Energy Action Network

ANNUAL PROGRESS REPORT

for VERMONT

2023

on EMISSIONS, ENERGY, EQUITY, and the ECONOMY

Contents

Energy Action Network (EAN) is pleased to present the 2023 Annual Progress Report for Vermont on Emissions, Energy, Equity, and the Economy. EAN produces this report because we believe that **energy and climate conversations should be grounded in and guided by the latest and highest quality data and analysis.** While led by EAN's nonprofit staff, the creation of this report is a collaborative effort that benefits from the work, insight, and generosity of many federal, state, and local data partners, as well as our broad and diverse network of members. Thank you.

On topics as complex and fast-changing as emissions, energy, equity, and the economy, we are always listening, learning, and seeking out new sources of credible information. We strive to work with appropriate humility, including an appreciation for where there are limits to available data and information, while being cognizant of the degree to which uncertainty exists in the data that we do utilize. Please do not hesitate to contact us if you have constructive feedback that could improve future versions of this report.

At EAN, we believe that facts matter — and that policy and program design should be careful, rigorous, and evidence-based. As we do our work together, EAN is committed to following science and to respecting the scientific method.

The March 2023 report from the Intergovernmental Panel on Climate Change (IPCC) provides an important and sobering touchstone. Specifically, **the IPCC report warns of a "rapidly closing window of opportunity to secure a liveable and sustainable future for all,"** while noting that "the choices and actions implemented in this decade will have impacts now and for thousands of years."[1]

Without rapid and deep cuts in climate pollution this decade — reductions that require a decisive move away from fossil fuels immediately — the IPCC warns of increased flooding, crop failures, catastrophic heat waves, and drought, all at levels that will be increasingly difficult for humanity to manage. The Chair of the panel said that "current plans are insufficient" to avoid these ever more destabilizing impacts and that **"we are walking when we should be sprinting."**[2] The catastrophic flooding that hit much of Vermont in July of 2023 further highlights the significant financial and social costs of not heeding these warnings.

In the race to avoid the worst consequences of a destabilized climate, we recognize that Vermont has a responsibility to pick up the pace. This responsibility is affirmed by the legal obligations established in the Global Warming Solutions Act (GWSA) of 2020 and is underscored by the fact that Vermont's per capita emissions are the second highest in New England and far above the global average.

The climate crisis and the need to transform our energy system beyond fossil fuels to become cleaner and more equitable and resilient is one of the greatest challenges and opportunities of this generation. As we engage together in this important collective effort, we offer this report to help inform considered, courageous, and essential action.

1. Intergovernmental Panel on Climate Change, "Synthesis Report of the IPCC Sixth Assessment Report (AR6)", 2023.
2. New York Times, "Climate Change Is Speeding Toward Catastrophe. The Next Decade Is Crucial, U.N. Panel Says", March 20, 2023.

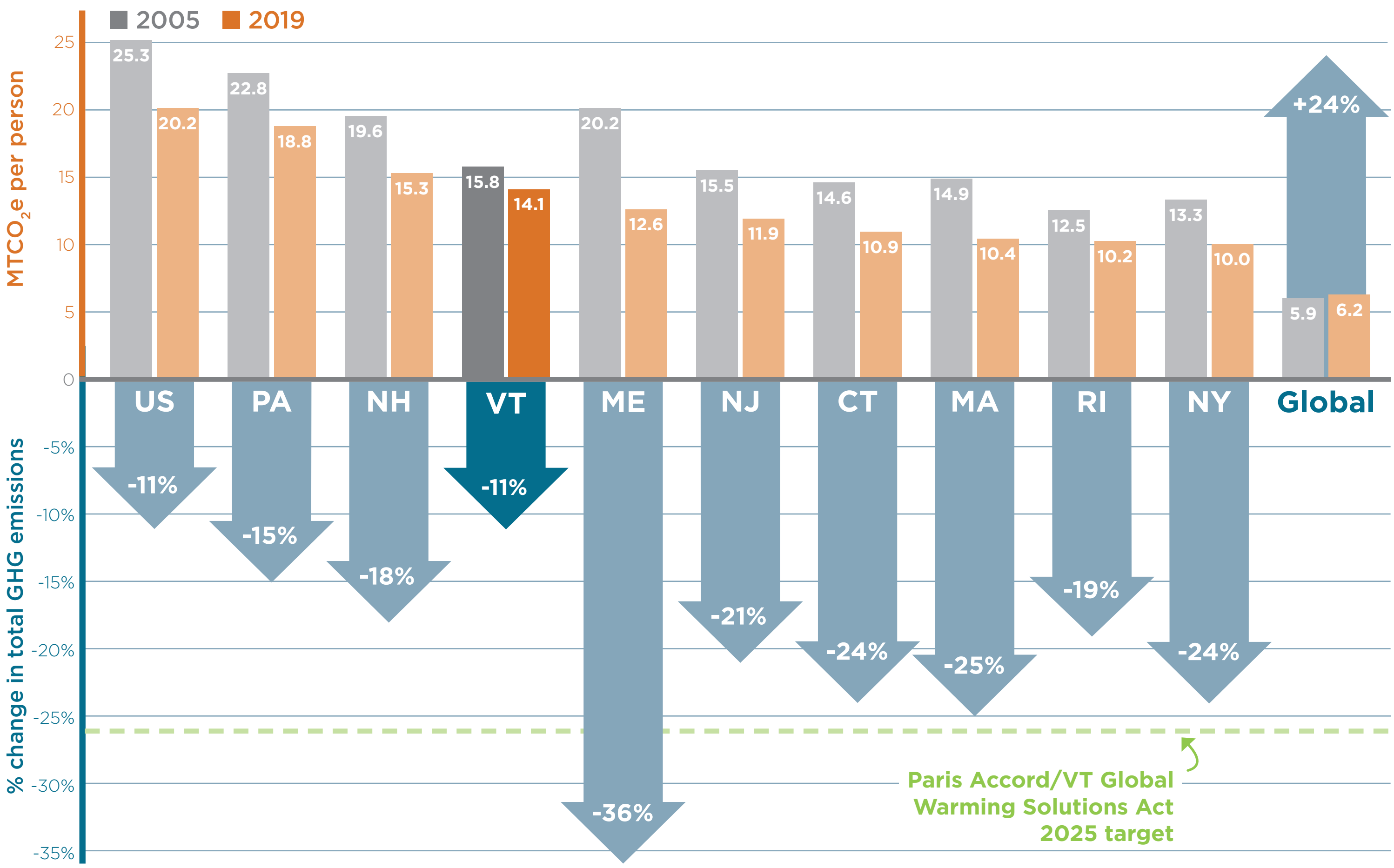
1. Vermont has a responsibility to do our part

Vermont has the second highest per capita greenhouse gas (GHG) emissions in all of New England, behind only New Hampshire. Extending the comparison to the entire Northeast, Vermont's per capita emissions are the 3rd highest, behind only New Hampshire and Pennsylvania.[1]

Looking globally, **Vermont's per capita climate pollution (about 14 tons of carbon dioxide equivalent, or CO_2e) is more than twice as high as the global average**, and significantly higher than from residents of many other countries, including China (9.6 tons CO_2e per person) and India (2.4 tons CO_2e per person).[2] Vermont also has far higher *cumulative historical* per capita emissions than most other places around the world, given that Vermonters have been intensively using fossil fuels for over 150 years.

Vermont has made the least progress toward the Paris Climate Accord targets of any state in the region. That said, each state started from a different baseline, presenting different opportunities for progress. For instance, a significant factor in Maine's emissions decline has been reductions in high-carbon fossil fuel use in their electricity sector. Vermont had less opportunity to achieve reductions in the same way, because our electricity portfolio was much less carbon intensive to begin with. Nevertheless, to meet Vermont's legal obligations and our global responsibility, much more is required of us now and going forward.

Per capita GHG emissions and reductions across the Northeast, 2005–2019



Sources: Vermont ANR, "Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990 - 2020," 2023; Connecticut DEEP, "Connecticut Greenhouse Gas Emissions Inventory: 1990-2021", 2023; Maine DEP, "Ninth Biennial Report on Progress Toward Greenhouse Gas Reduction Goals", 2022; Massachusetts DEP, "Massachusetts Annual Greenhouse Gas Emissions Inventory: 1990-2020, with Partial 2021 & 2022 Data", 2022; OpenData NY, "Statewide Greenhouse Gas Emissions: Beginning 1990", 2023; Rhode Island DEM, "2019 Rhode Island Greenhouse Gas Emissions Inventory", 2022; Clean Energy NH, 2023; New Jersey DEP, "New Jersey Greenhouse Gas Inventory," 2022; Pennsylvania DEP, "Pennsylvania Greenhouse Gas Inventory Report," 2022; U.S. EPA, "Inventory of Greenhouse Gas Emissions and Sinks: 1990-2019", 2022; U.S. Census Bureau, "Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico", 2019. Global average: Our World In Data, 2023.

1. EAN, "Assessing Vermont's climate responsibility: A comparative analysis of per capita emissions," 2023.
2. Gütschow, J. & Pflüger, M., "The PRIMAP-hist national historical emissions time series v2.4 (1750-2021)", 2022 via Climate Watch.

2. Vermont is not on track to meet legal GHG obligations without additional policy action

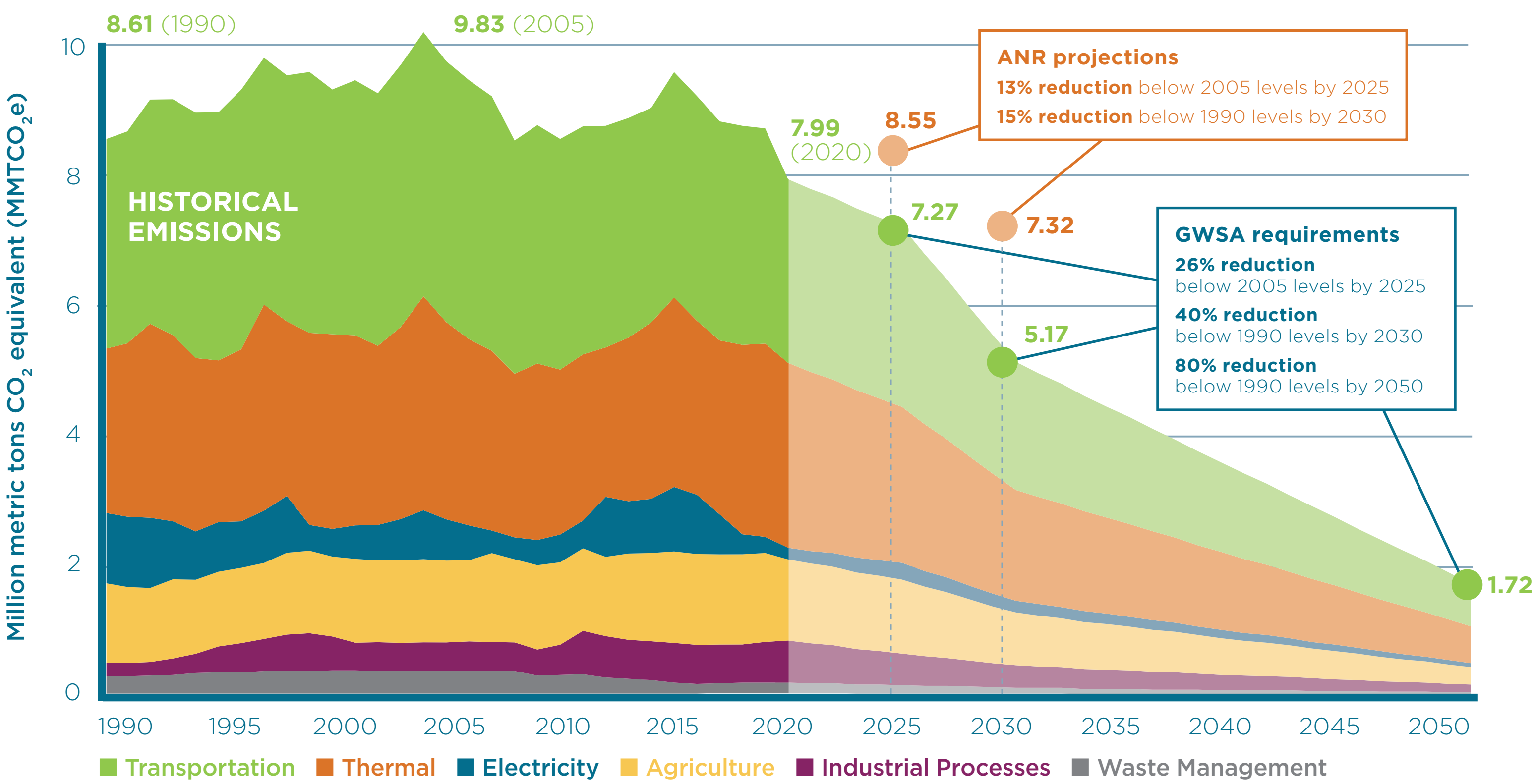
Vermont's Global Warming Solutions Act (GWSA) of 2020 established legal obligations for statewide GHG emissions reductions by 2025, 2030, and 2050. The latest data from the Vermont Agency of Natural Resources' Greenhouse Gas Inventory and Forecast (Vermont's GHG Inventory) show that Vermont's emissions stood at 7.99 million metric tons of carbon dioxide equivalent (MMTCO$_2$e) in 2020, equivalent to burning nearly 900 million gallons of gasoline.[1]

2020 was an outlier year for Vermont's transportation-related GHG emissions, with a 15% decline compared to 2019 caused by reduced vehicle travel due to the pandemic, beginning in March 2020. However, initial data suggest that gasoline and diesel sales increased by about 8.5% from 2020 to 2021,[2] so a partial rebound in transportation emissions will become apparent in future inventories — and it is very likely that this will contribute to 2021 emissions being higher than 2020 emissions.

Vermont's GHG Inventory also included a forecast for statewide emissions in 2025 and 2030, attempting to take into account business-as-usual projections, including the anticipated impact of the recently adopted Advanced Clean Cars II and Advanced Clean Trucks rules.[3] Although there is uncertainty in forecasting, **Vermont's GHG Inventory shows significant gaps between projected emissions and our legal obligations for both 2025 and 2030**.

However, modeling done for the Vermont Climate Council shows that **meeting our 2025 and 2030 legal obligations is possible given current technology — but not without additional policy action and investment**.

Vermont's historical GHG emissions and future requirements



Source: Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast: 1990-2020, 2023. **Notes:** There is a small amount of emissions from the "fossil fuel industry" category (i.e. fugitive emissions from fossil gas pipelines in VT), accounting for 0.3% of Vermont's overall emissions in 2020, that does not show up on this graph. The ANR projections for 2025 and 2030 are from Vermont's 1990-2020 GHG inventory, published in 2023, and reflect a business-as-usual scenario, including the impact of ACCII.

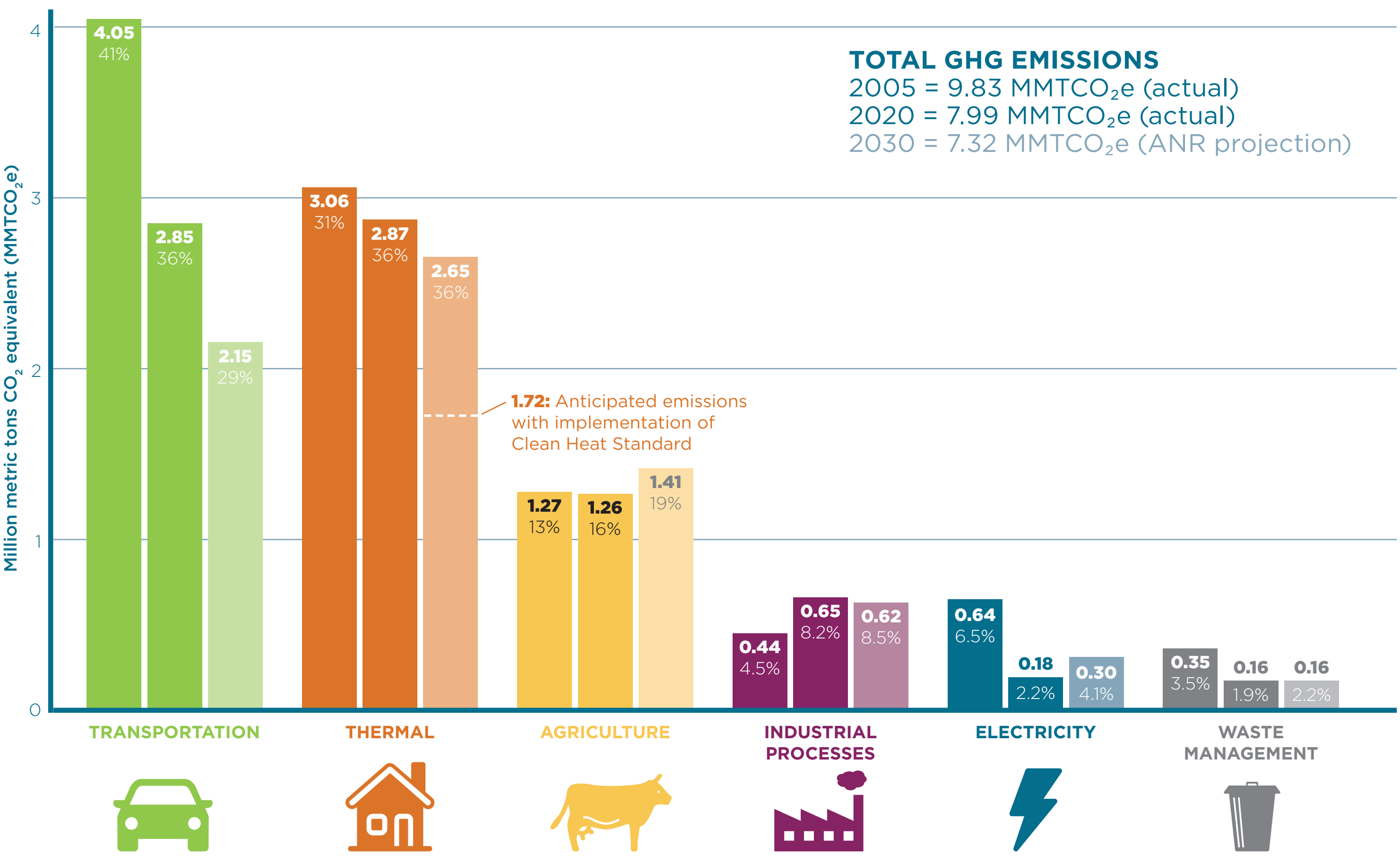
1. U.S. EPA Greenhouse Gas Equivalencies Calculator.
2. Vermont Legislative Joint Fiscal Office, 2023.
3. Vermont Agency of Natural Resources, "Supplemental Information for Vermont's Low Emission Vehicle and Zero Emission Vehicle Proposed Rules," 2022.

3. Thermal and transportation emissions are Vermont's largest sources of climate pollution

For the first time in the history of Vermont's GHG inventory, thermal sector emissions surpassed transportation emissions as the largest source of climate pollution in 2020. While this is a somewhat temporary effect related to the pandemic, **thermal sector emissions are projected to make up an increasing share of Vermont's climate pollution in a business-as-usual scenario, and to significantly surpass the transportation sector as Vermont's leading source of GHG emissions by 2030.**

The transportation sector has historically been Vermont's largest source of climate pollution, followed by the thermal sector. However, in 2020, GHG emissions from the two sectors were essentially the same. Looking ahead to 2030, ANR projects thermal emissions to be significantly higher than transportation emissions (primarily due to expected declines in transportation emissions by virtue of the Advanced Clean Cars II rules and increased EV adoption). However, if the Clean Heat Standard is fully implemented in 2026, thermal sector emissions would be expected to decline to approximately 1.72 $MMTCO_2e$ by 2030, significantly *lower* than the projected 2030 transportation sector emissions.[1]

Vermont GHG emissions by sector, actual (2005, 2020) and projected (2030)



Source: Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast: 1990-2020, 2023. **Note:** There is a small amount of emissions from the "fossil fuel industry" category (i.e. fugitive emissions from fossil gas pipelines in VT), accounting for 0.3% of Vermont's overall emissions in 2020, that does not show up on this graph. Values/percentages for 2030 are based on the VT Agency of Natural Resources' projections in the 1990-2020 GHG emissions inventory, published in 2023, and reflect a business as usual scenario, including the projected impact of Advanced Clean Cars II.

1. The Affordable Heat Act was passed in 2023 and begins the process of establishing a Clean Heat Standard in Vermont. This law is designed to reduce GHG emissions in the thermal sector by establishing requirements for importers of fossil heating fuels into Vermont.

4. Energy equity: Vermonters with lower incomes are disproportionately burdened by energy costs

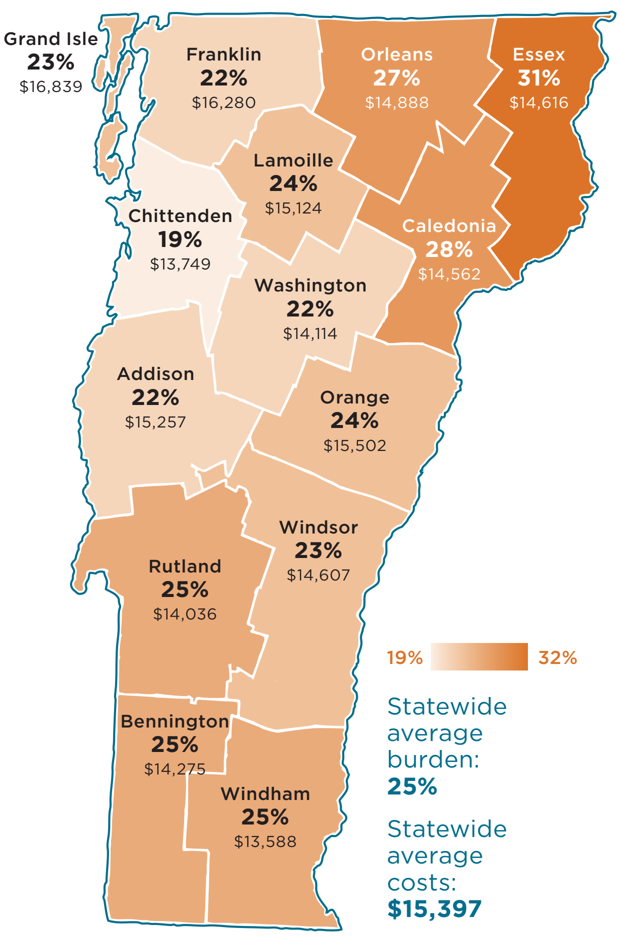
Vermont households with lower incomes typically use less energy than those with higher incomes. Nevertheless, **households with lower incomes, on average, face far higher energy burdens, meaning they spend a larger share of their income on energy.**

In the transportation sector, where we have the data to look at the "all-in" costs, including vehicle purchase, fuel, and maintenance, we can see that there is a significant geographic disparity in transportation energy burden throughout the state, with higher burdens in the Northeast Kingdom and Southern Vermont. Averaged across Vermont, households with lower incomes (80% of the area median income, or AMI) spend, on average, 30% of their income on these "all-in" transportation costs, compared to 25% for Vermonters at the state median income.

When looking at the combined average costs for heating fuel and electricity (without the associated equipment and maintenance costs, for which data are not available), the disparity in energy burden is especially pronounced between households with the lowest incomes, which spend 19% of their income on these fuels on average, and households at and above 100% of AMI, which spend 4% or less of their income on these energy sources.

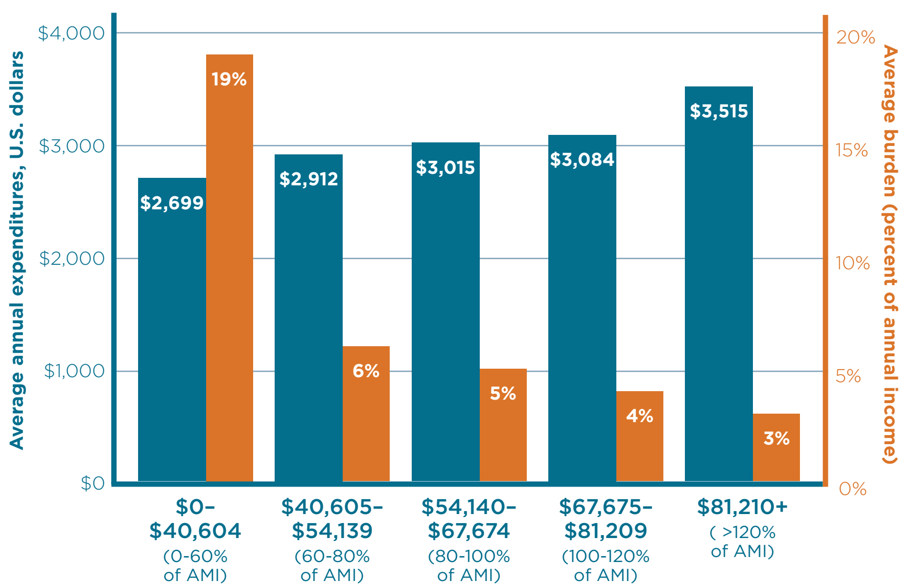
High energy burdens increase the risk of transitioning into poverty or of experiencing long-term poverty by 150-200%.[1] Higher energy burdens are also correlated with "greater risk for respiratory diseases, increased stress and economic hardship, and difficulty in moving out of poverty."[2]

Vermont household average transportation costs and burden, 2020



Source: Center for Neighborhood Technology, Housing and Transportation (H+T) Affordability Index, 2020. **Note:** The dollar amounts represent average total household expenditures on transportation, including vehicle operation and maintenance, fuel costs, and other transit costs. Transportation burden refers to the percent of household income spent on transportation costs.

Vermont combined average household heating and electricity fuel costs and burden by income level, 2017-2021



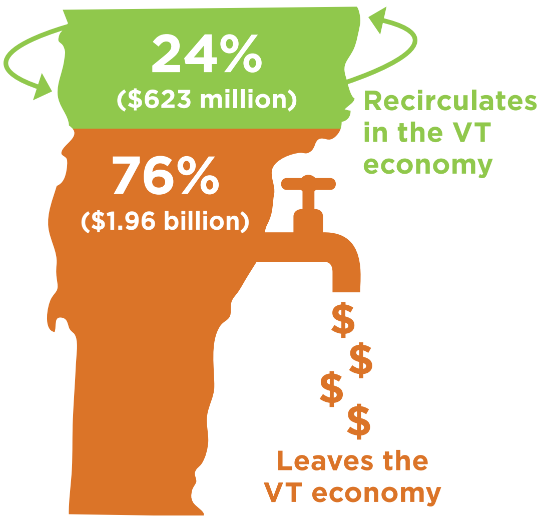
Source: U.S. Census Bureau, 2017-2021 American Community Survey 5-year Public Use Microdata Samples. **Notes:** Income categories are based on 2018-2021 median household income in Vermont of $67,674. Energy burden refers to the share of annual household income spent on energy. Costs include fuel only; they are not inclusive of equipment and maintenance costs.

