ENERGY ACTION NETWORK

ANNUAL PROGRESS REPORT

for VERMONT

2022

Emissions

Energy

Equity

and the Economy

Introduction to the Report

2022 marked the ten-year anniversary of EAN as a non-profit organization serving our broad network of members and the state of Vermont. As much as our organization and Network have changed over the last decade, some things have remained constant — especially our commitment to our founding principles, including:

- **Decisions should be guided by the highest quality data and analysis** and the latest science. EAN will continue to collect, produce, and share work — like this Annual Progress Report for Vermont – that helps ground and productively advance Vermont's energy and climate conversations with evidence and data.
- **We are better (and stronger) together:** no one person or organization can know everything about something as complex as our energy system. With a commitment to respect, civility, curiosity, and humility, we come together as a Network to learn and strategize about how to meet our energy and climate commitments in strategic and effective ways that lead to a more "just, thriving, and sustainable future."

As we contemplate these principles and our future, we must pause to recognize that the warnings from climate scientists are only getting more sobering. A recent Intergovernmental Panel on Climate Change (IPCC) report once again underlined the scientific consensus about the need to act immediately to significantly reduce and eventually end our dependence on fossil fuels or else risk missing **"a brief and rapidly closing window to secure a livable future."**[1]

In 2020 Vermont commited to doing our part in this collective global effort, making our emissions reduction targets legally binding with the passage of the Global Warming Solutions Act (GWSA). In 2021, a devoted group of Vermonters stepped up to craft **Vermont's first Climate Action Plan** (CAP), which was adopted by the Vermont Climate Council on Dec. 1, 2021.

1. See "IPCC adaptation report 'a damning indictment of failed global leadership on climate'", https://news.un.org

The CAP lays out the key pathways — and the recommended actions — necessary to meet our now legally binding emissions reduction requirements. **Many of the recommended actions were identified thanks to the work of dedicated EAN members** participating in Network Action Teams such as Weatherization at Scale, the Clean Heat Standard, and more. Many Network members also stepped up to serve on the Council or one of its subcommittees, or offered public comment that helped inform and shape the CAP.

Meeting Vermont's emissions reduction requirements is a pressing challenge. But the work before us also presents a massive opportunity for Vermont consumers and the Vermont economy. This is because transitioning away from high-cost, price-volatile fossil fuels that are 100% imported, towards lower-cost, price-stable renewable alternatives that keep more of our money local can result in **a win-win-win for our climate commitments, consumer protection, and economic resilience.** In fact, independent analysis conducted for the Vermont Climate Council and Public Service Department projects **$6.4 billion in net economic savings and avoided damages between now and 2050** by meeting our emissions reduction commitments.[2]

As we look ahead, we must acknowledge that the costs and benefits of our current energy system are not borne equitably. **It is not enough to have an energy transition that simply decreases emissions — we also need to ensure the energy transition increases equity.** Specifically, we must ensure that cost-saving benefits of strategies like weatherization and electrification go to people and communities who most need them: lower and middle income Vermonters who face a larger energy burden (the share of their income they spend on energy) than their wealthier neighbors. Consistent with the equity commitments of the Vermont Climate Council, we must also ensure that the needed investments in this transition come from those who have done the most to cause the problem and have the greatest ability to pay: the corporations that sell fossil fuel into Vermont and the wealthiest among us, who have historically created much more fossil fuel pollution.

2. Cadmus/EFG, Vermont Pathways Analysis Report 2.0, 2022.

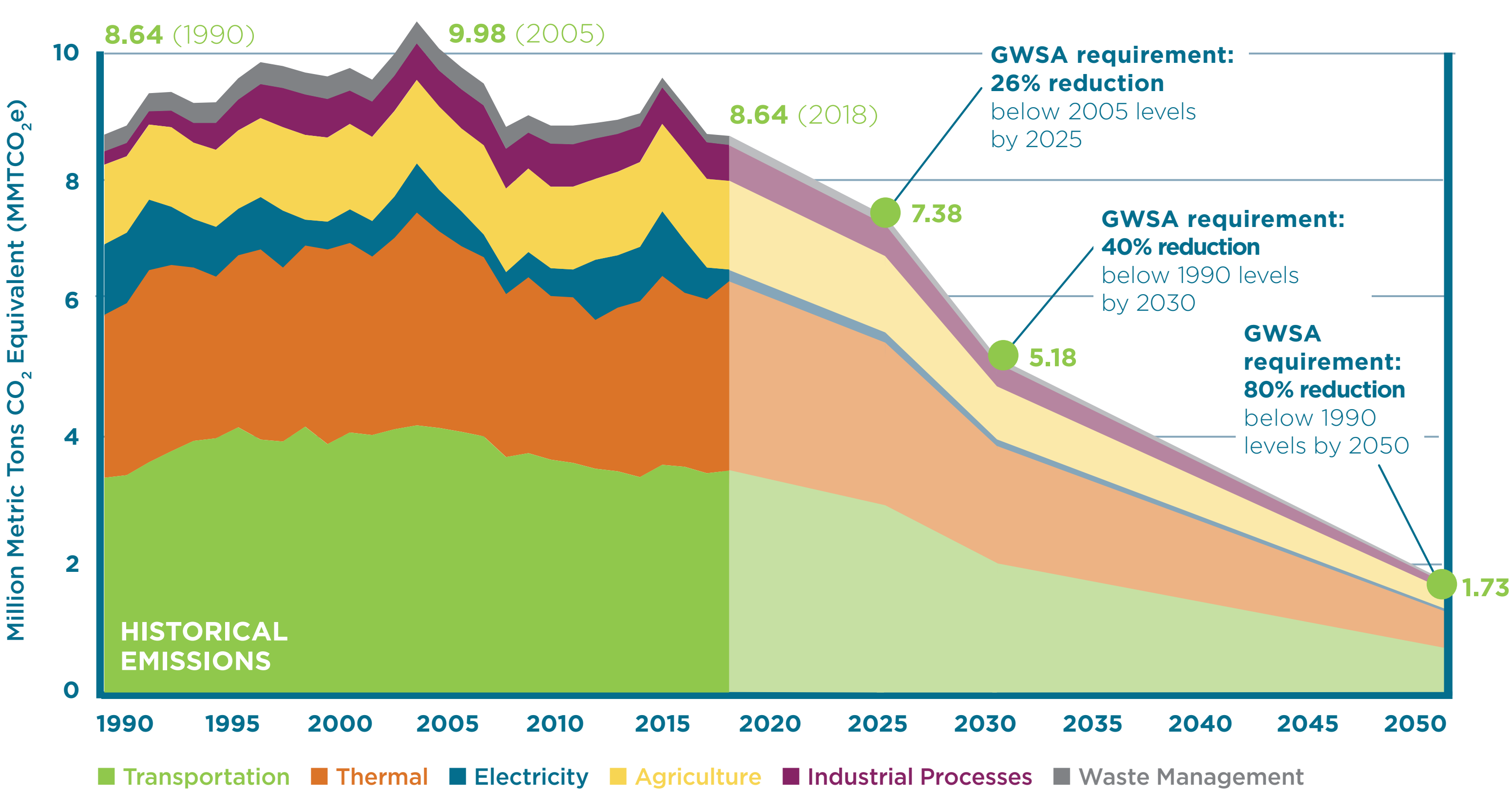
1. Vermont passed its first Climate Action Plan in 2021

As required by the Global Warming Solutions Act (GWSA) of 2020, the Vermont Climate Council adopted Vermont's first Climate Action Plan (CAP) in December 2021. The CAP identifies 26 pathways and proposes 64 strategies for necessary action to meet the emissions reduction requirements established in the GWSA. **The highest-impact emissions reductions strategy proposed was the Clean Heat Standard, which would require the thermal fuel sector to meet its share of emissions reduction by 2030.** The Clean Heat Standard alone would meet over one third of Vermont's emissions reductions responsibility under the GWSA. Despite being a strong recommendation of the Climate Council and receiving overwhelming support in the legislature, the future of the Clean Heat Standard is uncertain due to a veto by Governor Scott.

In addition, when the CAP was completed, the largest outstanding question was the path forward for reducing transportation emissions. A week and a half before the CAP deadline, the Transportation and Climate Initiative Program (TCI-P), a regional cap-and-invest program focused on the transportation sector, stalled after Connecticut and then Massachusetts pulled their support.

As this report goes to press in the summer of 2022, the Vermont Climate Council is working to identify one or more primary policy recommendations to ensure transportation sector emissions reductions in line with GWSA requirements are achieved, with one or more recommendations expected before the end of 2022. In particular, cap-and-invest strategies such as joining the Western Climate Initiative, and/or performance standard approaches such as a Clean Transportation Standard, are being actively considered.

Vermont's historical GHG emissions and future requirements



Source: Vermont Agency of Natural Resources, Vermont GHG Emissions Inventory and Forecast (1990-2017), 2021.

Financial savings from CAP

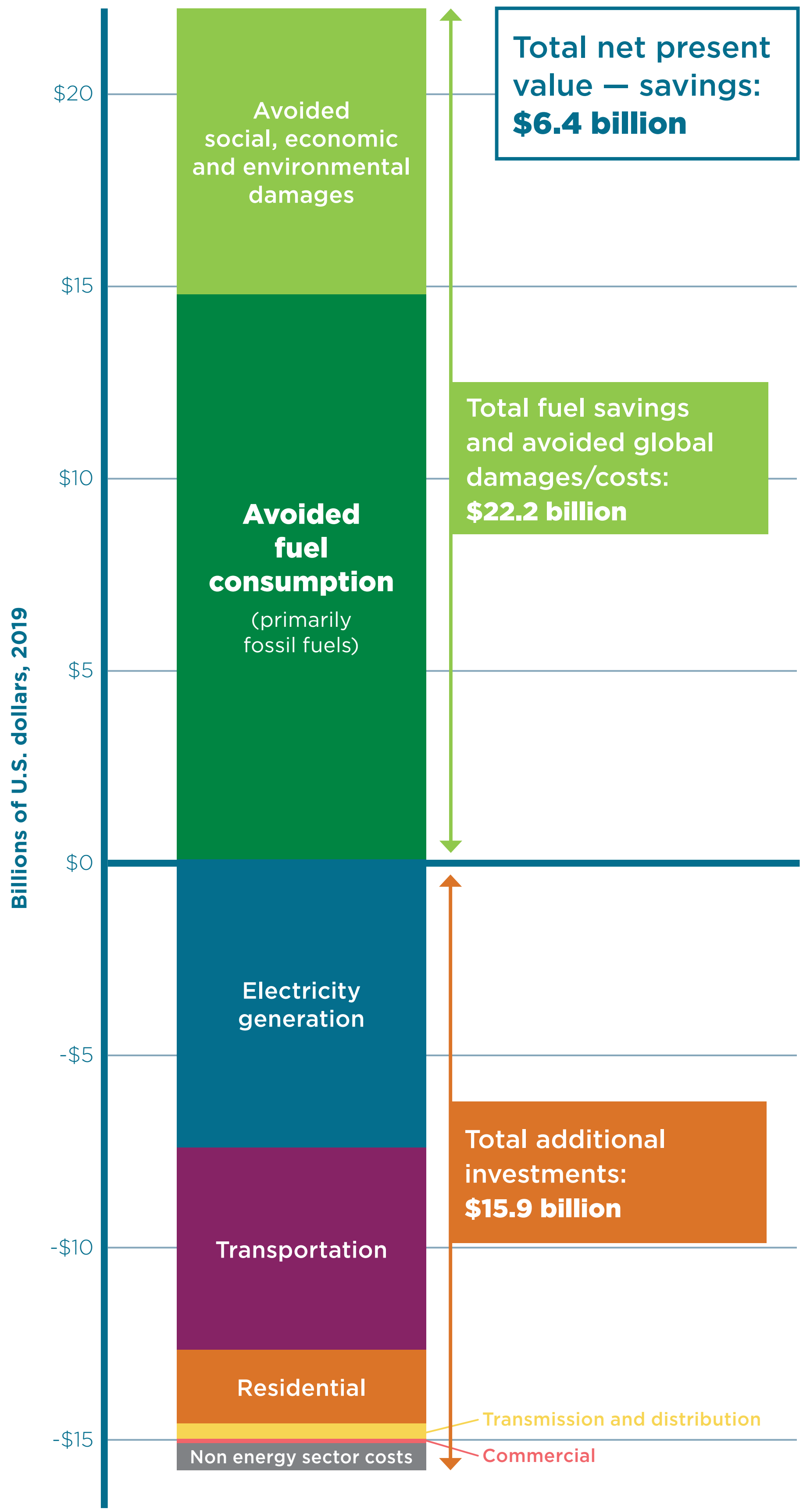
Meeting Vermont's emissions reduction requirements is a massive opportunity for Vermont consumers and the Vermont economy. When we transition from 100% imported, high cost, price volatile fuels to lower-cost, price stable clean energy, the result is a win-win: more money is kept local and in consumers' pockets.

The *Vermont Pathways Analysis Report* (or *Pathways Report*), produced for the Vermont Climate Council and Vermont Department of Public Service by Cadmus and Energy Futures Group (EFG) projects **$6.4 billion in net economic savings and avoided damages** between now and 2050 by meeting our emissions reduction commitments. The analysis anticipates the net creation of an average of 220 new jobs added (and subsequently retained) every year over the next three decades, adding up to 109,000 job years in total. **The growth in energy efficiency and clean energy jobs will far offset the comparatively few jobs that may be lost** at those fossil fuel companies that refuse to transition their business models.[1]

A major priority of the Climate Action Plan is an equitable energy transition for Vermonters. That means policies, programs, and incentives to provide Vermonters with lower and middle incomes with the ability to acquire products and services that allow them to reduce pollution and save money over time. **Holistic policy solutions and public funding are necessary to counteract deeply entrenched inequities and energy burdens resulting from fossil fuel dependence.** While this transition requires each of us to act, we can't leave it up to individuals to act alone.

1. Cadmus/EFG, Vermont Pathways Analysis Report 2.0, 2022.

Climate Action Plan: $ savings from pathways, net present value, 2015-2050



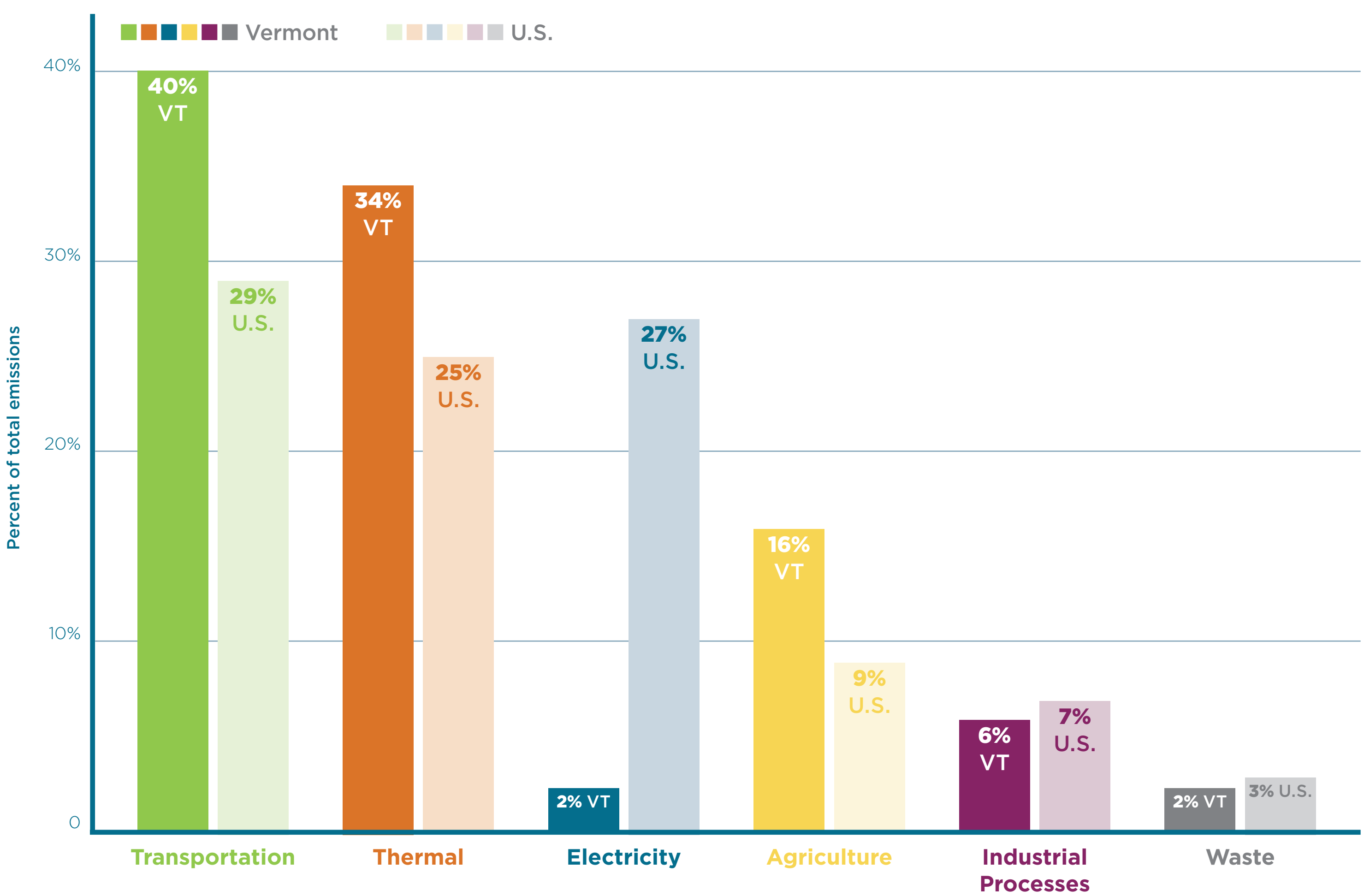
Source: Cadmus/EFG, Vermont Pathways Analysis Report 2.0, 2022.

2. VT needs to reduce GHG emissions from transportation and heating to meet our climate requirements

The overarching framework of the Global Warming Solutions Act (GSWA) provides a major opportunity for economy-wide emissions reductions. Historically, Vermont policy and regulatory requirements have primarily been focused on the electricity sector, which has resulted in significant reductions in electricity emissions over recent years. **At this point, nearly three-quarters of Vermont's GHG emissions come from the transportation and thermal sectors.** Compared to the U.S. as a whole, Vermont has a higher percentage of emissions coming from the transportation and building/thermal sectors, and less from the electricity sector.

The Vermont Climate Action Plan (CAP) includes many emissions reduction policy recommendations, with a heavy focus on thermal and transportation-related measures. These include pathways ranging from the expansion of residential weatherization and clean heating options, to providing incentives for the purchase of electric vehicles and and expanding infrastructure for transit and non-motorized transportation. While Vermont's electricity sector can and will become less carbon intensive over time, it is already much lower emitting than that of other states. This enables significant and immediate emissions reductions whenever Vermonters electrify our transportation and heating needs, instead of using fossil fuels.

GHG emissions by sector, U.S. vs VT (2018)



Source: Vermont Agency of Natural Resources, Vermont Greenhouse Gas Emissions Inventory and Forecast (1990-2017), 2021.; U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018, 2021. Note: Due to time lags in state and federal data reporting, 2018 is the latest data available.

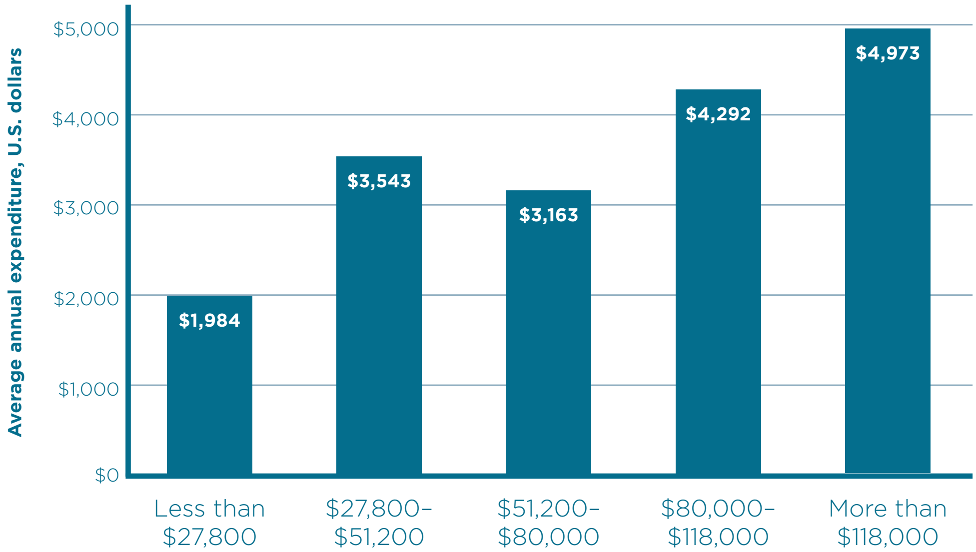
3. New policies and programs must help reduce energy burdens

The lowest-income Vermonters purchase less energy than upper-income Vermonters — but that energy spending takes up a much greater share of their household budgets.

Energy burden, the percentage of household income spent on energy, is a useful metric for comparing differential effects of energy spending on different communities. Efficiency Vermont's *2019 Energy Burden Report* examined geographic disparities in energy burdens, finding that the average varies by town from 6% to 20%. Notably, the towns with the highest energy burdens do not spend more on energy, they just have lower median incomes.[1]

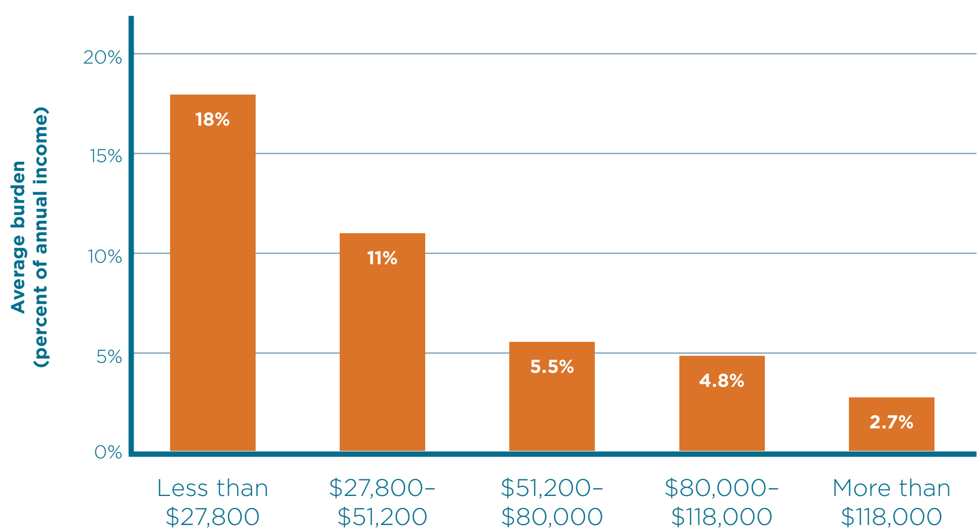
Challenges related to energy and climate do not exist in isolation from other societal challenges. They are interlinked and exacerbated by racial and economic inequities. Although data limitations prevented us from analyzing energy burden by race in Vermont, national assessments have shown that structural inequalities in U.S. energy systems cause energy insecurity that disproportionately affect BIPOC (Black, Indigenous, and people of color) households, and Black households in particular, with lasting, generational effects.[2]

Combined heating and electricity expenditures in Vermont, by income quintile



Source: U.S. Census Bureau, American Community Survey, 2018.

Combined heating and electricity energy burden in Vermont, by income quintile



Source: U.S. Census Bureau, American Community Survey, 2018.

It is not enough to meet the numerical targets of Vermont's energy and emissions reduction commitments — it is also very important to change *who* pays and *who* benefits. We need to quickly move beyond fossil fuels for our energy needs for both climate reasons and to support long term economic health. We also need to make sure that all Vermonters receive the benefits of the clean energy transition, with most costs borne by those who can most afford it.

