Introduction

Jared Duval

Councilor appointed to represent a Vermont-based organization with expertise in energy and data analysis

Member & Co-Chair, Science & Data Subcommittee

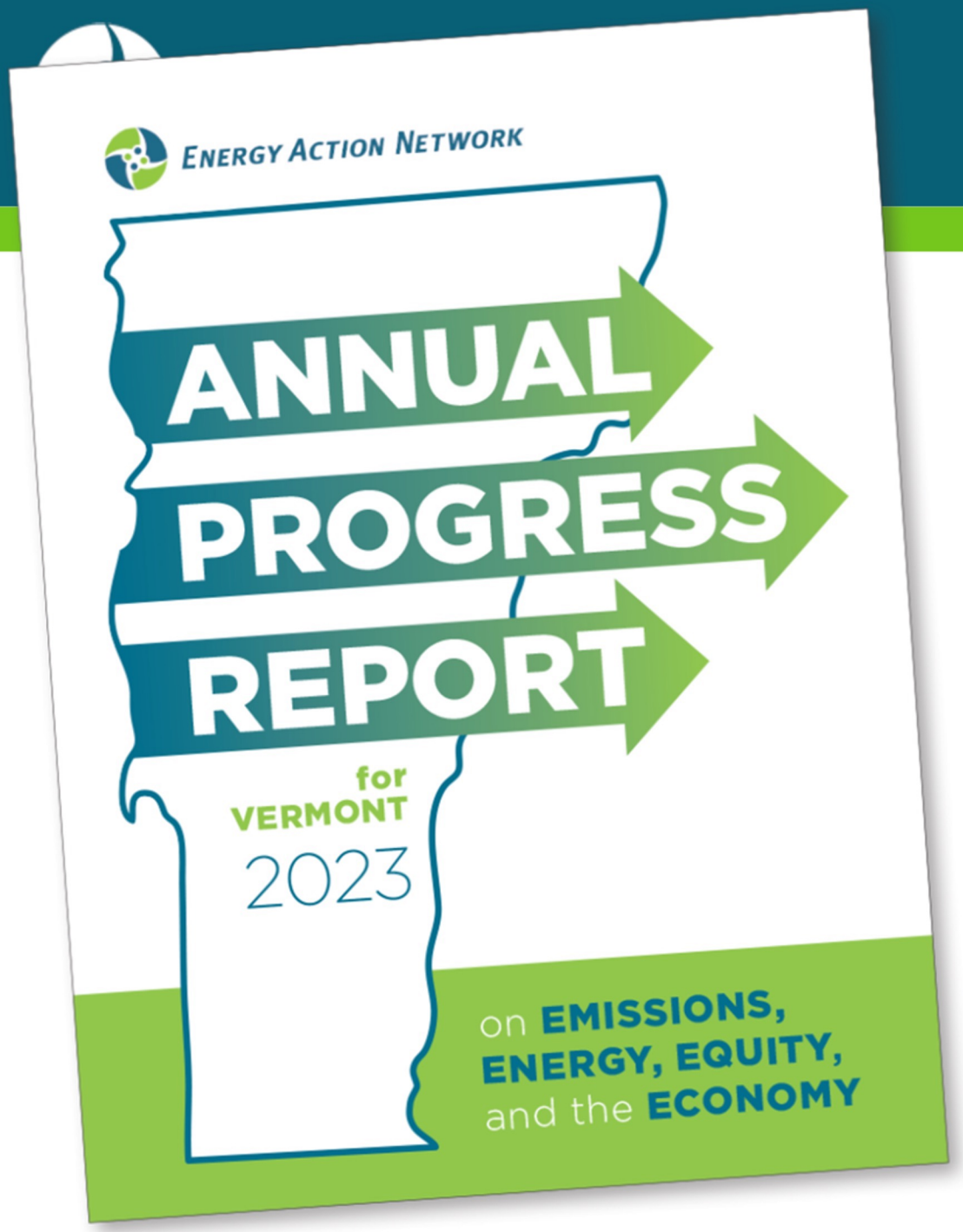
Member, Cross-Sector Mitigation Subcommittee

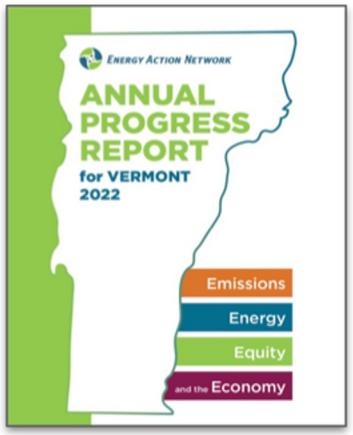
Executive Director, Energy Action Network

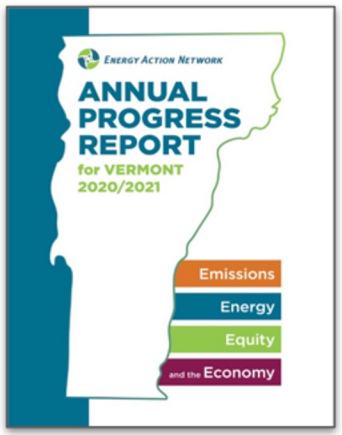
Climate Council

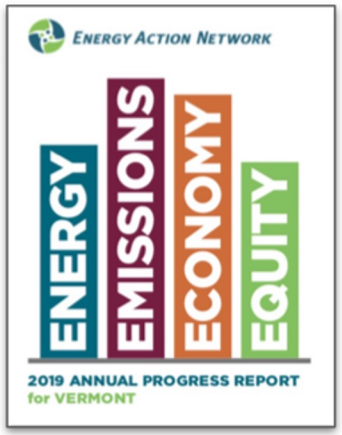
January 29, 2024

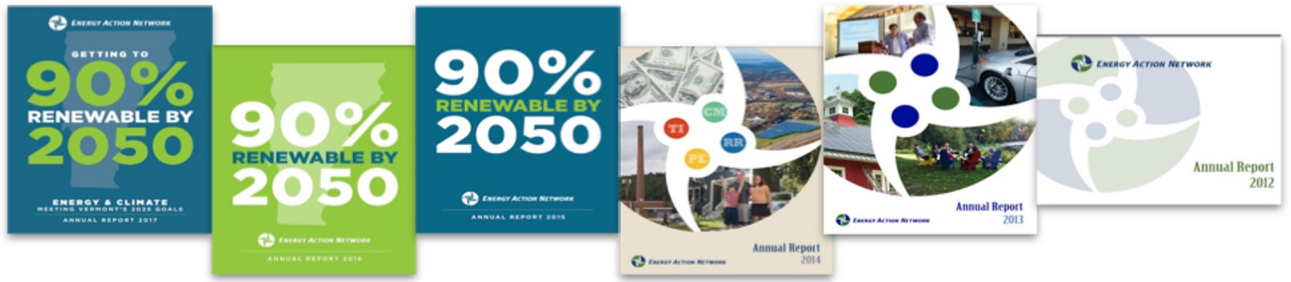
Data & Analysis











- Ensure Vermont's climate and energy conversations are grounded in and guided by the most current data and the highest quality analysis available.