1. Jeremiah Bohr and Anna C McCreery, "Do Energy Burdens Contribute to Economic Poverty in the United States? A Panel Analysis." Social Forces, 2019.
2. ACEEE, "How High Are Household Energy Burdens," 2020.

5. Relying on fossil fuels is a drain on Vermont's economy

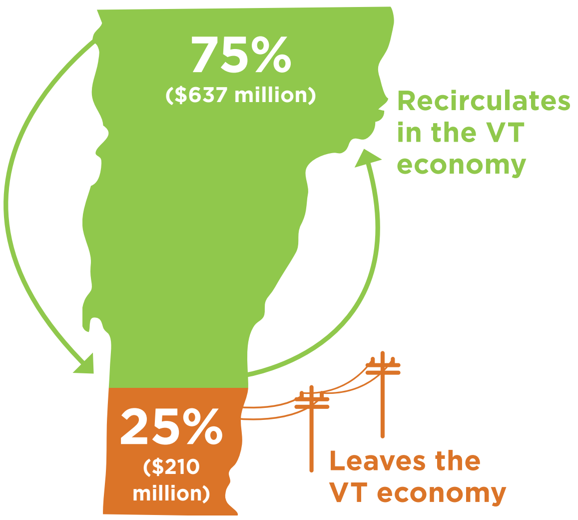
100% of the fossil fuels used in Vermont are imported from out of state. **More than three quarters of the money we spend on fossil fuels drains out of the state economy.** In 2022 alone, nearly $2 billion of the approximately $2.6 billion in total fossil fuel spending in Vermont left the state economy.

Vermont fossil fuel spending, 2022



Sources: Fossil fuel spending: Vermont Department of Taxes, 2023; VGS, 2023. Dollar recirculation share: EAN Senior Fellow for Economic Analysis, Ken Jones, 2023. **Note:** This graph includes spending on thermal and transportation fuels only.

Vermont electricity spending, 2021

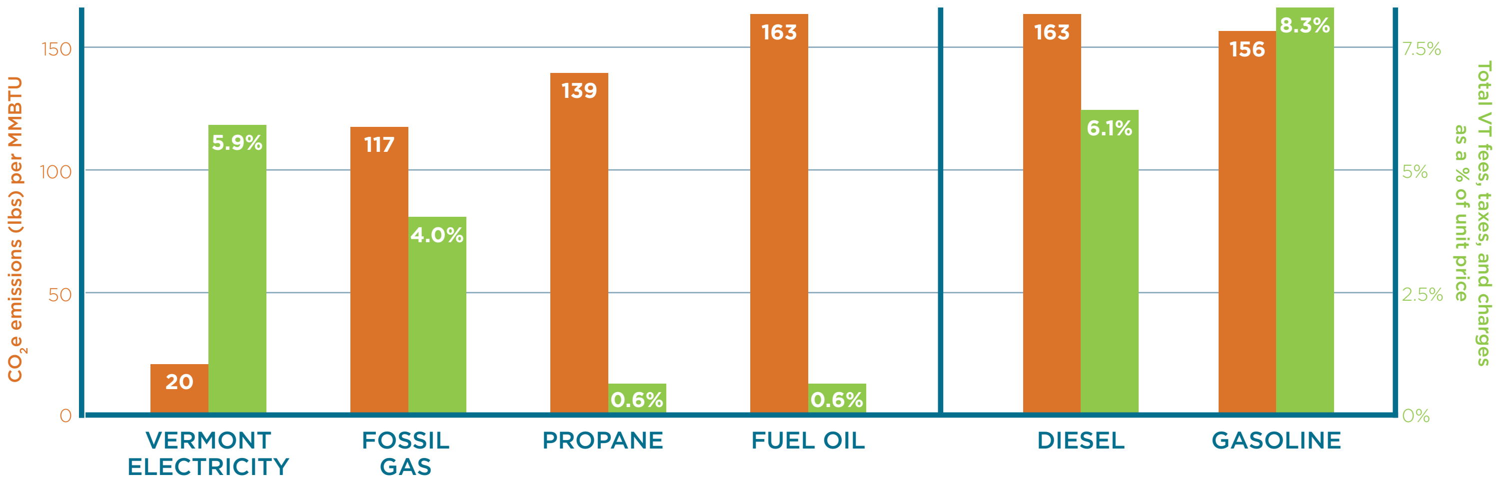


Sources: Electricity spending: Vermont Department of Public Service, 2021 Electric Utility Resource Survey; Dollar recirculation share: EAN Senior Fellow for Economic Analysis, Ken Jones, 2023.

The ratio is essentially reversed when we use electricity to meet our energy needs. For example, by driving electric cars or heating with high-efficiency electric heat pumps, 75% of the dollars we spend stay and then recirculate in Vermont. This is because most of the cost of delivering electricity is bound up in local labor and infrastructure, whereas most of the cost of fossil fuels goes to importing a global commodity product. Using electricity instead of fossil fuels creates a positive feedback loop that strengthens Vermont's economy, helping support working families by paying the salaries of Vermont lineworkers, tree-trimmers, and local clean power producers, among others.

Vermont doesn't require fossil heating fuels to contribute as much in fees and taxes as electricity (or as much as fossil fuels used for transportation), despite the fact that fossil fuels are such a drain on Vermont's economy and produce far more climate pollution than Vermont's electricity portfolio.

Vermont fees, taxes, and charges vs emissions



Sources: Emissions: For all fossil fuels: EIA, "Carbon Dioxide Emissions Coefficients". For VT electricity: "Assessing the GHG Impact of Beneficial Electrification in Vermont," EAN, 2023. Fees, taxes, and charges: Vermont Department of Taxes, 2023. 2022 Energy Efficiency Charge rates for electricity and fossil gas: PUC Determination of 2022 Energy Efficiency Charge Rates. Gas and diesel taxes and fees: Vermont Motor Fuels Tax, VFDA, 2023. **Note:** Unit price of fuels is based on the annual average in 2022. The totals for thermal fuels represent residential rates only.

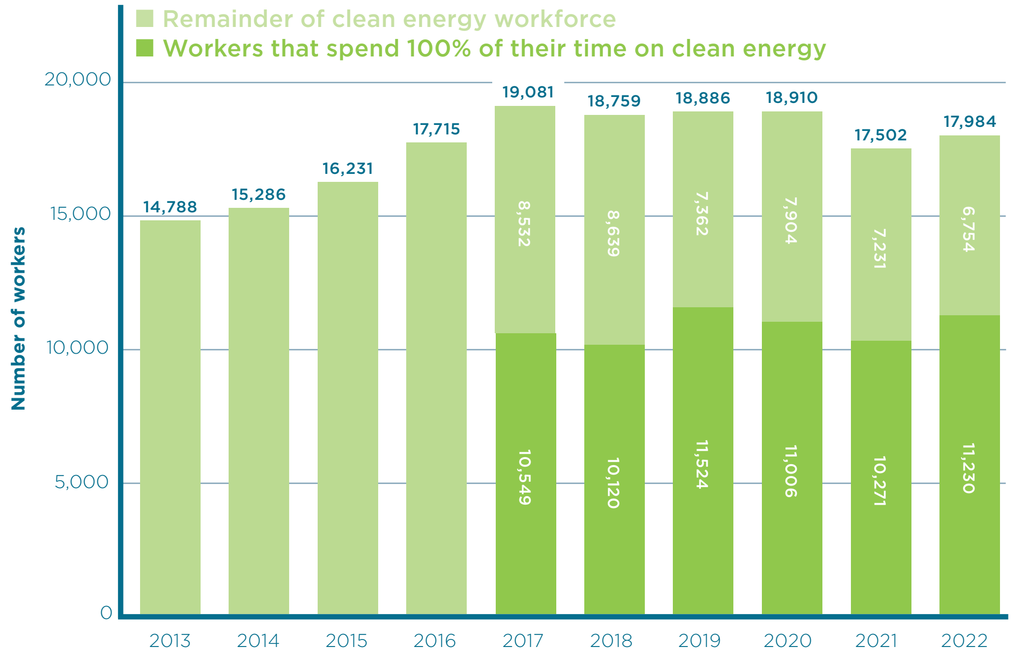
6. Meeting Vermont's climate commitments requires a larger climate workforce

To meet Vermont's obligation to cut climate pollution we will need to recruit and train an expanded clean energy and climate workforce — while also supporting and retaining existing workers and employers. As of 2022, there were about 19,400 Vermonters in the climate workforce, almost 18,000 of whom were clean energy workers, working in fields such as weatherization, installing and maintaining greener heating and transportation technologies, and deploying and maintaining renewables. **In fact, Vermont has the highest share of workers in the clean energy sector, per capita, in the country.**[1] Beyond the clean energy workforce, approximately 1,400 additional climate workers in Vermont are employed in agriculture and land management, waste management, public transit, education, financing and philanthropy, and selling and servicing efficient electric equipment.[2]

Employment in Vermont's clean energy sector grew annually between 2013 and 2017, and then remained relatively steady until the pandemic led to a reduction in employment across the economy. As of 2022, Vermont had not yet returned to our 2017 peak of clean energy employment.

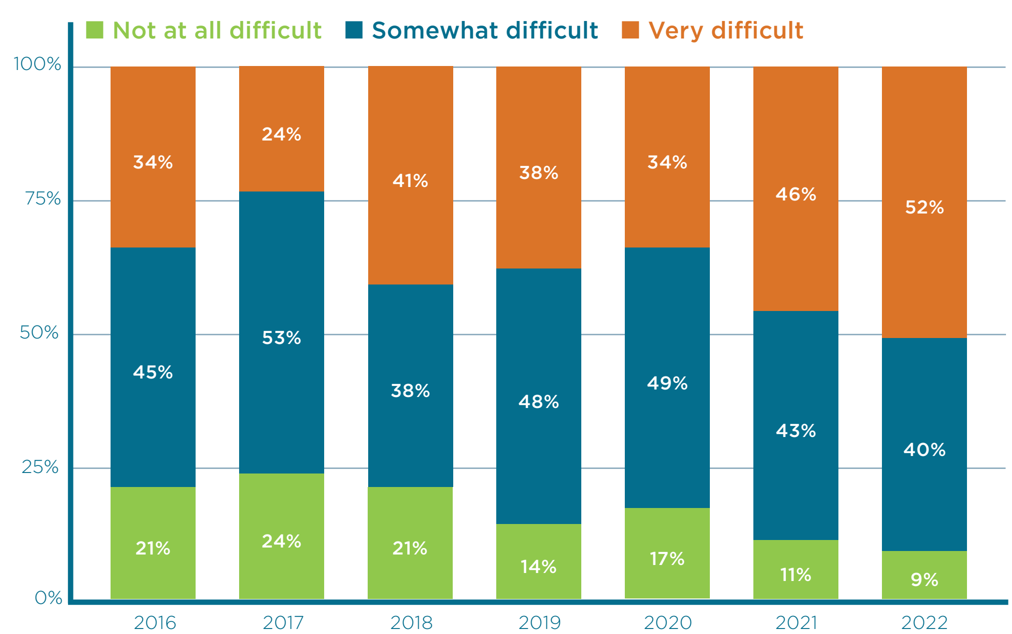
Vermont's clean energy employers have been encountering increasing difficulty in hiring workers over the past few years. As of 2022, more than half of Vermont clean energy employers said that it was "very difficult" to hire new workers, with only 9% reporting that it was "not at all difficult."

Vermont clean energy employment, 2013-2022



Source: Clean Energy Development Fund, VT Department of Public Service, "Vermont Clean Energy Industry Report," 2022. **Note:** Data on the number of workers who spend 100% of their time on clean energy was not available prior to 2017.

VT clean energy employer-reported hiring difficulty, 2018-2022



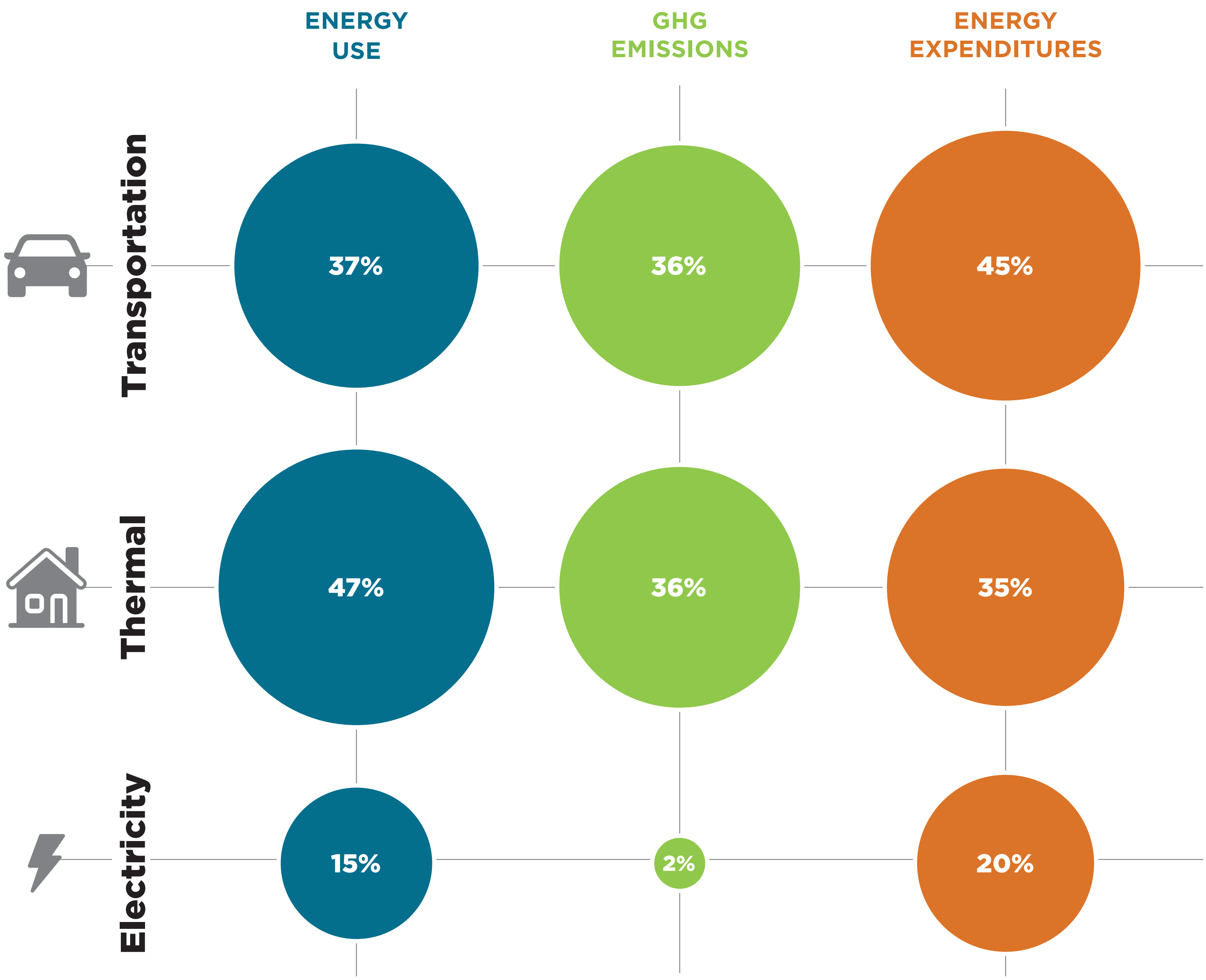
Source: Clean Energy Development Fund, VT Department of Public Service, "Vermont Clean Energy Industry Report," 2022. **Note:** Totals may not sum to 100% due to independent rounding.

1. Clean Energy Development Fund, VT Department of Public Service, "Vermont Clean Energy Industry Report," 2022.
2. EAN Climate Workforce Network Action Team, 2022.

Statewide total energy and emissions context

There are a number of different ways to look at the impacts of Vermonters' use of energy. But any way we look at it, if we think about "energy" only in terms of electricity, we are missing a very large part of the picture. In 2020, 74% of Vermont's greenhouse gas emissions came from energy use, with the largest sources, by far, being the thermal and transportation sectors. The largest share of Vermonters' energy expenditures is for transportation fuels, followed by thermal energy costs (mostly for fossil fuel heating).

A total energy transformation requires policy and programs to decarbonize transportation and heating, in addition to electricity. Electricity GHG emissions and costs are important — especially as more of our thermal and transportation load shifts to electricity — but whether we look at relative energy use, greenhouse gas emissions, or energy expenditures, **fossil fuels used for transportation and heating pose the biggest challenges in Vermont.**



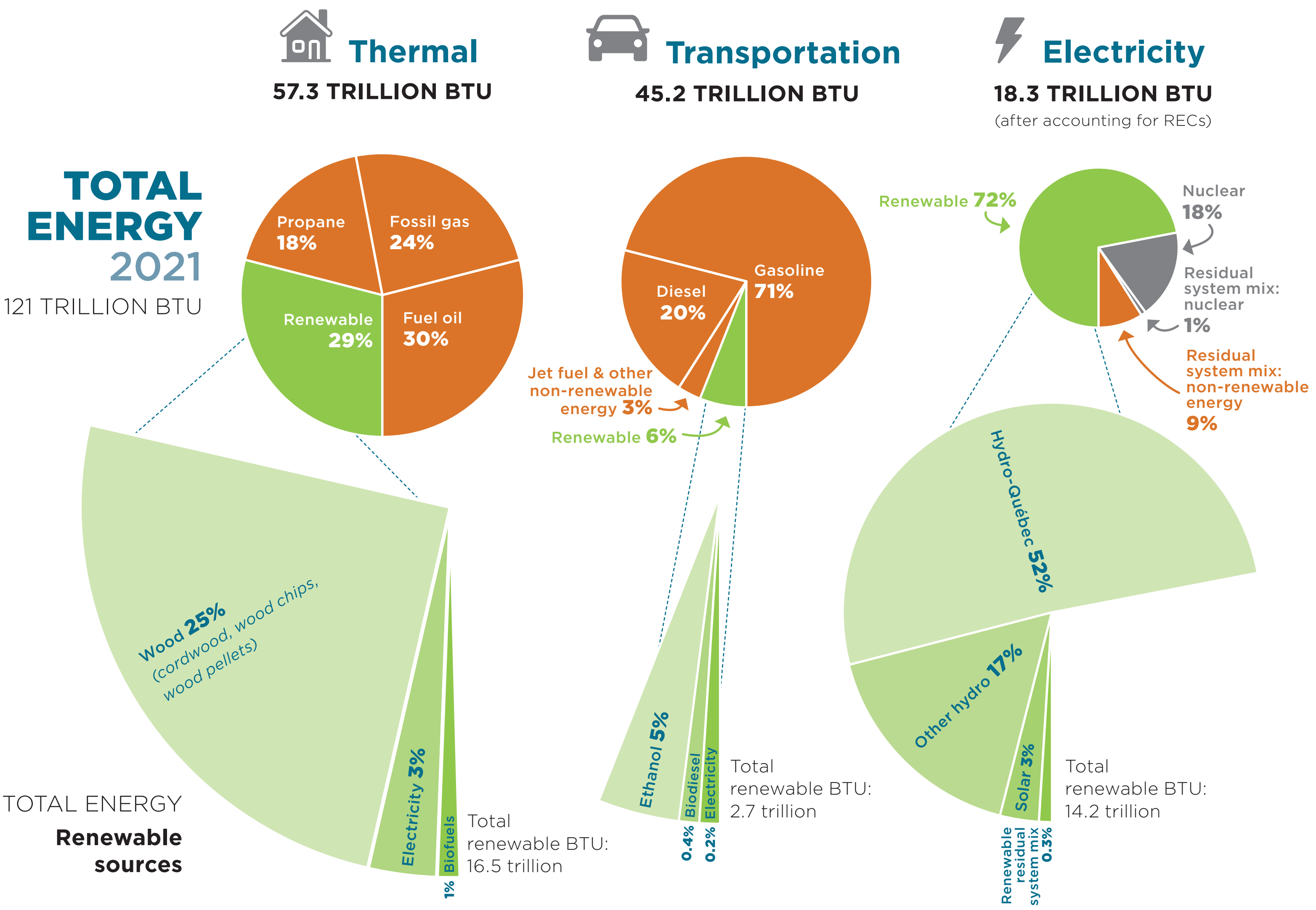
Sources: For 2021 energy use: Vermont Department of Taxes, 2023; EIA State Energy Data System (SEDS), 2023; Vermont Department of Public Service, 2021 Electric Utility Resource Survey. For 2020 GHG emissions: Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast: 1990-2020, 2023. For energy expenditures: Efficiency Vermont, Vermont Energy Burden Report, 2023. **Note:** Energy use does not add up to 100% due to independent rounding. GHG emissions do not add up to 100% because only energy sectors are shown, which are responsible for 74% of VT's total emissions (26% of Vermont's GHG emissions come from non-energy sectors).

Vermont's energy use by sector

Of Vermont's total energy consumption, the largest share (47%) is for thermal purposes, primarily for space and water heating in homes and buildings. While less energy is consumed for transportation than heating in Vermont, transportation is currently our most fossil fuel dependent energy sector: **94% of Vermont's transportation energy came from fossil fuels in 2021, compared to 72% in the thermal sector.**

As the thermal and transportation sectors electrify, the question arises of where and how to account for electric energy that is used in those sectors. Specifically, should that energy be counted in the electricity sector or within the transportation and thermal sectors, respectively?

EAN's convention is to account for the electric energy used for transportation and thermal purposes within the transportation and thermal sectors. Although this is not how emissions are tracked in Vermont's GHG Inventory, this convention allows us to have a clearer view of how quickly the thermal and transportation sectors are electrifying. This results in the electricity pie chart showing the amount of electricity that is used for everything *besides* transportation (i.e., electric vehicles) and thermal (i.e., heat pumps and electric resistance). Therefore, it primarily represents electric appliances (or "plug loads") and lighting. Using this approach, over time we will see increasing amounts of electric energy usage within the thermal and transportation energy pie charts.

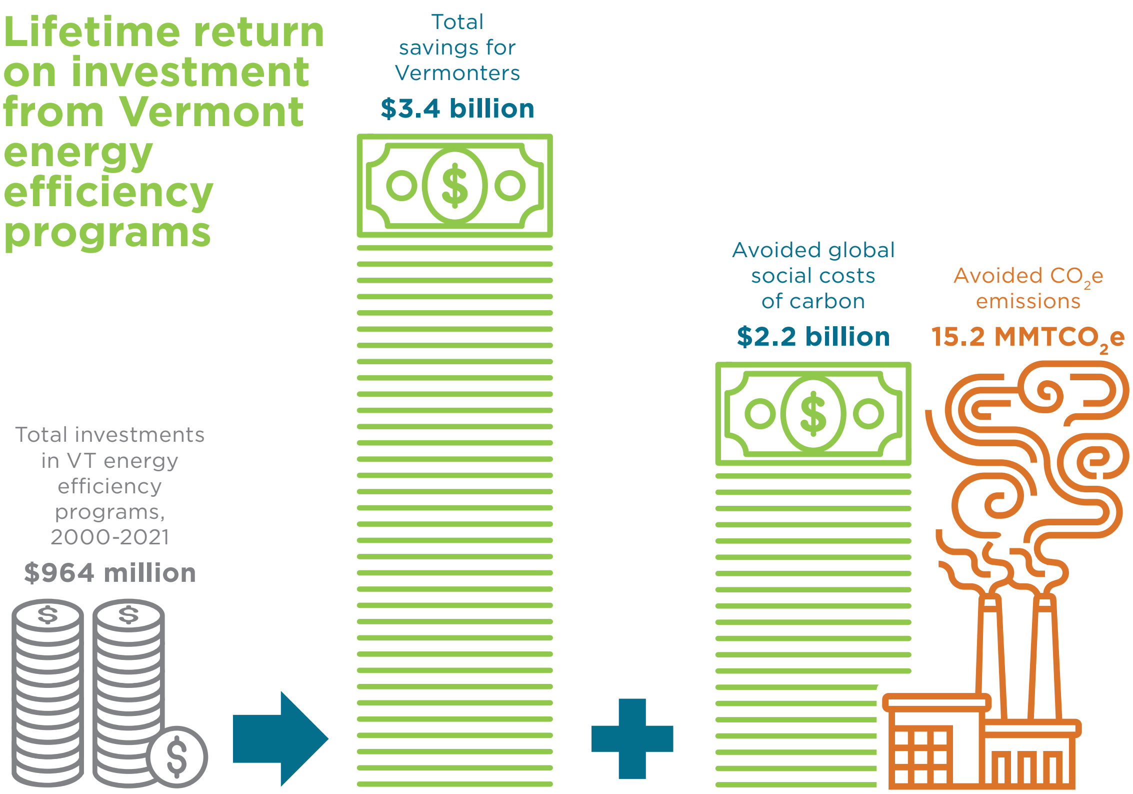


Sources: Energy Information Administration, 2023; Efficiency Vermont, 2023; Vermont Department of Public Service, 2023; Vermont Department of Taxes, 2023; EAN, 2023.
Note: The electricity pie chart does not include electricity used for thermal and transportation purposes, as that electricity usage is shown in the respective thermal and transportation pie charts. Percentages may not sum exactly to 100% due to independent rounding. The electricity pie chart shows Vermont's electricity portfolio after accounting for RECs. One result of this is that wind and biomass generation do not show up as electricity resources, since RECs from those resources are primarily sold out of state.

Vermont's energy efficiency programs generate a high return on investment

Over the past two decades, Vermonters have made cumulative investments of nearly $1 billion in energy efficiency programs, primarily supported by our efficiency utilities: Efficiency Vermont, Burlington Electric Department (BED), and VGS. Over the lifetime of the resulting measures, **Vermont will benefit from a 3- to 5-fold return on its energy efficiency investments, with almost $3.5 billion in savings from avoided energy costs alone, plus another $2 billion in avoided global damages** (as estimated via Vermont's adopted social cost of carbon).

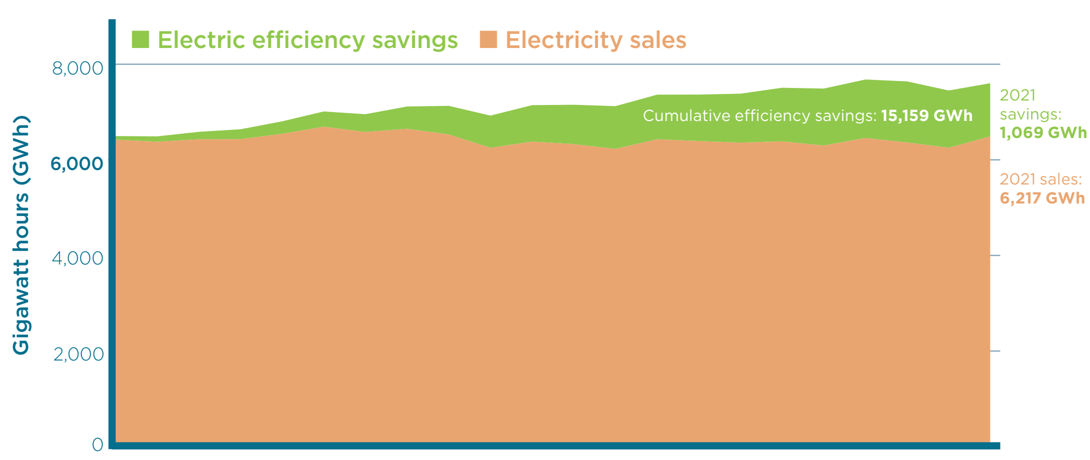
Lifetime return on investment from Vermont energy efficiency programs



Source: Efficiency Vermont, 2023; Burlington Electric Department, 2023; VGS, 2023. **Notes:** Social cost of carbon based on estimate of $146 per metric ton (EFG, "Marginal Abatement Cost Curves," 2022). Savings, avoided costs, and avoided emissions incorporate the modeled lifetime of the measures. Avoided CO_2e emissions are calculated by energy efficiency utilities using marginal emissions of the ISO-NE mix, rather than VT's electricity portfolio.