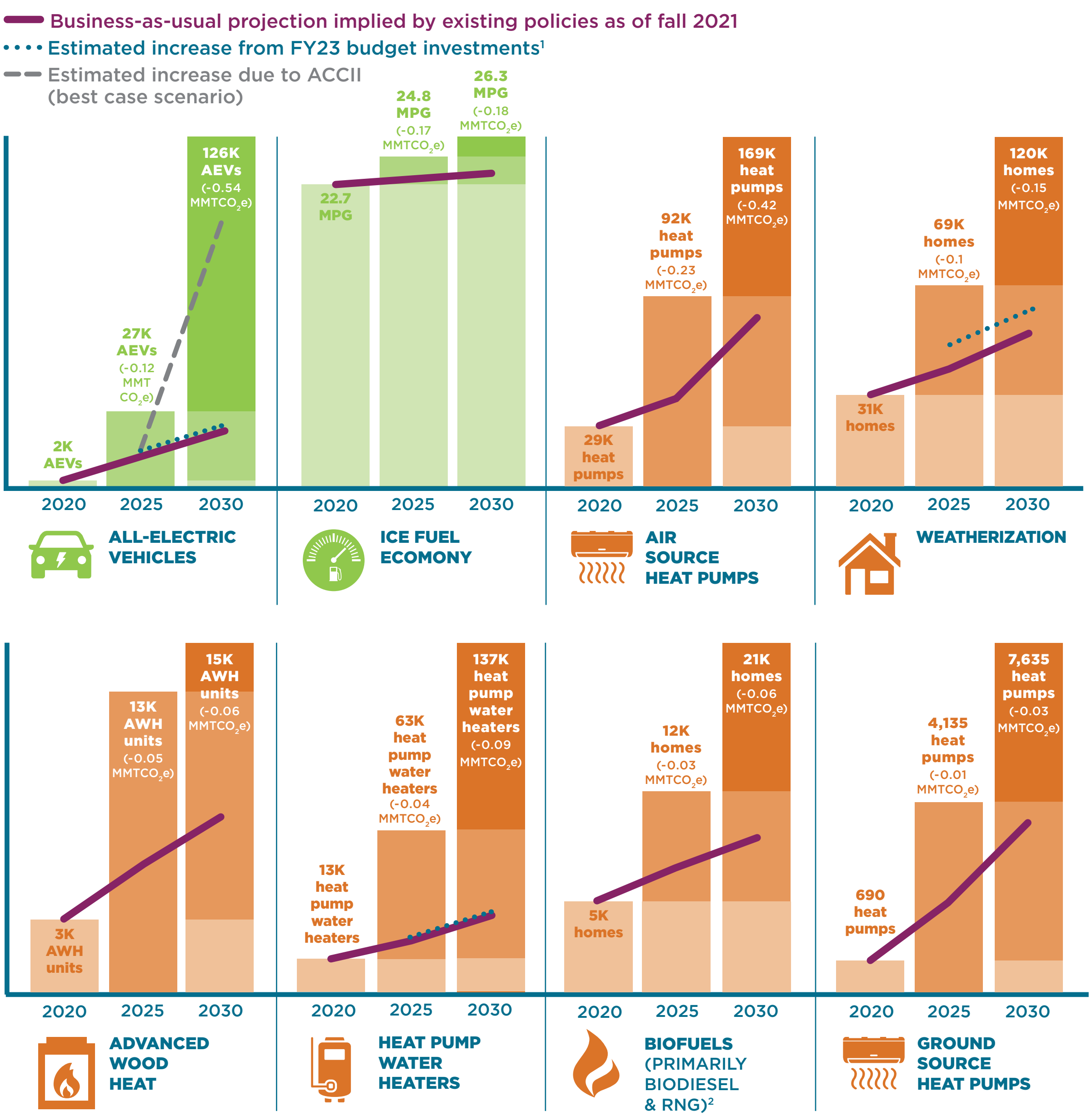
1. Efficiency Vermont, "Energy Burden Report", 2019.
2. Lewis, et al., "Energy efficiency as energy justice: addressing racial inequities through investments in people and places", 2019.

4. Climate Council Pathways Analysis shows how VT can meet emissions reduction requirements

The *Pathways Report*, produced for the Vermont Climate Council and Vermont Department of Public Service by Cadmus and Energy Futures Group (EFG) shows that we can meet our 2025 and 2030 emissions reduction commitments under the Global Warming Solutions Act (GWSA) with currently available energy technologies and proven best practices. **Although these emissions reductions are technically possible, they will require significant policy actions and investments. 2022 saw failures to approve key policy changes, including TCI-P and the Clean Heat Standard.** Even important investments approved in 2022 do not represent long-term solutions, such as Federal ARPA funding that will expire in 2026 — exactly the time when we need to scale up action and investments to meet our stronger 2030 GHG reduction requirement.

Because the vast majority of Vermont's emissions (74%) come from the transportation and thermal sectors, it is in those sectors that the most significant action is needed. The graphs on these pages highlight the highest-impact transportation and thermal measures in the *Pathways Report*, and show the scale of progress needed by 2025 and 2030 compared to a 2020 baseline. Some uptake of these measures would be expected to increase under a business as usual projection given existing policies and programs. However,

Top GHG reduction measures in Climate Council Pathways



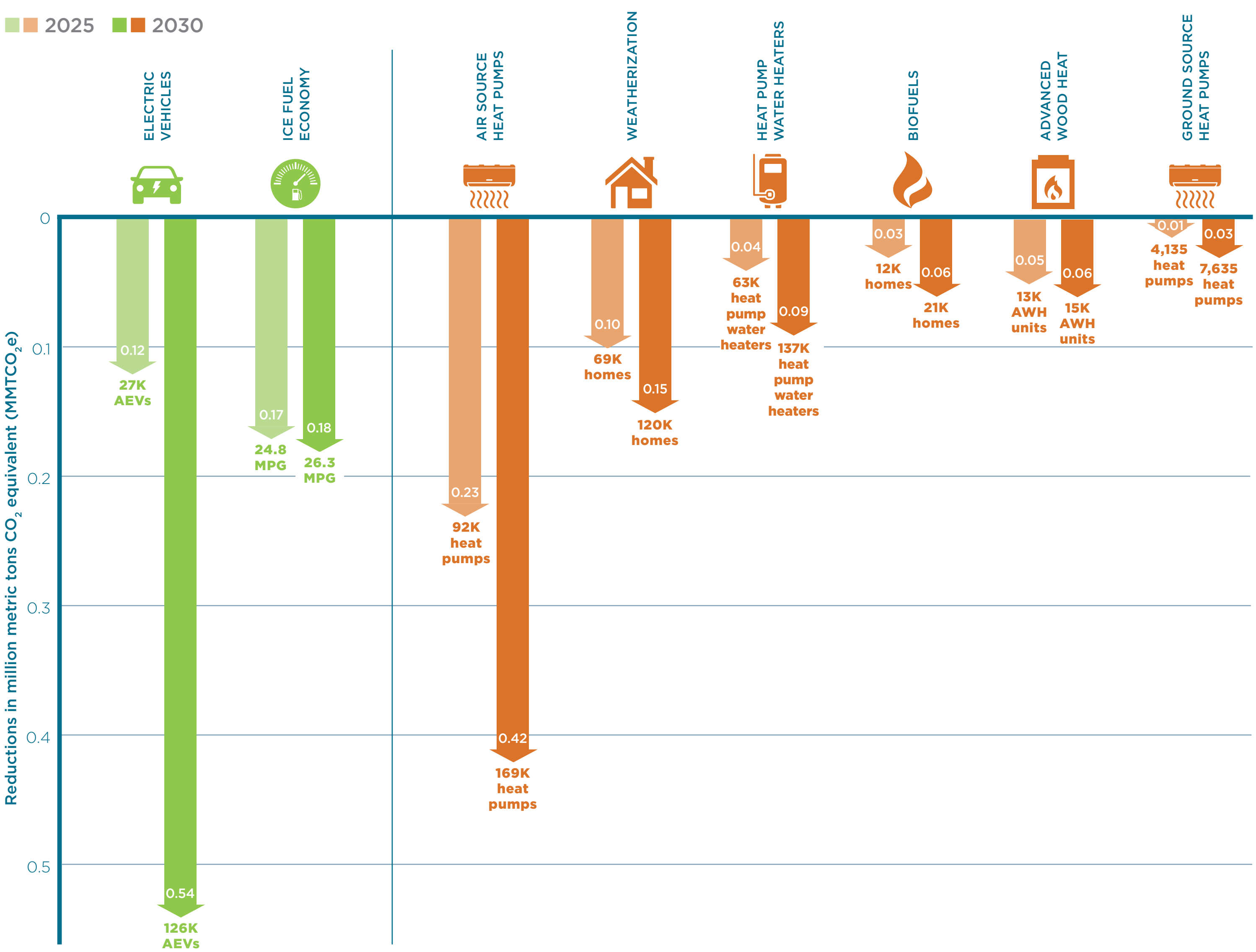
Source: Cadmus/EFG, Vermont Pathways Analysis Report 2.0, 2022; EAN Emissions Reduction Pathways Model, 2021. Note: While these Pathways account for a significant proportion of the required reductions, there are still necessary reductions that will need to come from other pathways in the transportation and thermal sectors, as well as from other non-energy sectors. These other reductions total to be roughly 0.45 MMT CO2e in 2025, and 1.85 MMT CO2e in 2030. **1.** EAN analysis. **2.** Rather than 5,000 homes heated by pure biofuels, VT has a high number of homes using fossil fuel blended with a small amount of biodiesel, or "renewable natural gas." The Cadmus/EFG model uses an equivalent number; the amount of biofuel currently used could heat 5,000 homes without blending.

without significant additional policies and programs, business as usual is not expected to get us anywhere near the requirements of the Global Warming Solutions Act, especially for 2030. The measures highlighted on the facing page are just the highest impact measures in the transportation and thermal sectors, and do not include all of the modeled measures needed to achieve the GWSA requirements. **We would need ALL of the pathways and measures, including but not limited to those in the transportation and thermal sectors, together at the scale and pace modeled to reach our GWSA requirements.** If we fall short on any one of them, other pathways and/or measures would need to do even more to make up the difference.

While the climate action investments committed in 2022 are an important start, these dollars alone — mostly federal funds meant to be spent between now and 2026 — will come nowhere near what is necessary to achieve the *Pathways Report* targets in the absence of additional, overarching policy and higher investments in future years. For example, at approximately $10,000 per project, $80 million for weatherization of Vermont homes may only produce around 8,000 of the 90,000 weatherization projects needed by 2030. The $12 million for EV incentives may only support the purchase of 3,000 additional AEVs — far short of the 127,000 expected to be necessary by 2030.

The graph below shows the GHG reductions that would come from technology adoption at the scale and pace modeled to meet Vermont's GWSA emissions reduction requirements, according to the *Pathways Report.*

Pathways emissions reductions, 2025 and 2030

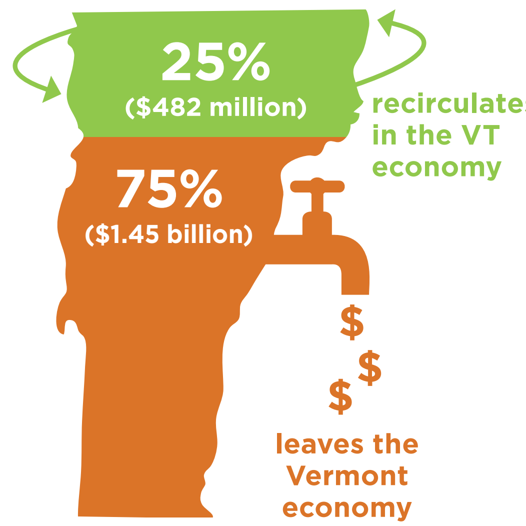


Source: Cadmus/EFG, Vermont Pathways Analysis Report 2.0, 2022; EAN Emissions Reduction Pathways Model, 2021 Note: While these Pathways account for a significant proportion of the required reductions, there are still necessary reductions that will need to come from other pathways in the transportation and thermal sectors, as well as from other non-energy sectors. These other reductions total to be roughly 0.45 MMT CO2e in 2025, and 1.85 MMT CO2e in 2030.

5. Relying on fossil fuels harms Vermonters and Vermont's economy

Vermont's reliance on fossil fuels for 72% of our home heating and 94% of our transportation harms both Vermont consumers and our state's economy. Fossil fuel prices are, on average, both high cost and highly price volatile. Crude oil prices have ranged from a low of less than $20 per barrel during the early days of COVID in April 2020, to over $100 per barrel during the Russian invasion of Ukraine in March 2022.[1] While Vermonters have no control over the prices of fossil fuels, or what countries are benefiting from our fossil fuel purchases, **we can have more control over how much money we spend on energy with efficiency improvements and by switching to non-fossil energy sources that cost less over time and keep more of our energy dollars local.**

Average annual fossil fuel spending in VT, 2010–2019

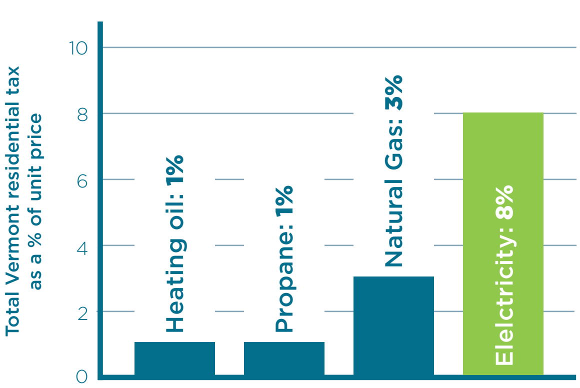


Source: Vermont Agency of Commerce and Community Development, 2022.

We can reduce our use of fossil fuels through efficiency measures like weatherizing our homes, buying more efficient vehicles, or by switching to less carbon intensive fuel types like biomass, including wood chips, pellets or cordwood, biodiesel, or renewable natural gas. **The best way to get off of fossil fuels is by switching to equipment that does not use fossil fuels at all.** All-electric solutions exist for home heating, water heating, transportation, property maintenance, and more. Even on a narrow cost-benefit analysis basis, Vermonters will often save money over the life of the equipment when they replace a piece of fossil fuel equipment with a comparable efficient electric option.[2] Policies and programs can help to alleviate some of the barriers to adoption of non-fossil equipment.

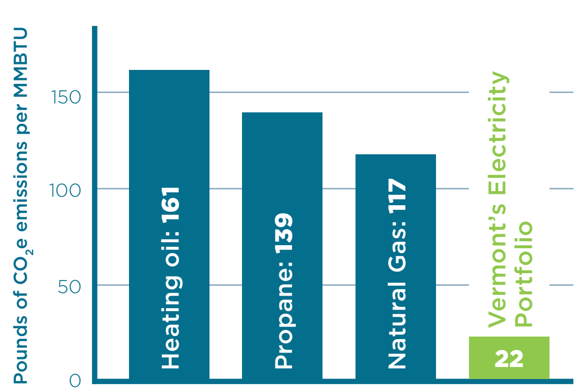
Three quarters of the money we spend on fossil fuels immediately drains out of the state, with only a quarter staying and recirculating in our economy. However, when we use electricity to provide the same services, by driving electric cars or heating with high efficiency electric heat pumps, 70% of the dollars we spend on energy stay and then recirculate in Vermont, helping pay the salaries of Vermonters, including lineworkers, tree-trimmers, and local clean power producers, while strengthening our local economy.

Vermont taxes and fees as percent of unit cost



Source: Vermont Department of Public Service, 2019; Vermont Fuel Dealers Association, 2021.

Pounds of CO_2e emissions per MMBTU



Source: EIA, Emissions Factors for Greenhouse Gas Inventories, March 2020.

However, Vermont currently imposes higher taxes and fees on electricity while allowing the most polluting energy sources that hold Vermont's economy back — fossil fuels — to contribute the least to public investment.

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1. U.S. Energy Information Administration (EIA), "Short Term Energy Outlook", 2022.

2. Note: Savings from electrification of transportation and heating will vary by utility territory, depending on specific electricity rates and on what fuel the household is transitioning from.

6. Meeting Vermont's climate commitments will only be possible if we grow our climate workforce

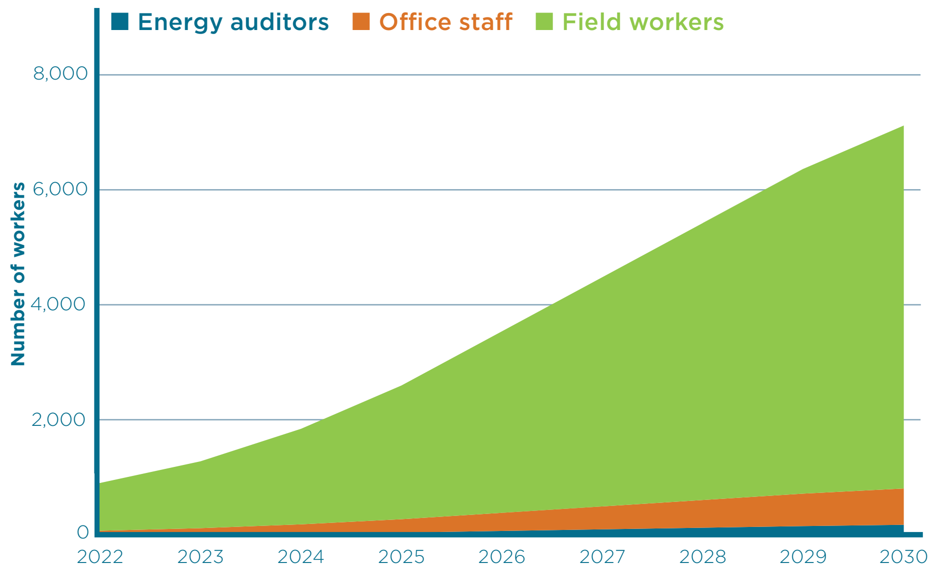
Vermont's climate workforce is made up of approximately 18,900 people who work at least some of the time in climate mitigation, adaptation, or resilience. This includes the 17,502 clean energy workers documented in the *2021 Clean Energy Industry Report*, plus climate workers in other sectors such as agriculture and land management, waste management, public transit, education, financing and philanthropy, and selling and servicing electric equipment.[1]

Reaching our climate requirements will require a significant increase in Vermont's climate workforce. For example, we currently have about 770 people working in weatherization as field workers, office staff, and energy auditors, but we may need more than 6,200 people in those careers by 2030.[2]

Similarly we had around 225 HVAC workers in Vermont in 2020 installing single-zone and multi-zone heat pumps, and will need to double those numbers to more than 450 people in those careers by 2030.

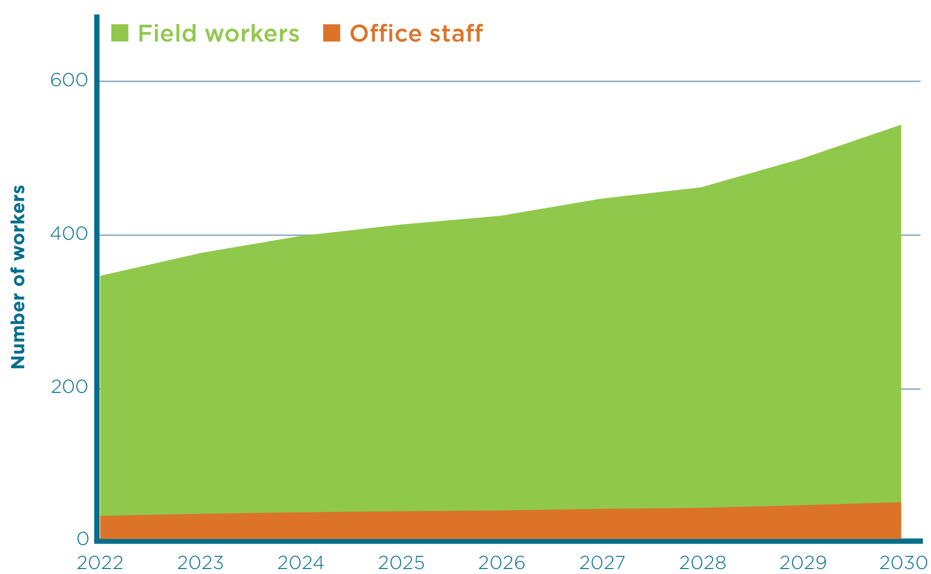
A significant increase in workforce requires long-term, ongoing funding sources to allow businesses to have confidence to expand. It requires training and support for workers and employers. And it also highlights the need for wrap-around services for workers, including affordable housing, transportation, and childcare. **A growth in climate careers is good for the state of Vermont and for Vermont workers** — but too many employers are currently finding it hard to hire the workers they need.

Projected workforce need to meet CAP weatherization target



Source: Weatherizations ramp up rate from Cadmus/EFG, Vermont Pathways Analysis Report 2.0, 2022. Workers per weatherization range from EAN Intern Raquel Smith, "Workforce Development in Vermont's Thermal Sector," 2021.

Projected workforce need to meet CAP heat pump target



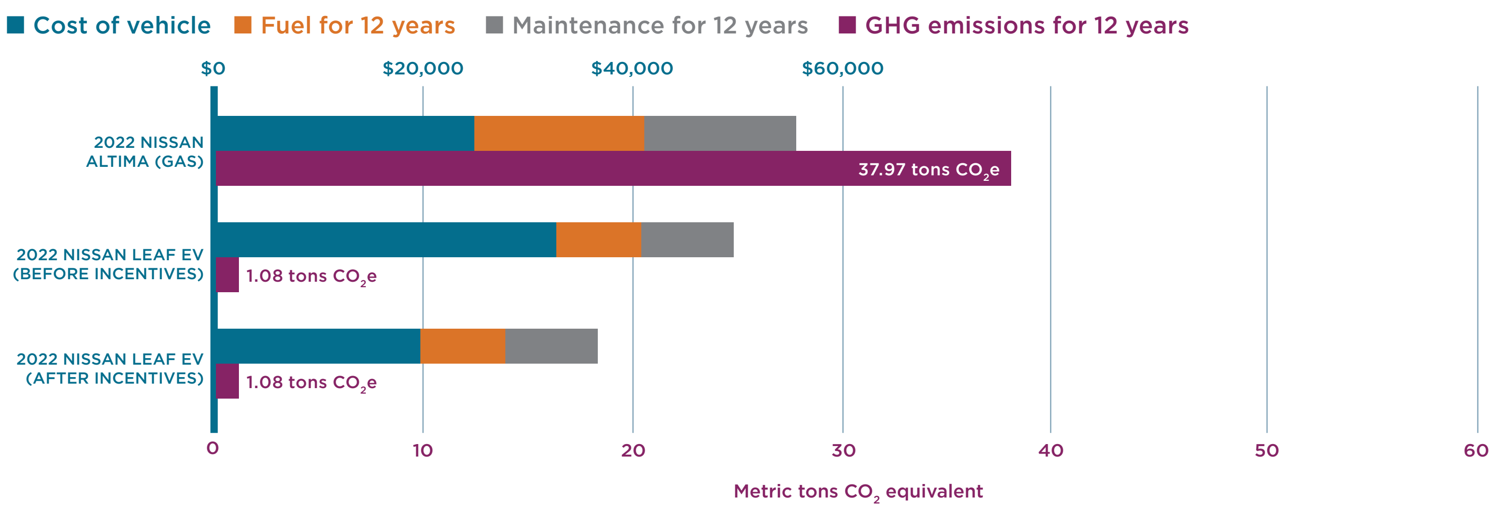
Source: 2025 and 2030 Heat Pump targets from Cadmus/EFG, Vermont Pathways Analysis Report 2.0, 2022. Heat pump installations per worker/per year are an average for single-zone and multi-zone heat pump installations from EAN Intern Raquel Smith, "Workforce Development in Vermont's Thermal Sector", 2021.

1. Clean Energy Development Fund at the Public Service Department, Vermont Clean Energy Industry Report, 2021. Additional Research by Climate Workforce Network Action Team.
2. The numbers of weatherization workers depend on efficiencies of scale and could range between 4,400 and 9,700 by 2030.

