of Commerce and Community Development reports that 63% of those expenditures left the Vermont economy entirely.[123] By spending energy dollars on relatively lower carbon-intensive electricity and wood, a greater share of that money will stay in-state, help employ Vermonters, and strengthen our economy.[124]

In addition to increasing reliance on fuels with a lower carbon intensity, improving the efficiency of Vermont's buildings will help reduce the heating demands facing Vermonters. Thermal modernization of our buildings to reduce GHG emissions and doing so in a way that recognizes the economic challenges faced by the most vulnerable Vermonters in keeping homes, businesses, and other buildings heated and comfortable is essential. With a focus on the most burdened households and businesses, Vermont can begin to address its climate challenges and pair up clean fuels options and weatherization programs to deliver comprehensive low-carbon building solutions.

Ability to Pay – Burdened Vermonters

Taking these steps can be expected to benefit the Vermont economy broadly but must also be designed to minimize adverse effects on low-income households, especially Vermonters most burdened by energy and housing-related costs. The expressions "energy burden" and "housing burden" describe the percent of household income that one spends on energy or on housing.[125]

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[119] Vermont Housing Needs Assessment, Vermont Housing Finance Agency ("VHFA Housing Needs Assessment"), February 2020, p. 2.

[120] Energy Action Network "Annual Progress Report for Vermont ANNUAL 2020/2021," p. 24 (EAN 2021); see also, https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

[121] "Vermont Greenhouse Gas Emissions Inventory and Forecast 1990-2017" May 2021

[122] Energy Action Network Clean Heat Working Group. October 2021. Review Draft "Clean Heat for a Cooler Planet: The Clean Heat Standard"

[123] See Section 4 Energy and Economy

[124] For wood heat, an average of 80 cents per dollar stays in state. EAN 2021, p. 25

[125] "What is the impact of energy burden in Vermont?" ("Energy Burden in Vermont") Rebecca Foster, Director Efficiency Vermont October 13, 2019.

While a central goal of the GWSA is to reduce GHG emissions, it will be critical to understand the effects of various GHG reduction policies on all Vermonters, especially those who struggle with the costs associated with housing and energy use.

Efficiency Vermont has studied energy burden in the state and determined that, on average, Vermonters spend about 10 percent of their income, or roughly $5,800 annually, on *energy* expenses. However, the actual energy burden that Vermonters face ranges statewide from 6% to as much as 20%.[126]

When one considers the cost of housing and energy, Vermonters face an even greater challenge. According to the Vermont Housing Finance Agency (VHFA), over 35% of all Vermont households (90,000) in the state are "cost-burdened" by their *housing* costs, meaning that either rent or mortgage, insurance, taxes and utilities consume at least 30% of their income.[127] Furthermore, of these cost-burdened Vermont households, over a third (39,000) spend in excess of 50% of their income for housing.[128]

Renters

Of Vermont's roughly 330,000 homes, about a quarter of them (80,000) are used or intended for renters.[129] Chittenden County has the highest rate (36%) of rental housing in the state. While the median construction year for owned homes in Vermont is the mid-1970s, median construction year for Vermont rental housing is significantly older, 1964.

In addition to the number of relatively old rental properties, a large portion of the Vermonters who rent, roughly 80%, are categorized as low-income, according to Efficiency Vermont and VHFA.[130] One quarter of all Vermont's renters pay between 30-49% of their income for housing, and another quarter pays 50% or more of their income for housing, i.e., rent and the cost of utilities.

Given the quality of buildings, the cost of fuels, and the number and income status of Vermonters who rent, it is critical that GWSA buildings and thermal policies incorporate social equity into all recommendations. These solutions will need to minimize adverse effects on low-income households and those most burdened by high energy bills.

Vermont has decades of experience developing policies and designing and implementing weatherization, energy efficiency, and clean energy initiatives that reduce energy use in buildings throughout the State – including residential, commercial, and industrial buildings of all sizes and types. Substantial work has been done (and is ongoing), including:

- Developing and periodically updating building energy codes
- Explaining the importance of code enforcement and seeking to ensure codes are being enforced

[126] Ibid
[127] VHFA Housing Needs Assessment, p. 2
[128] U.S. Census Bureau 2017 American Community Survey 5-year estimates from housingdata.org
[129] VHFA Housing Needs Assessment, p. 1
[130] "Vermont Energy Burden Report," Justine Sears and Kelly Lucci, October 2019; Vermont Housing Finance Agency. https://www.housingdata.org/profile/rental-housing-costs/renter-cost-burden

- Training architects, engineers, and builders on energy-efficient new construction and renovation practices
- Benchmarking buildings to increase awareness of building performance
- Including training on the economic and comfort advantages of energy efficient buildings in realtor training
- Offering weatherization, energy efficiency, and clean energy rebates, incentives, and services through Efficiency Vermont, electric and gas utility companies serving Vermont, and the Home Weatherization Assistance Program administered by the Office of Economic Opportunity and delivered by the four Community Action Agencies and the Northeast Employment Training Organization.

All these initiatives should be continued and potentially expanded and enhanced in the future. However, it is clear from multiple analyses completed by the Energy Action Network (EAN), modeling conducted during development of this Climate Action Plan, and others that significant, additional initiatives are needed beyond what is already underway in order to meet the GHG reduction requirements established in the GWSA.

Presented below are two major pathways recommended for reducing GHG emissions from buildings in Vermont. One focuses on improving building efficiency and the other focuses on setting a pathway to lower the carbon content of the fuels Vermonters have been using in buildings. In keeping with the GWSA's focus on ensuring equitable access to affordable energy for all Vermonters, these strategies and actions will both reduce GHG emissions from energy used in new and existing buildings and will help address inequities in energy costs, energy burdens, and those underserved by current offerings. The two major pathways are complementary; each makes the other work more effectively. One final note, it is important to recognize that because this is a plan, it is designed to create an outline for action. It does not go into the level of detail that will be required for actual program development and implementation.

Pathway 1 – Reduce energy use in buildings by at least 25% through cost-effective and affordable weatherization and energy efficiency improvements, as well as through use and enforcement of energy codes.

Beyond reduced GHG emissions, weatherization delivers multiple benefits for residents: lower monthly energy bills; improved housing affordability; enhanced home comfort; boosted health outcomes; improved resilience during temporary energy disruptions; reduced building maintenance cost; and, for homeowners, increased home value. Weatherization also provides immediate cost savings to residents and improves the effectiveness of other energy improvements.

Vermont has extensive experience delivering weatherization, fuel assistance, housing, funding, and financing programs. However, many more buildings need to be weatherized, creating the need to scale and to increase coordination among programs and offerings. Vermont also needs to support the expansion of a workforce capable of delivering the amount of weatherization services required.

Strategy 1 - Develop and implement a multi-year statewide Weatherization at Scale initiative

Weatherization at Scale is a statewide, multi-year initiative envisioned by a diverse Working Group of weatherization, energy efficiency, fuel supplier, and other stakeholders. It builds upon Vermont's deep technical expertise delivering weatherization services to nearly 30,000 homes during the past several decades. Modeling conducted for this Climate Action Plan indicates that at least 90,000 additional homes need to be weatherized by 2030 to contribute to meeting the GWSA reduction target for that year. This is an ambitious target that will require significant and ongoing support in the form of funding, training, materials procurement, and other resources. The Weatherization at Scale initiative identifies feasible strategies for recapitalizing Vermont's weatherization investment to fund home retrofits for low- and moderate-income households over the next decade. The weatherization work should recognize energy efficiency broadly. It should include traditional energy efficiency measures, electrical, health, and safety measures needed to comply with codes, and needed infrastructure upgrades such as wiring and service panels to enable electric vehicle charging, the adoption of heat pumps for space and water heating, and other strategic electrification opportunities.

- Coordinated Workforce Development - To deliver the necessary level of weatherization, Vermont will need to further develop its weatherization workforce. This will require a long-term, stable funding stream that gives the private sector certainty to invest in training crews and purchasing equipment knowing a market will exist to support long-term investments. Extensive work will be needed to recruit, train, place, and retain a diversified workforce to better include women, BIPOC, and New American communities. It will also be important to ensure that the quality of weatherization jobs remains high and is not undermined as weatherization activities ramp up rapidly to help meet the GWSA 2030 GHG reduction targets. Weatherization workforce development is an essential need and a cross-cutting issue that should be coordinated with workforce needs in other sectors.
- Enhanced Energy Coaching and Navigation Services - In order to better inform all Vermonters of available energy programs and services, the state should provide outreach, coaching, and navigation services to Vermonters with low and moderate incomes for the State's energy savings programs, including thermal and transportation energy efficiency programs.
- Tariff On-Bill Financing (TOBF) – TOBF provides up-front investment capital for use by a person or business with a utility account to reduce energy bills, for example by investment in a weatherization project. It is not a loan to the person – i.e., landlord or tenant – but instead an obligation assigned to the utility account itself. The funds provided by the utility or a third-party are paid back over time through a special tariff "attached to the meter" that serves the building. The program can and should be designed to ensure that the energy bill savings that are expected to result from the efficiency measure being financed are greater than the amount that will be charged via the tariff. Utilities adopting a TOBF program and energy coaches working with low- and moderate-income customers should also consider measures to prevent unintended consequences such as any increased likelihood of service suspension due to unpaid utility bills. A TOBF pilot is currently underway by Burlington Electric Department and successful TOBF programs have been developed and implemented in other jurisdictions that are

deemed to provide both energy and cost savings, and adequate consumer protection for utility customers.[131] [132]

As weatherization work proceeds it will be necessary to track the status of both the number of weatherization projects completed and the effectiveness of those projects in increasing building energy efficiency and in reducing GHG emissions. Real-time information on market activity will help inform program design and implementation improvements. In addition, it is reasonable to expect that program approaches and offerings will change over time as technologies, measures, and delivery methods improve.

Funding weatherization services to meet GWSA goals will place greater demands on the organizations that currently deliver weatherization services in Vermont. and all can all expect to experience these effects. However, it is also reasonable to expect that a weatherization funding commitment, especially one that is stable and long-term, will stimulate new entrants into the market to provide similar services, expanding Vermont's capacity to meet these demands, and creating employment and other economic opportunities.[133]

Finally, this work will need to meet Vermonters where they are. It should make it as easy, efficient, and affordable as possible for them to make these investments and avail themselves of potential financial incentives and financing to do so.[134]

Lead Implementer: Legislature, designated state agencies	
Action 1 - Adopt legislative or administrative recommendations consistent with those set out by the Weatherization at Scale Working Group (WWG) with the goal of weatherizing 90,000 additional homes by 2030[135] and allocate the funding needed to achieve the goal	**Impact –** To date, approximately 30,000 buildings have been weatherized in Vermont. Modeling indicates that at least 90,000 additional homes need to be weatherized by 2030 in order to meet the GWSA reduction requirement for the Buildings sector
	Equity – The Weatherization at Scale initiative envisioned by the Working Group would target those most vulnerable and historically underserved

[131] https://www.burlingtonelectric.com/on-bill-financing/
[132] https://www.energy.gov/sites/default/files/2021-07/financing-energy-improvements-utility-bills-market.pdf
[133] According to the "Vermont Clean Energy 2015 Industry Report," in 2015 Vermont passed legislation creating a 75 percent RPS by 2032, along with Hawaii, the highest RPS target in the United States. Between 2015 to 2016, solar jobs in Vermont grew by 29 percent, with an additional 400 solar jobs created in the state. https://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/CEDF/Reports/VCEIR%202015%20Final.pdf. Page 3.
[134] To facilitate the most rapid, inclusive, comprehensive uptake of energy improvements, it is essential to connect Vermonters with appropriate programs and services, especially more low-income and historically overburdened Vermonters
[135] EAN Weatherization at Scale Network Action Team "Weatherization at Scale Comments for Comprehensive Energy Plan and Climate Action Plan" memorandum to the Vermont Public Service Department and Vermont Climate Council, October 22, 2021 https://www.eanvt.org/events-and-initiatives/weatherization-action-team/

	as a focus of the State's efforts to significantly ramp-up weatherization activity. In addition, an On-Bill Repayment approach is envisioned that would prioritize homes with the highest energy burden and would scale incentives based on income. Aligning the initiative costs and benefits with low/moderate income residents and communities will ensure that weatherization services will be directed to those who most need to reduce energy costs, increase comfort, improve health impacts, and benefit from improved housing durability.
	Cost-Effectiveness – Expected to be high, but awaiting modeling results from Cadmus/EFG
Timeline to Implement – One calendar year to allow for legislative action and any required rule enactment	**Co-Benefits** - Reduces energy bills - Increases comfort - Improves health
	Technical Feasibility - Yes
Action 2 - Appoint a member of the administration to be responsible for coordinating executive agency weatherization workforce development efforts to: ensure the scaling up of workforce necessary to achieve the GWSA targets; to increase coordination among the wide variety of public and private entities involved in worker recruitment, training, placement, and retention, and; to avoid duplication of efforts across state government (enabling, cross-cutting action)	**Impact** – Enables achievement of weatherization target in Action 1
	Equity – Can improve equity as long priority is placed on measures that address unemployed/underemployed/ displaced workers
	Cost-Effectiveness - N/A
Timeline to Implement – 1st quarter 2022	**Co-Benefits** – Same as Action 1
	Technical Feasibility - Yes
Action 3 - Authorize implementation of a plan for coordinating and enhancing energy and financial coaching services for Vermonters with low and moderate incomes who could benefit from the State's energy savings programs that is consistent with recommendations from the Energy Counseling Savings Work Group and their	**Impact -** Enables achievement of the weatherization target in Action 1
	Equity – This action is specifically targeted to low/middle income households
	Cost-Effectiveness – N/A

legislative report and allocate the funding to achieve the plan goals and objectives.	
Timeline to Implement – 1st quarter 2022	**Co-Benefits** - Provides support and assistance to those most in need
	Technical Feasibility - Yes
Action 4 - Through legislation, encourage electric and gas utilities to offer their customers on-bill financing tariffs	**Impact** - Enables achievement of weatherization target in Action 1
	Equity – Facilitates performance of retrofits in low/middle income households
	Cost-Effectiveness – TBD based on program design
Timeline to Implement - During upcoming legislative session (No later than May 2021)	**Co-Benefits** – Creates a new funding mechanism that does not require personal debt
	Technical Feasibility - Yes

Strategy 2 - Institute a rental property efficiency standard (RPES)

Addressing rental property thermal efficiency is a complementary strategy to Weatherization at Scale. It specifically seeks to ensure that the market for rental property contributes to meeting the GWSA GHG emissions reduction goals. Expecting to equitably improve the efficiency of Vermont's rental housing cannot wait for efficiency investments to occur at the time of sale. Nor can Vermont expect building energy performance labeling alone to spur sufficient improvements in the efficiency of rental housing. Renters, by definition, are not in a position to invest in improving the efficiency of buildings owned by others, even with improved access to information or incentives. And because the typical lease has the renter assume responsibility for energy costs, landlords have limited motivation to make such investments in the absence of an efficiency standard. Addressing rental property thermal efficiency by providing support to landlords for a period of years can help them reduce emissions without creating undue harm to tenants, many of whom are cost-burdened Vermonters.[136] It not only emphasizes solutions that mitigate the high energy burden experienced by low to moderate income households living in rented properties. It recognizes that landlords are better positioned to make basic improvements to the efficiency of the buildings they lease.

Legislature, designated state agency	
Action 1 – Authorize the adoption of efficiency standards for rental properties, beginning with expanding the definition of "fit for human habitation" in 9 V.S.A. § 4457(a) by developing and passing	**Impact –** Complementary policy to Weatherization at Scale (Strategy 1/Action 1)

[136] Likewise, to better ensure continued rental property affordability, program designers could explore the conditioning of the receipt of program support on the agreement to limit subsequent rent increases due to property improvement.

legislation requiring owners of [a TBD minimum number of units] of rental housing to ensure that the efficiency of their rental units meets minimum standards [TBD efficiency code level] by December 31, 2030 and allocate the funding to provide technical and financial support during implementation of the standard.	**Equity** – Designed to benefit the approximately 80% of VT renters who are characterized as low income. Compliance with and enforcement of RPES may result in rent increases. Incentives or grants may be needed to ensure this does not occur.
	Cost-Effectiveness – Not modeled yet. Will depend on specifications in the rental property efficiency standard
Timeline to Implement - During upcoming legislative session (No later than May 2022)	**Co-Benefits** - Creates a new mechanism and technical assistance for landlords to improve livability and affordability for their tenants - Reduces energy bills - Increases comfort - Improves health - Creates local jobs
	Technical Feasibility - Yes

Strategy 3 - Improve the energy performance of all new buildings in Vermont

New buildings, and their associated energy use, last for decades. New construction offers either an opportunity for gains in building efficiency and related energy savings, or a potential lost opportunity for new housing stock. High efficiency construction techniques are well established and easier and less costly to implement than efficiency retrofits in existing buildings. High efficiency/low leakage building envelopes are also much better suited to support non-combustion technology such as heat pumps.

Public Service Department	
Action 1 - Regularly update the statewide residential building energy code, resulting in achieving a Zero Energy Ready building energy code by 2030.	**Impact -** Complementary policy to Weatherization at Scale (Strategy 1/Action 1)
	Equity - Compliance with and enforcement of building energy codes results in more energy efficient buildings and can result in lower emissions as well as reduced energy bills. However, complying with codes may increase construction or renovation costs. Especially for affordable housing, incentives or grants may be needed to help ensure that increased construction

	or renovation costs do not result in higher rental fees.
	Cost-Effectiveness - Not modeled
Timeline to Implement – Next update scheduled for September 2023; every three years after that	**Co-Benefits** - Ensures new construction will incorporate new energy efficient and clean energy options as best practices and technology continuously improve - Reduces energy bills - Increases comfort - Improves health - Creates local jobs
	Technical Feasibility - Yes
Action 2 - Develop and fund a state-level Energy Code Circuit Rider initiative that provides code training and enforcement assistance to municipalities to ensure awareness of and compliance with existing and future building energy codes	**Impact -** Complementary policy to Weatherization at Scale (see Strategy 1/Action 1). Impact could be further enhanced if additional and expanded training were offered as well to engineers, architects, and builders. However the need for municipal assistance was deemed a priority for most urgent action during development of this CAP.
	Equity – Does not directly address equity. However, improved building efficiency resulting from increased code compliance and enforcement will reduce energy use, decrease energy bills, and increase comfort and health. However, complying with building energy codes may increase construction or renovation costs. Especially for affordable housing, incentives or grants may be needed to help ensure that increased construction or renovation costs do not result in higher rental fees.
	Cost-Effectiveness – N/A
Timeline to Implement - by September 2023	**Co-Benefits** - Provides technical assistance and support needed especially by small municipalities that do not have the capacity and staffing to achieve this on their own.
	Technical Feasibility - Yes

Pathway 2 - Reduce building-related carbon emissions by reducing the carbon content of the fuels they use

Today, over 70 percent of Vermont's thermal energy use is fossil-based. About 40 percent of this is fossil gas and propane, while nearly a third is heating oil. For the last decade, Vermont has spent roughly $2 billion a year on fossil fuels, with 75 percent of those dollars leaving the state. In order to meet GWSA emission reduction goals, Vermont needs to transition away from its current carbon-intensive building heating practices to lower carbon alternatives. It also needs to do this equitably, recognizing economic effects on energy users, especially energy-burdened ones, the workforce currently providing these services, and on our overall economy.

Strategy 1 - Implement a Clean Heat Standard

A Clean Heat Standard (CHS) encourages fossil fuel providers serving Vermonters to decarbonize the fuels they supply. It is a performance standard that would be applied to all major suppliers of heating fuels in Vermont with the purpose of driving the market toward greater adoption of low-carbon fuels. As a performance standard, a CHS enables suppliers to choose the most beneficial ways to transition from current practices. It is also designed to allow Vermont's energy users to exercise their choices in how they transition to less carbon-intensive heating practices.

Because Vermont imports 100% of the fossil fuels we use for heating, the CHS would be applied upstream at the wholesale level – that is, on the state's only regulated natural gas supplier (Vermont Gas Systems), and on the large-scale fossil fuel companies that deliver fuels to Vermont's numerous fuel dealers. Fossil heat wholesalers would be required to deliver clean heat solutions to Vermont customers on a percentage basis that rises over time. The wholesalers could meet the standard through a wide range of actions – through their own activities or by purchasing credits from the activities of others. Energy efficiency and weatherization activities as well as low emissions clean heating options including advanced wood heat, biofuels, biogas, district heating, and solar thermal would be eligible as would increased electrification of heating through the use of heat pumps for space and water heating.

To ensure that it does not negatively affect energy-burdened Vermonters, the CHS would need to incorporate policies to minimize adverse effects on low-income customers, and potentially on other customer segments for which there may be equity concerns. The program will need to focus on low- and moderate-income households using fossil fuels to ensure they understand the benefits of the CHS and are positioned to take advantage of them This could include disconnection policy, fuel assistance, housing, or other programs to improve energy affordability for low-income households. Because the CHS provides a path for fuel deliverers to comply and transition into the provision of cleaner energy services, the CHS design is fair to traditional fuel suppliers and their employees.

Legislature	
Action 1 - Adopt legislation authorizing the Public Utilities Commission to administer a Clean Heat Standard consistent with the	**Impact –** TBD based on program design; potentially high if required emissions reductions are indexed to

recommendations of the Clean Heat Standard Working Group[137]	building/thermal sector share of GWSA reduction targets
	Equity – Can be designed to mitigate the disproportionate energy burdens and negative distributional effects of existing heating fuel costs on low- and moderate-income Vermonters. Works in concert with complementary programs, such as low-income weatherization and fuel assistance programs, to assist in the transition to cleaner heating solutions.
	Cost-Effectiveness – TBD based on program design
Timeline to Implement - Legislation by the end of the current session (May 2022) followed by up to 12 months for administrative process, including program design, orders, or rulemaking	**Co-Benefits** - Provides choice in how to meet GWSA targets Reduces energy bills - Creates a predictable and stable marketplace as fossil fuel businesses transition to clean energy services - Improves health - Creates local jobs
	Technical Feasibility - Yes

Strategy 2 – Transition the water heater market in Vermont to ensure the availability of water heaters whose total cost of ownership is lower than other models, and which can be controlled by electric utilities to help manage their power grids at low cost

The electrification of energy uses currently powered by fossil fuels represents one of Vermont's greatest opportunities to avoid building related GHG emissions. In addition to reducing emissions from combustion and saving consumers money, electrification is a low-cost and underused opportunity for utilities to actively manage and optimize their grid operations. Controllable water heaters will also improve Vermont's ability to adopt greater amounts of variable renewable resources. This strategy seeks to leverage the ability of water heaters, replaced at a rate of approximately 25,000 per year,[138] to store energy in the form of heat and allow electric utilities to manage their operation to realize both emission reductions and consumer savings.

Department of Public Service	
Action 1 - With neighboring states, require electric water heaters for sale to have a modular demand response communications port	**Impact –** Complimentary policy to establishing a Clean Heat Standard. Would enable the transition of fossil-fuel water heaters to state-of-the art,

[137]EAN Network Action Team – Clean Heat Standard Working Group - https://www.eanvt.org/events-and-initiatives/clean-heat-standard/
[138] EAN 2021, p. 25

	energy efficient water heaters whose heating can be timed to off-peak times of electricity use.
	Equity – Appliance standards do not typically address equity directly. However, the programs developed to implement such a standard can (and should) be. For example, any incentives created to stimulate market demand for controllable water heaters could be income sensitive and could prioritize equipment switch-outs in frontline and impacted communities.
	Cost-Effectiveness – Deemed to be high based on modeling results from Cadmus/EFG.
Timeline to Implement – Initiate discussion with neighboring states no later than July 2022	**Co-Benefits** – An initial step towards creation of a stable and predictable marketplace as fossil fuel businesses and equipment suppliers transition to clean energy services
	Technical Feasibility – Yes

Summary

It is important to note that, while the weatherization at scale suite of actions and the clean heat standard are interdependent, both strategies support the other, making each more effective at meeting the GWSA's just transition goals. Cleaner and more efficient heating appliances will work more effectively in homes that are more capable of maintaining internal temperatures. Likewise, as weatherization proceeds, the CHS will encourage the adoption of lower carbon fuels, producing opportunities for consumers to secure carbon reduction gains immediately. Furthermore, weatherization and energy efficiency improvements as well as an increase in managed electrification of heating[139] would be eligible for CHS credits. So, not only do they promote each other, but the relationship also helps in funding weatherization.

[139] Managing electrification load will be a critical strategy for enabling Vermont to accommodate the level of electrification and amounts of variable renewable energy envisioned in this Plan. See "Load Management and Grid Optimization" section of Electricity Sector Mitigation Pathways.

Electricity Pathways for Mitigation

The electric sector has made great strides in both reducing emissions from electricity purchases and use, and in reducing overall demand through efficiency programs. Therefore, in the near term, between now and 2030, the focus should be to maintain the progress made in the electric sector to ensure a cost-effective backbone for the very significant transition necessary to decarbonize the transportation and buildings/heating sectors.

Pathways, strategies and actions related to adaptation and resiliency regarding the electric sector and electric infrastructure – many of which are in further support of mitigation – are laid out thoroughly in other sections, particularly Section 12 and the other pathways in this Section 11, and are not repeated here. Recommendations regarding further research and actions on GHG emissions accounting from the electricity sector and in all other sectors is discussed in Section 9.

Keeping Vermont's electric supply affordable and increasingly carbon free and renewable will enable Vermonters to transition to low carbon electricity as fuel source in transportation and heating, the two largest sources of GHG emissions. The electricity sector needs to support that transition with a cost-effective, fully carbon-free or renewable electricity portfolio over time. Vermonters also need technical and financial help to upgrade their homes and businesses to support this transition. Finally, in carrying out this work, Vermont must ensure a strong, reliable, flexible grid at both the distribution and bulk transmission levels because Vermonters will be relying upon the grid even more so in the future to support decarbonization with many interconnected, distributed load and generation resources.

On a statewide basis, the electric sector is already relatively low carbon and will be nearly carbon free and largely renewable by 2030 under current utility long-term power supply contracts. The state's Renewable Energy Standard (RES) is already based upon a percentage of total retail sales/load and therefore is designed to keep pace with electrification.

State distribution utilities and the bulk transmission system operator, VELCO, already support coordination and long-range statewide transmission planning across service territories, through the Vermont System Planning Committee and Public Utility Commission (PUC) processes.

Vermont also already has in place certain programs to help support fossil fuel transition, through Tier 3 of the RES; already-deployed EV charging rates in certain utility territories; deployment of EV fast chargers (Level 3 and Level 2); and other strategies.

Going forward, Vermont will require significant increased efforts to decarbonize transportation and heating, including through electrification. This in turn will require both investments in infrastructure to support customer electrification (panel upgrades, home chargers, storage, and distributed energy resources (DERs) including small-scale renewable generation), and well-coordinated load management to minimize infrastructure costs associated with peak demand. The overall electricity portfolio also must account for the type of increased demand that will come from these measures; energy requirements are expected to be significantly higher in winter compared to summer. Finally, as noted in many public comments and those of Climate Council members, there are tradeoffs involved in any energy choice – different environmental impacts and burdens will occur with each, including the catastrophic environmental harm that has come from the use of fossil fuels. Transparently recognizing that these harms are not all equivalent,

and that the burdens of each fall differently, will be key to creating greater trust and accountability as we create a just transition.

Pathway: Further decrease GHG emissions from electric sector purchases

A primary mechanism for reducing GHG emissions will be electrification of the transportation (electric vehicles) and buildings (heat pumps) sectors. Electric vehicles and heat pumps are inherently more efficient than combustion technologies and therefore reduce energy usage and carbon emissions. However, emission reductions associated with electrification are closely linked with the power supply portfolio of the electric utility providing power to the device.

The GHG Inventory maintained by the Department of Environmental Conservation (DEC) bases emissions in the electric sector on the annual power supply portfolio of Vermont's utilities. This largely reflects the fact that Vermont is part of a regional electric grid where load and generation are balanced in real time; as more carbon-free energy is put onto the system there is less overall generation from fossil-fuel-fired plants. Every kilowatt hour of a clean energy resource that counts in Vermont's RES and other state's equivalent policies must actually be delivered and used into our New England region, as tracked annually through a registry and accounting system of Renewable Energy Credits maintained by the NEPOOL GIS. While in future years it may be possible to move to more seasonal or even daily/hourly tracking of the use of carbon-free resources, in the meantime it is critical that utilities continue and deepen their progress to utilize cleaner resources and help displace fossil fuel resources on our regional grid.

Strategy – 100% Carbon-free or Renewable Electricity

Vermont should develop 100% carbon free or renewable electric portfolio standard to ensure progress continues into the 2030s and beyond while being mindful of the economic impact on cost-burdened Vermonters and maintaining the cost-effectiveness of fuel-switching to electric measures.

Vermonters pay approximately $900 million in electricity costs per year, with over half that that amount associated with procuring energy. These costs are recovered from Vermont electric customers through cost- and usage-based electric bills and as such electric bills are an inherently regressive payment structure, something to keep in mind when looking at ways to utilize electric bills to achieve our state policy goals.

Vermont policymakers and stakeholders in the Climate Plan process have also been clear that they want to see Vermont move more aggressively toward clean electricity to support overall mitigation of emissions and decarbonization. Vermont's current RES aims to achieve 75% renewable resources annually by 2032; the accompanying analysis by Cadmus indicates that the current RES is adequate to meet the GWSA goals for 2025 and 2030. While Vermont's goal was forward-thinking when passed, other states in New England are increasing their required amounts of new renewable electricity and are also focusing on supporting existing carbon-free generation sources. For example, energy from HydroQuebec, which is defined as "renewable" in Vermont,[140] is supported in Massachusetts under its Clean Energy Standard – Existing[141] requirement for carbon-free resources procured to meet that state's carbon reduction mandates

[140] 30 V.S.A. § 8002(2)(C)
[141] 310 CMR 7.75

from 2020-2050. Similarly, both Massachusetts and Connecticut have policies that support nuclear energy to further carbon reduction policies.

Vermont must move toward a fully clean electric portfolio that strongly support new resources designed to displace fossil-fuel-fired generation in the region, not just existing. In doing so, it will be important to consider a number of questions, as outlined below, that embrace equity and also tackle whether our current structure that supports renewable electricity should be modified to support carbon-free resources. Regardless of the eventual design, a legislative requirement that Vermont's utilities have power supply portfolios that are 100% carbon free by 2030[142] will reduce electric sector emissions and enable deeper carbon reductions associated with electrification in the transportation and thermal sectors. The strategy recommends that new requirements are designed to fit already-procured resources, including long-term committed contracts for carbon-free resources that run through the mid-2030s.

Specifically, the General Assembly adopt a carbon reduction policy that directs the Public Utility Commission, utilizing expertise as appropriate, to identify, review, and research as needed design parameters for a 100% carbon-free or renewable electric portfolio standard that equitably promotes electrification.

Such a study would be used to inform subsequent legislative discussion and would take into account the additional studies being recommended by the Science and Data Subcommittee, including on GHG accounting. Given the numerous design options of such a mandate, the significant costs and potential impacts on low-income and cost-burdened Vermonters, and the fact that such a mandate would lock-in resource selection over a period of decades, the study will need to be designed in a manner that that structures a clean or renewable power supply requirement in a way to maximize GHG emissions reductions while protecting the interests of Vermonters in equity, economic development associated with local renewable generation, affordability, and other issues.

Questions that warrant further research in such a study include:

- Using existing renewables and new resources – the right mix for equity and additionality
    - Date of qualification for 'new' resources – considering both regional and instate generation
- In-state and out-of-state generation – the right mix for economic development, equity, affordability, land use, and other considerations
- Supporting generation of all sizes and types (small/large/hydro/wind/solar/storage etc.)
- Pace of increased requirements by type of resource/RES Tier
- Incentivizing resources to deliver when needed (e.g. during peak hours, noting that these are likely to shift over time; seasonal needs such as winter loads; how storage may fit in), taking into account the time scale on which renewability is measured now (annually) and in the future (e.g., quarterly, monthly, hourly)
- Siting, including environmental, community, and transmission system considerations
- Carbon impact of resources; what source/criteria are utilized; whether the framework changes to a carbon standard rather than a renewable standard

[142] Moving to 100% clean electricity portfolio by 2030 would align with the GWSA 2030 timeframe; however, under Vermont's current GHG inventory a later date, such as the 2032 compliance date currently in the Vermont RES, also would allow Vermont to meet its overall emissions reduction goals.

- Informed by any additional GHG inventory recommendations

Action

Lead Implementer: Legislature; Other Implementers: PUC, DPS, Utilities		
a.	Action details: Move from 75% Renewable Energy Standard to 100% Carbon Free or Renewable Electricity	Impact: High/enabling
		Equity: Depends on program design
	Timeline to implement: No later than 2030	Cost-Effectiveness: Depends on program design
		Co-Benefits: Depends on program design
		Technical Feasibility: Y

Pathway – Enable All Vermonters to Choose Electrification

Having a zero-carbon electricity supply along with electric transportation and heating options will not get Vermont the deep emissions reductions required by the GWSA unless Vermonters can choose these technologies easily and affordably. Vermont's largely older housing and building stock, rural infrastructure, and the complexities of navigating new technology create real hurdles to going electric. If we are not careful, we could repeat inequities seen in the deployment of other programs and infrastructure, like broadband and solar, where too few Vermonters have easy, affordable access to new technology. It will take sustained, committed work to enable all Vermonters to choose to go electric.

Strategy

Programs need to be focused on providing financial and technical assistance for Vermonters to upgrade electric service and to purchase and install equipment. Available federal funding, including through the recently-passed infrastructure legislation and through potential additional legislation targeted at GHG mitigation and resiliency, should be leveraged to make these often one-time or long-term investments. The basics are not flashy – the level of electric service to buildings and homes; the age of internal wiring; service panel upgrades – but they are absolutely key to giving Vermonters access to decarbonization through electrification. We also need to provide education and support for installing equipment such as EV chargers and new heating systems, so that the complexities of change do not create a barrier. And in doing this work, we have to think about how all types of buildings – old farmhouses on rural roads, those in our compact downtowns, multifamily homes and buildings, and mobile homes – can make the switch. Coordinating this work with weatherization and efficiency efforts is a must. We need to finally crack the code for offering Vermonters easy access to home and building upgrades. In doing so, we should neither insist that all must be done at once – since that is unaffordable and unrealistic for many – nor that one solution has to be elevated over another. Rather, when Vermonters are able to start an upgrade, the foundational work that would allow other measures to be done then or later should also be deployed. For example, installing 200-amp service upgrades to homes if insulation and other work affecting the shell of a building is being done. If a heat pump is being installed, consider an upgrade to the service panel with future expansion to EVs, solar, and storage in mind.

This work will have benefits not just in GHG reductions, but in long term affordability for Vermonter, greater resiliency, and economic activity. It will spur the need for more Vermonters to work to install equipment, meaning that we also must help plan for an adequate workforce for technical assistance and installation. This work also has the opportunity to create a more just transition, if we are successful in focusing programs and support for not only those who are income qualified but also those who have historically been left behind as new technologies roll out, particularly those in rural towns and marginalized communities.

Actions

<table>
<tr><td colspan="3">Lead Implementers: Legislature for funding initiatives; Utilities, Private Sector & Nonprofits</td></tr>
<tr><td rowspan="2">a.</td><td rowspan="2">Action details: Develop programs for implementation regarding 200-amp service and related building upgrades, coordinated with weatherization, efficiency, and equipment incentive programs (EV chargers, HP, storage, etc.), and ensure that any potentially related statewide program (such as Clean Heat Standard, if adopted, or enhanced weatherization efforts) includes building electrical upgrades in their design and funding models in order to enable decarbonization.</td><td>Impact: High/Enabling</td></tr>
<tr><td>Equity: Target lower income Vermonters, multifamily, and rural areas of Vermont without strong infrastructure.

Ensure direct financial support through equitable source for income qualified, plus easy financing access for all utilizing same tools as for weatherization and equipment financing, including possible on-bill payment through electric utility bills after pilot project for weatherization improvements currently underway.</td></tr>
<tr><td rowspan="3"></td><td rowspan="3">Timeline to implement: Initial enabling funding 1-2 years</td><td>Cost-Effectiveness: Depending upon tools funded and level of funding – see DPS Cost of Carbon Measures report</td></tr>
<tr><td>Co-Benefits - High
• Jobs/workforce dev
• Economic activity from sales of equipment and services
• Healthier buildings, healthier people
• Lower maintenance/ownership costs (e.g., EVs)</td></tr>
<tr><td>Technical Feasibility: Yes</td></tr>
</table>

Pathway – Load Management and Grid Optimization

As Vermont increasingly turns to electricity as a low- or no-carbon resource for transportation, heating, and related distributed energy purposes, our electric grid will become more complex, with more points of local connection and coordination, and we will rely on it even more so than today. This is true even for those Vermonters who increase their own resiliency with solar and storage because key to community and statewide resiliency is for us to act collectively – to pool distributed energy resources and coordinate their deployment through the greater electric grid. And we have to make this transition at a time when, due to climate change, we are facing more frequent, severe storms that damage infrastructure, including our electric system.

Other sections of the Climate Plan, particularly Sections 12 and 13, discuss actions needed to harden electricity infrastructure and create community-level resiliency. The goals of this Pathway will be to lower barriers and increase customer participation in load control programs and devices, to unlock the value Distributed Energy Resources can bring collectively, through coordination and management, to the greater grid, so that in the future our electric system is not only cleaner but also more reliable and cost-effective. To help support electricity sector emissions reductions cost-effectively, the way forward will include enhanced use of load control, through direct utility measures, dynamic rate design, and programs offered by energy services companies directly to customers, to flexibly manage and coordinate the electric grid. This will create not only greater equity statewide, particularly for our rural communities, but also greater overall benefits through more efficient, cost-effective electricity services and through supportive programs for load management that in turn create jobs and economic activity.

Strategy

We should support and expand on existing programs and policies that encourage load management and grid optimization, in order to enable the deep decarbonization we need through use of the electric sector.

For this strategy, tools already exist. We should continue to prioritize programs delivered by our efficiency utilities, electric utilities, and energy services companies to encourage load management and grid optimization, through utility Integrated Resources Plan (IRP) proceedings, regulation proceedings, rate designs, innovation pilots, and other existing PUC oversight. Rapid technological changes mean that we should encourage quick program evolution – we need to be willing to adapt and try new things to keep Vermont toward the front of the curve when it comes to optimizing our grid to support electrification. In the future, this will include many different individual functions, products, and technologies, from sensors and meters used today to new product-level features capable of dynamic load control, pricing signals and even billing, along with new distributed energy resource management platforms and intelligence to help coordinate it all. PUC review can help create equity by incorporating screening to ensure utilities pursue programs achieve overall least cost, taking into account carbon and societal benefits and other criteria.[143] Programs should be designed to deliver shared customer savings for load control, and to encourage customers to match where possible their own load to generation to optimize the system for the benefit of all, with a vigilant eye on equitable access that has often eluded us.

Actions

Lead Implementers: Utilities; Other Implementers: PUC, DPS, Private Sector		
a.	Action details: Support direct utility load control programs, including implementation of management platform	Impact: Medium/enabling
		Equity: High, if implemented with shared savings in mind so that all customers benefit

[143] The common need across state regulatory processes and government programs to train decisionmakers on equity and the principles of a just transition, as well as considerations regarding statutory criteria that would ensure those issues are included in decisions and programs, is treated in the [Crosscutting Themes] section of the Climate Plan.

	Timeline to implement: Ongoing	Cost-Effectiveness: Depends upon specific design and cost recovery, but purpose of these programs should be to more cost-effectively manage DERs across the grid than in the absence of such control.
		Co-Benefits: High. • Jobs (individual project deployment and infrastructure) • Enabling individual and community-level resiliency • Safety • Lower overall costs than in absence of programs, yielding economic benefits
		Technical Feasibility: Yes
Lead Implementers: Utilities; Other Implementers: PUC, DPS, Private Sector		
a.	Action details: Encourage dynamic rate offerings, including those designed to encourage direct load/generation matching, and rate design to support electrification through shared customer savings	Impact: Medium/enabling
		Equity: While rates must be offered to all similarly situated customers care must be taken to consider who will have the opportunity to benefit, such as Time of Use rates providing variable benefit to shift workers and avoiding "electrification" rates that do not share increased load benefits with all customers.
	Timeline to implement: Ongoing	Cost-Effectiveness: High, so long as shared savings are the goal. To the extent subsidies between customer groups are utilized, historically marginalized individuals and those who have not accessed energy programs successfully in the past should be prioritized.
		Co-Benefits: Medium, same as list above
		Technical Feasibility: Yes

Agriculture Pathways for Mitigation

Vermont farmers are motivated to be part of the climate change solutions and many already include climate mitigation as a major goal in managing their farm.[144] The agricultural sector's emissions account for 15.8 percent of Vermont's greenhouse gas (GHG) emissions.[145] The main mitigation options within the agricultural sector involve one or more of three strategies:[146]

1. **Prevention of emissions** to the atmosphere by conserving existing carbon pools in soils and vegetation **or by reducing emissions** of methane (CH_4) and nitrous oxide (N_2O) through management changes;
2. **Sequestration**—increasing the size of existing carbon pools, and thereby extracting carbon dioxide (CO_2) from the atmosphere; and
3. **Substitution**—substituting biological products for fossil fuels or energy-intensive products, thereby reducing CO_2 emissions.[147]

Carbon sequestration in agricultural landscapes is the mitigation strategy for agriculture that yields the greatest co-benefits, is the easiest and most immediate to implement, has the fewest equity concerns in Vermont, and has received significant attention from the global and scientific communities as a critical mitigation strategy[148]. Feed supplement strategies to reduce methane in enteric emissions can be associated with negative implications for herd health[149] and reliance on imported feed supplements that may negatively impact communities elsewhere, though more research is needed on the extent to which forage management may impact enteric methane and simultaneously support animal health. Adjustments in manure management are also considered among the suite of strategies that may help mitigate agricultural emissions sources, yet practices like methane digesters may not be scale appropriate for small farms, and other manure management practices may have tradeoffs with water quality. Recommendations below include elevating sequestration as a strategy to invest in, with known benefits and wide appeal, while

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[144] White, A.C., Faulkner, J.W., Conner, D.S., Mendez, V.E., and M.T. Niles, M.T. "How can you put a price on the environment?" Farmer perspectives on stewardship and payment for ecosystem services. *Journal of Soil and Water Conservation* (in press).

[145] Agency of Natural Resources – Department of Environmental Conservation – Air Quality and Climate Division. "Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990-2017." May 2021. https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf.

[146] While demand-side measures (e.g. reducing losses and wastes of food) may also play a also play a role in mitigation of climate change, these recommendations are not in-scope of the Agriculture & Ecosystems Subcommittee at this time.

[147] Allwood J.M., V. Bosetti, N.K. Dubash, L. Gómez-Echeverri, and C. von Stechow, 2014: Glossary. In: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_annex-i.pdf.

[148] Minasny, Budiman, Brendan P. Malone, Alex B. McBratney, Denis A. Angers, Dominique Arrouays, Adam Chambers, Vincent Chaplot et al. "Soil carbon 4 per mille." *Geoderma* 292 (April 2017): 59-86. https://doi.org/10.1016/j.geoderma.2017.01.002.

[149] U.S. Environmental Protection Agency. "Global Non-CO2 Greenhouse Gas Emission Projections & Marginal Abatement Cost Analysis: Methodology Documentation." September 2019.

simultaneously supporting proven technologies and exploring ways that other agricultural emissions sources can be mitigated with more careful consideration for tradeoffs and equity.

Today, Vermont farmers mitigate on-farm GHG emissions through the adoption of conservation practices. Importantly, many water quality best management practices provide co-benefits for climate mitigation, and implementation has increased dramatically in recent years. Through more widespread adoption of these conservation practices, which increase the organic matter content of agricultural soils, Vermont farmers have a realistic potential to sequester one million tons of CO_2-e annually[150]. Today, Vermont's agricultural soils already store over an estimated 63 MMT CO_2-e[151].

The agriculture sector is also highly vulnerable to climate change. Currently, the majority of crop losses reported in Vermont are due to weather extremes that have been increasing in intensity and frequency due to climate change[152]. Fortunately, many agricultural practices that increase carbon sequestration also enhance a farm's resilience to a changing climate. In fact, the most common strategy that Vermont farmers already employ to address extreme weather impacts is improving soil health[153], highlighting the importance of soil health as an important strategy to address both climate mitigation and adaptation. The Agriculture & Ecosystems Subcommittee recommends incentivizing farming systems that help all farmers both mitigate the drivers of climate change and build resilience to its impacts.

Agriculture – and other associated natural and working lands – is a nexus for building a resilient future for Vermont in the face of climate change that centers priorities of:

1. Improving soils, water, and resilience of the working landscape to combat climate change;
2. Increasing sustainable economic development and creating good jobs in Vermont's food and farm sector; and
3. Improving access to healthy, local foods for all Vermonters.