The over 15 $MMTCO_2e$ in avoided GHG emissions that Vermonters have achieved over the last two decades with the help of our efficiency utilities is nearly equivalent to avoiding two years' worth of Vermont's total climate pollution, as measured at Vermont's most recent annual GHG levels.

Electricity savings from electric efficiency utilities, 2000–2021



Source: Vermont Department of Public Service, Annual Energy Report, 2023. Data includes Efficiency VT and Burlington Electric Department.

Looking at electric efficiency measures in particular, **investments made by Efficiency Vermont and Burlington Electric Department have avoided over 15,000 Gigawatt hours (GWh) of electricity use cumulatively since 2000.** This has helped keep electricity costs lower than they would otherwise have been by avoiding the need for additional peak power purchases and new transmission.

Electrification lets us use less polluting energy — *and* less energy overall

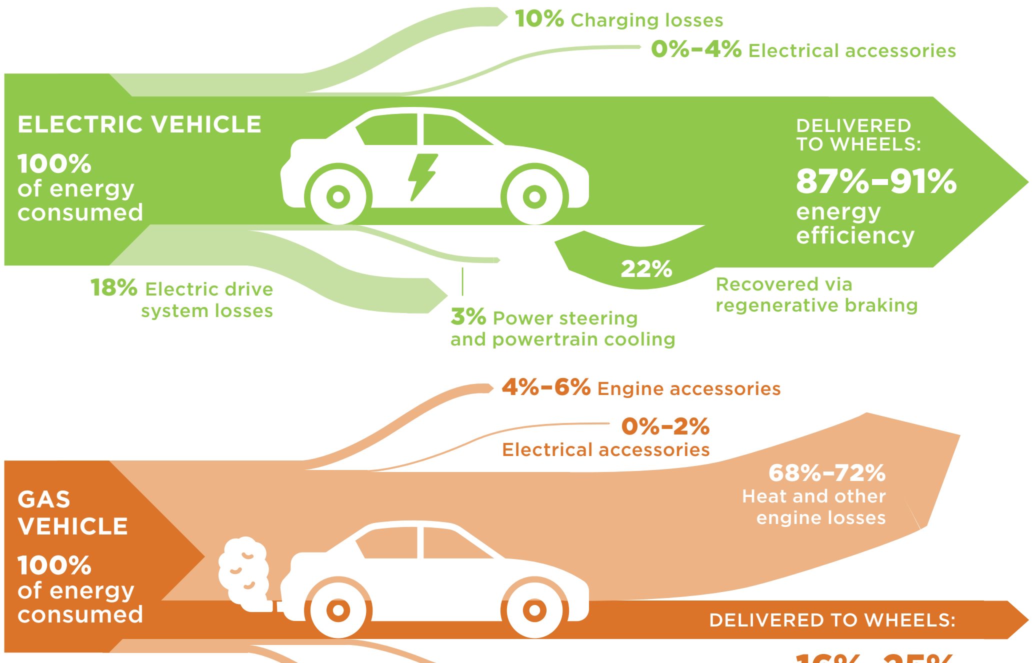
The benefit of electrifying transportation and heating goes beyond just moving away from a heavily polluting energy source — fossil fuels — to a much more climate-friendly energy source — Vermont's 90% fossil-free electricity portfolio. **There is a second, less recognized but equally important benefit to electrifying our transportation and thermal sectors: significantly less energy is needed to perform the same tasks.**

In the case of vehicles, **EVs are far more efficient (87%–91%) at converting energy into propulsion than fossil vehicles (16%–25%)**. This is because internal combustion engines lose most of the energy generated from gasoline or diesel as heat and other engine losses, with only a fraction of the total energy delivered to the wheels.

Heat pumps have similar efficiency benefits over fossil fuel heating equipment. Heat pumps achieve efficiency rates greater than 100% because the energy input is used to transfer—rather than generate—heat. **This allows heat pumps to achieve average efficiencies that are three, four, or more times greater than combustion-based heating appliances.**

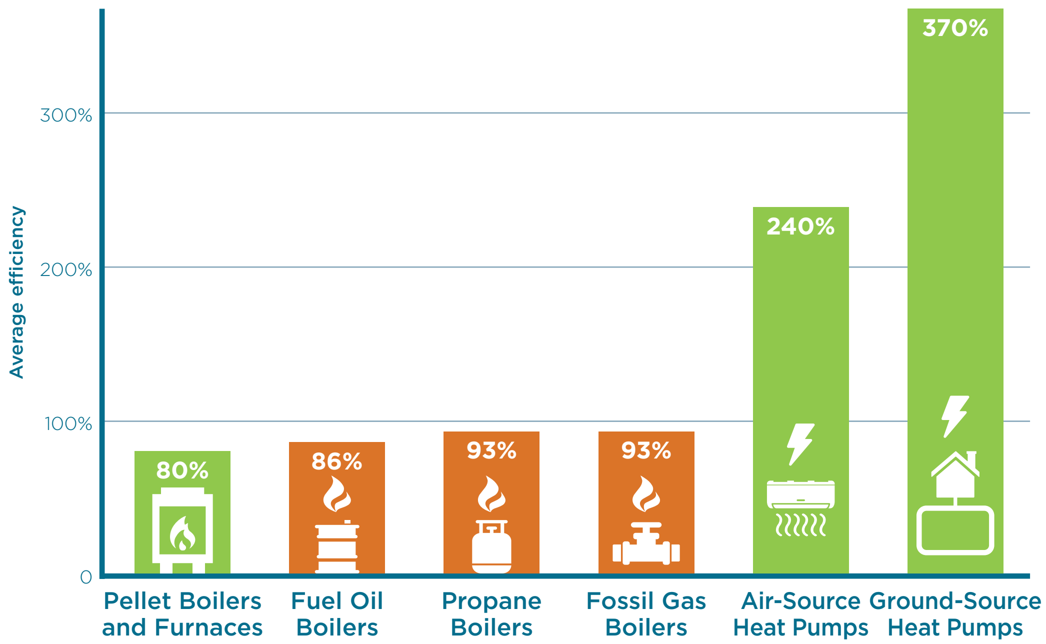
In short, beneficial electrification with high-efficiency equipment is not just about changing the source of energy — it's also about using far less energy overall.

Where the energy goes: Electric vehicles vs gas vehicles



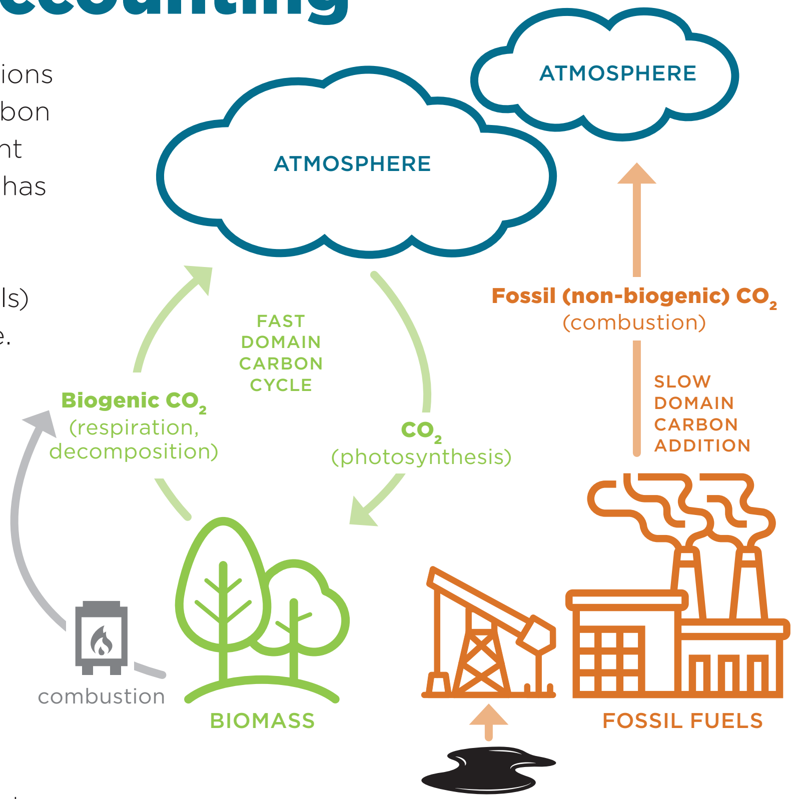
Source: fueleconomy.gov.
Note: Estimates shown are combined city and highway driving.

Average efficiency: New residential heating systems



Sources: Pellet stoves, air-source heat pumps, and fuel oil, propane, and fossil gas boiler efficiencies: Vermont Public Utility Commission, TAG Tier III Annual Report, 2021. Ground-source heat pumps: US Energy Information Agency, "Updated Buildings Sector Appliance and Equipment Costs and Efficiencies," 2023. **Notes:** Heating efficiency refers to the average rate at which an appliance converts energy from fuel to heat output, expressed as a percentage. Heat pumps are capable of achieving efficiency rates greater than 100% because the energy input is used to transfer—rather than generate—heat. Because of this, heat pumps can transfer more energy than they consume. Efficiency rates for air-source heat pumps can vary considerably depending on outdoor air temperature. The efficiency presented here is an average over the course of the heating season.

The carbon cycle and different methods of GHG emissions accounting



Comparing different types of greenhouse gas emissions can be complicated, especially when comparing carbon emissions from sources that operate on very different timescales. Burning fossil fuels releases carbon that has been stored underground for millions of years, from the "slow domain" of the carbon cycle. In contrast, biogenic sources of carbon (such as wood or biofuels) operate within the "fast domain" of the carbon cycle. **It is primarily the burning of fossil fuels, or the massive transfer of carbon from the slow domain to the fast domain of the carbon cycle, that has led to global climate destabilization.**[1]

Unlike sources of biogenic carbon, combusting fossil fuels always represents a significant net addition of CO_2 to the atmosphere. Carbon emissions from wood burning can be re-sequestered on biological timescales without creating a net addition to the amount of carbon in the fast domain of the carbon cycle, so long as the forest the wood came from stays as forest and regrows. **The uses of different types of biomass and biofuel should be rigorously assessed for their full climate impacts, especially when their use results in direct or indirect land use change, unsustainable harvesting practices, or degradation of ecosystems.**

Vermont's official GHG Inventory reports all greenhouse gas emissions from the combustion of fossil heating fuels, as well as the methane (CH_4) and nitrous oxide (N_2O) emissions from wood burning. However, to be consistent with IPCC inventory guidelines, Vermont does not count the carbon dioxide (CO_2) emissions from wood combustion in the energy portion of its GHG inventory, because such emissions should be accounted for in the Land Use, Land Use Change, and Forestry (LULUCF) sector. Accounting for the same emissions in multiple sectors would lead to double-counting.

> "Of the total anthropogenic CO_2 emissions [in the last decade], **the combustion of fossil fuels was responsible for 81–91%,** with the remainder being the net CO_2 flux from land-use change and land management (e.g., deforestation, degradation, regrowth after agricultural abandonment [...])."
>
> *—Intergovernmental Panel on Climate Change, "Synthesis Report of the IPCC Sixth Assessment Report (AR6)", 2023*

Another way of comparing emissions is to use a lifecycle assessment, including emissions from raw material extraction, processing, transportation, and distribution.[2] Lifecycle GHG emissions vary greatly depending on how each fuel is sourced and produced and are particularly dependent on the extent to which production results in direct or indirect land use change. Some biofuels — such as a B100 biodiesel made from recycled restaurant oil — are far less GHG intensive than fossil fuels. Other biofuels — such as a palm oil that was produced via deforestation — can be more GHG intensive than fossil fuels on a lifecycle basis.

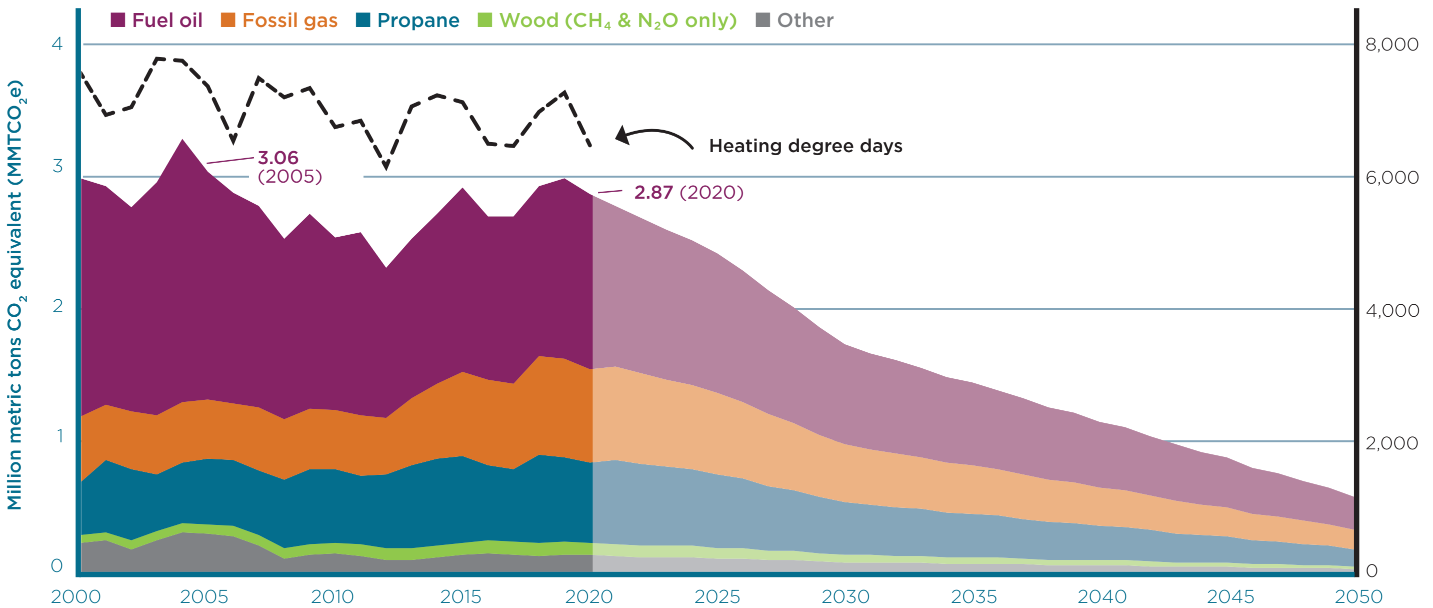
EAN carefully follows IPCC and EPA guidance, as well as the evolving peer-reviewed scientific literature. As peer-reviewed and official guidance evolves, we reflect it in our reporting and analysis.

1. Royal Meteorological Society, 2023.

2. The Affordable Heat Act (Act 18 of 2023) specifically requires reductions in lifecycle emissions from the thermal sector, with all fuels and fuel pathways (including wood and biofuels, in addition to fossil fuels) assessed on a lifecycle basis. Lifecycle assessment is also used for program compliance by the states of Washington, Oregon, and California.

Thermal sector greenhouse gas emissions and energy use

Historical VT thermal GHG emissions and future sector targets

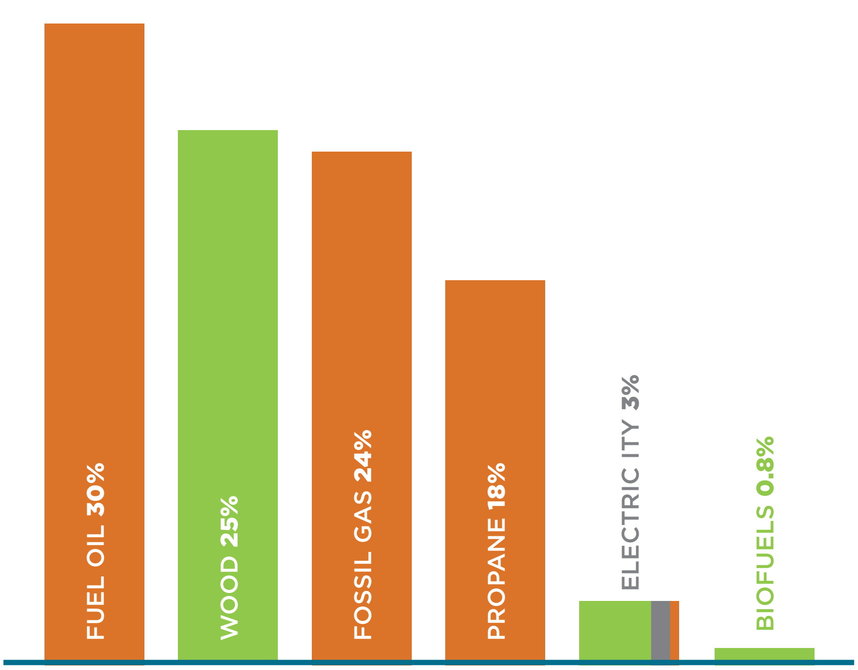


Source: Emissions: Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast: 1990-2020, 2023. Heating degree days: NOAA, Monthly Total HDD for Burlington, VT, 2023. **Notes**: There was a small amount of coal emissions in the early 2000s that are not visible on this graph. Heating degree days are a measure of how cold the temperature was on a given day, and compares the mean outdoor temperature to a standard temperature of 65F. It is measured by subtracting the mean temperature from the standard temperature and aggregated over the entire year.

The thermal sector, which consists of Residential, Commercial, and Industrial (RCI) fuel use, was responsible for 2.87 $MMTCO_2e$ of GHG emissions in 2020, making up 36% of Vermont's statewide total. **This marked the first time in the history of Vermont's GHG emissions tracking that the thermal sector surpassed transportation as Vermont's most heavily climate polluting sector.**

The majority (72%) of Vermont's thermal energy use is fossil fuel based, primarily fuel oil (30%), fossil gas[1] (24%), and propane (18%). In recent years, however, fuel oil sales have been declining relative to other fossil heating fuels. Wood heat makes up most of the rest of Vermont's thermal energy use, primarily from cord wood but also including wood chips and pellets.

Vermont thermal energy sources, 2021



Sources: VT Department of Taxes, 2023; EIA State Energy Data System, 2023; Efficiency Vermont, 2023. **Note:** The colors within the electricity bar represent the portions of VT's electricity that are from renewable (green), nuclear (gray), and non-renewable (orange) sources.

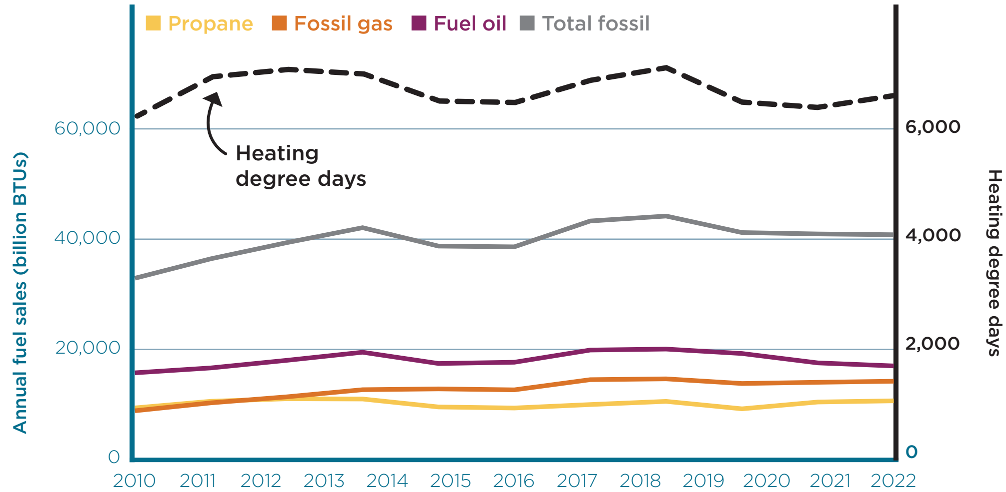
1. **Note:** Fossil gas is also sometimes referred to as "natural gas", "fossil natural gas", "pipeline gas", "fracked gas", "methane", or "gas."

Thermal sector GHG emissions typically move in line with how relatively warm or cold each year is (as measured by heating degree days). While this general trend is likely to continue, reducing dependence on fossil heating fuels will lead to lower emissions, even in colder years.

More than half of Vermont's thermal sector GHG emissions come from residential use. Second is commercial use, at 31%. **Weatherization, heat pumps, heat pump water heaters, and certain types of advanced wood heat and biofuels (specifically those with lower life-cycle emissions), all present opportunities to reduce emissions from heating and cooling homes and buildings.**

Investing in weatherization and transitioning heating from fossil fuels toward electricity and other renewable options are not just pollution reduction strategies — they are also *resilience* strategies. Specifically, better insulated homes improve health and comfort, both during extreme cold and heat events. Meanwhile, **fuel tanks and the toxic fossil fuels they hold are dangerous health hazards, especially during flooding events.** When fossil fuels leak into water, they harm human health and the environment, and, as we saw in the aftermath the 2023 floods, make clean up and recovery efforts that much more difficult and costly.

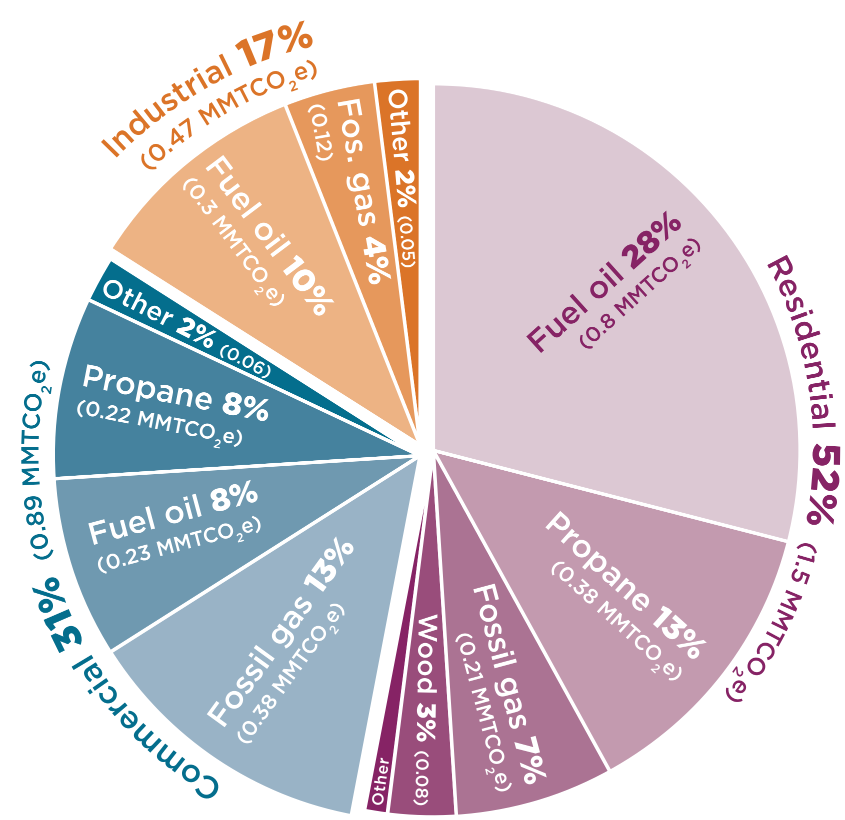
Annual fossil fuel heating sales in Vermont, 2010-2022



Source: VT Department of Taxes, 2023; U.S. Energy Information Administration, State Energy Data System (SEDS), 2023; VGS, 2023; NOAA, Monthly Total HDD for Burlington, VT, 2023. **Note:** A small amount of kerosene sold in VT each year is included within the annual totals for fuel oil. A small amount of coal is used for heating in VT, estimated by the Vermont Public Service Department in 2019 to be about 1% of total heating fuel use.

Vermont thermal GHG emissions by sector and fuel type, 2020

TOTAL THERMAL EMISSIONS 2.87 $MMTCO_2e$



Source: Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast: 1990-2020, 2023.

Thermal pathways to Global Warming Solutions Act requirements

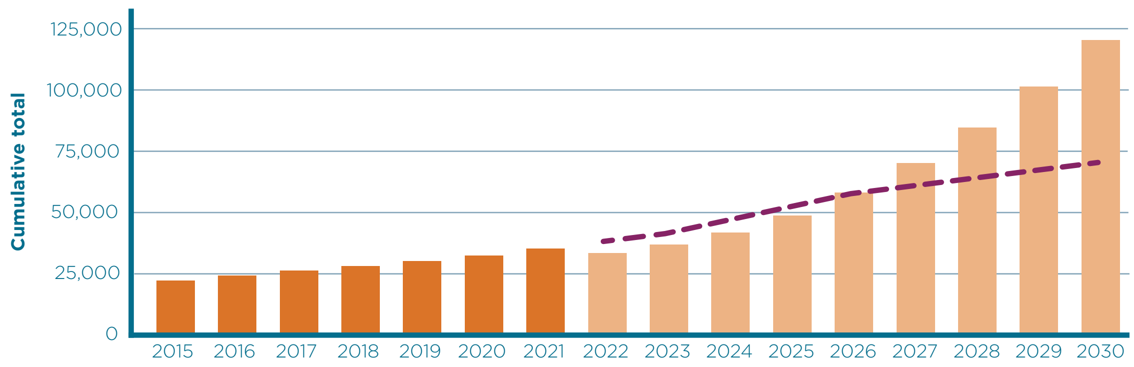
The solutions that can deliver the largest share of Vermont's required thermal sector GHG emissions reductions, as modeled for Vermont's Climate Action Plan, include weatherization and heat pumps for space and water heating. These graphs show the scale and pace of adoption expected to be necessary, as part of a broader portfolio of actions, to meet Vermont's emissions reduction obligations for 2030.

While it is possible to heat some well weatherized homes with modern cold climate heat pumps alone, often clean heating is not a one-or-the-other or a one-size-fits-all situation. Practical solutions depend on many variables. With Vermont's older buildings and cold climate, the best heating solutions frequently involve multiple renewable heating options working in combination, in the interest of reliability and resilience. For instance, advanced wood heating can provide supplemental or back-up heat to heat pumps, or vice versa.