- Present data and analysis in a cohesive and accessible way

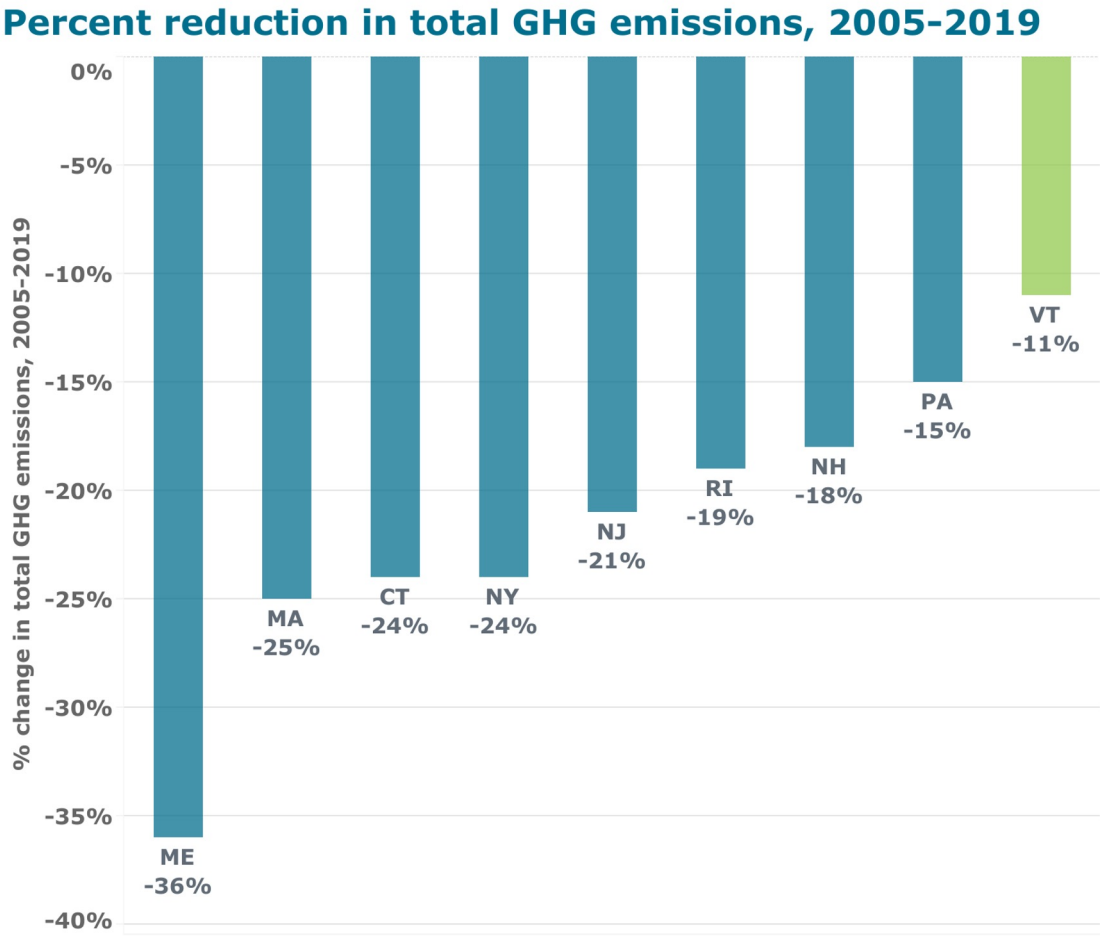
Latest EAN Research Paper: Assessing Vermont's Climate Responsibility

ENERGY ACTION NETWORK

Assessing Vermont's climate responsibility: A comparative analysis of per capita emissions

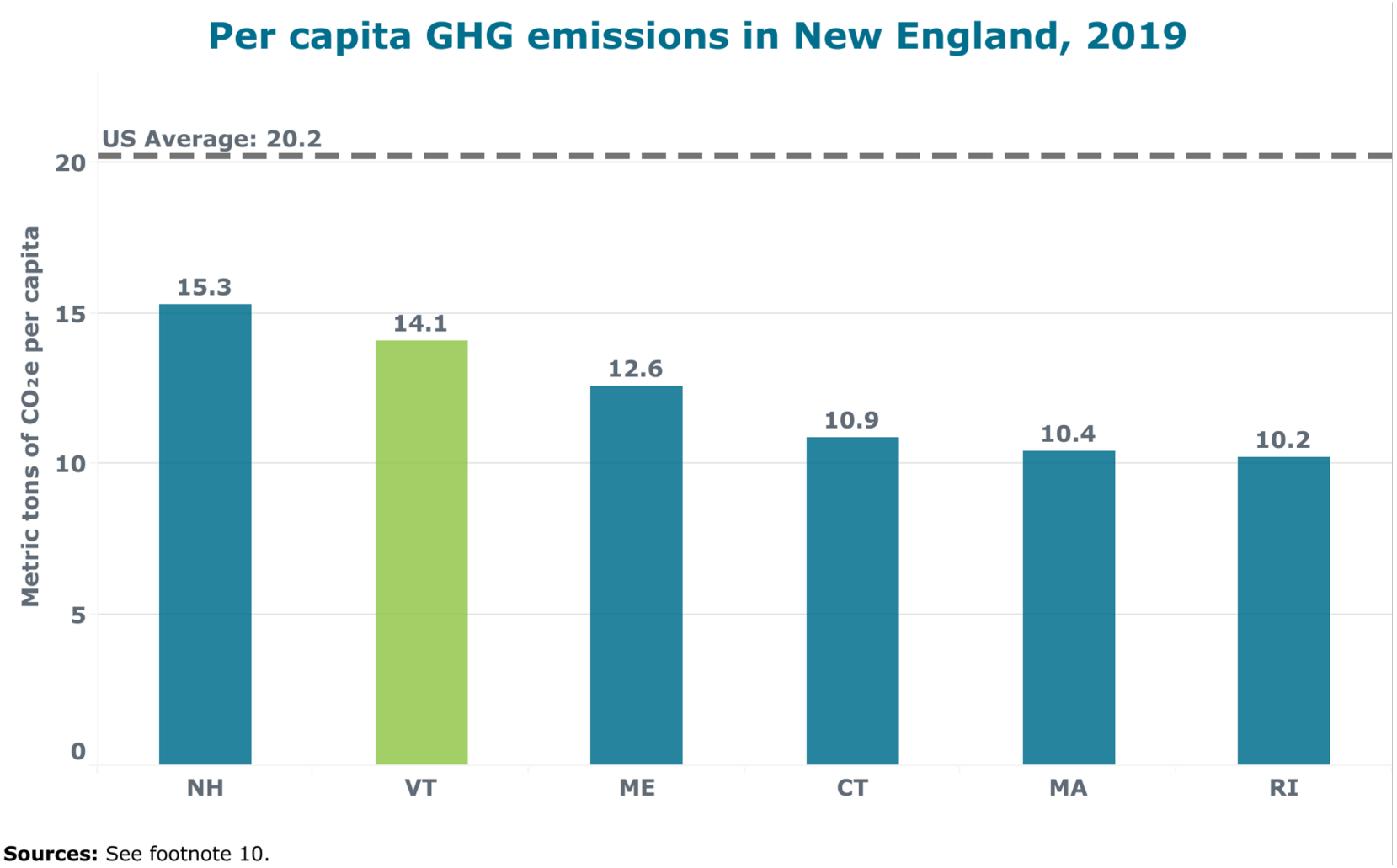
Authored by Lena Stier and Jared Duval
Energy Action Network
September 2023