The importance and focus on Vermont's agricultural soils to address climate change in these action recommendations is foundational to catalyze a paradigm shift in how farmers are acknowledged and empowered to perform their essential roles of environmental stewardship while providing food and fiber. Where historic federal food policy and current international markets have driven agriculture to particular farming systems and methods that have historically externalized costs of production to water, land, and air – a focus on the importance of Vermont's soils to address climate change and investment in the following **ten key actions** can help catalyze enterprise-level changes, remove the barriers to transition, and leverage the impressive engagement and work farmers have recently begun to undertake to address Vermont's water

[150] White, A.C. "Agricultural Greenhouse Gas Footprint in Vermont and Rough Quantification of Strategies to Meet Reduction Goals." Presentation to Agriculture & Ecosystems Subcommittee 5C Group. May 25, 2021.
[151] Galford, Gillian, Darby, Heather, Kosiba, Alexandra, and Hall, Frederick. "A Carbon Budget for Vermont: Task 2 in Support of the Development of Vermont's Climate Action Plan." September 2021.
[152] Vermont Climate Assessment. 2021. Due to be publicly released in Nov of this year. Lead authors are Galford, Faulkner & Dupigney-Giroux
[153] Vermont Climate Assessment. 2021. Due to be publicly released in Nov of this year. Lead authors are Galford, Faulkner & Dupigney-Giroux

quality challenges and expand and empower all Vermont farmers to adapt, build resilience to, and mitigate climate change.

Leveraging the state's existing water quality conservation programming is the first step to support agriculture in meeting the 2025 and 2030 emission reduction requirements established in the GWSA. Here exists a robust multi-partner service-delivery mechanism[154] for agriculture where natural climate solutions (NCS) (e.g. cover crops, nutrient management, manure management, reduced tillage, and riparian tree plantings) that have benefits for both water quality and GHG mitigation are already successfully being implemented by farmers across Vermont – over 300,000 acres of conservation practices have been implemented on Vermont farms since 2016 through state and federal programs.[155] These agricultural NCS can be delivered at a large scale, at cost-effective rates, yield immediate GHG mitigation benefits, have long lasting positive effects, and provide multiple co-benefits that support adaptation, resilience, and food security goals for Vermont.

Pathway A: Maintain and expand Vermont's natural and working lands' role in the mitigation of climate change through human interventions to reduce the sources and enhance the sinks of greenhouse gases.

Mitigation in this section incorporates the GWSA 10 V.S.A. § 590(3) definition of 'Mitigation' which means: "reduction of anthropogenic greenhouse gas emissions, and preservation and enhancement of natural systems to sequester and store carbon, in order to stabilize and reduce greenhouse gases in the atmosphere." This is consistent with the IPCC definition, "a human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs)"[156].

The strategy which provides the most immediate and cost-effective opportunities for mitigation from the agricultural sector is to:

Leverage, expand, and adapt existing State of Vermont programs that support the agricultural sector's mitigation of climate change through:

- **i. Prevention of emissions to the atmosphere by conserving existing carbon pools in soils or vegetation, or by reducing emissions of methane (CH_4) and nitrous oxide (N_2O);**
- **ii. Sequestration by increasing the size of existing carbon pools, and thereby extracting carbon dioxide (CO_2) from the atmosphere; and**
- **iii. Substitution of biological products for fossil fuels or energy-intensive products, thereby reducing CO_2 emissions.**

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[154] Vermont Agricultural Water Quality Partnership. https://vtagcleanwater.org/.

[155] Clean Water Interactive Dashboard data presented in Vermont Clean Water Initiative 2020 Performance Report. January 15, 2021. https://app.powerbigov.us/view?r=eyJrIjoiNTI5Y2QxZDEtODY3Ni00ZmYwLThjZTAtNjdiNTM3YTQyZjRkIiwidCI6IjIwYjQ5MzNiLWJhYWQtNDMzYy05YzAyLTcwZWRjYzc1NTljNiJ9.

[156] IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 117-130. https://www.ipcc.ch/site/assets/uploads/2019/01/SYRAR5-Glossary_en.pdf.

The majority of conservation practices funded through various state programs aimed at improving water quality by reducing erosion and nutrient loss also mitigate climate change by reducing carbon transport, sequestering carbon in plants and soils. The specific impacts of these conservation practices on climate mitigation are explained below. The state programs that support these climate mitigation practices should continue to be funded and expanded to increase adoption by Vermont farmers. Current state programs coordinate with federal programs to ensure as seamless and complementary a delivery of services as possible. As explained below, other programs may need further enhancement and funding to focus on climate mitigation in addition to water quality.

LEAD IMPLEMENTER Vermont Agency of Agriculture, Food & Markets (VAAFM)		
a.	**Action Details** **Implement agronomic practices that reduce tillage and increase vegetative cover, e.g. no-till, cover crop** Practices that reduce tillage intensity, such as reduced tillage and no-till conservation practices, reduce the emissions of CO_2 from the soil by reducing decomposition from less soil disturbance. Practices that increase herbaceous (non-woody) vegetative cover on crop fields, such as cover crop at the end of the growing season, or rotation of perennial hay crops with annual crops such as corn (crop rotation), sequester carbon as they grow. Thus, the more living plants on the field during the growing season the more carbon is sequestered. Vegetative cover, whether perennial (hay) or annual (cover crop) also reduce erosion and the loss of nutrients through runoff, and increase albedo effect, lowering ground temperatures. Practices that reduce tillage and increase vegetative cover not only have climate mitigation and water quality benefits but are also important for climate adaptation and resilience. These practices increase the organic matter content of the soil which	**Impact** In 2021, VAAFM funded over 24,000 acres of cover crop and 2,700 acres of conservation tillage. Vermont has about 90,000 acres of land suitable for cover crop and conservation tillage in 2021.[157] Implementation of these practices has been steadily increasing since 2016 and the rate of adoption has potential to continue to increase with sustained or expanded funding. While implementation of these agronomic practices are currently being tracked by VAAFM, a protocol needs to be researched and developed to quantify GHG mitigation from these practices for Vermont. In a Canadian study, cover crops were estimated to be the largest single source of mitigation potential from the agricultural sector with 26% of all potential agricultural mitigation coming from the adoption of cover crops. 12.5% of all considered NCS mitigation reductions in the study were estimated to come from cover crops.[158] **Equity** Jurisdictional RAP farms are eligible to apply for VAAFM programs. A comprehensive review for equity should be undertaken by state programs. Outreach regarding program

[157] U.S. Department of Agriculture Farm Service Agency. "Crop Acreage Data – 2020 Crop Year." https://www.fsa.usda.gov/news-room/efoia/electronic-reading-room/frequently-requested-information/crop-acreage-data/index
[158] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.

	increases infiltration (reduces runoff) and water storage, thereby reducing flooding and storing more water during times of drought. The Vermont Agency of Agriculture, Food and Markets (VAAFM) funds Cover Crop, Conservation Tillage (reduced tillage and no-till), and Conservation Crop Rotation through its Farm Agronomic Practices (FAP) program. USDA NRCS-VT funds additional implementation of these practices.	eligibility and availability should be expanded. **Cost-Effectiveness** High cost-effectiveness due to low cost of implementation and potential for scaling up adoption on farms. Literature suggests that the CO_2e/yr potential mitigation for cover crop as a mitigation strategy can be available at the following price points: 14% of total possible reduction at ≤ \$10/MT CO_2e; 46% of total possible reduction at ≤ \$50/MT CO_2e; 84% of total possible reduction at ≤ \$100/MT CO_2e.[159] Literature suggests that the CO_2e/yr potential mitigation for reduced tillage as a mitigation strategy can be available at the following price points: 22% of total mitigation potential at ≤ \$10/MT CO_2e; 44% of total mitigation potential at ≤ \$50/MT CO_2e; 67% of total mitigation potential at ≤ \$100/MT CO_2e.[160]
	Timeline to Implement: 0-6 months.	**Co-Benefits** This suite of agronomic practices provides overall adaptation, resilience, and water quality benefits including: reduced soil erosion, reduced nutrient runoff, increase on soil organic matter (soil health, infiltration, water storage), reduced flooding, resilience to drought and extreme rain events, reduced nitrogen fertilizer if planting legumes, reduced ground temperatures due to albedo effect of plant cover. **Technical Feasibility:** Yes
b.	**Action Details** **Expand Capital Equipment Assistance Program (CEAP) program to extend beyond water quality and incorporate climate change criteria.**	**Impact** Over 50,000 acres of conservation practices have been implemented through CEAP since 2018 that have co-benefits for GHG mitigation from the agricultural sector (e.g. reduced tillage, cover crop seeding). Farmers manage almost 530,000 acres of harvested

[159] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.
[160] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.

	The VAAFM Capital Equipment Assistance Program (CEAP) provides financial support for farmers to purchase the equipment necessary to implement many of the climate mitigation practices listed above in 'Action a', including no-till and cover crop, and various precision agriculture technologies that improve nutrient management. This program is an effective way to assist farmers to have the equipment available necessary to implement climate mitigation practices and thereby increase the rate of implementation and adoption across the state. CEAP primarily focuses on innovative equipment to improve water quality – which can have co-benefits for GHG mitigation, and the program currently can be used to increase mitigation by including equipment more specifically intended for climate mitigation[161]. Currently the program is funded through the Clean Water Fund, which focuses the program on clean water outcomes. Either an additional funding source or an agreement from the Clean Water Board to support climate focused practices is needed to expand the program beyond clean water practices.	cropland and pasture in Vermont[162] offering considerable opportunity for expanding adoption. While implementation of these agronomic practices are currently being tracked by VAAFM, a protocol needs to be researched and developed to quantify GHG mitigation from these practices for Vermont USDA has modeled potential mitigation by agricultural management category and CO_2 price level ($/MT CO_2e) and has found that of the 120 MMT CO_2e possible to be mitigated by US agriculture nationally, over one third of potential reductions could come from reducing tillage intensity.[163] USDA notes that "the mitigation benefits of reducing tillage intensity depend critically on reduced tillage practices being adopted in the long term." As CEAP supports the purchase of equipment for long term utilization, this program helps ensure persistent adoption and can help farmers overcome one of the largest barriers EPA has identified for agricultural adoption of reduced tillage practice which is initial capital costs.[164]
		Equity Jurisdictional RAP farms are eligible to apply for VAAFM programs. A comprehensive review for equity should be undertaken by state programs. Outreach regarding program eligibility and availability should be expanded.
		Cost-Effectiveness USDA has modeled that nationally, over 50% (21 MMT CO_2e) of the total mitigation

[161] 6 V.S.A. § 4828(a) "It is the purpose of this section to provide assistance to purchase or use innovative equipment that will aid in the reduction of surface runoff of agricultural wastes to State waters, improve water quality of State waters, reduce odors from manure application, separate phosphorus from manure, *decrease greenhouse gas emissions*, and reduce costs to farmers." Emphasis added.

[162] U.S. Department of Agriculture National Agricultural Statistics Service. "2017 Census of Agriculture." https://www.nass.usda.gov/Publications/AgCensus/2017/index.php.

[163] Pape, D., J. Lewandrowski, R. Steele, D. Man, M. Riley-Gilbert, K. Moffroid, and S. Kolansky, 2016. "Managing Agricultural Land for Greenhouse Gas Mitigation within the United States." Report prepared by ICF International under USDA Contract No. AG-3144-D-14-0292. July 2016. https://www.usda.gov/sites/default/files/documents/White_Paper_WEB_Final_v3.pdf (p.31)

[164] U.S. Environmental Protection Agency. "Global Non-CO2 Greenhouse Gas Emission Projections & Mitigation: 2015-2050." https://www.epa.gov/sites/default/files/2019-09/documents/epa_non-co2_greenhouse_gases_rpt-epa430r19010.pdf (p.60)

		potential from the adoption of reduced tillage practices is available below $30 per MT CO_2e.
	Timeline to Implement: 0-6 months	**Co-Benefits** Co-benefits are numerous for CEAP. For reduced tillage, co-benefits include air (reduced dust from wind erosion), biodiversity (increased soil microbial biodiversity), soil (reduced soil erosion and redistribution maintaining soil depth and water retention), water (increased soil water conservation and crop water use efficiency; improved water quality and reduced sediment loads)[165], and a moderate improvement for the energy efficiency of field operations as fewer tillage passes are taken and horsepower requirements are reduced for tractors.[166]
		Technical Feasibility: Yes
c.	**Action Details** **Implement grazing practices that increase vegetative cover and forage quality, e.g. rotational grazing** **Herbaceous vegetative cover** (non-woody plants) can be increased on pasture by reducing grazing pressure from livestock that can cause overgrazing, soil erosion and nutrient loss. Rotational grazing manages the amount of time livestock spend on a given pasture by rotating animals among various pastures and providing pastures sufficient time to regrow. Reseeding pastures increases vegetative cover in areas that may be denuded and can introduce more desirable species for forage. Nutrient management is also important on pastures	**Impact** Vermont has funded investment in improved grazing management on 11,500 acres since 2019[167]. Farmers report managing over 110,000 acres of permanent pasture in Vermont[168] offering considerable opportunity to expand adoption. While implementation of these agronomic and grazing practices are currently being tracked by VAAFM, a protocol needs to be researched and developed to quantify GHG mitigation from these practices for Vermont. EPA considers intensive grazing as an abatement measure for enteric fermentation and the mitigation of the release of CH_4 from ruminant animals. Globally, EPA places a reduction efficiency of -13.3% for beef cattle

[165] Drever, C Ronnie et al. "Supplementary Materials for Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/suppl/10.1126/sciadv.abd6034/suppl_file/abd6034_sm.pdf (Table S1)
[166] U.S. Department of Agriculture Natural Resources Conservation Service. "Conservation Practice Physical Effects on Soil, Water, Air, Plants, Animals, Energy, People; National Summary Tool FY2021." Technical Resources. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/econ/tools/?cid=nrcs143_009740.
[167] USDA NRCS-VT currently provides the majority of financial assistance programing with over 1,300 acres of prescribed grazing applied in 2019.
[168] U.S. Department of Agriculture National Agricultural Statistics Service. "2017 Census of Agriculture." https://www.nass.usda.gov/Publications/AgCensus/2017/index.php.

	to ensure plants have sufficient nutrients to grow and to avoid excess application of nutrients. Pasture management is also important for forage quality, which can reduce enteric emissions (discussed in action (j) below). VAAFM funds Rotational Grazing and No Till Pasture and Hayland Renovation (re-seeding) through the FAP program and various structural practices and management assistance to improve pasture quality through the Pasture and Surface Water Fencing (PSWF) program.	and -15.5% for dairy cattle from baseline CH_4 levels when intensive grazing is applied.[169] **Equity** Jurisdictional RAP farms are eligible to apply for VAAFM programs. A comprehensive review for equity should be undertaken by state programs. Outreach regarding program eligibility and availability should be expanded. **Cost-Effectiveness** VAAFM's FAP and PSWF programs seek to reduce the barriers to adoption for farmers to implement more management intensive grazing programs through technical and financial assistance to support plan development and water and fencing infrastructure design and installation. While there are both technical barriers and capital startup costs, annual operation and maintenance costs for management intensive grazing can represent a savings to farmers with EPA modeling an annual Operation & Maintenance Cost (in 2020 USD) between -$180 to +$1 per head for maintenance of implemented management intensive grazing practices globally.[170]
	Timeline to Implement: 0-6 months	**Co-Benefits** Multiple co-benefits are provided by farmers adopting management-intensive grazing on their farms. These include the reduction of nutrients transported to surface and groundwater through increases to plant vigor and uptake of nutrients. A slight to moderate improvement to terrestrial habitat for wildlife and invertebrates is noted as the improvement or maintenance of quantity and quality of forage for grazing and browsing animals' health and productivity improve or maintain the quantity and quality or connectivity of food and/or cover available for wildlife. Benefits to reduce soil erosion, improve water

[169] U.S. Environmental Protection Agency. "Global Non-CO2 Greenhouse Gas Emission Projections & Marginal Abatement Cost Analysis: Methodology Documentation." September 2019. https://www.epa.gov/sites/default/files/2019-09/documents/nonco2_methodology_report.pdf (p.S5-P168)
[170] Ibid

		utilization, improve plant condition, improve habitat for fish and wildlife, and other air quality benefits are noted.[171]
		Technical Feasibility: Yes
d.	**Action Details** **Implement agroforestry and silvopasture practices that integrate woody vegetation in agricultural production** **Woody vegetation** (trees and shrubs) also sequester carbon as they grow and store more carbon and for longer periods in their woody biomass compared to herbaceous vegetation. Agroforestry or agriculture that incorporates the cultivation and conservation of trees thereby increases the amount of carbon sequestered and stored compared to agriculture without trees. Practices that add woody vegetation on cropland include alley cropping, which adds rows of trees or shrubs in between rows of crops. Silvopasture is the deliberate and managed integration of trees and grazing livestock on the same land. USDA NRCS Vermont currently provides the bulk of technical and financial assistance for farmer adoption and implementation of agroforestry and silvopastoral practices. VAAFM will need to expand practice standards in its FAP and PSWF programs to provide technical and financial assistance for these conservation practices.	**Impact** Silvopasture systems are highly effective at mitigating GHG emissions from agriculture through the simultaneous management of tree crops, livestock grazing, and forage crops on the same unit of land. Canada estimates that tree intercropping and silvopasture system adoption represent 18% of the total annual mitigation potential from agricultural GHG mitigation pathways.[172] High potential for long-lasting climate mitigation from this practice is balanced against the need for near-term enhanced technical assistance to ensure successful adoption and integration of this practice on Vermont farms.
		Equity Jurisdictional RAP farms are eligible to apply for VAAFM programs. A comprehensive review for equity should be undertaken by state programs. Outreach regarding program eligibility and availability should be expanded.
		Cost-Effectiveness 100% of the annual mitigation potential for the adoption silvopasture is available at ≤ \$10/MT CO_2e in Canada. The same study estimates that 100% of the annual mitigation potential for the adoption of tree intercropping is available at ≤ \$50/MT CO_2e.[173]
	Timeline to Implement: 1-2 years	**Co-Benefits** Co-benefits for the adoption of agroforestry and silvopasture practices are numerous and span benefits for air, biodiversity, soil, water

[171] U.S. Department of Agriculture Natural Resources Conservation Service. "Conservation Practice Physical Effects on Soil, Water, Air, Plants, Animals, Energy, People; National Summary Tool FY2021." Technical Resources. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/econ/tools/?cid=nrcs143_009740.
[172] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.
[173] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.

		quality, and social considerations. Increased biodiversity and abundance of native bees and other beneficial insects is important to note, also increased economic benefit from the diversification of farm product and revenue.[174]
		Technical Feasibility: Yes
e.	**Action Details** **Implement edge-of-field practices that increase herbaceous and woody vegetation, e.g. CREP riparian forest buffer** **Woody** vegetation can also be added to the edge of crop fields or pastures through practices such as forested riparian buffers, windbreaks, or other tree/shrub establishments. VAAFM and USDA Farm Service Agency (FSA) jointly fund the Conservation Reserve Enhancement Program (CREP) to establish riparian forested buffers along Vermont's waterways. It is recommended that the payment rates for CREP be increased to incentivize further adoption across the state. **Herbaceous** vegetation can also be added to the edge of annual crop fields by expanding existing buffers or field borders. VAAFM funds such plantings via Filter Strip and Forage and Biomass Planting practices through its Grassed Waterway and Filter Strip (GWFS) program.	**Impact** Currently there are over 2,000 acres of CREP under contract, but many more acres of vegetated or forested riparian buffers are implemented in Vermont. While implementation of these agronomic practices are currently being tracked by VAAFM, a protocol needs to be researched and developed to quantify GHG mitigation from these practices for Vermont. High impact through the retirement of active cropland or enhancement of existing edge-of-field buffers to include herbaceous and woody species adjacent to surface waters. High impact of GHG mitigation potential through both cultivation of woody biomass and increases in soil organic carbon on a per-acre basis is limited to modest total impact by the scope of implementation – maintaining prime agricultural soils for crop production limits area of opportunity for implementation on a sharply increasing marginal abatement cost as foregone income and other opportunity costs are considered by farmers.
		Equity Jurisdictional RAP farms are eligible to apply for VAAFM programs. Farms also need to be eligible for USDA Farm Bill programs for CREP. A comprehensive review for equity should be undertaken by state programs. Outreach regarding program eligibility and availability should be expanded.
		Cost-Effectiveness

[174] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034. (p.70)

		High cost per acre of implementation relative to other NCS is noted for this action as there are multiple costs embedded in the per-acre rate, including: implementation of the conservation practice (e.g. tree planting) itself which is relatively labor and material intensive as well as incentive payments to offset forgone income and recurring rental payments for the farmer. A study in Canada finds that none of the 0.7 MMT CO_2e/yr annual mitigation potential from the practice of riparian tree planting is available for implementation ≤ $100/MT CO_2e.[175] The multiple conservation benefits outweighs the lower cost-effectiveness compared to other in-field conservation practices and elevates this program action to a high priority.
	Timeline to Implement: 0-6 months	**Co-Benefits** Air, biodiversity, soil, water, and social co-benefits are all enhanced from the implementation of edge-of-field conservation practices that increase herbaceous and woody vegetation. Benefits to aquatic and terrestrial habitats, as well as reduced runoff of sediment and nutrients from crop fields are major co-benefits of such practices. Increasing vegetation along waterways also reduces erosion and stabilizes banks during high precipitation events, improving water quality through reduced nutrient deposition. Trees and native plants also have many co-benefits for pollinators and wildlife. **Technical Feasibility:** Yes
f.	**Action Details** **Implement natural resource restoration practices that support climate mitigation and resilience, including river corridor easements, wetland restoration, and afforestation practices with consideration to agricultural land loss.**	**Impact** Various natural resource practices, such as wetland restoration and afforestation (both which sequester and store carbon), support climate mitigation and resilience. Restoration projects can increase the wetland acreage as well as restore wetland performance, and the benefits of afforestation on agricultural land are mentioned above. River corridor

[175] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.

	A network of state, federal, and non-profit partners offer and implement natural resource protection and restoration projects with willing landowners throughout Vermont. Whether paired with permanent farmland conservation easement or implemented separately, these restoration projects can leverage and enhance natural resource benefit on farms. Examples of these natural resource restoration programs include the DEC River Corridor Easement program, the USDA NRCS Wetland Reserve Enhancement Program, the USDA FSA Conservation Reserve Enhancement Program, among other site-specific practice enhancement programs administered by DEC or USDA NRCS. Natural resource restoration projects provide climate mitigation, adaptation, and resilience benefits – among significant co-benefits for water quality, aquatic and terrestrial habitat, and biodiversity. VAAFM is authorized to administer the Agricultural Environmental Management (AEM) Program at 6 V.S.A. § 4830 which can approve payments for conservation easements, land acquisition, farm structure decommissioning, site reclamation, and in-lieu payments for benefits that would otherwise be unrealized through the implementation of existing agricultural conservation programs. The AEM program can help extend the effectiveness of existing state and federal programs that target the natural resource restoration projects and can help bridge the gap of opportunity cost that might otherwise preclude a farmer from participating in a conservation program.	easements permanently protect dynamic streambanks, allowing for extensive climate resilience benefits and permanent forested buffers. Farmers in Vermont has conserved over 5,000 acres of wetlands through 68 permanent wetland easements with USDA NRCS.[176] All mapped wetlands and water bodies in Vermont have been identified to store 57 MMT CO_2-e with an annual sequestration of -0.01 MMT CO_2-e /yr.[177]
		Equity Farmers, as the owners and managers of the lands involved in this conservation area, are decision makers that need to be directly involved when considering equity outcomes. Robust farmer participation in natural resource conservation programs is occurring throughout Vermont because programs are responsive to farmer goals and priorities and sufficient technical assistance and financial assistance can support planning over multiple years to achieve implementation.
		Cost-Effectiveness As a means of mitigation for agriculture, natural resource restoration projects do not rank as highly on a cost per ton of CO_2 equivalent basis compared to agronomic practices applied to cropland, as an example. From a climate adaption and resilience perspective these natural resource restoration programs and practices are highly cost-effective. Taken together, these natural resource restoration programs are ranked high for both impact, cost effectiveness, and prioritization.
	Timeline to Implement: 0-6 months	**Co-Benefits**

[176] Jim Eikenberry, USDA NRCS VT Wetlands Specialist. Personal Communication.

[177] Galford, Gillian, Darby, Heather, Kosiba, Alexandra, and Hall, Frederick. "A Carbon Budget for Vermont: Task 2 in Support of the Development of Vermont's Climate Action Plan." September 2021. https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/Carbon%20Budget%20for%20Vermont%20Sept%202021.pdf

		Benefits to air, soil, water, biodiversity, wildlife habitat, flood resilience, as well as social considerations abound for these natural resource restoration projects. Ponding and flooding benefits are provided, wherein a restored wetland can provide flood storage during rainfall events.
		Technical Feasibility: Yes
g.	**Action Details** **Implement Nutrient Management and Amendments (e.g. biochar, compost) on cropland and grazing land.** Nutrient management balances the appropriate nutrient applications for optimum plant growth while minimizing loss of nutrients to soil, water, and atmosphere. **Nitrogen** is the primary nutrient of concern, that, through various pathways, can be emitted to the atmosphere as nitrous oxide (N_2O), a greenhouse gas 298 times more potent than CO_2 over a 100-year time period. Even nitrogen in the soil and water can ultimately be emitted to the atmosphere through processes of volatilization, runoff and leaching. Any practice or management that increases utilization or reduces loss of nitrogen to the environment reduces emissions, in addition to providing water quality benefits. Examples include precision agriculture, variable rate technologies for applying nutrients, and nitrogen inhibitors for improved fertilizer use efficiency, in addition to general nutrient application management. Both organic (e.g. manure) and synthetic nitrogen fertilizer have the potential to be lost to the atmosphere, however the creation of synthetic nitrogen fertilizer is an energy-intensive process,	**Impact** Both EPA and USDA consider nutrient management with a specific focus on the efficient utilization of nitrogen fertilizers as a strategy for agricultural GHG mitigation. Of the 40 MMT reduction potential from cropland management across the United States, USDA estimates that about 10% of the total mitigation potential comes from nitrogen nutrient management.[178]
		Equity Farms are required to comply with state nutrient management standards. Nutrient management standards are farm-size based.
		Cost-Effectiveness Technological costs can be high for the acquisition of variable rate technology or the use of inhibitors. Technical assistance and planning support is needed to assist with proper agronomic balancing. 90% of the annual mitigation potential is available at ≤ \$100/MT CO_2e though only 11% of the annual mitigation potential is available at ≤ \$10/MT CO_2e in the United States per a USDA study.[179]

[178] Pape, D., J. Lewandrowski, R. Steele, D. Man, M. Riley-Gilbert, K. Moffroid, and S. Kolansky, 2016. "Managing Agricultural Land for Greenhouse Gas Mitigation within the United States." Report prepared by ICF International under USDA Contract No. AG-3144-D-14-0292. July 2016. https://www.usda.gov/sites/default/files/documents/White_Paper_WEB_Final_v3.pdf (p.31)

[179] Ibid

	thus the use of **manure** *instead* of synthetic fertilizer is also a climate mitigation strategy. Planting **legumes**, which naturally convert atmospheric nitrogen to plant available nitrogen, is another way to naturally supply nitrogen instead of synthetic fertilizer. Programs that facilitate nutrient management education and planning for farmers are important to continue and enhance. All farms per the VAAFM Required Agricultural Practices Rule (RAPs) are required to follow nutrient management guidelines and all large, medium and certified small farms are required to develop and implement a nutrient management plan to USDA NRCS standards. VAAFM also funds grants for technical service providers to educate and assist farmers with the upkeep of nutrient management plans. VAAFM has begun and seeks to bolster investment in research, application, and adoption of precision agricultural technologies and their use on farms in Vermont. There are also various **carbon**-rich amendments that can be added to agricultural fields, which add carbon to the soils. Animal **manure** itself contains carbon and thus adds carbon to the soil when applied to crop fields or added directly by grazing animals on pasture. **Compost**, a soil like substance resulting from a *biological* process in which aerobic microorganisms decay organic materials such as manure and bedding, creates a more stable form of carbon that can be added to fields. **Biochar** is an even more stable form of carbon similar to charcoal that is produced by pyrolysis of biomass in the absence of oxygen; however, the *thermochemical* process is energy-intensive and therefore the net climate impact needs to be confirmed and verified before marketing to farmers—and is often cost-prohibitive.	

	Timeline to Implement: 0-6 months	**Co-Benefits** Benefits for air, biodiversity, and water quality can be realized through the implementation of nutrient management planning and implementation. Social considerations include a potential benefit to farm operations wherein their operating costs can be reduced while maintaining similar levels of crop productivity.
		Technical Feasibility: Yes
h.	**Action Details** **Implement methane capture and energy generation on farms, e.g. anaerobic digesters and covers.** Manure from livestock contain carbon and nitrogen, which can be lost to the atmosphere primarily as methane (CH_4) but also nitrous oxide (N_2O), both potent greenhouse gases—25 and 298 times more potent than CO_2 over a 100-year period[180], respectively. Emissions from manure management are significantly affected by **storage type**, duration, temperature, moisture and manure composition. Storage of manure as a liquid has four times[181] higher emissions compared to solid storage because more methane, which is more potent, is emitted from the *anaerobic* conditions of liquid storage, compared to more *aerobic* conditions of solid storage, which emits carbon dioxide (less potent).	**Impact** VAAFM, along with partners, have funded anaerobic digestors on 20 farms since 2005, which currently reduce emissions of nearly 16,000 animals, or 12% of dairy cow population in Vermont. This amounts to 27,000 $MTCO_2e$ reduced per year. Adding a digester to a liquid manure system can reduce methane emissions up to 90%[183]. Globally, EPA utilizes an 85% reduction efficiency across different digester or capture and flare systems .[184] The provision of Renewable Natural Gas (RNG) from on-farm anerobic digester products can provide a substitution benefit compared to other natural gas sources while abating emissions from manure management on farms in an effective manner. The destruction of CH_4 and conversion to CO_2 is a permanent climate benefit and is the only climate mitigation practice currently quantified in the Vermont GHG Emission Inventory.
		Equity

[180] Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. https://www.ipcc.ch/site/assets/uploads/2018/02/ar4-wg1-chapter2-1.pdf.

[181] Food and Agriculture Organization of the United Nations (FAO) Ex-Ante Carbon Balance Tool (EX-ACT). https://www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act/en/.

[183] Food and Agriculture Organization of the United Nations (FAO) Ex-Ante Carbon Balance Tool (EX-ACT). https://www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act/en/

[184] U.S. Environmental Protection Agency. "Global Non-CO2 Greenhouse Gas Emission Projections & Marginal Abatement Cost Analysis: Methodology Documentation." September 2019. https://www.epa.gov/sites/default/files/2019-09/documents/nonco2_methodology_report.pdf

	As such, switching from liquid storage (2.01) to solid storage (0.49), especially one that composts (0.28 $MTCO_2e$/dairy cow/year), reduces emissions from manure storage (4-7 times)[182]. Furthermore, reducing the amount of **time** manure is stored by increasing **grazing** time, which deposits manure directly on pasture, reduces emissions from manure storage (e.g. switching from confinement to grazing half of the year reduces emissions by half). However, the winter climate in Vermont and water quality standards necessitates a certain amount of manure storage. Additionally, the growing trend in manure storage is expansion of liquid storage. However, there are technologies that reduce emission from manure stored as a liquid. **Covers** on liquid storage prevent emissions from being emitted to the atmosphere and the captured methane (the primary component of natural gas) can be used as a fuel source on the farm. **Anaerobic Digestors** utilize bacteria to break down organic matter—such as animal manure, wastewater biosolids, and food wastes—in the absence of oxygen to create methane, which can be used as a biogas. Capturing methane from the storage of manure is an effective way to reduce emissions and create a renewable fuel source.	High initial capital costs and the need for long-term ongoing management of the systems provides a barrier to adoption for small to medium sized farms which have less farm staff and assets to offset initial startup as a system builds towards payback. **Cost-Effectiveness** Methane capture and energy generation projects have high initial capital costs. An example project for an 800-cow dairy farm cost $1.8 million dollars to implement but has a 7-year payback timeframe based on electricity generated and sold as well as use of waste-heat by the farm. A recent project on a Vermont farm was brought online in 2021 and produces Renewable Natural Gas as a product of the digestion process. While these systems have high-cost effective ratios, farmers themselves face significant upfront costs and ongoing maintenance for a project to be implemented successfully.
	Timeline to Implement: 1-2 Years	**Co-Benefits** Co-benefits for farm income and viability are an outcome of successfully implemented projects. Other co-benefits include the reduction of nutrients transported to surface water as management options for the farm are increased regarding storage, transport and application of wastes, proper field application of nutrients minimizes runoff losses.[185]

[182] Ibid

[185] U.S. Department of Agriculture Natural Resources Conservation Service. "Conservation Practice Physical Effects on Soil, Water, Air, Plants, Animals, Energy, People; National Summary Tool FY2021." Technical Resources. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/econ/tools/?cid=nrcs143_009740.

		Technical Feasibility: Yes
i.	**Action Details** **Research and pilot improved manure management and storage programs.** There may be additional methods or improvements to the manure storage strategies listed above that warrant additional research and development if proven to be effective. Emission from manure management represent 25% of the agriculture sector emissions in 2017[186]. It is important to consider equity of funding across all farm sizes when such technology is primarily feasible for large farms only. Other technologies may include acidification of manure[187] or addition of biochar[188] for example. VAAFM, through its Phosphorus Innovation Challenge (VPIC), is funding research and development of digestors, mobile composting units, and biochar which can have climate mitigation benefits.	**Impact** If the acidification of fresh manure slurries can replicate the impact of studies, it may be possible to reduce 64-99% of CH_4 emissions over the summer manure storage season.[189] Literature suggests that 90% of annual methane emissions can come through the summer months.[190] A control treatment of treating manure could have significant impact for Vermont's most common manure storage system type.
		Equity Research will need to investigate equity considerations in development and implementation of manure storage and treatment technologies.
		Cost-Effectiveness Cost-effectiveness will need to be considered against other NCS' that can be implemented on agricultural operations.
	Timeline to Implement: 1-2 years	**Co-Benefits** Reduction in emissions from manure storage can have co-benefits for air quality for this program.
		Technical Feasibility: Yes
j.	**Action Details** **Research and develop a climate feed management program, including both feed amendments (e.g. seaweed, biochar) and feed quality (e.g. forage quality) to**	**Impact** EPA reports and models that improved feed conversion is an abatement measure for enteric fermentation and the release of CH_4 globally. There is a range of reduction efficiencies that are reported that span from a

[186] Agency of Natural Resources – Department of Environmental Conservation – Air Quality and Climate Division. "Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990-2017." May 2021. https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

[187] S. O. Petersen, A. J. Andersen, J. Eriksen. "Effects of cattle slurry acidification on ammonia and methane evolution during storage." Journal of Environmental Quality 41 (2012): 88–94 (2012).

[188] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.

[189] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.

[190] H. Baldé, A. C. VanderZaag, S. Burtt, L. Evans, C. Wagner-Riddle, R. L. Desjardins, J. D. MacDonald. "Measured versus modeled methane emissions from separated liquid dairy manure show large model underestimates." Agriciculture, Ecosystems Environment 230 (2016): 261–270.

	reduce enteric methane emissions; consider downstream impacts, sustainability and equity. **Enteric fermentation** is a biological process that occurs in the digestive system of animals, primarily ruminants (e.g. cows, sheep, goats) that produces methane, primarily through belching. With Vermont being a large dairy state, nearly 50% of the agriculture sector emissions in Vermont are from enteric emissions[191]. However, enteric fermentation is a natural by-product of animals and thus has limited management options and minimal reduction potential[192]. [Although methane from cows is *biogenic* (naturally produced), because livestock are raised by humans, it is considered an *anthropogenic* source of emissions subject to emission tracking.] Two approaches offer potential for reducing enteric fermentation emissions. **Feed amendments**, such as seaweed and biochar, have been documented to reduce enteric emissions. However, it is important to source these products sustainably and equitably to not cause negative impacts to humans, environment, or climate. Furthermore, feed amendments tend to be costly. A more local approach is to improve the **feed quality**, which reduces enteric emissions per unit of product (milk, meat). Further research is needed to appropriately develop these strategies for farms in Vermont.	decrease of 39.4% per head to an increase of 39.6% per head. Vermont agriculture currently has high productive capacity per cow and so the Vermont specific impact is unknown and requires further research. **Equity** Research will need to investigate equity considerations in development and implementation of climate feed management program. **Cost-Effectiveness** The cost and cost-effectiveness of the implementation of a climate feed management strategy needs to be researched and considered compared to other NCS that can be applied across a farm's management area. The annual operation and maintenance costs estimated by the EPA for improved feed conversion programs range from $25 - $295 per head per year.[193]
	Timeline to Implement: 1-2 years	**Co-Benefits** Certain feed management strategies – such as adoption management-intensive grazing that

[191] Agency of Natural Resources – Department of Environmental Conservation – Air Quality and Climate Division. "Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990-2017." May 2021. https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

[192] U.S. Environmental Protection Agency. "Global Non-CO2 Greenhouse Gas Emission Projections & Mitigation: 2015-2050." https://www.epa.gov/sites/default/files/2019-09/documents/epa_non-co2_greenhouse_gases_rpt-epa430r19010.pdf

[193] U.S. Environmental Protection Agency. "Global Non-CO2 Greenhouse Gas Emission Projections & Marginal Abatement Cost Analysis: Methodology Documentation." September 2019. https://www.epa.gov/sites/default/files/2019-09/documents/nonco2_methodology_report.pdf. (S.5, P.167)

		increase forage uptake, availability, and quality for livestock – can have multiple co-benefits for farm profitability and associated air and water quality benefits associated with improved pasture management.
		Technical Feasibility: Yes

Other Non-Energy Emissions Pathways for Mitigation

The "Other Non-Energy Emissions" umbrella is made up of a variety of emissions sectors and categories, including emissions from the Industrial Processes, Solid Waste and Wastewater, Fossil Fuel and Agricultural sectors. There are a number of specific sources that contribute to greenhouse gas (GHG) emissions within this broader sector in Vermont which include the use of ozone depleting substances (ODS) substitutes, semiconductor manufacturing, solid waste and wastewater treatment, fugitive methane emissions from the transmission and distribution of natural gas, and numerous components related to agricultural emissions. Greenhouse gas emissions from the fossil fuel sector (fugitive methane emissions) will be addressed in the buildings sector section of this Chapter and agriculture sector emissions will be discussed and addressed in a separate Chapter of this report.

The majority of the greenhouse gases emitted by the sources within the Other Non-Energy Emissions sector are gases other than carbon dioxide (CO_2). These gases include methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), nitrogen trifluoride (NF_3), and sulfur hexafluoride (SF_6), all of which are significantly more potent than CO_2 in terms of their ability to warm the planet. Sulfur hexafluoride, for example, is roughly 22,800 times more potent than CO_2 on a 100 year time scale[194]. While some of these gases stay in the atmosphere for a very long time, others such as CH_4 have short atmospheric lifetimes (approximately 12 years). Reducing emissions of high GWP short-lived climate pollutant (SLCP) gases is a priority for impactful GHG reductions in the near term.

This section will present pathways to address emissions from the wastewater sector, the use of high global warming potential refrigerants, and the production of semiconductors. While emissions from the solid waste sector continue, significant progress has been made to date, and the implementation of the Universal Recycling Law[195] should further reduce emissions from that sector. Future plans will evaluate whether additional solid waste actions are necessary to meeting 2030 and 2050 requirements. Additional pathways, strategies, and actions are available in the appendix and are also recommended for action. The actions presented below, however, represent priority actions necessary to meet the Global Warming Solutions Act greenhouse gas emissions reduction requirements.

Pathway 1: Reducing Emissions of Refrigerants in Vermont

High global warming potential (GWP) HFCs are often used in refrigeration end uses, such as commercial and industrial refrigerators and freezers, and when leakage or accidental releases of these gases occur from the refrigeration systems it can produce significant greenhouse gas emissions. Monitoring and preventing the leakage of HFCs from large refrigeration systems and transitioning those systems to low GWP refrigerants will be an important step to reduce GHG emissions from the Industrial Processes sector. This pathway includes strategies to minimize emissions of high GWP refrigerants in several ways with a focus on monitoring, reporting, and

[194] Intergovernmental Panel on Climate Change (IPCC) – AR4 Global Warming Potential (GWP) values: https://archive.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html

[195] Vermont Department of Environmental Conservation, Waste Management and Prevention Division: https://dec.vermont.gov/waste-management/solid/universal-recycling

repair requirements for refrigeration systems over a certain size threshold, as well as leak detection systems and incentives for businesses to switch to lower GWP alternatives.

1. Adopting a Refrigerant Management Program (RMP) and Related Actions

Currently there is very little oversight related to the use of refrigerants in various systems around Vermont. Adopting a refrigerant management program, similar to that adopted by California[196], would require entities that use over a certain threshold of high GWP refrigerants to inspect and report on their systems periodically, and to fix any leaks. Additionally, permanent leak detection systems could be placed on larger refrigeration systems which would allow for more real-time monitoring and which has the potential to avoid catastrophic leaks, which have a much larger GHG emissions impact. These monitoring and leak detection components should also be coupled with incentives for businesses to transition away from high GWP refrigerants to lower GWP alternatives. This switch would reduce the overall potential for leakage or release of refrigerants from these systems and speed the phase out of high GWP HFCs already underway in new or retrofit equipment through the Act 65 rulemaking[197] process.

High (and consensus medium) Priority Actions

Lead Implementer: Agency of Natural Resources, VEIC		
a.	**Action Details** Work with VEIC and other stakeholders to complete additional outreach and education to help determine the scope and thresholds for a refrigerant management program (RMP) for Vermont, as well as to evaluate the potential impacs of such a program. Additionally work with VEIC and other stakeholders to better understand the number of entities and potential associated costs and benefits would be necessary. While the evaluation and review of potential program details would provide greater certainty, the resulting RMP would likely require registration, periodic reporting, and repair obligations for businesses that meet the refrigerant threshold requirements.	**Impact** Reductions of emissions from high GWP refrigerants is an important component for mitigating emissions from the Industrial Processes sector. Ozone depleting substances (ODS) substitutes make up approximately 60% of emissions from the Industrial Processes sector[198] and high GWP refrigerants are an important component of that total. **Equity** Addressing sectoral emissions from the industrial process sector ensures that all Vermonters and Vermont businesses are contributing to the shared emissions reductions requirements. To implement reductions in refrigerant emissions equitably, it is critical that Vermont support BIPOC and New American-owned businesses and other small businesses that are

[196] California Air Resources Board (CARB) – Refrigerant Management Program: https://ww2.arb.ca.gov/our-work/programs/refrigerant-management-program/about
[197] Vermont Department of Environmental Conservation (DEC): https://dec.vermont.gov/sites/dec/files/aqc/laws-regs/documents/Vermont_HFC_Rule_Adopted_CLEAN.pdf
[198] Vermont DEC – GHG Inventory: https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

		required to participate. That support should come in the form of financial incentives, language access, and project counseling.
		Cost-Effectiveness The cost effectiveness for this action is somewhat variable due to the many different types and sizes of refrigeration systems. Costs associated with the RMP would be connected to the inspection and reporting requirements, as well as to any repairs required if leaks were found. In many cases these costs could be recouped over time because fixing leaks would lead to smaller amounts of refrigerants that would need to be purchased.
	Timeline to Implement One to two years	**Co-Benefits** - Potential cost savings for participating entities through purchasing less refrigerant. - Reducing short-lived climate pollutants has important near-term GHG benefit.
		Technical Feasibility Yes
b.	**Action Details** Require and provide cost share for the installation of permanent leak detection systems for facilities using over a certain threshold of high GWP refrigerants. Permanent leak detection systems would provide real-time monitoring of refrigeration systems to detect and allow for leaks to be repaired quickly. Specific funding needs will be informed by the development of the RMP to help inform which entities would benefit or qualify. Additional work with VEIC and other stakeholders to better understand the number of entities and potential associated costs and benefits would be necessary.	**Impact** The GHG reduction impact from a permanent leak detection system is potentially high but depends upon the type and amount of refrigerant being used within the system. Permanent leak detection systems can prevent catastrophic leaks from large systems by providing real time information (as opposed to less frequent inspections conducted as part of the RMP) and enabling the fixing of leaks before they become major issues.
		Equity Addressing sectoral emissions from the industrial process sector ensures that all Vermonters and Vermont businesses are contributing to

		the shared emissions reductions requirements. To implement reductions in refrigerant emissions equitably, it is critical that Vermont support BIPOC and New American-owned businesses and other small businesses that are required to participate. That support should come in the form of financial incentives, language access, and project counseling.
		Cost-Effectiveness The cost-effectiveness of permanent leak detection systems is variable because it depends upon both the costs of the equipment as well as the leaks prevented.
	Timeline to Implement One to two years	**Co-Benefits** - Potential cost savings for participating entities through purchasing less refrigerant. - Reducing short-lived climate pollutants has important near-term GHG benefit.
		Technical Feasibility Yes
c.	**Action Details** Provide incentives for businesses to transition from high GWP refrigerants to lower GWP alternatives. Outreach and funding could be targeted through information collected through the RMP to transition applicable businesses away from high GWP refrigerants. This would be a voluntary program that could help to speed the phase out of these high impact GHGs. The incentives would complement and supplement the Act 65 rulemaking which currently requires the phase out of high GWP HFCs in new equipment and retrofits by end use, and this program could potentially be expanded to include end uses beyond just refrigeration.	**Impact** The impact of the incentives would be variable and depend on the projects funded. Given the expected rise in emissions of HFCs in the coming years[199] and their high GWPs and often short atmospheric lifetimes reducing the use of these gases is an important step to take in mitigating GHG emissions in Vermont.
		Equity Addressing sectoral emissions from the industrial process sector ensures that all Vermonters and Vermont businesses are contributing to the shared emissions reductions requirements. To implement reductions

[199] EPA Significant New Alternatives Program (SNAP): https://www.epa.gov/snap/reducing-hydrofluorocarbon-hfc-use-and-emissions-federal-sector-through-snap

		in refrigerant emissions equitably, it is critical that Vermont support BIPOC and New American-owned businesses and other small businesses that are required to participate. That support should come in the form of financial incentives, language access, and project counseling.
		Cost-Effectiveness The cost-effectiveness of incentivizing the transition from high GWP refrigerants to lower GWP alternatives is variable because it depends on the equipment being replaced or retrofitted, as well as the gas being replaced and the new alternative refrigerant. In some cases, a transition to a new low GWP refrigerant can provide efficiency benefits that would provide cost savings over time.
	Timeline to Implement One to two years	**Co-Benefits** - Potentially new or updated equipment for qualifying businesses. - Potential for cost savings over time through increased system efficiency.
		Technical Feasibility Yes

Pathway 2: Reduce Process Emissions from Semiconductor Manufacturing in Vermont

Greenhouse gas emissions associated with semiconductor manufacturing in Vermont make up approximately 34% of the total for the Industrial Processes sector[200]. Global Foundries is the sole semiconductor manufacturer in Vermont and the GHG emissions associated with their industrial sector emissions include a number of fluorinated gases, including sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and nitrogen trifluoride (NF_3). Producing semiconductors requires the use of a number of high GWP gases in the etching and

[200] Vermont DEC – GHG Inventory: https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

chemical vapor deposition (CVD) processes, as well as their use as heat transfer fluids[201] for various tools. Reducing emissions of these high GWP gases in these processes is important, but in many cases is technically challenging, and is an area where further exploration is needed.