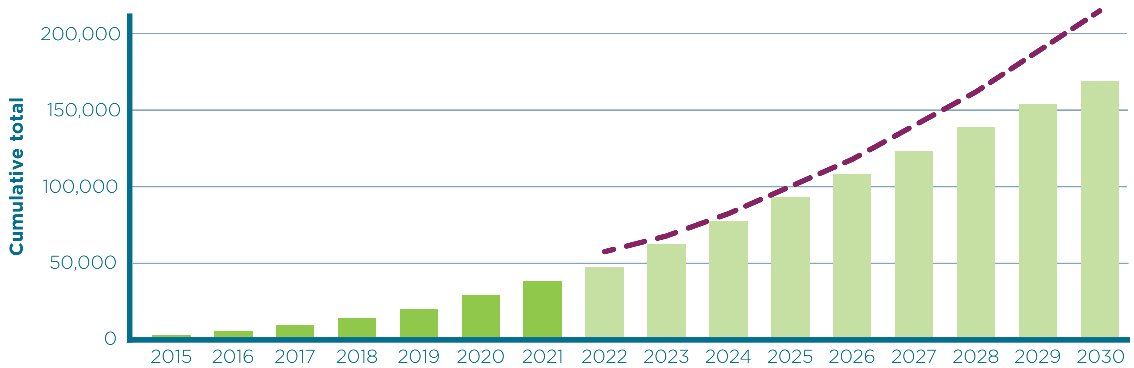
Vermont thermal measures: Historical uptake and Climate Action Plan pathways

Business-as-usual (BAU) projection

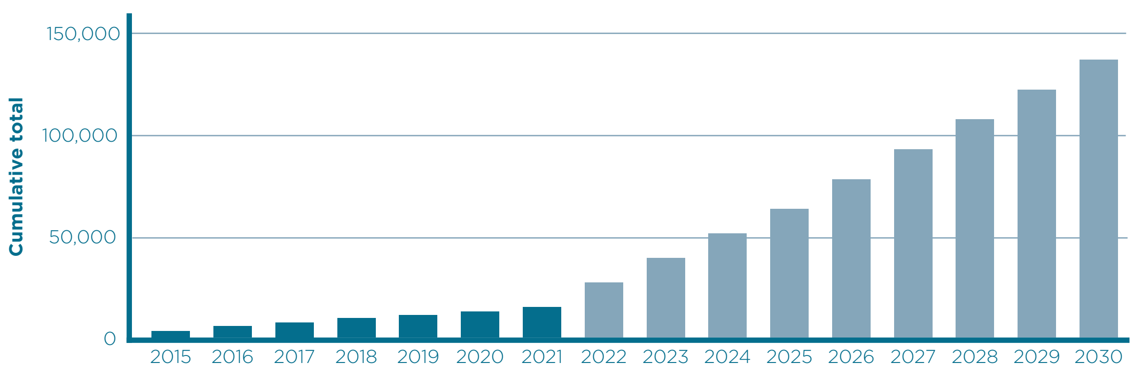
Weatherization (units comprehensively weatherized)



Air-source heat pumps



Heat pump water heaters

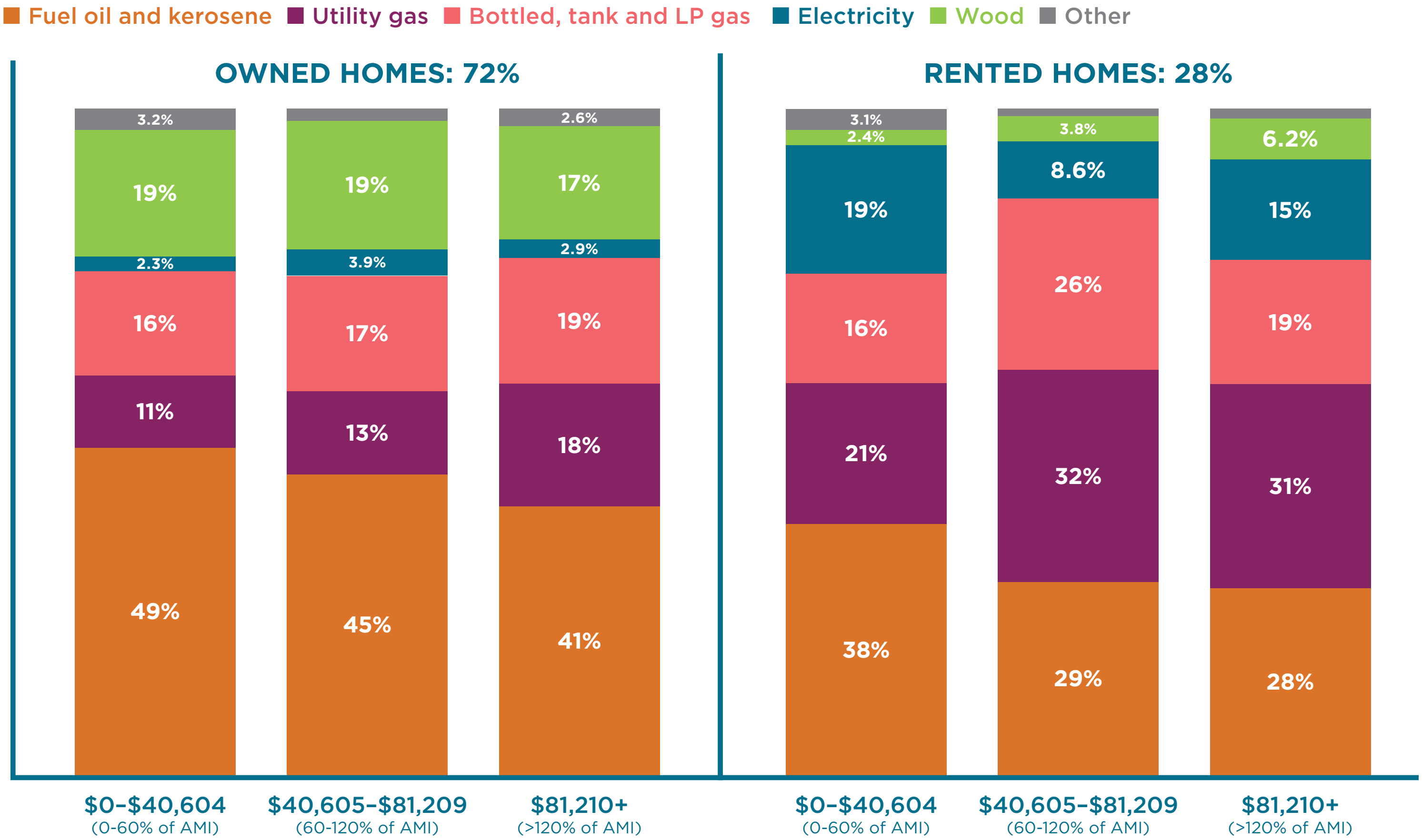


Sources: Historical uptake: Vermont Public Service Department, 2023; Efficiency Vermont, 2023. CAP pathways: Vermont Climate Council, "Initial Vermont Climate Action Plan," 2021. BAU projection: Vermont Agency of Natural Resources, 2023. **Note:** Lighter colored bars represent the necessary pace of adoption modeled for the initial 2021 Climate Action Plan (an update to the CAP pathways model was underway as of August 2023). BAU projection not available for heat pump water heaters at this time.

If Vermont is to meet our legal climate obligations by 2030, a business-as-usual approach will not be sufficient. However, if fully implemented, Vermont's Clean Heat Standard is designed to meet the thermal sector's share of responsibility for emissions reduction, and is projected to significantly increase the pace of heat pump adoption and weatherization.

Equity in the thermal sector

Vermont primary household fuel use by income and housing type



Source: U.S. Census Bureau, 2017-2021 American Community Survey 5-year Public Use Microdata Samples. **Note:** Income categories are based on 2018-2021 Vermont median household income of $67,674.

Households with lower incomes don't have the same access to improved heating options as their higher-income neighbors, placing already cost-burdened Vermonters at the mercy of some of the most costly and least efficient ways to heat their homes. In particular, **households with lower incomes are disproportionately dependent on two of the highest-cost heating sources: fuel oil and inefficient resistance electric systems.**

In Vermont, 72% of households own their home, while 28% rent — and there are big differences in how owned versus rented homes are heated. **In rental units there is often a split incentive, where the landlord is responsible for installation of heating equipment and weatherization, but the tenant pays the utility bill.** This disincentivizes improvements that could lead to financial savings and a healthier home for many renters.

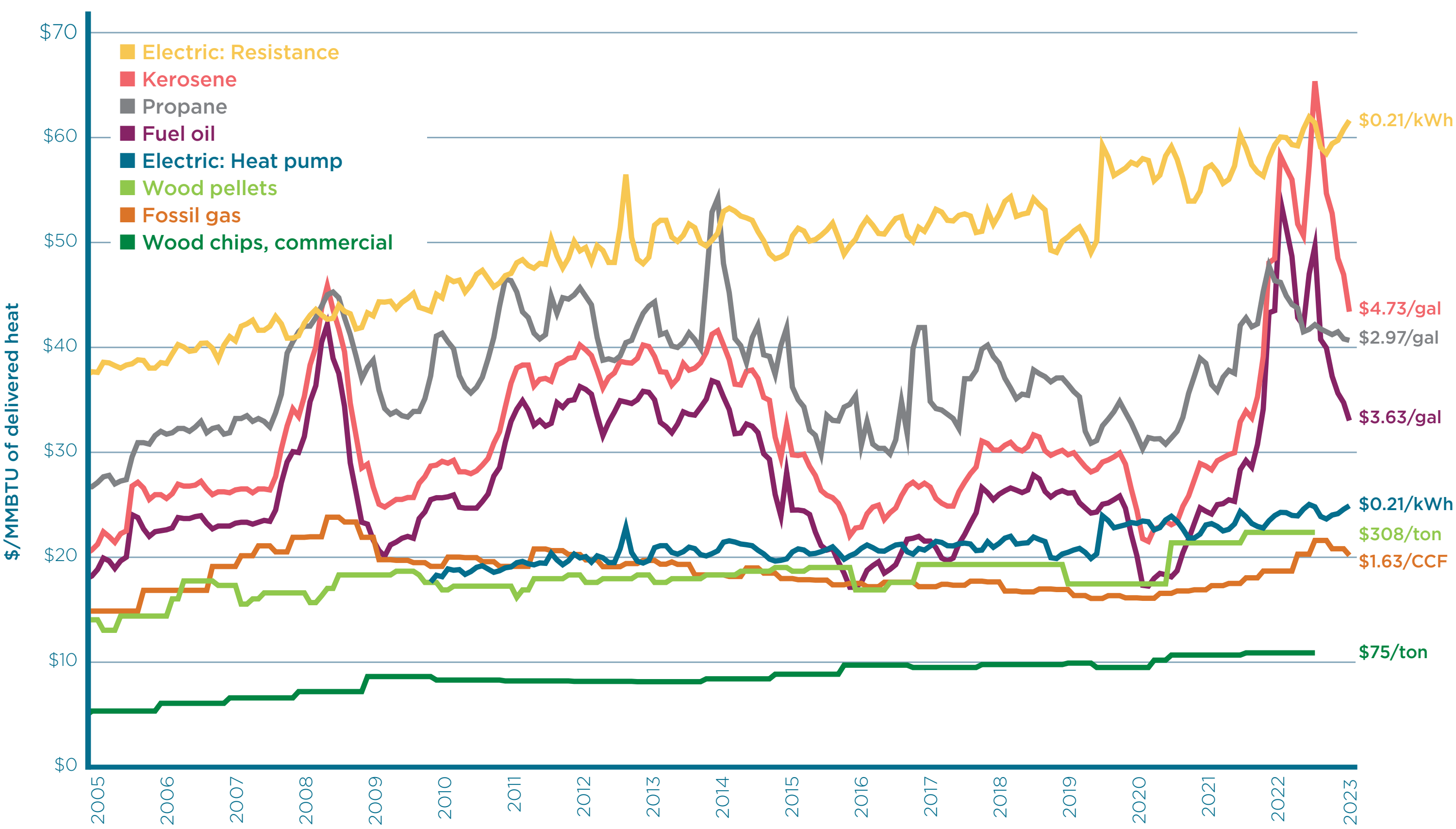
The use of electricity for heating provides a good example of this issue. ***Electric heat pumps*** are one of the most efficient, clean, and cost-effective ways to heat a home over time — but they have relatively high upfront purchase and installation costs. On the other hand, ***electric resistance heating*** (such as electric baseboard heating) is one of the most expensive ways to heat a home over time, yet it has very low upfront purchase and installation costs. This is a big reason why so many renters in the lowest third of the income distribution are still dependent on inefficient and high-cost electric resistance systems. Renters across the income spectrum are also much less likely than homeowners to have the ability to use low-cost, locally sourced wood to heat their homes.

High relative costs of home heating for Vermonters with lower incomes can lead to other inequities. For instance, households with lower incomes are more likely to find themselves choosing between adequate home heating and buying enough food for their families.

Thermal economics for Vermont and Vermonters

Fossil heating fuels like propane, fuel oil, and kerosene are high cost and price volatile. **Switching to fossil-free heating equipment, such as cold-climate heat pumps and advanced wood heat, can lower a household's energy costs while providing much more stable heating prices.** The unpredictable heating costs created by fossil fuel price volatility are especially challenging to Vermont households with lower incomes and those facing energy insecurity. Home weatherization is also a powerful strategy to decrease fuel costs, and often leads to a healthier and more comfortable home. For new buildings, meeting or exceeding energy codes and installing high-efficiency clean heating systems and appliances at the time of construction can ensure greater comfort and reduce costs over time, while avoiding fossil fuel use.

Cost comparison of different heating fuel options over time

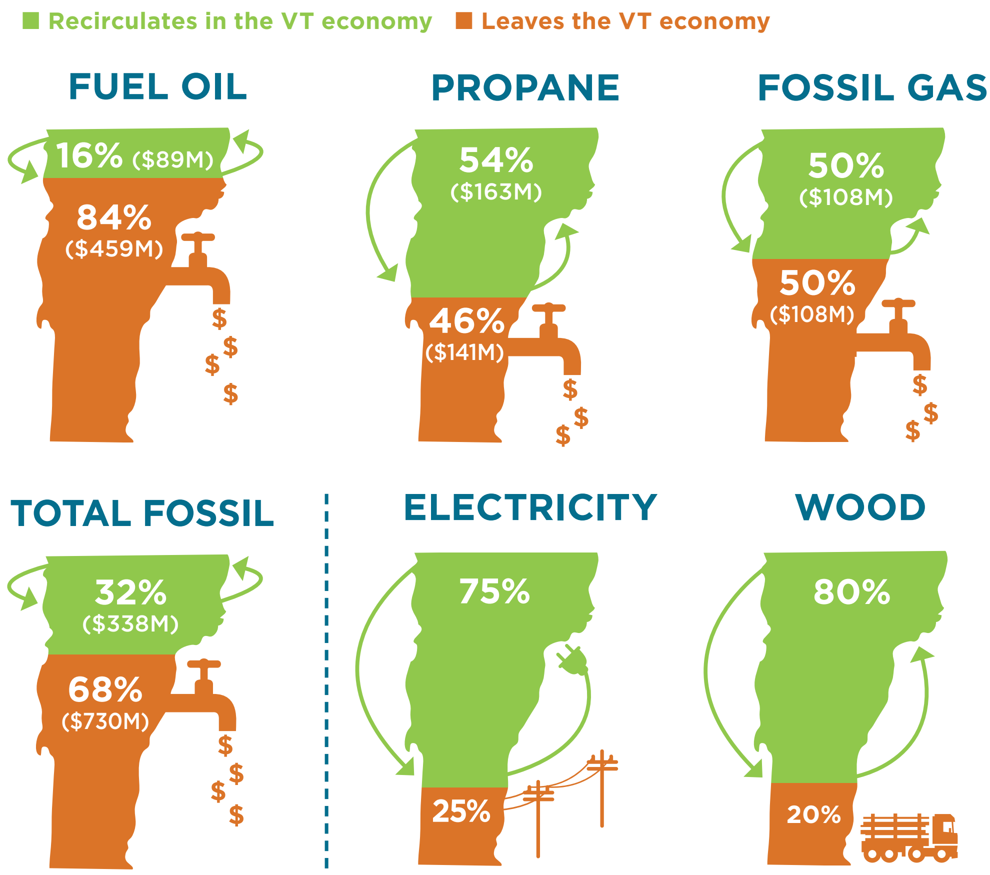


Sources: Fuel Oil, Propane, Kerosene: VT Department of Public Service, Fuel Price Report 2023. Fossil gas: VGS, 2023. Electricity: EIA, 2023. Wood Chips, Wood Pellets: Biomass Energy Research Center, 2023. **Notes:** Electricity prices presented here are a statewide average. Electricity prices vary by utility territory. The reason propane is more expensive per MMBTU than fuel oil but less expensive on a per gallon basis is because propane has a lower energy content per gallon. Propane's energy content is only 66% that of fuel oil, by gallon (EIA). Prices reflect data availability at time of publication: through November 2022 for wood fuels and through May 2023 for all others.

Switching away from fossil fuels for heating is also a boon to Vermont's economy. In 2022, Vermonters spent over $1 billion on fossil fuels for heating, with only 32% of that total staying in the Vermont economy. In contrast, when we heat with electricity and/or wood, a far greater share of money spent on heating (75% and 80%, respectively) stays and recirculates in Vermont. If more households and businesses switch to cleaner heating sources, not only can consumers save significant amounts of money on heating — more of the money they do spend will stay local, helping to employ our neighbors and strengthen the Vermont economy.

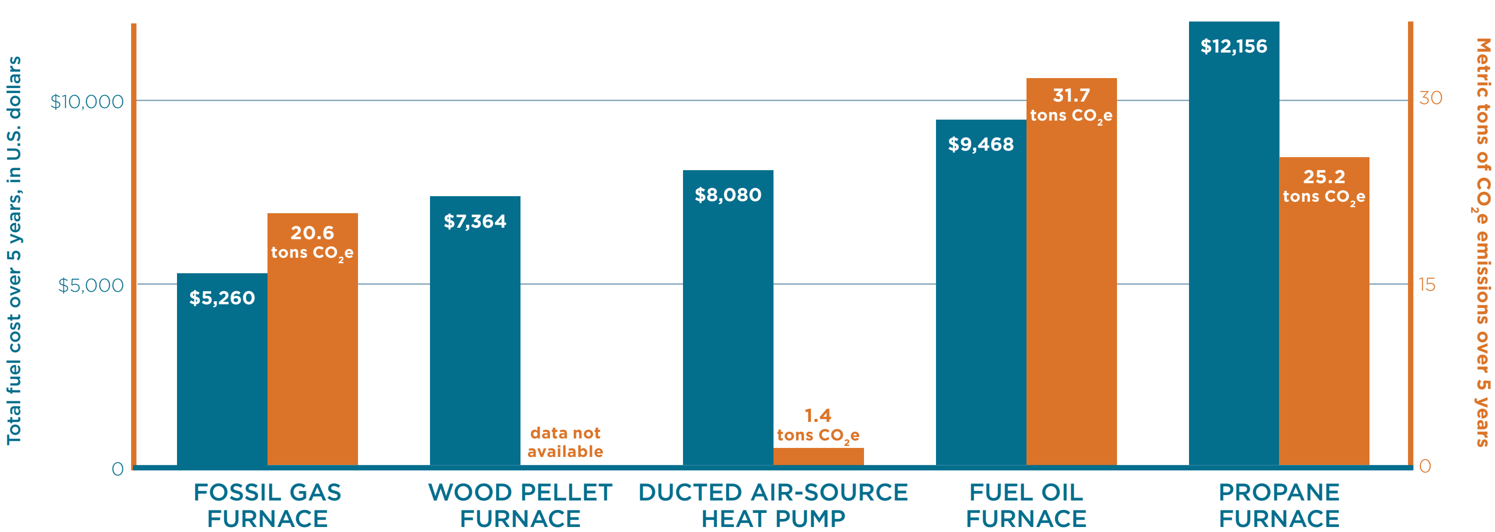
Based on the average life spans of heating equipment, each year an estimated 10,000 Vermont households replace their space heating systems and roughly 20,000 replace their water heaters.[1] **This time of change-out is a key moment of opportunity to replace old, dirty systems with more efficient and cleaner upgrades — and is also when Vermonters can avoid locking in decades of further pollution and high and unpredictable heating costs.** For instance, over the five year period from 2018-2022, Vermont households heating with propane faced average fuel costs that were over $4,000 higher than households heating with either a ducted heat pump system or a wood pellet furnace. The Inflation Reduction Act (IRA) and complementary state incentive programs will make the purchase and installation of cleaner equipment more accessible and affordable.

Thermal spending in VT, 2022



Sources: Electricity spending: Vermont Department of Taxes, 2023; VGS, 2023; Dollar recirculation share: EAN Senior Fellow for Economic Analysis, Ken Jones, 2023.

Average total 5-year heating costs and emissions by fuel in VT, 2018-2022

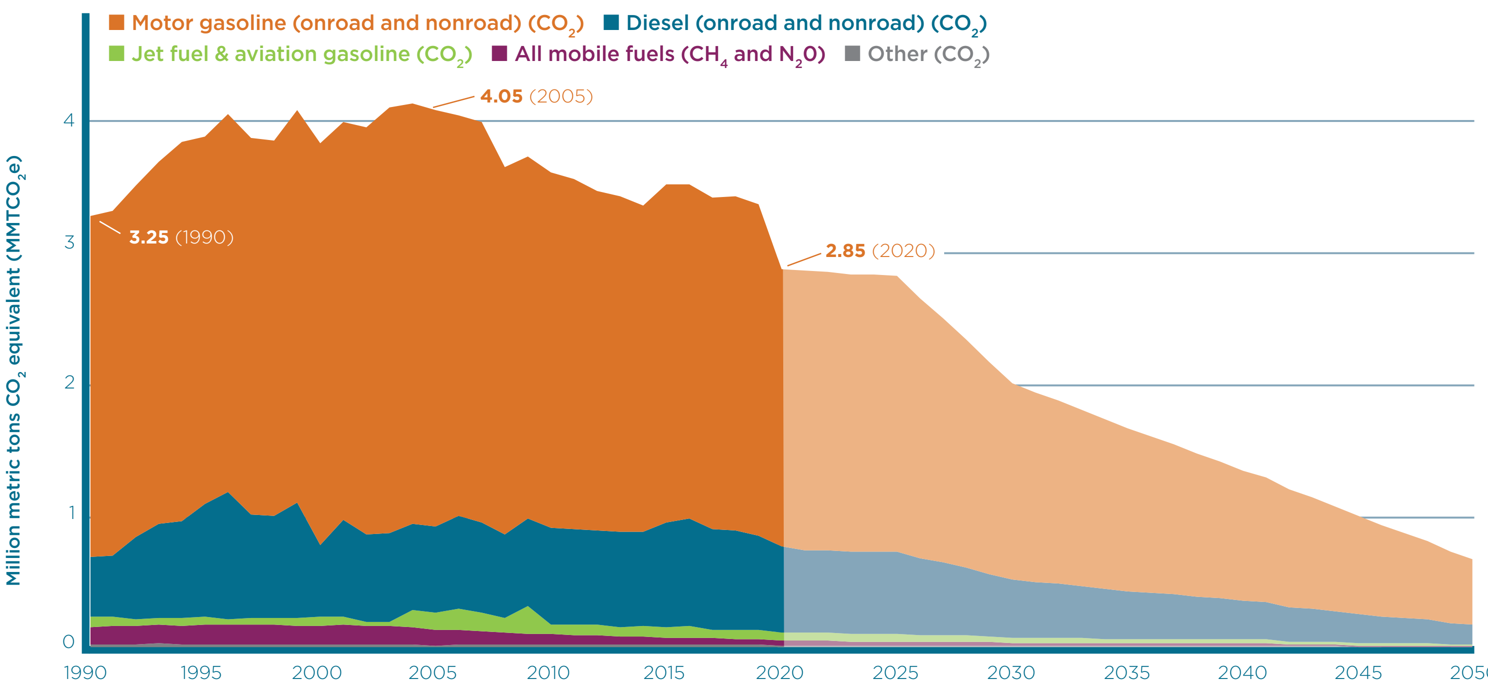


Sources: Propane and fuel oil prices: Vermont Department of Public Service, Retail Prices of Heating Fuels, 2023. Electricity prices: EIA, 2023. Fossil gas prices: VGS, 2023. Wood pellet prices: Biomass Energy Resource Center, 2023. Monthly heating degree days: NOAA/National Weather Service, 2023. Average efficiency rates of heating equipment and average heating load of a VT household: TAG Tier III Annual Report, 2021. Emissions factors for fossil fuels: EIA, 2023. Emissions factor for VT electricity: Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast: 1990-2020, 2023.

1. Estimates derived based on the number of households in Vermont (~260,000) and an assumed lifetime of 12 years for water heaters, 15 years for fossil furnaces, and 25 years for fossil boilers (2021 Efficiency Vermont Technical Reference User Manual). Approximately 72% of Vermont households are single-family homes.

Transportation sector greenhouse gas emissions and energy use

Historical VT transportation GHG emissions and future sector targets



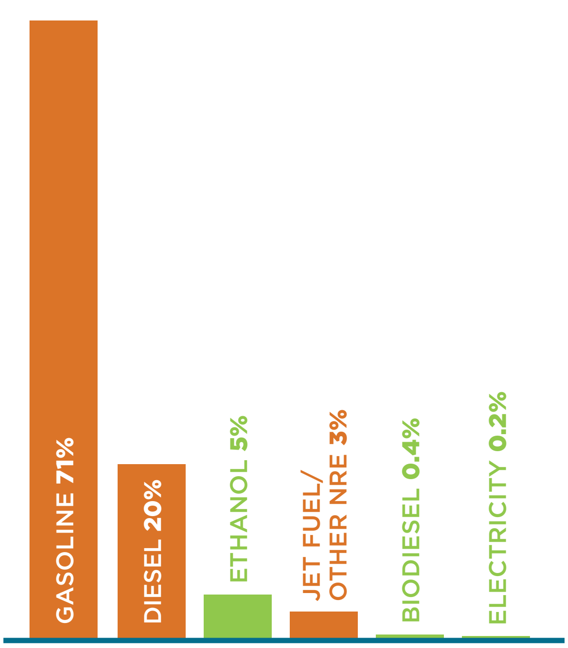
Source: Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast: 1990-2020, 2023.

Transportation GHG emissions totalled 2.85 $MMTCO_2e$ in 2020, making up 36% of Vermont's statewide climate pollution. This was both the lowest annual total for transportation emissions and the lowest share of overall emissions since the beginning of Vermont's GHG tracking (1990). However, 2020 was an outlier year: compared to 2019 there was a 15% decline in transportation emissions, as a result of the pandemic-related reduction in vehicle travel.

It is likely that we will see a partial rebound in intransportation emissions in Vermont's next GHG Inventory, given that initial data show gasoline and diesel sales increased by about 8.5% from 2020 to 2021.[1] That is likely to drive total 2021 statewide emissions higher than 2020 emissions.