Vermont: Least progress of any Northeastern state in reducing GHG pollution since 2005



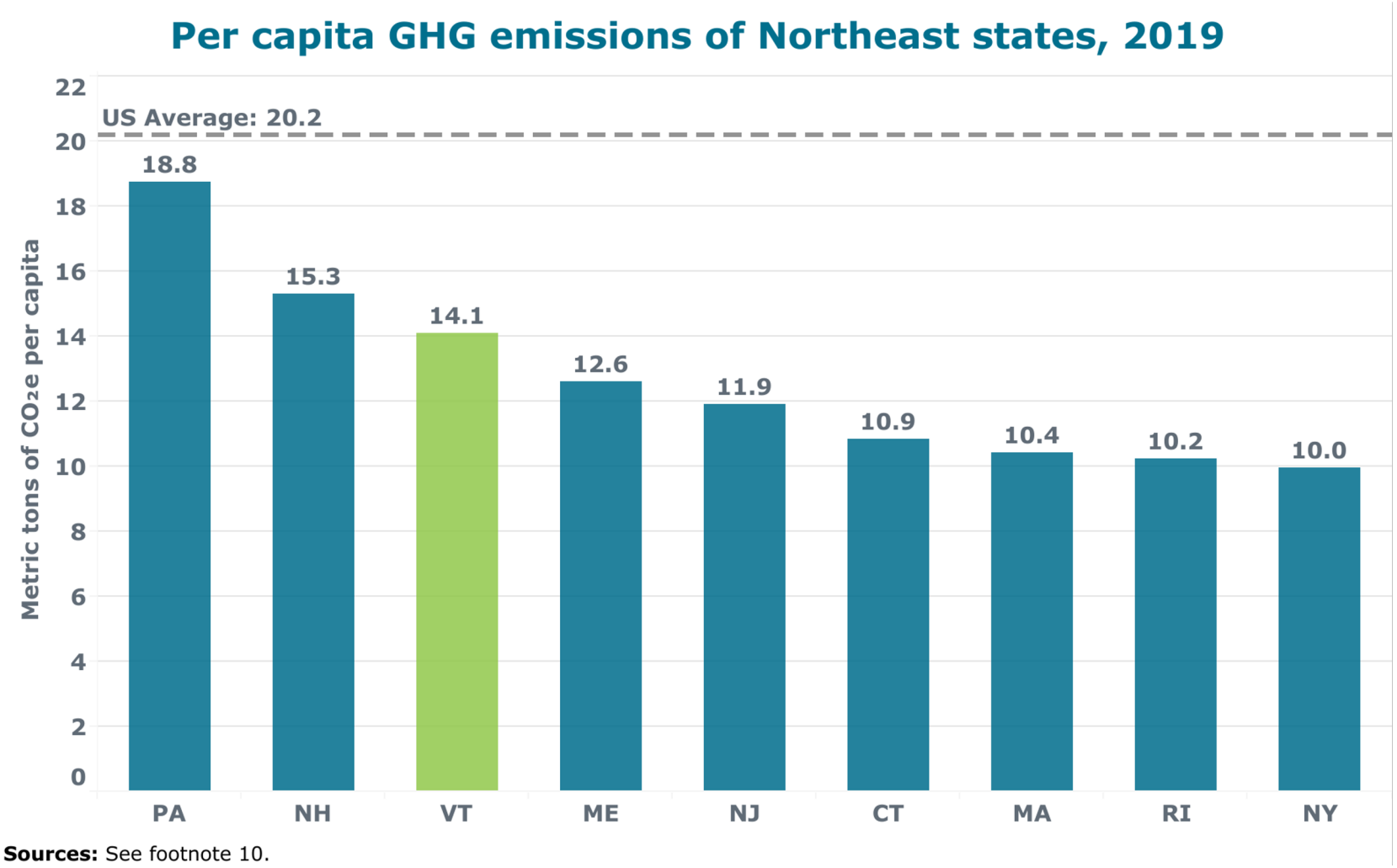
Sources: Vermont ANR, "Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990 - 2020," 2023; Connecticut DEEP, "Connecticut Greenhouse Gas Emissions Inventory: 1990-2021", 2023; Maine DEP, "Ninth Biennial Report on Progress Toward Greenhouse Gas Reduction Goals", 2022; Massachusetts DEP, "Massachusetts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

Vermont: 2nd highest climate pollution per capita in New England



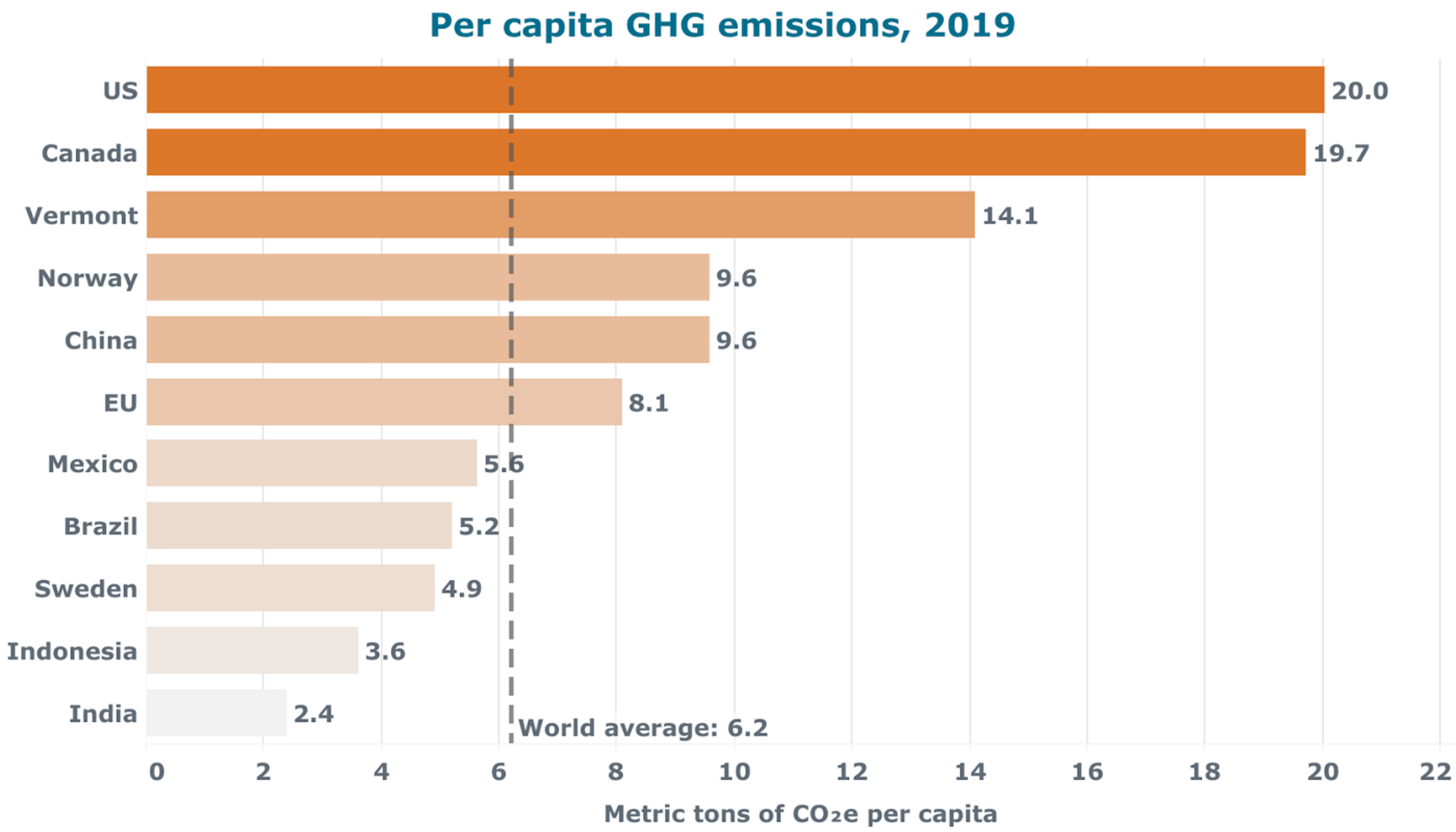
Sources: See footnote 10.