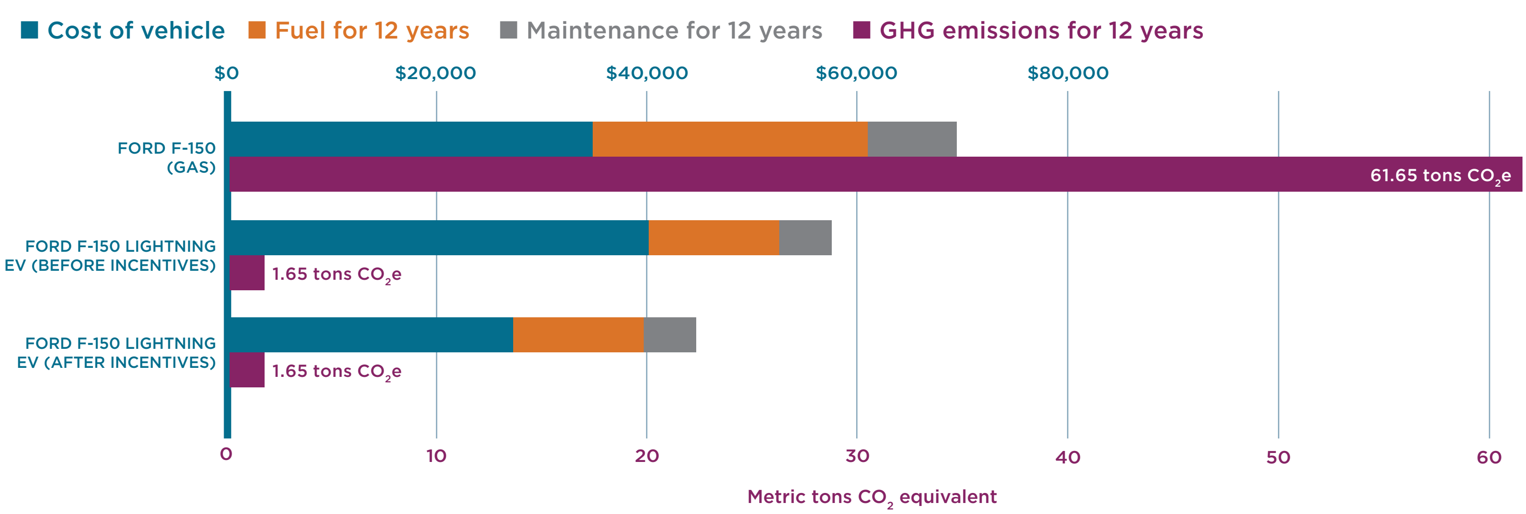
7. Equipment choices matter: To cut emissions and costs, we have to stop purchasing new fossil dependent vehicles and heating systems

Energy choices — especially the equipment we use to stay warm and to get around — have major implications for both the climate and our pocketbooks. When buying new fossil fuel dependent equipment, a decade or more of pollution, high costs, and price volatility gets locked in — none of which we can afford. In contrast, purchasing a more efficient and clean alternative can save money while reducing pollution. Here are comparisons of the costs and climate pollution that result from different energy equipment choices over their lifetime.

Costs and emission of comparable gas vs EV passenger cars

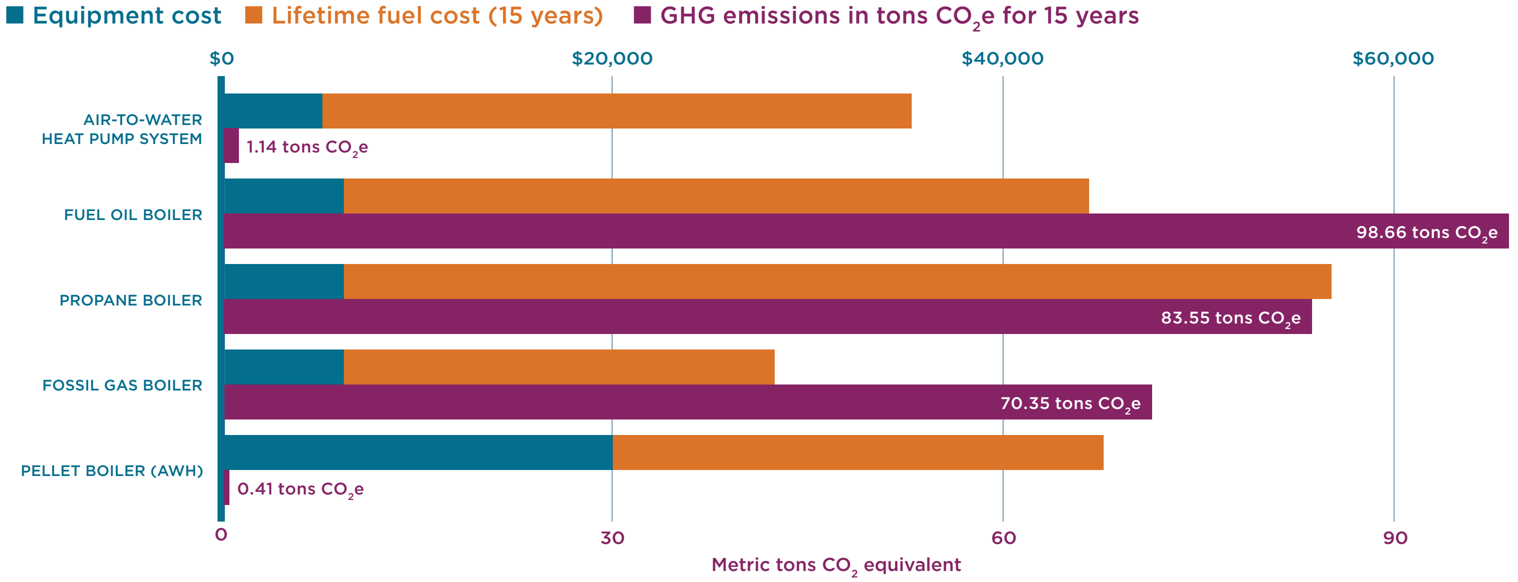


Costs and emission of comparable gas vs EV pick-up trucks

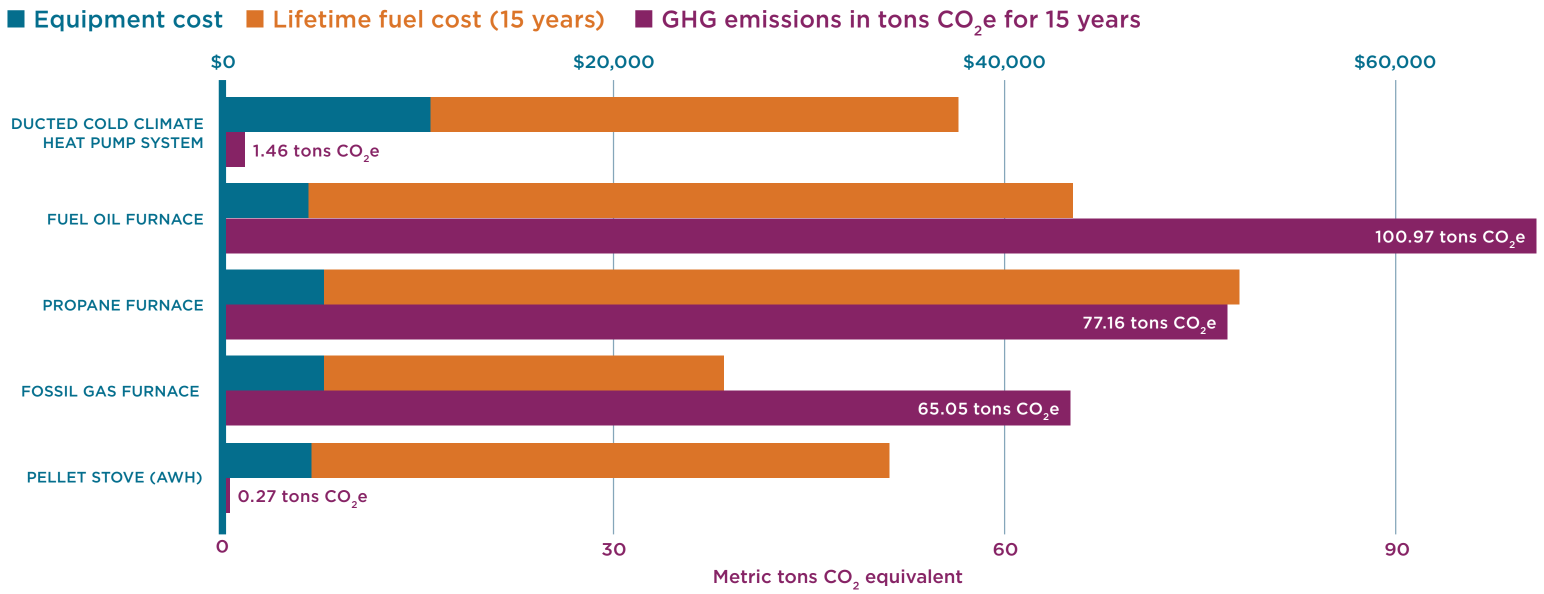


Sources and notes: Fuel costs are based on the average from December 2021 to May 2022 of $3.75/gallon of gasoline, and the May 2022, Green Mountain Power rate of $0.177/ kWh of electricity. CO2e value for VT electricity is 52 lbs/MWh. CO2e value for gasoline is 19.4 lbs/gallon. For EV vs ICE costs: EPA, Alternative Fuels Data Center Cost Calculator, 2022. For EV vs ICE Maintenance costs: U.S. Department of Energy, "FOTW #1190, Battery-Electric Vehicles Have Lower Scheduled Maintenance Costs than Other Light-Duty Vehicles", 2021. For vehicle costs: Drive Electric Vermont, 2022. For CO2e values of VT electricity: Vermont Agency of Natural Resources, 2021. For fossil fuel CO2e values: EIA, 2022. For fuel costs: PSD, 2022. For electricity rates GMP 2022.

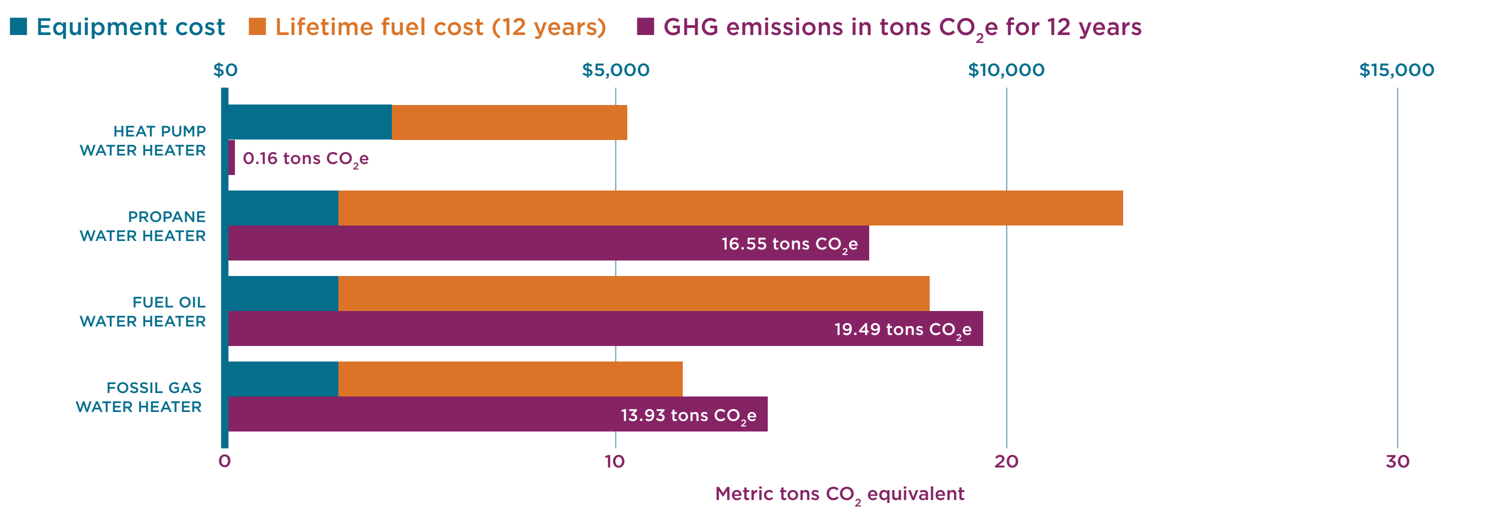
Costs and emissions from hydronic (hot water) heating systems



Costs and emissions from forced hot air heating systems



Costs and emissions from home water heating

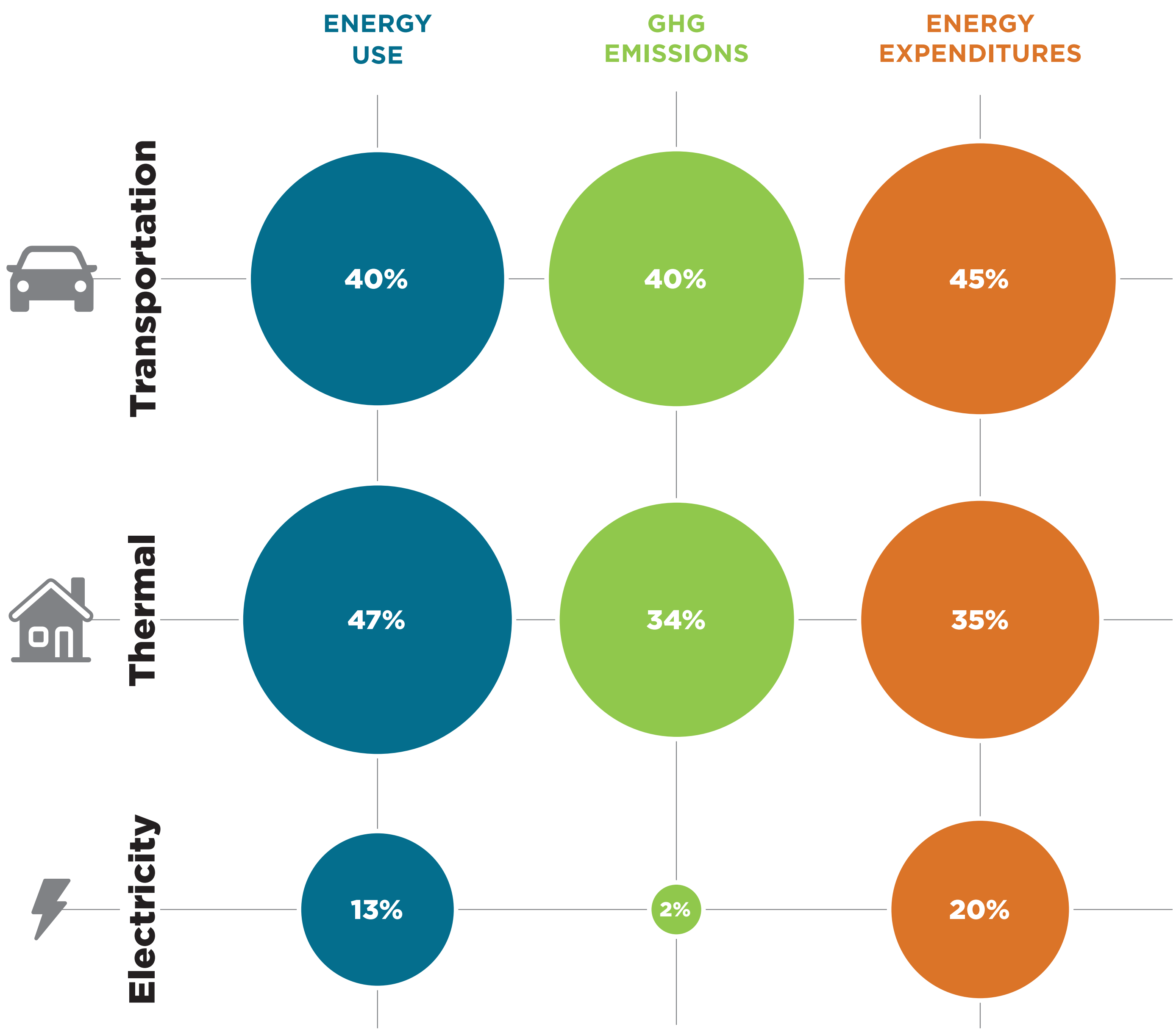


Notes: Cold Climate Heat Pump systems also provide energy efficient air conditioning, which has not been included in the net cost (or savings) and emissions comparisons. Fuel costs used were the May 2022 Green Mountain Power rate of $0.177/k@h, the average of the 2021/22 heating season for propane at $3.16/gallon, fuel oil at $3.61/gallon, and wood pellets at $300/ton, and the listed rates for fossil gas from VGS for Aug 2022.

Sources: For CO2e values of VT electricity and wood pellets: Vermont Agency of Natural Resources, 2021. For fossil fuel CO2e values: EIA, 2022. For fuel costs: PSD, 2022. For electricity rates GMP 2022. Equipment pricing from the TAG TRM where available. Additional pricing sources can be shared on request.

A total energy approach

There are a number of different ways to look at the impacts of Vermonters' use of energy. But any way you look at it, if we think about "energy" only in terms of electricity, we are missing a very large part of the picture. In Vermont, 76% of greenhouse gas emissions come from our energy use, with the largest portion coming from the transportation sector, followed by heating and cooling of buildings. We also spend the most money on transportation, followed by thermal energy (mostly for heating). **Electricity emissions and costs are important — especially as more of our thermal and transportation load shifts to electricity — but whether you look at relative energy used, greenhouse gas emissions, or energy expenditures, fossil fuels used for transportation and heating pose the biggest challenges in Vermont, from both an emissions and economics perspective.** A total energy transformation requires policy and programs to decarbonize transportation and heating, not just electricity. EAN Network Action Teams have helped develop programs and policies to reduce both expenditures and emissions in the transportation and thermal sectors, such as Replace Your Ride and the Clean Heat Standard.

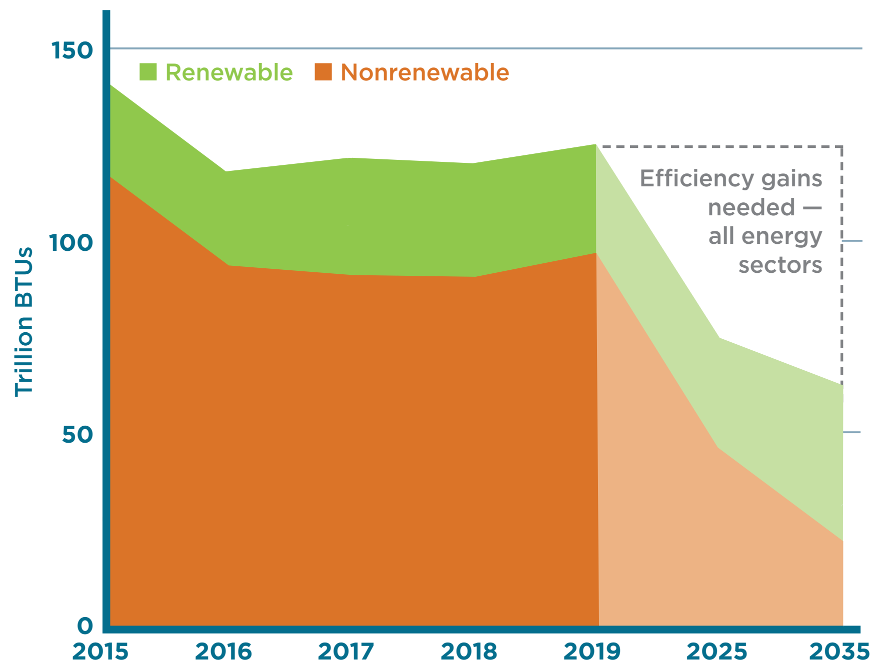


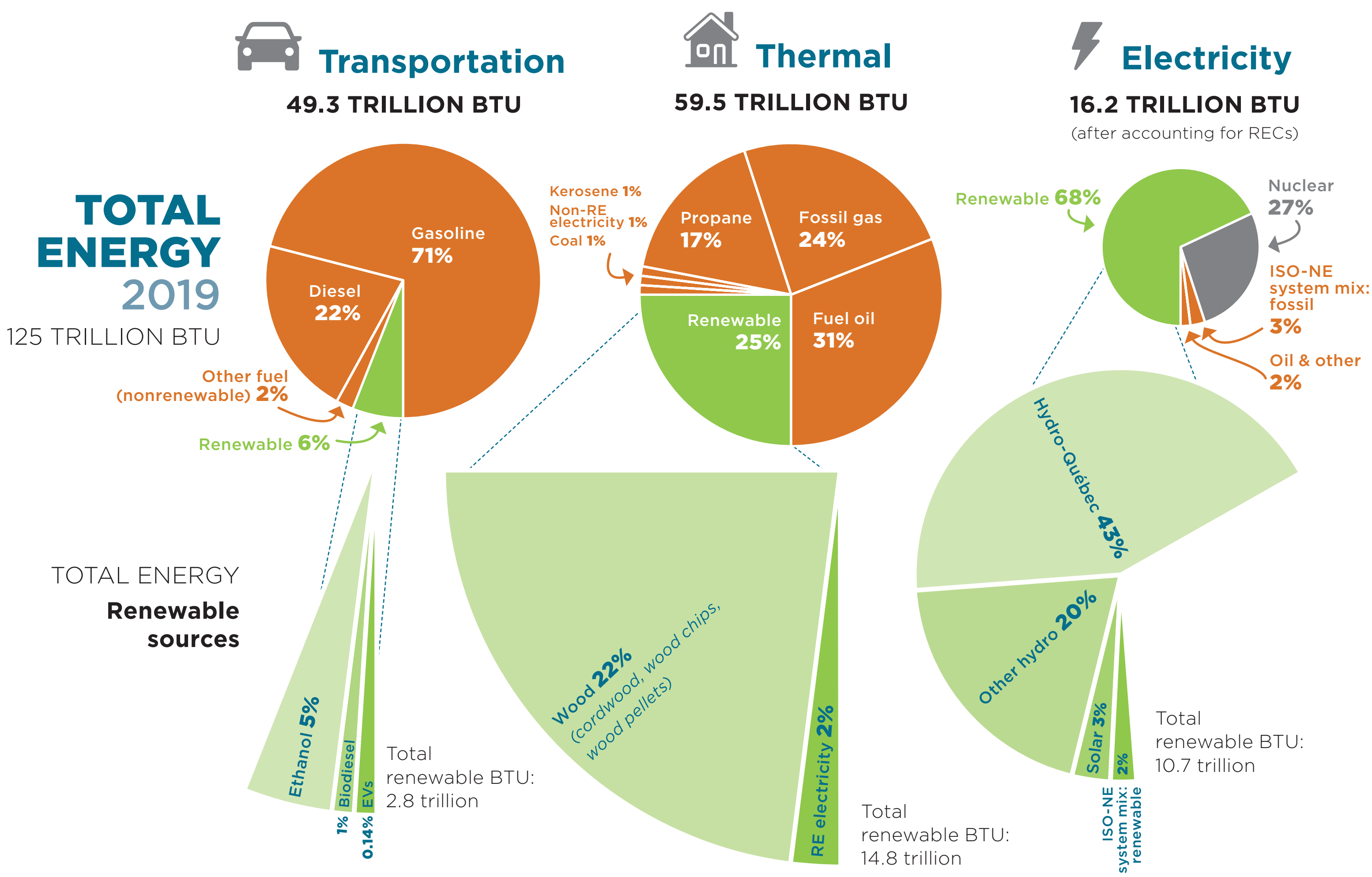
Source for Energy Use: Thermal and transportation based on EIA 2019 site energy; electricity from PSD site energy, after accounting for RECs.
Source for Emissions: VT Agency of Natural Resources. 2021. GHG Emissions Inventory, 1990-2018.
Source for Energy Expenditures: Vermont Energy Burden Report, VEIC (October 2019).