94% of the energy we use for transportation currently comes from heavily polluting fossil fuels — a much higher share of fossil fuel dependence than in any other energy sector. Gasoline accounts for 71% of total transportation energy use, primarily in passenger vehicles, while diesel makes up another 20%. In order to make durable reductions in climate pollution from the transportation sector, Vermont will need to move as quickly and comprehensively as possible beyond the use of fossil fueled, internal combustion vehicles.

VT transportation energy sources, 2021



Sources: VT Department of Taxes, 2023; EIA State Energy Data System, 2023; Efficiency Vermont, 2023. Electricity used for transportation estimated based on EV registrations as of Dec. 2021 and efficiency and VMT assumptions from the 2021 VT Transportation Energy Profile.

1. Vermont Legislative Joint Fiscal Office, 2023.

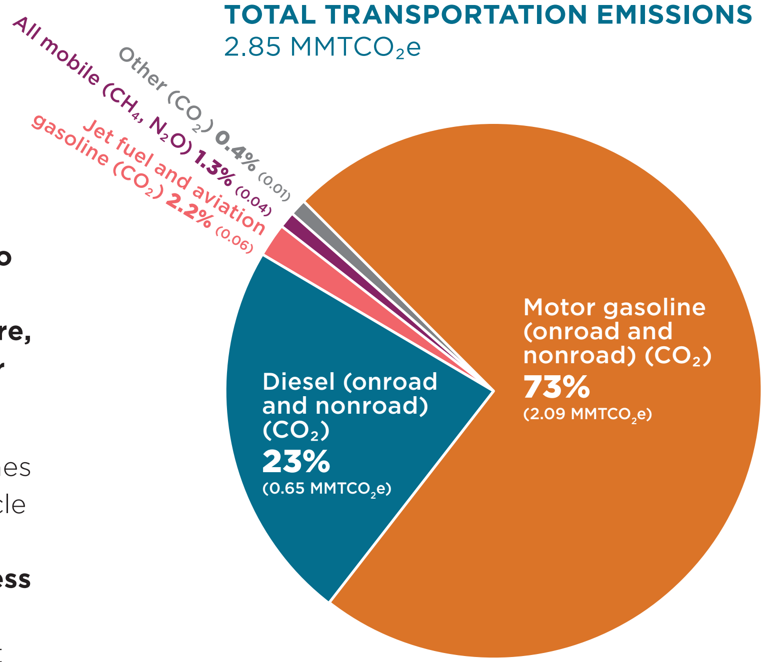
Vermont's GHG Inventory reports "tailpipe" emissions from the use of transportation fuels. However, an important question relates to the full *lifecycle* emissions created by different kinds of vehicles, since GHG emissions are also created during the manufacture and maintenance of vehicles.

Because of the energy used in the manufacture of batteries, EVs tend to be responsible for more GHGs in the initial production phase than internal combustion engine (ICE) vehicles. However, **due to their higher operating efficiency and the lower GHG profile of electricity than fossil fuels, EVs are, on the whole, much less polluting than ICEs over the life of the vehicle.**

Across the U.S., EVs are, on average, about 2.5 times less climate polluting than gas vehicles on a lifecycle basis. **With Vermont's relatively clean electricity portfolio, EVs end up being more than 5 times less climate polluting on a lifecycle basis compared to gas vehicles.** As both the U.S. and the Vermont electricity portfolios become lower emitting, GHG emissions associated with charging an EV, and therefore overall lifecycle emissions, will continue to decline over time.

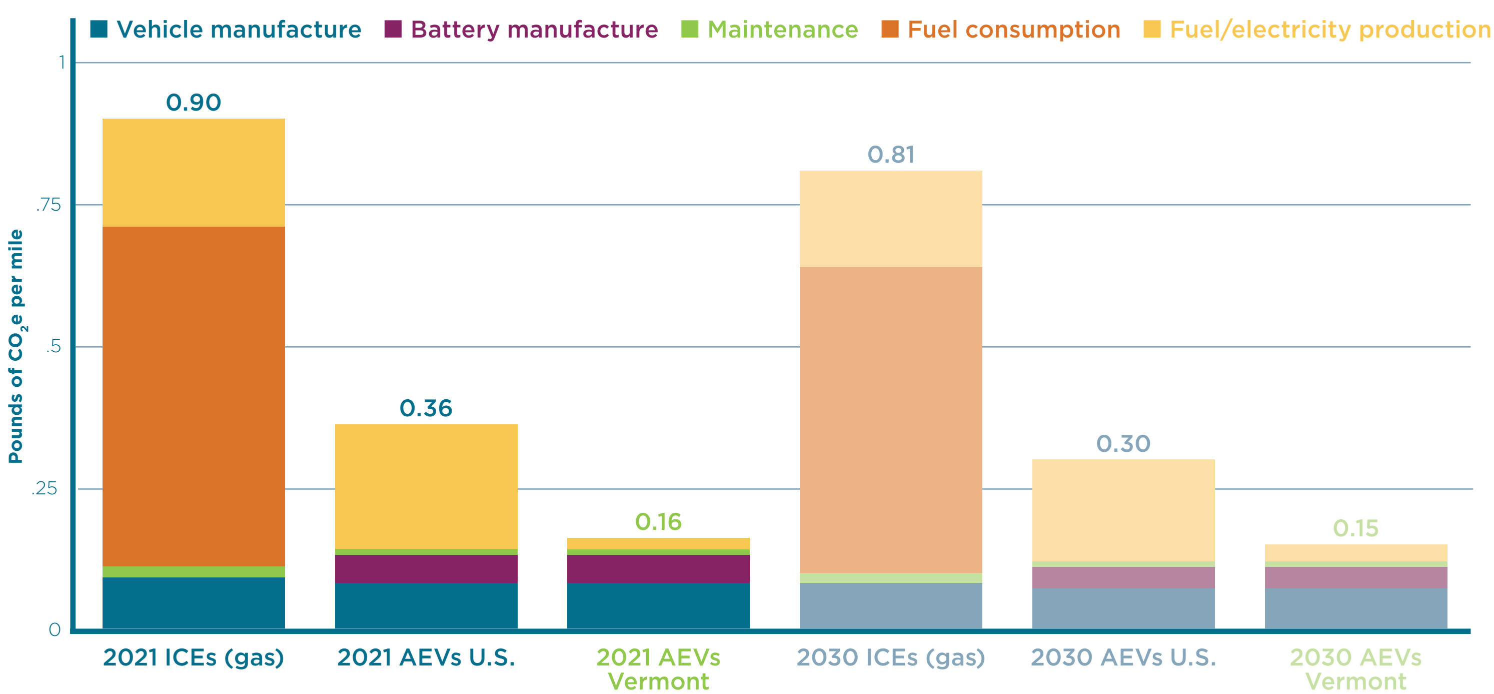
VT GHG emissions from transportation by source, 2020

TOTAL TRANSPORTATION EMISSIONS
2.85 $MMTCO_2e$



Source: Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast: 1990-2020, 2023.

Lifecycle GHG emissions of gas vs electric vehicles in the United States and Vermont



Sources: ICCT, "A Global Comparison of the Life-Cycle Greenhouse Gas Emissions of Combustion Engine and Electric Passenger Cars," 2021. VT electricity GHG emissions (actual and projected): Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast: 1990-2020, 2023. Average AEV efficiency: Vermont Agency of Transportation, Transportation Energy Profile, 2021. VT average VMT per capita: Federal Highway Administration, 2023. **Note:** AEV = all-electric vehicle, ICE = internal combustion engine vehicle. Emissions from AEVs are presented separately for the US and Vermont because Vermont's electricity portfolio is much lower-emitting than the national average. Emissions from AEVs in 2030 are expected to be lower than in 2021 because of the continued decarbonization of the electricity sector.

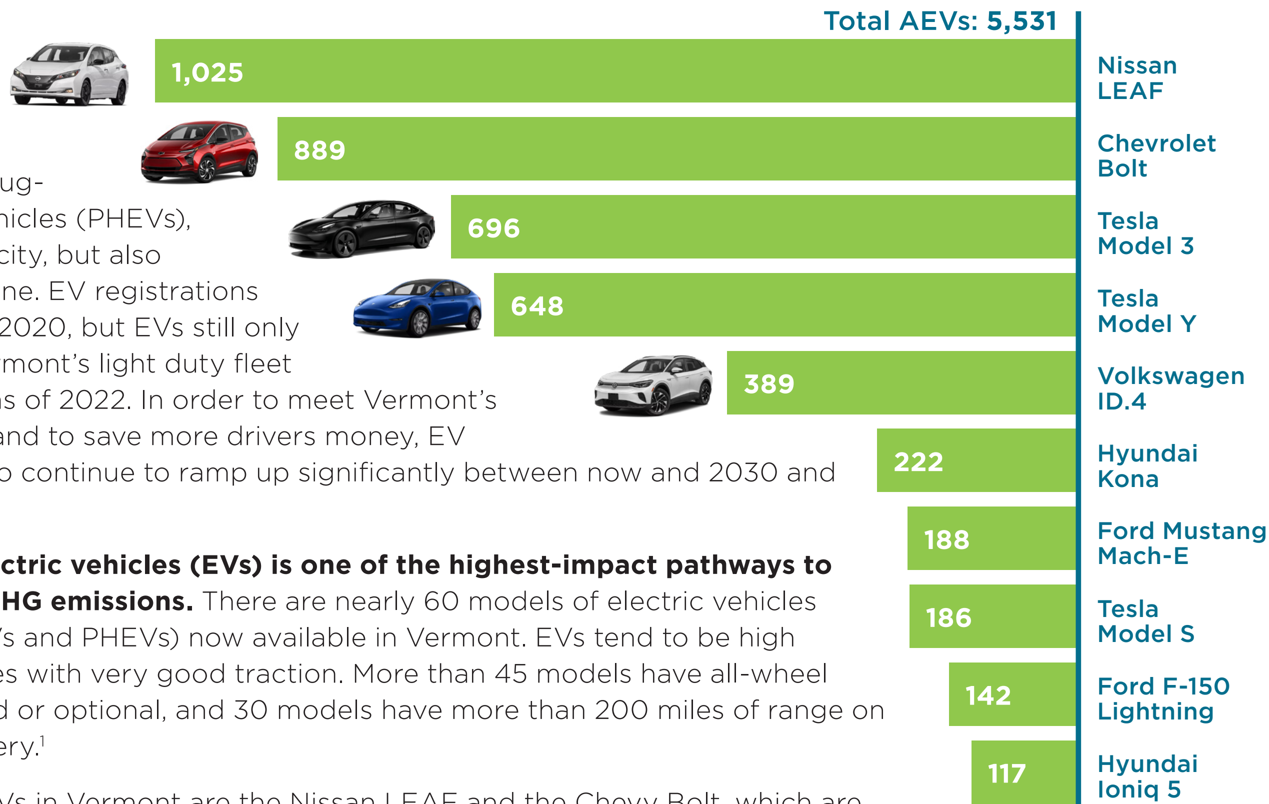
Vermont's growing EV fleet

In July 2023, there were 10,022 electric vehicles (EVs) registered in Vermont. This included 5,531 all-electric vehicles (AEVs), and 4,491 plug-in hybrid electric vehicles (PHEVs), which run on electricity, but also have a gasoline engine. EV registrations have doubled since 2020, but EVs still only made up 1.5% of Vermont's light duty fleet of 591,273 vehicles as of 2022. In order to meet Vermont's climate obligations and to save more drivers money, EV adoption will need to continue to ramp up significantly between now and 2030 and beyond.

Transitioning to electric vehicles (EVs) is one of the highest-impact pathways to reduce statewide GHG emissions. There are nearly 60 models of electric vehicles (including both AEVs and PHEVs) now available in Vermont. EVs tend to be high performance vehicles with very good traction. More than 45 models have all-wheel drive either standard or optional, and 30 models have more than 200 miles of range on a fully charged battery.[1]

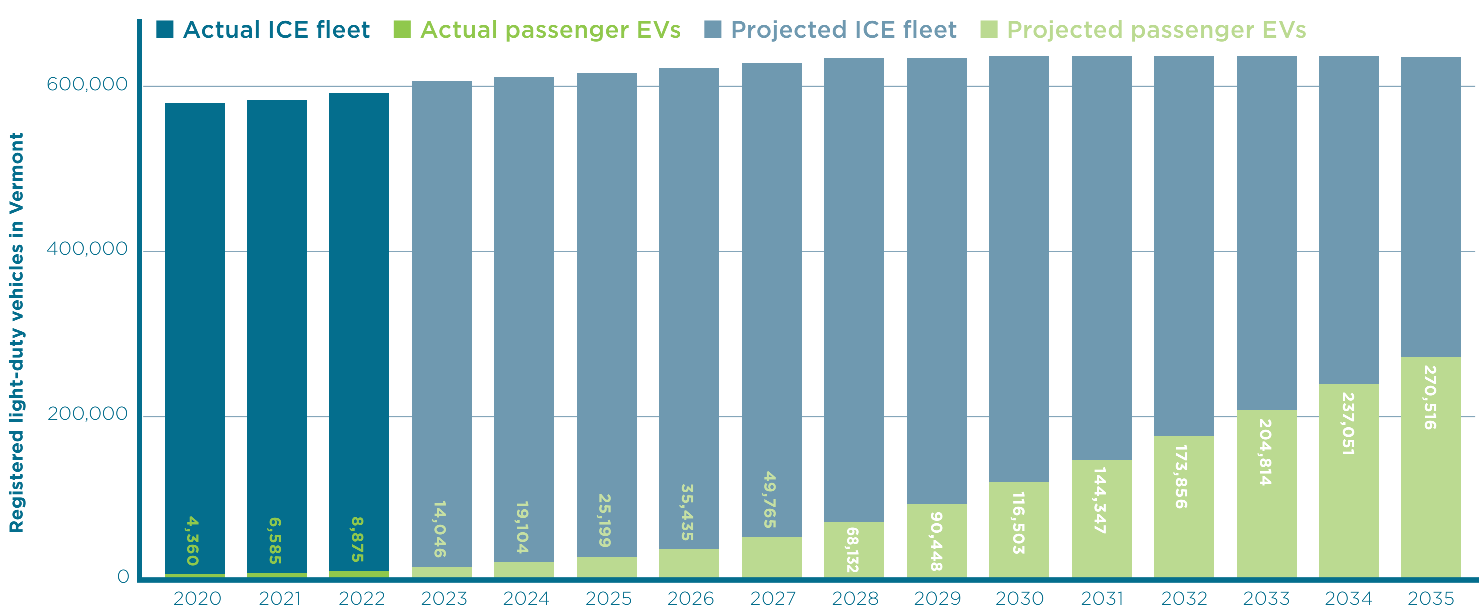
The most popular EVs in Vermont are the Nissan LEAF and the Chevy Bolt, which are two of the most affordable AEV models on the market. **Details about all available EVs, cost reducing incentives, and much more can be found on the Drive Electric Vermont website (driveelectricvt.com).**

Top 10 all-electric vehicle (AEV) models registered in Vermont, as of July 2023



Source: Drive Electric Vermont, July 2023 EV Registration Updates, 2023. **Note:** In addition to 5,531 AEVs, there were also 4,491 plug-in hybrid electric vehicles (PHEVs) registered in VT.

Vermont EV registrations: Actual and projected



Sources: Total fleet historical data: VT Agency of Natural Resources (ANR), 2023. Historical EV registrations: Drive Electric VT, 2023. Projectsions: Cadmus/EFG for ANR, "Vermont Pathways Analysis Report 2.0", 2022. **Notes:** ICE refers to internal combustion engine gas and diesel vehicles. EV registrations include both all-electric vehicles (AEVs) and Plug-in Hybrid Electric Vehicles (PHEVs).

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1. Drive Electric VT, 2023.

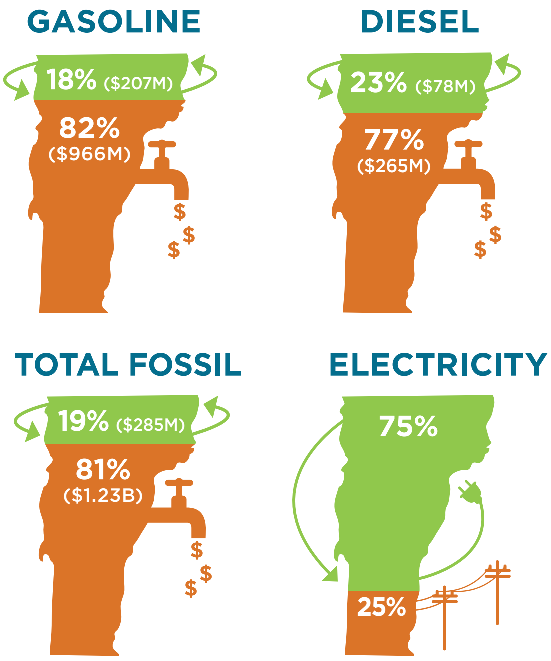
Transportation economics for Vermont and Vermonters

Shifting from fossil fuel to electricity as our primary energy source for transportation can benefit both consumers and the Vermont economy. **In 2022, Vermonters spent more than $1.5 billion on fossil fuels for transportation and only 19% of these dollars recirculated in the state's economy, with the rest immediately draining out of state.** In contrast, for every dollar we spend on electricity, approximately 75% stays and recirculates in the Vermont economy.

As has been especially clear in the last couple of years, drivers of gasoline and diesel vehicles are subject to high levels of volatility in fuel prices. **Electric vehicle charging costs, on the other hand, are consistently lower on a gallon-equivalent basis and much more stable.**

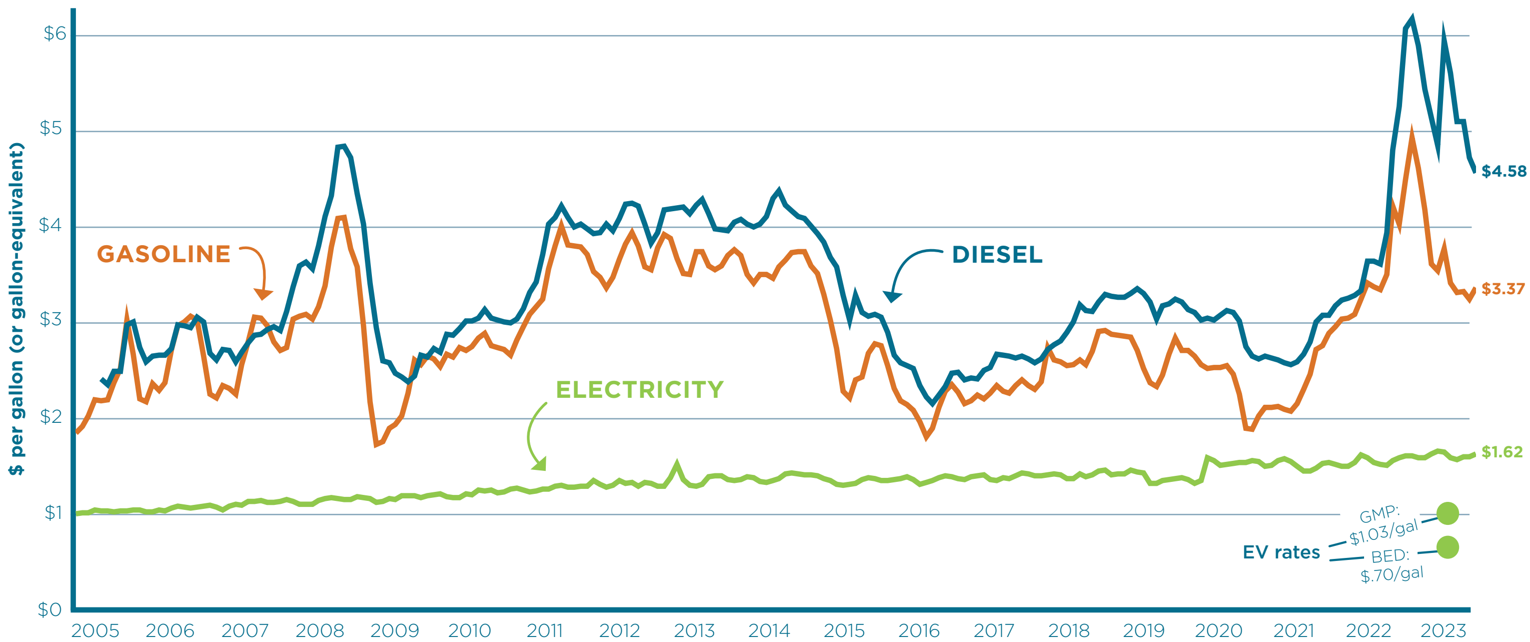
Some vehicle charging can be done at very low rates through utility programs like Burlington Electric Department's EV rate of 8.9¢/kWh (equivalent to about $0.70/gallon), or Green Mountain Power's (GMP) EV rate of 14.3¢/kWh (equivalent to about $1.03/gallon). While Vermont currently has the highest number of public charging stations per capita,[1] additional EV charging infrastructure — especially at multi-unit housing, workplaces, and public locations — is still needed to achieve a more equitable transition to electric vehicles.

Transportation spending in VT, 2022



Sources: Electricity spending: Vermont Department of Taxes, 2023; Dollar recirculation share: EAN Senior Fellow for Economic Analysis, Ken Jones, 2023.

Cost comparison of different transportation fuels over time in VT



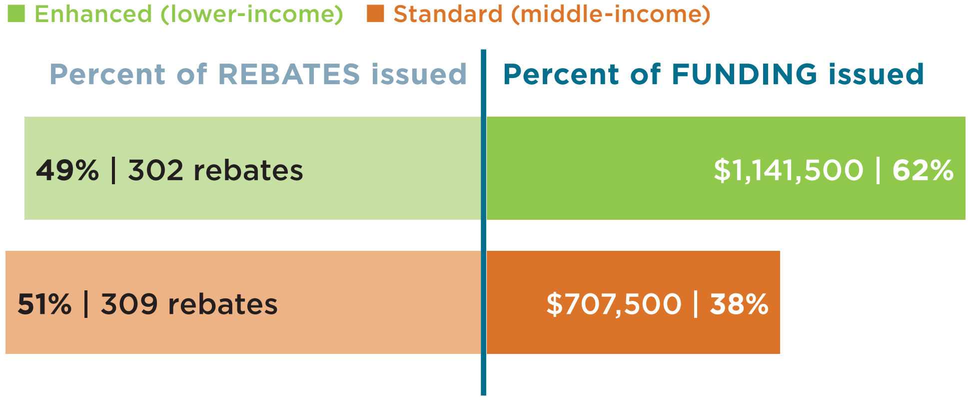
Sources: Gas and electric prices: EIA, 2023. Diesel: Vermont Agency of Transportation, 2023. EV rates: Green Mountain Power and Burlington Electric Department, 2023.
Note: Prices only available through April 2023 at time of publication.

1. Vermont Agency of Commerce and Community Development, 2023.

EVs save drivers money over time, especially with incentives

When comparing vehicle costs, it is important to look at the whole picture. While many electric vehicles have higher manufacturer's suggested retail prices (MSRPs) than comparable gas models, once federal, state, and utility incentives are factored in, the upfront cost of a new EV is often less than that of a new gas vehicle. **While Vermonters with moderate incomes have received slightly more of the incentives issued by the State (51%), nearly two-thirds of total incentive dollars (62%) have gone to Vermonters with lower incomes.** Vermont EV incentive funds are devoted to households with lower and moderate incomes, and for vehicles priced below a certain cap. This means that drivers with the highest incomes are ineligible for state incentives, as are those purchasing the most expensive EVs.

State incentives for new EVs, by income level



Source: Drive Electric VT/Center for Sustainable Energy, State Incentive Electric Vehicle Sales Dashboard, 2023. **Note:** Data shown here covers incentives issued for new EVs between July 7, 2022, and July 6, 2023. Detailed information on income eligibility for the enhanced and standard incentives can be found at driveelectricvt.com/incentives.

While incentives for new EVs are important, about two thirds of Vermonters purchase used vehicles.[1] Starting in 2023, federal incentives became available for used EVs as a non-refundable tax credit, which will be available as a more equitable point-of-sale rebate starting in January 2024. **The federal rebate can be combined with state and utility incentives to cut the cost of a used EV by up to $16,500 for Vermonters with lower incomes.**

Example cost of a used EV after incentives

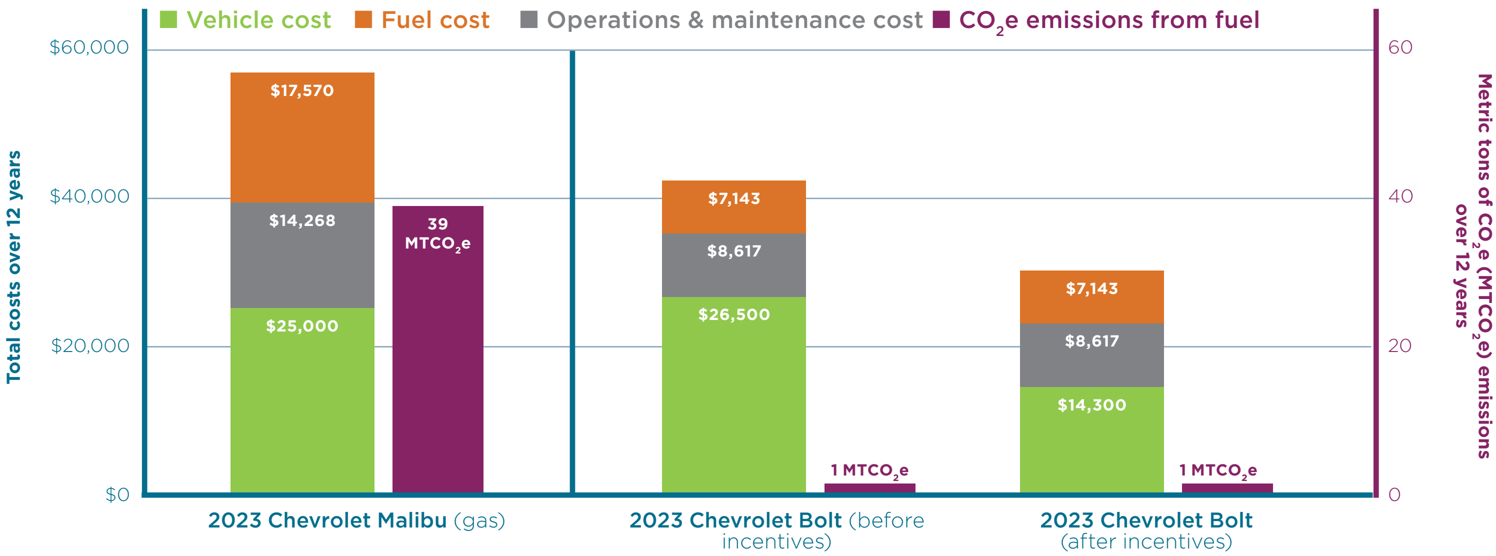
	< $50,000 income incentive	Standard incentive
Used 2021 Nissan LEAF S Plus cost	**$18,148**	**$18,148**
State: MileageSmart*	-$4,537	$0
State: Replace Your Ride**	-$5,000	-$2,500
Federal incentive***	-$4,000	-$4,000
Utility: GMP	-$2,500	-$1,500
Total incentives	**-$16,037**	-$8,000
Cost after incentives	**$2,111**	**$10,148**

Sources: Incentive amounts and eligibility: Drive Electric VT. Pre-incentive vehicle cost: Kelley Blue Book, typical listing price for a used 2021 Nissan LEAF S Plus. **Note:** Incentives vary based on household size, income level, and utility territory. To find out what you would be eligible for, go to driveelectricvt.com. *MileageSmart covers 25% of the cost of a used EV, up to $5,000. **Replace Your Ride is available to consumers scrapping an old ICE vehicle. ***Federal incentive is a non-refundable tax credit in 2023. In 2024 it will become a point-of-sale incentive.