Vermont: 3rd highest climate pollution per capita across the Northeast



Sources: See footnote 10.

Vermont's per capita emissions in a global context



Sources: Gütschow, J. & Pflüger, M., "The PRIMAP-hist national historical emissions time series v2.4 (1750-2021)", 2022 via Climate Watch; Our World in Data, 2023.

Vermont's per capita emissions are more than 2x the global average.

2 Key Points

1. The Inventory (Vermont's GHG Inventory and Forecast) is the official metric of progress toward/ achievement of emissions reduction in Vermont, as established by the GWSA. Any estimates of future year emissions need to align with Inventory inputs, assumptions, and methodologies to be relevant regarding projections of GWSA compliance.

2. In addition to the Inventory, modeled emissions estimates should align with and be checked against the latest actual reported data, including fossil fuel sales data for the transportation and thermal sectors from the Tax Department/JFO (often available in a more timely manner than the fully completed Inventory).

Global Warming Solutions Act (Act 153 of 2020)

* * * Greenhouse Gas Reduction Requirements * * *

Sec. 3. 10 V.S.A. § 578 is amended to read:

§ 578. GREENHOUSE GAS REDUCTION ~~GOALS~~ REQUIREMENTS

(a) ~~General goal of greenhouse~~ Greenhouse gas reduction requirements. ~~It is the goal of the State to~~ Vermont shall reduce emissions of greenhouse gases 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

VT LEG #350685 v.1

Global Warming Solutions Act (Act 153 of 2020)

Vermont ~~in order to make an appropriate contribution to achieving the regional goals of reducing emissions of greenhouse gases from the 1990 baseline,~~ as measured and inventoried pursuant to section 582 of this title, by:

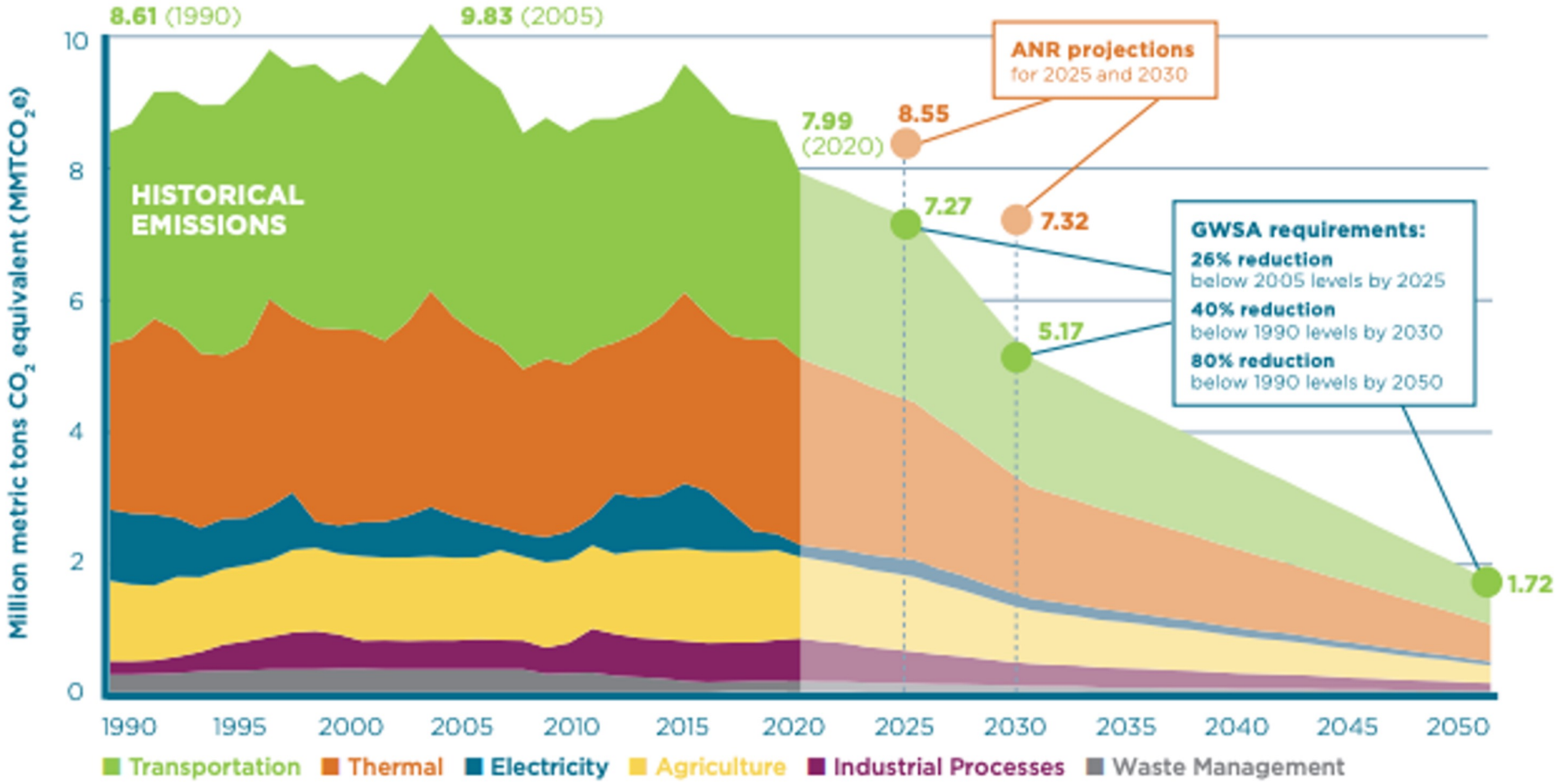
(1) ~~25~~ not less than 26 percent from 2005 greenhouse gas emissions by January 1, ~~2012~~ 2025 pursuant to the State's membership in the United States Climate Alliance and commitment to implement policies to achieve the objectives of the 2016 Paris Agreement;

(2) ~~50~~ not less than 40 percent from 1990 greenhouse gas emissions by January 1, ~~2028~~ 2030 pursuant to the State's 2016 Comprehensive Energy Plan; and

(3) ~~if practicable using reasonable efforts, 75~~ not less than 80 percent from 1990 greenhouse gas emissions by January 1, 2050 pursuant to the State's 2016 Comprehensive Energy Plan.