Targets for renewability in different sectors

The last 5 years of data shows a slight drop in overall energy use, accompanied by an increase in renewability for each sector. As we look to the future, the Comprehensive Energy Plan calls for a further decrease in overall energy use, accompanied by a heavy push towards renewability across all sectors. **By 2035, total energy use would have to be roughly half of its 2019 amount.** The decrease in total energy use is planned to come from efficiency measures, including efficiency gains from strategic electrification, implemented throughout the state in all sectors. By 2035, the total renewability proportion across all energy sectors is modeled to be around 52%, which is an increase from 16% in 2019. The Electric sector is anticipated to be completely renewable or carbon-free by that time, the Thermal sector 70% renewable, and the Transportation sector 45% renewable.

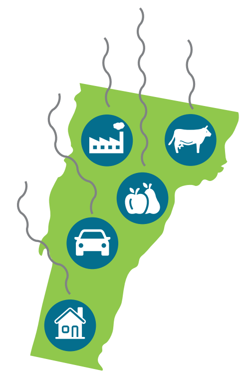
VT total energy to date and CEP targets





Sources: Energy Information Administration, Efficiency Vermont, Vermont Department of Public Service, Vermont Agency of Natural Resources, and Energy Action Network.

Accounting for greenhouse gas emissions



Vermont's Greenhouse Gas Emissions Inventory

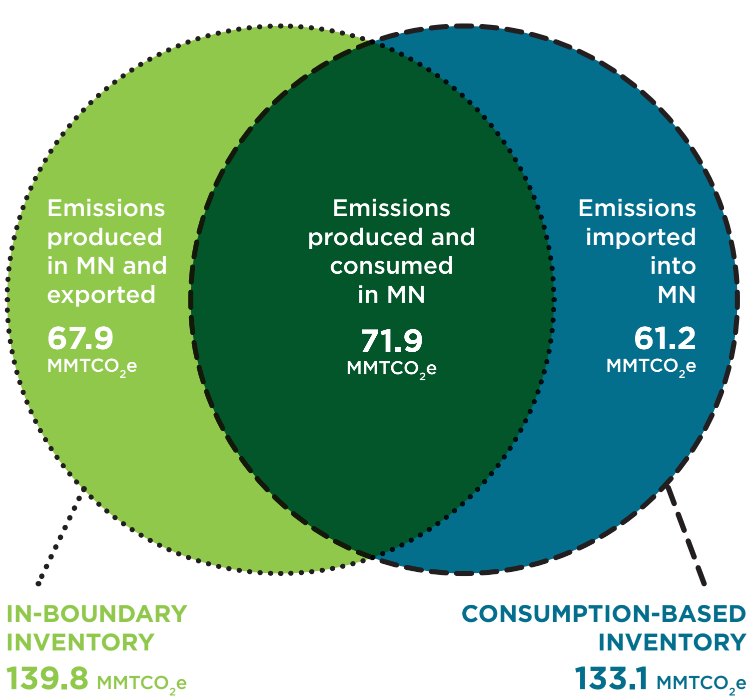
Vermont's official greenhouse gas inventory, compiled by the Department of Environmental Conservation, is what is known as an **"in-boundary" (also sometimes called territorial, sector-based, or production-based) inventory. It aims to account for all of the GHG emissions that are produced within the boundaries of the state of Vermont**. This is the type of inventory that nearly all countries, provinces, and states use, following Intergovernmental Panel on Climate Change (IPCC) protocol. Using this approach avoids double-counting of emissions between jurisdictions.

Consumption-based Inventories

However, when we use energy or consume materials in Vermont, those actions are also tied to emissions that occur outside of our borders, before they are imported into Vermont. **To achieve an accounting of emissions beyond state borders that a state can be viewed as being responsible for as a result of the consumption of its residents, consumption-based emissions inventories (CBEIs) are sometimes employed to supplement official in-boundary inventories.** Oregon and Minnesota are examples of states that have conducted CBEIs. However, it is important to note that a Vermont CBEI would not count emissions tied to consumer purchases of Vermont-made products that are exported to other places.

For this reason, and depending on the balance of imports and exports in a state's economy, a consumption-based inventory can result in higher, lower, or similar emissions totals as compared to a state's official in-boundary inventory. For instance, as a net-exporting state, Minnesota's CBEI showed slightly lower total GHGs than in its in-boundary inventory, as shown below. It is important to stress that one approach is not better or truer than the other — both approaches are legitimate and valuable lenses to understand the emissions we are responsible for.

Minnesota's in-boundary and consumption-based inventories



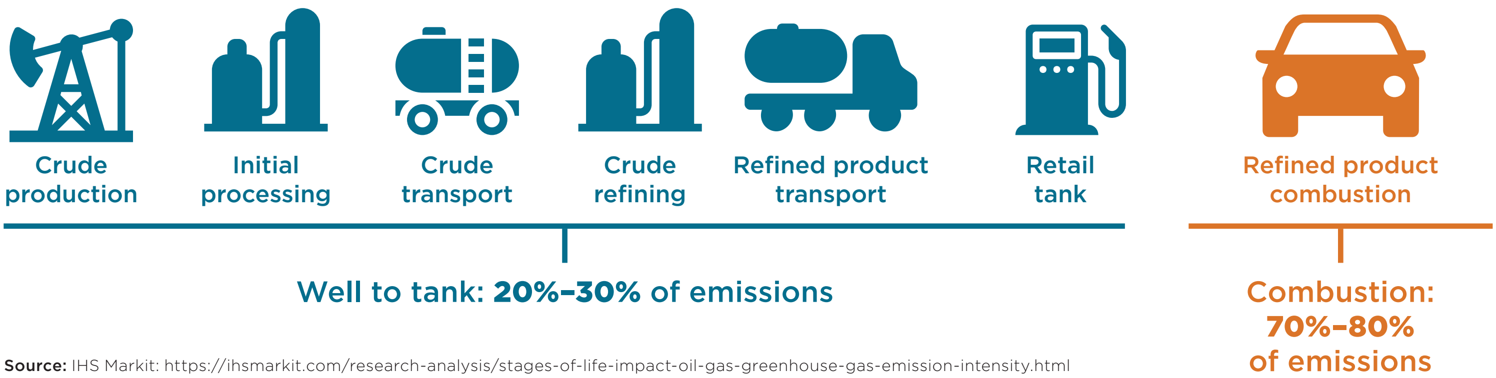
Source: Minnesota Pollution Control Agency, "Consumption-related emissions."

Lifecycle Emissions of Energy Use

Another supplemental approach, as required by the Global Warming Solutions Act, is to specifically assess the "emissions of greenhouse gasses from within the geographical boundaries of the state *and those emissions outside the boundaries of the state that are caused by the use of energy in Vermont.*"

The Vermont Climate Council and Agency of Natural Resources are currently working to develop a supplemental inventory for lifecycle emissions related to Vermont's energy use. This will include not just site emissions ("burner tip" or "tail-pipe" emissions), but also emissions coming from raw material extraction, processing, transmission, and distribution associated with all Vermont energy use, including transportation and heating fuels as well as our electricity consumption.

Lifecycle GHG emissions analysis applied to fossil fuels



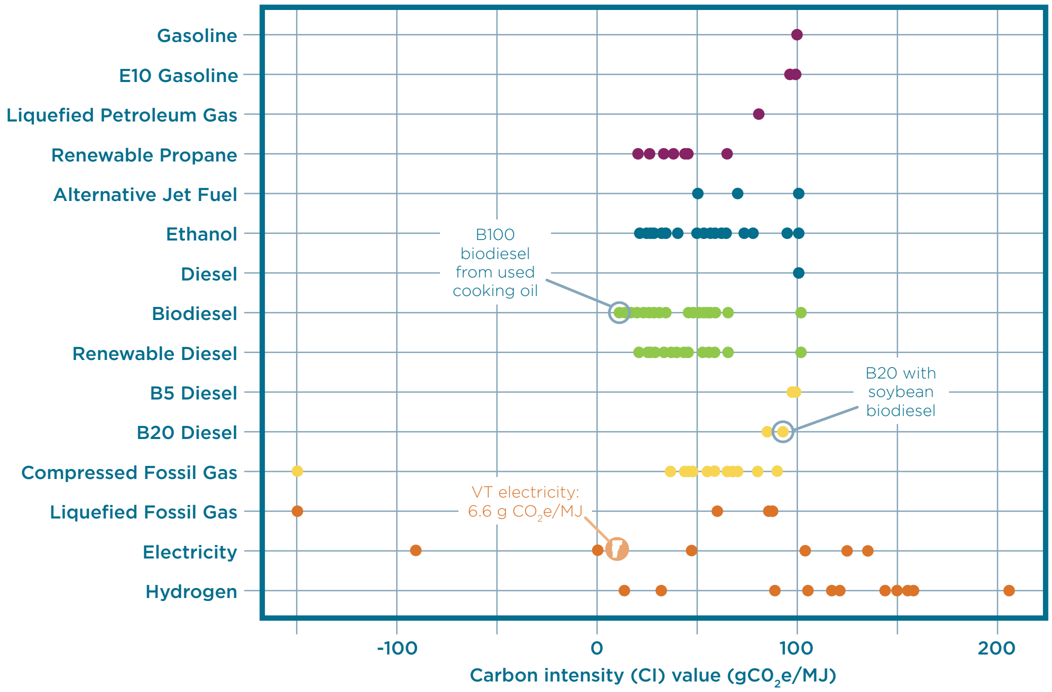
Source: IHS Markit: https://ihsmarkit.com/research-analysis/stages-of-life-impact-oil-gas-greenhouse-gas-emission-intensity.html

Biofuels and lifecycle emissions

Other states, including California and Oregon, already conduct lifecycle emissions analysis related to transportation energy use, building on the GREET model developed by Argonne National Labs. GHG emissions from a broad fuel type can vary depending on unique characteristics. **In particular, different biofuels have very different lifecycle emissions factors (or carbon intensities) based on how each fuel is sourced and produced, so it is important to distinguish between them rather than lump them together.**

Some biofuels, such as those produced from palm oil, create higher emissions than fossil fuels. Meanwhile other biofuels, such as those produced from recycled restaurant oil, produce much lower emissions than fossil fuels. Lifecycle analyses of biofuels can also account for emissions related to both direct and indirect land use change, as Oregon does for assessing compliance with its Clean Fuels Program. Note that each dot on the graph below represents a different carbon intensity value based on the unique source and production method for different transportation energy sources.

Carbon intensity values of different transportation fuels: Oregon clean fuels program



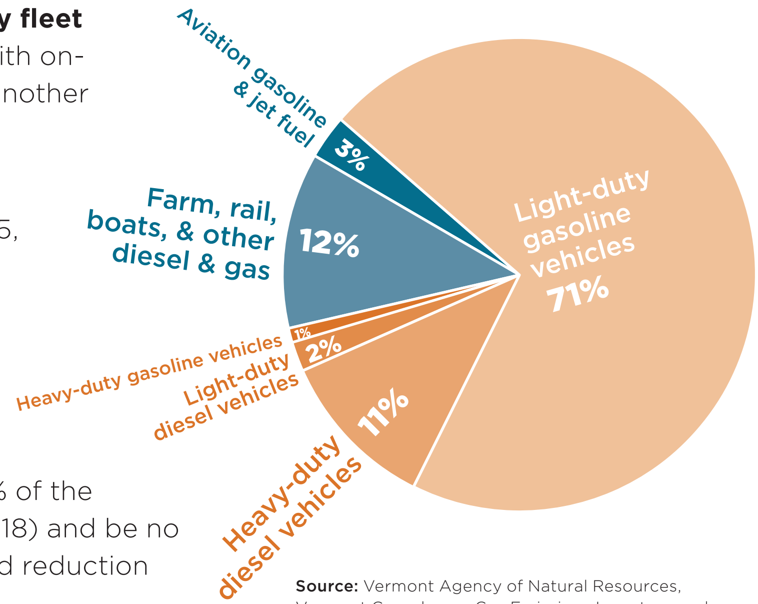
Source: Department of Environmental Quality : Fuel Pathways – Carbon Intensity Values : Oregon Clean Fuels Program : State of Oregon. The carbon intensity values for the program are expressed in grams of carbon dioxide equivalent per megajoule of energy (gCO2e/MJ). VT electricity carbon intensity figure is added by EAN and based on 2019 data from ANR of 15 lbs/MMBTU or 52 lbs/MWh.

Transportation sector fuels and greenhouse gas emissions

Transportation is responsible for 40% of Vermont's greenhouse gas emissions. This is directly related to the fact that 94% of the energy we use for transportation comes from heavily polluting fossil fuels, which is a much higher share of fossil fuel dependence than in any other sector.[1] **On-road gasoline use from the light duty fleet accounts for 71% of total transportation emissions,** with on-road diesel use from heavy duty vehicles contributing another 11% of emissions.[2]

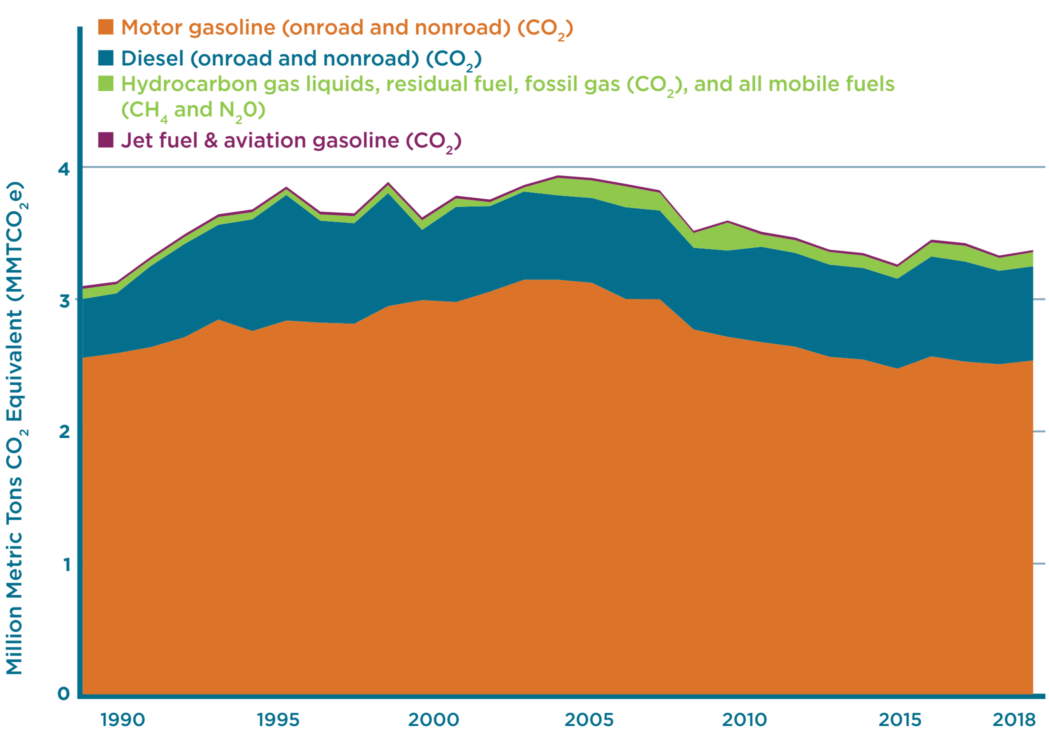
The Global Warming Solutions Act requires Vermont to reduce our emissions to 26% below 2005 levels by 2025, and 40% below 1990 levels by 2030. In 2019 our annual emissions were still higher than our 1990 emissions, though substantially lower than those from 2005. For the transportation sector to hit its sectoral emissions reduction targets, this would mean that our 2018 transportation emissions of 3.43 MMTCO_2e would need to decline to at least 2.93 MMTCO_2e by 2025 (40% of the needed reduction by 2025 or a 15% reduction below 2018) and be no higher than 2.05 MMTCO_2e by 2030 (40% of the needed reduction by 2030, or a 40% reduction below 2018).[3]

VT GHG emissions from transportation by type and fuel, 2017



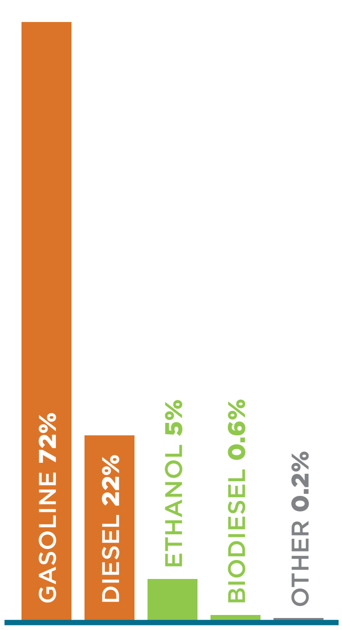
Source: Vermont Agency of Natural Resources, Vermont Greenhouse Gas Emissions Inventory and Forecast (1990-2017), 2021.

Historical VT transportation GHG emissions by source



Source: Vermont Agency of Natural Resources, Vermont Greenhouse Gas Inventory: 1990 - 2017, 2021.

VT transportation energy sources, 2019



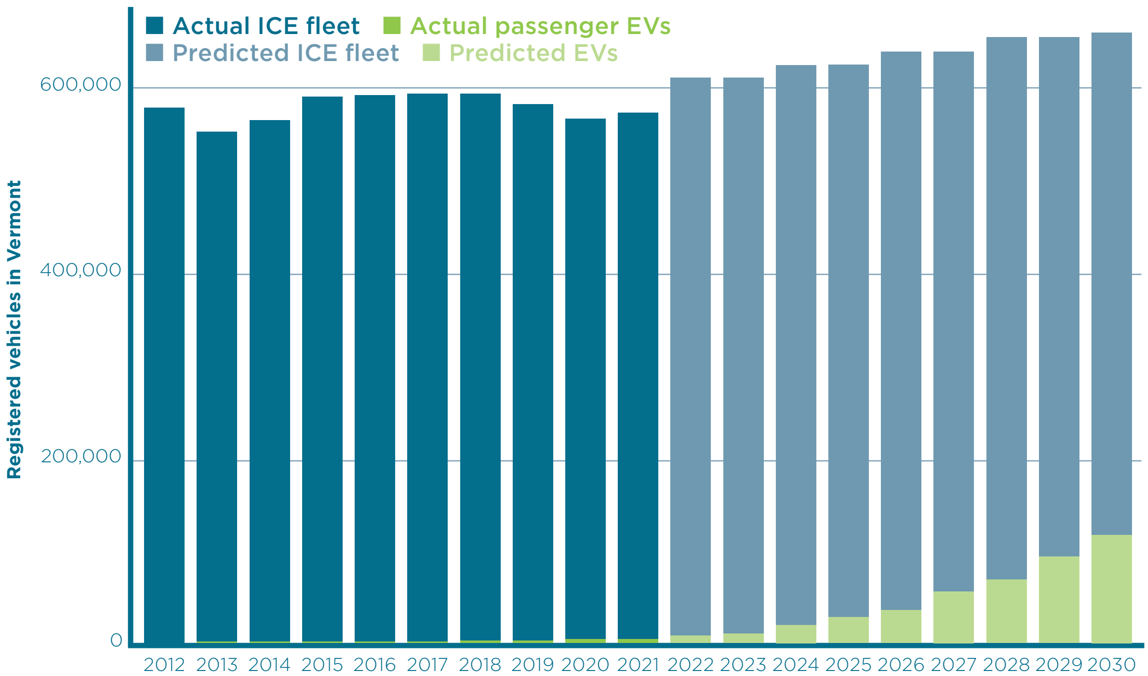
Source: EIA, 2020

1. EIA, 2018.
2. Vermont Agency of Natural Resources, VT Greenhouse Gas Emissions Inventory and Forecast (1990-2017), 2021.
3. Vermont Agency of Natural Resources, VT Greenhouse Gas Emissions Inventory and Forecast (1990-2017), 2021.

Transportation Pathways to Climate Action plan requirements

Transportation efficiency refers to reducing energy use and GHG emissions per mile traveled. Energy use and emissions are highly dependent on the vehicles we choose to purchase and the fuels they use: **electric vehicles (EVs) are three times more efficient[1] than gas or diesel vehicles, and smaller vehicles are generally more efficient than SUVs and pickup trucks, with crossovers (CUVs) in between.**

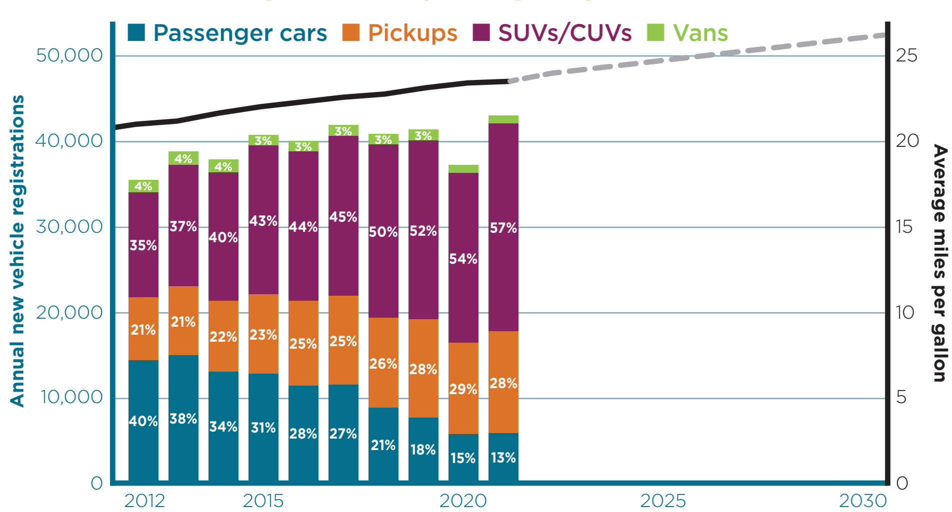
EV registrations: Historical trends and Pathways Analysis projections



Source: Historic Data: VEIC, VT Agency of Natural Resources, Drive Electric VT; Cadmus/EFG, Vermont Pathways Analysis Report, 2022

In order to reach our GHG reduction requirements, the *Pathways Report* calls for an increasing number of Vermonters to replace internal combustion engine (ICE) vehicles with more efficient all-electric vehicles (AEVs). Specifically, the *Pathways Report* sees a need to **increase the number of AEVs on the road from the 3,358[2] registered in Vermont in May of 2022 to 27,000 by 2025, and 126,000 by 2030. Although this represents a significant increase, EVs would still be a relatively small portion of Vermont's overall vehicle fleet, which was approximately 580,000 vehicles in 2021.[3]**

MPG for VT ICE fleet: Historical trends and Pathways Analysis projections



Sources: Historical Data - Vtrans, Vermont Transportation Energy Profile 2021; Future projections: Cadmus/EFG, Vermont Pathways Analysis Report 2.0, 2022; EAN Emissions Reduction Pathways Model, 2021; AutoCount data from Experian, as appearing in Vermont Auto Outlook.

The *Pathways Report* also recognizes that the efficiency of gasoline and diesel vehicles as measured by the miles per gallon (MPG) they achieve will likely continue to improve as technology advances. However, while vehicles have been getting more efficient overall, Vermonters have been buying bigger vehicles, offsetting some of the benefit we could be getting from these increasing fuel efficiency standards.[4]

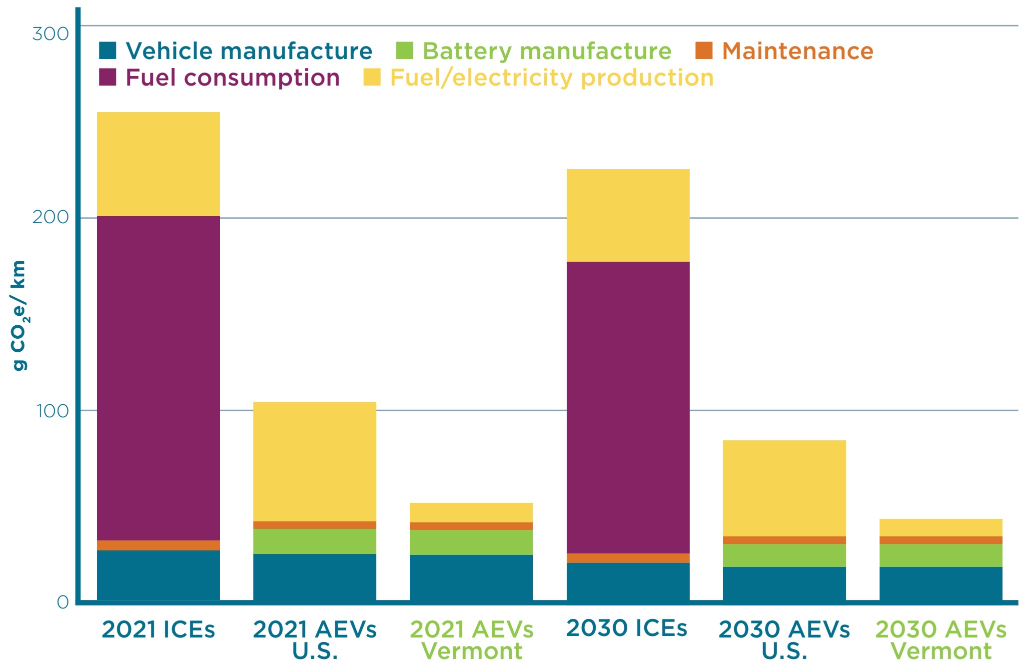
1. "Electric Motors Versus Internal Combustion Engines", Real Clear Energy, Michael Kelly, 2020
2. In addition to the 3,358 all electric vehicles, VT had 3,227 plug-in hybrids registered.
3. Cadmus/EFG, Vermont Pathways Analysis Report 2.0, 2022.
4. Vermont Vehicle & Automotive Distributors Association (VADA), Vermont Auto Outlook, 2022.