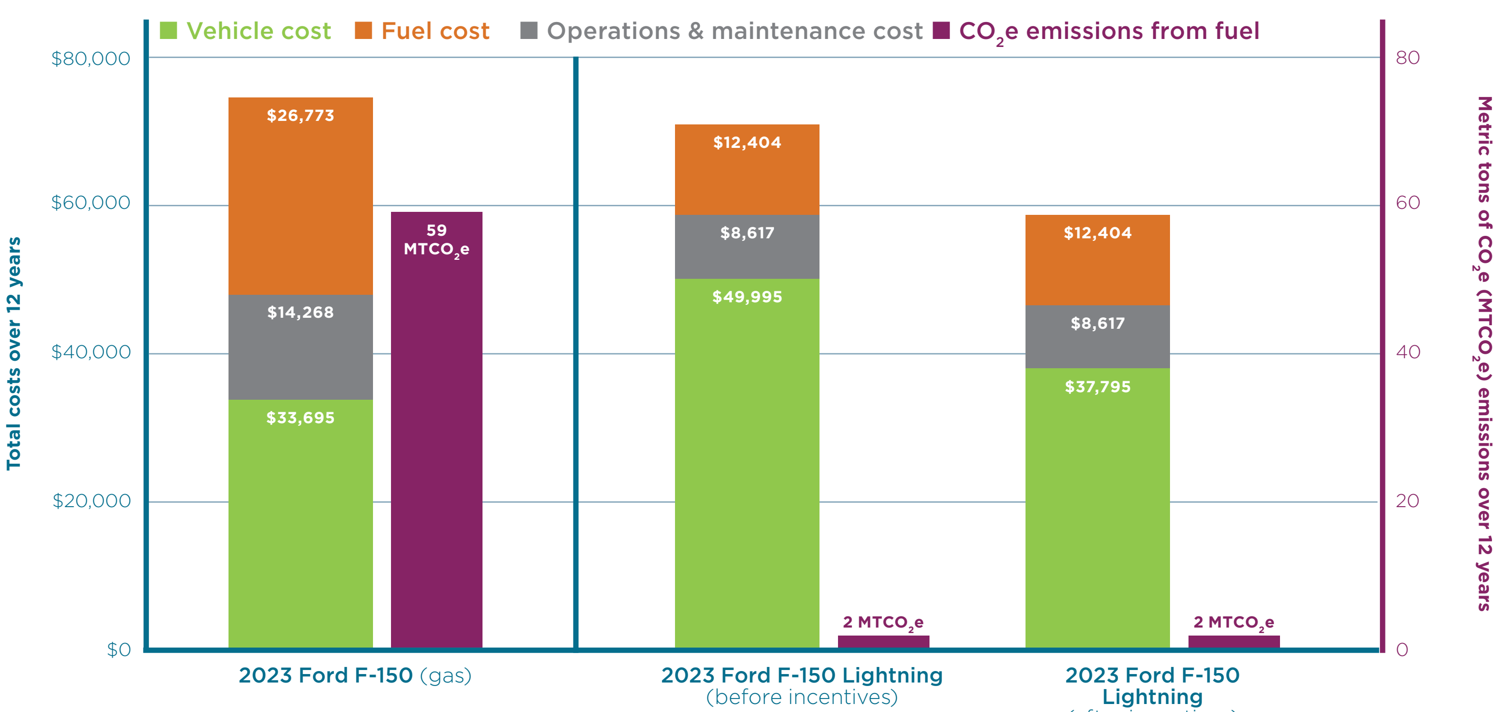
1. Vermont Department of Motor Vehicles, 2014-2018.

EV drivers also enjoy significant savings on fuel and, in the case of all-electric vehicles, on maintenance. All together, **EV drivers benefit from much lower lifetime costs of ownership than drivers of gas and diesel vehicles**. For instance, the lifetime cost of a 2023 Chevy Bolt (all-electric) is about *half* the cost of a comparable Chevy Malibu (gas) — while creating only a small fraction of the emissions from fuel use.

Lifetime costs and tailpipe emissions of comparable gas vs electric passenger cars



Lifetime costs and tailpipe emissions of comparable gas vs electric pickup trucks

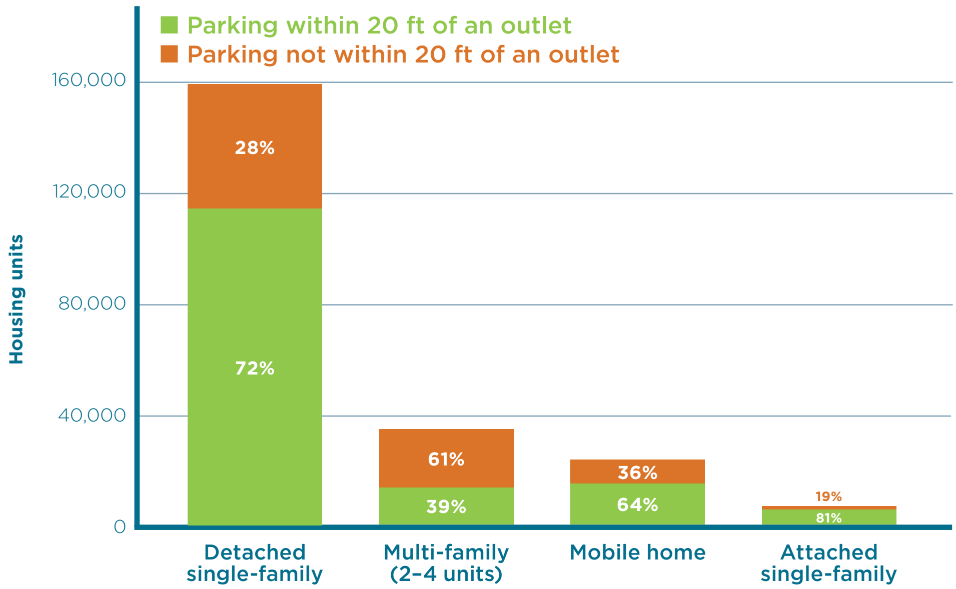


Sources: For vehicle costs: Drive Electric Vermont, 2023; Ford.com, 2023; and Chevrolet.com, 2023. For gasoline emissions: EIA, "Carbon Dioxide Emissions Coefficients". For electricity emissions: "Assessing the GHG Impact of Beneficial Electrification in Vermont," EAN, 2023. For fuel prices: Vermont Public Service Department, 2022, and GMP, 2023. For O&M costs: U.S. Department of Energy, "FOTW #1190, Battery-Electric Vehicles Have Lower Scheduled Maintenance Costs than Other Light-Duty Vehicles", 2021. **Notes:** Fuel costs are based on the 2022 average of $3.98/gallon of gasoline, and the March 2023 Green Mountain Power rate of $0.18/kWh of electricity. CO_2e value for VT electricity is 71 lbs/MWh. CO_2e value for gasoline is 19.4 lbs/gallon. Equipment costs represent the base MSRP for 2023 models. Fuel/charging costs can be even lower than presented with the use of EV charging rates offered by some utilities.

EV affordability and access

Vermonters in multi-family buildings (primarily renters) often have less access to EV charging at home than Vermonters who live in single-family homes. This leaves many EV drivers who live in multi-family buildings dependent on more expensive public charging options, and lessens the potential EV cost savings for Vermonters who rent and often have lower incomes. Unfortunately, this creates a significant barrier to EV adoption among the very Vermonters for whom cost savings could make the most difference.

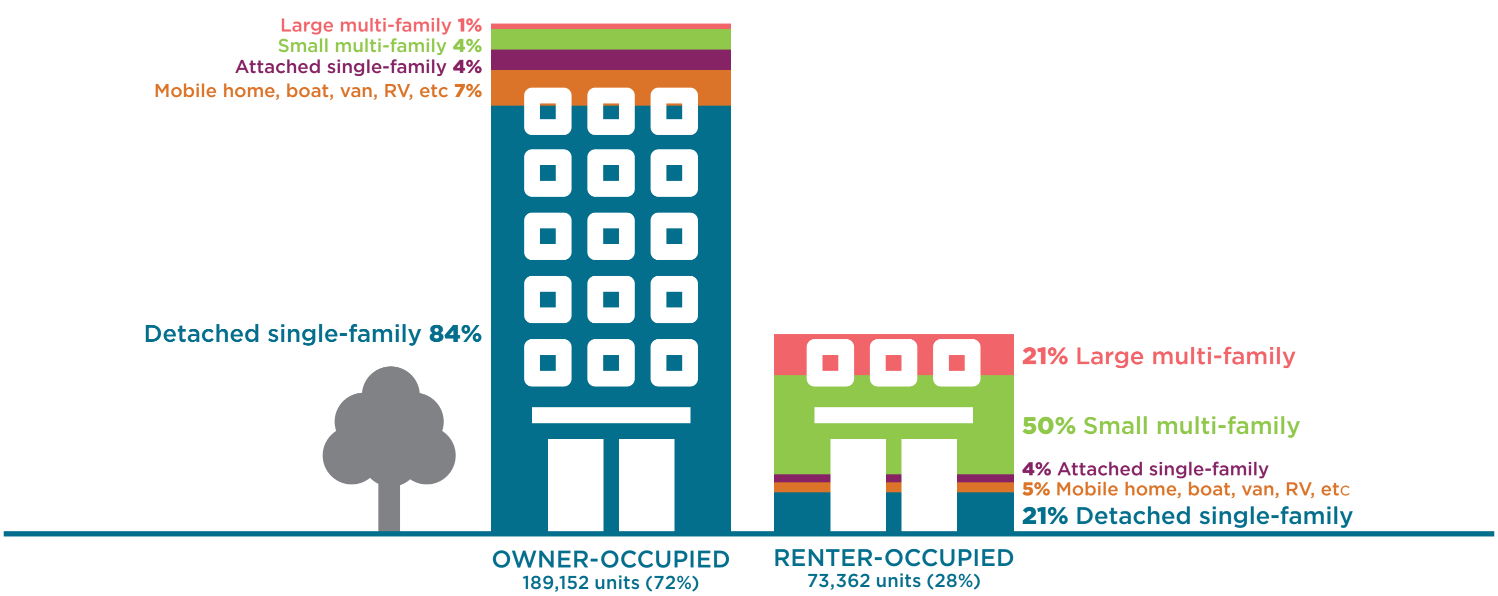
Parking proximity to an electrical outlet by building type in VT, 2020



Source: EIA, 2020 Residential Energy Consumption Survey (RECS) Data, 2023.

To realize the maximum cost-saving benefits of EVs, access to at-home or at-work charging is very important, since those rates tend to be much lower than public charging rates. For instance, the EV rate available to GMP's residential and commercial customers for at-home and at-work charging is about $0.14/kWh.[1] Level 2 public charging rates (about $0.20/kWh on average) are higher than most at-home or at-work charging rates, but they are still much lower than gasoline or diesel on a gallon-equivalent basis.[2] The fastest public chargers, known as DC Fast Chargers, have the highest rates, usually between $0.35 to $0.50/kWh (though even these rates can be cheaper than gasoline and diesel, depending on current pricing).[3]

Vermont housing units by tenure and type, 2017-2021



Source: U.S. Census Bureau, 2017-2021 American Community Survey 5-Year Estimates. **Note:** A small multi-family building contains 2–9 units; a large multi-family contains 10+ units.

1. Green Mountain Power, 2023.
2. $0.20/kWh is roughly equivalent to a gasoline price of $1.50 per gallon, whereas the average price of gasoline in Vermont in 2022 was $3.98 per gallon.
3. Drive Electric VT, 2023.

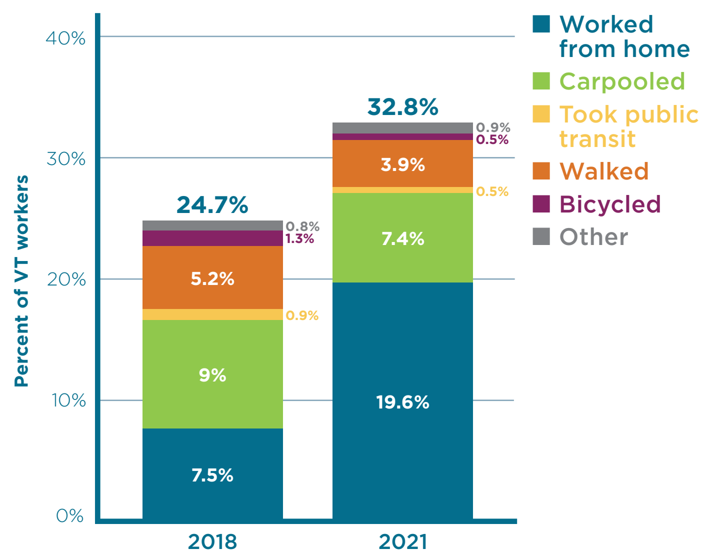
Transportation beyond personal vehicles

Vermont has seen significant shifts in transportation patterns in the last several years. Between 2018 and 2021, the share of Vermonters who commute to work in a single-occupancy vehicle decreased from just over 75% to 67%. This was driven by a significant increase in the share of Vermonters working from home (from 7.5% in 2018 to almost 20% in 2021) — a lasting effect of the pandemic. However, the pandemic also led to a *decrease* in all other commute modes besides telecommuting. In 2021, only 4.4% walked or biked to work, and only 0.5% used public transit, while these numbers were previously higher.

In Vermont, discussions around transportation often assume that most people have access to private vehicles. However, 25% of Vermonters do not have a driver's license — including youth, elders, people with disabilities, and people who choose not to drive.

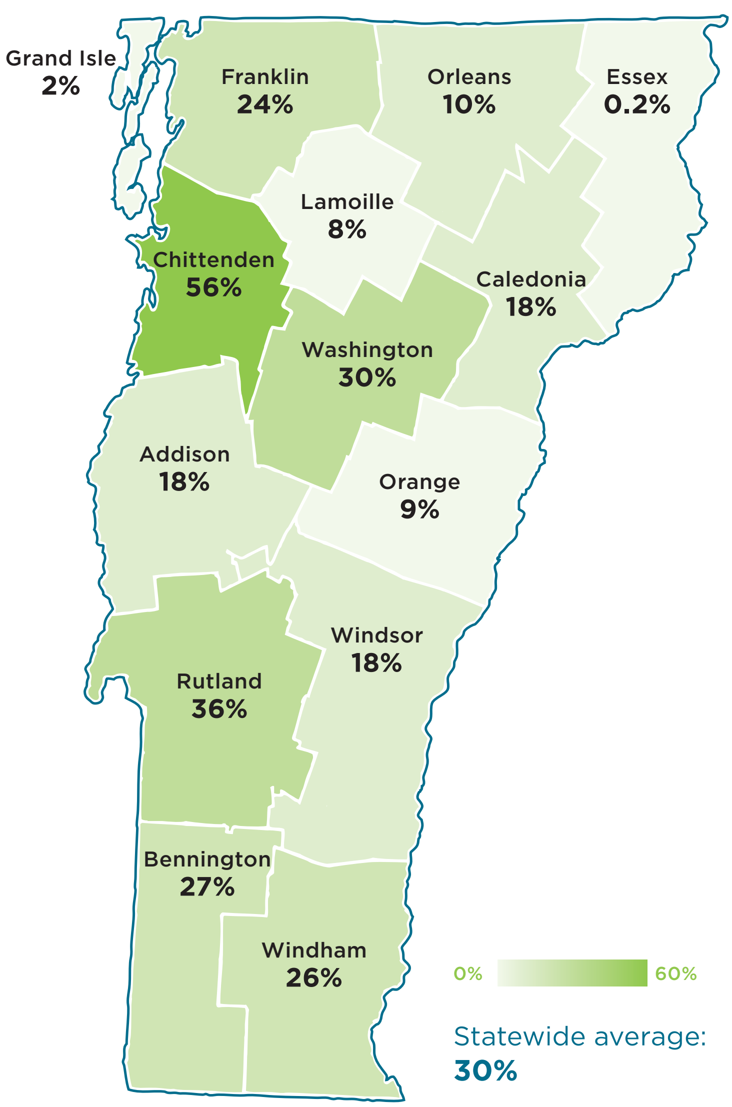
Access to safe, reliable, and affordable transportation options beyond personal vehicles is key to ensuring that all Vermonters can access jobs and community services, and participate in social and civic life. Given that Vermont is a largely rural state, many communities lack reliable access to public transit or safe walking and biking routes. That said, about 30% of Vermont households are within half a mile of a public transit line (though in many counties the share is much lower).

Usual commute mode in VT other than by single occupancy vehicle, 2018 vs 2021



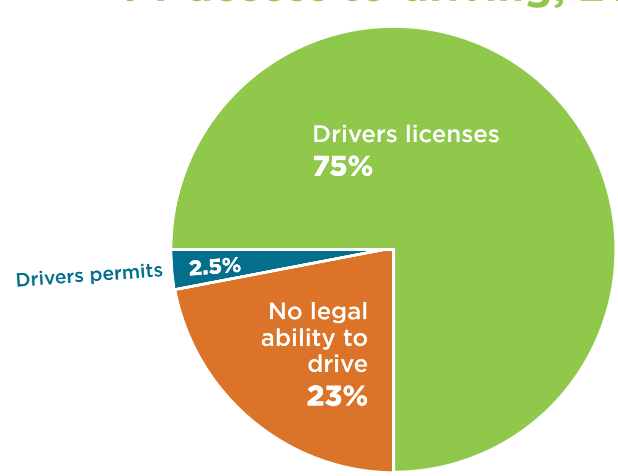
Source: U.S. Census Bureau, American Community Survey 1-year estimates, 2018 & 2021.

Percent of VT households located within half a mile of public transit



Source: Center for Neighborhood Technology, AllTransit Metrics, 2019.

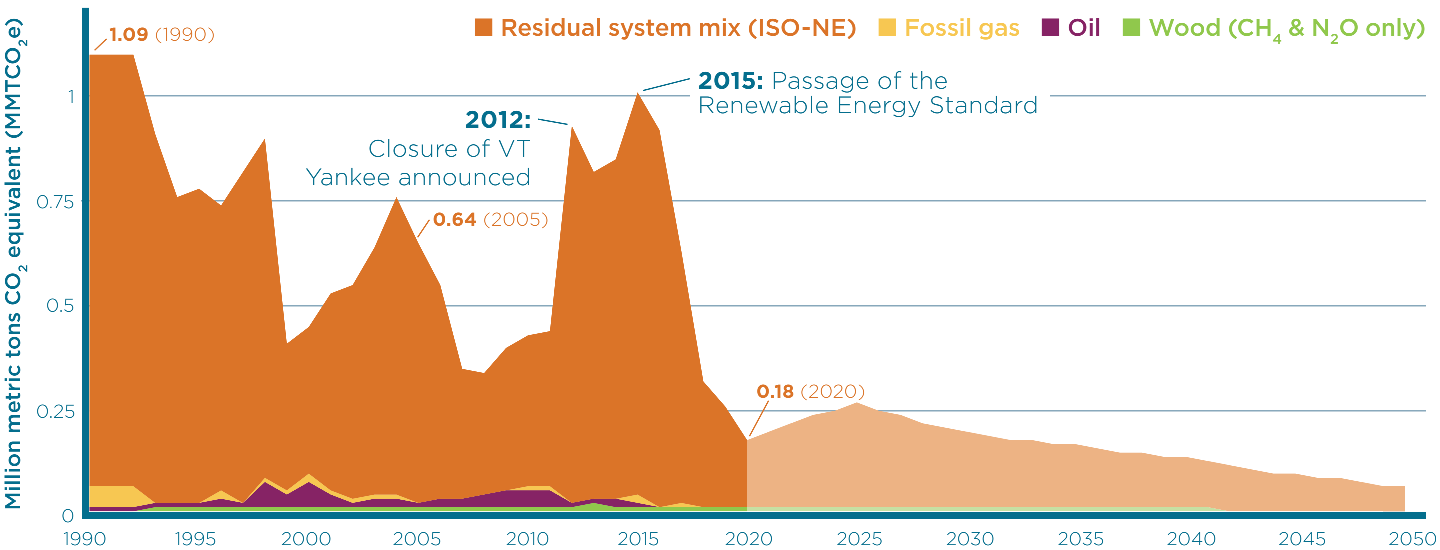
VT access to driving, 2020



Source: Vtrans, Vermont Transportation Energy Profile, 2021.

Electricity sector greenhouse gas emissions and energy use

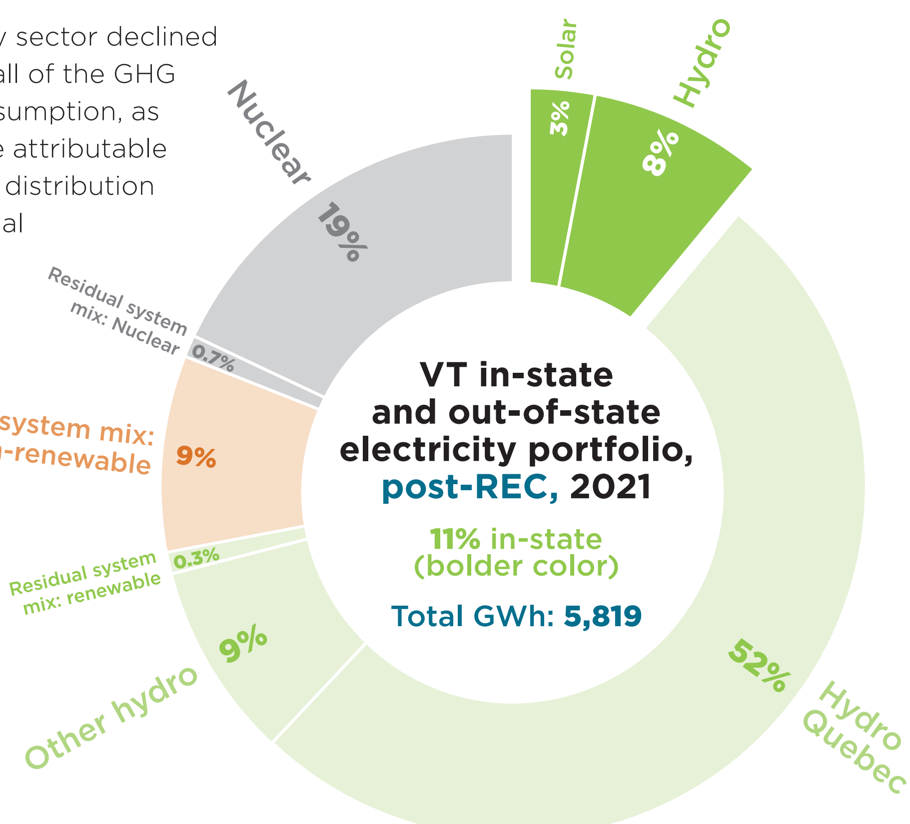
Historical VT electricity GHG emissions and future sector targets



Source: Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast: 1990-2020, 2023. **Note:** Since hydroelectricity does not produce GHG emissions at the point of generation, it has historically been counted as zero emissions by VT Agency of Natural Resources. However, a supplemental lifecycle emissions inventory for all of VT's energy use was underway as of August 2023.

GHG emissions from Vermont's electricity sector declined by 80% between 2015 and 2020. Nearly all of the GHG emissions from Vermont's electricity consumption, as reported in Vermont's GHG Inventory, are attributable to the portion of electricity that Vermont distribution utilities purchase from the regional residual system mix through New England's grid operator, ISO New England (ISO-NE).

The reduction in GHG emissions from Vermont's electricity sector is the combined result of two trends. First, between 2015 and 2021, the portion of Vermont's electricity portfolio from the ISO-NE residual system mix decreased from 52% to 10%,[1,2] as utilities met and exceeded Renewable Energy Standard (RES) requirements. At the same time, the renewability of the entire ISO-NE generation system has increased from just 4% in 2010 to 17% in 2021.[3]



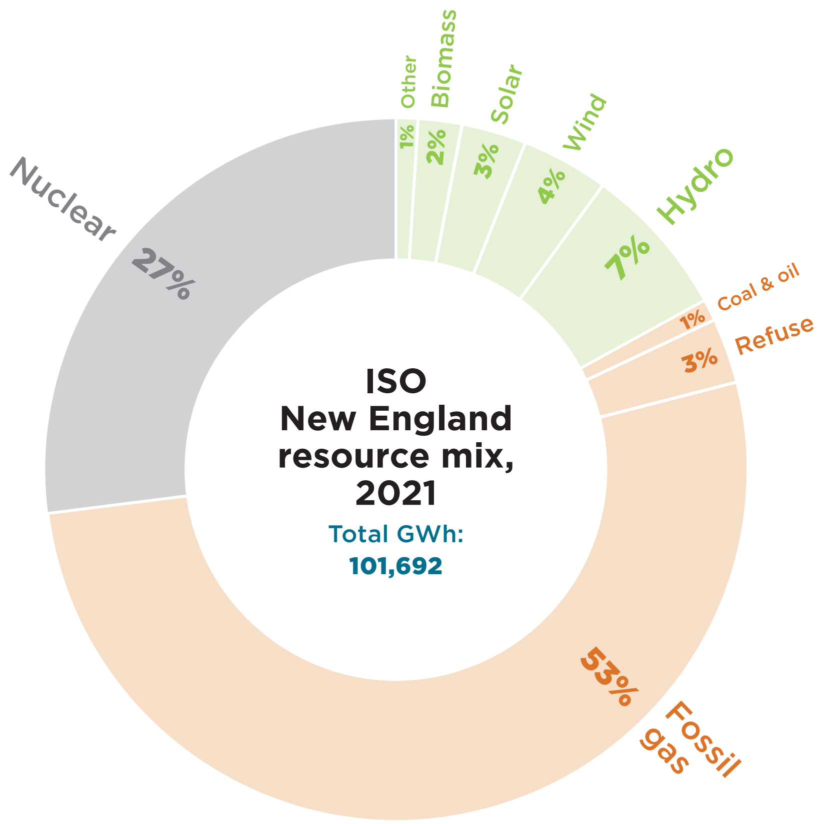
Source: Vermont Department of Public Service, 2021 Electric Utility Resource Survey.
Note: Non-renewable is primarily energy from fossil fuels.