* * *

Vermont's historical GHG emissions and future requirements



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

Total Modeled Emissions Do Not Align With Total Inventoried Emissions (2015 - 2020)

Year	Actual Reported GHG Emissions (ANR Emissions Inventory)	VT Pathways (LEAP) Modeled BAU emissions	Difference (MMTCO2e)	Difference (%)
2015	9.66	8.53	-1.13	-12%
2016	9.31	8.32	-0.99	-11%
2017	8.9	8.23	-0.67	-8%
2018	8.83	8.24	-0.59	-7%
2019	8.79	8.39	-0.4	-5%
2020	7.99	7.06	-0.93	-12%

Sources: ANR, Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990 – 2020, published April 2023. https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/_Vermont_Greenhouse_Gas_Emissions_Inventory_Update_1990-2020_Final.pdf. BAU emissions from VT Pathways/LEAP model, https://outside.vermont.gov/agency/anr/climatecouncil/Shared%20Documents/x-sector%20and%20task%20group%20revised_baseline_results_6_15_2023.pdf.

Inconsistent methodology for Agriculture emissions

	A	B	C	D	E	F	G	H	I	J	K	L
1	Direct (At Point of Emissions)											
2	Baseline v 3.27											
3	Branch: Vermont Pathways											
4	Units: Thousand Metric Tonnes CO2 Equivalent											
5												
6	Branch	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
7	Demand\Commercial	1,008.97	873.77	785.64	927.35	903.18	867.33	894.24	887.92	879.38	867.74	855.25
8	Demand\Industrial	412.81	419.03	454.81	454.31	455.33	481.74	418.29	406.69	406.22	406.12	406.05
9	Demand\Residential	1,458.19	1,329.81	1,401.96	1,499.27	1,568.69	1,416.89	1,283.62	1,198.62	1,116.90	1,025.01	947.64
10	Demand\Transportation	3,496.55	3,528.80	3,439.10	3,224.42	3,328.35	2,834.60	3,028.15	3,011.64	2,988.38	2,954.45	2,912.80
11	Non Energy\Agriculture	1,174.60	1,193.53	1,189.57	1,190.02	1,190.02	581.42	579.91	580.84	582.86	585.01	587.07
12	Non Energy\Industrial Processes	577.87	570.15	562.02	557.12	552.78	555.17	556.39	558.91	562.02	565.21	568.37
13	Non Energy\Waste	123.30	123.83	123.96	124.19	123.93	124.04	123.63	123.77	124.16	124.56	124.94
14	Transformation\Electricity Generation	265.65	256.63	248.98	244.40	244.21	177.59	163.50	135.45	112.25	120.14	135.35
15	Transformation\Heat Production	-	-	-	-	-	-	-	-	-	-	-
16	Transformation\Transmission and Distribution	10.01	20.02	20.08	23.23	23.44	21.81	21.59	21.34	21.11	20.76	20.44
17	Gross Emissions Total	8,528	8,316	8,226	8,244	8,390	7,061	7,069	6,925	6,793	6,669	6,558
18												

VT Fossil Fuel Sales - Transportation, 2015-2022

*In 2020, gasoline and diesel represented 96% of total transportation emissions

Year	Gasoline (gallons)	Diesel (gallons)	Gasoline + Diesel (gallons)	Change from previous year
2018	316,293,411	66,292,880	382,586,291	
2019	314,728,037	66,171,721	380,899,758	-0.44%
2020	262,417,698	61,703,853	324,121,551	-14.91%
2021	285,699,809	66,141,133	351,840,942	8.55%
2022	285,555,157	64,929,145	350,484,302	-0.39%
% change (2018-2022)	-9.72%	-2.06%	-8.39%	

Source: JFO/Vermont Department of Taxes

https://ljfo.vermont.gov/search/filter/keywords/gallons+taxed

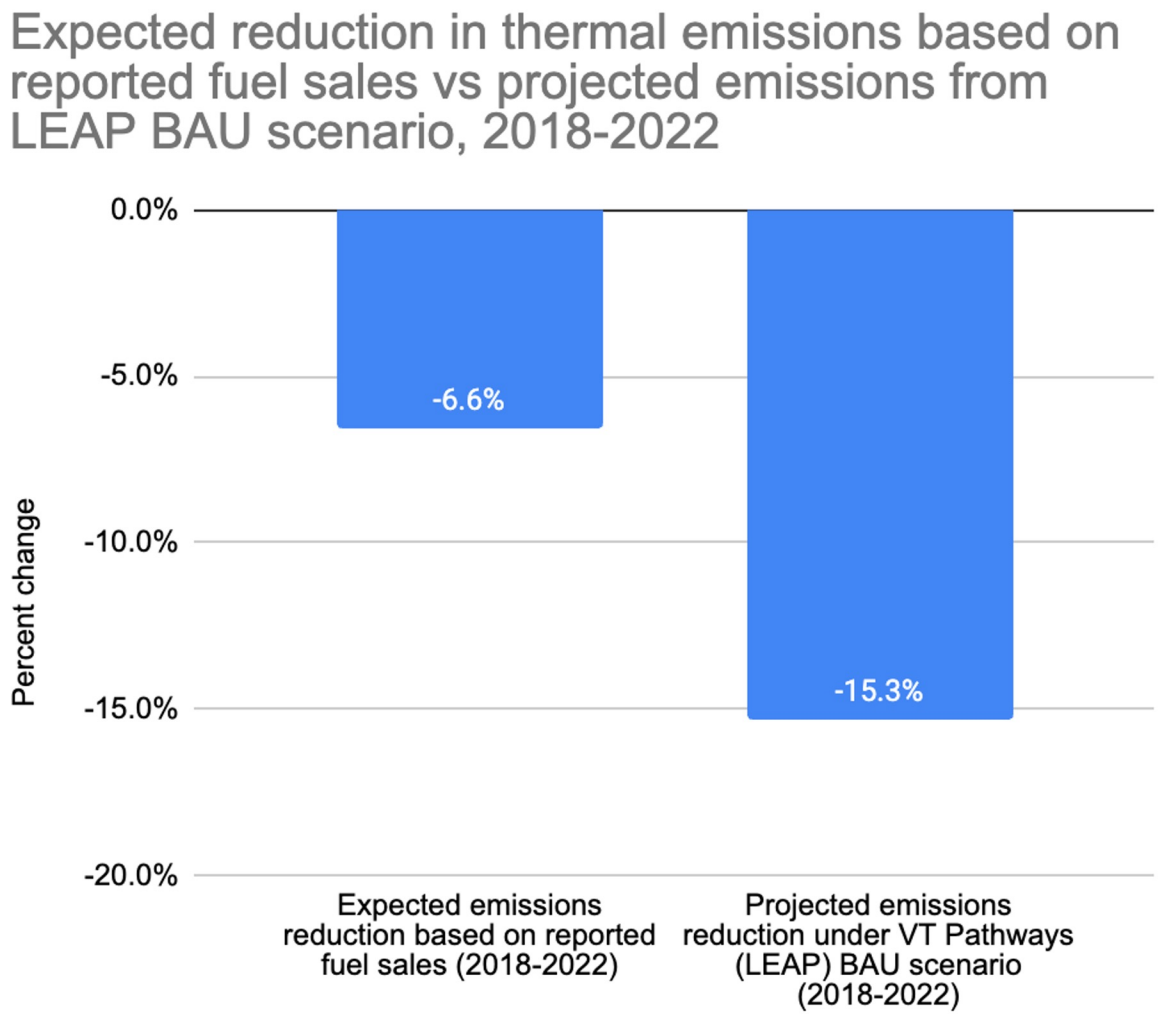
VT Fossil Fuel Sales - Thermal, 2018-2022