1. Continue to Explore Efficiencies and Alternatives to High GWP Fluorinated Gases in the Semiconductor Manufacturing Process

Because of the precision and extremely technical nature of the semiconductor manufacturing process, the options for mitigation strategies in the sector are somewhat limited. Potential reduction strategies in the sector include process improvements, the use of technologies to destroy the gases when emitted, and the use of alternative chemicals, or chemical substitutuions, to perform the same functions. Chemical substitutions can provide potentially significant emissions reductions, but require extensive review and testing before implementation. Global Foundries has been pursuing several of these actions already and discussions have been ongoing between Global Foundries, the Public Service Department (PSD), and the Agency of Natural Resources (ANR) through a pending Public Utilities Commission (PUC) proceeding considering Global Foundries' petition to become a Self-Managed Utility (SMU). The PUC proceeding may or may not result in emission reductions for Global Foundries consistent with the GWSA requirements. As of the date of this plan, the PUC proceeding has not been concluded. In the absence of sufficient and/or binding emissions reductions consistent with the GWSA requirements, ANR will promulgate rules in a timely manner necessary to ensure the 2025, 2030, and 2050 emissions redutions requirements are met. In the event that the PUC proceeding has not concluded by December 1, 2022, ANR will commence rulemaking.

High (and consensus medium) Priority Actions

Lead Implementer: Agency of Natural Resources, Department of Public Service		
a.	**Action Details** Under either PUC or ANR jurisdiction (see above), Global Founds will implement technologies for the destruction of emissions of high GWP gases and potentially use chemical substitutions in the semiconductor manufacturing process. These technologies and/or chemical substitutions would be implemented in line with GWSA greenhouse gas emission reduction requirements.	**Impact** Reducing emissions from semiconductor manufacturing can have a very direct impact because there is only one facility in Vermont producing those emissions. By working with Global Foundries to implement emissions reduction strategies, specifically including the fugitive gas destruction devices proposed as a component of the PUC process, significant reductions from the 0.19 million metric tons of CO_2 equivalent ($MMTCO_2e$) attributed the the facility for 2017 can be achieved.
		Equity Addressing sectoral emissions from the industrial process sector ensures that all Vermonters and Vermont businesses are contributing to

[201] EPA – F-Gas Partnership Programs – Semiconductor Manufacturing: https://www.epa.gov/f-gas-partnership-programs/semiconductor-industry

		the shared emissions reductions requirements.
		Cost-Effectiveness Reducing emissions from the semiconductor manufacturing sector is relatively expensive. The installation of the 28 fugitive gas destruction devices proposed as a part of the PUC process is estimated to cost roughly $10 million dollars. Costs associated with chemical substitutions are unclear, but may also provide meaningful emissions reductions.
	Timeline to Implement Dependent upon PUC proceeding outcome. If current proposal goes forward, implementation of devices will occur over the next several years.	**Co-Benefits** - Reductions of toxic co-pollutants including hydrofluoric acid (HF).
		Technical Feasibility Yes

Pathway 3: Reduce Fugitive Emissions from Wastewater Treatment Facilities

Greenhouse gas emissions from wastewater treatment facilities (WWTFs) included in the GHG inventory consist mainly of methane (CH_4) from the decomposition of organic materials under anaerobic conditions (in the absence of oxygen). Methane is a GHG that is 25 times more potent than CO_2 on a per mass basis with an atmospheric lifetime [202], based on current GHG inventory guideline values, making it an important focus for near-term GHG emissions reductions. Emissions of methane from WWTFs are created in anaerobic conditions in a digester and are generally either combusted for a beneficial use, such as the generation of heat or electricity, or flared (burned off), both of which convert the CH_4 to CO_2. Based on design standards for WWTF's, all of the treatment facilities with anaerobic digester systems in Vermont are required to be equipped with flares. Ensuring these flares are operational and functioning as they should be is a straightforward action that will help to reduce methane emissions from the facilities. Ideally, over the longer-term, beneficial uses of the methane produced in these anaerobic digesters can be incorporated, so that the produced methane can create energy for the facility or other uses. The strategy below represents a first step in that process.

1. Ensure Flares are Operational at Existing Anaerobic Digesters at Wastewater Treatment Facilities

There are currently 94 municipal wastewater facilities in Vermont and of those 94 facilities, 10 currently have anaerobic digester systems. The digester systems process treatment residuals from some of the larger municipalities in the state, which are often areas of high population

[202] Intergovernmental Panel on Climate Change (IPCC) – AR4 Global Warming Potential (GWP) values: https://archive.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html

densities and therefore produce significant volumes of wastewater as well as relatively large quantities of CH_4. Moreover, smaller municipalities often send treatment residuals to these larger WWTFs for further treatment in digesters. Additional review and outreach needs to be completed to determine the operational status of the flares at several of the 10 WWTFs with anaerobic digesters, but preliminary data suggests an opportunity for emissions reductions. Ensuring that the flares at several of these larger municipal facilities with digesters are operational could reduce emissions by an estimated 3,000 metric tons of CO_2e annually, and potentially more depending upon which additional facilities have non-functioning flares. One additional opportunity in this space is the potential for beneficial use of digester gas for digester facilities that do not currently have systems in place to take advantage of that existing fuel source. Installation of beneficial use systems may not be a cost-effective strategy for GHG mitigation, but does have co-benefits such as displacing fuel purchased for thermal needs and reliable and consistent electricity generation, as well as being able to recoup system installation costs over time.

High (and consensus medium) Priority Actions

Lead Implementer: Agency of Natural Resources		
a.	**Action Details** Ensure that flare systems are functional for all 10 of the WWTFs in Vermont with anaerobic digester systems. Conduct additional outreach to determine the operational status of flares at each facility and any potential issues surrounding maintaining the flares going forward. For facilities with digesters that do not have beneficial use capabilities, require a subsidized engineering evaluation to determine the costs associated with the installation of such a system.	**Impact** The impact of ensuring that existing flares on WWTF digester facilities are operational is likely relatively small, however, because the flares are already required to be present at the facilities, this action should be fairly easy to implement. Existing data suggests that approximately 3,000 metric tons of CO_2e could be reduced annually with the potential for greater reductions based on results from the additional outreach performed.
		Equity The operation of wastewater treatment facilities represents one of the most significant costs for Vermont municipalities, especially for low-income and economically depressed communities. Ensuring functioning flares across all community income spectrums is an important equity consideration. Further, functioning flares reduces odor and other public

		health concerns around facilities, addressing a significant environmental justice concern.
		Cost-Effectiveness The cost effectiveness of ensuring flares at WWTFs with digesters are operational is high. There will likely be costs associated with returning flares to operational status where they are not currently running. Cost-effectiveness for installation of beneficial use systems is likely low for GHG emissions reductions but is worth investigating in order to take advantage of an existing fuel source for other reasons.
	Timeline to Implement Two to three years	**Co-Benefits** - Reduction of nuisance odors
		Technical Feasibility Yes

Cumulative Assessment of Action on Carbon Reduction for 2025 and 2030 requirements

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.[203]

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.

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.

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

We will likely need all of them, or their equivalent, working in tandem at the scale and pace presented.

Pathways for Adaptation and Building Resilience in Communities and the Built Environment

There are a few common characteristics that define Vermont's landscape, people, communities, and social fabric. These characteristics include the rural nature of communities, the changing of the four seasons, ample opportunities for nature-based recreation, and the independent unassuming grit of the people. Climate change challenges Vermont communities and poses a risk to the systems and landscape that are central to our lives in this beautiful place. Storms are becoming more severe, more frequent, and more complex with each passing year. The 4th National Climate Assessment identifies the adverse impacts of drought and heavy precipitation events on rural areas of Northeast United States and highlights rural communities. "With little redundancy in their infrastructure and, therefore, limited economic resilience, many rural communities have limited ability to cope with climate-related changes[204]." Of the many natural hazards that impact Vermont, flooding poses the greatest risk to Vermont infrastructure and communities. According to the 3rd National Risk Assessment published by the First Street Foundation, Vermont has "26,565 residential properties, 7,030 miles of roads, 3,613 commercial properties, 273 infrastructure facilities, and 408 social facilities with operational flood risk today[205]."

Each year, Vermonters experience life-altering impacts of climate-related events. Nationally there has been over a 400% increase in the number of billion-dollar declared disasters since the 1980s[206]. Vermont is not immune to these impacts. During the period from 2010-2019 the President declared 17 Major Disasters occurred in Vermont which represents a significant increase over 2000-2009 in which there were 11, 1990-1999 in which there were 10, and 1980-1989 in which there were 2. These disasters include flooding, tornados, windstorms, ice and heavy snow, and tropical cyclones[207].

In 2011 Vermont was catastrophically impacted by Tropical Storm Irene. 225 communities were damaged by the storm, which followed record precipitation earlier that year. The resulting 7-11 inches of rainfall on the southern two-thirds of the state created one of the largest disasters in Vermont's history. Overall "13 communities had been completely cut off. 3,500 homes and businesses were damaged, including 500 mobile homes. 20,000 acres of farmland were under water, 500 miles of states roadway and some 200 bridges were damaged across the state, while

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[204] USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. https://nca2018.globalchange.gov/chapter/10/

[205] First Street Foundation. 2021. *The 3rd National Risk Assessment, Infrastructure on the Brink.* National Assessment, New York: First Street Foundation.

[206] (NCEI), NOAA National Centers for Environmental Information. 2021. *U.S. Billion-Dollar Weather and Climate Disasters (2021).* https://www.ncdc.noaa.gov/billions.

[207] US Federal Emergency Management Agency. n.d. *All Disaster Declarations.* Accessed 2021. https://www.fema.gov/disaster/declarations?field_dv2_state_territory_tribal_value=VT&field_year_value=All&field_dv2_declaration_type_value=All&field_dv2_incident_type_target_id_selective=All&page=4.

nearly 1,000 culverts had been washed away or damaged[208]." Irene poignantly demonstrated the need for Vermont to change course in climate adaptation. In the last 10 years, federal hazard mitigation funds have been leveraged to acquire and demolish almost 150 flood-vulnerable properties, implemented almost 70 infrastructure improvement projects, and created or updated 226 Local Hazard Mitigation Plans. The Emergency Relief and Assistance Fund statute, updated in 2014, incentivizes communities to increase their resilience to disasters through several actions that increase preparedness and break the cycle of disaster through hazard mitigation.

While these actions result in greater resilience to climate-related disasters, adaptation and resilience planning must also begin to incorporate an expanded paradigm about what it means to be truly resilient. While many strategies and actions in this section support continued efforts to increase resiliency to rain and flooding events, it also begins to expand the scope of work for understanding and preparing to be resilient to other changes to the climate, including higher average temperatures, extreme heat, and the ways in which new climate norms can have cascading effects on our health, key industries, and livelihoods.

This expanded paradigm for climate resiliency work should meet the Guiding Principles for Just Transition, which was developed per the mandate of the Global Warming Solutions Act. The guiding Principles for a Just Transition reflects a growing body of research that shows black, brown, indigenous, and low-income people and communities are disproportionately impacted by climate change, despite experiencing disproportionately fewer benefits and greater health, social and economic harms from the historic and ongoing industrial and economic growth that causes climate change. For example, the status quo is that residential flooding impacts are inversely correlated with socioeconomic status. To put a finer point on it, low-income Vermonters are more likely to live in flood prone locations and flood-vulnerable structures. Furthermore, projects to improve the situation are less easily accessed by Vermonters with lower incomes, renters, those in very rural communities, with limited e-connectivity, and/or with language and/or cultural barriers. To center equity and social justice in climate action planning, program design and outreach will need to explicitly be tailored to those with greatest vulnerability and least resources.

These pathways, strategies, and actions were drafted with the Principles for Just Transition in mind, however the full application of those principles to what is presented here, and direct engagement with frontline communities to inform these elements, remains to be done and will be done as the CAP continues to evolve. Furthermore, the Principles must apply to the entire GWSA lifecycle: the development of the CAP and its iterations, the development of legislation, the development of budgets, the promulgation of rules and regulations, and the execution and evaluation of programs. This section includes a Pathway and supporting strategies to increase capacity for building collective knowledge and collaborating on climate planning at the local, regional, and State levels. Strategies and Actions call upon infrastructure operators to assess climate threats, incorporate climate-resilient design standards, and strategically move critical infrastructure out of harm's way. If infrastructure projects are designed, evaluated, and constructed to meet these design standards rural communities will achieve the goal of sustaining critical services and lifelines with minimal disruption as a result of climate-related events in the

[208] Montpelier: Vermont Irene Recovery Office. 2013. *Irene: Reflections on Weathering the Storm.* Legislative Report.

future. Land-use policies must be modernized to recognize the increasing threat of climate events on developed structures with an overall goal of no or very limited new development in river corridors. And finally, acknowledging that access to safe, accessible, energy efficient and affordable housing is foundational to increasing both household and community resilience to climate change, this section of the plan proposes policy actions that will increase investment in housing availability and affordability by incentivizing new housing development, and remediating existing residential properties.

Vermont is experiencing climate-related events each year and those events are projected to increase in frequency, complexity, and severity. It is imperative to preserve and enhance Vermont's way of life by adapting to threats posed by climate change now and building resilience for the storms that we will inevitably face in coming decades.

PATHWAY 1: Increase capacity for climate resilience planning and implementation, and address inequities of under-resourced communities.

Climate change caused by greenhouse gas emissions is already affecting every inhabited region across the globe, and Vermont will face impacts from the effects of global climate change that are no longer avoidable[209]. While emissions reductions are still critical to avoid the most severe and widespread impacts, Vermont must also dedicate attention and resources to preparing for the unavoidable impacts of climate change. Early action and strategic investment today that increases resiliency also reduces future costs associated with recovering from or adjusting to climate impacts.

Adapting and becoming resilient to the impacts of a warmer climate will require significant investment at the local, regional, and State level. This investment will need to support changes to the information and processes used to make decisions, as well as to our physical infrastructure and social safety nets. Climate action will require that we increase collective knowledge on climate change impacts and resiliency measures, and support collaborative decision-making processes among community, civic and professional networks of people that shape and have a say in how communities in Vermont serve their members. Improving physical infrastructure and supporting social networks both enable Vermont to adapt to climate impacts and increase resiliency in the face of climate change and will also need significant investment.

Strategies

1. Provide tools and resources to help communities assess climate vulnerabilities and create climate resiliency plans.

Extreme weather events and disasters are not new to Vermont. Resources have been developed and deployed to successfully recover from extreme weather events. However, climate change is expected to increase the severity and frequency of extreme weather events, including high winds, heavy rain, hail and sleet while also creating new climate norms that cause persistent and ongoing impacts to physical health, economic stability, and community vitality of Vermont. Our

[209] IPCC 6TH Report, Summary for Policymakers. September, 2021. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

existing tools will need to be adapted to account for anticipated increases in frequency and severity of weather events, and new tools will be needed to identify and assess other climate change risks and vulnerabilities, particularly at the community scale. Tools for assessing climate change vulnerabilities and planning for resilience will help communities make the structural and investment changes needed to break the cycle of repetitive loss, speed post disaster recovery, and reduce long-term financial burden of disasters on communities, businesses, and individuals. Tools and resources for assessing climate vulnerabilities and planning for resilience should be developed in collaboration with EJ/under-represented communities, in acknowledgement that many of the tools used to inform policy decisions have historically caused harm to EJ communities.

Actions

a. Develop a climate planning toolkit to help towns assess vulnerabilities to climate change impacts, such as heat, air quality, drought, flooding, high winds, heavy rain, hail and sleet, and identify and prioritize actions to increase their resilience to climate change. Include newly developed tools, such as the vulnerability index, and existing tools, such as the AOT Repeat Flood Damage Inventory Tool, and the NOAA Climate Resilience Toolkit

Preliminary Assessment of Strategy against Criteria
Impact: Providing tools and information resources to assist with identifying, assessing and responding to climate change vulnerabilities enables climate change planning by helping to reduce the workload, particularly for under-resourced communities, and supporting a consistent and coordinated approach to climate change planning across the state. Providing tools and information resources is a first step towards impactful actions that improve resilience in communities across the State.
Equity: Tools for assessing vulnerability and plan adaptation actions should help the user of those tools understand the disproportionate impact that climate change has on frontline communities, particularly black and indigenous communities, identify who in their communities are likely to be most impacted by climate change, and provide guidelines, such as providing materials in the languages used by those most impacted, for engaging and consulting with impacted communities in completing vulnerability assessments and resiliency plans.
Cost-effectiveness: The investment needed to create and provide tools and resources to help communities identify, assess, and respond to climate change vulnerabilities is relatively low. It will require a one-time, upfront investment to update existing tools, create new ones, and develop a platform that makes them easily accessible to local and regional planners and community members. Some regular upkeep to keep tools relevant and up to date will also be required. Investment in tools to support climate planning can have a significant impact in reducing future costs by ensuring that vulnerabilities have been identified and actions to reduce them have been evaluated, identified, and leading to a high return on investment from climate actions.
Co-Benefits: Providing tools and information resources to support climate planning can improve all outcomes of climate work, including reducing emissions and sequestering

atmospheric carbon, in addition to improving resilience. Other co-benefits include improving public health outcomes, reducing the health risks from climate change impacts, reducing financial losses from climate change impacts, improving economic stability, and protecting natural resources.
Technical Feasibility: Yes

2. Establish permanent statewide funding and technical support for local and regional climate resilience planning and project implementation to enhance rural resilience to impacts of climate change.

Adapting to the impacts of climate change, and planning for resilience needs to be supported and informed by the local knowledge within Vermont's communities. Vermont's eleven Regional Planning Commissions (RPCs) play a critical role in supporting the State's 246 municipalities, especially those that are under-resourced. The RPCs ensure regional coordination and collaboration and help to advance State level goals and policy. The State can assist and collaborate with the Regional Planning Commissions and municipalities on climate planning by providing technical support and funding for the planning and implementation of projects that enhance community resilience to climate change impacts.

Actions

a. Increase funding to Regional Planning Commissions and local municipalities to support climate and energy planning and target funds to support towns with limited staff and marginalized populations that score high on the climate vulnerability index.
b. Create and fund one natural resource staff position at every Regional Planning Commissions to assist with implementation of climate policies and natural resources requirements such as Act 171 (forestry and habitat blocks). Use the Transportation Planning Initiative as a model to fund RPC natural resource staff and support trainings with ANR and other partners.
c. Increase and create a permanent state fund for design and implementation of local and regional climate adaptation and resilience projects.
d. Provide technical assistance to municipalities to assess the flood and erosion risks facing their drinking water and wastewater systems and identify potential mitigation improvements
e. Establish a state level individual assistance program to provide financial assistance to uninsured or underinsured households impacted by disasters not federally declared. Program should incorporate Community Action Agencies and supporting networks to ensure assistance is received expeditiously by those that need it most.

Preliminary Assessment of Strategy against Criteria
Impact: Resilience is unlikely to be achieved without human capital, funding, and technical support to begin building climate planning into current planning activities. Human, monetary, and technical resources are needed to complete a local or regional vulnerability assessments, develop resiliency plans, and implement resilience projects and programs. A permanent funding source to support staff capacity, climate resilience

planning, and project to reduce vulnerabilities and improve resiliency, would create a pipeline of projects that create resiliency in communities and across the State.
Equity: Increasing capacity to plan for and implement actions that improve resilience to climate change impacts should ensure that those who are most impacted by climate change experience contextual, procedural, corrective, and distributive equity in these investments. Due to historic and ongoing inequities, black, indigenous, and low-income communities, people of color, and persons with disabilities are often more vulnerable to climate change, and do not hold positions of power that make decisions on how and where climate action investments are made. These same segments of the population are repetitively impacted by disasters disproportionately. Community Action Agencies work with the most vulnerable people on a day-to-day basis and are therefore integral to ensuring assistance is provided post-disaster to the people who need it quickly. The benefits of investments in projects and programs have not been born equally by frontline communities. In many cases projects and programs that result in benefits for some cause direct harm to frontline communities, for example by siting infrastructure in a way that burdens frontline communities with negative environmental consequences and limits or excludes them from receiving the benefits[1]. Funds for resilience projects and programs should require representation from those most impacted by climate change, and work towards correcting past inequity (e.g. lack of investment or representation in project and program development) while preventing the exacerbation of existing inequities (e.g. investment cannot lead to displacement). Increased staff capacity to support climate action planning must have the ability and expertise to integrate the principles of the Just Transitions recommendations into their local climate action planning work.
Cost-effectiveness: Investment will likely be needed for more than 10 years. However, upfront investment in planning to improve resiliency provides a net benefit[210], and reduces the future costs associate with responding to climate impacts.
Co-Benefits: Increasing the capacity to do climate planning can improve all outcomes of climate work, including reducing emissions and sequestering atmospheric carbon, in addition to improving resilience. Other co-benefits include improving public health outcomes, reducing the health risks from climate change impacts, reducing financial losses from climate change impacts, improving economic stability, and protecting natural resources.
Technical Feasibility: Yes

3. Expand cross-sector collaboration to align efforts, share best practices, and leverage resources to advance resilience and preparedness efforts statewide.

To best meet the challenge of preparing Vermont's communities, infrastructure, businesses and residents to be more resilient to the impacts of climate change, we need an "all-in" approach to

[210] Research by the Global Center on Adaptation estimates that every dollar spent on adaptation results in between $2 and $10 of net benefits. https://gca.org/wp-content/uploads/2019/09/GlobalCommission_Report_FINAL.pdf

sharing information on climate impacts, collaborating to identify solutions and opportunities, and aligning efforts towards resiliency goals. A diverse group of stakeholders and partners, including non-profits, community organizations, public entities, business, and industry is needed to engage in the work of planning for climate resilience. The diversity of perspectives, priorities, and lived experiences can help to ensure that assessments of climate impacts and vulnerabilities is comprehensive, solutions that have broad benefits and support can be quickly elevated, and resources can be effectively leveraged to make progress towards resiliency goals. Any forums in which collaboration on climate planning occurs should be designed with, and designed to be inclusive of and welcoming to those most impacted by climate change.

Actions

a. Identify and develop new programs to address the full range of climate impacts, especially those that impact important Vermont industries, including drought, less or irregular snowfall, and shorter or irregular sugaring season.
b. Complete a Statewide climate change impact assessment for Vermont's commercial sector and natural resource based industries including but not limited to the ski, sugaring, and logging industries.

Preliminary Assessment of Strategy against Criteria
Impact: Ongoing and collaborative work to assess and plan for the full range of climate impacts and vulnerabilities, across communities, business sectors and natural resources leads to better informed, resourced, and effective programs that improve Vermont's resiliency to climate change impacts.
Equity: Cross sector collaborations should have the ability and expertise to integrate the principles of the Just Transitions recommendations into their collaborative processes. The validity of any of cross-sector collaborations for climate planning should consider the extent to which Just Transition principles where included in the collaborations, and are reflected in any outcomes of cross-sector collaborations.
Cost-effectiveness: Cross-sector collaboration is an enabling investment that ensures better return on investment of climate action by aligning stakeholders behind common information, goals and objectives, and leveraging private investment in climate action. S[211] investment in staff time and research and analysis support to organize and manage engagement with stakeholders over climate planning issues will be needed, and cross-sector collaboration will likely be needed for more than 10 years. However, upfront investment in planning to improve resiliency reduces the future costs associate with responding to climate impacts.
Co-Benefits: Supporting cross-sector collaboration in climate planning can improve all outcomes of climate work, including reducing emissions and sequestering atmospheric carbon, in addition to improving resilience. Other co-benefits include improving public health outcomes, reducing the health risks from climate change impacts, reducing financial

[211] https://openknowledge.worldbank.org/bitstream/handle/10986/35203/Enabling-Private-Investment-in-Climate-Adaptation-and-Resilience-Current-Status-Barriers-to-Investment-and-Blueprint-for-Action.pdf?sequence=5&isAllowed=y

losses from climate change impacts, improving economic stability, and protecting natural resources.
Technical Feasibility: Yes

4. Increase community participation in local governance and support civic engagement and citizen involvement.

Regular and inclusive opportunities for meaningful citizen engagement can help to ensure that climate planning is informed by and responsive to a broader audience of Vermonters. Identifying existing channels for community engagement, coming prepared to listen instead of present or convince, and being clear about how feedback and ideas will be reflected in ongoing climate work can help to encourage broader participation in climate planning. Forums in which collaboration on climate planning occurs should be designed with, and designed to be inclusive of and welcoming to those most impacted by climate change.

Actions

a. Require remote meeting options, including a call-in option for all meetings of public bodies; allow fully virtual meetings of public bodies with guidelines similar to the state of emergency's; evaluate options for online collaboration in preparation for a meeting that can be done with transparency.

Preliminary Assessment of Strategy against Criteria
Impact: Providing remote meeting options for meetings of public bodies, where critical conversations happen and decisions are made, enables more equitable opportunities to participate, and can encourage participation from those who may not be comfortable or able to attend in person meetings.
Equity: Providing remote participation options for public meetings is a good foundation for providing more equitable opportunities for civic participation in governance. Additional tools and support will be needed to ensure public meetings are design and run so that participants have a similar experience in the meeting, regardless of the method of participation. In addition, equitable participation in governance requires equity in opportunities to engage beyond remote options for public meeting. For example, resources and information should be made available in languages other than English.
Cost-effectiveness: Providing call in options is a low-cost action, that can be accomplished with the tools already used by most entities that run public meetings.
Co-Benefits: Increasing the capacity to do climate work improves all outcomes and co-benefits of climate work.
Technical Feasibility: Yes

PATHWAY 2: Proactively and strategically invest to enhance resilience in transportation, communications, water/wastewater, and energy infrastructure statewide.

The strategies and actions supporting this pathway will improve the resilience of the State's transportation, electric, and water infrastructure systems to climate change threats. All three sectors are considered critical infrastructure, which is defined in the Vermont Infrastructure Protection and Resilience Plan as "…public and private sector systems and assets, whether physical or virtual, that are so vital their incapacity or destruction would have a debilitating effect on the security, economy, public health or safety, environment, or any combination of these matters across any Federal, State, regional, territorial or local jurisdictions." Another way of describing criticality is that these infrastructure sectors are essential to supporting the resilience of communities, which are the ultimate users of the services they provide. The strategies and actions below do not specifically address other energy infrastructure, such as fuel depots or natural gas distribution networks, that support thermal heat for buildings and fuel for transportation or other uses. However, the resilience of other energy infrastructure to climate change will improve due to the strategies and actions below to the extent their operation depends on electricity and the transportation system. General information on the three sectors is provided below. Additional work is required to develop actions specific to communications, which will require engaging with the private sector owners of those services and related infrastructure systems.

Electric

The electrical grid in Vermont includes Transmission, Sub-Transmission, and Distribution facilities that transmit and distribute energy into, out of, and throughout Vermont, both from larger generation resources and local distributed generation resources. Vermont's electric grid has become a bi-directional conduit for electrical energy that serves residential, commercial, and industrial customers throughout the state.

Vermont has 17 electric distribution utilities (one investor-owned, two cooperatives, and 14 municipal electric utilities), with each having an exclusive service territory serving in total over 648,000 Vermont residents throughout the state. All Vermont distribution utilities own electric distribution facilities, and some own transmission facilities. Vermont also has a statewide transmission operator, the Vermont Electric Power Company (VELCO). Vermont electric utilities are fully regulated vertically integrated, meaning they can own and operate generation facilities.

Vermont's grid serves the electric needs of its citizens, in that it is the "highway" for electricity to flow from generators to load to meet demand every hour of the year. The grid has and will continue to become more critical in terms of both safety in a less forgiving climate as well as a key ingredient of decarbonization as we transition our thermal and transportation sectors off fossil fuels, primarily to fuel-switching to electricity.

Vermont's grid has become increasingly susceptible to climate-change induced severe weather, mainly due to the rural nature of our landscape and our unique geography locally in the northeastern U.S. Threats to the grid include more frequent, stronger storms, high winds, ice, and

heavy, wet snowstorms along with more frequent flooding from a large increase in extreme precipitation events. As Vermonters come to rely increasingly on electricity for heating and transportation, doubling down on grid resilience to keep pace with a changing climate will be essential.

Transportation

Vermont's transportation system includes 14,174 miles of public roadways of which 2,700 miles are maintained and operated by the Vermont Agency of Transportation. The balance of the highway system is managed by Vermont's 251 municipalities. Non-highway infrastructure and services include seven regional public transit operators providing nearly 5-million rides annually, 578 miles of active rail lines, 305 miles of which are owned by the state, and 16 public airports, 10 of which are owned by the state. The Agency of Transportation oversees 140 miles of rail-banked rail-trails and municipalities provide and maintain many more miles of sidewalks, shared-use paths and other pedestrian and bicycle facilities.

The transportation system is critical to the state's economy and quality of life and is essential for emergency response. It provides access to jobs and mobility for the movement of goods and services that are essential to Vermont businesses, brings tourists and other visitors to the state, provides access for residents' daily activities, and delivers food and other products that Vermonters need for everyday living.

The transportation related actions listed below emphasize resilience to damage from flooding and fluvial erosion, climate change threats which are identified by the 2018 Vermont State Hazard Mitigation Plan as the highest-ranking hazard in the state. The transportation system is also challenged by other incremental climate change threats such as more frequent freeze and thaw cycles, increasing mixed precipitation events, and greater variations between high and low temperatures which reduce service life and affect on-going maintenance and operational activities like snow removal.

Water

Water infrastructure is a critical support for a climate resilient society. Traditional water infrastructure consists of drinking and wastewater treatment and collection/distribution systems and their related appurtenances. Green infrastructure consists of engineered systems in developed lands that endeavor to mimic natural hydrology functions, by attenuating and treating ever-increasing stormwater flows, by using engineered wetlands to treat wastewater, and/or by using reclaimed water for landscape irrigation. Green stormwater infrastructure improves groundwater recharge, reduces flood scour, and limits sediment and nutrient pollution that kills fish in streams and rivers and produces harmful algal blooms in lakes and ponds. Green infrastructure also includes distributed or decentralized water supply and wastewater treatment infrastructure which can mitigate disruption of services by isolating climate-induced impacts. Natural infrastructure consists of existing or restored natural systems managed to provide for water storage and natural water purification, while promoting carbon storage. Human capital, in the form of a thriving environmental services sector is critical to the development, management, operation, and maintenance of all forms of water infrastructure, and must not be ignored as a key component of climate resilience.

Water infrastructure is regulated at the state level, and State agencies such as the Department of Environmental Conservation also provide significant financing and technical assistance resources. Municipalities and private entities are largely responsible for the operation, maintenance, and improvement of grey and green infrastructure, while non-profits typically administer the acquisition and restoration of natural infrastructure. Most natural and municipal infrastructure are publicly funded and financed with state, federal, or ratepayer dollars. The human capital necessary to support resilient water infrastructure cuts across the public, private, and non-profit sectors, and collectively should be considered a small but growing economic sector in its own right in Vermont.

All forms of water infrastructure are threatened by climate impacts, particularly flooding, and also drought. Public drinking water systems should be designed to accommodate climate change impacts, such as more droughts and more wet periods. Wellhead protection areas should take these swings into account and can be integrated into land conservation and recreation objectives.

During Irene, many municipal drinking and wastewater systems were disrupted or even lost due to the floods. While some of this infrastructure was restored, many systems, especially wastewater and stormwater systems, remain necessarily located in flood prone areas. In most municipalities served by public water systems and wastewater treatment facilities, the cost and complexity of moving water from source, to tap, to toilet, then treatment is minimized by the fact that water is typically pumped to a high location, then gravity-fed downhill from tanks and standpipes to treatment. During flooding, upland drinking water reservoirs may experience undue water loading threatening the integrity of their dams, while wastewater treatment facilities or water supply wells located in floodplains may be adversely affected by inundation or erosion. During drought, drinking water supply systems are not able to keep pace with demand, necessitating reliance on lesser-quality sources, or even hauling of water by truck. One alarming manifestation of drought on public water supply is the diminishment of sufficient volumes of water to support fire suppression; a significant threat to towns.

Strategies

1. Create a policy, planning and organizational foundation to support effective investments in infrastructure resilience.

A common theme for transportation, energy and water infrastructure is a need to better understand the threats and vulnerabilities caused by climate change, and how to use that information to guide decision-making and investments that improve resilience in an equitable and cost-efficient manner. State agencies would be the designated lead for almost all of these actions and most could be implemented within two years with adequate funding and dedication of staff resources. Although state agencies would lead most of these actions, they would have to be carried forward in collaboration with other stakeholders. Because these actions are laying the foundation for decision making, they provide an opportunity to incorporate equity from the start.

All Infrastructure Sectors

a. Develop a vulnerability index methodology and tool for broad use by stakeholders to identify priority areas for investment. The index will account for the vulnerability communication, energy, transportation and water infrastructure in addition to socioeconomic and equity factors that affect community resilience.

b. Update or adopt as appropriate infrastructure planning and design standards to reflect impacts from a changing climate, such as more frequent extreme weather as well as an increasing range of high and low temperatures, freeze/thaw cycles, and mixed precipitation (harden, incorporate redundancies, maximize life span, reduce annual maintenance and operational costs. etc.)

Electric

c. Seek federal stimulus (ARPA), infrastructure bill, and other non-ratepayer funding to defray costs of utility resilience upgrades that exceed benefits to ratepayers, such as:
   - Ubiquitous communications networks that enable full utilization and participation of distributed energy resources in an interactive grid.
   - Resiliency Zones: batteries installed at or near critical facilities, potentially paired with solar (and/or small wind) and with a microgrid /islanding where possible, to allow them to continue to operate in the event of extended disruptions to electric service.
   - Strategic upgrades to substations, distribution, and transmission capacity across the Vermont grid needed to enable the state's renewable and electrification goals, after first exploring feasibility of any lower-cost options, e.g. flexible load management, curtailment, and storage.
   - Emerging non-wires technologies that address major challenges system resilience (e.g. long-duration outages).
d. Create a framework for identifying and evaluating climate resilience threats and impacts to energy systems serving rural communities.

Transportation

e. Complete the flood vulnerability assessment of all bridges, culverts and road segments on the state and town highway systems, identify and prioritize needed investments. This action includes completing the statewide expansion of the Transportation Resilience Planning Tool.
f. Complete a flood vulnerability assessment of state-owned rail infrastructure to identify and prioritize needed improvements
g. Incorporate GHG reduction goals and CAP strategies, and actions related to resilience in the VTrans transportation planning and project development process.

Water

h. Increase funding for floodplain restoration, including buy-out programs
i. Increase investment to municipalities to support reductions in inflow and infiltration into wastewater collection systems.
j. Examine the climate impacts of sludge and biosolids to determine if regional facilities can reduce utility costs and climate impacts. Support investment in strategically placed facilities for sludge and septage processing (much is currently trucked to Montpelier/Chittenden Co.)
k. Increase investment to municipalities to support reductions in inflow and infiltration into wastewater collection systems.

l. Increase efforts and funding towards pollution prevention programs at wastewater facilities to ensure that facilities protect available treatment capacity, which can focus development on already-served designated centers.
m. Understand source water vulnerabilities and invest in planning efforts to assist communities, especially those that are vulnerable for their long-term water supply needs. Revamp funding programs for source protection programs, increase funding for programs (include existing and new water sources) and conservation easements
n. Increase the number of public water systems and publicly owned wastewater treatment works implementing an asset management program. Expanding programs, funding opportunities, and incentives to develop and implement these programs.
o. Continue investments in traditional and green infrastructure to intercept, sink and treat stormwater.
p. Encourage adoption of low impact development regulations for municipal zoning, including low water usage landscaping practices and increased density outside of flood prone areas.

Preliminary Assessment of Strategy against Criteria
Impact: This strategy will have a significant positive impact by providing a foundation of information about climate change threats and vulnerabilities, and how to use that information to guide decision-making and investments in an equitable and cost-efficient manner.
Equity: This strategy is supported by actions that provide opportunities for the early involvement of marginalized communities in the process to identify climate changes threats to infrastructure, prioritizing needs, and identifying equitable solutions.
Cost-effectiveness: This strategy is highly cost effective because it will help guide the efficient allocation of resources.
Co-Benefits: This strategy will address both resilience and adaptation and to a lesser extent GHG reduction.
Technical Feasibility: Yes

2. Public, private, and nonprofit entities should be prepared to respond and recover quickly to disruptions caused by severe weather and other climate change threats.

Since it is not possible to eliminate all vulnerabilities in transportation, energy and water infrastructure, the ability to respond quickly to major disruptions caused by climate change, such as flooding events, will always be a critical component to providing resilient infrastructure. There is only one high priority action included below due to the extensive experience of Vermont Emergency Management and all the other state agencies, regional planning commissions, municipalities, utilities, and others have in responding to and recovering from disasters.

All Infrastructure Sectors

a. Strategically integrate planning and preparedness across disciplines and geographies addressing the interdependencies of transportation, energy, communications, and other systems.

Preliminary Assessment of Strategy against Criteria
Impact: This strategy and action have a significant positive impact because they will improve the ability to respond quickly and effectively to severe weather and other disasters and other disruptions.
Equity: Integrating planning and preparedness creates an opportunity to determine how equity can be incorporated into emergency response.
Cost-effectiveness: Highly cost effective because the potential benefits are significant while the cost to implement better coordination is relatively low.
Co-Benefits: Primarily focused on resilience.
Technical Feasibility: Yes

3. Increase the resilience of critical infrastructure to severe weather and other climate change threats by reducing vulnerabilities of specific facilities.

Implementation of the actions below would result in projects that improve the resilience of specific transportation, utility, or water infrastructure. Most of these actions could begin within a couple of years with sufficient funding and staff resources, would be on-going and would result in a steady pace of improvements over time.

All Infrastructure Sectors

a. Identify mission critical facilities in collaboration with local and regional planners, utilities and transportation providers to identify actions, procedures, or investments to mitigate the impact of extreme weather events to services provided by these facilities Examples of mission-critical facilities include designated emergency shelters, first responder facilities, hospitals and other medical facilities, key infrastructure such as water/wastewater pumping and treatment and sewer, key communications infrastructure such as fiber nodes, government offices, fuel suppliers, transportation hubs, supermarkets and other facilities municipalities identify as critical to serving communities during extreme weather events.

Electric

b. Replace aging electric and communication infrastructure with the most appropriate resilient alternative when cost effective. For example, during normal replacement schedules for aging and unreliable lines, evaluate and where cost effective and feasible, improve resilience by relocating lines underground or through other options.

Transportation

c. Create a transportation flood resilience funding program to meet the requirements and related funding that are anticipated to be part of the 2021 reauthorization of the federal transportation act.

Water

d. Expand public investment, particularly hazard mitigation funding to flood-proof or relocate drinking water and wastewater treatment infrastructure at significant risk of flooding, when flood damaged, or during end-of-life refurbishment.
e. Work with Vermont villages and property owners to relocate septic systems and public or private drinking water wells that are at risk due to floods.
f. Develop programs to achieve net zero energy drinking water and wastewater treatment facilities Including microhydro, solar energy, heat exchange, building envelope; AND operational and technological efficiencies.
g. Improve road drainage around lakes / ponds to reduce stormwater runoff and erosion, especially on municipal roads.

Preliminary Assessment of Strategy against Criteria
Impact: This strategy will lead to incremental improvements in resilience at specific locations that will over time result in significant, real, and cumulative positive impacts on resilience.
Equity: Equity considerations need to be incorporated into the investments supported by this strategy.
Cost-effectiveness: The overall cost effectiveness is medium to high because the impact is significant while the cost to implement is medium to high.
Co-Benefits: The actions supporting this strategy will also support smart growth, improvements to non-auto modes of transportation which will help reduce GHG emissions, and water quality.
Technical Feasibility: Yes

4. Increase the resilience of critical infrastructure to severe weather and other climate change threats by improving system efficiency, reliability and redundancies.

While the actions in Strategy 3 focus on specific facilities, this strategy includes actions that seek to make systemwide improvement in resilience. Actions that lay the groundwork for systemwide improvements could happen within a couple of years leading to incremental improvements as specific initiatives are implemented.

All Infrastructure Sectors

a. Evaluate the risks and opportunities created by potential climate change in-migration to VT's critical infrastructure.

Communications and Transportation Infrastructure

b. Expand broadband to support remote work and tele-services to reduce the impact of travel disruptions.

Electric

c. Deploy foundational informational and operational technology statewide to enable and optimize storage and other distributed energy resources (e.g., GridLogic, Virtual Peaker, other emerging distributed energy resource management systems, in particular those that are open-source to various technologies and vendors)

Transportation Infrastructure

d. Update the 1995 Vermont State Highway Design Standards to create context sensitive, multi-modal projects that support smart growth per the Act 167 (2014) Sec 26 Report - VT State Standards Work Plan.
e. Increase infrastructure investment needed to for walking, biking and transit; support planning for regional bike corridors to improve safety and transportation options between community centers. Identify and eliminate barriers to development, including inequities resulting from match, maintenance and other requirements.

Preliminary Assessment of Strategy against Criteria
Impact: The impact of this strategy is high because it will lead to improvement in system-wide resilience. Also, because these are system-wide investments, they will reach all Vermonters.
Equity: Ensuring equity can be incorporated into the implementation of the actions.
Cost-effectiveness: The actions under this strategy have relatively low implementation costs but their resilience benefits are far reaching.
Co-Benefits: The resilience benefits of this strategy will also help reduce GHG emissions by supporting smart growth, sustainable transportation choices, and distributed energy sources.
Technical Feasibility: Yes

PATHWAY 3: Support the reduction of municipal, school district, residential, university, and hospital fossil fuel use in rural areas through equitable best practices that address the unique challenges of rural communities.

In the face of climate change, Vermont's rural communities are posed with a set of unique challenges that highlight the need for targeted support and investment for communities and institutions. Rural communities have limited capacity to respond to climate change impacts, due

in part to limitations in access to community resources[212]. Rural communities also frequently depend heavily on volunteers to meet community challenges, and often have limited locally available financial resources to help deal with the effects of climate change[213]. As Vermont plans for a reduction in fossil fuel use to meet its GHG mitigation requirements, specific policies and programs will be needed to assist rural communities in the transition to a carbon-free future.

Schools, universities, hospitals, businesses, and municipal organizations make up the main building blocks of Vermont's rural communities. The size, scope, and variety of each one's fossil fuel use varies across the state, as does each one's capacity and willingness to reduce fossil fuel use; the same is true regarding residential energy use. Thermal energy use, or heat, in buildings currently accounts for 34 percent of Vermont's greenhouse gas emissions, largely from burning fossil fuels: fuel oil, kerosene, natural gas, and propane. The transportation sector currently accounts for 40 percent of Vermont's GHG emissions[214]. Rural communities are often faced with a limited capacity at the municipal government level to take on new projects and programs. Coupled with the reality that rural communities rely heavily on single occupancy vehicles to access goods and services, and that the transportation sector makes up the largest portion of Vermont's greenhouse gas emissions, special attention should be paid to how rural communities and institutions access programs and resources, financial and otherwise, that allow them to lower their greenhouse gas emissions.

Equipping Vermont's rural communities with the appropriate support to reduce the use of fossil fuels will require significant support and investment. Tools are needed for municipalities and institutions to understand and educate on fossil fuel use and the economic benefits of electrification in their communities, while additional resources are needed to expand access to programs that focus on under resourced communities. Developing and supporting programs that give Vermont's rural communities a leg up on the transition to a carbon-free future will create long lasting benefits for Vermont's communities, Vermonter's quality of life, and the ability of rural communities to adapt to the changes imposed by climate change.

Strategies

1. Provide tools and resources to help assess data needs and establish best practices for rural communities, businesses, and institutions to reduce fossil fuel use.

The reduction of fossil fuel use in the transportation, and buildings and thermal sectors will both increase a community's ability to withstand the impacts of climate change, while also decreasing overall statewide greenhouse gas emissions, lowering the possibility of worsening climate impacts in the future. Additionally, and importantly, the transition to electric forms of transportation, heating, and cooling will also offer long term financial savings for communities.