Transportation efficiency

The emissions associated with any particular vehicle go beyond just the emissions from fueling the vehicle. Manufacturing and maintaining the vehicle are also sources of greenhouse gas emissions. Because of the energy used in the manufacture of batteries, EVs tend to be responsible for more GHGs in the production phase than internal combustion engine (ICE) vehicles. However, **due to their higher operating efficiency, and the lower GHG profile of electricity compared to fossil fuels, EVs are, on the whole, much less polluting than ICEs over the life of the vehicle.** This is especially true on Vermont's relatively clean electric grid, but is true across the U.S. as well. [1]

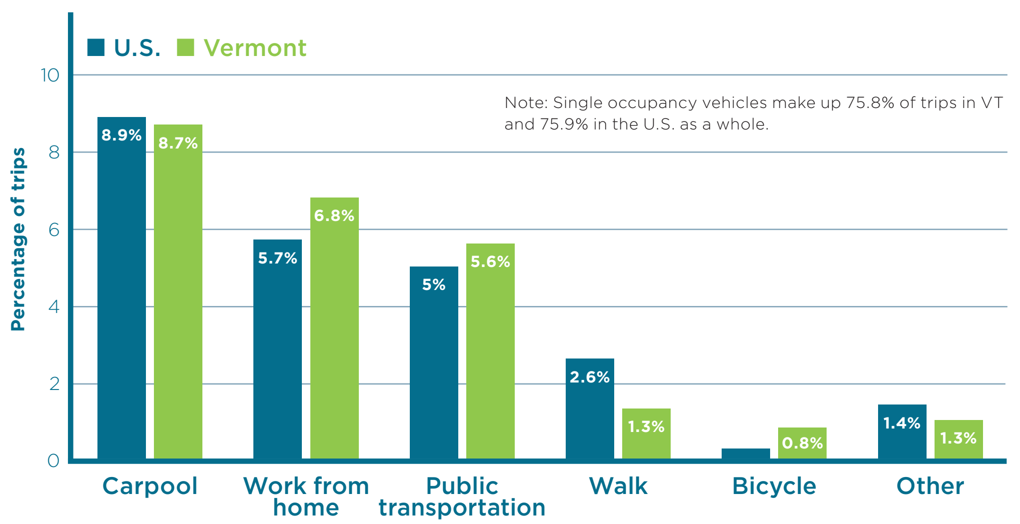
Transportation efficiency extends beyond just which vehicle we might use, and includes both land use and behavior choices. Pre-COVID, almost 76% of commuting trips in both Vermont and the U.S. were taken in single occupancy vehicles. Vermonters tended to work from home, take public transit, and bicycle at higher rates than the U.S. average, but carpooled and walked to work less often.[2] It is important to note that commuting only represents 30-40% of all household vehicle miles traveled.[3] **It remains to be seen how durable some of the shifts in transportation choices related to COVID may be over the next few years, including effects on telecommuting, public transit, active transportation, and carpooling. Increasing any of these has the potential to help reduce our greenhouse gas emissions by reducing vehicle miles traveled.**

Lifecycle GHG emissions of ICE vs EVs in the United States and Vermont



Source: ICCT, A Global Comparison of the Life-Cycle Greenhouse Gas Emissions of Combustion Engine and Electric Passenger Cars, 2021. Updated for VT electricity GHG emissions, EAN, 2022.

Commute mode share for non-single occupancy vehicle trips, 2019



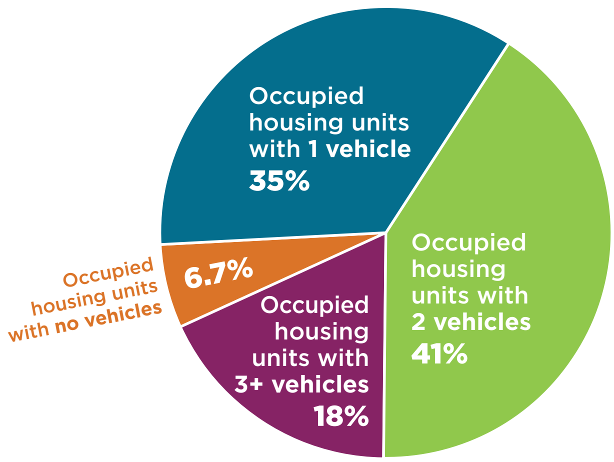
Source: VTrans, Vermont Transportation Energy Profile, 2021.

1. ICCT, A Global Comparison of the Life-Cycle Greenhouse Gas Emissions of Combustion Engine and Electric Passenger Cars, 2021. Updated for VT electricity GHG emissions, EAN, 2022.
2. VTrans, Vermont Transportation Energy Profile, 2021..
3. Vermont ACCD, 2022.

Transportation equity

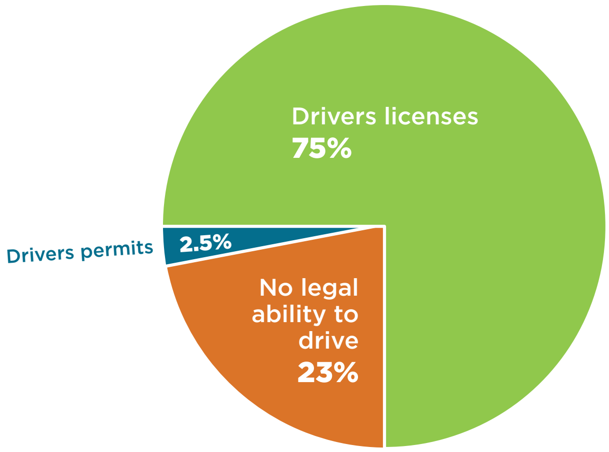
There are many disparities in access to safe, reliable, and affordable transportation between different demographic groups in Vermont. **For our neighbors who are young, seniors, have disabilities, or have low incomes, inadequate transportation options can create a major barrier — reducing employment and education options, as well as making it harder and more time-consuming to get to medical appointments, grocery stores, and social engagements.**

VT vehicles available, 2021



Source: U.S. Census Bureau, American Community Survey 5-year Estimates, 2022.

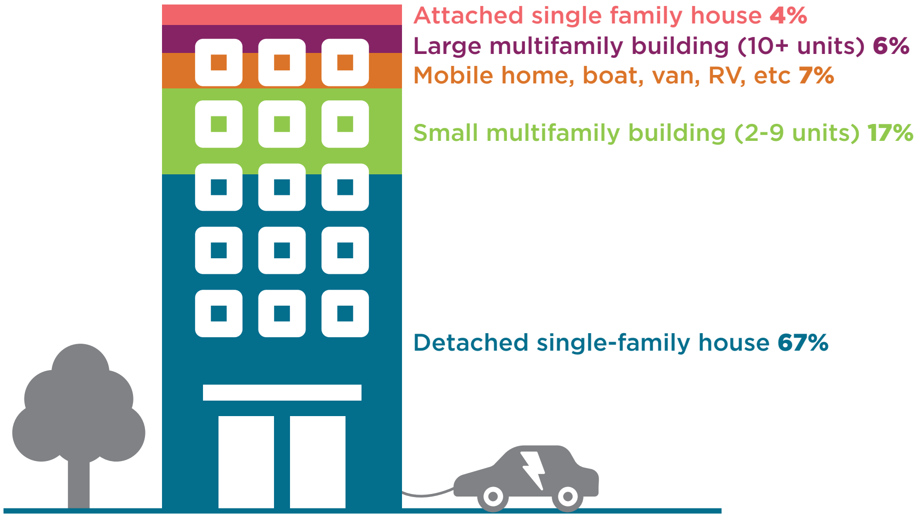
VT access to driving, 2020



Source: Vtrans, Vermont Transportation Energy Profile, 2021.

In Vermont, discussions around transportation tend to 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.[1] And some households don't have a vehicle available to them at all, with 6.7% of occupied housing units in Vermont lacking a vehicle. [2]

Vermont housing units by type



Source: U.S. Census Bureau, American Community Survey 5-year Estimates, 2013-2017.

Even for individuals who do have access to both driving and a vehicle, **the transition to electric vehicles can be hampered by inadequate access to EV charging infrastructure.** Although policies and funding are thankfully advancing to address this issue, it often remains more difficult to drive an EV for renters and those living in multifamily buildings. Only about two-thirds of Vermonters live in detached single family housing, where charging is most easily installed.[3]

1. VT Department of Transportation, Vermont Transportation Energy Profile, 2021.
2. U.S. Census Bureau, American Community Survey 5-year Estimates, 2022.
3. U.S. Census Bureau, American Community Survey 5-year Estimates, 2013-2017.

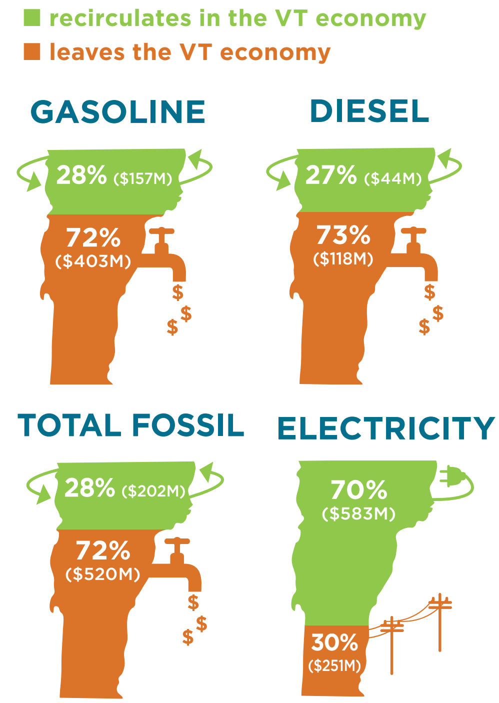
Transportation and the economy

In 2019 transportation accounted for 45% of Vermonters' energy expenditures — a year when the average price of gasoline was $2.64/gallon and diesel averaged $3.10/gallon.[1] As was made especially clear in early 2022, **drivers of gasoline and diesel vehicles are subject to wide price swings for their fuel. As of May 2022, the average cost of gasoline in Vermont was $4.51, while diesel was $6.29. Electric vehicle charging costs 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 off peak EV rate equivalent to $0.70/gallon, or Green Mountain Power's off-peak rate of about $1.07/gallon-equivalent.[2] Increased EV charging infrastructure is needed to allow more Vermonters to benefit from an equitable transition to electric vehicles, with new charging needed at multi-unit housing, workplaces, and public locations.

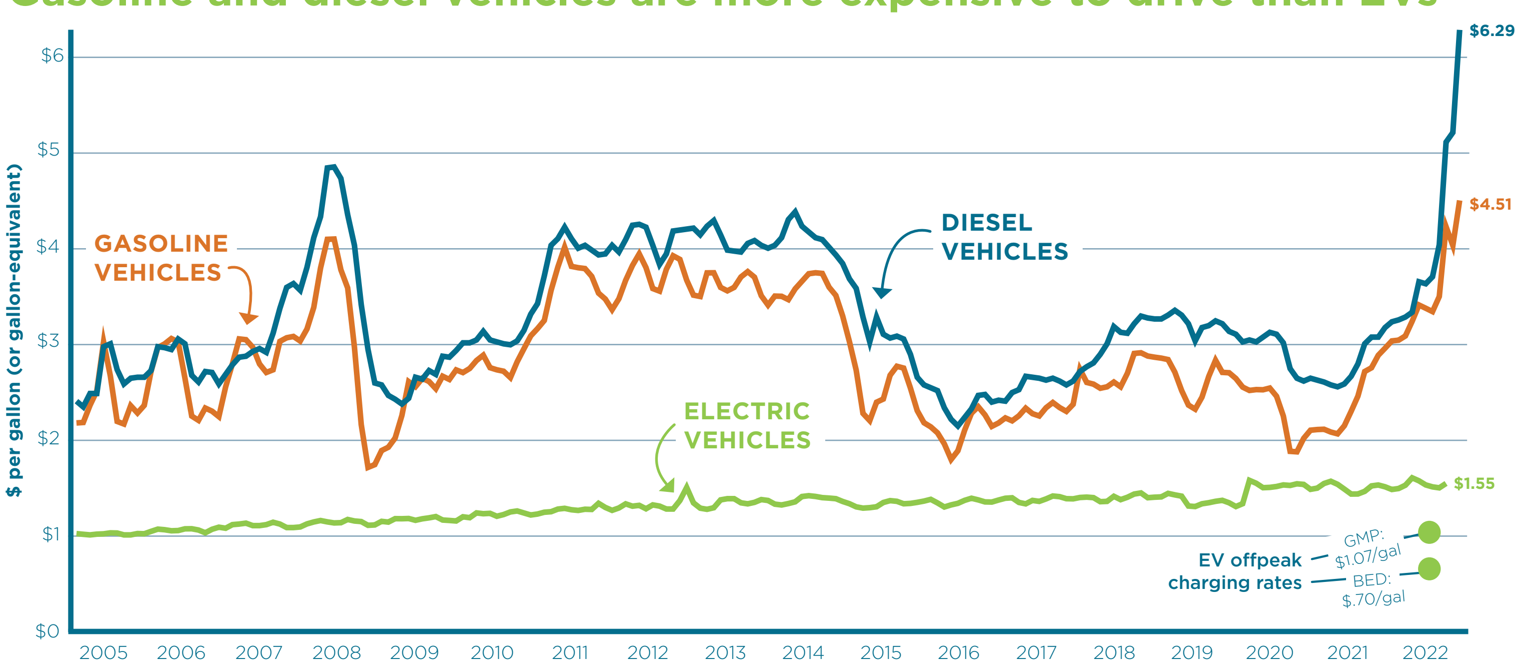
Shifting from fossil fuel to electricity as our primary energy source for transportation can benefit both consumers and the Vermont economy. **In 2020, Vermonters spent more than $700 million on fossil fuels for transportation — a number that could be more than twice as high in 2022, based on fuel prices through May of 2022. In 2020, only 28% of these funds recirculated in the state's economy, with the rest immediately draining out of state.** In contrast, for every dollar we spend on electricity, 70% recirculates in Vermont, supporting local lineworkers, tree trimmers, and clean power producers, among others.[3]

Transportation spending in VT, 2020



Source: Vermont Agency of Commerce and Community Development. 2022

Gasoline and diesel vehicles are more expensive to drive than EVs



Sources: Gas and Electric — Drive Electric VT (via EIA); Diesel — Vermont Agency of Transportation (VTrans). Diesel and gas prices as of May 2022; electricity price as of March 2022.

1. VEIC, Vermont Energy Burden Report, 2019. VT Department of Public Service, Retail Prices of Heating Fuels, 2022.
2. Drive Electric VT, 2022. VT Department of Transportation, 2022. GMP and BED, 2022.
3. Vermont Agency of Commerce and Community Development, 2022.

Electrifying transportation: Increasing options, decreasing costs

Transitioning to electric vehicles (EVs) is one of the highest-impact pathways for reducing GHG emissions in Vermont. There are at least 50 models of all-electric vehicles (AEVs) and plug-in hybrids (PHEVs, which run on electricity, but also have a gasoline engine that can be used for longer trips) available in Vermont. EVs tend to be high performance vehicles with very good traction. More than 35 models are available with all-wheel drive either standard or optional, and at least 25 models get more than 200 miles per charge.[1]

As the number and variety of EVs has increased, prices have also come down. Incentives offered by federal and state governments, and by utilities, bring prices down even more. There are additional programs available to lower income Vermonters, such as Replace Your Ride and MileageSmart. As of spring of 2022, 15 models in Vermont had a base cost less than $40,000, and 5 had a base cost under $30,000 — and that's before accounting for the significant incentives that can take an additional $10,000 or more off the price.[2] **Details about available vehicles, cost reducing incentives, and charging infrastructure, can be found on the Drive Electric Vermont website (driveelectricvt.com).**

1. Drive Electric Vermont, 2022.
2. Drive Electric Vermont, 2022.

Subaru Crosstrek (electric + gas)
Range: 17 miles electric + a gas engine
Base price $35,845 (before rebates and incentives)

Chevrolet Bolt (EUV)
Range: 247 miles
Base cost spring 2022: $25,600 (before rebates and incentives)

Nissan Leaf Plus
Range: 226 Miles
Standard monthly lease spring 2022: $179

Ford E-Transit Van
Range: 126 Miles
Cargo Space 315 ft[3]

Electric Bikes
E-bikes or motorcycles can replace car trips for some people. Utility and state discounts bring down their price.

Chrysler Pacifica Hybrid (electric + gas)
Seats 7
Standard monthly lease spring 2022: $382

Electric Transit Bus
Vermont had 4 electric transit buses on the road with 15 more funded or on order as of spring of 2022.

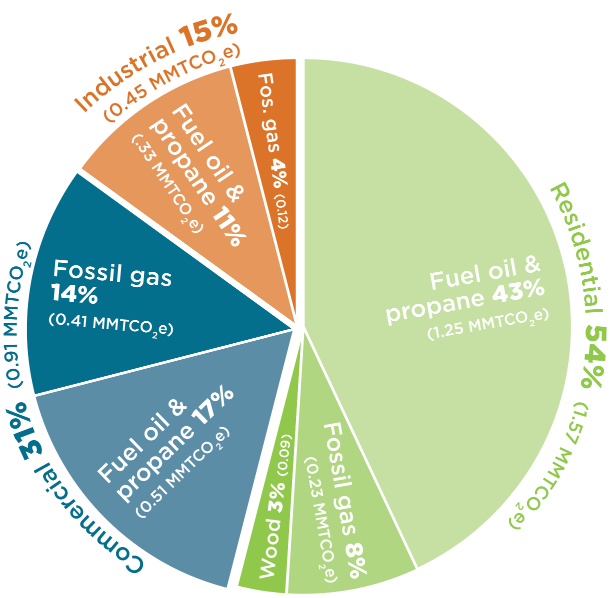
Electric School Bus
Vermont had 6 electric school buses on the road with 4 more on order at the end of the 21/22 school year.

Ford Lightning
Base price below $40,000 (before rebates and incentives)
Can be used as a generator on job sites or to provide backup power at home.

Photo credits. Cars: Drive Electric Vermont. Electric School Bus: VEIC. Electric Transit Bus: Dan Currier. Electric Bike: online image.

Thermal sector fuels and greenhouse gas emissions

Vermont thermal GHG emissions by sector and fuel type



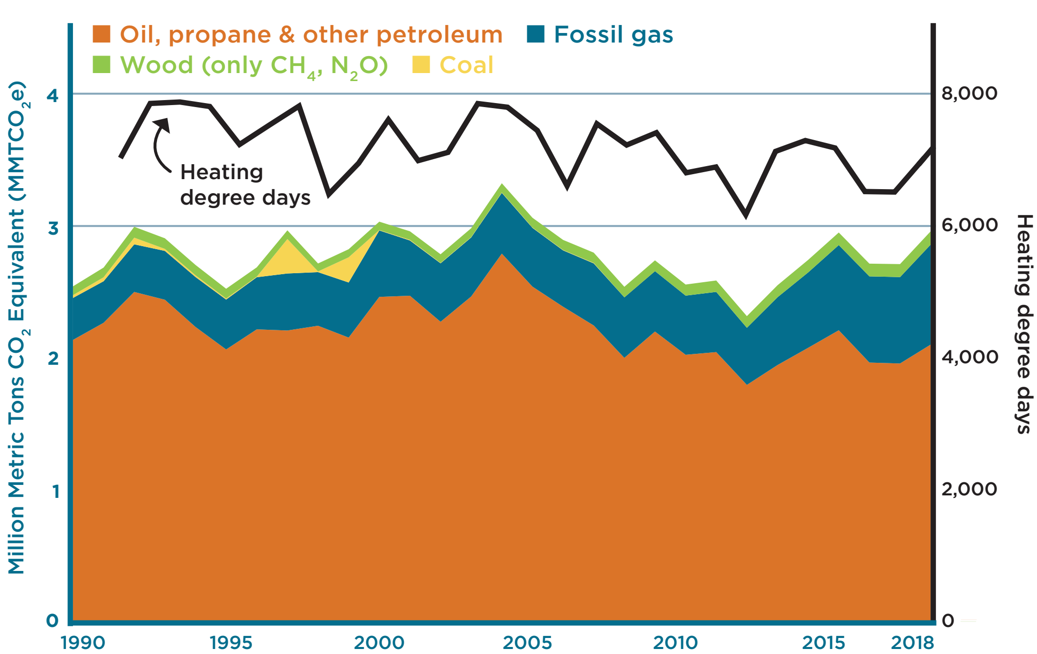
Source: Vermont Agency of Natural Resources, Vermont Greenhouse Gas Emissions Inventory and Forecast (1990-2017), 2021. There is a small amount of emissions from wood heating in the commercial sector, but it is too small to show up on this pie chart

The thermal sector accounts for about 34% of Vermont's total GHG emissions, making it the state's second largest source of climate pollution, behind only transportation (40%). Historically, thermal sector emissions have moved roughly in line with how relatively warm or cold each heating season has been (as measured by heating degree days), and thus how much heating fuel has been used.

The majority (74%) of Vermont's thermal energy use is fossil fuel based. More than half of thermal sector emissions come from residential use, followed by the commercial sector. Reducing thermal emissions means moving away from fossil fuels to heat our homes and businesses.

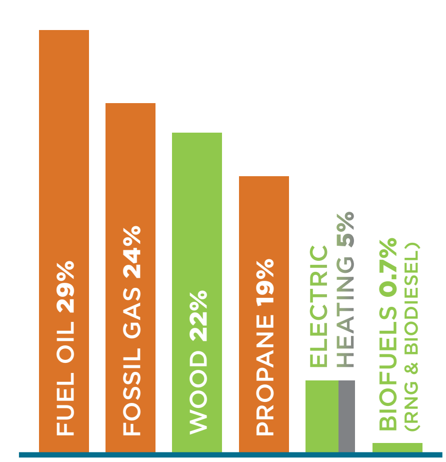
Vermont's electricity portfolio is around 93% carbon free, so using heat pumps powered by that relatively clean electricity is a powerful way to cut emissions. While wood heat is not necessarily a carbon neutral option, it is almost always "carbon better" than fossil fuels — especially when wood is locally and sustainably sourced. For example, wood heating can achieve more than a 50% reduction in lifecycle GHG emissions compared to fossil fuels.[1] Additionally, sustainably sourced biodiesel or renewable natural gas (RNG) can displace more carbon intensive fossil fuels used in many Vermont heating systems.

Historical VT thermal GHG emissions by source



Source: Vermont Agency of Natural Resources, Vermont Greenhouse Gas Inventory: 1990–2017, 2021. Note: 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. Heating degree day measurements are aggregated over the entire heating season.