1. Vermont Department of Public Service, 2023.

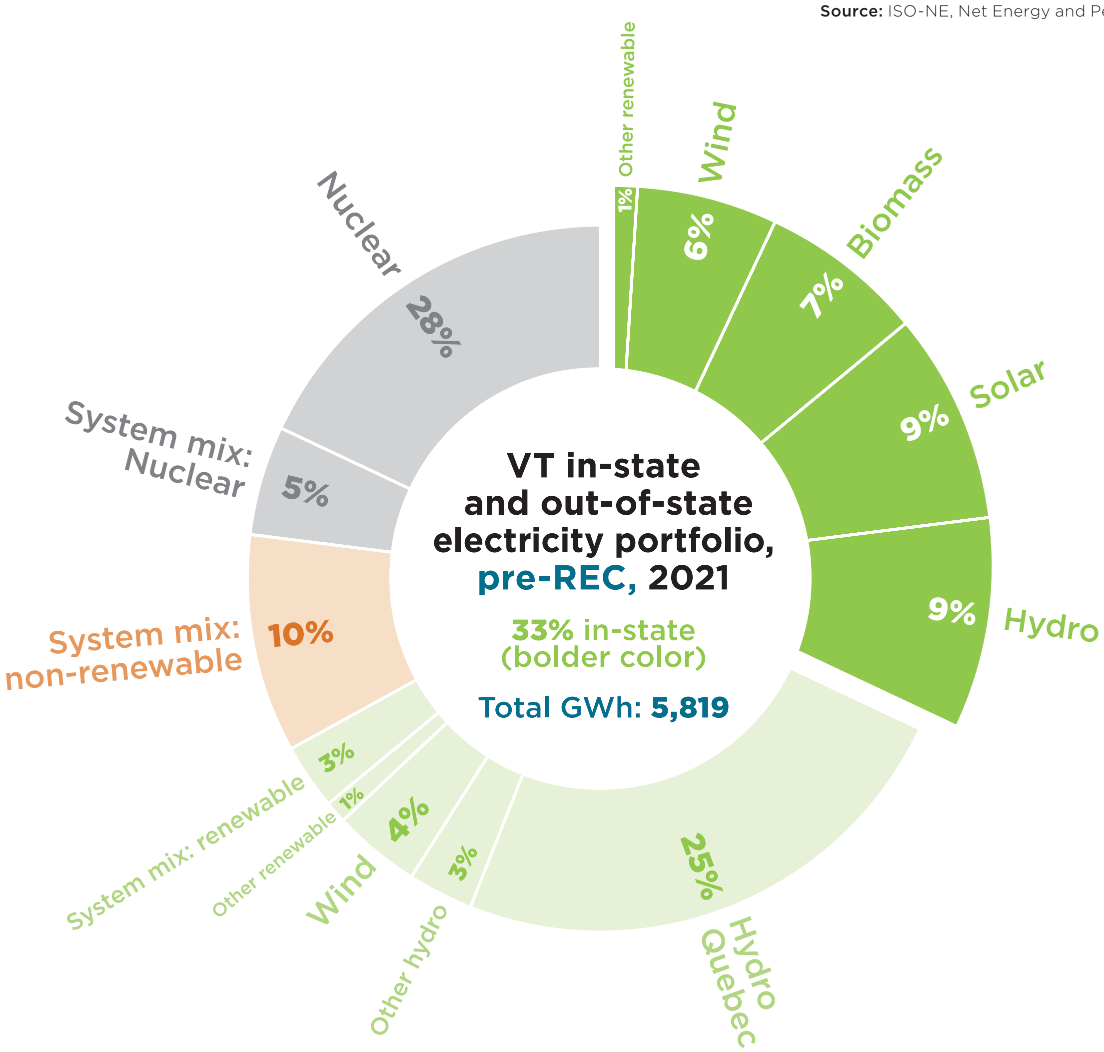
2. The share of Vermont's electricity that comes from system mix is larger than in previous reports because the PSD revised its methodology to account for total electricity use, inclusive of transmission and distribution losses. These losses are not accounted for in retail sales (the basis of past reports).

3. ISO-NE Net Energy and Peak Load Reports.

Vermont's electricity sector GHG emissions are reported on the basis of utilities' purchases of Renewable Energy Credits (RECs), which are the marketable property rights to the renewable attributes of power generation. This is consistent with the rules and practices of Vermont's Renewable Energy Standard (RES), emissions accounting in most other New England States, and the regional electricity market in which we operate. However, regardless of whether one considers electricity sector emissions via our purchased portfolio (post-REC accounting), as Vermont officially does, or from energy deliveries to Vermont (pre-REC accounting), the key takeaway is the same either way: **Vermont has the least carbon intensive electricity sector (CO_2e/MWh) of any state in the U.S.**[4]



Source: ISO-NE, Net Energy and Peak Load by Source Report, 2022



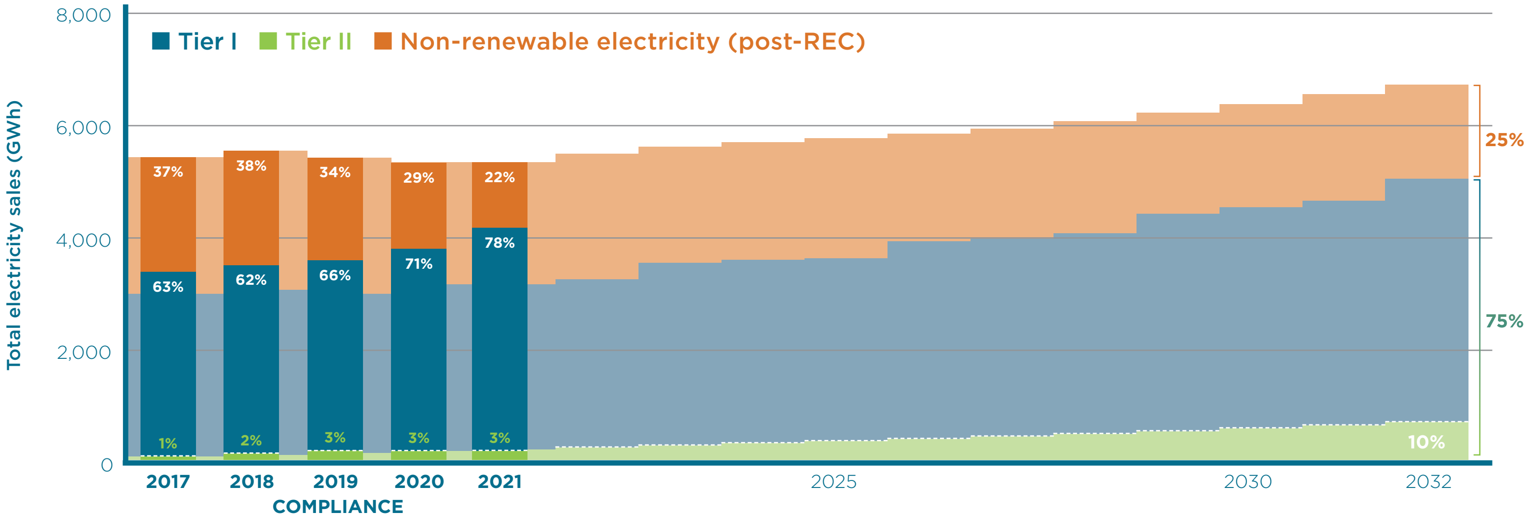
Source: Vermont Department of Public Service, Electric Utility Resource Survey, 2023.
Note: Non-renewable is primarily energy from fossil fuels.

While there is still more progress to make in the electricity sector, Vermont's relatively low-emitting electricity portfolio already makes electrification of the higher polluting, more fossil fuel dependent transportation and thermal sectors especially beneficial from a GHG reduction standpoint. **Either way of looking at the data shows that 10% or less of Vermont's electricity purchases come from fossil fuel sources.**

4. Leigh Seddon, EAN, "Assessing the GHG Impact of Beneficial Electrification in Vermont", 2023.

Vermont's Renewable Energy Standard

Vermont RES requirements and compliance, 2017–2032



Sources: Compliance and projections: Vermont Department of Public Service, 2023. RES requirements: 30 V.S.A. § 8005 (a) (1) (C). **Note:** Distributed renewable generation that qualifies for Tier II also qualifies for, and is included in, Tier I. The percentages shown on the blue bars represent total Tier I generation, including Tier II (shown in green). For purposes of RES compliance, non-renewable electricity includes nuclear.

Vermont's Renewable Energy Standard (RES) consists of three tiers of requirements meant to transform the electricity sector and contribute to decarbonization.

Tier I requires utilities to increase the share of electricity they purchase from renewable sources over time, allowing Renewable Energy Credits (RECs) to come from any source of renewable electricity that can be delivered to ISO-NE.[1] **In 2021, the Tier I requirement was that at least 59% of Vermont's total retail electricity sales come from renewable sources. Utilities significantly exceeded that requirement, with renewable electricity making up 78% of total retail sales.[2]** Three Vermont utilities — Burlington Electric Department, Washington Electric Co-op, and Swanton Electric — are 100% renewable on the basis of their annual REC retirements.[3] Additionally, Vermont Electric Co-op and Green Mountain Power have announced public commitments to be 100% renewable on an annual basis by 2030 and report that they are already 100% carbon-free.

Tier II requires utilities to procure an increasing amount of electricity from small-scale, in-state renewables. In 2021, all Vermont utilities met the requirement of 3.4% of electricity sales coming from Tier II resources.

Tier III requires utilities to either procure additional renewable distributed generation eligible for Tier II, or to acquire fossil fuel savings from energy transformation projects that reduce fossil fuel use for their customers. To meet their Tier III obligation, Vermont utilities have created programs that incentivize the purchase and installation of cleaner technologies in the thermal and transportation sectors — such as heat pumps and electric vehicles. This aspect of the RES is one way that Vermont has started to promote a total energy transition through policy. **In 2021, all Vermont utilities met the Tier III requirement of achieving fossil fuel reductions equivalent to 4.66% of their electric sales. Over 75% of total Tier III savings resulted from utility incentives for residential or commercial heat pumps and another 14% came from incentives for electric vehicles.[4]**

It is important to note that RES requirements for Tiers I, II, and III apply relative to total retail electricity sales, regardless of the amount of those sales. Specifically, as electricity sales increase — led by beneficial electrification of the transportation and thermal sectors — renewable electricity generation will also have to increase to achieve the same percentage requirements for Tier I, II, and III compliance on a larger base of sales.

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1. To date, nearly all Tier I RECs have come from hydropower and the Hydro-Quebec System Mix.

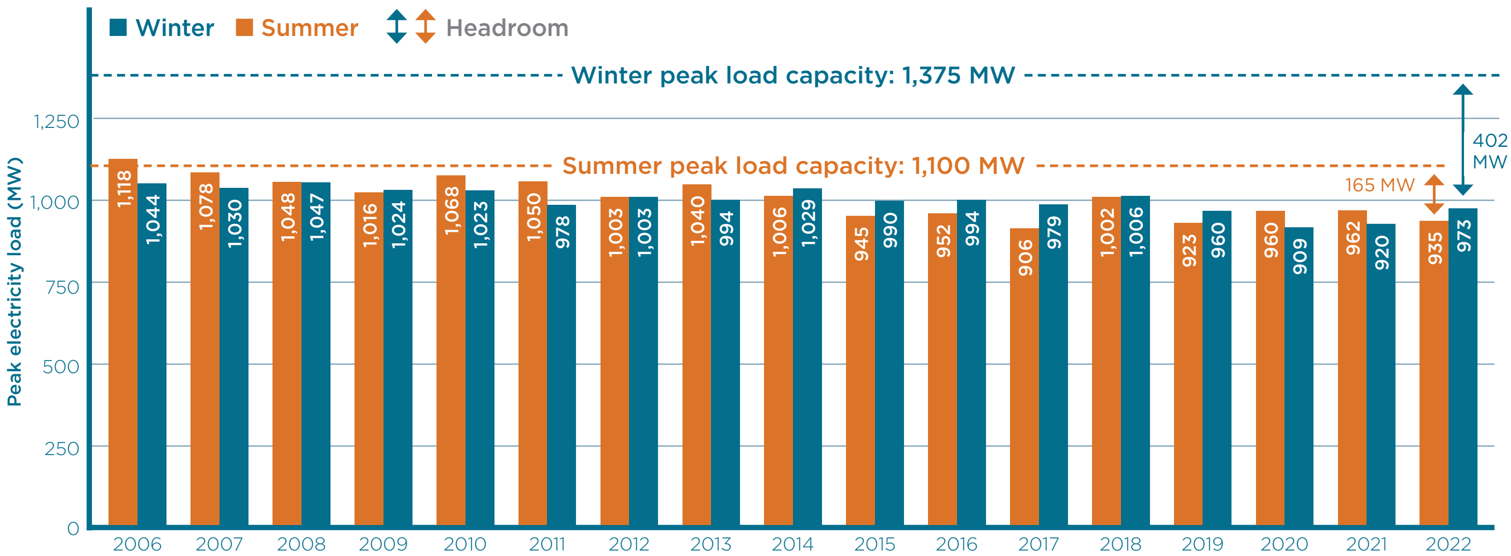
2. The share of renewables shown on this page does not align with the pie chart on page 28 because RES compliance is based on utilities' retail sales, whereas Vermont's emissions inventory calculates electricity sector emissions based on total electricity purchases, inclusive of transmission and distribution losses (which are not included in retail sales).

3. Vermont Department of Public Service, "2023 Annual Energy Report", 2023.

4. Vermont Department of Public Service, "2023 Annual Energy Report", 2023.

Beneficial electrification and Vermont's transmission and distribution system

Vermont seasonal peak electricity loads, 2006–2022



Source: VELCO, 2023.

Beyond a direct reduction in electricity sector emissions, having a cleaner electricity mix has a second, more powerful benefit. **Beneficial electrification — or switching from fossil fueled equipment to high-efficiency electric equipment for heating and transportation to achieve GHG emissions reductions — is more effective at reducing emissions in Vermont than in any other U.S. state.** This is because Vermont's electricity portfolio is the cleanest in the nation, whether measured by generation purchases or on a REC accounting basis.

Furthermore, thanks to gains in electric efficiency advanced by the work of efficiency utilities Efficiency Vermont and Burlington Electric Department and thanks to new, in-state distributed renewable electricity generation, a significant amount of headroom for additional load now exists in our electric transmission and distribution system. **This means we can accommodate widespread beneficial electrification while saving ratepayers money compared to the alternatives, as fixed costs are spread over a broader base of sales.**

The Vermont Electric Power Company (VELCO) reports that our transmission system is already capable of serving a peak load of at least 1,100 megawatts (MW) in the summer, and is predicted to be capable of serving at least 1,375 MW in the winter. The *2021 Vermont Long-Range Transmission Plan* found minimal impacts to the transmission system in its high load scenario at a summer peak of 1,209 MW and a winter peak of 1,471 MW. However, unlike in summer, the electric grid remains largely untested at high loads in winter.[1]

Between 2019 and 2022, Vermont's annual peak load has consistently been less than 975 MW, much less than the historic high of 1,118 MW in 2006. For context, VELCO estimates that charging 100,000 EVs simultaneously would add about 100 MW to the peak load. However, this scenario is unlikely, given that Vermont already has widespread load control measures such as managed charging and residential energy storage that would avoid charging of all vehicles at the same time on the grid.

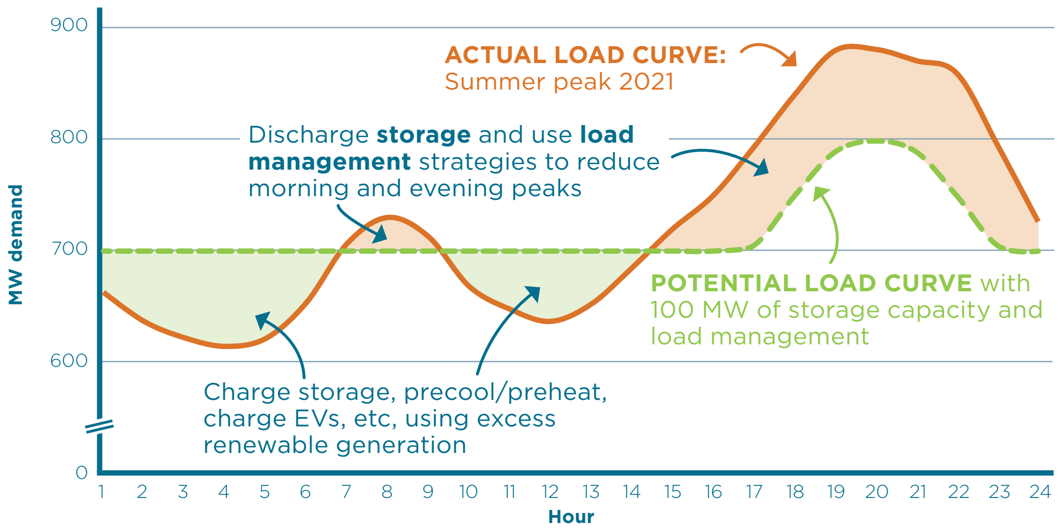
In short, VELCO reports that **the current transmission system is capable of handling high levels of electrification through 2030,** with small scale upgrades at certain points on the distribution system and increased use of load flexibility. Beyond 2030, VELCO projects that the heavy use of load management (for example, not charging EVs at periods of peak demand), and adjustments in tie-line flows, will be increasingly necessary to accommodate these higher loads without building additional transmission assets.

1. Vermont is a dual peaking state, meaning that peak electrical demand can occur during the summer or the winter. However, due to ambient temperature differences, the winter season allows for about 25% more transmission capacity than in the summer.

The role of flexible load management and energy storage in expanding electrification

As Vermont continues to electrify the transportation and thermal sectors, implementation of flexible load management (FLM) strategies will become increasingly important. **Flexible load management can help shift electricity loads away from periods of peak demand — when the power supply tends to be more expensive and less clean — thereby improving grid resilience, saving customers money, and reducing GHG emissions.**

Flattening VT's load curve: Scenario with flexible load management and energy storage



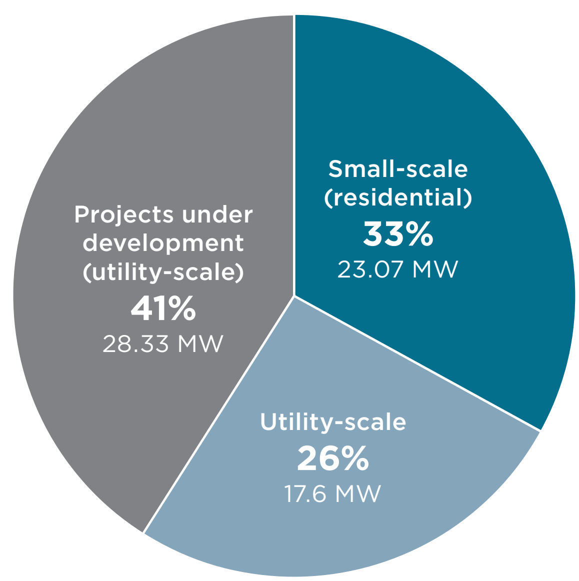
Source: ISO-NE, Hourly load reports for Vermont, 2023. **Note:** Aside from the actual load curve, the other portions of this graph are illustrative.

Examples of FLM strategies include: incentivizing EV charging outside of peak periods by offering lower rates, implementing thermal load flexibility (including pre-heating and pre-cooling buildings before an expected peak), and deploying energy storage technologies.

Battery storage is one of the energy storage technologies with an important role to play in facilitating electrification while promoting increased energy resilience for Vermont communities. Vermont has significantly scaled up battery storage capacity at the residential, community, and utility levels. For example, Green Mountain Power (GMP) and Vermont Electric Co-op (VEC) have facilitated battery installations in more than 4,000 Vermont homes through their home battery programs. Additionally, multiple Vermont utilities have partnered with local communities to build out energy storage projects, such as GMP's solar + storage microgrid project in Panton, VT.[1]

Vermont had nearly 41 MW of battery storage deployed as of the end of 2022, more than half of which were small-scale residential installations, in addition to another 28 MW of utility-scale storage under development. That is almost a 55% increase from Vermont's installed capacity of 26.5 MW in 2019.

Vermont battery storage projects through 2022



Sources: Vermont Department of Public Service, 2023; VEC, 2023. **Note:** Small-scale residential only includes GMP and VEC customer installations. Utility-scale includes all storage resources that are not individual customer installations.

Continuing to develop a diverse array of energy storage and other FLM technologies can help achieve a cleaner and more resilient energy system. However, achieving the most equitable distribution of these benefits will require intentional policy and program design.

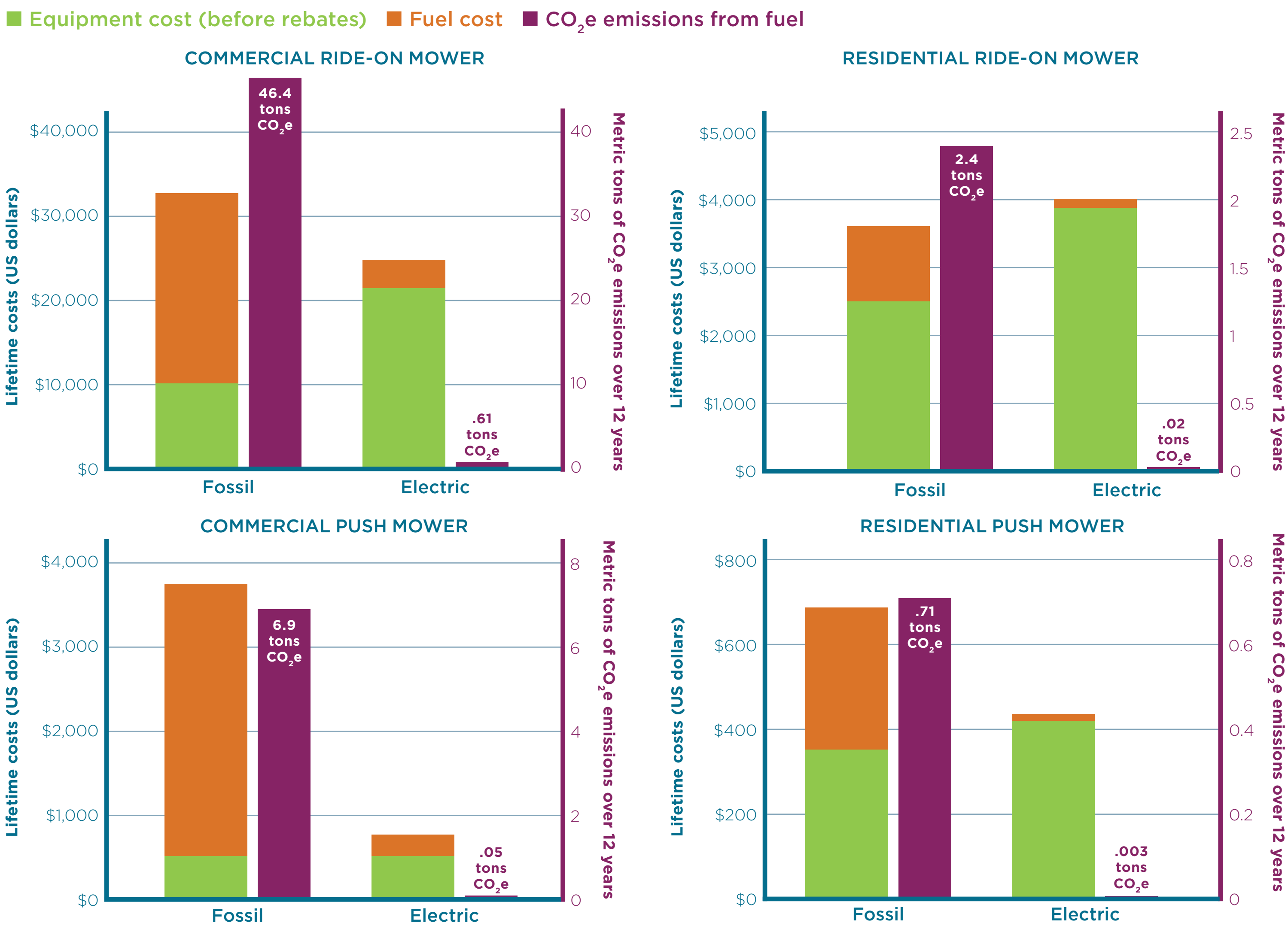
1. Clean Energy Group & Clean Energy States Alliance, "Energy Storage Policy Best Practices from New England: Ten Lessons from Six States", 2021.

Electrifying lawn maintenance equipment: Increasing options, decreasing costs

It is increasingly possible to move away from fossil fuels for lawn care and property maintenance. **The lifetime costs of most electric lawn equipment is lower than that of most fossil fuel equipment, even before rebates.** This is mainly because powering a piece of electric equipment is much cheaper than fueling fossil equipment, even though the up-front purchase price of electric lawn equipment is often higher. In addition to the significant reductions in GHG emissions from switching to electric lawn equipment, ending the use of fossil fuel equipment also leads to local air quality improvements from decreased toxic and carcinogenic air pollution, including particulate matter and smog forming pollutants (NOx and VOCs), as well as a decrease in noise pollution. It is estimated that operating a new gasoline lawn mower for one hour emits the same amount of volatile organic compounds (VOCs) as driving a new gasoline car for 45 miles.[1]

The graphs below show the lifetime costs of commercial and residential technologies *before* the rebates that are offered for electric equipment by most Vermont electric utilities. Rebates are currently in the \$50–\$300 range for many pieces of residential equipment, but can be as high as \$1,000–\$3,500 for commercial ride-on lawnmowers.[2]

Lifetime costs and emissions of electric vs fossil lawn equipment



Sources: Vermont Public Service Department, Tier III "Technical Resource Manual," 2021; EIA, 2023; Vermont Public Service Department, Retail Prices of Heating Fuels, 2023.
Note: Fuel cost for electricity is based on Green Mountain Power's rate of \$0.18/kWh as of October, 2022. Fuel cost for gasoline is based on the 2022 average of \$3.98. Lifetimes for each piece of equipment vary. Data here is drawn from the Tier III Technical Resource Manual.