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[212] USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. https://nca2018.globalchange.gov/chapter/10/

[213] USGCRP, 2014: Chapter 14: Rural Communities, Climate Change Impacts in the United States: The Third National Climate Assessment. https://nca2014.globalchange.gov/downloads/low/NCA3_Full_Report_14_Rural_Communities_LowRes.pdf

[214] Vermont Agency of Natural Resources, Vermont Greenhouse Gas Emissions Inventory and Forecast (1990-2017), May 2021. https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

For communities to plan appropriately for decreasing fossil fuel use across sectors, data on current fossil fuel use is needed at the municipal level to support planning and assessment of needs.

Initiatives to collect data for use at the municipal level have been undertaken in the past, some with the support of Regional Planning Commissions (RPCs). For example, in 2009 RPCs on a statewide effort used DOE American Recovery and Reinvestment Act (ARRA) funding to provide energy audits and management of energy efficient implement projects for municipal buildings. The Windham Regional Commission has continued this work by creating a guide for municipalities to use to weatherize their buildings[215]. Barriers to data access should continue to be identified as communities and institutions examine their fossil fuel use and plan for transitions to cleaner energy sources. In addition, best practices will need to be identified, such as the example provided above, to help guide communities on their transition away from fossil fuel use for heating and transportation. Initiatives such as the example provided will need to be expanded upon to provide equal access to data on energy use, and assistance to implement best practices on energy efficiency and electrification across communities.

Actions

a. Require the collection of fossil fuel usage data for municipal operations for buildings, vehicle fleets, and utilities; identify data gaps and ways to collect that data for measuring change in fossil fuel use going forward.
b. Ensure data on fossil fuel usage at the municipal level is available and accessible in one location for municipal and public use.
c. Engage higher education institutions to actively participate in developing systems to gather, compile, update, extrapolate fossil fuel data and make that available to the public.
d. Identify, develop, and share best practices for reducing municipal, school district, residential, commercial, and industrial fossil fuel consumption. Identify and assess existing practices and note gaps.

Preliminary Assessment of Strategy against Criteria
Impact: Data is needed in order to assess the impact that other measures have on GHG mitigation, fuel switching, and energy efficiency. Having a system in place to gather and track fossil fuel usage data at the municipal level, as well as best practices for municipalities to implement for reduction of fossil fuel use, are action that enables other actions that help Vermont reach its GHG mitigation requirements.
Equity: To enhance equity of this strategy, traditionally underserved and impacted communities will be identified, and their input will be solicited on equitable practices for data collection, display of data, and accessibility of data. As this strategy is implemented, consideration should also be given to how this data is shared and explained to traditionally underserved and impacted communities, so the impact of data collection is clear. Implementation should ensure data gathering and explanation of data is translated into other languages, and that best practices are tailored to impacted communities.

[215] http://www.windhamregional.org/images/docs/publications/weatherizing-town-buildings.pdf.

Cost-effectiveness: This strategy would likely have a moderate cost, meaning some of the actions needed for this strategy would need a new revenue source for a short-term period. Actions under this strategy do have an overall high impact, meaning this strategy results in an overall high ranking for cost-effectiveness. This strategy would help establish a baseline that would educate communities and reduce confusion around fossil fuel use. In the long term, this would save time and effort in planning initiatives and would further enable the work of future projects needed to decrease fossil fuel usage.
Co-Benefits: Data collection at a municipal level would have broad co-benefits across GHG emission reduction and climate resilience and adaptation initiatives. By involving high education institutions in the collection of data, co-benefits across educational initiatives could be seen. In addition to data collection, establishing best practices for communities to reference could add to benefits in public health due to reduction of the use of fossil fuels. In addition, broad benefits for community planning projects could be realized due to easily accessible data.
Technical Feasibility: Yes

2. Equitably expand access to programs that provide options to rural homeowners, landlords, municipalities, school districts, universities, and hospitals for weatherization, electrification, and utility upgrades.

In addition to access to fossil fuel use data at the municipal level that allows for planning and the local level, existing programs that support weatherization, electrification, and utility upgrades will need to be expanded to provide equitable access to communities and institutions. Programs that provide several options for weatherization, electrification, and utility upgrades to homeowners, renters, landlords, municipalities, school districts will be needed as Vermont works towards meeting its GHG reduction requirements. Especially in rural communities where access and knowledge of program may be more limited than in urban areas, an increased focus should be placed on education and access to local, regional, statewide, and federal programs that incentivize and promote a move away from fossil fuel use. Many of the actions listed below will require additional funding and third-party financing resources and represent a variety of stakeholder that will need to be engaged to implement these initiatives.

Actions

a. Ensure that there is broad and statewide public education and promotion of benefits, economic and otherwise, and opportunities for fossil fuel reduction.
b. Evaluate all existing state-funded programs for effectiveness, access, and equity and consider increased funding for weatherization, energy efficiency and electrification programs in order to expand access to all Vermonters, and to expand programs with zero up-front costs. Existing programs may include Efficiency Vermont rebates, HEAT Squad - NeighborWorks of Western Vermont home energy audit program, and the Shared Equity program[216]. In addition, the private sector should be engaged to provide innovative third-party financing opportunities that are paid for over time by the customer.

[216] https://vhcb.org/our-programs/housing/home-ownership

c. Explore Commercial PACE (Property Assessment Clean Energy) program for municipalities and other programs to elevate, such as bonding to support a statewide Tariffed On-Bill Finance Pilot and funding for a revolving loan fund for Public-Serving Institutions with retrofits. There may also be a need to continue providing the funding to support interest rate buydown (IRB) in EVT's Home Energy Loan and Business Energy Loan programs.
d. Create new educational programs so existing energy efficiency, electrification, and utility upgrade programs may increase their public education and outreach.
e. The Public Service Department should ensure that all utilities provide similar opportunities for all customers (rebates, incentives) to encourage fossil fuel reduction, electrification, and energy savings.
f. Increase low-income weatherization through the State Weatherization Assistance Program including technical assistance to help households and landlords manage the process.
g. Entities that provide rebates for weatherization should stabilize rebate values year to year.
h. Expand workforce development programs such as the VT Training Program or the Department of Labor's Workforce Education & Training Fund; cover costs for businesses to train in-house auditors/technicians. Pilot new programs in rural areas where workforce needed is greater.
i. Revise state building energy codes and standards to require a minimum 200 Amp service for new construction as electrification expands.
j. Provide funding to assist low-income homeowners to upgrade electric service to 200 Amps. Electric utilities and renewable energy developers could provide new incentives and financing options through third-party financing mechanisms, on bill financing, RES Tier III incentives[217], third-party power purchase agreements, and grants. All programs must include equal access to renters.
k. Implement a statewide program to support electrification of municipal fleet vehicles ensuring it is designed to allow equitable access and participation to municipalities regardless of tax base.
l. Support water and wastewater systems in conducting and implementing energy audits and recommendations for energy reduction and electrification.
m. Develop cost-effective programs to support renewable energy development on school and other municipal property, and evaluate and eliminate unnecessary statutory barriers related to capital financing and land purchase/lease.
n. Help individuals, municipalities, and businesses through the process of weatherization, energy efficiency and fuel switching upgrades by establishing and funding Weatherization and Efficiency Navigators at each Regional Planning Commission (RPC), expanding the services currently available at CAP agencies and VEIC, and ensuring coordination and a whole systems approach among the entities providing services. to .
o. Review and expand existing programs to support landlords in weatherizing rental properties, including St. Johnsbury Rental Housing Improvement Program, and other programs in counties and towns[218].

[217] https://publicservice.vermont.gov/content/tier-iii-renewable-energy-standard#:~:text=Tier%20III%20%E2%80%93%20Energy%20Transformation&text=For%20Tier%20III%2C%20the%20RES,until%20reaching%2012%25%20in%202032.
[218] https://accd.vermont.gov/housing/resources-rules/renters-landlords

Preliminary Assessment of Strategy against Criteria
Impact: The expansion of programs that provide weatherization, electrification, and utility benefits to communities and institutions will have a tremendous impact on Vermont's overall ability to mitigate greenhouse gasses and be more resilient to climate change impacts. The actions under this strategy would impact broad change, reaching to town governments, institutions, businesses, and individuals.
Equity: While the programs referenced in the actions under this strategy are broad ranging, traditionally underserved and impacted communities must be identified, and their input solicited on the expansion and creation of these programs. These communities include smaller, less capable municipalities, low-income homeowners, renters, individuals without homes, and those who have high transportation burdens. Low-income and minority households tend to pay higher prices per unit of energy due to less efficient homes, so special attention should be paid to the expansion of existing programs and how benefits can be shared or targeted to help frontline and impacted communities.
Cost-effectiveness: Adding resources to strengthen existing and creation of new weatherization, electrification, and energy efficiency programs will require some up-front investment. However, due to the lifetime net cost decrease over time, the upfront investment will result in more affordable systems of energy for communities and institutions.
Co-Benefits: Increasing the capacity of existing weatherization, electrification, and utility upgrade programs will have long term benefits for not only reduction of GHG emissions, but co-benefits in resilience and adaptation. Increasing the capacity of weatherization programs would bring added health co-benefits due to the decreased cost of heating and cooling, reduction of pest infiltration, and measures to reduce excess moisture that impact respiratory health. Weatherization and energy efficiency programs have the potential to decrease the overall cost of fuel for households, which would have a significant impact on low-income and minority households who tend to pay higher prices for fuel. Switching to more efficient technologies has co-benefits for all those who pay energy bills - tax payers, business owners, institutional leaders, landlords, homeowners. Co-benefits also accrue to the economy: forest industry, contractors, utilities, energy businesses.
Technical Feasibility: Yes

PATHWAY 4: Change Vermont's land-use policies so current and future land development will be adaptive and resilient to climate change impacts

How Vermont chooses to use its land-based resources will have a significant impact on our ability to create and maintain resilient communities and natural resources. Vermont's current approach to land use planning is decentralized and relies on voluntary adoption and implementation of land use policy at the municipal and regional scale. The political and operational capacity to implement land use policies varies widely among municipalities and regions. This results in a patchwork of inconsistent local and regional land use policies to regulate and guide current and future land use.

These inconsistencies compromise the ability of the State to implement land use policy that also meets climate goals, and raises equity and environmental justice concerns. Municipalities and regions with the most political and operational capacity can direct land use policy to be formed in a way that does not share the burdens and benefits of land use decisions that meet Statewide

community needs. If an adaptation and resilience strategy or action is deemed essential, it is necessary for the state to give objective consideration to what level of government has the ability and capacity for actual implementation in a timely manner, and what partnerships are necessary for effective execution.

Strategies

1. Increase investment in the infrastructure (sewer, water, stormwater, sidewalks, bike lanes, EV charging, broadband, energy supply) needed to support communities that are more resilient to climate disruptions, equitable, resource efficient, and protects the adaptive capacity of natural resources.

Investment in infrastructure is essential to make our existing communities more resilient to climate change hazards, including precipitation events that are forecast to become more frequent and intense. Many of Vermont's villages and downtowns were settled in locations to harness water power, which also puts them at risk for flooding and, in some cases, fluvial erosion. Many of the actions recommended here address the well documented risks of flooding and impact to our water supply and management systems. Additional work will be needed to identify other climate risks, and the infrastructure investments that can make communities more resilient to them. For example, as we better understand localized risks and vulnerabilities of our power distribution systems, additional recommendations for investing in infrastructure that can improve a community's resilience in the event of power outages will need to be developed. tMunicipal plans and bylaws are important regulatory tools to reduce vulnerabilities, particularly to flooding, but it is the presence of foundational infrastructure that will make climate resilient and adaptive settlement actually possible.

Actions

a. Revise stormwater permitting as needed to ensure green infrastructure is primary in design considerations.
b. Increase investment in stormwater and green infrastructure, including separating combined wastewater and storm water systems, to protect public health and water quality.
c. Complete a Climate Readiness assessments of drinking water, stormwater, and wastewater infrastructure. (This is an EPA tool that looks at all climate impacts including, fires, droughts, flooding, etc.).
d. Examine regionalization efforts and sharing of resources for all water utilities.
e. Invest in enhancing water sources in vulnerable communities to enhance resilience to long-term drought.
f. Increase investment to municipalities for new and expanded water and wastewater facilities to support reductions in inflow and infiltration into wastewater collection systems.

Preliminary Assessment of Strategy against Criteria
Impact: Investing in infrastructure than minimizes disruption to climate events improves community-wide resilience to climate change impacts.
Equity: Investment in infrastructure should ensure that those most impacted by climate change experience contextual, procedural, corrective, and distributive equity in the

implementation of infrastructure investments to address climate change. Due to historic inequities black, indigenous, and low-income communities, people of color, and persons with disabilities are often more vulnerable to climate change. While infrastructure investments can improve resilience, some infrastructure investments have historically caused harm to these communities by siting infrastructure in a way that burdens them with negative environmental consequences and limits or excludes them from receiving the benefits[1]. Infrastructure projects should include the voices of those most impacted by climate change, and work towards correcting past inequity (e.g. lack of investment or representation in infrastructure development) while preventing the exacerbation of existing inequities (e.g. investment cannot lead to displacement).
Cost-effectiveness: The investment needed to add or improve infrastructure to support community resilience is likely high, however may be offset by avoided future costs associated with climate impacts. More research and analysis is needed to quantify the cost/savings of investment in infrastructure that improves resilience.
Co-Benefits: Many of the infrastructure investments needed to increase resiliency also provide immediate health, economic, and environmental benefits. For example, investment in broadband improves resilience to climate impacts by allowing for better connectivity among community members when physical connectivity is not possible due to road closures. However, it also can improve the economic vitality and social connectivity of a community under non-climate event conditions.
Technical Feasibility: Yes

2. Develop permanent private and public funding sources to flood-proof, elevate and purchase commercial and residential properties, as well as conserve and restore ecosystem services upstream to protect our people, property, environment, and economy from flooding.

Nationally, the FEMA Hazard Mitigation grant programs provide $7 in avoided costs for every $1 invested; however, some communities, particularly rural communities, have not been able to make use of this funding due to the administrative burden of managing a FEMA award, the lack of a sustainable funding source to provide the required 25% non-federal funding match, and limitations within program eligibility. A permanent State funding program for flood hazard mitigation would enable communities use of federal funds by providing a source of funding for the required 25% match and funding for the purchase of both structures and easements to conserve natural areas that are not eligible for federal funding.

Actions

a. Establish a dedicated, comprehensive state level program with funding to strategically purchase or match funding for hazard-prone properties, easements to conserve river corridors, floodplains, forests, and wetlands to reduce overall flood risk and enhance flood storage statewide.
b. Expand the eligibility criteria and increase funding for VHCB's conservation and buyout program, to address any flood-vulnerable structures.

c. Fund ERAF for non-federal disasters in towns that have adopted floodplain and/or river corridor bylaws and to support the 25% non-federal match for buyouts and develop criteria for distribution when funding is limited.

Preliminary Assessment of Strategy against Criteria
Impact: Flooding is a key, known impact that is likely to increase as storms become more frequent and intense in Vermont. Reducing vulnerability to flooding will have a significant impact on individual community members, and the community at large to be resilient to, and recover from flooding events.
Equity: Due to historic inequities black, indigenous, and low-income communities, people of color, and persons with disabilities are often more vulnerable to climate change impacts, such as flooding. Disbursement of these permanent funding sources to mitigate vulnerability to flooding must ensure that those most impacted by climate change, and especially those also impacted by historic inequity receive the benefits of these funding sources.
Cost-effectiveness: The investment needed is likely high, however offset by avoided future costs associated with climate impacts, and the cost of remediating, especially for repetitive flood damages. Hazard mitigation grant provide a $7 return on investment for every $1 spent.
Co-Benefits: Reducing vulnerability to flooding by flood proofing, buying out high and repetitive risk properties, and improving the natural adaptive capacity of river ecosystems also provides public health benefits by reducing the risk of soil and water contamination, reducing exposure to contaminated flood waters.[219]
Technical Feasibility: Yes

PATHWAY 5: Ensure that all people have access to safe, accessible, energy efficient, and affordable housing

A home is a basic human need. It provides a foundation for household health and safety, security, well-being, and prosperity. People that have access to safe, accessible, energy efficient and affordable housing are more resilient to climate change impacts compared to people who are unhoused or living in unsafe, isolated, unaffordable or inefficient housing.

Today, too many Vermonters, 24% - nearly a quarter - over 150,000 people, are spending more than 30% of their income on housing. Vermont's housing stock is also old and energy inefficient, which contributes to the high number of substandard housing units, adds to the cost burden by increasing the cost of heating and cooling and increases resident health risks. Non-white households are more heavily burdened by housing challenges. About half of non-white

[219] https://www.cdc.gov/healthywater/emergency/extreme-weather/floods-standingwater.html

households experience a housing problem, while one third of white households face housing problems[220].

Meeting current and future housing needs of residents, businesses, and communities requires immediate action. Yet it's clear that we also need to change the status quo for housing and carefully consider how, where and for whom housing is rehabilitated and built, to ensure equitable, safe and affordable housing that enables resilience to climate change. Locating in compact walkable centers can also improve resiliency and reduce household costs. Additional housing actions related to the siting of new housing in compact walkable centers can be found in Chapter 15, Compact Settlement.

While housing insecurity has been a longstanding issue in Vermont, increased migration due to the coronavirus pandemic exacerbated the housing crisis, causing dramatic increases in housing competition and prices[221]. This gives has given us valuable insights into how the housing market could be affected by climate migration, and presents an opportunity to proactively plan for housing rehabilitation and development that can meet the demand for housing while improving the resilience of the people living in it.

The housing crisis and the climate crisis are inextricably linked, and Vermont must work through the tension between expediency and thoughtful planning, all while aligning investments and regulation to increase the availability of and access to fair, safe, and affordable housing.

1. Update state and local land-use governance, regulations, practices, and investments to eliminate barriers to housing development

Vermont's Planning and Development Act is one of the State's key tools for influencing where and how much housing is built. Its housing policies were last update in 2003[222] and do not reflect the significant shifts in household composition and needs over the last 20 years. Today, 69%[223] of Vermont's households are one- or two-person households with diverse needs and preferences. 83% % of Vermont's rental supply is privately owned and an estimated 6,960 of these units are substandard .[224] Legislation and funding to expand our understanding of the current housing stock and update the land use and housing provisions will support state, regional, and local planners' work to create housing that meets peoples' needs and is safe, affordable and allows them to be more resilient to climate change impacts. Successful state planning reforms have moved at the speed of trust through organized and resourced statewide conversations. For Vermont to be a place where people of all backgrounds can live in a safe and affordable home, state, regional, and local land use leaders must consider the structures that prevent or welcome diverse, resilient homes and neighborhoods.

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[220] The U.S. Department of Housing and Urban Development estimates the number of households with housing problems by identifying households that experience one or more of the following issues; lacking kitchen facilities, lacking complete plumbing, overcrowding, cost burdened.
https://www.vhfa.org/documents/publications/vt_hna_2020_report.pdf

[221] According to VHFA data, the median Vermont primary home sold for $259,900 during the first six months of 2021, compared to $245,000 throughout 2020, a six percent increase.
https://www.housingdata.org/profile/homeownership-costs/primary-home-sales-ytd

[222] http://www.leg.state.vt.us/docs/legdoc.cfm?URL=/docs/2004/acts/ACT115.htm

[223] https://www.housingdata.org/profile/population-household/household-size

[224] https://vhfa.org/sites/default/files/publications/vt_hna_2020_report.pdf

Actions

a. Increase manufactured housing tax credits to replace older and inefficient manufactured homes.
b. Expand the existing program to relocate mobile home park homes and residents outside of flood vulnerable locations.
c. Create a rental registry and inspection program to locate all of Vermont's rental housing and improve their quality and safety.
d. Expand pilot program to train a network of local builders in the design and building of small and mid-sized and accessory dwelling units (mother-in-law apartments) and fund homes starts within communities planning and investing in development-ready infrastructure, building development partnerships, and updating zoning bylaws to welcome new homes.
e. Convene a statewide conversation on the Vermont Municipal and Regional Planning and Development Act's (24 VSA, Chapter 117) provisions on land use and housing to outline amendments and strategies that will expand housing choice, opportunity, and improve community resilience.

Preliminary Assessment of Strategy against Criteria
Impact: Comprehensive action to remove regulatory barriers and ensure adequate resources can have a significant, cumulative impact on increasing housing projects that increase the availability of safe and affordable housing.
Equity: Any changes to land use governance, regulations and practices need to ensure that those most impacted by housing insecurity experience contextual, procedural, corrective, and distributive equity in the implementation of this strategy. Due to historic inequities black, indigenous, and low-income communities, people of color, and persons with disabilities are often more housing insecure. Governance structures, regulations and procedures have explicitly prevented black and indigenous communities and people from accessing affordable and safe housing choices. Changes to governance, regulations and procedures should include the voices of those most impacted by housing insecurity, and work towards correcting inequity in access to housing choices.
Cost-effectiveness: This strategy is highly cost-effective, requiring minimal investment to achieve an increase in housing rehabilitation and development over the status quo.
*Co-Benefits: C*o-benefits of updating state and local land-use governance, regulations and practices include improved efficiency in government operations, improved customer service experience for constituents, and better collaborative relationships between stakeholders involved in governance and regulatory processes.
Technical Feasibility: Yes

2. Increase investments in the preservation and development of both private-market and nonprofit-owned affordable housing.

A recent pilot initiative to remediate vacant, blighted, and unsafe housing units[225] has highlighted untapped opportunities to revitalize existing and develop new housing by using innovative funding models to create homes. The pilot provided $30,000 grants to private property owners who contributed at least 10% to the home remediation costs, and succeeded in bringing approximately 250 rental homes in existing buildings back online, and with affordability provisions in place. Future legislation should continue to allocate funding for innovative housing investments in both rental and owner-occupied housing stock that leverage private initiative and non-profit innovation.

Vermont benefits from a robust network of non-profit housing developers that are committed to addressing affordability needs in perpetuity. They have often been on the leading edge of housing development choices that reduce total homeownership costs by meeting high energy efficiency standards and creating new housing units in locations that reduce driving distance and travel costs by being closer to jobs and services. These commitments tend to increase cost per unit when compared to units developed in Greenfields where land and permitting cost are less. Funding support is needed to ensure these organizations can continue to build housing that also achieves Vermont's climate goals.

Actions

a. Continue to fund housing investments that leverage private initiative and funding to cost-effectively create housing units under models like the Re-Housing Recovery Program funding and the proposed Vermont Housing Investment Program.
b. Create programs to assist prospective homebuyers to purchase and make improvements to homes that are energy inefficient and otherwise in need of immediate investment.
c. Increase support for mission-driven, non-profit housing developers to maintain their ability to produce high-quality, energy- and location-efficient housing.

Preliminary Assessment of Strategy against Criteria
Impact: Providing direct investment is a significant incentive that enables more housing projects, especially more affordable housing projects, than what would be supported by the private housing market alone.
Equity: Investment in housing should ensure that those most impacted by housing insecurity experience contextual, procedural, corrective, and distributive equity in the implementation of investments to increase housing. Investments in housing has not provided equitable access to housing choice, and the wealth generating benefits of homeownership. Housing projects should include the voices of those most impacted by housing insecurity, and work towards correcting past inequity (e.g. lack of equitable access to housing choice) while preventing the exacerbation of existing inequities (e.g. investment cannot lead to displacement).
Cost-effectiveness: Public investment that leverages private funds to rehabilitate and build new housing is a highly cost-effective strategy.

[225] According to VHFA, approximately 83% of Vermont's rental supply is privately owned and an estimated 6,960 of these unites are substandard or vacant.

Co-Benefits: Access to affordable housing can also improve health outcomes, increase community and civic engagement, and support healthy local economies. Preservation of existing housing can reduce the use of natural resources to create needed housing.
Technical Feasibility: Yes

3. Increase access to fair and affordable housing for Vermonters who are housing instable.

People and families who spend more than 30 percent of their income on housing are considered to be cost burdened, and at risk of facing housing insecurity. Over 24% of Vermont's households and more than half of all renters are cost burdened or severely cost burdened[226]. Housing insecurity disproportionately affects BIPOC communities, older Vermonters, and those living on low incomes. As rents continue to rise due to increased migration and a tightening supply, more Vermonters are experiencing homelessness. After many years of thoughtful collaboration between housing providers, advocacy groups, and lawmakers, the legislature has allocated an unprecedented $195 million (Act 74 of 2021) to increase housing stability and prevent future increases in homelessness. However, finding lasting solutions to Vermont's housing challenges requires a sustained effort. For Vermont to be place that welcomes people of all backgrounds, we must find ways house everyone who needs a home, increase our commitment to racial justice, and remove discriminatory housing barriers.

Actions

a. Implement the recommendations of the Analysis of Impediments to Fair Housing.
b. Increase funding for community-based homelessness prevention and rapid re-housing.

Preliminary Assessment of Strategy against Criteria
Impact: This strategy has significant impact on the pathway, ensuring that people are able to access, and do not face barriers to accessing housing that is available.
Equity: Housing insecurity disproportionately affects BIPOC communities, older Vermonters, and those living on low incomes. Those most impacted by housing insecurity experience contextual, procedural, corrective, and distributive equity in the implementation of this strategy.
Cost-effectiveness: Strategies to prevent homelessness and increase access to stable, affordable housing are more cost effective than strategies that provide emergency or transitional housing.
Co-Benefits: Access to stable and affordable housing can improve health outcomes, increase community and civic engagement, and support healthy local economies.
Technical Feasibility: Yes

[226] https://www.housingdata.org/profile/income-employment/cost-burden

Pathways for Adaptation and Building Resilience in Natural and Working[227] Lands

In Sections 11 and 14 of this Climate Action Plan, means to mitigate the effects of climate change are recommended through both emissions reductions efforts as well as carbon sequestration and storage initiatives, respectively. Given best available data[228], the global community recognizes the need to aggressively reduce the amount of greenhouse gases in the atmosphere, and Vermont, via the Global Warming Solutions Act, has established state-level reduction requirements for 2025, 2030, and 2050. These efforts, critical as they are, are intended to slow the speed of climate change in the decades ahead – to course correct for future generations – but will not mitigate climate change as we experience it today[229].

The impacts of a changing climate to both our natural and built environments are widely studied, from changes that have already been observed, to those that are being modeled by climatologists across the world[230] and here in Vermont[231]. In order to create a habitable, resilient present and future, climate change adaptation efforts are essential. In the previous Section (12), strategies and actions to build resilience in the built environment are proposed. This section will focus on the role that Vermont's natural and working lands and waters can play, both in helping our ecosystems and agricultural and forested land adapt to a changing climate, as well as leveraging their inherent ability to offer adaptation and resilience value to our communities, often referred to as nature-based solutions (NbS), or through practicing traditional ecological knowledge (TEK).

Current models suggest that the northeastern region of the United States will see an increase in annual precipitation, and that the increase will most likely come in the form of more high precipitation events and not simply more days with rain each year[232]. Vermont's forests can retain significant water loads via headwater storage, just as intact, connected floodplains and river corridors can absorb excess water and reduce high, erosive energy during flooding events. Our wetlands can act as a sponge for additional rainfall, while also providing critical habitat for fish and wildlife. Water storage potential is also critical for the natural and working lands economy, which can be impacted not only by flooding, but also during periods of drought. Protecting and enhancing biodiversity will support Vermont's agricultural and forestry sectors and improve public health. In short, the Agriculture & Ecosystems Subcommittee recognizes that supporting our natural systems will, in turn, empower them to support our human infrastructure –

[227] For the purposes of this document we use the language "working and natural lands" as described and used in the GWSA Statute, but note that this terminology should be further considered since all lands in fact "do work" including but not limited to forage, shelter, wildlife habitat, water quality, spiritual sustenance, and many other ecosystem goods and services.
[228] https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf
[229] https://nca2018.globalchange.gov/chapter/28/
[230] https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf
[231] Vermont Climate Assessment. 2021. Due to be publicly released in Nov of this year. Lead authors are Galford, Faulkner & Dupigny-Giroux
[232] https://nca2018.globalchange.gov/chapter/18/

our communities, our economy, our built environment – restoring a balance in our shared ecosystems.

Climate change adaptation efforts, especially those that employ NbS and TEK, require upfront investments, but economists agree that the long-term savings are vast, given the rapidly increasing cost of climate change impacts[233]. Beyond economic returns, adaptation efforts yield myriad co-benefits – from building rural economic resilience to sequestering and storing carbon, improving soil health to maintaining habitat connectivity, and more.

The recommendations in this section aim to increase the adaptive capacity of Vermont's natural and working lands and waters, as well as enhance the resilience of our natural and human systems to a changing climate, through science-based, technical and traditional knowledge. The increased incidence of drought, extreme precipitation events, and changes in temperature patterns associated with climate change in Vermont have already begun to negatively impact our natural and human communities and systems. At the same time, features of Vermont's natural and working landscapes have absorbed and reduced climate risks, such as the impacts of extreme precipitation and associated floods. Broadly, the strategies that the State of Vermont must take to secure the health, resilience, and benefits of climate adaptation in natural and working lands include critical investments in the upfront costs of proactive implementation of adaptation practices, implementation of land use policies that support both appropriate, resilient development and natural resource conservation and protection, research and training to support land managers in making climate-informed plans and decisions, active integration of traditional ecological knowledge with science-based knowledge, innovative funding mechanisms to enable adaptation and resilience, greater support for floodplain and riparian restoration efforts, and enhanced protections of biodiversity.

[233] https://www.ipcc.ch/site/assets/uploads/2018/02/WGIIAR5-Chap17_FINAL.pdf

Pathway 1 - Adaptation: Sustain, restore, and enhance the health and function of Vermont's lands and water to help both natural and human communities adapt to climate change

This pathway includes strategies and actions that apply science-based, technical and traditional ecological knowledge (TEK) to the management of natural and working land that supports its capacity to absorb and recover from the impacts of climate change. In Vermont, climate change has already begun to negatively impact farms, forests, lands and waters through more frequent droughts, heavier rainfall events, and changes in temperature patterns. At the same time, features of Vermont's lands and waters have absorbed and reduced climate-risks, such as the impacts of extreme precipitation and associated floods.

Key Strategies & actions:

1. **Increase technical assistance, capacity, education, and resources to support private and municipal farm and forestland owners, planners and managers for climate change adaptation.** Farms and forests are already experiencing the impacts of shifting seasons, altered weather patterns, and increasingly extreme weather associated with a changing climate, and though the majority of Vermont farmers understand their vulnerability to extreme weather associated with climate change, they report a lack of financial capacity and technical skills to adequately address climate-related risks and invest in adaptation[234]. Outreach, education, and technical assistance will enable Vermont's land managers to better anticipate, prepare for, respond to, and recover from the impacts of climate change. Farmers and foresters already seek out this kind of advice from UVM Extension, other Vermont institutions of higher education, and other technical service providers, but climate programming is often soft-funded and dependent on competition with national grant opportunities. To meet the needs of Vermont's land managers in adapting to the impacts of climate change, dedicated funding to provide consistent expertise, education and assistance is essential.
    a. Enhance and support funding for technical assistance to farmers (e.g. fully fund UVM Extension to support climate adaptation training for agriculture and support other institutions of higher education in this endeavor), landowners (e.g. fund climate adaptation training through FPR's Forests & Climate program), and municipalities (e.g. fully implement Act 171)
    b. Increase funding to Regional Planning Commissions (RPCs) to hire and support natural resource staff, potentially through Natural Resource Conservation districts.

[234] White, A., J. Faulkner, S. Sims, P. Tucker, and K. Weatherhogg. "Report of the 2017–2018 New England Adaptation Survey for Vegetable and Fruit Growers." *Department of Plant and Soil Science, University of Vermont, Burlington* (2018).

c. Develop & fund climate adaptation planning and training for all farmers and foresters.

Preliminary Assessment of Strategy against Criteria
Impact: Education and training for farmers and foresters will have a significant positive impact on adoption of climate adaptation practices and planning among land manager.
Equity: To enhance equity of this strategy, traditionally underserved and impacted communities will be identified. Then they will be included as subject matter experts during the design of trainings, and targeted programming must be developed to meet their contextually specific needs.
Cost-effectiveness: Proactively investing in climate adaptation on Vermont's lands costs far less than the cost of recovering and rebuilding from climate-related damages and is extremely cost effective.
Co-Benefits: This strategy is primarily focused on resilience and adaptation but will have mitigation benefits of carbon sequestration, as well as biodiversity, water quality, soil conservation, buffering damage to downstream built communities; create jobs in rural communities; enhance sustainability of rural and working livelihoods; and reach impacted communities.
Technical Feasibility: Yes

2. **Promote and incentivize Climate Adaptation forest management practices.** Integrating climate change adaptation considerations into planning and forest management can help reduce climate-related risks, such as declines in forest productivity, losses in forest cover and biodiversity, and disruptions to ecological processes. However, Vermont's forest managers need to know what those options are, how to implement them, and how to evaluate success, as well as to have the financial capacity to adopt new techniques. Resources on climate adaptation for northern forests have already been developed in part by regional efforts such as the Northern Institute of Applied Climate Science[235] and the USDA Climate Hubs[236] which can be used to create locally-specific guidance. Practice-based cost-share incentive programs are needed to enable land managers to make changes and adopt new practices.

   a. Develop education/outreach materials and training regarding climate adaptation forestry specific for Vermont forest types and conditions.
   b. Where appropriate, promote planting future climate adapted tree and crop species
   c. Make the state guide to maintaining and creating resilient forests more usable[237]
   d. Develop a 'pay-for-practice' incentive program and explore state tax policy incentives for forest landowners to adopt climate-adaptive management practices.

Preliminary Assessment of Strategy against Criteria

[235] Northern Institute for Applied Climate Science (NIACS). Climate Change Response Framework. https://forestadaptation.org/

[236] https://www.climatehubs.usda.gov/sites/default/files/USDA%20FS_2016%20Forest%20Adaptation%20Resources_GTR_NRS87-2.pdf

[237] https://fpr.vermont.gov/sites/fpr/files/Forest_and_Forestry/Forest_Health/Library/Climate%20change%20report_final_v6-18-15a.pdf

Impact: Education and support for foresters will have a significant positive impact on adoption of climate adaptation practices and planning in forests.
Equity: To enhance equity of this strategy, traditionally underserved and impacted communities will be identified. Then they will be included during the design of trainings, and targeted programming must be developed to meet their contextually specific needs. Incentive programs must offer differentiated rates, incentives and enrollment preference to address equity.
Cost-effectiveness: Proactively investing in climate adaptation on our lands costs far less than the cost of recovering and rebuilding from climate damage and is extremely cost effective. The cost effectiveness comes also from the protection of critical ecosystem services, e.g. if forests degrade from climate change, we will have to bear higher costs for water quality clean up, etc.
Co-Benefits: This strategy is primary focused on increasing the resilience and adaptation of forests but will have mitigation benefits of carbon sequestration and storage, as well as biodiversity, water quality, soil conservation, buffering damage to downstream built communities, create jobs in rural communities, enhance sustainability of rural and working livelihoods, and reach impacted communities.
Technical Feasibility: Yes

3. **Promote funding for nature-based solutions and traditional ecological knowledge efforts and incorporate into state funding and planning efforts.** Nature-based solutions (NbS) and traditional ecological knowledge (TEK) systems are knowledge domains that are leveraged to address climate change adaptation around the world. Integrating this expertise will have a positive impact on climate adaptation and resilience in Vermont. Nature-based solutions [238] include actions like ecological restoration projects, which **protect, sustainably manage, and restore natural and modified ecosystems in ways that simultaneously address climate change, protect biodiversity and support human well-being.** Traditional ecological knowledge[239] is defined as 'a cumulative body of Indigenous knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment.' TEK plays an important and sometimes central role in climate adaptation initiatives and can support detection of environmental changes, the development of adaptation strategies, and offer guidance or inspiration for cultural and psychological shifts in how society relates to nature. Investment in NbS and TEK efforts at both the funding and planning levels, will be invaluable in leveraging the role that our lands and waters can play in creating a resilient, climate-adapted future.

    a. Complete a statewide audit of technical assistance, funding, and regulatory programs to review support for NBS and TEK and assess the degree to which they support or hinder climate adaptation, and use the findings to create planning and/or funding prioritization criteria that better align state programs.

[238] https://www.iucn.org/theme/nature-based-solutions

[239] https://www.fs.fed.us/pnw/pubs/pnw_gtr879.pdf

b. Develop financial mechanisms (e.g. a revolving loan fund, green bank, loan guarantees, pension fund investments, etc.) to de-risk capital investment in and support for NBS and TEK projects.
c. Elevate the role TEK plays in climate adaptation and resilience and incorporate TEK into state-led climate assessments, planning efforts, and prioritization frameworks,
d. Incentivize nature-based solutions(NBS) and traditional ecological knowledge (TEK) in state regulatory processes and funding programs,
e. Include local Indigenous people knowledgeable in TEK and Vermont's youth in state, regional and municipal resource management planning.

Preliminary Assessment of Strategy against Criteria
Impact: Investments in NBS and TEK can have a significant positive impact on both the climate resilience of our communities and infrastructure and the adaptation of both aquatic and terrestrial species and natural communities.
Equity: Local Indigenous experts must be included as content experts and be compensated for consulting the state on a process for integration of TEK. The way TEK is integrated will need to be approached with community directed, culturally sensitive methods to knowledge exchange and communication.
Cost-effectiveness: Mitigating major flood damage and losses of biodiversity through investment in natural solutions and TEK is extremely cost effective.
Co-Benefits: This strategy is primarily focused on resilience and adaptation in forests but will have mitigation benefits of carbon sequestration, as well as biodiversity, water quality, soil conservation, buffering damage to downstream built communities, create jobs in rural communities, enhance sustainability of rural and working livelihoods, and reach impacted communities
Technical Feasibility: Yes

4. **Manage natural and working lands for biodiversity, forest health, and climate resilience.** The reality of a changing climate and a changing world means our lands and waters' biodiversity, forest health, and climate resilience is something that must be actively managed for, protected, and cultivated. Enhancements in soil health and increases in vegetative cover will slow the flow of water over land and increase filtration into the soil therefore mitigating downstream flood surges and improve water quality. While some management practices are well understood in their ability to enhance resilience, research is needed on new and emerging climate adaptation practices in our lands and waters. The cost of implementation of adaptation practices limits the degree to which land managers can make the necessary changes to promote biodiversity and climate resilience. The impacts of severe weather events have already proved devastating to farms, and Vermont farmers report a lack of financial capacity to adequately address climate-related risks and invest in adaptation[240].

[240] White, A., J. Faulkner, S. Sims, P. Tucker, and K. Weatherhogg. "Report of the 2017–2018 New England Adaptation Survey for Vegetable and Fruit Growers." *Department of Plant and Soil Science, University of Vermont, Burlington* (2018).

The same is true for Vermont forest managers, many of whom are also farmers. Resilience funds have been identified as helpful for recovery, but they are currently underdeveloped and under-resourced. Phenological variability and increased ground disturbance is altering Vermont's biodiversity, creating imbalance in Vermont's ecosystems.

a. Fund increased investment in healthy soils education and implementation of practices.
b. Enhance resilience funds to support the financial capacity of land managers to respond and adapt to natural hazard and climate impacts.
c. Fund support for local academic institutions, researchers, and applied research to evaluate best climate management practices for our lands.
d. Support research efforts to better understand forest ecosystems, local climate change, and impacts to farms, wetlands, forests and ecosystem services.
e. Incentivize and provide appropriate support for invasive species control efforts, specifically where populations threaten ecosystem function and processes.
f. Through direction to VT Fish & Wildlife and VT Forests, Parks and Recreation, establish primary land management objectives of protecting and improving forest health and biodiversity on state lands, municipal lands, and private lands enrolled in UVA.

Preliminary Assessment of Strategy against Criteria
Impact: Investing in the management of natural and working lands for climate resilience will have significant climate adaptation and resilience benefits to both landscapes and downstream built communities.
Equity: Traditionally underserved and impacted communities will first be identified for all actions. They will be included during the design of targeted programming to meet the contextually specific needs of these stakeholders. Impacted communities will be consulted during the development of programs and RFPs. Incentive programs will offer differentiated rates and enrollment preference to address equity.
Cost-effectiveness: Mitigating flood damage, irreparable biodiversity loss, and farm closures through proactive investment in natural solutions is extremely cost effective when compared to the cost of doing nothing.
Co-Benefits: This strategy is primary focused on resilience and adaptation but will have mitigation benefits of carbon sequestration, as well as biodiversity, water quality, soil conservation, buffering damage to downstream built communities, create jobs in rural communities, enhance sustainability of rural and working livelihoods, and reach impacted communities.
Technical Feasibility: Yes

5. **Plan and regulate for climate resilience and adaptation.** The integration of a 'climate lens' across existing state, regional, and municipal planning efforts and regulations can help meet the GWSA's resilience and adaptation goals via existing efforts. Likewise, increasing an awareness of other climate change efforts and climate action across state agencies and employees and creating power-balanced spaces for communication among staff from multiple levels could increase synergy among goals, education, and work across the State of Vermont agencies who will implement the recommendations of the Climate Action Plan.

a. Establish "climate resilience zones" informed by existing data, bolstered with new research/science, to identify locations that have high resilience potential for both the natural and built environments and use to inform land use development and regulations
b. Per the formula in statute, fully fund Regional Planning Commissions (RPCs) to ensure sufficient capacity necessary to address climate change in regional and municipal plans.
c. Direct the Legislature to authorize development and implementation of a Statewide Land Use Plan. In doing so, the Legislature should clarify how and if a State Land Use Plan informs or directs land use planning, policy and regulation at the local, regional, and state level.
d. If a State Land Use Plan is authorized, explore creation of a State Planning Office and/or other potential structures within the executive branch to implement the Plan at the state level.
e. Create a mechanism, position or body within the Executive Branch to ensure coordinated climate action across state government with just transitions and environmental justice expertise. This inter-agency body or mechanism is intended to connect actions *beyond the scope* of the Climate Action Plan implementation, with a goal of ensuring effective communication across agencies that work together to promote climate change mitigation/adaptation/resilience and adding a consistent climate lens to the myriad of regulatory and funding programs.

Preliminary Assessment of Strategy against Criteria
Impact: Identifying and protecting resilience zones will have significant climate adaptation and resilience benefits to both landscapes and downstream built communities. Greater climate awareness and coordination among agency staff may have impacts on climate adaptation and mitigation efforts
Equity: Inclusion of more voices and paying attention to power dynamics in the implementation of climate policy and programs embodies procedural equity. Impacted and historically underserved communities will be identified, and then seats for their voices will be included in all councils and committees that make decisions impacting these communities. Representatives from impacted communities will be compensated for their time to participate in meetings, and facilitators will be tasked with ensuring these voices not be marginalized by the group dynamic, overtly or through micro-aggressions.
Cost-effectiveness: This strategy has the potential to be very cost effective, in that it draws on exiting efforts and structures, and may create synergy and efficiency through better government coordination on climate change, and climate informed planning.
Co-Benefits: Equity, resilience, education, potentially others
Technical Feasibility: Yes

6. **Increase flood resilience of the natural and built environments.** Because of Vermont's topography, the state has always experienced flooding in low-lying areas; however, in recent years these events have become more common, more widespread, and more severe due to climate change. The 2010s saw a three-fold increase in federally-declared disasters from the previous decade, the majority of which were due to flooding. Climate modeling suggests that

these trends will continue[241], and so Vermont must plan to promote flood-resilient human and natural communities and invest in and maintain our intact landscape to leverage nature-based solutions that can help mitigate the impacts of severe flooding.

a. Incentivize water storage in natural areas to promote flood resilience and biodiversity through expansion of wetland, floodplain, and/or river corridor easements that better compensate landowners/managers.
b. Ensure opportunities for floodplain reconnection and nature-based solutions are considered a high priority in the Statewide Conservation & Buyout Program through incorporation of multi-stakeholder developed prioritization criteria.
c. Invest transportation funding in improving flood resilience and aquatic and terrestrial connectivity.

Preliminary Assessment of Strategy against Criteria
Impact: Increasing flood resilience through investments in nature-based solutions can have a significant positive impact on both the climate resilience of our communities and infrastructure and the adaption of both aquatic and terrestrial species and natural communities.
Equity: Impacted communities will be identified and compensated for consulting on implementation of these recommendations. This can be an equitable strategy provided investments are made where there is a willing landowner who is compensated fairly.
Cost-effectiveness: Mitigating major flood damage on Vermont's built environment and natural communities through investment in natural solutions is extremely cost effective.
Co-Benefits: This strategy is primary focused on resilience and adaptation but will often have mitigation benefits, especially when areas are maintained or restored to a natural condition where trees, shrubs and other vegetation can sequester and store carbon at a higher rate than the baseline.
Technical Feasibility: Yes

7. **Promote healthy, connected river corridors, floodplains and wetlands.** River corridors, floodplain, riparian and wetland ecosystems support critical ecosystem functions that are foundational to biodiversity, ecosystem resilience, habitat, flood surge regulation, erosion mitigation, carbon storage, and climate adaptation of natural communities. A river corridor is the land area adjacent to a river that is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel and that is necessary for the natural maintenance or natural restoration of a dynamic equilibrium condition and for minimization of fluvial erosion hazards.[242] Floodplains are the areas adjacent to rivers where inundation flooding occurs during high flow events, which are increasing in frequency and intensity due to climate change. Both the inundation flooding of floodplains and the dynamic, erosive flooding associated with river corridors pose a risk to health and safety when homes, transportation corridors or other permanent infrastructure are sited too closely to a river.