*In 2020, fuel oil, propane, and fossil gas represented over 92% of thermal emissions

	Fuel oil, kerosene, other		Propane		Fossil gas		
Year	Gallons	MMBtu	Gallons	MMBtu	MMcf	MMBtu	Total MMBtu
2018	142,760,715	19,772,359	105,640,210	9,661,008	13,732	14,226,352	43,659,720
2019	144,042,019	19,949,820	112,071,541	10,249,167	13,882	14,381,752	44,580,738
2020	138,113,813	19,128,763	96,992,594	8,870,167	13,043	13,512,548	41,511,478
2021	125,390,288	17,366,555	110,776,478	10,130,730	13,270	13,747,720	41,245,005
2022	121,538,893	16,833,137	114,116,456	10,436,178	13,433	13,916,588	41,185,903
% change (2018 - 2022)		-14.87%		8.02%		-2.18%	-5.67%

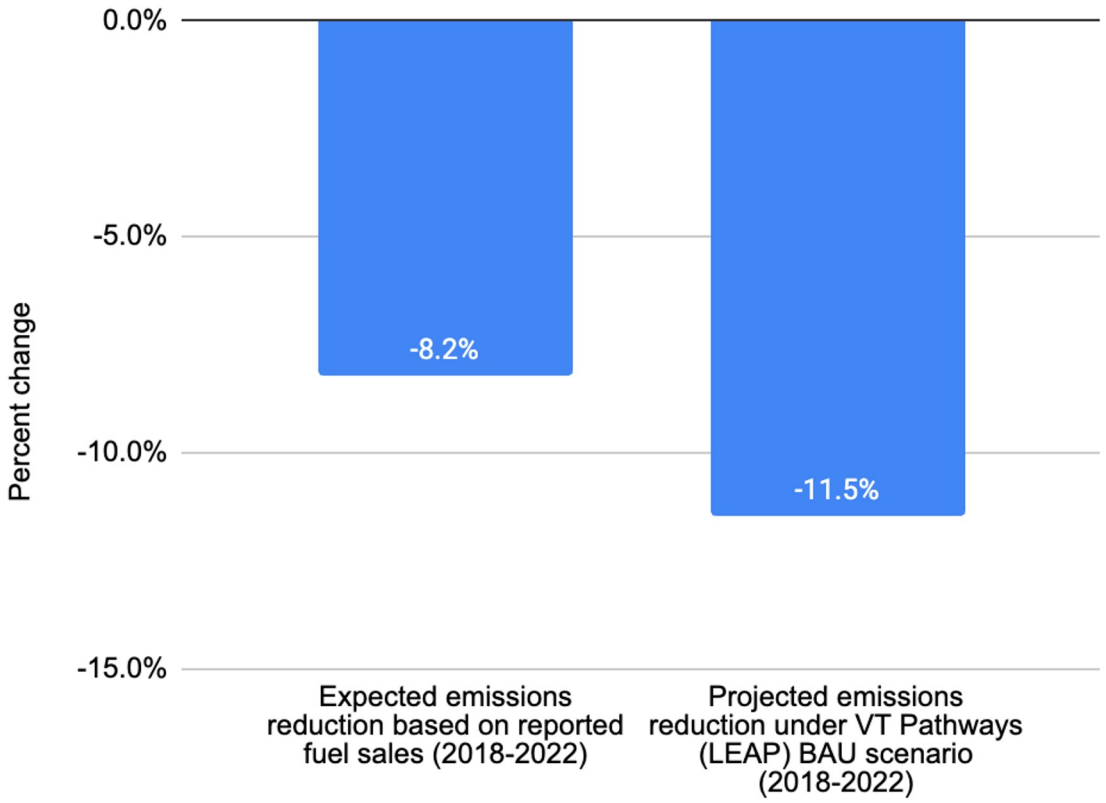
Sources: For fuel oil and propane: Vermont Department of Taxes; for fossil gas: EIA

Modeled Thermal Emissions Do Not Align With Expected Emissions Based On Actual Fuel Sales (2018 - 2022)