Vermont heating energy sources, 2018



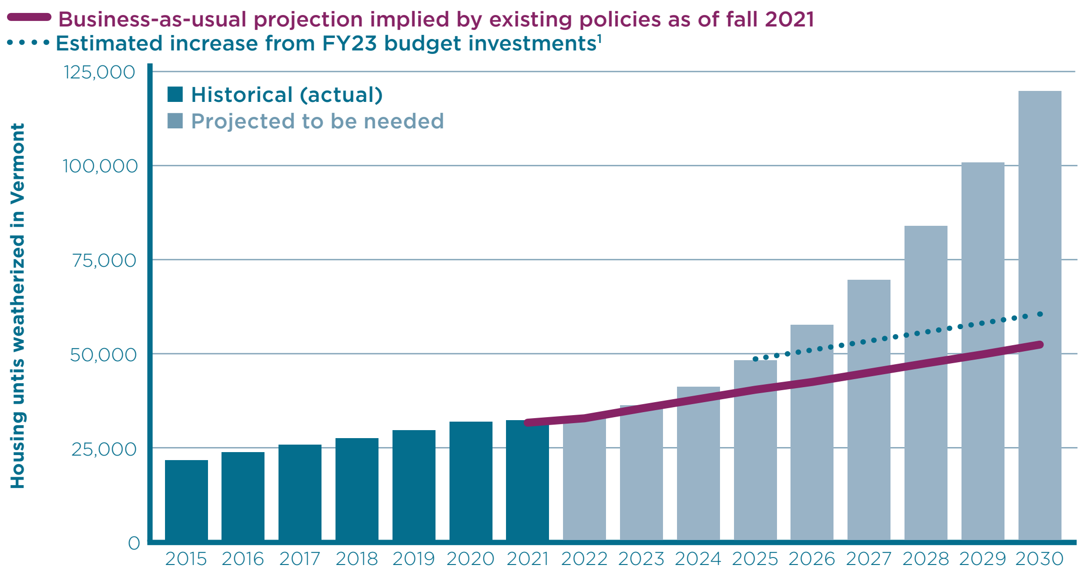
Source: EIA, 2020; Vermont Department of Public Service, 2020; Efficiency Vermont, 2020; Vermont Agency of Natural Resources, 2020.

1. SIG-NAL, 2015

Thermal Pathways to Climate Action Plan requirements

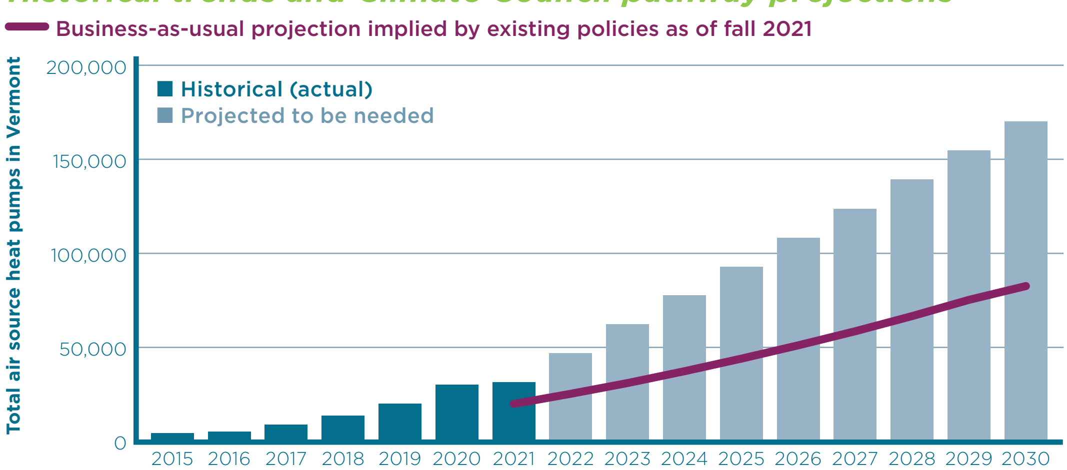
Weatherization in Vermont

Historical trends and Climate Council pathway projections



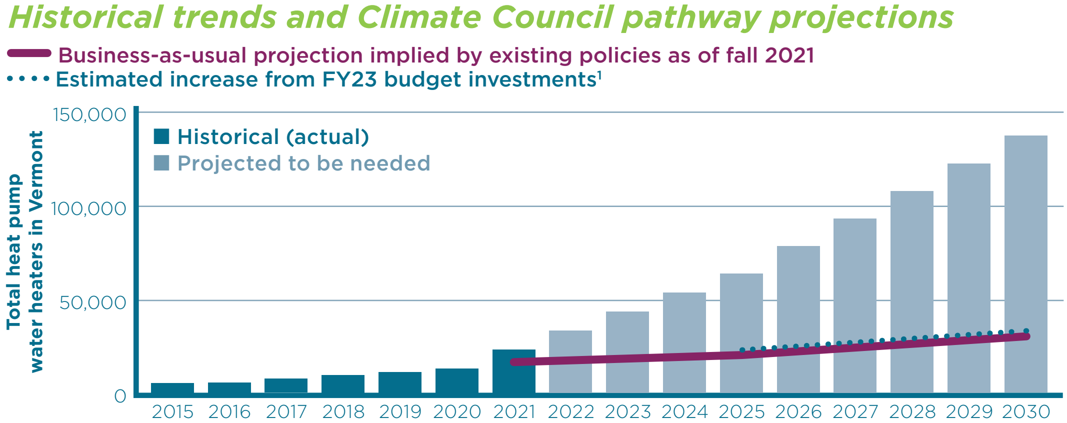
Air source heat pumps in Vermont

Historical trends and Climate Council pathway projections



Heat pump water heaters in Vermont

Historical trends and Climate Council pathway projections



Sources for all three graphs: Historical Data: EAN Energy Dashboard, 2021 (primarily from Efficiency Vermont); Future projections: Cadmus/EFG, Vermont Pathways Analysis Report 2.0, 2022.

1. EAN analysis.

The good news is that no matter where you live in Vermont or what type of building you're trying to heat, there are efficient, clean heating technologies that can work cost effectively, right now. Proven clean heat solutions include weatherization, efficient electric heat via heat pump systems, advanced wood heating options, and/or B100 biodiesel.

The solutions that can deliver the largest share of Vermont's required thermal sector GHG emissions reductions, as modeled in the *Pathways Report*, are heat pumps for space and water heating, as well as weatherization. These graphs show the scale and pace of adoption expected to be necessary as part of the portfolio of solutions needed to meet Vermont's emissions reduction requirements for 2030.

However, clean heating is not an either/or situation. **Often the best solutions are both/and — involving multiple renewable heating options working in combination, providing supplemental or back-up heat to each other, especially after weatherization has occurred, in the interest of reliability and resilience.**

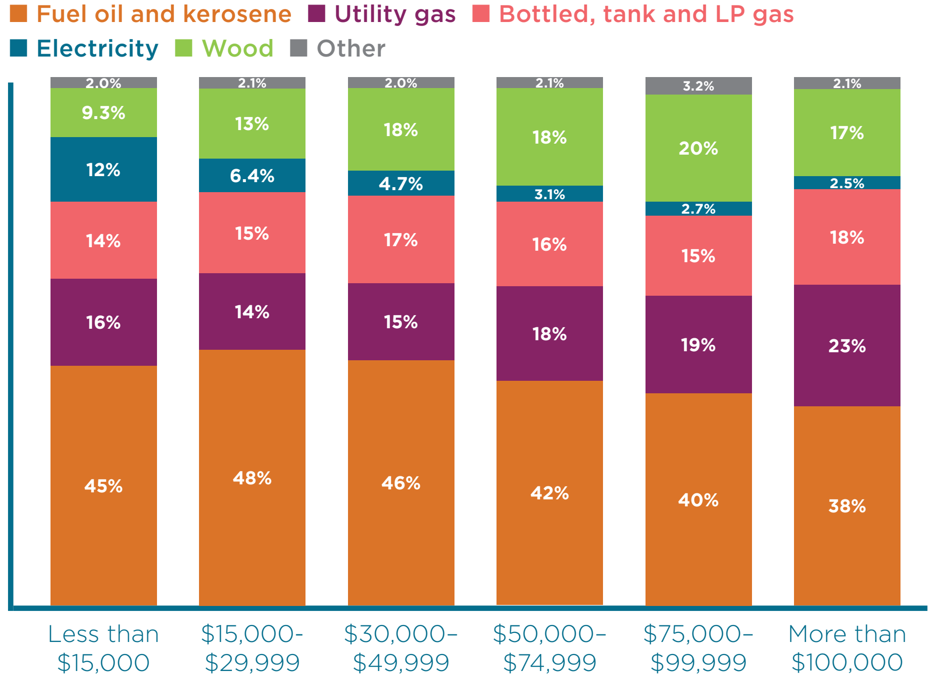
Equity in the thermal sector

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

In Vermont, 73% of households own their home, while 27% 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.

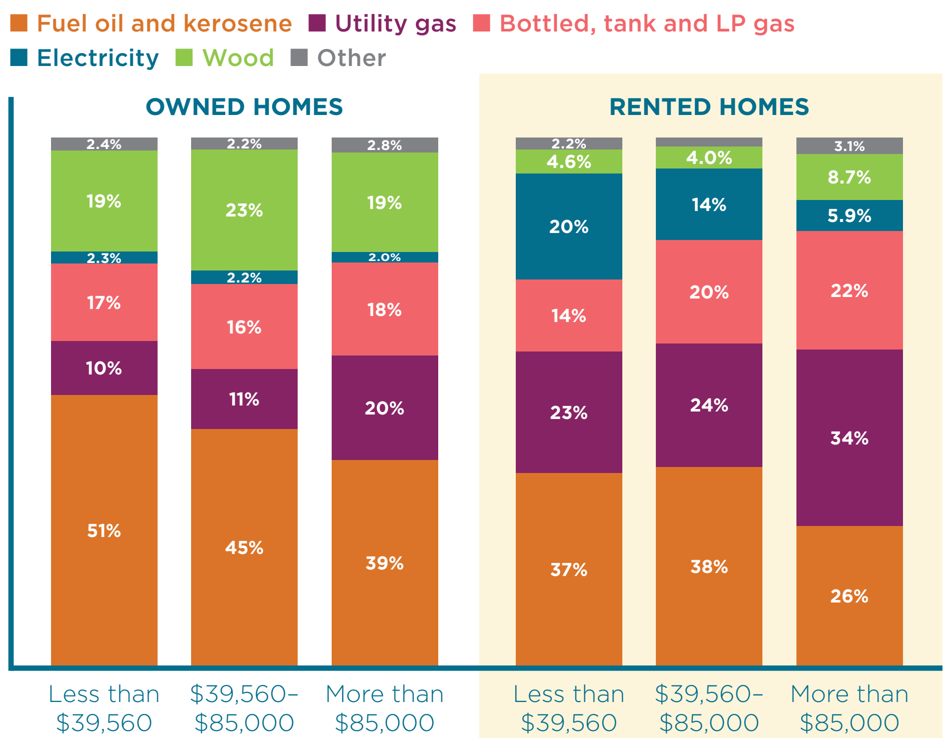
The use of electricity for heating provides a good example of this issue. Electric heat pumps are one of the most efficient, clean, and cost-effective ways to heat a home over time — but they have relatively high upfront purchase and installation costs. On the other hand, electric resistance heating is the most expensive way to heat a home over time, yet it has very low upfront purchase and installation costs. This is a big reason why a full 20% of renters in the lowest third of the income distribution are still dependent on inefficient and high-cost electric resistance systems. Renters also are much less likely to have the ability to use low-cost, locally sourced wood to heat their homes, across the income spectrum.

VT primary household fuel use by income



Source: U.S. Census Bureau, American Community Survey, 2018.

Vermont primary household fuel use by housing type



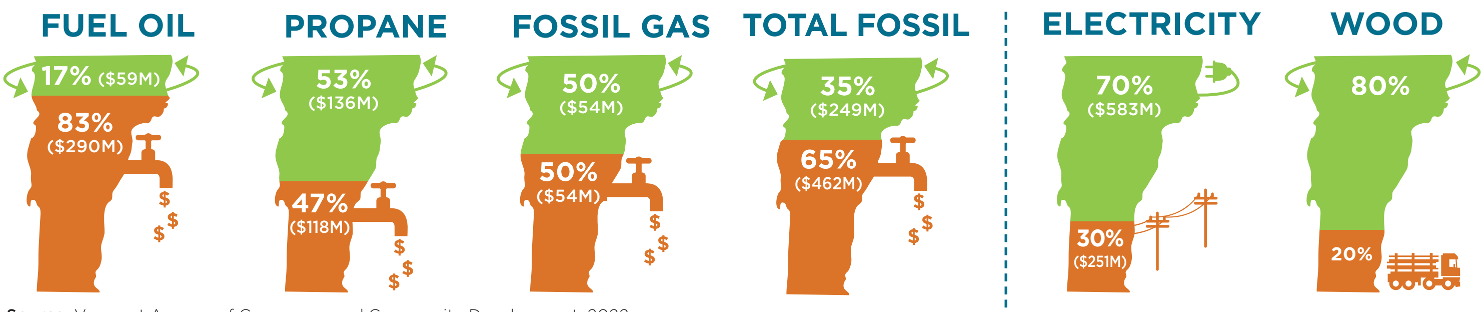
Source: U.S. Census Bureau, American Community Survey, 2018.

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

The thermal sector and the economy

Thermal spending in VT, 2019

■ recirculates in the VT economy ■ leaves the VT economy



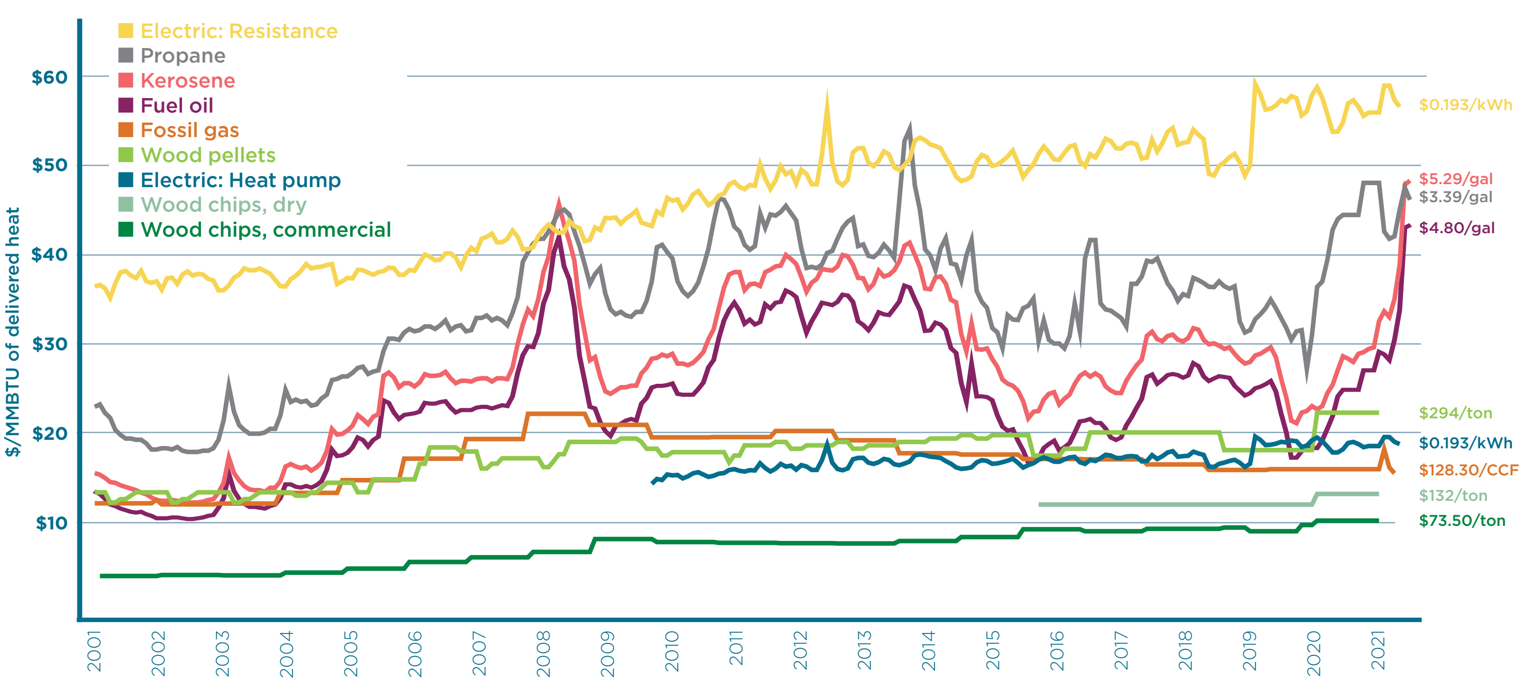
Source: Vermont Agency of Commerce and Community Development. 2022.

Prices for fossil fuels like propane, fuel oil, and kerosene have historically been high and volatile. **Switching to electric heat pumps and/or wood heat options can simultaneously lower a household's energy costs and offer more stable fuel prices.** Even fossil gas, which has been historically stable, has experienced price volatility over the last year. Home weatherization also results in decreased fuel costs, as the resulting efficiency gains lead to reduced energy use.

Switching away from-fossil fuels for heating is also a boon to Vermont's economy. In 2019, Vermont spent about $711 million on fossil fuels for heating. In contrast, when we heat with electricity (70%) and/or wood (80%), a greater share of money spent on heating stays and recirculates in state. If more households switch to these 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.

Given the life cycles of heating equipment, each year about 12,500 Vermont households replace their space heating systems and roughly 25,000 replace their water heaters. **This time of change-out is the key moment of opportunity to replace old, dirty systems with more efficient and clean upgrades — and is also when Vermonters can avoid locking in decades of further pollution and unpredictable heating costs.**

Cost comparison of different heating fuel options over time



Sources: Fuel Oil, Propane, Kerosene, Gasoline, Diesel, Wood Pellets: VT Department of Public Service, Fuel Price Report, 2021. Fossil Gas, Electricity: EIA, 2021. Wood Chips: Biomass Energy Research Center, 2021. Note 1: Electricity prices presented here are a statewide average. Electricity prices vary by utility territory. Note 2: 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).

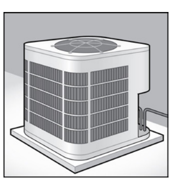
Home heating: Advanced equipment allows Vermonters to move away from fossil fuels

Heat pumps for heating and cooling

There are several different kinds of heat pumps, but all are highly efficient heating and cooling systems. Heat pumps use less energy compared to electric resistance, propane, or oil systems, reducing annual post-installation costs and greenhouse gas emissions. Heat pumps also avoid the risk of running out of fuel and remove the need to store fuel on site. Heat pumps use electricity to concentrate and move heat, using technology similar to a refrigerator, which allows them to deliver more energy than they use.[1] Heat pumps work particularly well in a well-insulated, air-tight building. Some installations warrant a backup source of heat,[2] especially in a building that isn't well-weatherized, because the efficiency of heat pumps does decrease at very low temperatures, though the technology is continually improving.[3]

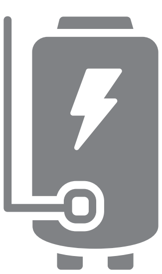
Ductless Heat Pumps / Mini-splits or Air-to-Air

Mini-splits draw heat from outdoor air, and deliver it through hot air systems inside the building. To heat a whole home, multiple of these heat pumps are generally needed.



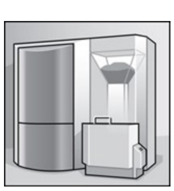
Centrally Ducted Heat Pumps or Air-to-Water

Centrally ducted heat pumps use the existing ductwork or water-radiators in a building to deliver heat and cooling to the building.



Heat pump water heaters

Heat pump technology is also increasingly used in water heaters. Heat pump water heaters are slightly more expensive than fossil equipment to purchase, but their lifetime costs are usually lower than a fossil fuel system.



Advanced wood heat: Efficient boilers and stoves

Advanced Wood Heat (AWH) refers to highly efficient, clean burning appliances ranging from a new EPA certified wood stove to a wood pellet stove or wood chip boiler. Some AWH systems, like pellet boilers, can even be automated, meaning they can be programmed with a thermostat. Although AWH systems are often more expensive to install, their fuel is much less expensive, and the lifetime costs can be less than a fossil fuel system.

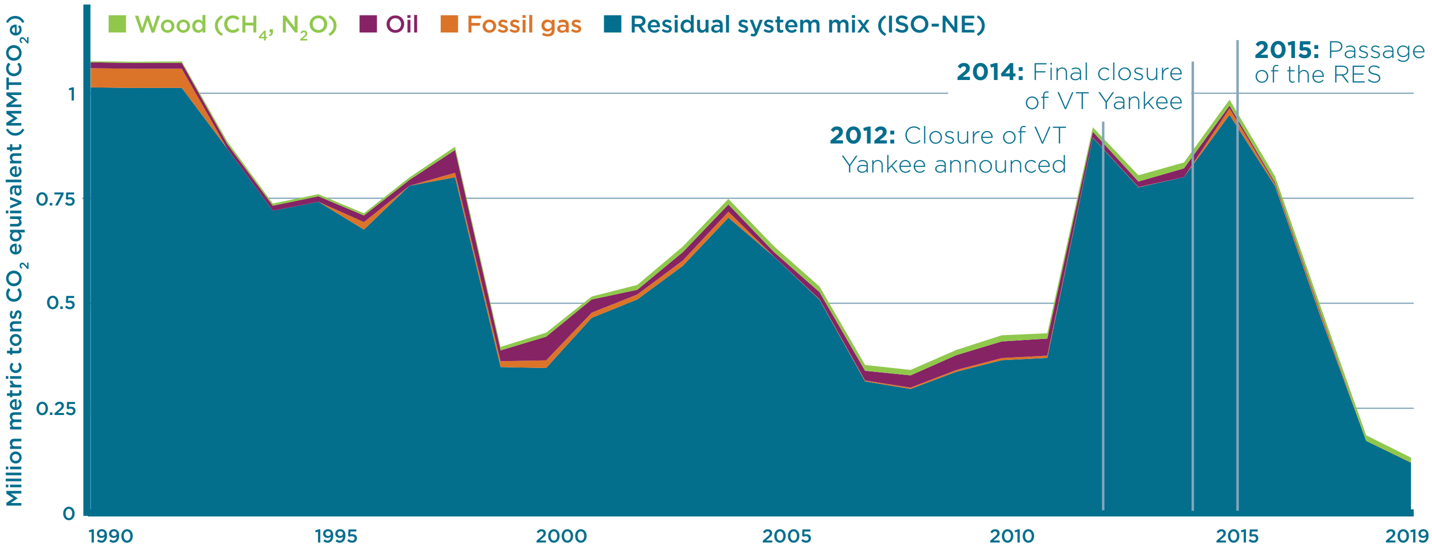
1. Efficiency VT: https://www.efficiencyvermont.com/products-technologies/heating-cooling-ventilation/heat-pumps

2. Backup heating options include wood heat systems, electric resistance heat, or existing boilers or furnaces (using fossil fuel or biofuel).

3. Home or business owners should always consult with efficiency and heating professionals before changing a heating system. The most appropriate options vary depending on individual circumstances.

Electricity sector energy consumption and greenhouse gas emissions

Historical VT electricity GHG emissions by source



Source: Vermont Agency of Natural Resources, Vermont Greenhouse Gas Inventory: 1990 - 2017, 2021. Note: Since hydroelectricity does not produce GHG emissions at the point of generation, it has historically been counted as 0 emitting by VT Agency of Natural Resources. However, a supplemental lifecycle emissions inventory for all of Vermont's energy use is underway.