[241] https://nca2018.globalchange.gov/chapter/18/
[242] https://floodready.vermont.gov/flood_protection/river_corridors_floodplains/river_corridors

Minimizing new encroachments in these areas helps to maintain adequate connections between a river and its floodplain and sufficient room for river corridors to meander overtime, without resulting in costly and potentially life-threatening impacts. Riparian areas are the areas between aquatic (water) and terrestrial (land) ecosystems. Riparian areas can be found along streams, rivers, lakes, wetlands and other waterbodies[243]. These areas have critical ecological functions that connect the aquatic and terrestrial ecosystems, thereby supporting unique habitats, natural communities, and high biological diversity[9, 244, 245]. Riparian areas maintain high quality aquatic habitat by protecting water quality and by providing shade, organic matter, and structure necessary for healthy aquatic systems. Vegetated riparian areas also create bank stability, which reduces erosion during high precipitation events and in turn reduces impacts to water quality. They also help to physically protect our farms and towns by reducing flood surges. Riparian areas function as terrestrial wildlife habitat and travel corridors connecting larger areas of intact habitat and are critical for the species migration that climate adaptation necessitates. Wetlands are important and valuable ecosystems for Indigenous activities. The Carbon Budget[246] developed for the Vermont Climate Council confirms wetlands are a net carbon sink. In addition to these mitigation benefits, wetlands absorb storm water during high precipitation events, are a critical source of water during periods of drought and provide critical habitat for a range of species adapting to climate change. A UVM study, following Tropical Storm Irene, found that intact wetlands and floodplains have the ability to reduce flood damages by 54-78%[247]. In Vermont, wetlands enjoy significant regulatory protection and benefit from a host of conservation programs; however, opportunities exist to do more.

a. Support and fund research and design to strategically invest in floodplain and river corridor reforestation efforts. Specifically, develop an inventory of priority/critical headwater and floodplain storage areas, prioritize investments for restoration and protection in these areas, and use to inform Compact Settlement planning efforts.
b. Expand support for riparian buffer enhancements to easements with a goal of increasing the amount of vegetation and biodiversity in riparian areas.
c. Increase support for wetland restoration and protection.

Preliminary Assessment of Strategy against Criteria
Impact: Maintaining or increasing the functions and values of riparian areas across the state leading to a more resilient and adaptive landscape for a wide range of

[243] Riparian Science Technical Committee (RSTC). 2007. Analysis of the Current Science Behind Riparian Issues. Report to the Minnesota Forest Resources Council
[244]https://vtfishandwildlife.com/sites/fishandwildlife/files/documents/Conserve/RegulatoryReview/Guidelines/Riparian_Management_Guidelines_ANR_Lands_2015.pdf
[245] Vermont Agency of Natural Resources (VT ANR). 2005. Riparian buffers and corridors: technical papers. Waterbury, VT. http://www.anr.state.vt.us/site/html/buff/buffer-tech-final.pdf
[246] Galford G, Darby H, Hall F, and Kosiba AMK. 2021. A Carbon Budget for Vermont.
[247] https://www.sciencedirect.com/science/article/abs/pii/S092180091630595X

species. Identifying areas with critical floodplain and river corridor function to inform land use planning, conservation and regulatory efforts can result in river systems that have the room to safely flood and meander, reducing impacts on homes, infrastructure and other costly investments, resulting in a more resilient landscape. Wetlands are highly protected but expanded conservation and restoration efforts will yield increased impacts over the baseline.
Equity: If the identification of critical areas ultimately results in a loss of certain land use or development rights, landowners will need to be compensated in a fair and equitable manner. Impacted communities will be identified and compensated for consulting on implementation of this recommendation. Can provide additional funding for landowners interested in protecting riparian areas but may result in some loss of use by other landowners in riparian areas. Generally wetland areas have low commercial potential and are valued for their ecological, recreation and aesthetic qualities, so expanded protections are likely equitable.
Cost-effectiveness: Identification of these critical areas through remote sensing and analysis is relatively cost-effective, but will require some investment in state agencies, universities or consultants to conduct the work. Site specific analysis will be more costly. However, if inundation flooding or significant fluvial erosion can is avoided through this strategy, the magnitude of savings to the state and individual landowners far exceeds the cost. Wetland protection and restoration is generally a cost-effective endeavor. The additive cost of riparian provisions in easements and the cost of riparian restoration is relatively low and the benefits can be great.
Co-Benefits: This strategy primarily has resilience and adaptation benefits, but if critical areas are identified and retained in a natural condition, they may reforest or otherwise see an increase in carbon sequestration and storage resulting in mitigation benefits. Vegetated riparian areas enable ecological adaptation to climate change, improve the resilience of our communities, and provide some mitigation benefits through the growth and maintenance of trees, shrubs and plants; there are also water quality benefits. Wetlands support climate mitigation, adaptation and resilience.
Technical Feasibility: Yes

Pathway 2 - Viability: Support and empower Vermont's natural and working lands owners, managers, and caretakers to enhance farm and forest viability and to make informed decisions to increase resilience and adaptation to climate change.

The actions under this pathway have a fundamental foundation in education, incentivization and economic stimulation which will support and empower farmers, foresters and land managers, and enhance local markets with a positive focus on greenhouse gas emissions mitigation and climate change resilience benefits. Adaptation and resiliency to climate change will require investments of resources and technical knowledge to ensure the implementation needed to address climate concerns, but the success of this effort is dependent on the ongoing viability and sustainability of those who own and manage the land on which these changes will be made. Without solid technical and financial support, landowners cannot learn about new technologies and practice changes, implement them accurately or maintain them for long-term impact, and fundamental to all of this is the ability for these changes to continue to support the functions of our natural lands and the livelihood and success of our land managers.

Actions that foster partnerships at all levels are essential to developing strategies that empower all of Vermont's working landowners to address climate change. State, federal and local partners provide ongoing education and support for new advances and best practices as well as additional financial resources, and these partnerships must grow to meet the demands of our changing climate and the need to address equity for beginning and socially disadvantaged landowners, those with less access to technical and financial resources, BIPOC and other marginalized communities or individuals. New equity models for land access and ownership should be created and expanded. In addition, creative land ownership, leasing or land access models that might include multiple users of large tracts of land, where feasible, should be researched. Currently, farmers and foresters must navigate a complex maze of regulatory and permitting frameworks in addition to state and federal funding opportunities; these systems will need to be assessed for equity and efficiency in order to streamline the process both for the benefit of the practitioners and for our lands and waters.

KEY STRATEGIES AND ACTIONS

1. **Support and enhance local food markets for greater viability, mitigation, and resilience benefits:** The Vermont Farm To Plate (F2P) strategic plan states that Vermont will face considerable disruption to the local food system and farm viability because of climate change. Increasing in-state and regional markets will reduce the risk to large food system disruptions while addressing the needs of lower income communities. Implementation of the priorities in the F2P strategic plan is recommended.

Preliminary assessment
Impact: Providing farmers and producers of natural resource products with local outlets for their products increases resiliency to changes in climate, disruptions to the

national food system and inequitable impacts on marginalized communities and individuals. Local markets also decrease transportation impacts and fuel usage.
Equity: Increasing local markets addresses inequities among income levels in accessibility to sufficient, nutritious local food.
Cost-effectiveness: Increasing economic viability by ensuring markets is one of the most cost-effective ways to address climate resilience.
Co-Benefits: Having a viable local market helps to enhance the rural economy and increase landowner economic ability to address other natural resource needs such as water quality.
Technical Feasibility: Yes

2. **Foster partnerships at all levels (state, federal, nonprofit, and private sector): essential to recognizing, capacitating, and building strategies for landowners to address climate change and enhance community resilience:** Vermont's small size and community-based collaborations and networking have long enabled state and federal partners to support and assist landowners in the best methods for mitigating natural resource impacts. With the additional climate concerns, these partnerships must not only be maintained but strengthened to ensure the most efficient and effective means for maximizing opportunities for co-benefits of all programs.
    a. Dedicate funds to support Vermont Natural Resources Conservation Districts and farmer watershed organizations with the specific objective of allowing them to reach other farmers, foresters and landowners, with education about climate resilient practice implementation.
    b. Maintain the Ag & Ecosystems Subcommittee through development and implementation of the Global Warming Solutions Act (GWSA) and the Climate Action Plan (CAP) to cultivate, build and reinforce state, federal, nonprofit, and private sector collaborations.
    c. Fund a research project to fully understand household food insecurity in Vermont and how to invest in its elimination. The design and implementation of the research project should engage academics, advocacy groups, and impacted individuals, and include research on geographic spread, root causes, and costs to the health care, educational, and emergency response systems (as written in the 2021-2030 F2P Strategic Plan pg. 158). (Collaborate with Hunger Free Vermont, Vermont Foodbank, VT Releaf Collective).
    d. Work closely with USDA NRCS's 2021 Action Plan for Climate Adaptation and Resilience to leverage resources and increase efficiencies of practice education and implementation. Coordinate with NRCS Ecosystem Restoration Program to make it more efficacious and accessible for Vermont in the wake of disasters.

Preliminary assessment
Impact: Providing technical assistance and education has long-proven broad positive impacts across the agriculture, forestry and natural resource sectors.
Equity: Increased partnerships and collaborations will provide access across communities and individuals with synergistic positive results.
Cost-effectiveness: Partnerships and collaborations have already proven that a modest outlay of financial support provides considerable payoffs.

Co-Benefits: Broader partnerships through a wide sector of the agricultural community benefits additional farmers, land managers, and landowners and provides opportunities for evaluating co-benefits of practice changes for the highest economic and environmental value.
Technical Feasibility: Yes

3. **Expand funding for existing programs dedicated to farmland access, forestland ownership and conservation, and leverage this funding to increase land access through flexible and new ownership financing mechanisms, policies, and models:** Innovative financing is going to be critical to successfully expanding funding and resources needed to support climate change adaptation and resilience (e.g., performance mortgages, shared equity models, ground leases, appropriation of $3 million in low-cost capital to a Community Development Financial Institution or other lender, policy incentives to encourage multiple tenants or owners on larger tracts of land, and low-cost and long-term farm leasing on publicly held lands).A particular emphasis on the needs of beginning, socially disadvantaged, and Black, Indigenous, and People Of Color (BIPOC) farmers (as written in the 2021-2030 F2P Strategic Plan pg. 30) is critical, especially education and support for navigating the financing, permitting and funding to ensure all landowners have access to the same resources and opportunities.
    a. Investigate innovative funding mechanisms which increase farmland access, **forestland ownership** and conservation and will assist with implementation of climate smart agricultural practices, crop insurance for diversified Vermont-scale farms, and emergency recovery following extreme weather events, to better respond when climate change related events occur.
    b. Assist food, forest product and farm businesses with navigation of municipal and state permit requirements and regulations. This will create a more supportive environment for business growth and diversification, especially as it relates to forest products processing and distribution, on-farm accessory businesses, farm employee housing, and development of off-farm distribution, and storage infrastructure (as written in the 2021-2030 F2P Strategic Plan pg. 33).

Preliminary assessment
Impact: Equal access to land, through conservation and other land access programs, for agricultural and forestry activities is critical and has high positive impact for climate resilience and adaptation.
Equity: For too long, the lack of access to land and the tools (such as capital) to operate that land have been negative strikes against our society. Managing this issue fairly and equitably is vital to our future success for managing our climate.
Cost-effectiveness: Very cost effective, to support and expand existing successful programs.
Co-Benefits: Multiple co-benefits to farm transition, when engaged and productive land managers produce high quality products in a way that increases climate adaptation and resilience.
Technical Feasibility: Yes

PATHWAY 3 - Economies: Grow and connect local and sustainable natural and working lands' economies, markets, and food systems while ensuring and providing equitable access to said economies, markets, and food systems for Vermont's people.

A clear co-benefit of thriving and resilient natural and working lands is our ability as citizens to benefit in reciprocal ways from sustainable stewardship. Protecting our natural environment for its social benefits of climate adaptation as well as flood resilience, water quality and food security does not mean a resulting negative economic impact. Improving and protecting our natural systems brings new opportunities for economic development, while addressing the untenable food insecurity issues faced by many Vermont citizens.

The Agriculture and Ecosystem subcommittee benefited greatly from the recent extensive process of developing the Vermont Farm to Plate Strategic Plan: 2021 – 2030. This is a valuable resource from a multi-stakeholder lens regarding how we might move forward to pursue a just and equitable agricultural economy. All three of the legislative directives for the strategic plan goals (increasing economic development and jobs; improving resilience of the working landscape in face of climate change; and improving access to healthy local foods for all Vermonters) directly support the work included in the strategies and actions below. The F2P plan also confirms the need to prioritize our agricultural land base, infrastructure, and food security in order to increase Vermont farm and food system resilience to the impacts of climate change [248]. To that end you will find that we have pulled multiple actions from the F2P plan into our work that we felt complimented or elevated our pathways and strategies.

In our current frameworks, economies tend to trump all to the detriment of our natural resources. We instead choose to envision a future with a sustainable and robust working lands economy due to practices, harvesting, and methodologies rooted in the Indigenous values of reciprocity, responsibility, respect, reverence, and relationships. In layman's terms, if we take care of nature, nature will take care of us. Recognition of the intersection of the natural landscape and its benefits to our environmental and climate goals, to the well-being and security of Vermonters is the overarching priority of the strategies below.

KEY STRATEGIES AND ACTIONS

1. **Develop, expand, and sustain local markets specifically for food, agricultural, and forest products in ways that ensure food sovereignty and security and provide for all Vermont's peoples.** The further development, expansion, and creation of robust and innovative local markets has both the potential to reduce GHG emissions from food waste and food miles, as well as build out more just and sustainable livelihoods for those living and working within our farm and forest sectors. For our natural lands to continue to provide us with climate adaptation and resilience benefits, our landowners, managers and citizens who

[248] Farm to Plate Strategic Plan - https://www.vtfarmtoplate.com/assets/resource/files/Vermont%20Agriculture%20and%20Food%20System%20Strategic%20Plan%202021-2030.pdf. P. 9

support this work must also be supported. Additionally, ensuring food security for all Vermonters is not just a co-benefit of related climate actions but is a valuable strategy of its own. "Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs. It is development that achieves economic viability, environmental sustainability, and social equity and well-being" [249].

It is critical moving forward to take the time to fully understand where we are and where we wish to go. We see the 2021-2030 Farm to Plate Strategic Plan as a good starting place and highly recommend the development of an equivalent forest sector strategic plan and the mapping of Vermont's agricultural land base and production capacity to better understand where we are and how we build just and equitable policies moving forward.

a. Support robust funding for Working Lands Enterprise Initiative and prioritize funding to businesses that have climate/low carbon goals.
b. Develop a strategic plan for the forest economy, modeled on the Farm-to-Plate strategic plan but improved to better incorporate impacted stakeholders and principles of equity, as well as examining our current language and approach to forest management.
c. Develop supply chain substitutions which better support local products.
d. Support research and development efforts, and expansion of new markets and opportunities for local wood products processing and manufacturing in Vermont.
e. Develop alternative markets for low-grade wood, focusing on cellulose insulation, bioplastic composites, or biofuels.
f. Research the efficacy of food hubs as public infrastructure (e.g libraries and public infrastructure).
g. Map Vermont's agricultural land base and production capacity, including geographic data about predicted climate change impacts, aggregation and distribution infrastructure, and regional dietary needs (as written in the 2021-2030 F2P Strategic Plan pg. 32).
h. Provide additional support for critical programs that help Vermont's agricultural sustainability and ability to address climate issues including:
    - Support the growth of VAAFM Meat Inspection and Agricultural Development programs, which will help expand Vermont products into the regional marketplace and develop consumer education and public awareness campaigns around the steps involved in getting meat products from farm to table;
    - Fund a pilot aggregation and sales system that effectively serves both the charitable food system and institutional and other market channels, through a structured partnership among established processors, aggregators, and gleaners. The pilot would include data collection on specific marketable surplus food products;
    - Support the Vermont Farm to School Network;
    - Support organizations in the charitable food system to source food directly from Vermont farmers;
    - Create a Local Food Access Funding Program;

[249] Farm to Plate Strategic Plan,

- Develop a distribution and logistics infrastructure investment plan to guide strategic transportation investments with the express purpose of improving the efficiency and cost-effectiveness of in-state and regional food distribution. Include a business plan analysis for a public/private Vermont wholesale terminal market that would provide cross-docking, cold storage, and logistical service between Vermont producers and regional wholesale buyers;
- Using the infrastructure study as a guide, increase public-private investment in intermediated market distributors to improve operational efficiencies and overall sales through improved marketing, infrastructure, route optimization and shared transportation-management software, and access to logistics professional development and consulting.

Preliminary Assessment of Strategy against Criteria
Impact: High impact, potential to reach entirety of state
Equity: Were the true language of food sovereignty applied as we move forward, positive implications for a more just and equitable future are huge. Within the context of funding, TA access, market, food, and land access there are massive amounts of work necessary to repair the damage of historic and present-day harms to our most impacted communities.
Cost-effectiveness: Moderate. Similarly, to the necessary transitions in the energy sector, the upfront cost is more, but the benefits in the long term pay for themselves.
Co-Benefits: High. Both from a mitigation and adaptation/resilience standpoint investing in this strategy could advance numerous components of broader societal benefit; public health, equity, economic prosperity, carbon storage and sequestration and workforce opportunities.
Technical Feasibility: Yes

2. **Promote workforce development in all working lands sector along all points of the supply chain:** So often in our quest for farm or forest business viability we are pursuing infrastructure investments. We need our focus to shift slightly: from *farm* and forest viability to ***farmer*** and forester/logger viability, business viability to land, water, and forest viability. As we have observed, public investment in infrastructure (manure pits, water quality projects) without an equal investment in farmers and farmworkers does not adequately support farmers, limiting their ability to support the needs of the climate crisis. When farms go out of business, we run the risk of losing the value that land brings to climate resilience.

   Our current workforce is ready to rise to the challenge but needs support in developing a business system where becoming a farmer or farmworker, a forester, a logger, a logistics manager at a food hub, is a viable career path that supports the natural lands enterprises that research consistently shows are essential to address our climate adaptation strategies, immediately and into the future.

   a. Develop, endorse and implement fair trade and equitable labor practices and just livelihoods for the natural and working lands sector
   b. Better resource state programs to support landowners' personal and professional development, and where needed, develop additional affordable and accessible training programs such as apprenticeships, certificates, stackable credentials, and

concurrent degrees. Provide training to natural land managers in securing, retaining and supporting employees.

Preliminary Assessment of Strategy against Criteria
Impact: This strategy could have a high impact, particularly in our rural communities and natural communities. Resourced people are able to care for our natural and working lands far better. Additionally as a state we all benefit from increased clean water efforts, food security, and more circular local economies.
Equity: A well-resourced workforce well equipped to steward our lands into the future will be critical. Particularly given costs of higher education, building out options to "earn while you learn" offer new pipelines to education and viable careers. Any new policies implemented should be created using the Just Transitions *Guiding Principles* and equity screening rubric.
Cost-effectiveness: Though it will require investment, existing revenue streams could be redirected and prioritized differently, with a climate resilience and equity lens to accomplish some of these goals.
Co-Benefits: Immense. A state where the working lands economy sustained just livelihoods would result in massive net benefits for all; could provide for an entirely reinvigorated work force, enhanced circular economies, keeping more dollars in state, and the enhanced resilience of our natural and working lands and therefore our people.
Technical Feasibility: Yes

3. **Strengthen all aspects of working lands' supply chains and the associated infrastructure to support them:** Similar to above but focused on the necessary infrastructure investments and upgrades that will allow our working lands' sector to build out their production, distribution, and logistical capacity. Again, as we determine our methodologies for siting and development, we need to be transparent about potential impacts and harms and frame our new projects within the *Guiding Principles.*
    a. Make significant investment in storage, processing, and distribution infrastructure in order to enhance product innovation and quality across all Vermont food and forest products.
    b. Support product-specific value chain development through facilitation of producer, distributor and buyer matchups and supporting producer-driven aggregation, distribution, and marketing enterprises.

Preliminary Assessment of Strategy against Criteria
Impact: Moderate to High.
Equity: Though siting and development of infrastructure/processing would need to be implemented using the *Guiding Principles* equity screening rubric, building out our local supply chains and distribution cuts down on our upstream emissions and inequitable impacts in other places in the globe. The more we can source here, the less we emit, the less we degrade the environment's resources in other places though clearly our regulations a
Cost-effectiveness: Moderate. Initial costs are high, but long-term benefits equate to overall cost-effectiveness. Development of supportive and creative infrastructure is essential to the success of agricultural and forestry sustainability through market development.

Co-Benefits: If build out utilizing the *Guiding Principles* the co-benefits of these investments are high.
Technical Feasibility: Yes

4. **Ensure equitable access to local foods, culturally relevant foods, land, funds, grants, and technical assistance for people who have been historically marginalized and come from impacted communities:** The reality of Vermont is no different than anywhere else in the United States. The land we now know as Vermont is the ancestral and unceded homelands of the Abenaki and Mohican peoples that were appropriated by Europeans and their descendants. A Additionally, redlining and inequity that denies our BIPOC, LGBTQIA+, disabled, migrant worker and low-income communities from accessing land, homes, loans, technical assistance, culturally relevant foods and access to just and dignified lives. Equitable access to all communities increases our ability to creatively and sustainably support our working lands economies and the related climate benefits.
    a. Build out and utilize TEK to build out connections to our Tribal and Indigenous communities in the development and utilization of traditional products, e.g. birch syrup, sumac spices, etc.
    b. Uplift and resource the work of the Vermont Releaf Collective and other BIPOC led organizations
    c. Improve funding opportunities and create equitable access for BIPOC organizations and BIPOC owned businesses by developing multi-year, unrestricted BIPOC centered grants and loan programs.
    d. Build out and utilize TEK to build out connections to our Tribal and Indigenous communities in the development and utilization of traditional products, e.g. birch syrup, sumac spices, etc.
    e. Uplift and resource the work of the Vermont Releaf Collective and other BIPOC led organizations
    f. Improve funding opportunities and create equitable access for BIPOC organizations and BIPOC owned businesses by developing multi-year, unrestricted BIPOC centered grants and loan programs.

Preliminary Assessment of Strategy against Criteria
Impact: High. The ability of all of Vermont's people to become resilient and adaptive is imperative to our shared future. Additionally, so many of the practices and tenants that we embrace as regenerative, organic, or sustainable can be directly attributed to global Indigenous traditions and it is incumbent upon us to restore both the appropriate attribution of these practices and the ability of our BIPOC communities to practice them.
Equity: Any endeavors that are pursued must be done so as directed and informed by the communities for whom they are created. Our typical power dynamics and structures must be flipped and the sovereignty of our BIPOC communities to self-determine the direction with which they nourish themselves, their land, and their communities must be the goal.
Cost-effectiveness: Moderate – High.
Co-Benefits: Repairs harms, sustains lands and communities, heals trauma and builds deeper connections for communities to land and their ability to sustain.
Technical Feasibility: Yes

5. **Develop a Vermont food security and sovereignty plan, centered around a thriving food system, and inspired by community-based responses to food insecurity and disruptive events:** 1 in 3 Vermonters are food insecure and additionally we know that many of our frontline and impacted communities face massive barriers to access when trying to sustain themselves and their families, including many of the very people who produce food for others. As was witnessed during COVID the brittleness of our food systems impacts our people quickly. The ability of our state to feed its people will be imperative as climate change and its realities take further hold.
    a. Involve food insecure individuals as well as farmers in the planning, and investigate questions including, but not limited to, affordable housing, health care, transportation, siting of retail grocery stores, food distribution, and ensuring the continued production of food in Vermont to increase resilience and adaptation for all.
    b. Work to adopt state and regional level policies, procedures, and plans to ensure that the Vermont food supply is sufficient to withstand global or national food supply chain disruptions caused by climate change and other disasters.

Preliminary Assessment of Strategy against Criteria
Impact: Substantial, particularly for our most vulnerable communities.
Equity: Actions in this realm must be undertaken utilizing the *Guiding Principles.* The traditional power dynamics and control must give way to the voices of those who are most impacted by food insecurity and disruptive events. Community engagement will be paramount and the needs expressed will need to be addressed vs. our more traditional pejorative approach. How do communities wish to access food? What do they need? Where do they want it? These questions apply to Strategy 4 as well.
Cost-effectiveness: Could be done in very cost-effective ways, but would need funding for compensation for community members asked to participate and lend their expertise.
Co-Benefits: Food is a fundamental right, ensuring Vermonters are fed, particularly our children, is a moral obligation.
Technical Feasibility: Yes

PATHWAY 4 – Land use: Shape land use and development that support carbon sequestration and storage, climate resilience and adaptation, and natural and human communities for a sustainable and equitable future

The way in which Vermonters live on and interact with the land will directly affect our ability to meet our goals to reduce greenhouse gas emissions, sequester and store carbon, and adapt and build resilience to the impacts of climate change. Further, the climate crisis is exacerbating other crises, including a shortage of housing, as more people move to Vermont to escape the impacts of harsher climates and harsh climate events elsewhere. Similarly, along with the climate crisis, we also have a biodiversity crisis. Past land use decisions have resulted in declines in the number of species, reductions in the size of populations, and losses of habitats across Vermont. It is critical that we use this opportunity to address all climate-related crises and create thoughtful land use planning for Vermont that helps to increase biodiversity and resilience to climate change, while accommodating the need for more housing and new sources of energy.

To meet these goals, we need policies and programs that protect our forests and fields, both those that are wild and unmanaged and those that are actively managed. Similarly, we need policies and programs to protect and restore our wetlands, floodplains, rivers, and lakes. At the same time, we need policies and programs that encourage the development of walkable and livable villages, town centers, and downtowns, along with complementary policies and programs that discourage the development of our remaining open spaces in the form of sprawl. Finally, we need policies and programs that guide decisions to help us appropriately site renewable energy projects and other components of the low-carbon energy infrastructure of the future so critical to our success in achieving our climate goals, while avoiding and minimizing impacts to our lands and waters.

This kind of work, developing policies and programs to protect our land, is not new to Vermonters. We have a structure of governance, laws, policies, and programs that further many of these goals already. Vermont has recognized that the maintenance of the ecological functions of the land and all the amazing diversity of living creatures is critical to our future prosperity and maintenance of our quality of life. This future depends upon protecting this landscape while continuing to draw sustenance from it. We also know that there are gaps in this system and that many people have not shared in the environmental, economic and other benefits associated with our state's lands, our green hills and silver waters. We also worry that many people who now depend upon the land for their livelihood may get left behind.

To ensure a just transition to a system that fully realizes the potential of the land to sustain Vermont's communities into the future, we need an inclusive and transparent planning process that uses science to inform our decisions and does not place the needs of any one group of Vermonters over another. We also need to provide present and future landowners the information and tools they need to help us meet our climate goals while still making a living. To achieve our goals, we need to invite all Vermonters to understand, be part of and benefit from this transition. Finally, we need a system of accountability that ensures that we are all abiding by the plans and shared expectations that we establish for how we live on the land.

The following recommendations are intended to provide important steps towards this shared vision for Vermont.

KEY STRATEGIES AND ACTIONS

1. **Promote and incentivize compact settlement and reduce forest fragmentation:** Effective land use in Vermont requires understanding both sides of the land use coin – Vermonters need walkable and livable communities with sufficient housing and places to work and shop. We also need healthy forests, farms, fields, and waters. Our challenge is to plan for and guide development to the places where we already have or want to construct the necessary infrastructure for transportation, energy, communications, and human services, and away from the open spaces so critical to both our ecological and economic health. The Agriculture & Ecosystems subcommittee recognizes the value and importance of investing in and planning for compact settlement as a key strategy for conserving Vermont's natural and working lands and waters. Given the cross-cutting nature of compact settlement, which supports not only conservation, but also resilient, affordable housing, efficient transportation networks that reduce emissions, and more, the actions developed by this subcommittee have been captured in Section 15, under Compact Settlement.
    a. Provide enhanced technical assistance and support to municipalities and regions, including outreach and education for landowners and community members, to develop and implement town plans intended to maintain forest blocks and connecting habitat as authorized by Act 171, and effective zoning and subdivision bylaws to maintain forest blocks and connecting habitat.
    b. Develop required climate-based framework and/or criteria for state grant and regulatory programs.

Ltr.	Action and Timeline	Criteria
a.	Provide enhanced technical assistance and support to municipalities and regions, including outreach and education for landowners and community members, to develop and implement town plans intended to maintain forest blocks and connecting habitat as authorized by Act 171, and effective zoning and subdivision bylaws to maintain forest blocks and connecting habitat.	*Impact:* Local and regional plans, and landowner understanding of and compliance with those plans, are foundational to making informed land use decisions
		Equity: Transparent and inclusive planning processes are essential to ensuring that all Vermonters have a voice in determining an equitable balance of land uses
		Cost-effectiveness: Investing in planning, plan implementation, and plan communications and outreach are among the most cost-effective means of

		informing and guiding development decisions.
	Can be implemented in the near term	*Co-Benefits:* Making smart land use decisions, informed by science and robust public process will provide a full array of community and environmental benefits in addition to supporting our climate goals.
		Technical Feasibility: Yes
b.	Update Act 250 to include criteria that better address climate change, forest fragmentation and forest loss, to incentivize growth in the state's designated centers and better address the specific challenges to working lands enterprises; revise Act 250 governance, staffing, public engagement, and the role of State Agency permits in the Act 250 process to create the enterprise capacity necessary to implement new climate related criteria and respond to future land use pressure from climate change and in-migration of climate refugees.	*Impact:* Improved land use decisions, both in the Act 250 permitting process, and also by developers and landowners as they contemplate significant land development projects.
		Equity: Reinforcing land use patterns that prioritize development in settled areas and protect open spaces and working lands has the dual benefit of providing housing in walkable and livable communities, while protecting open spaces and supporting rural communities. Improving the governance and decision-making process of Act 250 could increase the transparency, predictability, and effectiveness of the decision-making process, including making the citizen engagement and appeal process more accessible.
		Cost Effectiveness: These changes will require only modest state investment in the state agencies tasked with implementing Act 250, and will provide greater predictability and efficiency of decisions regarding land use development.
	Can be implemented in the near term	*Co-Benefits:* Making smart land use decisions, informed by science and robust public process will provide a full array of

		community and environmental benefits in addition to supporting our climate goals.
		Technical Feasibility: Yes
c.	Amend Act 250 to encourage housing development within certain state designated centers in order to incentivize compact, dense settlement in areas with adequate local land use laws and existing infrastructure, reducing development pressures on open spaces such as greenfields and forested locations.	*Impact:* See (b) above.
		Equity: See (b) above.
		Cost Effectiveness: See (b) above.
	Can be implemented in the near term	*Co-Benefits:* See (b) above.
		Technical Feasibility: See (b) above.
d.	Reduce regulation of development in downtowns and village centers to cluster development. Address barriers to clustered development (i.e., Act 250, local zoning, aging infrastructure, etc.), provide statewide guidance, and incentivize housing in village centers and existing built areas to encourage development away from open fields and forests, and river corridors.	*Impact:* See (b) above.
		Equity: See (b) above.
		Cost Effectiveness: See (b) above.
	Can be implemented in the near term	*Co-Benefits:* See (b) above.
		Technical Feasibility: See (b) above.
e.	Incentivize, prioritize, and/or require development in growth areas and town centers to achieve compact settlement (must include investment in water/wastewater infrastructure planning and siting).	*Impact:* See (b) above.
		Equity: See (b) above.
		Cost Effectiveness: See (b) above.
	Can be implemented in the near term	*Co-Benefits:* See (b) above.
		Technical Feasibility: See (b) above.
f.	Develop required climate-based framework and/or criteria for state grant and regulatory programs.	*Impact:* State agencies make a multitude of decisions that affect the way in which Vermonters live on and interact with the land. Leveraging funding and regulatory programs through incorporating climate change criteria can enable a significant collective impact

		Equity: The climate-based framework should also include elements that address equity in order to ensure that the benefits of the decisions are equitably distributed, and that the process used to reach those decisions are inclusive and transparent
	Can be implemented in the near-term	*Cost Effectiveness:* The time and expense of developing and implementing the framework across state government will need additional funding from the General Assembly
		Co-Benefits: Due to the breadth and scope of state decisions impacting the environment, it is difficult to speak with precision about the nature of the co-benefits, but the framework should be designed with the goal of optimizing co-benefits
		Technical Feasibility: Yes

2. **Include biodiversity and resilience goals in the planning and management of natural and working lands (both public and private).** Through careful study, monitoring, and planning, we can develop a shared understanding of how to optimize the many benefits of Vermont's lands and waters while making significant progress towards our climate goals. These plans need the support of strong policies and programs that provide both restrictions and incentives to guide land use in order to be effective.
   a. Improve statewide forest planning efforts on State and Federal Lands, including development of an action plan by ANR for how State Lands will help accomplish Vermont Conservation Design targets by 2030 and 2050, and collaborate with the U.S. Forest Service (Green Mountain National Forest) planners for more unified forest planning across the state.
   b. Support efforts to research, educate about, and implement practices informed by traditional ecological knowledge such as using fire to promote regeneration and coppicing, where appropriate for Vermont's forests and ecosystems.
   c. Adopt a state policy of no net-loss of natural and working lands (including active and passively managed forests, agricultural lands, and wetlands) accounting for the transitions of lands within and between these conditions, with aspiration for a net gain. (1) As part of this effort, track land use trends to quantify degree of no net-loss, including aggregating data on subdivision, land transfers, and the loss and/or fragmentation of forests, agricultural lands and wetlands to inform progress and state policy. (2) Develop a strategy to increase the area of land in functioning wetlands, with an initial focus on protecting and recovering the highest quality wetlands ("Class I Wetlands" in ANR's wetlands rules), consistent with the goal of ensuring no net loss of other categories of natural and working lands.
   d. Amend the Use Value Appraisal (UVA) program to allow for

(1) greater development of old forest structure as articulated in the targets of Vermont Conservation Design;
(2) the enrollment of wildland reserves under the existing forestland category where conditions and eligibility criteria are met as defined by Forest Parks and Recreation, facilitating the development of old forest conditions through active restoration and/or passive management as a means of enrollment in the Old Forest ESTA (ecologically significant treatment area) category;
(3) privately held parcels with 'Forever Wild' easements on them, held by a qualified 501c(3), to be enrolled in the UVA Program in the Conservation Category; and
(4) the potential for, and implications of, developing a new category of enrollment for land in UVA which allows for passive management modeled on the 'open-space' designation included in similar programs elsewhere in New England.

e. Identify lands needing conservation because they are in or adjacent to the built environment that have large impact to human health, wellbeing, and equity.
f. Revise the Flood Hazard Area & River Corridor (FHARC) rule to incorporate statewide jurisdiction and permitting authority for river corridors for all kinds of development.

Ltr.	Action and Timeline	Criteria
a.	Improve statewide forest planning efforts on State and Federal Lands, including development of an action plan by ANR for how State Lands will help accomplish Vermont Conservation Design targets by 2030 and 2050, and collaborate with the U.S. Forest Service (Green Mountain National Forest) planners for more unified forest planning across the state.	*Impact:* Through taking actions to implement the Vermont Conservation Design goals, and coordinating with the U.S. Forest Service regarding forest management in the Green Mountain National Forest, Vermont will increase the amount of old forest, protect biodiversity, and work to advance resilience to climate change
		Equity: Taking action to protect the mix and range of principles reflected in the Vermont Conservation Design goals, and goals for the Green Mountain National Forest, and through engaging in a transparent and inclusive planning process, Vermont can ensure that all voices are heard and considered in the decisions affecting the predominant land use type in Vermont
		Cost Effectiveness: The State of Vermont will need additional capacity to fully support and realize the actions needed to meet Vermont Conservation Design goals
	Can be implemented in the near term	*Co-Benefits:* Protecting forests through an inclusive planning process will ensure that we optimize the ecological, and other intangible benefits of Vermont's forests

		Technical Feasibility: Yes
b.	Support efforts to research and implement practices informed by traditional ecological knowledge such as using fire to promote regeneration and coppicing, where appropriate for Vermont's forests and ecosystems.	*Impact:* Increasing the use of forest management methods that reflect traditional ecological knowledge, and that mimic natural disturbance can have a variety of benefits and should be both encouraged and evaluated
		Equity: Using traditional ecological knowledge is both respectful of the Western Abenaki and Mohican traditions and provides an opportunity to learn from the experiences of the people who have inhabited and sustained the land in Vermont since time immemorial
		Cost Effectiveness: The state will need to invest in developing the experience and tools to use and understand these methods which have not been commonly or sustainably applied in the past two centuries in Vermont
	Can be implemented in the near term	*Co-Benefits:* The co-benefits of sustainably managed forests include the full array of benefits associated with keeping land open and usable In addition, there may be benefits not fully understood such as control of introduced ~~s~~pecies and pests, or improved regeneration of native species dependent upon natural disturbances.
		Technical Feasibility: Yes
c.	Adopt a state policy, and associated monitoring and enforcement, of no net-loss of natural and working lands (including active and passively managed forests, agricultural lands, and wetlands) accounting for the transitions of lands within and between these conditions, with aspiration for a net gain. (1) As part of this effort, track land use trends to quantify degree of no net-loss, including aggregating data on subdivision, land transfers, and the loss and/or fragmentation of forests, agricultural lands and wetlands to inform progress and state policy. (2) Develop a strategy to increase the area of land in functioning wetlands, with an initial	*Impact:* Maintaining the amount of land in working or natural status is essential to ensuring that Vermont can sequester and store the carbon necessary to meet its overall climate goals and can steward those lands to optimize climate benefits. Restoring the natural functions of even greater amounts of land provides a significant opportunity to grow those climate benefits. The intent of this recommendation is to ensure that there is no net loss within each natural and working lands category. Further, the aspiration for a net gain in these categories is not intended to result in policies to shift land out of one natural

	focus on protecting and recovering the highest quality wetlands ("Class I Wetlands" in ANR's wetlands rules), consistent with the goal of ensuring no net loss of other categories of natural and working lands.	and working lands category into another, but instead for policies that increase the areas of land in all categories. These policies, if successful, will mean that there is less land available for development and will require more effective and efficient use of lands that are already developed.
		Equity: Through adopting this policy and taking actions to increase access to the benefits of natural and working lands for all, Vermont has an opportunity to address inequities in patterns of land use ownership and access
		Cost Effectiveness: The costs of achieving this goal are associated with a number of related actions including land conservation and restoration programs, improved regulatory oversight, and additional landowner education and technical assistance. This recommendation should be read in parallel to the recommendation to encourage more walkable and livable communities. This development pattern, keeping open land open and focusing new housing and businesses in areas already developed, is more cost effective for municipal and state government, and for individuals and businesses, given the greater efficiencies associated with relying on existing infrastructure, and access to private and public services.
	Can be implemented in the near to medium term.	*Co-Benefits:* Through adopting and taking actions to implement this policy, Vermont can realize a broad array of co-benefits beyond carbon storage and climate resilience, including clean water, wildlife habitat, biodiversity, public health and wellbeing, open space, and vibrant, prosperous rural communities
		Technical Feasibility: Yes
d.	Amend the Use Value Appraisal (UVA) program to allow for (1) greater development of old forest structure as articulated in the targets of	*Impact:* The current use or UVA program has provided a substantial incentive over the past 50 years for private landowners to avoid developing their land, while supporting rural communities. Through

	Vermont Conservation Design; (2) the enrollment of wildland reserves under the existing forestland category where conditions and eligibility criteria are met as defined by Forest Parks and Recreation, facilitating the development of old forest conditions through active restoration and/or passive management as a means of enrollment in the Old Forest ESTA (ecologically significant treatment area) category; (3) privately held parcels with 'Forever Wild' easements on them, held by a qualified 501c(3), to be enrolled in the UVA Program in the Conservation Category; and (4) the potential for, and implications of, developing a new category of enrollment for land in UVA which allows for passive management modeled on the 'open-space' designation included in similar programs elsewhere in New England.	adapting this program to consider the an array of public benefits including those relating to climate change, we will both incentivize management practices that continue to support rural communities dependent upon the production of food, timber, and fiber from the land, while enhancing non-extractive uses which also support rural communities such as outdoor recreation and wildlife viewing
		Equity: This recommendation most directly benefits current landowners and, given inequities in land ownership patterns, should be coupled with other policies that increase access to land ownership for people historically and disproportionately precluded from the same level of access to land ownership. We also need to consider the impacts of any changes on the people who depend upon forest management for their livelihood and enact policies to ensure

		that they can transition to this new vision for forest management.
		Cost Effectiveness: Depending on how these changes are structured, there could be a significant increase in the state resources needed to sustain the investment in the benefits of incentivizing landowners to keep their land undeveloped
	Can be implemented in the near to medium term.	*Co-Benefits:* Keeping land open and undeveloped brings with it the full panoply of environmental, economic, and community benefits associated with our working lands.
		Technical Feasibility: Yes
e.	Identify Natural and Working Lands (NWL) for conservation in or adjacent to the built environment that have large impact to human health, wellbeing, and equity.	*Impact:* In addition to the climate benefits of conserving more rural or remote lands that provide wildlife habitat and other purposes, due their remoteness from human populations, we will also realize climate benefits from conserving lands that are closer to developed lands and the most at risk for being converted to housing and commercial development.
		Equity: There is a substantial equity benefit of increasing the access of people living in developed areas to open and natural lands
		Cost Effectiveness: This recommendation alone will not hold a significant cost, but will require a targeted application of other conservation strategies on this list that will have costs in terms of the expense of building state capacity to administer the programs, and to pay for land acquired or conserved through those programs
		Co-Benefits: While the benefits to wildlife may not be as substantial as protecting larger blocks of land remote from population centers and the built environment, there will be benefits to species of insects, including pollinators, amphibians, reptiles, birds and mammals that tolerate proximity to humans, as well as to migratory wildlife such as birds that need food and shelter. Further, some of the most imperiled, and unique, natural

		communities are located in areas of significant development pressure such as the Champlain Valley.
		Technical Feasibility: Yes
f.	Revise the Flood Hazard Area & River Corridor (FHARC) rule to incorporate statewide jurisdiction and permitting authority for river corridors for all kinds of development.	*Impact:* Functioning floodplains are one of Vermont's greatest assets in responding to the increase in the frequency and intensity of flood events caused by climate change. Local governments frequently lack the expertise and resources to implement floodplain and river corridor protections at a watershed scale as needed to achieve healthy ecosystems and flood resilient communities. Enhanced statewide oversight of development within floodplains and river corridors is a critical step for Vermont to be able to realize the opportunity to better protect floodplains and river corridors from development, and allowing those intact systems to, in turn, protect communities from flood-related impacts
		Equity: Communities that have been underserved and people in a lower income bracket frequently find housing in flood-prone areas. Regulating development in these areas both prevents housing from being developed where it is in harm's way, protects lives, and also reduces downstream flood damage. Further, because under-resourced towns often are unable to appropriately regulate development and navigate cumbersome federal regulations through the National Flood Insurance Program, communities less resourced to respond to flood-related disasters are more likely to allow development in those hazardous locations. This recommendation provides statewide consistency and equity in providing for Vermonters' safety.
		Cost Effectiveness: The state will need to incur the cost of building the additional capacity necessary to administer an expanded regulatory program, including improved guidance and technical

		assistance. The state will also reduce the costs of responding to and recovering from flood-related disasters.
		Co-Benefits: Floodplain forests are an important carbon sink in addition to providing climate resilience, are critical to protect water quality, and frequently provide important community natural space
		Technical Feasibility: Yes

3. **Invest in strategic conservation in order to increase the pace of permanent conservation towards 30x30 targets (described in federal report "Conserving and Restoring America the Beautiful") , with Vermont Conservation Design acting as the guiding plan for prioritization of efforts.** One of Vermont's great achievements over the past fifty years has been its investment in permanent land conservation, such as protecting natural and working lands from development through public ownership or purchasing development rights to be held by land trusts. We recommend taking advantage of the strong programs and Vermont's experience in doing this important work by increasing our conservation investments, with special attention and focus to those lands that best serve our climate goals, while also addressing the longstanding inequities present in our current patterns of land ownership.
    a. Expand use of the Water Infrastructure Sponsorship Program (WISPr) to improve accessibility and use for restoration projects.
    b. Promote statewide landscape connectivity and forest blocks conservation planning through robust support of the Staying Connective Initiative and use of Vermont Conservation Design and TNC's Resilient and Connected Landscape in state program prioritization frameworks.
    c. Through permanent conservation coupled with both active and passive restoration efforts on both public and private lands, allow approximately 9% of Vermont's forest to become (or be maintained as) old forest, specifically targeting 15% of the matrix forest within the highest priority forest blocks identified in Vermont Conservation Design to achieve this condition.
    d. Create a statewide environmental justice policy.
    e. Per the formula in statute, fully fund the Vermont Housing & Conservation Board (VHCB); including $3M for the Farm & Forest Viability Program and increase annual VHCB funding above the statutory amount by 15%, targeting those funds for implementation of conservation actions recommended in CAP, especially those related to forests.
    f. Identify and protect climate refugia.
    g. Use best available data and mapping to analyze existing portfolio of conserved agricultural lands to identify forest, wetland and natural community restoration opportunities and prioritize funding for these projects.
    h. Maintain a suite of Farmland Conservation & Protection tools ranging from voluntary, regulatory and planning (e.g. easements, Act 250, planning, zoning).