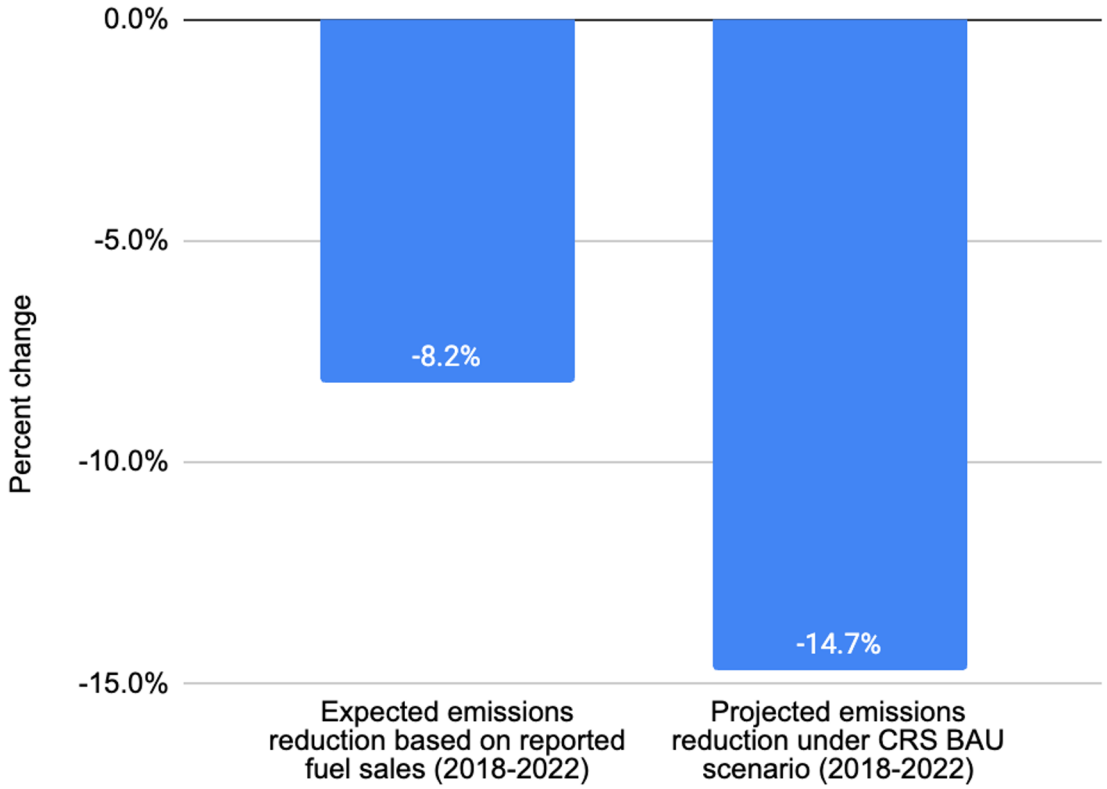


Modeled Transportation Emissions Do Not Align With Expected Emissions Based On Actual Fuel Sales (2018 - 2022), *especially in the CRS Baseline

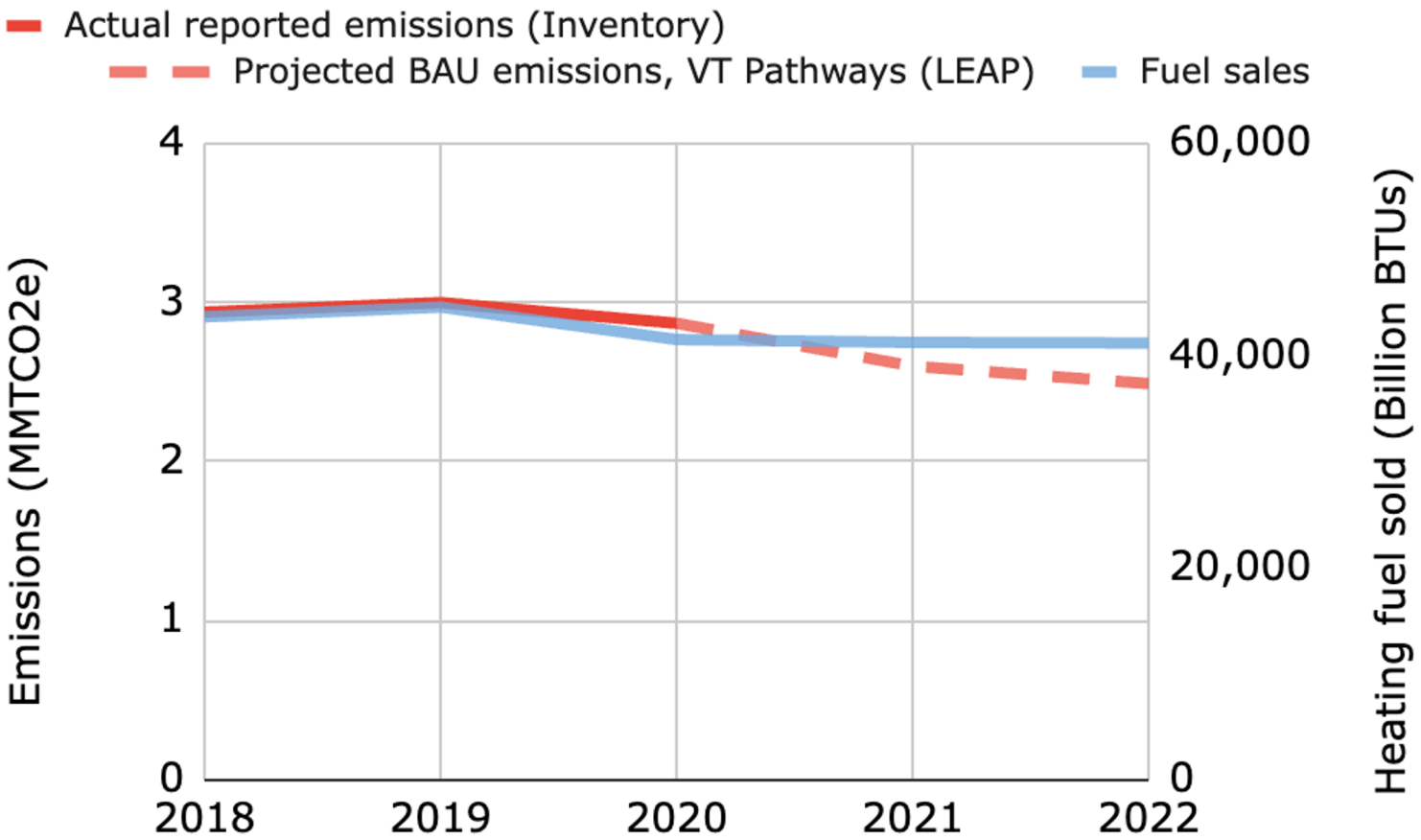
Expected reduction in transportation emissions based on reported fuel sales vs projected change in emissions from LEAP BAU scenario, 2018-2022