Nearly all of the GHG emissions reported in the state's official inventory from Vermont's electricity consumption are attributable to that portion of electricity that Vermont distribution utilities purchase from the regional residual system mix through ISO New England (ISO-NE), the independent system operator, or grid operator, for New England. Between 2017 and 2020, the ISO-NE residual system mix portion of Vermont's electricity portfolio decreased from 30% to 3%.[1] At the same time, the renewability of the entire ISO-NE generation system has also been increasing: from just 4% in 2010 to 16% in 2021.[2]

The net result of these trends was a drop of more than 80%—from 0.81 to 0.13 MM tons—in Vermont's electricity sector GHG emissions between 2016 and 2019.[3] **Vermont now has the least carbon intensive electricity portfolio (CO2e/MWh) in the U.S.** While there is still more progress we can and must make in the electricity sector, Vermont's relatively low-emitting electricity portfolio already makes the electrification of other sectors especially beneficial, as discussed in the Transportation and Thermal sections of this report. Vermont's electricity sector GHG emissions are reported on the basis of the utilities' Renewable Energy Credit (REC) purchases, post-REC accounting. This is consistent with Vermont's Renewable Energy Standard (RES), emissions accounting in other New England States (except New Hampshire), and the regional electricity market in which we operate.

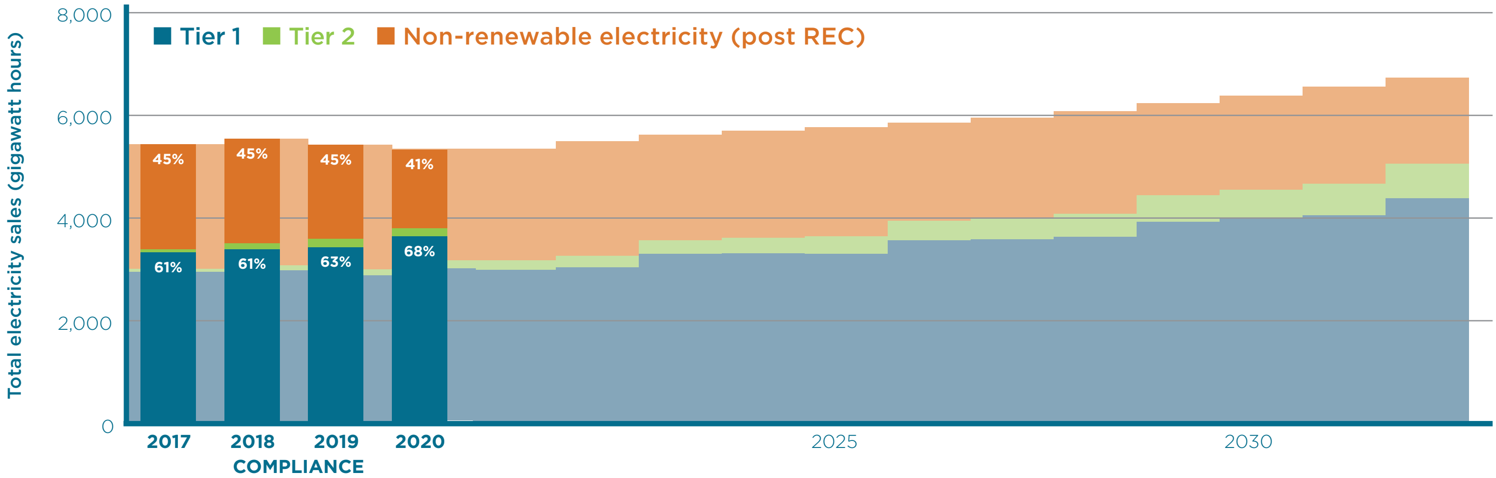
However, even if we look at our electricity sector emissions from energy deliveries to Vermont, pre-REC accounting, those emissions are still the lowest in the nation[4]. Some point out that "there is no Vermont electricity," since we are part of the ISO-New England grid. Technically speaking, we do utilize the same electricity pool as every other state in the region, given the unique physical properties of electricity (i.e. electrons do not respect state borders). **But Vermont can only be responsible for the electricity we purchase — we can't control other states' purchasing decisions.**

It is also worth noting that, after California and upstate New York, the "grid mix" from ISO-NE is still one of the lowest-emitting in the United States. For instance, charging an EV anywhere in ISO-NE territory is the equivalent of getting 150 miles per gallon from a GHG emissions perspective.[5]

1. Vermont Department of Public Service, 2020 Electric Utility Resource Survey, 2021.
2. ISO-NE, 2021.
3. Vermont Agency of Natural Resource, Vermont Greenhouse Gas Emissions Inventory and Forecast (1990-2017), 2021.
4. Leigh Seddon, EAN Senior Fellow. EAN Research Brief: "Assessing the GHG Impact of Strategic Electrification in Vermont", Summer 2022.
5. Union of Concerned Scientists, "Are Electric Vehicles Really Better for the Climate? Yes. Here's Why", 2020.

VT Renewable Energy Standard compliance

Vermont Renewable Energy Standard targets and compliance



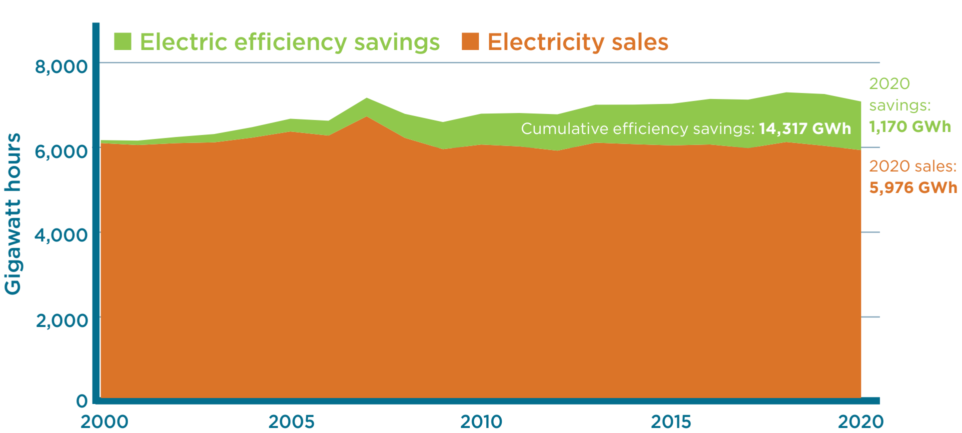
Source: Vermont Department of Public Service, 2020.

Vermont's Renewable Energy Standard (RES) requires utilities to increase the share of electricity they purchase from renewable sources over time. **Data from 2020 shows that utilities have exceeded initial RES Tier I requirements, achieving 68% total renewable electricity for Vermont.** Tier I allows for Renewable Energy Credits (RECs) — which are the marketable property rights to the renewable attributes of power generation — to come from any source of renewable electricity that can be delivered to ISO NE. To date nearly 100% of Tier I RECs have come from hydropower and the Hydro-Quebec System Mix. All utilities met the 2020 Tier II requirement that 2.8% of electricity sales must come from small-scale, in-state renewable electricity. Three Vermont utilities — Burlington Electric Department, Washington Electric Co-op, and Swanton Electric —have reached 100% renewability based on post-REC accounting. Additionally, Vermont Electric Co-op and Green Mountain Power have announced public commitments to be 100% renewable by 2030 (and 100% carbon-free by 2023 and 2025, respectively).[1]

Tier III of the RES requires utilities to either procure additional renewable distributed generation eligible for Tier II, or acquire fossil fuel savings from energy transformation projects that reduce fossil fuel use for their customers. In response, Vermont utilities have created programs that incentivize renewable technologies in the transportation and thermal sectors — such as electric vehicles and heat pumps. This aspect of the RES is one way that Vermont has started to promote a total energy transition through policy. **In 2020, all Vermont utilities met the Tier III requirement of 4% of their electric sales, primarily through energy transformation projects that reduced fossil fuels.[2]**

In addition, the important role of our efficiency utilities cannot be overstated. The work of Efficiency Vermont and Burlington Electric Department have resulted in a cumulative efficiency savings of 14,317 GWh through 2020 and will continue to be key going forward.

Electricity savings from electric efficiency utilities



Source: Vermont Department of Public Service, 2021 Annual Energy Report, 2021. Data includes Efficiency VT and Burlington Electric Department.

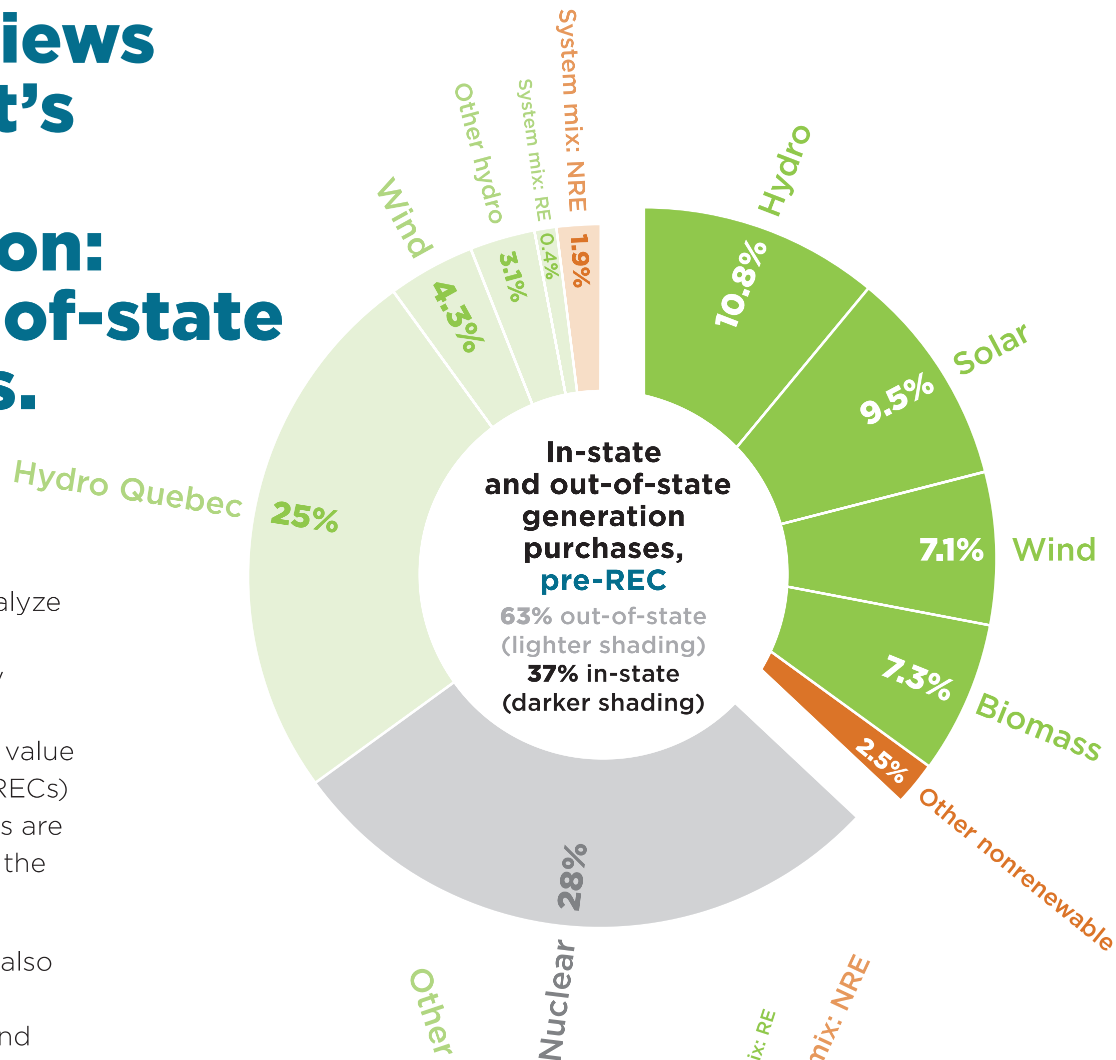
1. Vermont Department of Public Service, 2020.
2. Vermont Department of Public Service, 2020.

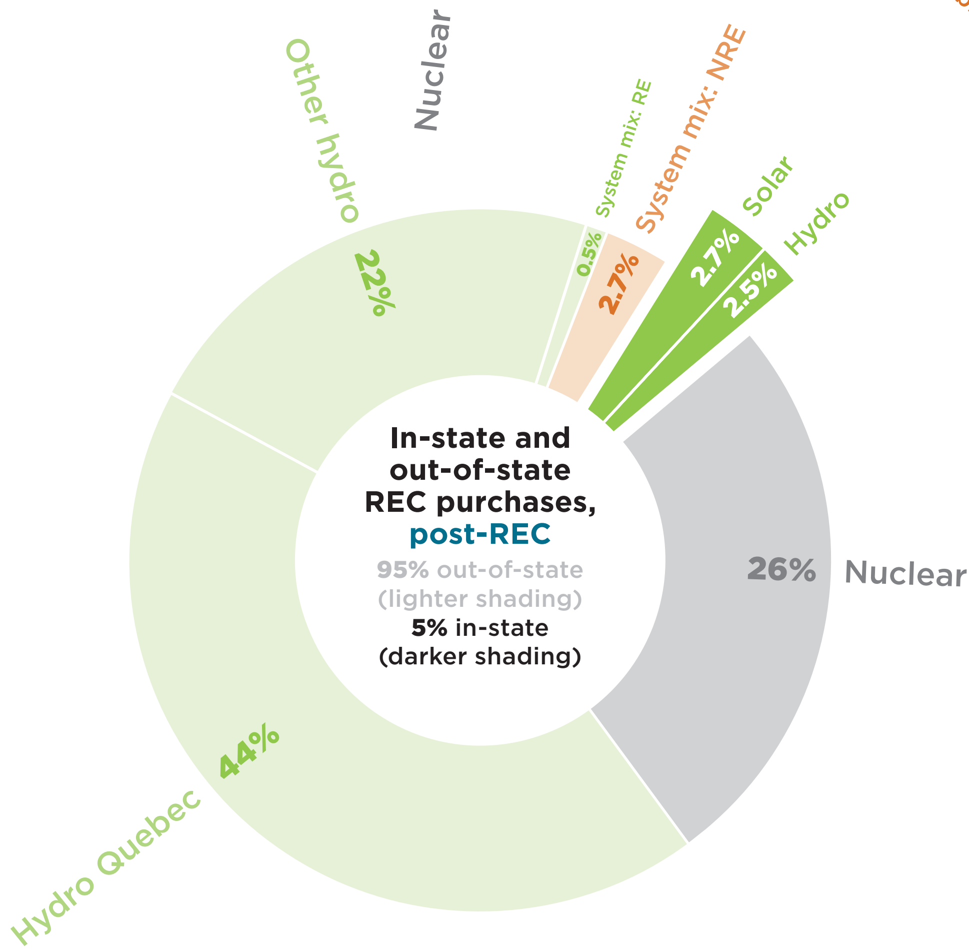
Different views of Vermont's electricity consumption: In- vs. out-of-state and pre- vs. post-REC

There are several ways to analyze Vermont's electricity profile. While we generate electricity from a variety of renewable sources in Vermont, the high value Renewable Energy Credits (RECs) from many of those resources are sold by utilities to help lower the cost of RES compliance.

Going a step further, we can also compare in-state and out-of-state electricity generation and purchases, both pre-and post-REC accounting. In 2020, 35% of pre-REC generation was composed of in-state renewables. This shifts down to 5% when looking at post-REC purchases, as Vermont legally measures our portfolio, in compliance with the Renewable Energy Standard. These charts show a snapshot of 2020 numbers. It should be noted that the balance of different resources changes year to year depending on weather and other factors. However, post-REC renewability must always comply with annual RES requirements.

Either way of looking at the data shows that Vermont's electricity consumption is 96%–97% carbon-free and less than 5% fossil fuel.

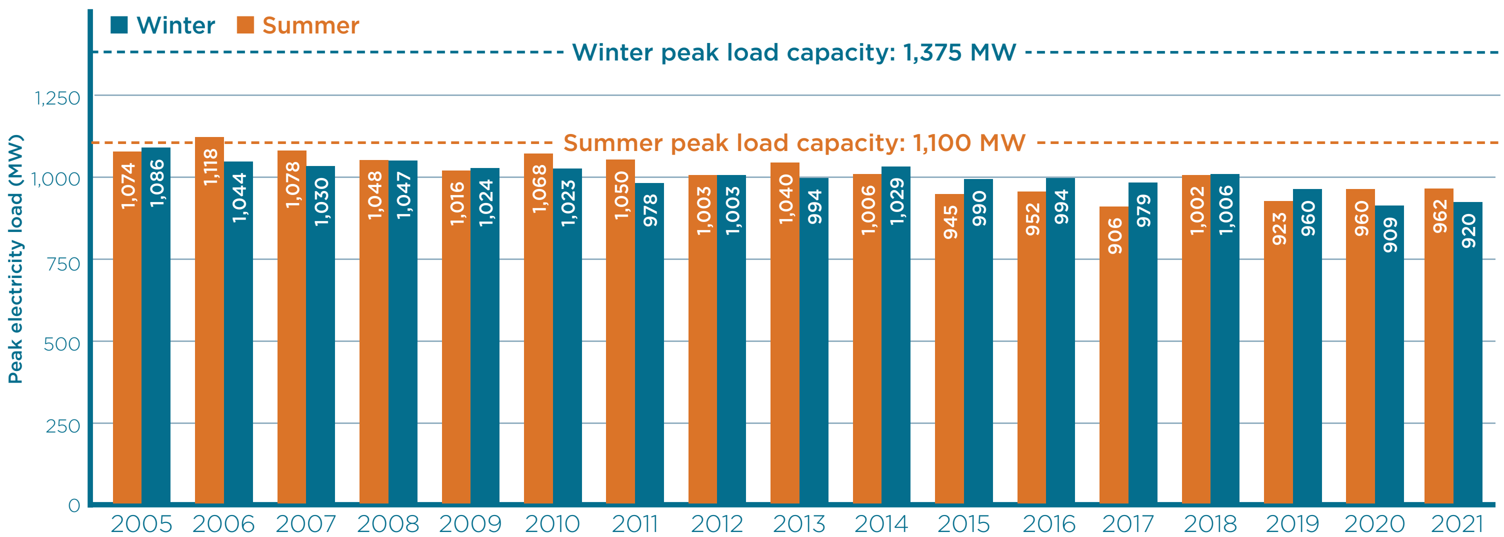




Source: Vermont Department of Public Service, 2020 Electric Utility Resource Survey, 2021.

Beneficial electrification and Vermont's transmission and distribution system

Vermont seasonal peak electricity loads, 2005–2021



Source: VELCO, 2022. This data shows VELCOs VT Load actuals. In the 2020/21 EAN Report we instead showed the VT Billing Load from ISO-NE, which is different.

Beyond a direct reduction in electricity sector emissions, a cleaner electricity mix has a second, much more powerful benefit. **When Vermonters switch from fossil fuels to electricity — say for an electric vehicle, heat pump system, or other technology — we benefit from having the least GHG intensive electricity portfolio of any state in the country** (either when measured based on in-state generation or based on in- and out-of-state purchases). Beneficial electrification in Vermont — or switching from fossil fuels to electricity for heating and transportation to achieve GHG and other pollution reductions — is more effective at reducing GHG emissions than in any other U.S. state because of our comparatively clean electricity portfolio.

Furthermore, thanks in large part to the great work done on electric efficiency by efficiency utilities Efficiency Vermont and Burlington Electric Department and 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 all ratepayers money.**

The Vermont Electric Power Company (VELCO) reports that our transmission system is already capable of serving, conservatively, a peak load of about 1,100 megawatts (MW) in the summer, and is predicted to be capable of serving, again conservatively, about 1,375 MW in the winter. The *2021 Vermont Long-Range Transmission Plan* found minimal impacts to distribution transformers in the high load scenario at a summer peak of 1,209 MW and a winter peak of 1,471 MW. However, unlike in summer, the distribution system remains largely untested at high loads in winter.[1] In both 2019 and 2020, Vermont's annual peak load was less than 960 MW (our historic high was 1,118 MW in 2006). For context, an estimate from VELCO is that charging 100,000 EVs simultaneously would add about 100 MW to our peak load. However, that doesn't account for the reality of widespread load control measures that are already in place and growing (i.e., managed charging and residential storage).

In short, **our current transmission system is capable of handling high levels of electrification through 2030** (though relatively smaller scale upgrades at certain points on the distribution system will be necessary, and increased use of load flexibility may be needed). VELCO's *2021 Vermont Long-Range Transmission Plan* specifically states that even when modeling a "high load" scenario through 2030 we are "able to address transmission concerns." Beyond 2030, VELCO projects the heavy use of load management (for example, not charging EVs at periods of peak demand) and adjustments in tie-line flows as being increasingly necessary to accommodate high loads.

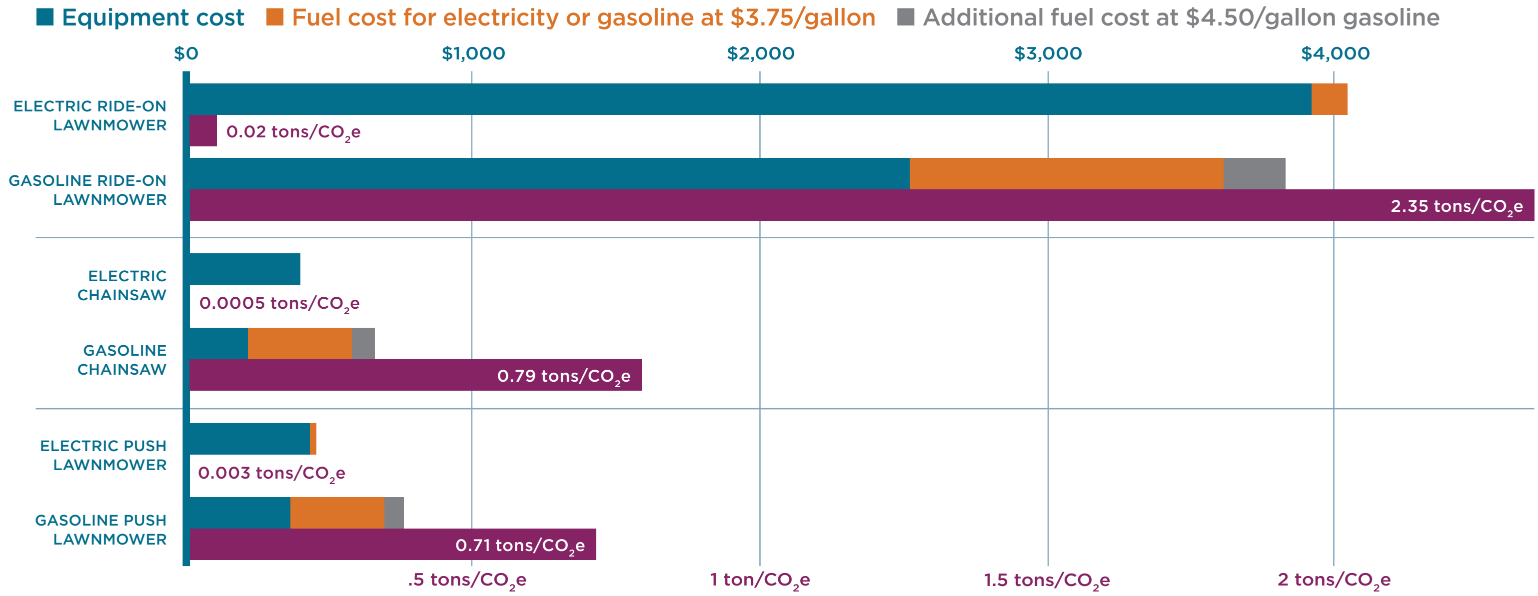
1. Vermont is a "dual peaking state." VT had its highest system peak in the summer of 2006. Since then summer peak demand has been dropping due to efficiency efforts and solar generation. As we electrify transportation and heating, winter peaks will grow. However, the good news is that due to ambient temperature differences, the winter season allows for about 25% more transmission capacity than in the summer.