Ltr.	Action and Timeline	Criteria
a.	Expand use of the Water Infrastructure Sponsorship Program (WISPr) to improve accessibility and use for restoration projects.	*Impact:* Through innovative financing, local governments can support ecological restoration that provides important ecosystem services and reduced flood damage, while also using methods that sequester and store carbon
		Equity: If implemented in a manner that promotes natural climate solutions and green infrastructure in developed areas, this program has the potential to benefit people in communities with less access to green or natural space. Given the current complexity and design of this program, accessibility for under-resourced municipalities is a concern, so revising the program would create greater access and ensure that public funding is being equitably dispersed.
		Cost Effectiveness: This program provides a cost-effective means of using bonds and state financing to support projects that are less expensive than traditional water infrastructure projects
	Can be implemented in the near term	*Co-Benefits:* Restoration projects funded through WISPr include benefits to wildlife, access to open and green space in communities, as well as a primary purpose to protect water quality
		Technical Feasibility: Yes
b.	Promote statewide landscape connectivity and forest blocks conservation planning through robust support of the Staying Connective Initiative and use of Vermont Conservation Design and TNC's Resilient and Connected Landscape in state program prioritization frameworks.	*Impact:* Through strategically conserving forestland, Vermont will increase the amount of carbon sequestered and stored in our forests as well as allow for wildlife and plant movement across the landscape, protect biodiversity, protect climate refugia, increase resilience to extreme weather and improve water quality.
		Equity: Taking action to conserve forests, and through engaging in a transparent and inclusive planning process, Vermont can ensure that all voices are heard and considered in the decisions affecting the predominant land use type in Vermont.
		Cost Effectiveness: The State of Vermont will need additional capacity to fully

		support and realize the actions needed to meet these conservation goals
	Can be implemented in the near term	*Co-Benefits:* Protecting forests through an inclusive planning process will ensure that we optimize the ecological, economic and other intangible benefits of Vermont's forests
		Technical Feasibility: Yes
c.	Through permanent conservation coupled with both active and passive restoration efforts on both public and private lands, allow approximately 9% of Vermont's forest to become (or be maintained as) old forest, specifically targeting 15% of the matrix forest within the highest priority forest blocks identified in Vermont Conservation Design to achieve this condition.	*Impact:* See 3.b. above
		Equity: See 3.b. above
		Cost Effectiveness: See 3.b. above
		Co-Benefits: See 3.b. above
		Technical Feasibility: See 3.b. above
d.	Create a statewide environmental justice policy.	*Impact:* By ensuring that the various programs proposed to address climate change in this report are evaluated in light of environmental and climate justice concerns, the state will ensure that a broader range of the public benefit from and support the actions taken under this plan, ensuring the long-term stability of programs that need to continue for decades in order to be effective.
		Equity: By definition, the creation of an environmental justice policy will further equity.
		Cost Effectiveness: The cost of this recommendation is the time and effort of state agency staff and leadership who will develop and adopt this policy across all relevant state programs. The benefits in terms of achieving a broader and more equitable distribution of the benefits of environmental protection and conservation will easily exceed those costs.

		Co-Benefits: A central benefit of pursuing environmental justice is the engagement of all Vermonters in the critical work of taking actions to address climate change.
		Technical Feasibility: Yes.
e.	Per the formula in statute, fully fund the Vermont Housing & Conservation Board (VHCB); including $3M for the Farm & Forest Viability Program and increase annual VHCB funding above the statutory amount by 15%, targeting those funds for implementation of conservation actions recommended in CAP, especially those related to forests.	*Impact:* Through conserving forest and farmland, Vermont will increase the amount of carbon sequestered and stored in our forests and farms, as well as an array of other environmental and economic benefits described above, and prevent the conversion of those lands to development, with the added benefit of preventing sprawl and carbon intensive development patterns and creating the space for the natural and working lands economy and those that depend on it to continue to steward their land sustainably.
		Equity: Taking action to conserve forests and farms, and through engaging in a transparent and inclusive public funding process, Vermont can ensure that all voices are heard and considered in the decisions affecting the working and natural lands in Vermont
		Cost Effectiveness: The State of Vermont will need to increase funding for this purpose over the long-term, as well as to invest in building the additional state and non-profit land trust capacity to fully support and realize the actions needed to meet these conservation goals
		Co-Benefits: Protecting forests and farms will ensure that we optimize the ecological, economic and other intangible benefits of Vermont's forests
		Technical Feasibility: Yes
f.	Identify and protect climate refugia.	*Impact:* Vermont's plants and wildlife will be impacted by climate change, as will plants and wildlife throughout the region and the nation. Protecting natural and open working lands and waters in Vermont may be one of the only hopes for many species
		Equity: People need the same benefits provided by open and natural lands as

		plants and wildlife – increasing investments in the places our wild flora and fauna need to thrive is an investment in the same places that people need to thrive
		Cost Effectiveness: The cost of implementing this action is tied to the other related proposed actions to conserve and protect natural lands
		Co-Benefits: The ecosystem services of the land we protect as climate refugia will provide community benefits such non-material benefits like outdoor recreation, clean water, and flood resilience
		Technical Feasibility: Yes
g.	Use best available data and mapping to analyze existing portfolio of conserved agricultural lands to identify forest, wetland and natural community restoration opportunities and prioritize funding for these projects	*Impact:* Through careful analysis and prioritization, Vermont will be able to optimize the use of public funds to have the greatest impact at a landscape scale
		Equity: Taking action to prioritize the land we conserve will provide an important opportunity to also consider historic inequities related to access to open and natural spaces for underserved communities.
		Cost Effectiveness: The cost of carefully analyzing and evaluating data about land conservation will be outweighed by the ability to focus public resources where they will have the greatest impact
		Co-Benefits: Ensuring land conservation programs to have the greatest climate benefits will also ensure that we optimize the ecological, economic and other intangible benefits of Vermont's natural and working lands
		Technical Feasibility: Yes
h.	Maintain a suite of Farmland Conservation & Protection tools ranging from voluntary, regulatory and planning (e.g. easements, Act 250, planning, zoning).	*Impact:* See 3.e. above
		Equity: See 3.e. above
		Cost Effectiveness: See 3.e. above
		Co-Benefits: See 3.e. above

		Technical Feasibility: See 3.e. above

4. **Increase technical assistance, capacity, education, and resources to support private farm and forest land owners in addressing the trends relating to intergenerational transfer.** The vast majority of Vermont's natural and working lands are privately owned. Currently, Vermont is facing a significant demographic shift in land ownership, including working forests and farms, with the risk of a concurrent shift in the use of these lands from forests and farms to development. Providing present and future landowners with the tools to manage this transition will help ensure that we protect our lands and waters and that we proactively and appropriately resource the next generation of forest and farm landowners and managers.
    a. Support forestland succession/estate planning efforts to reduce forest parcelization and fragmentation through implementation of the Act 171 'Intergenerational Transfer of Forestland Working Group Recommendations' of 2017.
    b. Develop and implement a farmer retirement program to facilitate the transfer of intact farmland.

Ltr.	Action and Timeline	Criteria
a.	Support forestland succession/estate planning efforts to reduce forest parcelization and fragmentation through implementation of the Act 171 'Intergenerational Transfer of Forestland Working Group Recommendations' of 2017.	*Impact:* Keeping forests as forests, with all of the ecosystem services that forests provide including climate mitigation and adaptation benefits associated with forests, requires that the many and private forest landowners have access to the technical and legal resources necessary to keep those forest parcels intact
		Equity: Managing through this demographic shift in land ownership patterns creates opportunities to enhance the access of people traditionally excluded from land ownership in Vermont
		Cost Effectiveness: Support and technical assistance to private landowners requires resources and capacity. The state can invest in expanding existing programs within FPR, VHCB and other non-profit organizations to provide these services at a reasonable cost, with significant public benefits
	Can be implemented in the near term	*Co-Benefits:* At the same time that this program provides helpful information to landowners about succession planning, these interactions will build trust and the opportunity to educate landowners about the best conservation practices to manage forests sustainably
		Technical Feasibility: Yes

b.	Develop and implement a farmer retirement program to facilitate the transfer of intact farmland	*Impact:* Keeping farms as farms, with all of the ecosystem services, including climate mitigation and adaptation benefits, associated with farms, requires that farmers have access to the technical and legal resources necessary to keep their farms from being sold for development
		Equity: Managing through this demographic shift in land ownership patterns creates opportunities to enhance the access of people traditionally excluded from land ownership opportunities in Vermont
		Cost Effectiveness: Support and technical assistance to farmers requires resources and capacity. The state can invest in expanding existing programs within AAFM, VHCB and other non-profit organizations to provide these services at a reasonable cost, with significant public benefits
		Co-Benefits: At the same time that this program provides helpful information to farmers about succession planning, these interactions will build trust and the opportunity to educate landowners about the best conservation practices to manage these lands sustainably
		Technical Feasibility: Yes

5. **Avoid, minimize, and mitigate the negative impacts of renewable energy generation on natural and working lands.** Vermont's transition to a future in which renewable energy is a major source of energy is necessary to achieve our greenhouse emission goals. At the same time, to date, that transition has been a bumpy one, with significant controversies over the places if and where biomass, wind, hydropower, and solar projects will be located, and a long-standing controversy over the use of electricity generated from nuclear and from hydro outside the state, such as in northern Quebec on Indigenous land. Critically, new renewable generation infrastructure must avoid and minimize to the greatest extent possible impacts on Vermont's forests, which support a range of ecological services critical for climate resilience and adaptation and provide the single largest source of carbon sequestration and storage in the state. Analysis conducted for the VCC by Cadmus indicates that Vermont has seen a steady decline in sequestration. If that historic trend continues the state will not meet the GWSA's 2050 net zero target, even if the 2025 and 2030 emission reduction targets are achieved. The Cadmus analysis indicates Vermont must maintain sequestration at or above projected 2035 levels in order

to be net zero by 2050 – since forests provide by far the greatest share of the state's sequestration, all efforts should be made to locate new renewable energy infrastructure outside of forests and minimize tree clearing associated with new plants. To achieve this goal, we must do the heavy lifting of engaging at the local, state, and regional level to establish a process, guidelines, and expectations for how we plan for, design, and transition to a low-carbon energy future, while simultaneously reducing impacts to our natural and working lands and waters. Work by Regional Planning Commissions to inventory potential renewable energy sites as part of their Regional Enhanced Energy Plans is an important step. We need to evaluate the effectiveness of these planning efforts. In addition, an underutilized strategy is to use a combination of siting requirements and incentives to encourage the development of renewable energy projects in areas that are already developed, like buildings and parking lots.

a. Evaluate the effectiveness of the program of Regional Enhanced Energy Plans and the application of these plans to decisions by the PUC in terms of their ability to direct the siting of renewable energy projects in a manner that avoids the conversion of working and natural lands and the loss of the carbon storage and sequestration, climate resilience, and other co-benefits that are associated with those lands. If the process of developing and implementing the system of Regional Enhanced Energy Plans is not achieving this goal, then adjust the laws and regulations applicable to renewable energy siting to ensure the effectiveness of the plans.
b. Incentivize or carefully consider mandating solar and wind capacity on new buildings as well as in previously-disturbed/developed areas and avoid and minimize forest clearing for renewables through incentives and other siting polices, rules, and regulations.
c. Consider the need for incentives to site new renewable energy generation on parking lots, rooftops, and already altered locations. And discourage and penalize siting of new renewable energy generation on intact ecosystems, forests, and natural land.

Ltr.	Action and Timeline	Criteria
a.	Evaluate the effectiveness of the program of Regional Enhanced Energy Plans and the application of these plans to decisions by the PUC in terms of their ability to direct the siting of renewable energy projects in a manner that avoids the conversion of working and natural lands and the loss of the carbon storage and sequestration, climate resilience, and other co-benefits that are associated with those lands. If the process of developing and implementing the system of Regional Enhanced Energy Plans is not achieving this goal, then adjust the laws and regulations applicable to renewable energy	*Impact:* Engaging local governments at a regional level to evaluate and prioritize locations for siting renewable energy projects will provide greater clarity for renewable energy project developers and reduce conflicts when projects are proposed. An effective planning process will also provide useful information to assist decision-makers ensure that renewable energy projects are consistent with state, regional and local goals for the conservation of natural and working lands.

	siting to ensure the effectiveness of the plans.	
		Equity: Taking action to site renewable energy projects in a manner that avoids or minimizes the impact on natural and working lands, and through engaging in a transparent and inclusive planning process, Vermont can ensure that all voices are heard and considered in the decisions affecting land use decisions in Vermont.
		Cost-effectiveness: Community engagement and planning requires resources for regional planning commissions, local governments and state agencies including ANR, PSD and PUC. At the same time, resolving conflicts in advance through a planning process can avoid the costs of delay and conflict associated with contested siting decisions.
		Co-benefits: Vermont needs to grow the renewable energy capacity in the state significantly in order to meet greenhouse gas emissions targets. Vermont also needs to invest in the conservation lands in order to maximize carbon storage and adapt to the impacts of climate change. The balancing of these two climate priorities will continue to increase pressure on local and state agencies to make decisions that are informed both by community interests and by an accurate assessment of the impact that those projects could have on natural and working lands if not carefully sited.
		Technical Feasibility: Yes.
b.	Incentivize or mandate solar and wind capacity on new buildings as well as in previously-disturbed/developed areas and avoid and minimize forest clearing for renewables through incentives and other siting polices, rules, and regulations.	*Impact:* Increasing the amount of renewable energy developed in harder-to-develop locations will result in reduced market pressures to develop those projects on open and undeveloped land that is providing important ecosystem services, including the storage and sequestration of carbon
		Equity: Reducing barriers to accessing renewable energy resources in more

		intensively developed areas, including multi-family housing, will extend the benefits of renewable energy to people who might not otherwise have access
		Cost Effectiveness: A central barrier to the development of renewable energy projects in already developed areas are the costs. The state will have to consider a combination of greater incentives for renewable energy installation, and increased restrictions on projects on undeveloped land, both of which will have real economic costs. At the same time, extending the benefits of renewable energy to more people in more densely populated areas has the potential to become more efficient and effective once the necessary investments in technology and infrastructure are made
	Can be implemented in the near term	*Co-Benefits:* Keeping natural and working lands open and undeveloped provide a much greater degree of environmental co-benefits including clean water and wildlife habitat than when developed
		Technical Feasibility: Yes.
c.	Require incentives to site new renewable energy generation on parking lots, rooftops, and already altered locations. And discourage and penalize siting of new renewable energy generation on intact ecosystems, forests, and natural land.	*Impact:* See 5.b. above.
		Equity: See 5.b. above.
		Cost Effectiveness: See 5.b. above.
		Co-Benefits: See 5.b. above.
		Technical Feasibility: Yes.

Pathways for Sequestration and Storing Carbon

Vermont's natural and working lands and waters are our greatest asset in mitigating the impacts of climate change. Natural climate solutions (as outlined in section 13) are conservation, restoration and improved land management actions that increase carbon storage or avoid greenhouse gas emissions in landscapes and wetlands across the globe. Combined with taking action to reduce our emissions through the preceding strategies and actions, natural climate solutions offer Vermont some of our best options in the response to climate change. These strategies and actions will help us build a more resilient and adaptive Vermont while also helping us sequester and store more carbon. Natural and working lands (NWL) in Vermont currently store over 2,000 MMT CO_2–e, and sequester carbon at a current annual rate of -2.91 MMT CO_2 –e [250]. We must act to ensure that we maintain and enhance this sequestration and storage capacity.

Those that live and work in these ecosystems have a critical role in helping us reduce our net emissions. Management decisions on NWLs can result in both the reduction of emissions and also increased absorption and storage of carbon dioxide (sequestration) from the same unit of land – these management choices also result in net sequestration across forestry, wetlands, and agricultural emissions.[251] Therefore, it is critical that we empower landowners and those within the farm and forest sectors to select the best management decisions to both ensure the continued sequestration and long-term storage of carbon. A critical component of moving into a resilient and adaptive future in the face of our changing climate lies squarely in our ability as a state to empower, embrace, and increase the inherent resiliency of our natural and working lands and ecosystems to provide for our shared future.

Outlined below is a set of pathways, strategies, and actions that will not only empower our land to store and sequester carbon, but uplift and resource the land stewards, landowners, farmers, foresters, and caretakers who interact with our natural and working lands every day. As a result, Vermont will also realize significant co-benefits, including buffering the impacts of extreme precipitation and drought stress, reducing downstream flood risks, supporting biodiversity, protecting water quality and enhancing productivity and investing in healthy soils that benefits all of us immensely. This work also seeks to acknowledge the systems in which we are currently mired, those that capitalized farmers and foresters into extractive methods of production and resulted in both deep inequity to our land base, historically marginalized populations, frontline, and impacted communities, including farmers and foresters themselves.

Efforts to invest in the capability of our natural and working lands to sequester and store carbon are being undertaken by farm and forest managers on their lands throughout Vermont today, but as we face increased extreme weather events, generational land transfer, exacerbated income and

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[250] Galford et al. 2021. A Carbon Budget for Vermont. Insert link https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/Carbon%20Budget%20for%20Vermont%20Sept%202021.pdf

[251] Ex-ACT modeling from carbon budget. https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/Carbon%20Budget%20for%20Vermont%20Sept%202021.pdf

social inequity it will be incumbent upon us all to transform the manner with which we design and implement our approach moving forward to ensure that both an equity and climate lens are first and foremost in how we prioritize our actions. Vermont is fortunate to have large forest, wetland, and agricultural carbon stocks but we must take action to maintain them. While carbon sequestration rates are not constant, we can invest in conservation practices and more while also further advancing research and monitoring to foster a deeper understanding of Vermont's sequestration potential.

To meet the required objectives of the GWSA and mitigate drivers of climate change, it is critical that the State of Vermont invest in measures to protect existing carbon stocks, increase the net balance of carbon sequestration in natural and working landscapes, better understand the way land management changes influence the storage and sequestration of carbon, and accurately track changes over time. These strategies and actions give land managers the financial and technical support to implement practices that protect and increase carbon in the landscape so that Vermont can complement its emission reductions with sequestration and storage goals that get the state to net zero.

PATHWAY - Maintain and expand Vermont's natural and working lands' role in the mitigation of climate change through human interventions to reduce the sources and enhance the sinks of greenhouse gases.

STRATEGIES AND ACTIONS

6. **Leverage, expand, and adapt existing State of Vermont programs that support the agricultural sector's mitigation of climate change through:**
   - Prevention—of emissions to the atmosphere by conserving existing carbon pools in soils or vegetation, or by reducing emissions of methane (CH_4) and nitrous oxide (N_2O);
   - Sequestration—by increasing the size of existing carbon pools, and thereby extracting carbon dioxide (CO_2) from the atmosphere; and
   - Substitution—substituting of biological products for fossil fuels or energy-intensive products, thereby reducing CO_2 emissions.

     a. Implement agronomic practices that reduce tillage and increase vegetative cover, e.g. no-till, cover crop.
     b. Expand Capital Equipment Assistance Program (CEAP) program to extend beyond water quality and incorporate climate change criteria.
     c. Implement grazing practices that increase vegetative cover and forage quality, e.g. rotational grazing.
     d. Implement agroforestry and silvopasture practices that integrate woody vegetation in agricultural production.
     e. Implement edge-of-field practices that increase herbaceous and woody vegetation, e.g. riparian forest buffer (e.g. CREP).

f. Implement natural resource restoration practices that support climate mitigation and resilience, including river corridor easements, wetland restoration, and afforestation practices with consideration to agricultural land loss.
g. Implement Nutrient Management and Amendments (e.g., biochar, compost) on cropland and grazing land.
h. Implement methane capture and energy generation on farms, e.g., anaerobic digesters and covers.
i. Research into improved manure management and storage.
j. Research and develop a climate feed management program, including both feed amendments (e.g., seaweed, biochar) and feed quality (e.g., forage quality) to reduce enteric methane emissions; consider downstream impacts, sustainability and equity.

Preliminary Assessment of Strategy against Criteria
Impact: Over 300,000 acres of cumulative agricultural conservation practices have been implemented by farmers in Vermont since 2016.[252] The adoption of natural climate solutions (NCS) and technologies to address water quality impacts on farms have co-benefits for GHG mitigation goals in Vermont. USDA reports that mitigation efforts across agricultural cropland management, manure management, and pasture management can provide over 70 MMT of CO_2-e emission reduction across the United States.[253]
Equity: Soil health can be improved across all sectors of Vermont agriculture. Access to state programs is coordinated with federal programs to attempt to provide the most coverage for different sized farms with different planning and management goals.
Cost-effectiveness: A 2021 study reports that in Canada, agricultural cropland management could provide the most GHG mitigation potential by 2030 at the most cost-effective price point across all natural climate solutions evaluated, with over 68% of the 44.4 MT CO_2-e mitigation potential for agriculture costing less than $100/MT CO-e.[254] Quantifying the mitigation benefit of existing agricultural conservation practices and extending their reach is an immediate first step Vermont can take to mitigate agricultural GHG emissions.
Co-Benefits: Vermont's air, biodiversity, soil, water, and social considerations are improved through the implementation of existing agricultural conservation programming described in actions (a) – (j) above. Specific examples of co-benefits in addition to GHG mitigation potential include: • Overall adaptation, resilience, and water quality benefits • Reduced soil erosion • Reduced nutrient runoff

[252] Clean Water Interactive Dashboard based on data from Vermont Clean Water Initiative 2020 Performance Report. January 15, 2021. https://app.powerbigov.us/view?r=eyJrIjoiNTI5Y2QxZDEtODY3Ni00ZmYwLThjZTAtNjdiNTM3YTQyZjRkIiwidCI6IjIwYjQ5MzNiLWJhYWQtNDMzYy05YzAyLTcwZWRjYzc1NTljNiJ9.

[253] Pape, D., J. Lewandrowski, R. Steele, D. Man, M. Riley-Gilbert, K. Moffroid, and S. Kolansky, 2016. "Managing Agricultural Land for Greenhouse Gas Mitigation within the United States." Report prepared by ICF International under USDA Contract No. AG-3144-D-14-0292. July 2016. https://www.usda.gov/sites/default/files/documents/White_Paper_WEB_Final_v3.pdf.

[254] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.

• Increase in soil organic matter (soil health, infiltration, water storage) • Reduced flooding • Resilience to drought and extreme rain events • Reduced nitrogen fertilizer if planting legumes • Reduced ground temperatures due to albedo effect of plant cover
Technical Feasibility: Yes

7. **Create a system for tracking and accounting metrics and indicators for natural and working lands.** The tracking and accounting for emissions reductions and sequestration are inadequate for natural and working lands and need improvement and additional resources for development and maintenance. Extensive datasets exist for water quality implementation but need specific quantification for climate mitigation (a). Additionally, the current tools used for quantification are inadequate for the complicated management mechanisms and natural processes occurring on natural and working lands that lead to climate mitigation (b). Finally, update the state's inventory to reflect guidance set by the Intergovernmental Panel on Climate Change (IPCC) of the United Nations to account for net emissions. Adequately tracking and accounting for emissions gains and losses from natural and working lands is essential to justly credit and further incentivize ongoing climate mitigation work by farmers, foresters, and other land managers.
    a. Develop a methodology and protocol for quantifying climate mitigation, resilience, and adaptation impacts of existing state and federal water quality implementation programs as reported through the annual Clean Water Initiative Performance Report. The Clean Water Initiative Performance Report "summarizes the State of Vermont's clean water efforts and demonstrates how investments are making a difference through accountability measures."[255] As mentioned, most water quality conservation practices and programs also have climate mitigation, resilience, and adaptation benefits. Recommend using existing tracking systems and quantify the climate benefits from this existing implementation and data tracking. The data spans state and federal funding programs and regulatory programs that drive clean water efforts and coordinates across agencies to track these efforts and monitor progress.
    b. The Vermont Climate Council has recommended developing and issuing a Request for Proposals (RFP) that will review and analyze methodological gaps of emission inventory tools currently used by the State of Vermont to quantify greenhouse gas emissions for evaluating changes in the Agriculture, Forestry and Other Land Use (AFOLU) sector and the tools' alignment with the Intergovernmental Panel on Climate Change (IPCC), Environmental Protection Agency (EPA), and peer state methodologies and approaches. The specific recommendations for this RFP can be found in the Carbon Budget Report memo found in Appendix XX.
    c. Based on the findings of the technical RFP mentioned in action step (b) of this strategy, the VCC should consider recommending that the State of Vermont GHG emissions inventory protocol established in 10 V.S.A. § 582 be amended to include an inventory of GHG emissions that align with the intent and standards of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

[255] Vermont Clean Water Initiative 2020 Performance Report. January 15, 2021. https://dec.vermont.gov/sites/dec/files/wsm/erp/docs/2021-01-15_CleanWaterPerformanceReport_SFY2020-FINA-PDF-A.pdf.

that will include a net GHG emission accounting for the agriculture, forestry and other land use (AFOLU) sector.

Preliminary Assessment of Strategy against Criteria
Impact: Currently, agricultural mitigation in the form of management practices that reduce emissions as sequestration on agricultural cropland is not counted in the current GHG Emissions Inventory. With over 300,000 acres of agricultural conservation practice implementation since 2016 that have GHG mitigation potential and associated Emission Reduction Coefficients – these practices are currently tracked but not counted for agricultural mitigation. The scale of mitigation from the agricultural sector has been identified by a Canadian study to be the largest single opportunity amongst all evaluated natural climate solutions (NCS) – the potential scale of impact for mitigation is large in Vermont if mitigation potentials are counted through the VT GHG Emission Inventory.
Equity: The current GHG Emissions Inventory only quantifies non-CO_2 emissions from the agricultural sector. Absent from current emission accounting are the stocks and fluxes of CO_2 from agricultural cropland – management impacts are also not provided for in the current GHG Emissions Inventory for agriculture. Ensuring that the State of Vermont GHG Emissions Inventory comports with IPCC standards is essential for an equitable accounting for the AFOLU sector.
Cost-effectiveness: Over 300,000 acres of agricultural conservation practices have been tracked on an acre-by-acre basis through state and federal programs since 2016 for water quality improvement metrics. Development and implementation of a protocol to count existing agricultural programming that has co-benefits for agriculture is a cost-effective approach that leverages existing programs.
Co-Benefits: Co-benefits for water quality are tracked through existing state and federal tracking mechanism which are quantified for phosphorus reduction benefits for water quality.
Technical Feasibility: Yes

8. **Implement a Payment for Ecosystem Services (PES) program for natural and working lands.** Managers of natural and working lands, including farmers and foresters, provide important environmental or ecosystem services to the public, such as clean air and water, reduced flooding, or sequestration and storage of carbon. A Payment for Ecosystem Services (PES) program provides a quantifiable and verifiable framework to credit and compensate for the benefits of stewardship that produces numerous ecosystem goods and services. PES programs vary in design and could focus on particular ecosystem services or land uses, i.e. (a) farms or (b) forests, or both, and could offer direct payments or other financial compensation, such as tax credits (c). Regardless of design, PES is an innovative and important mechanism to further climate mitigation occurring on natural and working lands.

    a. Develop and implement a PES program for healthy soils and soil carbon sequestration on farms.
    Act 83 of 2019 convened the Payment for Ecosystems Services Working Group whose purpose is to recommend financial incentives designed to encourage farmers in Vermont to implement agricultural practices that improve soil health, enhance crop

resilience, increase carbon storage and stormwater storage capacity, and reduce agricultural runoff to waters. Final program recommendations from the PES Working Group are due in January 2023.[256]

b. Develop and implement a PES program for forestland owners including water filtration/cycling, carbon sequestration, etc.
c. Incentivize management for ecosystem services through a tax credit system that compensates landowners/managers for maintaining or restoring ecosystem services.

Preliminary Assessment of Strategy against Criteria
Impact: A PES program – as conceived for Vermont – seeks to leverage Vermont's natural and working lands (NWLs) to deliver ecosystem services on a performance basis that provides cost-effective additionality to Vermont's existing environmental programming. Quantifying whole-farm and whole-parcel management and the entirety of bundled or stacked practices can help provide a fuller picture of ecosystem service benefit Vermont's NWLs can deliver for Vermont's climate goals.
Equity: A core consideration for the development of a PES Program in Vermont is how to ensure a program is implemented equitably – should payments be based on annual, incremental environmental benefit, or threshold based with payments above a set additionality. Goals of a PES Program are to be inclusive of the multiple agricultural sectors in Vermont, not just the largest land users and managers.
Cost-effectiveness: Literature suggests that natural and working lands and the application of natural climate solutions (NCS) are cost-effective and immediate contributions to GHG mitigation efforts that can be deployed across land uses at cost-effective rates.[257]
Co-Benefits: The PES Working Group has identified water quality, climate change mitigation, and watershed resilience as the three focus areas for evaluation and payment in a PES program around soil health. Multiple more co-benefits can be quantified through the enhancement of soil health.
Technical Feasibility: Yes

9. **Address upstream waste and downstream emissions from food waste and synthetic fossil-fuel based inputs.**
    a. Develop program for tracking and limiting the use of chemicals, substances, or products that contribute to climate change in Vermont and leverage existing legislative activity on this topic.
        i. VAAFM currently tracks statewide commercial pesticide use as well as statewide fertilizer use. This data is currently used to establish trends in the use of these inputs as our agricultural systems evolve.
        ii. Programs to track these agricultural inputs already exist at VAAFM but have not been assessed through the lens of contributions to climate change. VAAFM or the new newly established Agricultural Innovation Board (AIB) established by Act 49 of 2021 can prioritize an assessment of the impacts and

[256] https://agriculture.vermont.gov/pes
[257] Drever, C Ronnie et al. "Natural Climate Solutions for Canada." *Science Advances* 7, 1 (June 2021). https://www.science.org/doi/10.1126/sciadv.abd6034.

benefits our agronomic management systems have on offsetting climate change.

iii. An assessment of Vermont's different agronomic practices and management, such as, conventional, organic, no-till, and cover cropping, should be weighted for impacts on climate change based on agricultural inputs, fuel consumption, carbon sequestration and other measurable factors.

b. The state should identify simple, low- and no-cost mechanisms to increase organics diversion and provide incentives and business and workforce development to private organics haulers and composters (including farms).

i. Act 41 of 2021 created an Agricultural Residuals Management Program to be administered by VAAFM. The purpose of this new chapter of law is to establish a program for the management of residual wastes generated, imported to, or managed on a farm for farming in Vermont.

Preliminary Assessment of Strategy against Criteria
Impact: Both actions may help to identify and implement further actions and strategies to reduce GHG emissions.
Equity: The AIB includes 13 members named by the General Assembly which represent multiple stakeholders in the process – farmer input is embedded in the process with required farmer surveys in every county to better help understand farm use of inputs.
Cost-effectiveness: Leveraging existing state processes to the extent possible ensures no duplication of efforts and that available resources are targeted for maximal impact.
Co-Benefits: Reduction of external inputs for farming operations can help reduce operating costs and increase farm profitability. Co-benefits for soil health if composting of food residuals and application to cropland is conducted in conformance with state requirements.
Technical Feasibility: Yes

10. **Develop and implement programs which incentivize management practices which maintain or increase forest carbon storage.** Approximately 80% of Vermont's 4.5 million acres of forestland are in private ownership. Private forestland owners in Vermont have the opportunity to take meaningful action towards mitigating the impacts of climate change and building resiliency in our forests but are generally excluded from traditional carbon markets (and the associated revenue, which could enable these actions) due to the average parcel size and the high up-front cost associated with developing such complex projects. Models which provide for incentive payments to landowners who adopt specific Improved Forest Management practices which measurably enhance carbon sequestration could provide the economic opportunity which is currently missing.

a. Create or adopt existing certification standards where management activities account for principles of Improved Forest Management towards increased carbon storage, as well as maintaining and creating resiliency (as described in existing state guidance such as *Maintaining and Creating Resilient Forests in Vermont: Adapting Forests to Climate Change*, VTFPR 2015, or as modeled in existing programs such as the American Forest Foundation's *Family Forest Carbon Program*).

b. Apply these certification standards to the procurement of forest products utilized in energy or thermal generation facilities subject to PSB oversight (parallel to the existing review for state mapped deer winter yard, etc.) through potential revisions to the renewable energy standard.
c. Explore additional market opportunities for certified products, expanding the potential revenue base to support Improvement Forest Management (parallel FSC, SFI, etc.)

Preliminary Assessment of Strategy against Criteria
Impact: 80% of Vermont's forests are in private ownership. Vermont's forests store over 1.7 billion metric tons (Mt) of CO2 equivalent (CO2e) and sequester (take in) more than 5 million Mt CO2e each year
Equity: Expands opportunity to smaller 'Vermont Scale' forest landowners who would otherwise be excluded from traditional carbon markets; removes significant upfront capital requirements which would otherwise be a barrier
Cost-effectiveness: Potentially allows smaller forestland owners to access climate finance (private capital) from existing markets; leverages market-based incentives for adoption of practices
Co-Benefits: Sustaining all fundamental ecological functions of intact forests
Technical Feasibility: Yes

11. **Leverage market-based solutions, such as existing or new regional carbon market opportunities, to incentivize forest management practices which sequester and store greater amounts of carbon in our forests.** Carbon markets provide a largely untapped opportunity for forestland owners in Vermont. The generation of carbon offset credits can provide a significant revenue stream to forestland owners, increasing capacity for improved management, and the ability to hold and maintain intact forestland. Financially viable projects generally require large (5,000+ acre) ownerships, therefore aggregation for parcels (generally 200+ acres in size) is critical for viability, Aggregation is currently allowed for under existing Voluntary Market standards. These opportunities build on existing incentives and/or provide synergy from multiple stewardship mechanisms. Recent spatial analysis by the Vermont Land Trust and UVM Carbon Dynamics Lab has identified close to 330,000 acres in privately held forest parcels > 500 acres in size which could be eligible for such aggregation opportunities. In terms of conservation priority, these parcels present the greatest opportunity for aggregated carbon projects to contribute to the sustainability and ecological functionality of Vermont's working landscape through the maintenance of these forests and the Improved Forest Management practices employed.
    a. Work to develop a new Vermont-Based or regional (modeled on RGGI) Carbon Credit marketplace with necessary research and standards which address concerns around the efficacy of baseline establishment, accounting for additionality, the potential for leakage, and address equity for the diversity of wood lot owners across the state
    b. Incentivize the in-state purchase of carbon credits developed by Vermont-based or regional carbon projects through a system which addresses concerns of accounting (i.e., additionality and leakage)

Preliminary Assessment of Strategy against Criteria
Impact: 80% of Vermont's forests are in private ownership. Vermont's forests store over 1.7 billion metric tons (Mt) of CO2 equivalent (CO2e) and sequester (take in) more than 5 million Mt CO2e each year
Equity: Such models could still exclude smaller forest holdings (<200 acres, which could potentially access practice-based payments as described in preceding strategy) but would provide an opportunity for mid-sized forestland owners currently excluded from existing markets.
Cost-effectiveness: Potentially allows smaller forestland owners to access climate finance (private capital) from existing markets; leverages market-based incentives for adoption of practices
Co-Benefits: Sustaining all fundamental ecological functions of intact forests
Technical Feasibility: Yes

12. **Increase tree coverage.** Trees remove carbon dioxide from the atmosphere through the process of photosynthesis and capture that carbon in the form of wood or other organic matter. Trees remain the most efficient and cost-effective form of carbon capture technology at scale presently available.
    a. Expand tree and other planting efforts on private land to promote restoration efforts to reforest riparian areas, wetland buffers, and degraded lands.
    b. Expand funding and support to the Vermont Community Canopy Program.
    c. Provide incentives for restoration and expansion of floodplain forests.
    d. Increase funding to tree planting via Renewable Energy Standard (RES).
    e. Increase support, funding, and education for increased urban tree planting efforts expansion to increase access to natural spaces and improve carbon sequestration/storage in the urban environment.

Preliminary Assessment of Strategy against Criteria
Impact: Impact is scaled to the degree of increased tree cover; a typical hardwood tree can absorb as much as 48 pounds of carbon dioxide per year, sequestering approximately 1 ton of carbon dioxide by the time it reaches 40 years old
Equity: The financial capacity to support planting efforts presents a potential barrier. Afforestation efforts will need to account for land use changes which impact existing use.
Cost-effectiveness: High
Co-Benefits: Mitigation of heat island effects in urban areas; associated impacts to water quality and landscape scale restoration; wildlife habitat enhancement; aesthetics
Technical Feasibility: Yes

PATHWAY - Energy & Materials: Support and empower Vermont's farmers, foresters, and land workers to capacitate renewable energy and building product transitions

Vermont's farmers, foresters, and land workers can be key actors in harnessing appropriate renewable energy on farms and working lands while protecting those lands, soils, and resources

for the valuable multiple benefits they provide from food to biodiversity to clean water. In addition, farmers, foresters, and workers can bring materials from wood to straw to building markets which can reduce the use of high carbon footprint materials like steel and concrete. Overall, the state must track the sustainability of the climate transition to be aware of and mitigate the potential adverse consequences of renewable energy and materials to people and natural resources.

STRATEGIES AND ACTIONS

13. **Educate, track, and appropriately reward on-farm renewable energy**: Farms can be the source of renewable electricity like solar. However, farmers need information about how best to undertake analysis for their farm's potential, what incentives are available for installation, and how to protect valuable farmland, soils, and forests while contributing to renewable energy production.
    a. Reward and support renewables on farms on rooftops, barns, storage facilities, and minimizes or avoids loss of working and natural lands to renewables development.
    b. Increase outreach and incentives to on-farm solar installation on existing built infrastructure.

Preliminary Assessment of Strategy against Criteria
Impact: Can increase distributed, renewable energy sourcing across the state on farms while protecting working lands for other climate purposes.
Equity: Provides for equity among farm sizes to both produce electricity and receive payments for doing so. Directing renewables onto the built part of farms would ensure lands, waters, and soils remain for climate storage, adaptation and resilience.
Cost-effectiveness: Through utilizing such federal grant programs as Rural Energy for American Program (REAP), could lower costs for farmers and makes time to payback to farmers and Vermont achievable.
Co-Benefits: Preserves working lands for other climate benefits; provides additional income stream/cost savings for farmers and foresters that improves their viability and provides more resources for additional climate related practice implementation in land management.
Technical Feasibility: Yes

14. **Promote and incentivize use of local wood and agricultural products to reduce embodied carbon footprint.** Vermont can be an important source of its own and other adjoining states' building materials that can reduce the carbon footprint of construction. Steel and concrete require extensive carbon to produce and create emissions in their production. Materials can include wood, straw, and other materials.
    a. Promote and incentivize use of agricultural and sustainably harvested wood -based construction materials (subject to existing certification criteria or procurement standards to be developed) over imported wood and/or non-wood materials with high carbon footprints (such as steel, concrete, etc.) Continue to research life-cycle accounting of these products for greatest impact.

b. Through state procurement standards, require that publicly funded building projects use chain of custody certified wood products (MASS timber, cellulose insulation, etc.) that have been harvested under sustainable procurement standards over materials with a higher carbon footprint (such as steel, concrete, etc.). Prioritize locally sourced wood products when possible.
c. Develop a regional certification standard for forestry to validate carbon storage values for forest building products (methodologies supporting supply chain validation for carbon storage are frequently using FSC as a proxy; regional-scale certification standards focused on net carbon benefit are needed for product transparency)
d. Develop alternative markets for non-timber wood, focusing on cellulose insulation, bioplastic composites, or biofuels

Preliminary Assessment of Strategy against Criteria
Impact: Can reduce carbon-intensive building materials in Vermont while increasing local economies providing local materials for local building and construction as well as other products such as bioplastics.
Equity: Provides additional markets for local farmers and foresters. Would need to be designed well to allow small lot owners to participate. However, if not implemented appropriately, could do harm to natural lands, wildlife, and foraging in forests.
Cost-effectiveness: For relatively low cost can harness market forces. Though, certification programs will require costs to create and maintain.
*Co-Benefits: P*rovides additional income to farmers, foresters, and forestry-related businesses to increase their viability while increasing a more locally-driven construction and other products' supply chain.
Technical Feasibility: Yes

15. **Transition fuel sources for the forestry and maple sector.** To also reduce GHG emissions from the forestry and maple sectors, incentives and support can be provided to move to lower carbon fuels for such activities evaporators and vacuum pumps for maple production and biofuels for forest equipment.
    a. Provide funding to incentivize sugar makers to switch evaporators from fossil fuels to wood pellets and incentivize elimination of diesel generators for sap vacuum pumps.
    b. Incentivize alternative fuels such as biofuels or offsets for logging equipment.

Preliminary Assessment of Strategy against Criteria
*Impact: R*educe carbon footprint of local sugar maple industry and logging
Equity: Provides incentives for often small-scale producers and businesses to convert to lower carbon alternatives so they too can have support and be part of the overall transition.
Cost-effectiveness: Requires up front technical support and incentives for change with longer-term benefits of reduced GHG emissions from Vermont enterprises.
*Co-Benefits: P*rovides potential cost-savings and payback to producers over time.

Technical Feasibility: Yes

16. **Sustainably source renewable energy products and materials.** While Vermont will benefit from renewable energy sources and materials produced in Vermont and elsewhere, these sources and materials may also have adverse impacts to air and water quality (e.g., the mining of rare earth metals for batteries), natural lands (the fragmentation of habitat due to wind or solar projects), indigenous peoples (the harm to sacred sites, traditional hunting and foraging lands from large-scale hydro), and environmental justice populations. Vermont should develop and deploy ways to ensure our efforts to address climate do not pose undue and unintended consequences to nature or people.
    a. Fund competitive research to track and innovate on the sustainability and ethical implications of renewable energy materials and products being consumed to meet the CAP including solar, wind, biomass, energy storage, and recycling of materials.

Preliminary Assessment of Strategy against Criteria
Impact: Over time ensuring that climate choices supported by the State do not create adverse consequences.
Equity: Can provide an important screen for choices that may affect traditionally marginalized populations.
Cost-effectiveness: Requires cost upfront without direct benefit initially but over time can inform and shape transition choices in a more responsible and equitable way.
Co-Benefits: Reduction in harm to air, water, soils, wildlife, and people.
Technical Feasibility: Yes

17. **Address biomass for thermal heat regarding climate mitigation, co-benefits and its impacts** [*NOTE: the Ag and Eco subcommittee has not had time to engage with Cross-Sector mitigation on this important but complex topic nor sufficient time to research, understand and offer more specific actions on this topic. The Subcommittee may further refine these actions in later drafts.]*

    Definition: As used in this section, "biomass" means material from trees, woody plants, or grasses, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, farm, rangeland, or wildland-urban environment that is the product of forest management, land clearing, ecosystem restoration, or hazardous fuel reduction treatment (from Biomass Energy Developing Working Group, Final Report, Vermont Legislative Council, January 2012)

    a. Prohibit the expansion of current and any new large-scale, industrial scale electric generation biomass facilities in the State of Vermont.
    b. If such facilities operations cannot be sufficiently improved to address their negative footprint on adjacent neighborhoods and communities and ensure that they are producing net GHG emission reductions, then such facilities should be closed and sufficient training for employees to transition to forestry and renewable energy jobs should be provided.

c. Research the carbon accounting of various methods of and practices for harvesting and burning woody biomass for heat to develop recommendations for the most climate beneficial sources, methods, and technologies. The intent of the research is to inform appropriately scaled, community-based uses for biomass for thermal heat in institutional applications for thermal or combined heat/power applications that both reduce GHG emissions and protect and sustain Vermont's forests for storage, sequestration, and numerous other co-benefits.
d. Ensure appropriate oversight, regulation and management of biomass facilities and their fuel sources to ensure that the outcomes intended (e.g., local sourcing, GHG reductions, etc.) are achieved.
e. If research in "b" above identifies local, climate-beneficial approaches and oversight in "c" occurs, then support the use of Vermont sustainably harvested woody biomass for heating in efficient modern wood heating devices as a means of providing an income stream to forest landowners and, in this way, creating an incentive to keep forests as forests, as well as providing a low-cost source of non-fossil fuel heating. In addition, develop a program of education and outreach and technical assistance to encourage those methods and practices while ensuring oversight and regulation of those appropriate methods and practice.
f. Regulate, including preventing, if necessary, flow of wood pellets or similar commercial scale wood-derived energy products based on research in "b" above to ensure sustainable harvesting of "net GHG-reducing" pellets (i.e., composition, source wood, etc.).

Preliminary Assessment of Strategy against Criteria
Impact: Through research and appropriate oversight and management, ensures that biomass for thermal heat is sustainable and reduces GHG emissions.
Equity: Provides a staged approach to further advancing biomass for thermal heat in Vermont in an equitable way for both people and places that also seeks to avoid adding to inequities already created by large-scale electric biomass facilities.
Cost-effectiveness: Both conducting research and improving oversight, this strategy will ensure biomass for thermal heat may advance in Vermont without unintended and adverse consequences, including costs to people, air, land, and climate.
Co-Benefits: Sustaining natural lands for a host of storage, sequestration, and resilience purposes, helping provide income to Vermont's forestry sector, and providing a means of affordable heat to Vermonters.
Technical Feasibility: Yes

Cross-Cutting Pathways

The recommendations found in this plan are intended to lay the foundation for the state to better adapt to and mitigate the effects of climate change, while also seeking economic opportunities. Many of the climate solutions put forward in the preceding sections, while organized around emission reductions, improving resilience and adaptation, and sequestering and storing carbon, have co-benefits beyond their primary objective. As the legislature, state, regional entities, municipalities, non-governmental organizations, and others work to advance this multi-stakeholder plan, this Council recommends lifting up actions that will help Vermont meet multiple objectives. While many of the recommendations have co-benefits, several pathways are particularly impactful, and a coordinated approach will ensure a focus on maximizing climate action benefits in all areas. As such, the following pathways were pulled from their respective sections to be represented here.