1. Banks and McConnell, "National Emissions from Lawn and Garden Equipment," EPA, 2015.
2. Efficiency Vermont, 2023.

Vermont statutory energy and emissions targets, 2023 status

OVERALL STATUS

- Already met or on track to meet
- Undetermined
- Not met or not on track to meet

CHANGE FROM LAST YEAR'S EAN REPORT

- ↑ Increase in year-to-year progress
- → Year-to-year progress flat
- ↓ Decreasing rate of year-to-year progress

	GOAL OR STATUTE	TARGET	TARGET DATE	OVERALL STATUS (2022 APR)	OVERALL STATUS (2023 APR)	TREND '22-'23 APR
GHG EMISSIONS	**Act 153** (Vermont Global Warming Solutions Act of 2020): Reduce greenhouse gas emissions at least 26% below 2005 levels (9.83 MMTCO$_2$e) by 2025.	-26% 7.27 MMTCO$_2$e	2025	-10% 8.64 MMTCO$_2$e (2018)	-19% 7.99 MMTCO$_2$e (2020)	↑
GHG EMISSIONS	**Act 153** (Vermont Global Warming Solutions Act of 2020): Reduce greenhouse gas emissions at least 40% below 1990 levels (8.61 MMTCO$_2$e) by 2030.	-40% 5.17 MMTCO$_2$e	2030	+3% 8.64 MMTCO$_2$e (2018)	-7% 7.99 MMTCO$_2$e (2020)	↑
GHG EMISSIONS	**Act 153** (Vermont Global Warming Solutions Act of 2020): Reduce greenhouse gas emissions by 80% below 1990 levels (8.61 MMTCO$_2$e) by 2050.	-80% 1.72 MMTCO$_2$e	2050	+3% 8.64 MMTCO$_2$e (2018)	-7% 7.99 MMTCO$_2$e (2020)	↑
TOTAL ENERGY	**CEP (2016/2022):** Meet 90% of the state's energy needs through renewables — including thermal, transportation, and electric (Note: Energy sourced in-state and out-of-state).	90%	2050	23% (2019)	27% (2021)	↑
TOTAL ENERGY	**CEP (2016):** Reduce total energy use from 2010 levels (118.6 TBTU) by over 30% by 2050 through efficiency and conservation, across thermal, transportation, and electric.	-30% 83 TBTU	2050	+4.6% 124 TBTU (2019)	+2% 121 TBTU (2021)	→
TOTAL ENERGY	**30 V.S.A. 8002 (2015):** RES Tier III - Require 2% of total utility retail sales (BTU equivalency) in 2017 to reduce fossil fuel consumption, rising to 12% in 2032. Projects must be new, in-state, and in service in 2015 or later.	2% 12%	2017 2032	2.7% (2020)	5.3% (2021)	↑
TOTAL ENERGY	**24 V.S.A. 4302(c)(7) (2016):** Develop energy plans for regions and municipalities consistent with the CEP goals.	11 regions	2018 for RPCs Voluntary for towns	11 regional, 73 town approved (2022)	11 regional, 92 town approved (2023)	↑
TRANSPORTATION	**CEP (2016):** Reduce total transportation energy use by 20% from 2015 levels (48.9 TBTU) by 2025.	-20% 39.1 TBTU	2025	+0.8% 49.3 TBTU (2019)	-7.6% 45.3 TBTU (2021)	↑
TRANSPORTATION	**CEP (2022):** Reduce transportation emissions by 26% below 2005 levels (4.05 MMTCO$_2$e) by 2025, 40% below 1990 levels (3.25 MMTCO$_2$e) by 2030, and 80% below 1990 levels by 2050	-26% 3 MMTCO$_2$e	2025	-16% 3.4 MMTCO$_2$e (2018)	-29.6% 2.85 MMTCO$_2$e (2020)	↑
TRANSPORTATION	**CEP (2016):** Hold vehicle miles traveled (VMT) per capita to 2011 levels.	11,390	2030	11,772 (2019)	10,262 (2021)	↑
TRANSPORTATION	**CEP (2016):** Reduce share of single-occupancy vehicle commute trips by 20% of 2011 levels (79.5%) to 64%.	64%	2030	75.9% (2019)	72.5% (2021)	↓
TRANSPORTATION	**CEP (2016):** Double the share of bicycle and pedestrian commute trips from 7.8% to 15.6%.	15.6%	2030	6.9% (2019)	5.8% (2021)	↓
TRANSPORTATION	**CEP (2016):** Triple the number of state park-and-ride spaces from 1,142 to 3,426.	3,426	2030	1,734 (2021)	1,896 (2023)	↑
TRANSPORTATION	**CEP (2016):** Increase public transit ridership by 110% from 4.6 million to 8.7 million annual trips.	8.7M	2030	2.44M (2021)	3.54M (2022)	↑
TRANSPORTATION	**CEP (2016):** Increase the share of renewable energy in all transportation to 10% by 2025 and 80% by 2050.	10% 80%	2025 2050	6% (2019)	6% (2021)	→
TRANSPORTATION	**CEP (2016):** Increase renewably powered vehicles: Increase % of the vehicle fleet that are electric vehicles to 10% by 2025.	10%	2025	1.1% (2021)	1.5% (2022)	↑
THERMAL	**CEP (2016):** To reduce total fossil fuel consumption across all buildings by an additional one-half percent each year from 2005, leading to a total reduction of 10% by 2025.	-10% 31.3 TBTU	2025 34.6 TBTU	+28.9% 44.6 TBTU (2019)	+17.9% 40.8 TBTU (2021)	↑
THERMAL	**CEP (2022):** Meet 30% of thermal energy needs from renewable energy by 2025, and 70% by 2042.	30% 70%	2025 2042	25% (2019)	30% (2021)	→
THERMAL	**CEP (2016):** Install 35,000 cold climate heat pump systems by 2025.	35,000	2025	29,018 (2020)	36,709 (2021)	↑
THERMAL	**CEP (2022) and CAP:** Weatherize 120,000 households by 2030, relative to a 2008 baseline.	120,000	2030	31,338 (2020)	34,324 (2021)	↑
THERMAL	**CEP (2016):** Increase wood's share of building heat to 35% by 2030.	35%	2030	24.3% (2018)	25.4% (2021)	↑
ELECTRICITY	**30 V.S.A. 8002 (2015):** RES Tier 1 - Total Renewable Electric - Obtain 55% of annual electric sales from renewables for each retail electricity provider in Vermont by 2017, and 75% by 2032. RECs retained (in-state and out-of-state).	55% 75%	2017 2032	68% (2020, post-REC)	77.7% (2021, post-REC)	↑
ELECTRICITY	**CEP (2022):** Meet 100% of electricity needs from carbon-free resources by 2032	100%	2032	87% (2019)	90% (2021)	↑
ELECTRICITY	**30 V.S.A. 8002 (2015):** RES Tier 2 – Distributed Generation - Require 1% of electric sales to come from distributed generation in 2017, rising to 10% by 2032. Projects starting in mid-2015 are eligible, and new NM and SO projects count if RECs are retired (in-state).	1% 10%	2017 2032	2.7% (2020)	3.2% (2021)	→
ELECTRICITY	**30 V.S.A. 8005a(c) (2011):** Issue Standard Offer (SO) contracts to new SO plants until a cumulative capacity of 127.5 MW is reached (new plants 2.2MW or less commissioned on or after Sept 30, 2009) (in-state).	127.5 MW	2022	124.78 MW under contract 76.36 MW commissioned (2022)	129.14 MW under contract 77.4 MW commissioned (2023)	N/A

SOURCES: GHG Emissions: Vermont Agency of Natural Resources, Vermont Greenhouse Gas Emissions Inventory and Forecast (1990-2020), 2023. **Total Energy:** Vermont Department of Taxes, 2023; EIA, 2021 State Energy Data System, 2023; PSD, Annual Energy Report, 2023; Efficiency Vermont, 2023; VAPDA, 2023. **Transportation:** Vermont Department of Taxes, 2023; EIA, 2021 State Energy Data System, 2023; Efficiency Vermont, 2023; Federal Highway Authority, Highway Statistics, 2023; Vtrans, 2023; U.S. Census Bureau, American Community Survey 5-year estimates, 2017-2021, 2023; Amtrak, 2020; Drive Electric VT, 2023; ANR, 2023. **Thermal:** Vermont Department of Taxes, 2023; EIA, 2021 State Energy Data System, 2023; PSD, 2023; ANR, 2023; Efficiency Vermont, 2023. **Electricity:** PSD, Electric Utility Resource Survey, 2023; PSD, Annual Energy Report, 2023; VEPP, 2023.

EAN Network Action Teams

Since 2020 EAN members and public sector partners have identified strategic initiatives annually through a competitive pitch process, based on their potential to help Vermont rapidly, cost-effectively, and equitably reduce fossil fuel use and greenhouse gas pollution. Each winning pitch has resulted in a Network Action Team made up of EAN members and partners, supported by EAN staff and a small grant. Information about all present and past Network Action Teams can be found on the EAN website at eanvt.org/network-action-teams. Examples of teams active as of the summer of 2023 include:

Clean Heat Working Group

This Network Action Team was integral in developing the concept of a Clean Heat Standard and options for how one could be equitably and effectively implemented in Vermont. This policy would require fossil fuel corporations and utilities that sell heating fuels in Vermont to reduce their climate pollution over time, in line with Global Warming Solutions Act requirements.

Weatherization at Scale

Weatherizing homes helps reduce greenhouse gas emissions while decreasing home energy costs and increasing home comfort for Vermonters. This Network Action Team has been working to increase funding and financing to scale up weatherization, with a target of 90,000 additional Vermont homes weatherized by 2030.

Climate Workforce

To achieve Vermont's required greenhouse gas emission reduction targets, we need to train thousands of Vermonters with the skills to support an electrified transportation sector, install clean energy solutions, weatherize homes, build net zero commercial buildings and sustainably manage our working lands, forests, and waterways. This Network Action Team is coordinating around strategies, pathways, and funding to reach these goals.

Networked Thermal Systems

Networked geothermal is a promising but largely unexplored solution for Vermont's thermal sector that uses shallow boreholes and water-filled loops to heat and cool an entire street, campus, or village center. This Network Action Team is building a coalition to support development of geothermal and other kinds of thermal energy networks in Vermont, to make this clean energy solution available to more Vermonters.

Network Action Teams started in 2020-2022

- **Weatherization at Scale:** 2020–present
- **Clean Heat Working Group:** 2020–present
- **Climate Workforce:** 2021–present
- **Networked Thermal Systems:** 2022–present
- **Switch and Save:** 2021–present
- **Tenant Weatherization Protection:** 2022–present
- **Transportation Cap and Invest:** 2022
- **Future of Rural Transit:** 2020–2023
- **Clean Transportation Equity:** 2021–2022
- **Replace Your Ride:** 2020–2021

Who We Are

Energy Action Network (EAN) consists of over 200 active member organizations and public sector partners. Member organizations include nonprofits, businesses, utilities, and institutions of higher education. Public sector partners include local, state, and federal offices and officials. All EAN members share a mission of achieving Vermont's climate and energy commitments in ways that create a more just, thriving, and sustainable future for Vermonters.

Non-Profits

American Institute of Architects Vermont (AIA VT)
Sarah O Donnell, Catherine Lange

Associated Industries of Vermont (AIV)
William Sayre

Audubon Vermont
David Mears, Margaret Fowle

Building Performance Professionals Association of Vermont (BPPA)
Jonathan Dancing, Malcolm Gray, Russ Flanigan, Chuck Reiss, Tom Perry

Capstone Community Action
Sue Minter, Paul Zabriskie, Liz Sharf, Sam Hunt

Champlain Valley Office of Economic Opportunity (CVOEO)
Paul Dragon, Virginie Diambou, Dwight DeCoster

Climate Economy Action Center of Addison County
Steve Maier, Spencer Putnam, Richard Hopkins, Mike Roy, Diane Munroe

Community Rides Vermont
Chris Cole, Amanda Carlson

Conservation Law Foundation
Elena Mihaly, Chase Whiting

Drive Electric Vermont
David Roberts

Evernorth
Kathy Beyer

Fairbanks Museum
Adam Kane

Intervale Center
Travis Marcotte

Lake Champlain Chamber
Catherine Davis, Tom Torti, Austin Davis

Local Motion
Christina Erickson

NeighborWorks of Western Vermont (NWWVT)
Heather Starzynski, Melanie Paskevich

New England Grassroots Environmental Fund (NEGEF)
Bart Westdijk

Northern Forest Center
Rob Riley, Maura Adams, Joe Short

Old Spokes Home
Jon Copans

Preservation Trust of Vermont
Ben Doyle, Jackson Evans

Public Assets Institute
Stephanie Yu

Regulatory Assistance Project (RAP)
Richard Cowart, Rick Weston, David Farnsworth, Nancy Seidman

Renewable Energy Vermont (REV)
Peter Sterling, Jonathan Dowds, Kit Price

ReSOURCE
Thomas Longstreth, Pam Laser

Rights and Democracy
Alison Nihart, Tom Proctor

Shelburne Farms
Megan Camp

Sustainable Heating Education Outreach
Jeff Rubin

Sustainable Montpelier Coalition
Elizabeth Parker

Sustainable Woodstock
Michael Caduto, Jenevra Wetmore

The Nature Conservancy
Lauren Oates

Vermont Businesses for Social Responsibility (VBSR)
Roxanne Vought, Kristin Warner

Vermont Center for Independent Living (VCIL)
Peter Johnke

Vermont Climate and Health Alliance
Dan Quinlan

Vermont Council on Rural Development (VCRD)
Jessica Savage, Laura Cavin Bailey, Jenna Koloski, Margaret McCoy

Vermont Energy and Climate Action Network (VECAN)
Johanna Miller

Vermont Energy Education Program (VEEP)
Sophia Donforth, Mariah Keagy

Vermont Green Building Network
Jenna Antonino DiMare

Vermont Housing and Conservation Board (VHCB)
Gus Seelig, Jen Hollar, Craig Peltier

Vermont Housing Finance Agency (VHFA)
Maura Collins, Chris Flannery, Mia Watson

VEIC
Rebecca Foster, Jennifer Wallace-Brodeur, Justine Sears, Alison Donovan, Adam Sherman, Dan Reilly, Damon Lane, Jay Pilliod, Dave Roberts

VT Independent Power Producers Association
Mathew Rubin

Vermont Interfaith Power and Light
Ron McGarvey, Richard Hibbert, Sam Swanson

Vermont Land Trust (VLT)
Abby White

Vermont League of Cities and Towns (VLCT)
Ted Brady, Abby Friedman

Vermont Natural Resources Council (VNRC)
Brian Shupe, Johanna Miller, Jamey Fidel, Kati Gallagher, Greta Hasler

Vermont Passive House
Chris Clarke Miksic, Paul Sipple, Enrique Bueno

Vermont Public Interest Research Group (VPIRG)
Paul Burns, Ben Edgerly Walsh, Tom Hughes, Jordan Heiden

Vermont Sustainable Jobs Fund (VSJF)
Ellen Kahler, Janice St Onge, Christine McGowan, Jake Claro, Geoff Robertson

Vermont Works for Women
Rhoni Basden, Alison Lamagna

Vital Communities
Sarah Brock, Anna Guenther

Businesses

3E Thermal
Randy Drury, Fritz Fay

AllEarth Renewables
David Blittersdorf

Bee the Change
Mike Kiernan

Bourne's Energy
Peter Bourne, Levi Bourne, Jim Kurrle

Black Bear Biodiesel
Jim Malloy

Building Energy
Russ Flanigan

Built by Newport
Dave Laforce

Butternut Mountain Farm
David Marvin, Ira Marvin, Emma Marvin, Ed Fox

Casella
Joe Fusco

Catalyst Financial
Bob Barton, Marianne Barton

Catamount Solar
Kevin McCollister

C.T. Donovan Associates, Inc.
Christine Donovan

Downs Rachlin Martin PLLC
Will Dodge

Dynapower
Adam Knudsen, Richard Morin

Eco-Equipment Supply, LLC
Steven Wisbaum

Encore
Chad Farrell, Phillip Foy, Derek Moretz, Chad Nichols, Kate Desrochers

Energy Balance, Inc.
Andy Shapiro

Energy Co-op of Vermont
Shelley Navari

Energy Futures Group (EFG)
Richard Faesy, Chris Neme, Gabrielle Stebbins, Dan Mellinger, David Hill

Forward Thinking
Jeff Forward

Fresh Tracks Capital
Cairn Cross, Lee Bouyea

Grassroots Solar
Bill Laberge

Green Lantern Solar
Luke Shullenberger, Bill Miller, David Carpenter

KSV
Harrison Grubbs

Maclay Architects
Bill Maclay

MMR
Justin Johnson

Montpelier Construction
Malcolm Gray

National Life Group
Charlie Maitland

New Leaf Design
Tom Perry

Northam Forest Carbon
Tim Stout

Norwich Solar Technologies
Jim Merriam, Joel Stettenheim, Martha Staskus

NRG Systems
Justin Wheating

Packetized Energy
Paul Hines, Bonnie Pratt

Pellergy
Andy Boutin

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Ernie Pomerleau

Reiss Building and Renovation
Chuck Reiss

Saunders | Raubvogel | Hand
Geoff Hand

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SunCommon
James Moore, Jake Elliott

Sunrun
Chris Rauscher

Sunwood Biomass
David Frank

Tied Branch Clean Energy Consulting
Ryan Lamberg

Vanesse Hangen Brustlin, Inc (VHB)
Carla Fenner

Vermont Economic Development Authority (VEDA)
Sam Buckley

Vermont Energy Contracting & Supply Corp.
Mark Stephenson, Nick Papaseraphim

Vermont Wood Pellet Co.
Chris Brooks

VSECU
Rob Miller, Laurie Fielder, Simeon Chapin, Lisa LaSante, Valerie Beaudin

Utilities

Burlington Electric Department (BED)
Darren Springer, Mike Kanarick, Jennifer Green, Tom Lyle, Chris Burns, Mike Russom, Amber Widmayer

Efficiency Vermont (EVT)
Peter Walke, Kelly Lucci, Jake Marin, Hillary Andrews, Steve Spatz, Laura Capps

Green Mountain Power (GMP)
Mari McClure, Liz Miller, Kristin Carlson, Josh Castonguay, Candace Morgan, Kristin Kelly, Maria Fischer, Doug Smith, Chris Cole, Madeline Murray-Clasen

Vermont Electric Power Company (VELCO)
Tom Dunn, Kerrick Johnson, Hantz Presume, Mark Sciarotta, Shana Louiselle

Vermont Electric Cooperative (VEC)
Rebecca Towne, Andrea Cohen, Jake Brown, Cyril Brunner

Vermont Gas Systems (VGS)
Neale Lunderville, Dylan Giambatista, Jill Pfenning, Tom Murray, Richard Donnelly, Chris Charuk, Greg Morse, Tim Perrin, Morgan Hood, Andrea McNeil, Jonathan Drovin

Vermont Public Power Supply Authority (VPPSA)
Ken Nolan

Washington Electric Co-op (WEC)
Louis Porter, Bill Powell

Higher Education

Dartmouth College, Tuck School of Business
April Salas, Melody Brown Burkins

Goddard College
Catherine Lowther

Middlebury College
Diane Munroe, Dan Suarez, Jon Isham, Mez Baker-Medard

Norwich University
Tara Kulkarni, Michael Cross

University of Vermont (UVM)
Jon Erickson, Richard Watts, Amy Seidl, Abby Bleything

UVM Extension
Sidney Bosworth, Sarah Tichonuk

UVM Gund Institute
Taylor Ricketts, Jeannine Valcour

UVM Transportation Research Center (TRC)
Greg Rowangould, Dana Rowangould

UVM Vermont Clean Cities Coalition
Peggy O'Neill-Vivanco

Vermont Law and Graduate School
Rod Smolla, Jennifer Rushlow, Dave Celone, Kevin Jones

Vermont State University
Pat Moulton

Public Sector Partners

Local

Legislators: *Vermont's State Representatives and Senators*

Town Energy Committees: *Town Energy Committees from across Vermont*

Cities: *Burlington (Mayor Miro Weinberger), South Burlington (Paul Conner, Director of Sustainability)*

Regional

Regional Planning Commissions & Regional Development Corporations: *Adam Lougee, Andrew L'Roe (Addison), Peter Gregory (Two Rivers Ottauquechee), Callie Fishburn, Jim Sullivan, Allison Strohl (Bennington County), Melanie Needle, Charlie Baker, Ann Janda, Marshall Distel (Chittenden), Catherine Dimitruck, Linda Blasch (Northwest), Dave Snedeker, Alison Low, Allison Webster (Northern Vermont Development Association), Chris Campany, Marion Major, Colin Bratton (Windham), Sam Lash (Central Vermont), Adam Grinold (Brattleboro Development Credit Corporation)*

Green Mountain Transit Regional Transit Authority: *Chris Damiani, Jamie Smith*

Tri-Valley Transit: *Mike Riderer*

State

Agency of Agriculture, Food and Markets: *Anson Tebbetts, Diane Bothfeld, Alex DePillis*

Agency of Commerce and Community Development: *Lindsay Kurrle, Laura Trieschmann*

Agency of Natural Resources: *Julie Moore, Jane Lazorchak, Ed McNamara, Billy Coster, Collin Smythe, Megan O'Toole, Brian Woods*

Agency of Transportation: *Joe Flynn, Michele Boomhower, Andrea Wright, Patrick Murphy, Ross McDonald, Dan Currier*

Department of Buildings and General Services: *Brian Sewell*

Department of Environmental Conservation: *Heidi Hales*

Department of Forests, Parks and Recreation: *Sam Lincoln, Paul Frederick*

Office of Economic Opportunity (OEO): *Low Income Weatherization: Geoff Wilcox, Robert Leuchs*

Department of Labor (DOL): *Mathew Barewicz*

Public Service Department: *June Tierney, TJ Poor, Melissa Bailey, Lou Cecere, Anne Margolis, Andrew Perchlik, Phillip Picotte, Ed Delhagen, Kelly Launder, Claire McIlvennie, Keith Levenson, Adam Jacobs*

Vermont Public Utility Commission: *Anthony Roisman, Riley Allen, Margaret Cheney, Tom Knauer*

Vermont Center for Geographic Information (VCGI): *John Adams, Tim Terway*

Vermont State Treasurer: *Mike Pieciak, Gavin Boyles, Ashlynn Doyon*

FEDERAL

Office of Senator Peter Welch: *Rebecca Ellis*

Office of Senator Bernie Sanders: *Haley Pero, Ethan Hinch*

Office of U.S. Representative Becca Balint

USDA Rural Development, VT/NH Office: *Sarah Waring, Jon-Michael Muise, Ken Yearman*

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New England Federal Credit Union, President & COO

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Regulatory Assistance Project, Principal

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VEIC, Director, Consulting

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KAREN GLITMAN *Center for Sustainable Energy (CSE), Senior Director, Transportation and DER Markets*

KEN JONES *Economic Research Analyst* | **BILL REGAN** *Regan Leadership, LLC, President*

BETH SACHS *VEIC, Co-Founder & Director Emerita*

Staff

JARED DUVAL
Executive Director

CARA ROBECHEK
Deputy Director and Network Manager

LENA STIER
Data Manager & Research Analyst

Mission

Energy Action Network (EAN) works to achieve Vermont's climate and energy commitments in ways that create a more just, thriving, and sustainable future for Vermonters.

Collective impact approach

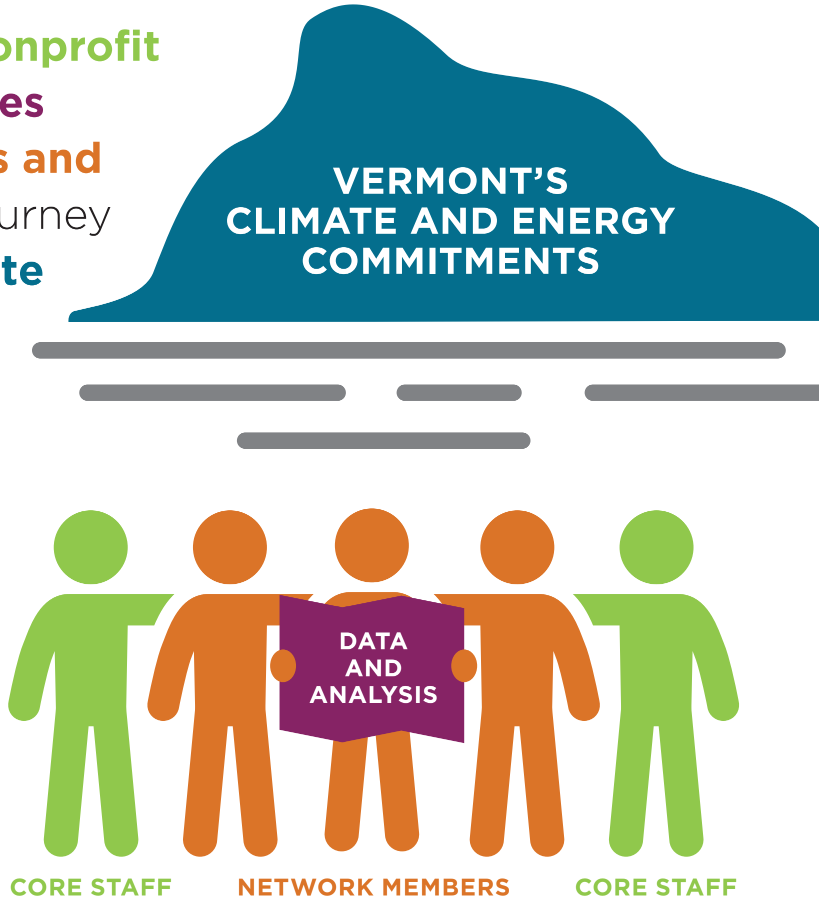
Energy Action Network (EAN) is a diverse network ofnonprofits, businesses, utilities, institutions of higher education, public agencies, and other organizations working together in a collective impact framework and supported by a backbone nonprofit organization to further the Network's mission.

The Network approaches its work together through two key lenses:

1) Total energy transformation: We work toward efficient and renewable energy use across all sectors.

2) Strategic leverage areas: We work to enable systemic change at a scale and pace necessary to achieve Vermont's climate and renewable energy commitments, focusing on Policy & Regulatory Reform, Capital Mobilization, Public Engagement, and Technology Innovation. Network Action Teams work on strategic projects identified and selected by the Network.

The core staff of EAN's backbone nonprofit organization compiles data, produces research and analysis, and **convenes and supports the EAN Network** as we journey together to achieve **Vermont's climate commitments and energy goals.**



EAN's core nonprofit staff supports the EAN Network in the following ways:

- **Stewards a common agenda** for Network members and public sector partners.
- **Collects data and measures results** through regular tracking and analysis.
- **Coordinates mutually reinforcing activities** to develop, share, and advance high-impact ideas.
- **Ensures regular communication** to and across the Network.

Energy Action Network

9 Bailey Avenue #2, Montpelier, VT 05602

EANVT.ORG

Thank you!

EAN's 2023 Annual Progress Report for Vermont on Emissions, Energy, Equity, and the Economy is the result of a collaborative effort, reflective of our broad and diverse network of members and public sector partners. We would like to particularly thank the following agencies and organizations for their contributions to the content, data, and analysis within the report: Vermont Agency of Natural Resources, Vermont Department of Public Service, Vermont Agency of Transportation, VEIC, and the UVM Transportation Research Center.

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The primary co-authors of the report are EAN staff — Jared Duval, Lena Stier, and Cara Robechek — and EAN Senior Fellow Leigh Seddon. Design and layout is by Dana Dwinell-Yardley (ddydesign.com). Photo of Jared Duval on page 38 by Mike Dougherty/VTDigger.

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