Electrifying lawn maintenance equipment: Increasing options, decreasing costs

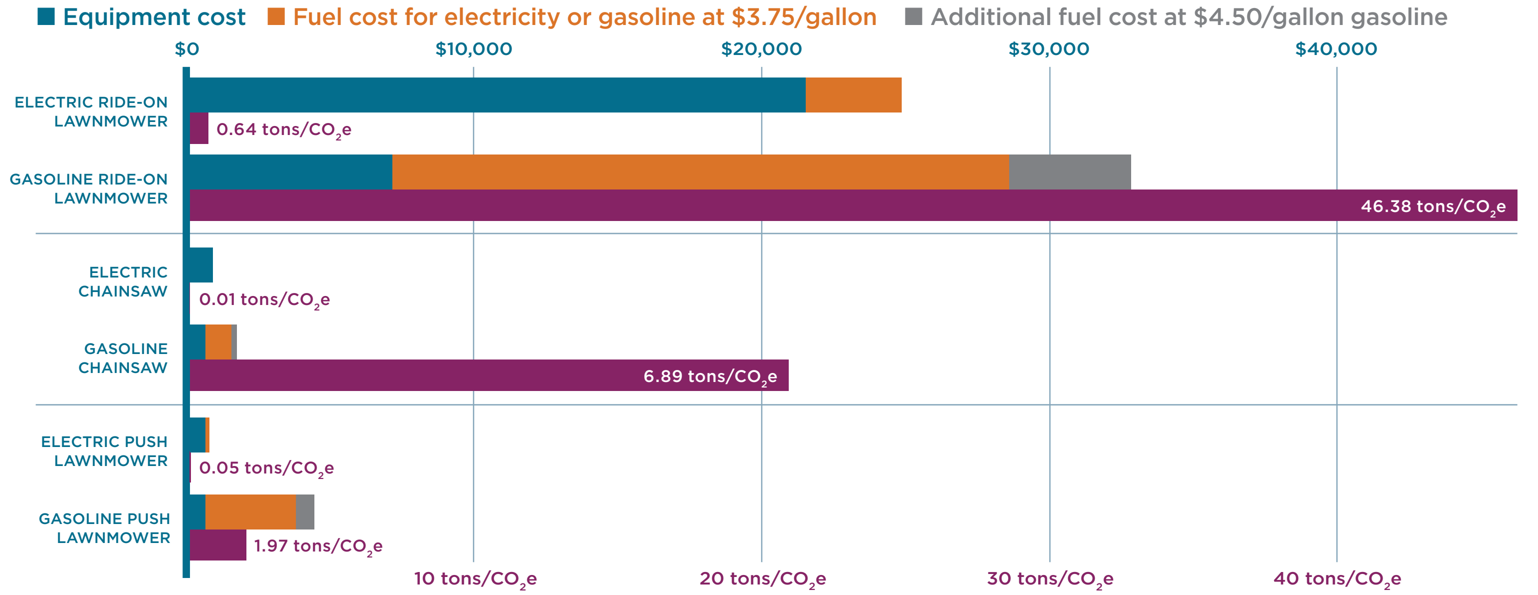
There are increasingly promising options for moving away from fossil fuels for lawn care and property maintenance. **The lifetime costs of most electric lawn equipment is lower than that of fossil fuel equipment, even before rebates.** However, this is mainly because fueling a piece of electric equipment is much cheaper than buying fossil fuel, even though the purchase price of the technology may be higher. In addition to the significant reductions in GHG emissions from switching to electric equipment, ending the use of fossil fuel equipment leads to local air quality improvements from decreased particulate matter and smog forming pollutants (NOx and VOCs), and a decrease in noise pollution.

The graphs on this page show the lifetime costs of commercial and residential technologies before the rebates for electric equipment offered by most Vermont electric utilities. Those rebates are currently in the \$50–\$200 range for many pieces of residential equipment, but can be as high as \$1,000–\$3,500 for commercial ride-on lawnmowers.

Lifetime costs and emissions: Residential electric vs fossil lawn equipment



Lifetime costs and emissions: Commercial electric vs fossil lawn equipment



Note: Electricity pricing is based on Green Mountain Power's May 2022 rate of \$0.177/kWh. Lifetimes for each piece of equipment vary, data here drawn from the Tier III Technical Resources Manual. **Source:** Vermont Public Service Department, Tier III "Technical Resource Manual", 2018. Additional analysis by EAN.

Vermont statutory energy and emissions targets, 2020 status

OVERALL STATUS

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

CHANGE FROM LAST YEAR'S EAN REPORT

→ Year-to-year progress flat | ↑ Increasing rate of year-to-year progress | ↓ Decreasing rate of year-to-year progress

	GOAL OR STATUTE	TARGET	TARGET DATE	OVERALL STATUS (2021 APR)	OVERALL STATUS (2022 APR)	TREND '21-'22 APR
GHG EMISSIONS	**Act 153** (Vermont Global Warming Solutions Act of 2020): Reduce greenhouse gas emissions at least 26% below 2005 levels by 2025.	-26%	2025	-13% (2018)	-13% (2018)	N/A
GHG EMISSIONS	**Act 153** (Vermont Global Warming Solutions Act of 2020): Reduce greenhouse gas emissions at least 40% below 1990 levels by 2030.	-40%	2030	+0% (2018)	+0% (2018)	N/A
GHG EMISSIONS	**Act 153** (Vermont Global Warming Solutions Act of 2020): Reduce greenhouse gas emissions by 80% below 1990 by 2050.	-80%	2050	+0% (2018)	+0% (2018)	N/A
TOTAL ENERGY	**CEP (2016):** 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	24% (2018)	23% (2019)	→
TOTAL ENERGY	**CEP (2016):** Reduce total energy use (from 2010 levels) by over 30% by 2050 through efficiency and conservation, across thermal, transportation, and electric.	-30% 83 TBTU	2050	120 TBTU (2018)	124 TBTU (2019)	↓
TOTAL ENERGY	**30 V.S.A. 8002 (2015):** RES Tier III - Require 2% of utility 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	3.3% (2019)	2.7% (2020)	N/A
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 approved (regional) 69 approved (town) (2021)	11 approved (regional) 73 approved (town) (2022)	↑
TRANSPORTATION	**CEP (2016):** Reduce total transportation energy use by 20% from 2015 levels by 2025.	-20% 39.1 TBTU	2025	-10% 45.3 TBTU (2018)	49.3 TBTU (2019)	↓
TRANSPORTATION	**CEP (2016):** Reduce transportation-emitted GHGs by 30% from 1990 levels by 2025.	-30% 2.32 $MMTCO_2e$	2025	+3% 3.43 $MMTCO_2e$ (2018)	+3% 3.43 $MMTCO_2e$ (2018)	N/A
TRANSPORTATION	**CEP (2016):** Hold vehicle miles traveled (VMT) per capita to 2011 levels.	11,390	2030	11,773 (2019)	11,772 (2020)	→
TRANSPORTATION	**CEP (2016):** Reduce share of single- occupancy vehicle commute trips by 20% of 2011 levels (79.5%).	59%	2030	81.4% (2017)	75.9% (2019)	↑
TRANSPORTATION	**CEP (2016):** Double the share of bicycle and pedestrian commute trips from 7.8% to 15.6%.	15.6%	2030	7.7% (2018)	6.9% (2019)	↓
TRANSPORTATION	**CEP (2016):** Triple the number of state park-and-ride spaces from 1,142 to 3,426.	3,426	2030	1,639 (2019)	1,734 (2021)	↑
TRANSPORTATION	**CEP (2016):** Increase public transit ridership by 110% to 8.7 million annual trips	8.7M	2030	5.12M (2019)	4.71M (2021)	↓
TRANSPORTATION	**CEP (2016):** Increase Passenger Rail Trips: Quadruple Vermont-based passenger rail trips from 2011 levels (91,942) to 400,000 trips annually.	400,000	2030	99,280 (2019)	149,795 (2021)	↑
TRANSPORTATION	**CEP (2016):** Increase the share of renewable energy in all transportation to 10% by 2025 and 80% by 2050.	10%	2025	6% (2018)	6% (2019)	→
TRANSPORTATION	**CEP (2016):** Increase Renewably Powered Vehicles: Increase % of the vehicle fleet that are Electric Vehicles to 10% by 2025.	10%	2025	0.8% (2020)	1.1% (2021)	↑
THERMAL	**CEP (2016):** To reduce total fossil fuel consumption across all buildings by an additional one-half percent each year, leading to a total reduction of 6% by 2017 and 10% by 2025.	-10%	2025	+5.5% 36.5 TBTU (2018)	+7.5% 37.5 TBTU (2019)	↓
THERMAL	**CEP (2022):** Meet 30% of thermal energy needs from renewable energy by 2025, and 70% by 2042.	30% 70%	2025 2042	23% (2018)	25% (2019)	↑
THERMAL	**CEP (2016):** Cold Climate Heat Pumps: Install 35,000 cold climate heat pump systems by 2025.	35,000	2025	18,940 (2019)	29,018 (2020)	↑
THERMAL	**CEP (2022) and CAP:** Weatherize 120,000 households by 2030, relative to a 2008 baseline.	120,000	2030	29,238 (2019)	31,338 (2020)	↑
THERMAL	**CEP (2016):** Increase wood's share of building heat to 35% by 2030.	35%	2030	24.3% (2018)	24.3% (2018)	N/A
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	64% (2019, post-REC)	68% (2020, post-REC)	↑
ELECTRICITY	**CEP (2022) and CAP:** Meet 100% of energy needs from carbon-free resources by 2032, with at least 75% from renewable energy		2032	93% (2018)	93% (2019)	→
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	2.2% (2019)	2.7% (2020)	↑
ELECTRICITY	**30 V.S.A. 8005a(c) (2011):** Issue Standard Offer 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	112.97 MW under contract 69.86 MW projects commissioned (2020)	124.78 MW under contract 76.36 MW projects commissioned (2022)	↑

SOURCES: GHG Emissions: Vermont Agency of Natural Resources, Vermont Greenhouse Gas Emissions Inventory and Forecast (1990-2017), 2021. Total Energy: ANR, 2020; EIA, 2019; PSD, Electric Retail Sales, 2020; Efficiency Vermont, 2021; VAPDA, 2022. Transportation: EIA, 2019; Efficiency Vermont, 2021; Federal Highway Authority, Highway Statistics, 2020; U.S. Census Bureau, 2021; Vtrans, 2021; American Community Survey, 2018, Vermont Transportation and Commute Statistics; Drive Electric Vermont, 2022. Thermal: EIA, 2019; PSD, 2021; ANR, 2020; Efficiency Vermont, 2021, Electricity: PSD, Electric Utility Resource Survey, 2020; PSD, Retail Sales, 2020; VEPP, 2021.

EAN Network Action Teams

Each year, EAN members and public sector partners identify strategic initiatives through a competitive pitch process, based on their potential to help Vermont rapidly, cost-effectively, and equitably reduce fossil fuels and greenhouse gas pollution. Since 2020, each winning concept has established a Network Action Team to move the idea forward, supported by EAN staff and a small grant.

Network Action Teams initiated from pitches at the EAN Summit in Fall of 2021:

Climate Workforce

To achieve Vermont's required greenhouse gas emission reduction targets, we need to train thousands of Vermonters with the skills to electrify our 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 defining and quantifying the workforce needed to reach the requirements of the Climate Action Plan, and coordinating around strategies, pathways, and funding to reach these goals.

Switch and Save

When we install new fossil-fuel dependent equipment it locks us into high-cost and price volatile fuels and many years of pollution. This Network Action Team is finding strategies to help Vermonters switch away from fossil fuels at the time when they are buying new equipment. As a first step the Network Action Team proposed a program to provide income-qualified Vermonters with new, energy efficient heat pump water heaters at low or no cost (including electrical work). This program, which secured $5 million in the 2023 state budget, will focus on Vermonters with older water heaters that are at risk of failure in the near future (or those whose water heaters have just failed).

VT Clean Transportation Equity

Vermont emits more greenhouse gasses in transportation than in any other sector. As the Vermont Climate Council considers policy options to address these emissions, this Network Action Team is advancing a collaborative process to identify the highest impact investment opportunities, in terms of cost-effective and equitable greenhouse gas reduction strategies and actions, for clean transportation revenue in Vermont.

Network Action Teams initiated from pitches at the EAN Summit in Fall of 2020:

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 being weatherized by 2030. Working groups are also exploring topics related to workforce and technical approaches.

Clean Heat Standard

This Network Action Team was integral in developing the concept of a Clean Heat Standard, and detailed suggestions 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. The policy passed in both the Vermont House and Senate in 2022 by strong margins, but came up short of an override of the Governor's veto by one vote in the House.

Future of Rural Transit

This Network Action team has been exploring steps that can be taken to combine public and school transportation into a single electrified public transportation system.

Replace Your Ride

A Replace Your Ride program, to help low-income Vermonters affordably switch to clean transportation options, was proposed by this Network Action Team and passed through the Vermont legislature in the 2021 session. The pilot will be rolled out by the Vermont Agency of Transportation in the fall 2022.

Who We Are

Energy Action Network (EAN) consists of over 100 active members representing business and finance, utilities, non-profits, and higher education, along with over 100 local, state, and federal public sector partners. All EAN members share a mission of achieving Vermont's 90% renewable by 2050 total energy commitment and of significantly reducing Vermont's greenhouse gas emissions in ways that create a more just, thriving, and sustainable future for Vermonters.

Business and Finance

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

Dunkiel-Saunders | Elliott | Raubvogel | Hand
Geoff Hand

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
Brian Gray

Energy Futures Group
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 Group
Luke Shullenberger, Bill Miller, Sam Carlson, Ralph Meima, David Carpenter

KSV
Harrison Grubbs

Maclay Architects
Bill Maclay

MMR (MacLean Meehan & Rice)
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, Jacob Flanigan

NRG Systems
Justin Wheating

Packetized Energy
Paul Hines, Bonnie Pratt

Pellergy
Andy Boutin

Pomerleau Real Estate
Ernie Pomerleau

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

Reiss Building and Renovation
Chuck Reiss

Seventh Generation
Ashley Orgain

Stone Environmental, Inc.
Barbara Patterson, Nick Floersch, John Hanzas, Carleigh Cricchi

SunCommon
James Moore, Duane Peterson

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

Vermont Green Building Network
Jenna Antonino DiMare

Vermont Housing and Finance Agency (VHFA)
Maura Collins, Chris Flannery, Ken Pulido

Vermont Wood Pellet Co.
Chris Brooks

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

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

Biomass Energy Resource Center (BERC)
Adam Sherman

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

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

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

Climate Economy Action Center of Addison County
Spencer Putnam, Richard Hopkins

Conservation Law Foundation
Elena Mihaly, Chase Whiting, Dale Azaria

Drive Electric Vermont (DEV)
David Roberts

Fairbanks Museum
Adam Kane

Intervale Center
Travis Marcotte

Lake Champlain Chamber
Tom Torti, Catherine Davis, Austin Davis

Local Motion
Karen Yacos

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, Paul Cillo

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

ReSOURCE
Thomas Longstreth, Pam Laser

Rights and Democracy
Kiah Morris, Dan Fingas, Tom Proctor, Alison Nihart

Shelburne Farms
Marshall Webb, Megan Camp

Sustainable Heating Education Outreach
Jeff Rubin

Sustainable Montpelier Coalition
Elizabeth Parker, Laura Brooke

Sustainable Woodstock
Michael Caduto, Jenevra Wetmore

The Nature Conservancy
Heather Furman, Lauren Oates, Eve Frankel

Vermont Businesses for Social Responsibility (VBSR)
Roxanne Vought, Jordan Giaconia

Vermont Center for Independent Living (VCIL)
Peter Johnke

Vermont Climate and Health Alliance
Dan Quinlan

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

Vermont Energy and Climate Action Network (VECAN)
Johanna Miller, Greta Hasler

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

Vermont Energy Investment Corporation (VEIC)
Rebecca Foster, Damon Lane, Jennifer Wallace-Brodeur, Justine Sears, Jay Pilliod

VT Independent Power Producers Association
Mathew Rubin

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

Vermont Land Trust (VLT)
Nick Richardson, Abby White

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

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

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

Vermont Public Interest Research Group (VPIRG)
Paul Burns, Ben Edgerly Walsh, Sebbi Wu, Liam O'Sullivan, Tom Hughes

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

Vermont Vehicle and Automotive Distributors Association (VADA)
Marilyn Miller

Vermont Works for Women
Rhoni Basden

Vital Communities
Sarah Brock, Anna Guenther

Utilities

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

Efficiency Vermont (EVT)
Peter Walke, Kelly Lucci, Dan Reilly, Sarah Wolfe, Jake Marin, Hillary Andrews

Green Mountain Power (GMP)
Mari McClure, Liz Miller, Brian Otley, Robert Dostis, Kristin Carlson, Josh Castonguay, Graham Turk, Kristin Kelly, Maria Fischer, Doug Smith, Chris Cole

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

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

Vermont Gas
Neale Lunderville, Dylan Giambatista, Jill Pfenning, Tom Murray, Richard Donnelly, Chris Charuk, Greg Morse, Tim Perrin

Vermont Public Power Supply Authority (VPPSA)
Ken Nolan, Julia Leopold

Washington Electric Co-op (WEC)
Louis Porter, Bill Powell, Roger Fox, Stephen Knowlton

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

Northern Vermont University
Jason Shafer

Norwich University, Center for Global Resilience and Security
Tara Kulkarni

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, Stephen Posner

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

UVM Vermont Clean Cities Coalition
Peggy O'Neill-Vivanco

Vermont Law School
Kevin Jones

Vermont Technical College
Pat Moulton, Dan Costin

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), Montpelier (Mayor Anne Watson), South Burlington (Paul Conner, Director of Sustainability)*

REGIONAL

Regional Planning Commissions and Regional Development Corporations: *Dave Snedeker, Alison Low, Irene Nagle (Northern Vermont Development Association); Adam Lougee, Andrew L'Roe (Addison); Peter Gregory, Geoff Martin, Steven Bauer (Two Rivers Ottauquechee); Jim Sullivan, Allison Strohl (Bennington County); Melanie Needle, Charlie Baker, Marshall Distel (Chittenden); Catherine Dimitruck, Linda Blasch (Northwest); Chris Campany, Marion Major, Colin Bratton (Windham); Bonnie Waninger, Zachary Mia, 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, Ken Jones, Laura Trieschmann*

Agency of Natural Resources: *Julie Moore, Billy Coster, Jane Lazorchak, Ed McNamara*

Agency of Transportation: *Joe Flynn, Michele Boomhauer, Andrea Wright, Ross McDonald, Dan Currier*

Department of Buildings and General Services: *Brian Sewell*

Department of Environmental Conservation: *Heidi Hales, Collin Smythe, Megan O'Toole, Brian Woods*

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

Office of Economic Opportunity (OEO): *Low Income Weatherization: Sarah Phillips, Geoff Wilcox*

Department of Labor (DOL): *Sarah Buxton, 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*

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

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

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

Vermont State Treasurer: *Beth Pearce*

FEDERAL

Office of Congressman Peter Welch: *Rebecca Ellis*

Office of Senator Bernie Sanders: *Haley Pero, Ethan Hinch, Camila Thorndike, Erhard Mahnke*

Office of Senator Patrick Leahy: *Tom Berry, Chris Saunders*

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

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SUE MINTER
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Burlington Electric Department, General Manager

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BILL REGAN *President, Regan Leadership, LLC*

BETH SACHS *Founder VEIC emeritus*

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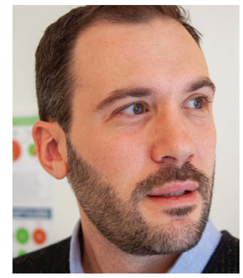

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Energy Futures Group, Managing Consultant

STEPHANIE YU
Public Assets Institute, Deputy Director

JENNIFER WALLACE-BRODEUR
VEIC, Director, Consulting

Mission & goals

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.

EAN is working to help Vermont meet the requirements of the Global Warming Solutions Act, which includes reducing greenhouse gas pollution to 26% below 2005 levels by 2025, to 40% below 1990 levels by 2030, and to 80% below 1990 levels by 2050, and to meet the goals of the Comprehensive Energy Plan, including achieving 90% of Vermont's total energy needs from renewable sources by 2050.

Collective impact approach

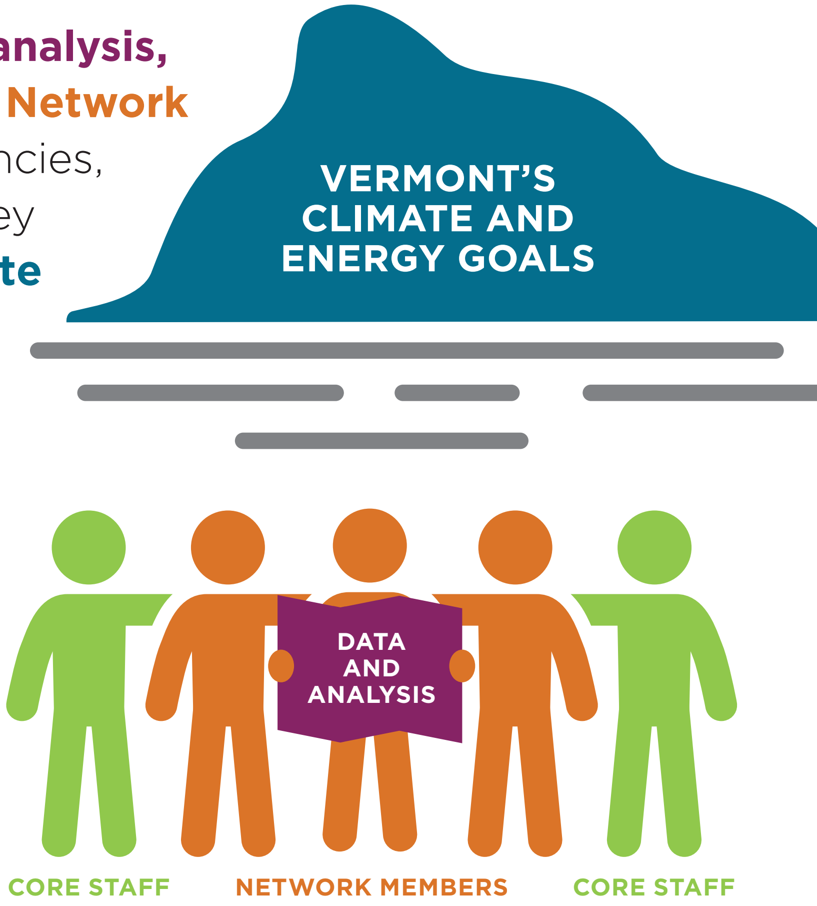
Energy Action Network (EAN) is a diverse network of nonprofits, businesses, public agencies, and other organizations working together in a collective impact framework and supported by a core staff to further the Network's mission.

We approach our 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 energy and emissions commitments, focusing on Policy & Regulatory Reform, Capital Mobilization, Public Engagement, and Technology Innovation. We also support Network Action Teams working on strategic projects identified and selected by the Network.

EAN's core staff compiles **data and analysis,** and convenes and supports the **EAN Network** of nonprofits, businesses, public agencies, and other organizations, as we journey together to achieve **Vermont's climate commitments and energy goals.**



EAN's core staff supports the work of Network members in the following ways:

- **Steward a common agenda** for Network members and partners.
- **Collect data and measure results** through regular tracking and analysis.
- **Coordinate mutually reinforcing activities** to develop, share, and advance high-impact ideas.
- **Ensure continuous communication** to and across the Network.

ENERGY ACTION NETWORK

17 State Street, Suite 205, Montpelier, VT 05602

EANVT.ORG
VTENERGYDASHBOARD.ORG

Thank you!

EAN's 2022 Annual Progress Report for Vermont is a collaborative effort, reflective of our diverse network members and public sector partners. We would like to thank the following agencies and organizations for their contributions to the content, data, and analysis within the report: the Vermont Department of Public Service, Vermont Agency of Natural Resources, Vermont Agency of Commerce and Community Development, Vermont Agency of Transportation, the Vermont Energy Investment Corporation, and the UVM Transportation Research Center.

EAN is also deeply grateful to the funders who make this report and all of our work possible, including the Maverick Lloyd Foundation, Green New Fund, Garfield Foundation, Canaday Family Trust, High Meadows Fund, Vermont Low Income Trust for Electricity (VLITE), John Merck Fund, Sustainable Future Fund, Ittleson Foundation, Bonwood Social Investments, VSECU, and the Bridgewood Fieldwater Foundation.

The primary co-authors of the report were EAN staff — Jared Duval, Mei Butler, 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.