Compact Settlement

PATHWAY 1: Support compact settlement patterns that contribute to the reduction of GHG emissions, enhance community and built environment resilience, and help conserve natural and working lands.

Compact settlement, sometimes referred to as “smart growth”, is a key strategy for addressing climate change. Vermont’s city, town and village centers, and other areas with the density and a mix of uses are characterized as “compact settlement” or “smart growth”, as described in Vermont planning law ((24 V.S.A. §4302) l: (1) To plan development so as to maintain the historic settlement pattern of compact village and urban centers separated by rural countryside.

Compact settlement has been at the core of Vermont’s land use goals as it provides numerous economic, health, quality of life, and environmental benefits. When thoughtfully planned, compact settlement, including infill and redevelopment, can also support many of the State’s climate goals and actions, including energy efficiency, greenhouse gas emissions reductions, community climate resilience and adaptation, and preservation of the resilience and sequestration benefits provided by healthy natural and working lands.

As an alternative to sprawl, compact settlements do the following:

- facilitate mobility options that are more efficient and produce less GHG emissions, such as walking and bicycling, by making the most common places people to need to get to and from closer to one another;
- create densities necessary for providing reliable transit options that are more efficient and produce less GHG emissions
- enable a shared network of electric vehicle charging stations for home and destination charging;

- create densities necessary for more efficient and resilient energy supply systems, such as district heating and cooling and microgrids;
- enable development of housing at a scale that meets the needs of current and future Vermonters, including energy efficient multi-family housing options;
- protect and conserve natural and working lands, critical to ecosystem and public health, natural and community resilience, and Vermont's economy;
- create opportunities to retain and expand commercial and social services that serve local customers that are in close proximity to the goods and services offered;
- reduce social isolation and provide more opportunity for neighbors to congregate.

In the absence of achieving compact settlement, as Vermont grows the state will continue to see rural sprawl that causes fragmentation of intact forests, loss of agricultural land, an increase in cars and trucks on Vermont roadways and an increase in traffic, congestion, and emissions associated with vehicle travel, and a decline in community cohesion, among other negative impacts[258][259].

Recognizing these negative trends, the Vermont Legislature has enacted several laws that aim to promote and enable compact settlement[260]. Similarly, three subcommittees of the Vermont Climate Council (Agriculture & Ecosystems, Cross-Sector Mitigation, and Rural Resilience & Adaptation) prioritized compact settlement as a key tool for comprehensively addressing climate change. In acknowledgement of this uniquely cross-cutting approach, actions from each of these subcommittees have been elevated into the strategies below, which highlight the importance and value of investing in compact settlement.

Strategies

1: Increase investment in the infrastructure (sewer, water, stormwater, mixed-use development, housing, sidewalks, bike lanes, EV charging, broadband, energy supply) needed to support compact, walkable development.

To function properly as part of the solution to climate change, compact settlement needs well designed infrastructure to create places that are desirable, in addition to reducing emissions and being more resilient to climate impacts.

Community drinking water and wastewater disposal are fundamental elements of functional compact developments. For existing compact settlements with existing community water and wastewater systems, those systems must be maintained and upgraded to meet health and water quality standards, and their capacity must grow as population increases and/or new establishments require service. Existing compact settlements that do not have community water supply and wastewater systems will require the establishment of such systems to enable retention and compact growth of residential and commercial. In most villages, small lot sizes coupled with poor soils and existing well water and septic systems make it challenging to build a conventional on-site wastewater collection (septic) system. Many Vermont-scale settlements also do not have the density of users

[258] https://fpr.vermont.gov/sites/fpr/files/About_the_Department/News/Library/FOREST%20FRAGMENTATION_FINAL_rev06-03-15.pdf

[259] https://www.vtrural.org/sites/default/files/content/futureofvermont/documents/VTTransitions_Ch3.pdf

[260] 24 V.S.A. § 4302, 10 V.S.A. § 6086, 24 V.S.A. § 2793c, 24 V.S.A. § 2791, 10 V.S.A. § 6301, 10 V.S.A. § 6604c, Act 183, Act 171

necessary to afford traditional wastewater treatment facilities. In these instances, community-scale soil-based wastewater treatment systems are an important option for wastewater management that can be integrated with existing use of private wells and either replace or coexist with existing septic systems.

Public drinking water systems should be designed to accommodate climate change impacts, such as more droughts and more wet periods. Wellhead protection areas should take these swings into account and can be integrated into land conservation and recreation objectives.

Because many of Vermont's existing compact settlements grew up along waterways, promoting compact settlements also requires improved resilience. Managing flood and fluvial erosion hazards in Vermont's compact settlements will be a critical component of a successful climate response. Stormwater infrastructure is needed to protect structures and property as well as water quality and can be integrated with public green spaces that provide benefits beyond stormwater management. Managing flooding in compact settlements has both upstream and downstream implications, and land use and land conservation policies should address floodwater attenuation and mitigation capacity that anticipates greater flood frequency and intensity.

New, infill and redeveloped housing should frame public spaces, provide a diversity of housing options for different stages of life, be energy efficient, and safe and comfortable spaces as our climate changes. Connected bicycle, pedestrian and public transit infrastructure should be developed or improved to provide affordable, safe, and healthy ways of getting around that do not require a vehicle. Compact settlement-centered microgrids can facilitate renewable energy production, storage, and resilience against outages. Similarly, compact settlements can be internet connectivity hubs where both wired and wireless systems can serve a greater concentration of users. Physical planning and design can bring all of these elements together to create a vision for the community, serve as the foundation for policy and bylaw development, and inform capital improvement planning and budgeting, including grant and financing strategies.

Actions

a. Increase investment in municipalities to improve, expand and build new drinking water and wastewater infrastructure to support compact development, <u>including asset management tools to support long-term operation and maintenance</u>.
b. Make village centers permanently eligible for the downtown transportation fund that builds infrastructure needed to increase walking, biking and transit.
c. Increase weatherization investments, and incentives, for energy efficient projects in buildings located in energy cost-burdened communities and communities with greater concentrations of older buildings, rental property, and low and moderate incomes.
d. Expand the existing downtown and village tax credit program eligibility to offset the cost to elevate or flood proof existing buildings located in areas with increased flood risks.
e. Support public private partnerships to fund the design and construction of new infill housing in existing neighborhoods.
f. Expand the eligibility of the existing downtown and village center tax credit programs to revitalize neighborhood housing in and around state designated centers.
g. Increase Municipal Planning Grant (MPG) funds to support physical planning and design, zoning modernization and bylaw adoption that creates housing growth opportunities and more housing choices.

h. Establish a rolling planning grant for communities in need of consulting assistance to prepare Neighborhood Development Area (NDAs) applications. This designation works to align state and local regulations to increase housing options within compact centers.

Preliminary Assessment of Strategy against Criteria
Impact: All growth and development has some impact, but compact development reduces climate change impacts, as well as other impacts such as those to natural resources and public expenditures. Impact of compact development on climate change goals should be assessed by comparing it to the climate change impacts of the alternative, which is dispersed, sprawling development. Compact development cannot be part of the climate solution without the infrastructure to support and make compact settlements a preferred and accessible choice for where people live, work, and meet their basic daily needs. While increasing investment for the infrastructure needed to support compact settlement is imperative, the processes that go into infrastructure projects have long lead times, meaning it can take years to bring a project from concept to completion. In addition to long lead times for infrastructure projects, impacts are often slow to accumulate or are indirect, making them difficult to measure and attribute progress towards climate goals to individual infrastructure projects. Further work is needed to ensure that the infrastructure itself is also resilient to climate impacts (see Section 12).
Equity: Investment in infrastructure should ensure that those most impacted by climate change experience contextual, procedural, corrective, and distributive equity in the implementation of infrastructure investments to address climate change. Due to historic inequities black, indigenous, and low-income communities, people of color, and persons with disabilities are often more vulnerable to climate change. While compact development can improve resilience and equitable and affordable access to housing, transportation and amenities, investments in infrastructure have historically caused harm to these communities by siting infrastructure in a way that burdens them with negative environmental consequences and limits or excludes them from receiving the benefits[261]. Infrastructure projects, including the physical planning and design of communities, should include the voices of those most impacted by climate change, and work towards correcting past inequity (e.g. lack of investment or representation in infrastructure development) while preventing the exacerbation of existing inequities (e.g. investment cannot lead to displacement).
Cost-effectiveness: Additional work is needed to identify a cost effectiveness metric for actions that have both emissions and resilience impacts across many sectors, and to establish a "business as usual" scenario baseline against which cost-effectiveness can be measured.
Co-Benefits: Compact development can reduce emissions and improve resilience. It reduces development pressure on natural and working lands, increasing their ability to sequester carbon. It also creates communities that are more vibrant, diverse, walkable, and economically stable, especially if designed with universal accessibility in mind. Increased investment in the infrastructure that's needed to support compact communities also has public health, economic prosperity, and workforce opportunity benefits. Further research and analysis is needed to identify and quantify specific benefits that are associated with specific patterns of compact settlement and specific types of infrastructure investments.
Technical Feasibility: Yes

[261] https://ejatlas.org/#

2. Update state and local land-use governance, regulations, and practices to remove barriers to compact settlement and improve coordination on land use issues across agencies, departments, municipalities, boards, commissions, and authorities.

For the past 50 years, Governors, state agencies, the General Assembly, non-profit advocacy groups, regional entities, and cities and towns have worked collectively and intentionally to strengthen Vermont's downtowns and villages and the state's historic settlement pattern of compact centers surrounded by farms and forest lands. The dramatic turnarounds of downtowns like St. Albans, Bennington, White River Junction, and St. Johnsbury and in villages like Newbury, Albany and Putney are the results of many years of thoughtful and incremental actions. These resulting partnerships, networks, and policy frameworks create a strong foundation to help communities adapt to a changing climate and become more sustainable, affordable, equitable, and prosperous. A thoughtful review and objective assessment of Vermont's land use planning and regulatory ~~r~~ framework is necessary to understand what key policies can be implemented statewide and in a timely manner.

-Based on the outcome this assessment, policymakers can modernize the state's existing framework of regulations and incentives to not only strengthen Vermont's brand, economy, and communities -- but drive down emissions, expand equity and environmental justice, prepare communities for warmer and wetter weather, and remove the carbon already in the atmosphere. Because local plans and plan implementation are left to the option of municipalities, including whether or not to have a plan, some critical land use policies, especially those related to life and safety, may need to be implemented at the state level.

Actions

a. Hire a consultant to review and assess the state designation programs that recognize and support Vermont's compact settlement areas.
b. Pass legislation to create a multi-stakeholder committee process with funding to support the development of a statewide land use planning policy and implementation plan that guides development to growth areas, town centers, and appropriate rural locations, and limits the development within ecologically sensitive/risk-prone areas. The Legislature should clarify how and if this plan informs or directs land use planning, policy and regulation at the local, regional, and state level.
c. If a State Land Use Plan is authorized, explore creation of a State Planning Office and/or other potential structures within the executive branch to implement the Plan at the state level.
d. Direct the Legislature to authorize development and implementation of a Statewide Land Use Plan. In doing so, the Legislature should clarify how and if a State Land Use Plan informs or directs land use planning, policy and regulation at the local, regional, and state level. Create a State-wide redevelopment authority to bank land[262], underwrite acceptable risk, address blight, vacancy, and brownfields, improve building flood resilience in settled areas, and plan for new neighborhood development and infrastructure.

[262] to manage and repurpose an inventory of underused, abandoned, or foreclosed property

e. Prioritize public funding for mixed-use developments near transit hubs in regional and rural centers[263]
f. Provide enhanced technical assistance and support to municipalities and regions, including outreach and education for landowners and community members, to develop and implement town plans intended to maintain forest blocks and connecting habitat as authorized by Act 171, and effective zoning and subdivision bylaws to maintain forest blocks and connecting habitat. Because forest and habitat blocks do not end at state and national boundaries, support engagement in interstate and bi-national forest block and habitat connectivity efforts such as the Staying Connected Initiative at both the state and regional levels.
g. Update Act 250 to promote compact settlement by:
    i. waiving the mitigation fees for prime agricultural soils[264] for alternative or community wastewater systems that will serve a state designated center.
    ii. removing the population-based caps on the Act 250 exemption for priority housing projects
    iii. including criteria that better address climate change, forest fragmentation and forest loss, to incentivize growth in the state's designated centers and better address the specific challenges to working lands enterprises;
    iv. updating its governance, staffing, public engagement, and the role of State Agency permits in the Act 250 process to create the enterprise capacity necessary to implement new climate related criteria and respond to future land use pressure from climate change and in-migration of climate refugees.
    v. removing Act 250 jurisdictional thresholds for housing development within and immediately adjacent to certain state designated centers to incentivize compact, dense settlement in areas with adequate local land use laws and existing infrastructure, reducing development pressures on open spaces such as greenfields and forested locations. These centers should grow in a manner by which walking and biking are preferred means of mobility, and mobility infrastructure should be designed for universal accessibility.
h. Amend Neighborhood Development Area (NDA) enabling statute to allow the inclusion of river corridors upon local adoption of River Corridor bylaws.
i. Create an office of Strategic Investment and Coordination that supports achievement of land use planning goals by aligning and resolving conflicts in state and local regulations and funding and provides a permitting platform from both the customer and policy objective perspective.
j. Align development regulations and remove financial barriers to compact development in and around downtowns and village centers (i.e., Act 250, local zoning, aging infrastructure, etc.). Provide statewide guidance and incentivize housing in built up areas to encourage development away from open fields and forests, and river corridors.

Preliminary Assessment of Strategy against Criteria

[263] http://maps.vermont.gov/ACCD/PlanningAtlas/index.html?viewer=PlanningAtlas
[264] 10 V.S.A. § 6093. If a project subject to Act 250 jurisdiction contains soils that are mapped by NRCS as prime agricultural soils, or soils in recent agricultural use, offsite mitigation fees are paid by the project into the Vermont Housing and Conservation Trust for the purpose of preserving primary agricultural soils of equal or greater value.

Impact: State and local land use regulations play a significant role in shaping growth patterns in Vermont. Removing barriers, reducing burdens, and providing incentives can have significant impact in directing growth to compact settlement.
Equity: Any changes to land use governance, regulations and practices need to ensure that those most impacted by climate change experience contextual, procedural, corrective, and distributive equity in the implementation of this strategy. Due to historic inequities black, indigenous, and low-income communities, people of color, and persons with disabilities are often more vulnerable to climate change. Governance structures, regulations and procedures have explicitly prevented black and indigenous communities and people from participating in wealth generating activities associated with land ownership and use of land and resources for economic growth. Changes to governance, regulations and procedures should include the voices of those most impacted by climate change, and work towards correcting inequity in ownership and use of land resources.
Cost-effectiveness: Administrative and regulatory changes do require staff time and effort, and occasionally require consultant support. However, these are one time, relatively low costs that unlock social, environmental and economic benefits and cost savings that are associated with compact development. Coordination across the stakeholders responsible for and engaged in land-use decisions requires regular and sustained human capacity (time, expertise and decision-making authority) to participate in, inform and build consensus around land use decisions.
Co-Benefits: Co-benefits of updating state and local land-use governance, regulations and practices include improved efficiency in government operations, an improved customer service experience for constituents, and better collaborative relationships between stakeholders involved in governance and regulatory processes.
Technical Feasibility: Yes

3. Fund research, data collection and digital maps to provide insights on land use decisions in Vermont and the impact it can have on climate and resilience goals and outcomes.

Land use choices play a foundational role in meeting the States climate goals, and can either enable or impede meeting our emissions reductions, carbon sequestration and climate resilience goals. The impacts of land-use decisions on greenhouse gas emissions, carbon sequestration and improved resiliency are often slow to accumulate and can be indirect, making them difficult to measure and attribute to specific land-use decisions over time. Research and data on land use in other states and jurisdictions is difficult to scale to Vermont with enough confidence to support decision making, as the rural nature of the State is assumed to have a significant impact on the outcomes of different land use decisions.

The lack of quantitative and Vermont specific data that demonstrates the value and tradeoffs of different land use decisions, particularly of compact development over dispersed land use patterns, and particularly related to meeting climate goals, presents a challenge to making sound land use decisions that are coordinated to balance multiple and sometimes competing objectives, and build consensus around land use decisions that achieves the greatest possible outcomes across multiple goals and objectives. For example, data on energy demands for different land use patterns could inform land use planning that is sensitive to and supportive of planning for energy systems that can meet our climate and energy goals, including emissions reductions, energy

resilience, and lower energy costs. While land use planning can often serve complementary objectives, tensions between competing land uses inevitably arise. For example, Title 24 Chapter 117 calls for compact development in historic settlements, which relieves development pressure on natural and working lands and revitalizes and retains the character of Vermont's historic settlement pattern. However, existing settlements are often along river corridors, raising concerns that focusing new development in these areas to advance compact settlement patterns will create more infrastructure that is at risk of inundation flooding or fluvial erosion hazards. The tension between the goals to encourage growth in compact historic centers, reduce the vulnerability of built infrastructure, and protect natural resources requires objective information to facilitate negotiation and consensus building around land use decisions that can achieve the greatest possible outcome for multiple, and sometimes competing objectives.

Actions

a. Pilot a land value taxation study in five communities to evaluate grand list shifts and incentivize compact development as taxes are levied based only on the value of the underlying land and not on the value of any buildings or other improvements to the site[265].
b. Fund a study that quantifies the vehicle miles traveled and GHGs for both compact and dispersed areas of development as well as the co-benefits of compact centers.

Preliminary Assessment of Strategy against Criteria
Impact: Robust data and analysis supports and ensures that actions to support compact development support the goals of the Climate Action Plan and deliver on co-benefits. This strategy will be particularly impactful in continued development and implementation of climate action, as research and analysis on the costs and climate benefits of compact development, particularly in Vermont and particularly in relation to climate resilience, is far less developed than that of emissions reductions actions in the transportation, buildings, and energy supply sectors.
Equity: While data and research are often considered to be objective and neutral, data collection processes and analysis methods can be inherently biased, leading to programs and policies that further exacerbate inequities[266]. Ensuring equity in this most basic first step of policy and program development is critical to ensuring more equitable policy and programs[267]. Data collection, research and analysis that can provide insights on the impacts that land use decisions can impact climate goals needs to ensure that those most impacted by

[265] In Vermont, property taxes are assessed on the value of land, buildings, and improvements. Taxing improvement value acts as a disincentive to put land to productive use, since by increasing the value of a building, one increases their tax liability. This rewards speculators and property owners who let valuable land sit idle or buildings fall into disrepair. A land value tax is generally favored by economists as it does not cause economic inefficiency and it tends to reduce inequity.
https://www8.gsb.columbia.edu/faculty/jstiglitz/sites/jstiglitz/files/2015%20Origins%20of%20Inequality.pdf

[266] Richardson, Rashida and Schultz, Jason and Crawford, Kate, Dirty Data, Bad Predictions: How Civil Rights Violations Impact Police Data, Predictive Policing Systems, and Justice (February 13, 2019). 94 N.Y.U. L. REV. ONLINE 192 (2019), Available at SSRN: https://ssrn.com/abstract=3333423

[267] https://www.adalovelaceinstitute.org/blog/structural-racism-impact-data-ai/

climate change experience contextual, procedural, corrective, and distributive equity in its implementation.
Cost-effectiveness: Data acquisition, research and analysis is likely to require both staff time and consultant support. A climate focused research agenda will likely need to be pursued over many years. Onetime costs for discreet projects to answer specific questions about climate action would be needed. Investment in robust data and analysis would ensure that climate actions are pursued in a cost-effective way. Partnerships could reduce the costs of ongoing research, help to build the collective knowledge of stakeholders, and enable consensus building around climate action.
Co-Benefits: The data, research and analysis needed to evaluate, develop and implement compact settlement actions in support of climate goals may also be useful to other community or State decision making processes.
Technical Feasibility: Yes

Education

Pathway: Create accessible, equitable research, partnerships, and education; promote shared understanding; and invest in sustainable workforce development for the natural and working lands sector.

Education and understanding, especially around our ecosystems and land in this state is a vital part of solving the climate crisis. This must include the risks and changes that will follow inaction with regard to the climate crisis as well as the strategies to address this crisis, to ensure equitable access to opportunities and a shared knowledge that will build our transition to a better future. Education of people around the state about the actions to slow climate change as well as an enabling set of actions that will allow for creating capacity for the future is critical to all ages, but especially for intergenerational equity.

Education also strengthens the success of every other pathway towards resilient climate adaptation. Agricultural, forestry and natural resource landowners and managers need education to implement nature based practices that will mitigate and sequester greenhouse gases, that will positively affect their viability, and help them, and future land managers to adapt to a changing climate in a positive and vibrant manner.

STRATEGIES AND ACTIONS

18. **Provide funding for climate-related education at all levels, outreach, research, and technical assistance programs**: Investment in climate related education will create the support and understanding around the need to implement climate mitigation, resilience, and adaptation actions. Education programs for land owners, practitioners, students, and teachers about climate change, its impacts and steps that can be taken now, are necessary to influence personal and systemic action and build workforce capacity and general knowledge with regard to the impacts of climate change and the strategies necessary to prevent it.

a. Enhance education, outreach, and technical assistance programming to support farmer learning and adoption of climate smart agricultural practices and ensure equitable access through the creation of two full time UVM Extension staff and part time staff for each National Resource Conservation District.
    a. Grow the capacity of additional VT academic institutions and indigenous-led & BIPOC organizations to offer technical support to farmers and foresters, such as Middlebury College perennial program with TEK.
b. Establish and fund an educational program that explains the role that Vermont farmers and foragers and their high-quality, local food products play in maintaining a low climate impact
c. Create a climate curriculum teachers fellowship program to engage teachers in leading and sharing their climate curriculum ideas with other teachers
d. Amend the Vermont State Board of Education's Education Quality Standards to incorporate environmental and climate change education at all grade levels (consider folding under "Science" and "Social Studies" curricula)
e. Redesign the state education funding model so that Career and Technical Education centers have independent funding streams and budgets. Create and fund legislation to support other educational programs that strengthen the workforce pipeline, including a range of accessible postsecondary educational models (e.g. apprenticeships, concurrent enrollment, and stackable credentials)
f. Support increased investment in healthy soil education through educational mini-grants for teachers to all audiences (including agriculture, homeowner, forestry, publications, K-12 schools and institutions of higher learning) and implementation of practices through funding of Best Management Practices challenges, technical assistance programs, and cost shares.
g. Develop and make available accessible outreach and educational materials that communicate the issue of climate change and local impacts to the general public, which include and highlight the role that Vermont's natural and working lands play in providing solutions to climate change.
h. Establish stronger relationships between state agencies and regional planning commissions, and faculty at Vermont and adjacent state institutes of higher learning, creating opportunities for state and regional research needs to become an aspect of faculty research agendas.

Preliminary Assessment of Strategy against Criteria
Impact: Education of our current land managers is the most critical enabling action to create immediate and long-term impacts on greenhouse gas reduction or mitigation and adaptation. Additionally, the impact of the given strategies will result in a proactive approach to climate issues through increased education of future generations who will sustain these actions over time.
Equity: This strategy will advance equity by providing opportunities for all and increased opportunities. A focus on accessibility and funding will ensure that this strategy and these actions have the potential to create progress towards environmental justice and equity.
Cost-effectiveness: This strategy is very cost effective given the many co-benefits and huge cost of inaction. Though there is not an ability to have cost per outcome at this time, investment in education, especially climate education is a no regrets policy.

Co-Benefits: Educational strategies by design have many co-benefits simply by increasing the amount of climate mitigation practices, future management that will proactively address climate and a society with a better understanding of its role in climate action. These actions will have numerous co-benefits to the land and people, thereby improving the wellbeing of communities. Increased education about the issues facing our community will develop understanding of additional ways to solve them.
Technical Feasibility: Yes

19. **Develop and promote climate-related educational materials for private landowners to empower them to make climate-informed decisions about their land and waters:** The majority of Vermont land is privately owned. Therefore, it is important to create educational programs to encourage more climate friendly practices and learning.
    a. Create and deploy river corridor and floodplain buffer extension-type program, that provides educational material and technical assistance for private landowners
    b. Identify and explain practices that create and enhance pollinator habit, wildlife habitat and biodiversity
    c. Promote the values of planting future climate adapted tree species and crops in an effort to expand tree planting efforts on private land. Thereby promoting restoration efforts to reforest riparian areas, wetland buffers, and unhealthy soil.
    d. Create infrastructure and educational programs around community and backyard composting and recycling
    e. Educate Vermont landowners about the benefits of reducing lawn mowing frequency, and amount of mowed lawns to increase biodiversity and ecosystem health, and ultimately reduce emissions.

Preliminary Assessment of Strategy against Criteria
Impact: Although some of these actions may appear to some as having a low impact the suite of actions in this strategy is important. These enabling actions create capacity for future plans, build awareness and create collateral to harness the power of the majority of the state land.
Equity: There are extreme equity issues with regards to land ownership in this state. Therefore, in order for this strategy to be truly equitable it must be coupled with the development of plans to promote equitable access to land ownership, developed by the state and incorporated in future plans. That said, this strategy includes actions to educate the general public greater than the land-owning population, and seeks to make the action of owning land in Vermont more equitable through the adoption of better land use management practices. The education of land owners to encourage better management practices will improve communities as a whole, providing benefits to non-land-owning residents thereby improving equity. The implementation of this strategy should carefully consider the recommendations set out in the equity rubric.
Cost-effectiveness: Investment in education is extremely cost effective. These actions are small investments that go into creating materials and programs will have wide reaching impacts. Education and increased understanding of the potential impacts of and actions needed in the face of a changing climate are essential to achieving the rate and scale of the mitigation, adaptation, and resilience measures needed to achieve both the immediate and long term requirements of the GWSA.

Co-Benefits: This strategy will have an extremely high number of co-benefits. Education in all capacities is important, but these actions will lead to increased climate resilience, healthier environments, increased cultural capital, more understanding and many other co-benefits.
Technical Feasibility: Yes

20. The language in Vermont agencies must be reviewed and updated to be more equitable.
    a. Secretaries and Commissioners in relevant agencies must make this a top priority.
    b. Train the staff and leadership about the history of Vermont including the harm that has been done in the name of conservation in Vermont. These recommendations seek to better reflect and align with Climate Council's 2021 proposal for today and desire for and commitment to equity. In addition, this will help the people working in these areas to obtain cultural humility.

Preliminary Assessment of Strategy against Criteria
Impact: Background: The General Assembly recognizes that further legislative action should be taken to address the continuing impact of State-sanctioned eugenics polices and related practices of disenfranchisement, ethnocide, and genocide. (*No. R-114. June 2021 -- Joint resolution sincerely apologizing and expressing sorrow and regret to all individual Vermonters and their families and descendants who were harmed as a result of State-sanctioned eugenics policies and practices (J.R.H.2)).* Rural Vermont Plan for the Future 1931, Chapter 4 on Topography and Climate, Chapter 5, Soils, Chapter 6, Agriculture, Chapter 7 Forestry was the beginning of, and foundation for, the language and philosophy of that various Vermont Agencies that echoes the beliefs of the Eugenicist from 1920's and 1930's and is inequitable and inappropriate (i.e., ANR and Vermont Dept. of forests parks and recreation and other agencies' foundational documents used words, ideas, and categorizations for people like "defected people, defected children," "people of average talent," "deplorables," "crippled," and for nature "loss bearing low grade trees," "eliminate poor trees and inferior species," "soil has little to no agricultural value," and "waste land, and "idle hillsides" that echo in language used today) (see also UVM President Sullivan's apology letter of UVM's role in eugenics from June 21, 2019). Therefore: This strategy will work on changing the systems that have lead to great harm of communities especially indigenous communities. This strategy will have a big impact on the way that we view this work and the extent to which that view is formed by the eugenics movement and therefore will greatly improve our state, having a high impact.
Equity: This strategy at its core creates equity through the consideration of indigenous knowledge and the movement away from a system based in eugenics.
Cost-effectiveness: This strategy is highly cost effective. Any costs that this may create are necessary for equity and to undo the harms created by the Vermont eugenics movement.
Co-Benefits: There are so many co-benefits to this action because it is changing the way we regard a variety of topics throughout state government and it will change the way we think in turn improving our communities and creating co-benefits along the way.
Technical Feasibility: Yes

Personal Action That Individual Vermonters Can Take To Reduce Emissions

Vermont's Climate Action Plan sets Vermont on a path to making the transformative change needed to realize a resilient future. While large-scale, systemic changes are needed at the international, national, and state level regarding public policy and market transformation, Vermonters have an individual role to play as well. As of 2018, statewide greenhouse gas emissions totaled 8.64 million metric tons of CO2 equivalent (CO2e).[268] With an estimated 2018 Vermont population of 626,299 people,[269] per capita emissions were approximately *13.8 tons of climate pollution* – higher than the per person average of any other New England state.[270]

The primary reasons for our relatively high per capita GHG emissions are our significant use of fossil fuels for transportation and heating. Together, those two sectors make up 74% of Vermont's total in state climate pollution.[271] Specifically, the largest sources of Vermont's GHG emissions are the use of fossil fuels like gasoline and diesel for transportation, and of fuel oil, propane, and natural gas for home and building heating.

It is important to note that wealthier households, on average, create much more climate pollution than lower-income households.[272] While individual circumstances vary[273], for most Vermonters,[274] the single highest impact personal decision they can make is to commit, whenever practicable, to never again purchase brand new pieces of fossil-fuel dependent equipment. This is especially true of vehicles and space heating systems, but is also relevant for water heaters and smaller pieces of equipment like lawn mowers and snow blowers. Today there are the technologies available to do nearly all of the things fossil fuel dependent equipment has done in the past, but now with less pollution and often at lower cost thanks to modern electric options or sustainable use of renewable fuels such as wood heat or B100 biodiesel.

It is also important to recognize that for many households living with low incomes, limited credit access, renters without control of their heating system, and/or who confront a confusing

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[268] See Table 10 on page 36. https://dec.vermont.gov/sites/dec/files/aqc/climate-change/documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2017_Final.pdf

[269] https://www.healthvermont.gov/sites/default/files/documents/pdf/HS_STAT_2018_Population_Estimates_Bulletin.pdf

[270] See page 10, https://www.eanvt.org/tracking-progress/annual-progress-report/2019-progress-report/

[271] Vermonter's consumption of goods that are produced elsewhere are not accounted for in Vermont's in-boundary emissions inventory but also play a role in global climate pollution. Therefore, being aware of the carbon footprints of consumer purchases and opting for more climate friendly alternatives can play a role as well.

[272] See "Wealthier families have a larger footprint" https://www.pbs.org/newshour/science/5-charts-show-how-your-household-drives-up-global-greenhouse-gas-emissions

[273] It is important to note that wealthier households, on average, create much more climate pollution than lower-income households. See: https://www.pbs.org/newshour/science/5-charts-show-how-your-household-drives-up-global-greenhouse-gas-emissions

[274] While individual Vermonters may have specific and important opportunities to reduce climate pollution and/or preserve carbon sinks by virtue of individual circumstances, for instance their profession (such as farming) and/ or other factors (like being a forest-land owner), this section focuses on actions that are available to the vast majority of Vermonters.

marketplace, especially when language barriers are present, the desire and commitment to purchase cleaner equipment may not be enough. That is why this CAP includes many recommendations regarding policies, programs, and incentives that are necessary to ensure an equitable transition beyond fossil fuels. Specifically, it is important to design programs and incentives such that the up-front costs of the cleaner alternative are no more than the cost of the more polluting option, whether via incentives or via financing options that recognize lifetime savings, and to make sure those are accessibly communicated and provided.

Purchasing brand new fossil-fuel dependent equipment not only often locks in decades or more of climate pollution that we can no longer afford if we are to meet our emissions reduction commitments: it also often locks in dependence on higher-cost, more price-volatile fossil fuels that strain the budgets of Vermont consumers and create a drain on the Vermont economy. In contrast, efficient electric and renewable alternatives significantly cut climate pollution; often cost less over their lifetime, with lower and more stable energy prices[275]; and do more to strengthen the Vermont economy and support local jobs because they help keep more of our energy dollars recirculating locally.[276] With existing and future incentives and increasing market adoption, clean and efficient options to fossil-fuel dependent equipment are not only becoming more available, they are becoming more affordable as well.

A. Transportation

On average, more vehicle miles per person per year are traveled in Vermont (11,773 in 2019[277]) than in any other New England state.[278] The vast majority of these miles are currently driven in fossil fueled vehicles. Per person, the largest single source of climate pollution created by most Vermonters comes from their transportation, specifically the use of gasoline and diesel fueled vehicles. On average, of the 13.8 tons of GHG pollution that Vermonters emit, per capita per year, around 5 tons per year comes from fossil-fueled transportation.[279]

Recognizing again that individuals face different circumstances, that wealthy Vermonters tend to consume more fuel and thus bear a greater responsibility to reduce pollution, and the vital role that public policy and programs need to play to make clean choices more equitably accessible, the most effective ways for Vermonters to reduce emissions from transportation generally include:

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[275] Whether and to what degree electrification lowers heating costs depends on an array of factors, including but not limited to: utility territory (i.e., differential electricity rates); the fuel it is displacing (i.e., savings potential is greater for fuel oil and propane users, often not for natural gas users) variable efficiencies depending on temperature (i.e. heat pumps are less cost effective when temperatures drop below zero); and proper programming and use.

[276] See page 8, https://www.eanvt.org/tracking-progress/annual-progress-report/2021-annual-progress-report/

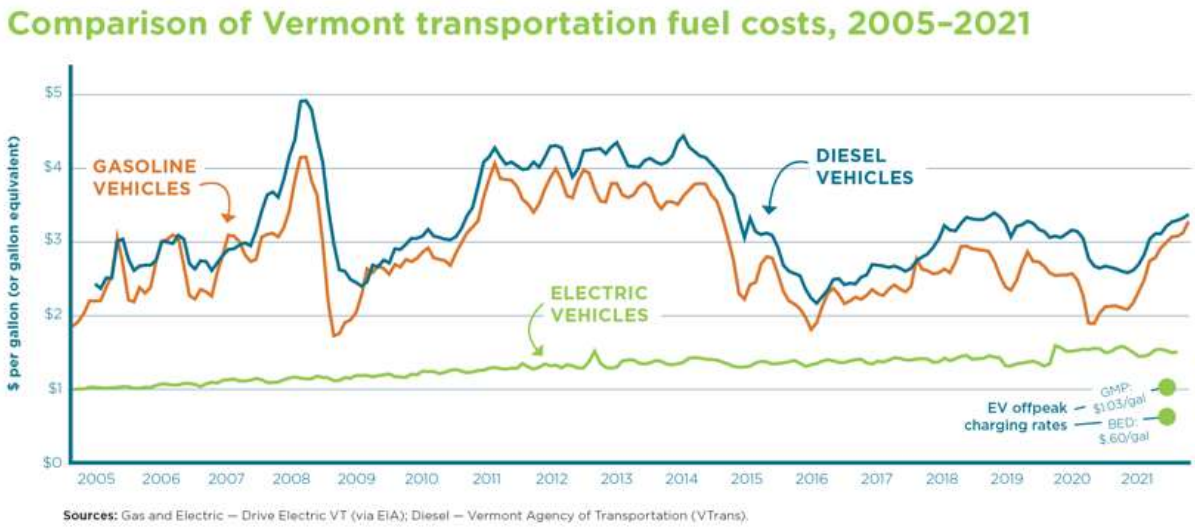
[277] Federal Highway Authority: Highway Statistics, 2019.

[278] See page 16, https://www.eanvt.org/tracking-progress/annual-progress-report/2021-annual-progress-report/ Here again, wealthier households are responsible for more pollution, with Northeastern US households earning over $100,000/ year driving about 50% more miles/year than households earning under $25,000/year. See slide 21 here: https://legislature.vermont.gov/Documents/2022/WorkGroups/Senate%20Natural%20Resources/Energy/W~Jared%20Duval~Energy,%20Emissions,%20Economy,%20Equity~2-3-2021.pdf

[279] The data bear this rough estimate out whether you divide statewide transportation emissions by total population (top-down estimate) or whether you add up transportation emissions using, for instance, total VMT and average fleet fuel efficiency (bottom-up).

The most effective ways for Vermonters to reduce emissions from transportation include:

- Choosing electric vehicles instead of new fossil fueled vehicles, whenever practicable. For the full array of electric vehicle models available in Vermont, see https://www.driveelectricvt.com/find-your-ev/compare-models
    - Note that, with Federal, State, utility, manufacturer, and/or other incentives combined, EVs (whether new or used) are often less expensive up front than fossil fuel alternatives. EV's are also less expensive to operate over their lifetimes, due to fuel and maintenance savings. The Union of Concerned Scientists, for instance, estimates that EV drivers in rural Vermont can average over $1,500 a year in combined fuel and maintenance savings compared to fossil fuel drivers.



- Reducing vehicle miles traveled when practicable, including utilization of transit services
- When electric vehicles, transit, or other mentioned options are not feasible choices, it is better (both from a pollution and cost reduction standpoint) to use (or make a next vehicle choice) that is more fuel efficient. More fuel-efficient options include: plug-in hybrids (PHEVs), hybrids, or otherwise more fuel-efficient models.
- Minimizing unnecessary air travel.

Resources:

Drive Electric Vermont: https://www.driveelectricvt.com

MileageSmart: https://www.mileagesmartvt.org

Go! Vermont: https://www.connectingcommuters.org

Fuel Economy: https://www.fueleconomy.gov

B. Heating

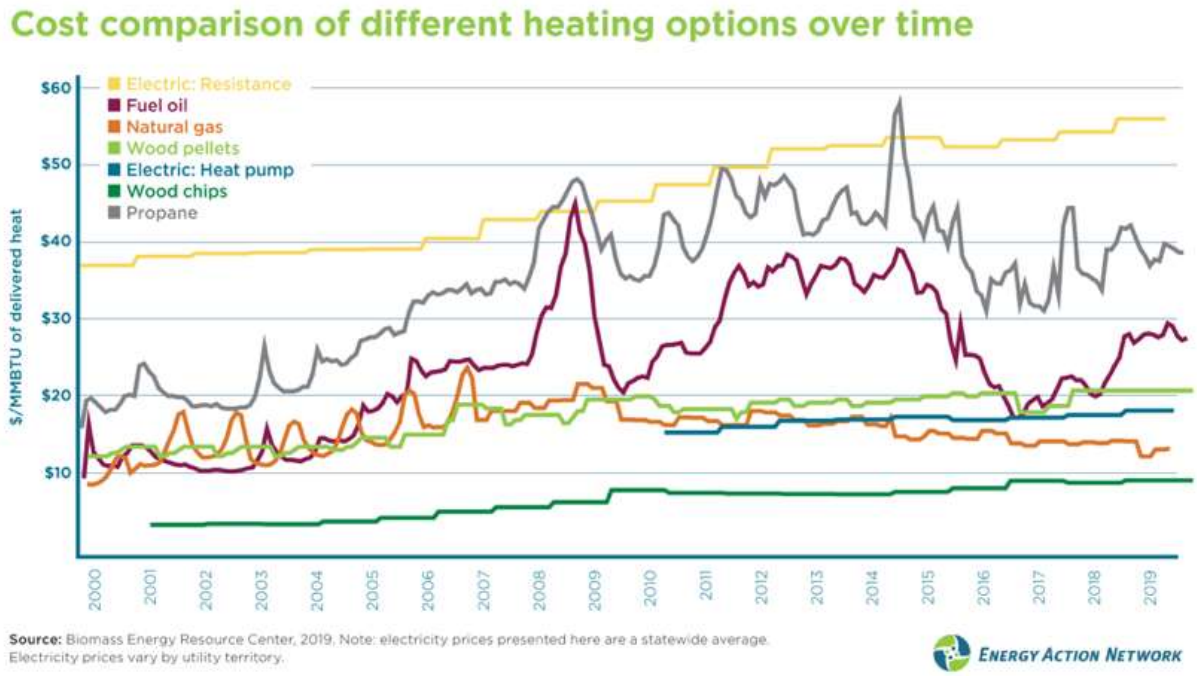
After transportation, the second largest source of per capita GHG emissions in Vermont comes from fossil fueled heating systems. 72% of Vermont's heating energy sources come from fossil fuel (primarily fuel oil, natural gas, and propane).[280] On average, of the 13.8 tons of GHG

[280] Page 22, https://www.eanvt.org/tracking-progress/annual-progress-report/2021-annual-progress-report/

pollution that individual Vermonters emit per capita, per year, over 4 tons per year come from fossil-fueled heating (including space and water heating).

The most effective ways for individual Vermonters to reduce their emissions from heating (often while saving money and improving health[281]) include:

- Home weatherization
- When possible, switching from fossil-fuel dependent heating systems to cleaner and more efficient systems, including: heat pumps, advanced wood heating options, and/or B-100 biodiesel.
- Note: while not as high impact as the options listed above, it is also beneficial to, when possible, use smart thermostats (also known as programmable or set-back thermostats) to lower temperatures when the home or building is empty, thereby lowering heating costs without sacrificing comfort.



- Note: Net savings or costs related to heating changes vary considerably based on a number of variables, including what the prior heating source(s) was and what the new source(s) becomes. Generally speaking, the greatest cost-savings will be available to homeowners and renters who are able to move away from heating with old resistance electric systems, propane, and/or fuel oil, especially when moving toward efficiently used heat pumps in electric territories with lower rates, and/or heating with efficient pellet and wood stoves. In contrast, moving from natural gas (historically the lowest cost and most price stable fossil heating option for Vermont consumers) to an electric or renewable alternative could increase heating costs.

Resources:

281

For example, on the health benefits of weatherization: https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_CH_WxHealth.pdf

- Vermont Energy Saver website: https://energysaver.vermont.gov/
- A Vermonter's Guide to Residential Clean Heating and Cooling[282]
- Vermont Home Energy Profile: https://www.clearlyenergy.com/vermont
- Efficiency Vermont: https://www.efficiencyvermont.com/services

C. Refrigerants and Consumption-Based Emissions

While vehicles, heating systems, and other equipment purchases are usually the single most consequential climate-related decisions that most individual Vermont consumers make, such purchases are infrequent, sometimes only happening once every decade or more. And it is not just the time of purchase that matters: when and how these pieces of equipment are disposed of also matters. Specifically, it is very important to dispose of any items containing refrigerant (refrigerators, freezers, air conditioners, vehicles, heat pumps, etc.) correctly, as they contain very potent greenhouse gases.[283]

Other more frequent consumer decisions and actions, while less significant on their own, can add up over time to make a difference as well. Climate-conscious purchasing decisions can include trying to be aware of and taking into account the "carbon footprint" of consumer products and choosing climate friendly options (to the degree information is available); purchasing goods locally when possible; minimizing purchases of carbon-intensive products; and following the timeless wisdom of "reduce, reuse, recycle".[284] It is important to note that many of the "upstream" or "lifecycle" emissions related to Vermonters' consumption do not show up in Vermont's Greenhouse Gas Emissions Inventory, because such emissions often occur in other states or countries. However, regardless of location, if our demand for and consumption of such products and services is leading to emissions, we can be at least partially understood to be responsible for them.[285]

Resources:

Carbon Footprint Calculator: https://coolclimate.org/calculator

Cross-cutting Themes

Throughout the development of the Climate Action Plan, several themes were identified which do not have an immediate impact on reducing emissions, resilience to climate impacts, and sequestering carbon, but are nonetheless foundational in supporting the implementation and efficacy of the actions that are being recommended in this plan. This section highlights those cross-cutting themes that the Council recognizes are foundational to the work of climate action, but given the timeline to develop this Climate Action Plan, need additional discussion and work

[282] https://publicservice.vermont.gov/sites/dps/files/documents/A%20Vermonter%27s%20Guide%20to%20Residential%20Clean%20Heating%20and%20Cooling%20%282021%29.pdf

[283] For proper safe and proper disposal of equipment containing refrigerant, see: https://www.efficiencyvermont.com/news-blog/news/no-cost-curbside-appliance-recycling-helps-free-up-space-bring-in-cash and https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/SWRule.final_.pdf

[284] See: https://www.pbs.org/newshour/science/5-charts-show-how-your-household-drives-up-global-greenhouse-gas-emissions

[285] For more on the difference between in-boundary emissions vs. consumption-based emissions, see Appendix … (EFG paper on the GHG Inventory and Supplemental Analysis).

from the Council to ensure recommendations support the full scope of actions included in this plan.

A limited suite of actions are outlined below relevant to three of the five themes. Those actions were developed in subcommittee discussions and were identified as relating to the broader cross-cutting bodies of work that are needed to enable transformative climate action. The themes of State Government, Community, and Partner Capacity; and identification and consideration of the tradeoffs associated with choices, do not identify specific actions, but rather speak to the broader themes that are referenced in many actions throughout this plan. As noted earlier in this section, further work will be needed after the adoption of this initial Climate Action Plan to ensure the scope of the themes below capture the importance of these recommendations in supporting and enabling climate solutions.

Environmental Justice Policy

Environmental justice is the equitable access to environmental benefits, proportionate distribution of environmental burdens, fair and equitable treatment and meaningful involvement in decision making, and recognition of the unique needs of people of all racial and ethnic groups, cultures, socioeconomic statuses, and national origins. It works to redress structural and institutional racism, colonialism, and other systems of oppression and harm done to Black, Indigenous and People of Color (BIPOC) and other communities and ecosystems that have experienced marginalization and degradation. Environmental Justice (EJ) also seeks to address insufficient governmental responses at the local, state, and federal level to environmental crises due to the racial/ethnic demographics, national origin, or socioeconomic status of highly-impacted communities.

Unlike many states, Vermont does not yet have its own Environmental Justice policy. This is a glaring omission in state policy that has been recognized by the U.S. Environmental Protection Agency and Vermont Department of Environmental Conservation. Lack of a clear state EJ policy results in a piece-meal, radically insufficient approach to understanding and addressing – with clear definitions, metrics and essential procedural and language-access strategies – environmental justice. It also potentially puts Vermont at a distinct disadvantage, likely limiting the state's ability to access federal transportation funds and potentially other federal funding sources.

Vermont must take a comprehensive approach to supporting efforts within communities across the state to alleviate environmental burdens and enhance environmental benefits while sharing responsibility for that work in a just and transparent way. Issues of poor water and indoor air quality, energy cost burdens, lack of transportation, food insecurity, vulnerability to natural disasters, and associated health risks disproportionately affect low-income and BIPOC populations in the state.

The Just Transitions Subcommittee developed the *Guiding Principles for a Just Transition,* which were used to evaluate and prioritize the recommendations presented in this Climate Action Plan. Additional detail on the Guiding Principles and their creation can be found in section 7 – Building Equity into the CAP. The Guiding Principles will continue to be used to guide and evaluate the work of the Climate Council, but the Council recognized that additional work is needed to ensure that environmental justice is incorporated into state policy and program development and evaluation.

The state needs a comprehensive policy for identifying and addressing these disproportionate impacts. That is why the Vermont Climate Council supports the adoption of a statewide Environmental Justice policy to be incorporated into the work of agencies and departments across state government. Such a policy should support the delivery of environmental benefits to disproportionately burdened communities in the form of access to clean air and water, affordable clean energy and transportation options, healthy food, climate resilience, and local green jobs. An EJ policy is important to pursue and should also be approached as an iterative process that centers the needs of most impacted communities and offers real, community-based solutions to environmental problems.

Workforce Development

From 2019-2020, clean energy jobs[286] grew by 0.1 percent, which is just under the overall statewide employment growth rate of 0.2 percent over the same time frame. Like Vermont's overall statewide labor market, the growth in clean energy jobs has remained steady over the past three years.[287] While clean energy jobs account for only some of the sectors referenced in the Climate Action Plan, this stagnant trend reflects the broader need for additional funding, support, and training to grow the workforce that is needed to implement the climate change solutions identified in the Climate Action Plan.

Throughout the Climate Action Plan, actions identify the need for training and resources for workforce development in sectors that cross GHG mitigation, climate adaptation, resilience, and carbon sequestration work. While actions focused on workforce development cannot be tied directly to measurable GHG emissions, they are nonetheless important to supporting climate change solutions and as such, have been identified as a cross-cutting theme in Vermont's Climate Action Plan.

The Climate Council recognizes the importance of workforce development and acknowledges the need to further expand upon recommendations in this Plan. The actions listed below are those directly related to workforce development and represent the areas where the Climate Council has specifically identified the need for additional workforce development programs. As this Plan is further refined and implemented, a greater emphasis will be placed on the study and implementation of workforce development programs, to include a focus on programs that support historically marginalized communities. Programs will support sectors both impacted by the implementation of climate change policies, and sectors focused on GHG mitigation, climate adaptation and resilience, and carbon sequestration, to ensure current and future generations are equipped to deal with climate change.

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[286] A clean energy job is defined as any worker that is directly involved with the research, development, production, manufacture, distribution, sales, implementation, installation, or repair of components, goods, or services related to the following sectors: Renewable Energy Generation; Clean Grid and Storage; Energy Efficiency; Clean Fuels; and Clean Transportation. These jobs also include supporting services such as consulting, finance, tax, and legal services related to energy. https://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/CEDF/Reports/2020%20VCEIR%20Final.pdf

[287] https://publicservice.vermont.gov/sites/dps/files/documents/Renewable_Energy/CEDF/Reports/2020%20VCEIR%20Final.pdf

Actions

Strategy: Support workforce development in trades and skills that are needed to implement the climate action plan.

- Provide workforce training and professional development to cultivate expertise in resilient and energy efficient building practices.
- Create an apprentice program to support more Vermont-based builders with expertise in resilient and energy efficient building practices.
- Appoint a member of the administration to be responsible for coordinating executive agency weatherization workforce development efforts to: ensure the scaling up of workforce necessary to achieve the GWSA targets; to increase coordination among the wide variety of public and private entities involved in worker recruitment, training, placement, and retention, and to avoid duplication of efforts across state government.

Strategy: Promote workforce development in all working lands sectors, along all points of the supply chain

- Develop, endorse, and implement fair trade and equitable labor practices and just livelihoods for the natural and working lands sector.
- Better resource state programs to support landowners' personal and professional development, and where needed, develop additional affordable and accessible training programs such as apprenticeships, certificates, stackable credentials, and concurrent degrees. Provide training to natural land managers in securing, retaining and supporting employees.
    - The state should identify simple, low- and no-cost mechanisms to increase organics diversion and provide incentives and business and workforce development to private organics haulers and composters (including farms). Act 41 of 2021 created an Agricultural Residuals Management Program to be administered by VAAFM. The purpose of this new chapter of law is to establish a program for the management of residual wastes generated, imported to, or managed on a farm for farming in Vermont.

Strategy: Address biomass for thermal heat regarding climate mitigation, co-benefits, and its impacts

- If such facilities operations cannot be sufficiently improved to address their negative footprint on adjacent neighborhoods and communities and ensure that they are producing net GHG emission reductions, then such facilities should be closed and sufficient training for employees to transition to forestry and renewable energy jobs should be provided.

State Government, Community, and Partner Capacity

Many actions throughout this Climate Action Plan identify the need for new programs and policies without explicitly calling out how those new requirements would impact the existing capacity of the organizations that would support those efforts. Achieving our emissions requirements and adaptation, resilience, and sequestration targets in a way that is equitable, affordable, cost effective, and sustainable will require that we to pursue every available opportunity to dramatically reduce greenhouse gas emissions. The challenge is immense, and the Council acknowledges that the existing capacity of state government and partner organizations

such as the Community Action Agencies, Regional Planning Commissions, smaller stakeholder groups, etc. will need to be adequately resourced to tackle the challenge.

The steps and action needed to implement this plan and to impact climate action will take significant work and coordination across state agencies, private and non-profit partners, municipalities, and impacted communities. To that end, the Council recommends the following actions:

1. Invest in and expand state government and community partner capacity (e.g. Regional Planning Commissions, Community Action Agencies, etc.) to support necessary integrated climate action planning and implementation.
2. Create a mechanism, position or body within the Executive Branch to ensure coordinated climate action across state government with just transitions and environmental justice expertise. This interagency body or mechanism is intended to connect actions both within and beyond the scope of the GWSA-required Climate Action Plan, with a goal of ensuring effective communication across agencies that work together to promote climate change mitigation/adaptation/resilience, and adding a consistent climate lens to the myriad of regulatory and funding programs.

As this Plan is implemented, implementers should ensure that the existing capacity of organizations to take on actions identified within this Plan is considered when policies and programs are developed. In addition, the Council has identified the need to further build out the recommendations around state government, community, and partner capacity, to ensure careful thought is put into how, and at what level, actions are assigned and implemented.

Building Codes

Throughout the Climate Action Plan, recommendations regarding building codes and standards can be found in GHG mitigation and climate adaptation and resilience sections, highlighting building codes as a cross cutting theme in this Climate Action Plan. Whether it be for energy efficiency, ability to handle increased electrification demands, renewable energy siting, or for increased resilience to the impacts of climate change, building codes and standards stand out as an important tool to address climate change.

Outside of larger municipalities, many Vermont towns do not have buildings codes, or lack the ability to enforce them. The actions listed below reflect the initial recommendations from the Climate Council regarding building codes and standards. The Council however acknowledges that additional work will need to be done to develop a set of recommendation regarding building codes that wholistically recognize the importance of codes and standards to impact emissions reduction and resilience to climate change impacts.

Actions

- Regularly update the statewide residential building energy code, resulting in achieving a net zero building energy code by 2030.
- Develop and fund a state-level Energy Code Circuit Rider initiative that provides code training and enforcement assistance to municipalities throughout Vermont to ensure awareness of and compliance with existing and future building energy codes.

- Audit existing residential building codes to ensure that standards account for anticipated climate change impacts to Vermont, including but not limited to increased temperatures extremes and precipitation.
- Develop sample building standards for resilient design and construction.
- Revise state building energy codes and standards to require a minimum 200 Amp service for new construction as electrification expands.
- Incentivize or mandate solar and wind capacity on new buildings as well as in previously disturbed/developed areas and avoid and minimize forest clearing for renewables through incentives and other siting polices, rules, and regulations.
- Authorize the adoption of efficiency standards for rental properties, beginning with expanding the definition of "fit for human habitation" in 9 V.S.A. § 4457(a) by developing and passing legislation requiring owners of [a TBD minimum number of units] of rental housing to ensure that the efficiency of their rental units meets minimum standards [TBD efficiency code level] by December 31, 2030.

Benefits and Burdens of Energy Choices

One theme that emerged consistently across subcommittees when considering pathways to mitigate GHG emissions, or find ways to adapt to our changing climate, is the need to identify and consider the trade offs associated with any choice we make. For example, in the consideration of transportation, changing from fossil-fuel based internal combustion engines to battery electric vehicles will significantly cut GHG emissions in a key polluting sector in Vermont, and will help reduce overall dependence upon the polluting fossil fuel industry. However, rare earth mining necessary for battery technology also has ecological, economic, and cultural impacts in the areas where these resources exist. Those same minerals are necessary for both residential- and grid-scale batteries that could help store solar and wind power for times when needed.

Meanwhile, solar PV is free of GHG emissions at the point of generation and has the ability to reduce our reliance on fossil fuels for electricity generation regionally and create greater resilience locally, but requires the use of several industrial materials and rare earth minerals to create the panels far from Vermont. Hydroelectric power, particularly large reservoir systems such as deployed by HydroQuebec, is created by damming rivers and flooding forestland that also can displace Indigenous people and harm their cultural resources; yet it produces abundance baseload power at times that the sun does not shine and the wind does not blow. Its output is, over the long run after accounting for forest loss and emissions from the biomass flooded by the dams, GHG-free and is significantly less polluting that fossil fuel sources even in the shorter term. Nuclear power creates GHG-free electricity in abundance but has significant impacts associated with spent radioactive fuels and enhanced safety risks from operations. Biomass, wind turbines, and lower-carbon fuels like biofuels and natural gas — all have impacts associated with their extraction, processing and use that must be weighed against the GHG emissions of the alternatives that otherwise would be utilized.

More examples were raised throughout our process for creating this Climate Action Plan; indeed, every choice has potential benefits and burdens, including their effects on frontline individuals and communities. Overall, our purpose in crafting this initial plan has been to address the overriding, existential problem confronting us now: global GHG emissions must decline, rapidly and permanently, if we are to avoid the worst effects of climate change and maintain a livable

planet for future generations. The speed with which Vermont and the rest of the world must transform calls for us to utilize existing technology wherever possible. That is why throughout this Climate Action Plan we recommend transformation away from fossil fuel sources of energy, while recognizing that there are burdens and impacts associated with these choices that should be recognized. While these impacts should also be mitigated where feasible, the imperative of reducing GHG emissions must be paramount.

Climate Action Plan Implementation

Implementing Vermont's Climate Action Plan

The adoption of an initial Climate Action Plan (CAP) is a critical step in ensuring Vermont meets the requirements of the Global Warming Solutions Act (GWSA), setting the stage for immediate action. Implementing the plan will require government leaders to move with urgency to achieve its outcomes. Significant resources will be needed do this, as will continued engagement with Vermonters and transparent metrics to ensure accountability and communicate where progress is occurring, and where more work is needed. While significant investments are needed in the coming years, the successful implementation of this plan, and future iterations thereof, will help ensure a vibrant and resilient Vermont for future generations.

The objectives put forward in this plan will require the investment of significant public dollars. But investments and market forces will not necessarily create a just and equitable transition to a decarbonized economy without concrete actions to ensure a Just Transition. Equity must be at the center of how the State implements this plan, including a focus on strategies that consider the disproportionate impact of climate change on rural, low income, and marginalized communities. Programs and incentives for building resilience must be designed to be accessible to all Vermonters and to not unfairly burden any groups, communities, geographic locations, or economic sectors.

This plan seeks to provide a roadmap for actions that will meet the state's greenhouse gas reduction requirements and resilience goals. For this plan to be successful, however, the support and engagement of Vermonters is critical — to mobilize a broad coalition of state, local, and regional governments, nonprofits, academic institutions, and private interests taking collaborative, decisive action. Significant and sustained investments, well-financed programs, properly capitalized lending entities and individual financial commitments will all be needed to implement the Climate Action Plan and realize important outcomes like the weatherization of Vermont's current housing stock and the development of new, energy-efficient housing that helps the state address its housing shortage; resilient natural and working lands to provide natural climate solutions and a myriad of co-benefits such as supporting our recreational economy; transportation infrastructure resilient to more frequent, intense storms; and enhanced incentive programs that make cleaner vehicles and heat switching within reach of everyone.

No single funding stream will achieve our climate goals. Climate action requires leveraging a variety of sources — existing and new, private and public, local, state, and federal — and innovative financing mechanisms to support sector-level transformations and the ability of Vermont lenders to make crucial long-term investments in climate-focused projects and initiatives. Further, the unprecedented federal recovery funding for the COVID-19 pandemic, coupled with the recent passage of the Infrastructure Investment and Jobs Act, gives Vermont an opportunity to move quickly to accelerate implementation and to do so equitably.

Moving from Policies to Program Design

A critical next step for the Council will be to develop a robust understanding of the long-term funding needs and financing options for climate action. The actions put forward in this plan are

at varying stages of development, with many of them requiring specific program design and further work to understand the financial opportunities and costs prior to implementation. The legislature will play a critical role as it takes up actions, but the Council and its subcommittees will also need to transition to organize to develop a framework needed to further refine actions and ready them for implementation and consider funding options. This will mean aligning the Council's budget and resources, including Councilors, subcommittees and staff to advance priority actions.

Further Economic Analyses for High-Priority Actions

The purpose of the economic impact analysis completed for this initial Climate Action Plan (CAP) was to inform the Council on the macroeconomic impacts of the transitions identified as necessary to comply with the Global Warming Solutions Act (GWSA). These impacts include changes in employment, labor income, value-added activities, and outputs compared to Vermont's baseline. This analysis considers the aggregate economic impact over the full period of implementation, including both capital and on-going operational costs (and savings), and was not intended to consider point-in-time costs that would potentially be borne by individual Vermonters and/or businesses to support implementation. The modeling did compare pathways and made observations on the strongest drivers of economic impacts and areas where impacts may be improved through future policies. With the current modeling, sub-state level economic analysis examining two regions within Vermont is possible if data are available at that granularity. This was discussed with the technical consultants, and all agreed to reserve this as a potential follow-up task at this time.

With the creation of its first CAP, the Council is endeavoring to articulate both *what* Vermont must do to reduce emissions and increase resiliency and equity, as well as *how* to do it. The former task identifies the transformations needed to achieve emissions reductions and is the focus of the LEAP analysis and economic modeling described in Section 11. The latter is concerned with the mechanisms available to achieve desired policies, which requires analysis beyond economic impact modeling. This analysis includes assessment of costs, co-benefits, market readiness, etc. Now that the Council has finalized actions for prioritized pathways, the Council will further consider options for follow-on research and analysis which will be necessary to address specific policy-related questions.

Recommendations for American Rescue Plan Act Funds

With the passage of the American Rescue Plan Act (ARPA), which includes a $2.7 billion package of aid for Vermont, Vermont has an unprecedented opportunity to strengthen our economy and communities through significant investments in one-time ARPA dollars. More than half of these dollars are directly appropriated to federal agencies, individuals, local governments, education institutions, and others. Leaving approximately $1 billion for the state to expend over the next four years.

The Climate Action Plan includes projects that are well-suited to ARPA funding and important to meeting the requirements of the Global Warming Solutions Act. Recognizing this opportunity, the Governor and Legislature have committed up to $200 million dollars for implementation of the Climate Action Plan. This is in addition to the ARPA dollars that have already gone to support initiatives such as fuel-switching, and the hazard mitigation buyout program. To recommend how this funding is directed to the Governor and Legislature, the Council first

needed to adopt this plan and set priorities. The Council will convene in December to prepare an addendum to this plan with its recommendations for ARPA funding. Working together with the Governor and Legislature to direct these funds, will ensure a successful first step to committing to the priorities put forward within and ensuring Vermont is making the necessary investments to ensure a resilient future.

Future consideration will also need to be given to funding coming to Vermont from the Infrastructure Investment and Jobs Act, a once-in-a-generation investment in our nation's infrastructure and competitiveness. This funding is focused on rebuilding America's roads, bridges and rails, expanding access to clean drinking water, ensuring every American has access to high-speed internet, tackling the climate crisis, advancing environmental justice, and investing in communities that have too often been left behind. As these funds align with the Climate Action Plan recommendations, prioritization of these funds will be critical to further advancing the recommendations included here.

Just Transition, Public Engagement and Equity Considerations in Implementation

The Just Transitions Guiding Principles adopted by the Vermont Climate Council provide a framework for climate action to be utilized during the continued development and ongoing implementation of the Climate Action Plan. These principles set expectations for the Climate Council and its sub committees to conduct their work, what recommendations they make and how investments, implementation and oversight of the plan must occur. The Guiding Principles have helped to shape the beginning of a process of community engagement, co-creation, and the prioritization of recommendations that speak to issues of equity and justice. The Climate Council has taken some important first steps. However, the Council and Just Transitions Subcommittee have also heard significant frustration around the timeline which has prevented adequate and inclusive engagement. Time and resource constraints have prevented a robust equity analysis and public engagement process. Both are essential to move away from a status quo that exacerbates inequities and places impacted communities at greater risk from climate change. Historically, impacted, and frontline communities have been marginalized by insufficient governmental responses to environmental crises at the local, state and federal levels. Procedural equity requires that impacted communities have the opportunity to provide input and support development of the climate policies that directly affect them, and policy makers have the opportunity to collaborate with communities so that Vermont's climate solutions meet community needs.

It is essential for just transitions principles to be promoted in the development of legislation, the development of budgets and appropriations, the development and implementation of rules, regulations, and programs, and the evaluation of the execution thereof. For these reasons, it is crucial for the next steps of the Climate Council, the legislature, and the executive branch to consider the following:

Expand Public Engagement

- Provide adequate funding and staffing resources for the Climate Council, the legislature, and agencies responsible for taking action to adopt more inclusive and innovative engagement strategies.

- Present key materials in plain and accessible language, including translation into multiple languages during ongoing planning and implementation efforts, particularly outreach materials intended for a public audience.
- Provide transparent information and opportunities to engage in many ways and via various media to create a more inclusive process. Specifically, ensure materials and resources are easy to navigate and provide a clear path and timeline for engagement.
- Create opportunities for engagement that empowers impacted communities and is ongoing, allowing for dialogue over time, rather than one-time or one way communication. Direct and inclusive engagement is different from traditional marketing or public hearing processes. Engagement is meant to be collaborative with a goal of co-creation, which requires meeting people in their communities and using trusted organizations and community members to facilitate outreach.
- Create opportunities to hear from Vermonter's during all processes created by the Global Warming Solutions Act, including: all future generations of the Climate Action Plan, throughout legislative and rulemaking processes, during implementation, and so on.
- Coordinate public engagement efforts related to climate actions. The Climate Council's public engagement plan calls for supporting and working through and with trusted community organizations to reach impacted communities. This essential strategy is critical to reaching impacted communities and requires coordination and support. The Climate Council is well-poised to support coordination.

Commit to Ongoing Use of the Guiding Principles

- Use the Guiding Principles, assessment questions and rubric during the legislative, rule-making, and ongoing implementation and monitoring and assessment efforts. The Climate Council has adopted the Guiding Principles and should play a lead role in supporting their ongoing use by all relevant stakeholders.
- Provide training to support the ongoing use of the Guiding Principles by the Climate Council, the legislature, and the executive branch.
- Encourage incorporation of the Guiding Principles Assessment Questions into the Equity Impact Assessment (EIA) tool currently used by the executive branch for evaluating budget needs, new program development and policy recommendations. This will enhance and broaden the EIA, as well as add consistency to ongoing climate efforts.
- Encourage the Legislature and Joint Fiscal Office to use the Guiding Principles in its work, specifically the role that the assessment questions and rubric could play in priority setting and policy and budget development. Budgets are the ultimate policy statement and just transitions must be elevated among the GWSA's implementation priorities.
- Encourage the Legislature to include strategies to mitigate burdens and maximize benefits for impacted communities in climate-related legislation, which could include establishing a minimum percentage of climate action investments for impacted communities.
- Ensure that future Legislative deadlines consider procedural equity and allow adequate time and resources to support the necessary public engagement.

Remain Accountable to Achieving a Just Transition

- All climate action strategies and actions should include metrics to measure equity impact. The Climate Council will play an ongoing role in monitoring and tracking progress and results during implementation and future planning. Metrics related to equity impact should be part of regular, ongoing reporting and will help the Climate Council understand whether Vermont is achieving its goals related to a just transition.
- Keep impacted communities informed of results and changes through deliberate and focused communication with organizations directly involved with rural, marginalized and frontline communities, as the Council assesses the equity impact of climate actions; providing materials to be shared with members.
- Implement a monitoring and assessment approach that brings together and presents data in meaningful ways that both holds provides accountability and communicates the impact and implementation status of the GWSA with all communities. Consider a dashboard that shares progress, captures data and depicts implementation gaps.
- Conduct a regular review of progress and issue a Just Transitions progress report every two years. A report is an important tool for accountability and offers an opportunity to share strategies and establish best practices in reaching Vermont's climate equity goals.

Legislative Action and Rule Making

Legislative Action and Rule Making for Emissions Reductions.

The implementation of the Climate Action Plan (CAP) will require the legislature to advance significant legislation and funding to support the actions. The Global Warming Solutions Act (GWSA) also requires that the Secretary of the Agency of Natural Resources adopt rules consistent with the Climate Action Plan, as adopted, on or before December 1, 2022. The following is a collective suite of actions which will require legislative action or rulemaking to achieve the GWSA requirements for curbing greenhouse gas emissions. These are all considered by the Council to be a high priority for immediate action. Other high priority actions not related to emissions reductions, are contained within the plan but not shown here.

Sector	**Action**	**Need Legislative Action**	**Ready for Rule/ Order[288]**	**Notes**
Transportation	CARB Advanced Clean Cars II (ANR, pursuant to 10 V.S.A. 567 and 558)		Yes	
Transportation	CARB Advanced Clean Trucks, Low NOx Omnibus, and Phase II GHG for Truck Trailers Rule (ANR, pursuant to 10 V.S.A. 567 and 558)		Yes	
Transportation	TCI-P Model Rule (ANR, pursuant to 10 V.S.A. 558)		Yes	

[288] The Public Utilities Commission should be allowed to determine whether or not to implement policies via rule or order.

Transportation	Authorize and direct VTrans to evaluate and expand the EV Purchase Incentive program, Mileage Smart program and Replace Your Ride program (Transportation Bill)	Yes		
Transportation	Authorize and direct VTrans/DMV/Dept of Taxes to implement vehicle efficiency price adjustment (DMV Misc. Bill or other)	Yes		
Transportation	Authorize and direct Interagency EVSE Working Group to implement EVSE Deployment Plan (Transportation Bill or other)	Yes		
Transportation	Direct the PUC to initiate a proceeding to develop EV charging rates with a goal of incentivizing EV adoption	Yes		
Transportation	Authorize and direct an interagency committee including, but not limited to, ANR, VTrans and PSD to receive and allocate TCI-P revenue informed by the Equity Advisory Board	Yes		
Transportation	Authorize and direct AOE and ANR to implement an electric and high efficiency transportation unit in existing education and awareness programs	Yes		
Transportation	Authorize and direct VTrans, in consultation with ANR, to implement a MHD vehicle purchase incentive program and an electric auxiliary system incentive program	Yes		
Transportation	Authorize and direct VTrans to develop and adopt a State Sustainable Transportation Plan (Transportation Bill)	Yes		
Transportation	Appropriate eligible ARPA dollars, Infrastructure Investment & Jobs Act (IIJA)	Yes		

	federal infrastructure dollars, potential Build Back Better Act federal funds, other eligible federal funds, and corresponding state match funds to implement allowed investments in transportation infrastructure and other projects that align with the actions within the Transportation Sector Pathways of the CAP			
Buildings/ Thermal	Adopt legislative or administrative recommendations consistent with those set out by the Weatherization at Scale Working Group (WWG) with the goal of weatherizing 90,000 additional homes by 2030	Yes		
Buildings/ Thermal	Authorize implementation of a plan for coordinating and enhancing energy and financial coaching services for Vermonters with low and moderate incomes	Yes		This will be an element of Weatherization Working Group recommendations.
Buildings/ Thermal	Authorize electric and gas utilities to offer their customers on-bill financing tariffs	Yes		
Buildings/ Thermal	Authorize the adoption of efficiency standards for rental properties, beginning with expanding the definition of "fit for human habitation" in 9 V.S.A. § 4457(a) by developing and passing legislation requiring owners of [a TBD minimum number of units] of rental housing to ensure that the efficiency of their rental units meets minimum standards [TBD efficiency code level] by December 31, 2030	Yes		
Buildings/ Thermal	Regularly update the statewide residential building energy code, resulting in achieving a Zero Energy Ready building energy code by 2030.	Yes		PSD regularly updates RBEC; legislation indicated to require ZER

Buildings/ Thermal	Develop and fund a state-level Energy Code Circuit Rider initiative	Yes		
Buildings/ Thermal	Adopt legislation authorizing the Public Utilities Commission to administer a Clean Heat Standard	Yes		
Buildings/ Thermal	With neighboring states, require electric water heaters for sale to have a modular demand response communications port	Yes		
Non-energy	Limit greenhouse gas process emissions from the manufacturing of semiconductors (10 V.S.A. §558)		Yes	Note that this rulemaking may not be required if these reductions are achieved through a Public Utilities Commission order or a Certificate of Public Good requiring GHG emissions reductions from Global Foundries that align with proportional emissions reductions necessary to achieve the requirements in the GWSA.
Non-energy	Appropriate funds to ANR (or another entity) to implement an incentive program to fund cost sharing for the installation of permanent leak detection systems for facilities using over a certain threshold of high GWP refrigerants.	Yes		
Non-energy	Appropriate funds to ANR (or another entity) to incentivize businesses to transition from high GWP refrigerants to lower GWP alternatives.	Yes		

Technical Analyses Next Steps

An immediate next step for the Council after December 1 will be to prioritize further technical analyses needed to advance climate action and future iterations of the Climate Action Plan (CAP). Significant technical analyses and modeling efforts been completed to inform the recommendations in this plan, but many of the recommendations need additional, more detailed evaluation to inform program design. Future analyses will also need to be coordinated with related work being done by agencies, to ensure a consistent approach to climate action in state policies and programs. Examples include the Comprehensive Energy Plan led by the Department of Public Service and the Payment for Ecosystem Services working group led by the Agency of Agriculture and Food Markets.

With the Plan adopted, the Joint Fiscal Office of the Vermont General Assembly (JFO) is required "…to prepare an analysis of the economic, budgetary and fiscal costs and benefits of the Plan." As the need for further economic modeling is highlighted in the CAP, coordinating with JFO will be important to ensure any work advanced through the GWSA is complimentary and additive to JFO's analysis. Also required in the GWSA is the development of a municipal vulnerability indice. This was not completed for this initial CAP and is a priority as the Council advances future work. The main suite of actions highlighting the continued need for technical analyses are summarized in the table below; in general, the analyses identified exceed resources available in the current GWSA appropriation to ANR and will require additional funding to support the work.

Technical Analysis Required	**Section Detailed in CAP**
Advance supplemental accounting and further research and data gathering is also called for supplemental upstream and/or lifecycle accounting of emissions related to the use of energy in Vermont.	(9) Greenhouse Gas Inventory
Developing and issuing a Request for Proposals (RFP) that will review and analyze methodological gaps of emission inventory tools currently used by the State of Vermont to quantify greenhouse gas emissions for evaluating changes in the Agriculture, Forestry and Other Land Use (AFOLU) sector.	(9) Carbon Budget
Establishing a periodic and consistent carbon inventory and forecast for Vermont.	(9) Carbon Budget
Develop a "municipal vulnerability index" to identify those communities that may be most adversely affected by climate change.	(12) Pathways for Adaptation and Building Resilience in Communities and the Built Environment
Hire a consultant to review and assess the state designation programs that recognize and support Vermont's compact settlement areas.	(15) Cross-Cutting Pathways
Hire a consultant to engage stakeholders and support the development of a state Land Use Plan that guides development to growth areas, town centers and appropriate rural locations and limits development within ecologically sensitive / risk-prone areas.	(15) Cross-Cutting Pathways

Fund a study that quantifies the vehicle miles traveled and GHGs for both compact and dispersed areas of development as well as the co-benefits of complect centers.	(15) Cross-Cutting Pathways

Climate Council Next Steps

The Climate Action Plan is the result of more than a year of work that included input from five subcommittees. Adopting an Initial Climate Action Plan is an important milestone, but it is only the first step. The work of the Climate Council is ongoing, and the Council has been clear that this is an initial plan. Climate science and climate action are incredibly complex and multi-faceted with significant potential implications for every aspect of modern life. The timeline made it very challenging to address all the objectives identified in the Global Warming Solutions Act (GWSA) to the level of detail needed to fully weigh and consider what is being proposed, and there are several pathways for further work beyond December 1.

While the legislature and the Agency of Natural Resources will work to advance numerous actions put forward in this plan through legislative action and rulemaking, the Council will work to further advance areas work in several key areas, including but not limited to:

- Funding and financing options, with a specific emphasis on prioritizing recommendations for the expenditure of the American Rescue Plan Act dollars to advance the implementation of this plan.
- Overseeing the rollout of the Climate Action Plan and a comprehensive public engagement strategy.
- Furthering the implementation of the Guiding Principles and the Scoring Rubric in the program design of priority actions.
- Organizing the subcommittees work to focus on next steps to further the resilience, adaptation and sequestration actions prioritized in this plan.
- Prioritizing new technical analyses to inform future iterations of this plan.
- Advancing the measuring and assessing action tool contemplated in this plan.

Given this, we envision a robust and on-going engagement by the Council for the foreseeable future, on behalf of Vermonters, to realize the transformative change needed to meet both the challenges and opportunities of climate change.

Measuring and Assessing Progress

As part of this initial plan, the Council must set forward a framework for assessing progress. Specifically, the Global Warming Solutions Act (GWSA) requires that the state track key components of its climate action, including:

a. The State's greenhouse gas emissions and progress towards meeting reduction requirements;

b. The effectiveness of the initiatives, programs, and strategies set forth in the CAP;

c. The effects of climate change on the State's climate, wildlife, and natural resources; and

d. Progress towards improving existing resiliency of the State's communities, infrastructure, and economy to current and anticipated effects of climate change.

Vermont is fortunate to have a solid foundation to inform this work. Vermont's Energy Action Network (EAN) has long maintained a Vermont Energy Dashboard. EAN's dashboard aggregates efficiency, heat, electricity, and transportation measures implemented at the state and local level in support of Vermont's goal to achieve 90% of its energy needs through increased efficiency and renewable sources by 2050. In addition, the Department of Public Service (DPS), in partnership with EAN and other stakeholders, is in the process of updating its data management infrastructure with the aim of developing a sustainably supported and streamlined process for reporting, managing, and transparent sharing of energy-related data in the state. This process has begun to map data flows in the energy sector with plans for a data infrastructure pilot to be advanced in conjunction with Vermont's Agency of Digital Services. Any database developed in support of the CAP can and should be pursued in conjunction with this effort.

This section seeks to summarize ongoing discussions on how Vermont can track progress on the actions, strategies, and pathways that are intended to drive progress on Vermont's CAP and inform next steps for database development.

Tracking Objectives

As Vermont implements the initial CAP, the State will develop a data infrastructure that can help inform future decision-making on the policies, programs, and initiatives needed to mitigate the impacts of climate change. With regards to the GWSA requirements listed above, it is anticipated that a CAP Monitoring and Evaluation Database (database) should:

- Demonstrate progress on meeting emissions reductions requirements (per Requirement A), which should be achievable in the near-term based on the GHG inventory baseline and existing data sources.

- Demonstrate progress on increasing resiliency (per Requirement D), which will require the development of a resiliency baseline and the collection of new data by which the State can measure impacts on communities, infrastructure, and the economy.

- Provide data with which the State can conduct impact evaluations, as well as performance measures to track outputs and indicators to track outcomes, to ensure compliance with the requirement to evaluate the effectiveness of programs (Requirement

B). The database will not replace program tracking but will help catalyze complete and consistent tracking across multiple initiatives. Performance measures and indicators will include both technical impacts as well as equity of access, participation and impacts.

The database will not be utilized to measure the effects of climate change on the State's climate, wildlife, and natural resources (Requirement C). Instead, the Council recommends this remain under the jurisdiction of the Vermont Climate Assessment. Future discussion on how these two resources should be coordinated is warranted.

Based on these objectives, the four primary goals for the database are the following:

1. **Policy-Decision Support Tool:** Support the State and its partners in making climate policy decisions with best available information.
2. **Sustainable Data Management:** Create a data governance plan, flexibly accommodate future data needs, and coordinate relevant data and reporting across multiple private and public entities.
3. **Open and Accessible Data:** Provide access to key data sources to organizations and members of the public engaged in climate action that wish to utilize Vermont's data to support their work.
4. **Public Education:** Inform the public about progress on achieving GWSA commitments, including emissions reductions, sequestration, adaptation, resilience, and equity.

Policy-Decision Support Tool

The accelerated pace at which Vermont will need to implement the strategies and actions in the CAP is imperative for meeting the reduction requirements in the GWSA. While the State's GHG Inventory provides essential insights into Vermont's GHG emissions over time, the data sources upon which it relies inherently means that there will always be a lag in its production. To support policy-decision makers in implementation of the CAPs, which must be updated every four years, the Council anticipates it is essential that a database provide more close-to real-time data on key implementation metrics than is currently feasible through the Vermont Greenhouse Gas Inventory. This will mean, for example, the database will be structured to accept regular updates on activities from implementing organizations and published with minimal lag. It will be important to have the Database and Inventory remain aligned over time, where applicable and feasible. Where not, it will be essential that the Council and that State articulate the methodological differences that cause any varying results and what insights, if any, policy makers and the public should draw from those variation.

To support the development of policy, the Council recommends that a logic model be used to help clearly articulate the ways in which the data being collected and reported relates to the goals of the CAP and to the performance measures that the State has control over. A logic model requires the mapping of each of action to a desired result and can help identify what else should we be tracking as an indicator of progress toward the requirements of the GWSA. This will require mapping backwards from the outcomes intended from the policies and strategies delineated in the CAP to the key metrics that must be achieved; to the data with which the State can evaluate progress; and finally, to the data which are available (now or in the future) from implementing organizations and state agencies. For example, to track and report on a Clean Heat

Standard, it would be necessary to keep track of the levels of activity across multiple strategies, such as heat pump installations, weatherization and increased consumption of biofuels blends. This would also be supported by select impact evaluations, for example to better understand the energy and emissions impacts and costs from each measure as they are installed and used by customers.

Sustainable Data Management

Sustainable Data Management is a multi-faceted issue that must be addressed during the development of the database. First, a clear plan for data governance will be necessary to define the availability, usability, integrity, and security of the database. The data governance plan should include a governance team, a set of data standards and policies (including data security), a quality assurance process, and implementation procedures.

Second, the database must be designed to flexibly adapt to changes over time. The data needs may shift to support future CAP updates and/or in response to program evaluations. Developing a solution capable of handling these changes is important to recognize at the onset.

Third, it is essential to create an infrastructure for sustained coordination on data sources. The responsibility for implementing the CAP strategies and actions is likely to span Vermont's agencies and include numerous outside parties. The database infrastructure must allow for ease of reporting by responsible parties, with limited additional reporting burden, and should support data managers across Vermont state government to share resources that can and should inform key decisions. This may include a pathway for voluntary data reporting by partners, with the goal of obtaining a more complete understanding of the actions that are supported by the CAP.

Open and Accessible Data

The Council recognizes that while the database cannot be all things to all people, actors across Vermont are going to wish to use the data to inform their own decision making. The Council recommends that while the database be constructed in a manner that primarily supports State policy design, that it also be structured in a manner that ensures the data is open, accessible, and exportable whenever legally permissible. This is intended to ensure that users can utilize this important data set to conduct their own analysis to suit their needs.

Public Education

A final goal of the database is to create a narrative for the public from the numbers. To this end, the Council recommends that the database be built with the long-term goal of data visualization in mind. In particular, it will be important for the database to support the development of key findings and graphics for the first update of the CAP in 2025, including the types of measures that can identify areas where progress is being made and where we are lagging. Furthermore, the database may be useful in tracking metrics that can help identify barriers to changes in individual behavior needed to achieve the goals of the CAP.

Database Development Next Steps

The Council anticipates a series of steps will be necessary to develop the database:

- **Logic model and metric creation**: The database development will begin with mapping the logic models for how Vermont anticipates achieving greenhouse gas reductions, as well as increases in sequestration, resiliency, and equity. As part of these models, the key metrics through which Vermont anticipates driving changes should be clearly identified and linked to the performance measures that the State and its partners have control over.

- **Data mapping**: With these logic models and metrics in place, it will be possible to map the data sources and flows that currently exist, as well as identify gaps in data that will need to be filled. This process should include reviewing work done to date by DPS and EAN to determine the best way to align their efforts with database development efforts. As part of this data mapping process, the Council recommends that key data reporting partners be identified, and the reporting relationship codified between them and the State of Vermont.

- **Data governance**: A data governance plan should be drafted, and a governance team identified, to guide the development of the database. The data architecture, database design, storage, and security are all informed by the data governance plan.

- **Infrastructure recommendation and development**: A database infrastructure will be selected and developed based on the objectives and goals listed above, with both near-term and long-term priorities in mind. To the extent possible, this should create sustainable long-term engagement across state agencies managing data to efficiently aggregate data that already exists, rather than developing new reporting or input requirements for staff or reporting entities and be built with readily available tools, so that it is accessible to a wide variety of users.

- **Testing and iteration**: Once developed, the Council anticipates it will be important to continue iterating on the database to ensure stakeholder feedback improves its usability over time.

Ensuring that Vermont is making swift and steady progress towards action on the GWSA will require that decision-makers across Vermont state government and its CAP partners have access to up-to-date information on the key metrics anticipated to drive change in the CAP. In doing so, the monitoring and evaluation database will support an evaluation of compliance with the requirements of the GWSA. The Council recommends prioritizing this key use case in the near-term, while also ensuring the data is open and accessible to anyone that wants to utilize it and, ultimately, presented in an easily digestible format for the public.

Connect with the Council

On September 17, 2021, the Vermont House voted to pass the Global Warming Solutions Act (GWSA), creating the Vermont Climate Council, an assembly of scientists, industry and sector leaders, state officials, and engaged citizens to develop this Climate Action Plan.

Following the release of this Plan, the Vermont Climate Council will continue to meet regularly to further refine and help support the on-going implementation of this plan. The Council is charged with producing a revised Climate Action Plan at a minimum every four years, going forward.

Pursuant to the GWSA, Climate Council members appointed by the Speaker of the House are appointed for an initial term of two years. Members appointed by the Committee on Committees are appointed to an initial term of three years. Thereafter, each appointed members shall serve a term of three years until earlier resignation or removal. The Council values the importance of having a diverse pool of applicants for future positions on the Climate Council. A diverse set of Councilors with varied professional and personal backgrounds is needed to ensure this and future Climate Action Plans propose climate change solutions that speak to the needs and experiences of all Vermonters. Anyone interested in serving on the Vermont Climate Council is encouraged to reach out to their Legislator to seek appointment to the Council.

The Council invites public comments and questions on the Climate Action Plan and its work to support implementation of the plan moving forward. The Council and subcommittee meetings are always open to the public, and an updated calendar of meetings can be found on the Council's website: climatechange.vermont.gov/getinvolved/calendar/month. The Council also welcomes public comments through the public comment portal found on the Council's website: climatechange.vermont.gov/getinvolved.

The Council looks forward to continuing to work with Vermonters on transformative climate action for this and future generations.

Definitions and Acronyms

1. Act 171
2. Act 250
3. Act 65
4. active restoration
5. Adaptation
6. Adaptation
7. Advanced Clean Cars (ACC)
8. Advanced Clean Trucks (ACT)
9. AFOLU
10. Anaerobic digester
11. ANR
12. ANR
13. AR4, AR5, and AR6
14. Atmospheric lifetime
15. automated wood pellet boilers
16. B100 biodiesel
17. Battery Electric Vehicle
18. bcf
19. beneficial electrification
20. biodiversity
21. biofuels
22. Biogenic greenhouse gases
23. Biomass
24. bioplastic composites
25. BIPOC
26. Burlington Electric Department (BED)
27. CAP
28. CARB
29. Carbon Budget
30. Carbon Flux
31. Carbon sequestration
32. carbon sink
33. Carbon Stock
34. CEAP
35. cellulose insulation
36. Chemical vapor deposition (CVD)
37. CHS
38. Clean Energy Industry Report
39. Clean Heat Standard
40. climate refugia
41. climate resilience
42. climate resilience zones
43. CO2 allowance
44. CO2 equivalent (CO2e)
45. cold climate heat pump

46. CREP
47. Criteria Air Pollutants
48. cross-docking
49. Data Governance Plan
50. DEC
51. demand response
52. Discount rate
53. Distributed Energy Resources
54. EAN
55. EFG
56. Electric vehicle
57. EPA
58. equilibrium condition
59. erosive flooding
60. ESTA
61. ESTA
62. F2P
63. fauna
64. FHARC
65. floodplain storage
66. flora
67. fluvial
68. food hubs
69. food miles
70. forest fragmentation
71. forest parcelization
72. Forest productivity
73. Fossil fuel
74. FPR
75. gleaners
76. Global warming potential (GWP)
77. Green Mountain Power (GMP)
78. Greenhouse gas
79. Gross emissions accounting
80. Gross State Product
81. GWP100
82. GWP20
83. GWSA
84. headwater storage
85. Heat transfer fluids
86. HVAC
87. Hydrofluoric acid (HF)
88. Hydrofluorocarbons (HFCs)
89. inundation flooding
90. IPCC
91. Just Transitions
92. Key Category
93. LEV

94. LGBTQIA
95. Lifecycle accounting
96. Light Duty Vehicle
97. load management strategies
98. Logic model
99. Low NOx Omnibus Rule
100. Matrix forest
101. Medium and Heavy-Duty Vehicle
102. Methane (CH4)
103. Mileage Smart
104. Mitigation
105. MMTCO2e
106. MWh
107. Nature-based Solutions (NbS)
108. NCA5
109. NCEI
110. NCS
111. NEPOOL GIS
112. Net emissions accounting
113. Nitrogen trifluoride (NF3)
114. Nitrous oxide (N2O)
115. Non-Energy Emissions
116. NRCC
117. NRCS
118. NRCS
119. NWL
120. off-peak
121. Ozone depleting substances (ODS) substitutes
122. passive restoration
123. pay-for-practice
124. Perfluorocarbons (PFCs)
125. Performance Indicators
126. Performance Measures
127. PES
128. Phase II GHG Rule
129. Phenological
130. Planform
131. Plug-in Hybrid Electric Vehicle
132. price parity
133. price volatility
134. PSD
135. PUC
136. PUC
137. RAPs
138. REC
139. redlining
140. Renewable
141. renewable energy

142. renewable energy capacity
143. Renewable Energy Standard (RES)
144. renewable natural gas
145. Replace Your Ride
146. Resilience
147. Resilience
148. Riparian
149. RMP
150. RPC
151. RPCs
152. Rural Communities
153. SDSC
154. Seasonal growing degree days
155. Section 177 of the Clean Air Act
156. Sequestration of carbon
157. Short-lived climate pollutant (SLCP)
158. SMU
159. Social Cost of Carbon (SCC)
160. SOV
161. Statewide Conservation and Buyout Program
162. Substitution
163. Sustainability
164. Sulfur hexafluoride (SF6)
165. TA (p26)
166. TCI-P
167. Thermal efficiency
168. TNC (p48)
169. total energy burden
170. Traditional Ecological Knowledge (TEK)
171. Transportation Bill (T-Bill)
172. Union of Concerned Scientists
173. USDA
174. UVA
175. VAAFM
176. VELCO
177. Vermont Climate Assessment
178. Vermont Conservation Design
179. Vermont Energy Dashboard
180. Vermont Greenhouse Gas Emissions Inventory
181. VGS
182. VHCB
183. VMT
184. Weatherization
185. WISPr
186. working lands
187. WWTF
188. ZEV

Attachments

Attachments will be included with the initial CAP adopted on December 1, 2021, if ready, and will be added after December 1, 2021, when ready.