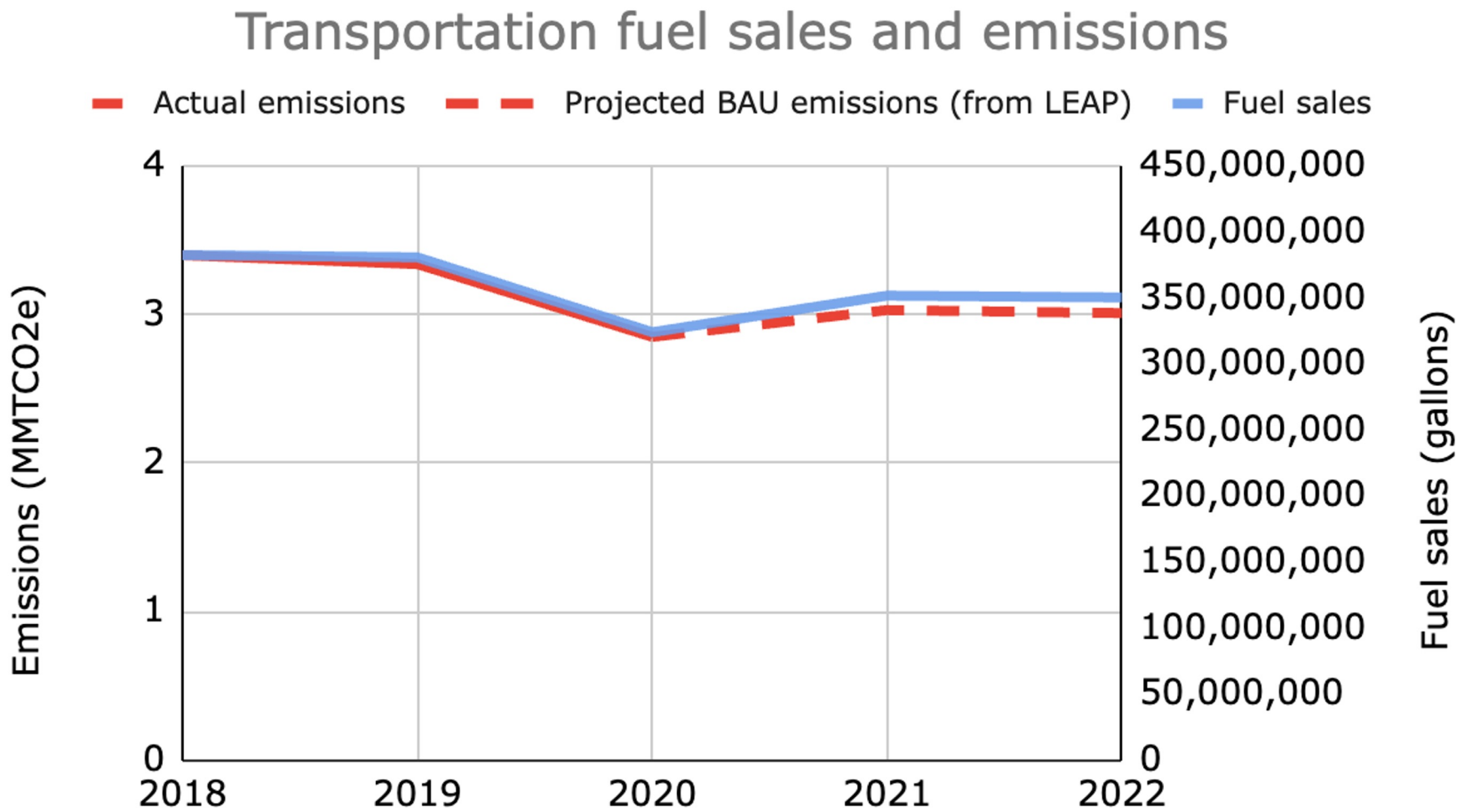


Expected reduction in transportation emissions based on reported fuel sales vs projected change in emissions from CRS baseline scenario, 2018-2022



Thermal fuel sales and emissions




Transportation fuel sales and emissions
Actual emissions
Projected BAU emissions (from LEAP)
Fuel sales
Emissions (MMTCO2e)
Fuel sales (gallons)
4
3
2
1
0
450,000,000
400,000,000
350,000,000
300,000,000
250,000,000
200,000,000
150,000,000
100,000,000
50,000,000
0
2018
2019
2020
2021
2022

Why Does Getting These Projections Right Matter?

- Compliance with Vermont law/ meeting GWSA obligations
- Ensuring that VT is doing our part/ doing our fair share toward meeting science-based pollution reduction targets (i.e., the GWSA targets matter not just because they are legal obligations but also because they are a moral/ ethical responsibility)
- Ensuring that revised Climate Action Plan recommendations can actually achieve the appropriate (minimum) scale and pace of climate pollution reduction necessary (i.e., we don't want to run the risk of doing too little).
- The less we do or think we have to do on emissions reduction risks achieving a lower net societal benefit (note: using the latest EPA figure for the Social Cost of Carbon, all economy-wide modeled pathways for VT emissions reduction by 2050 result in net societal benefit, from about $2 billion to $3.5 billion). Doing less would also leave more Vermonters stuck with dependence on high-cost, price-volatile, and polluting fossil fuels that is higher than necessary and/or longer than necessary.

Recommendations & Questions

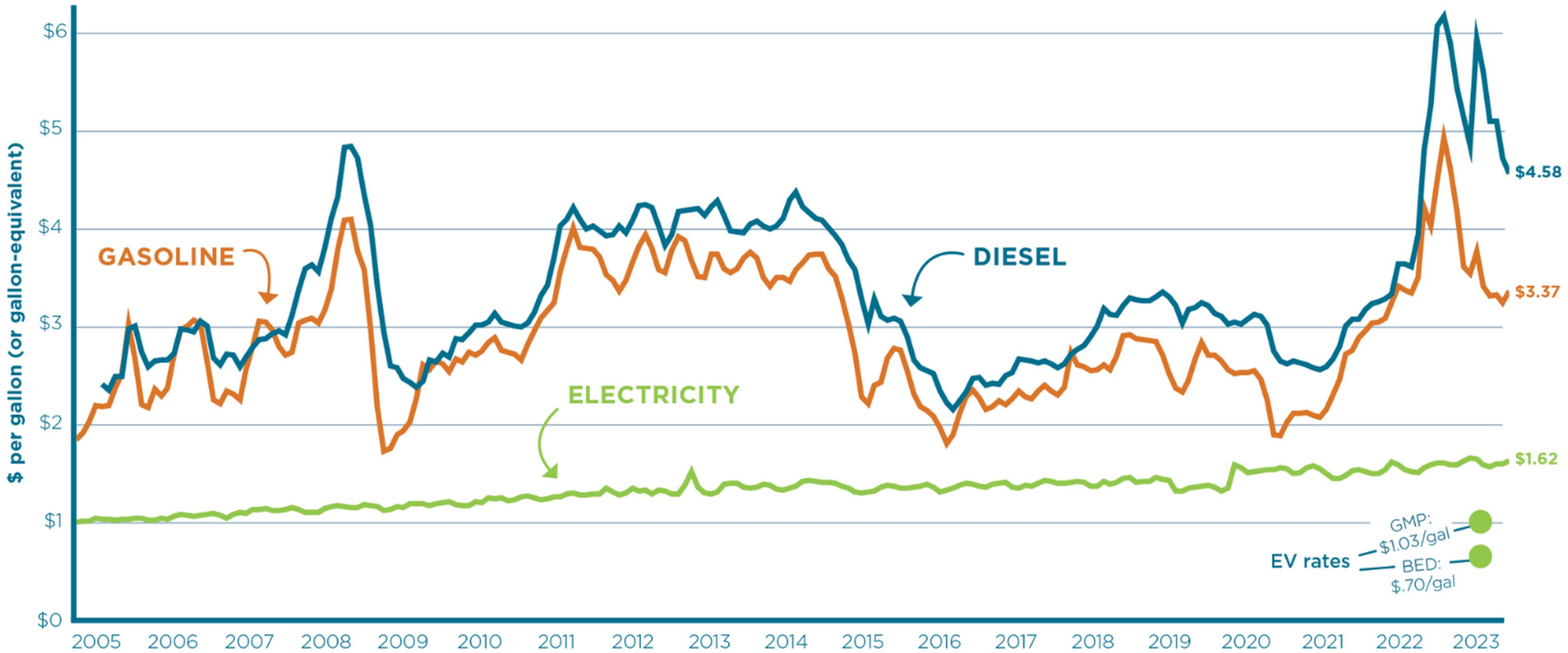
Recommendation: Update the Pathways/BAU analysis to reflect/ align with Inventory inputs, assumptions, and methodologies.

> Question: Is this possible in the existing LEAP model or do we need a new/different model that can/ will align with the Inventory?

Recommendation: Continually check Pathways/BAU projections against actual reported data, as it becomes available. Adjust/ calibrate the model to be as current and accurate as possible.

Recommendation: For future year projections, produce a range of possible values with associated confidence intervals rather than a single projected value without any characterization of uncertainty/confidence.

Cost comparison of different transportation fuels over time in VT



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

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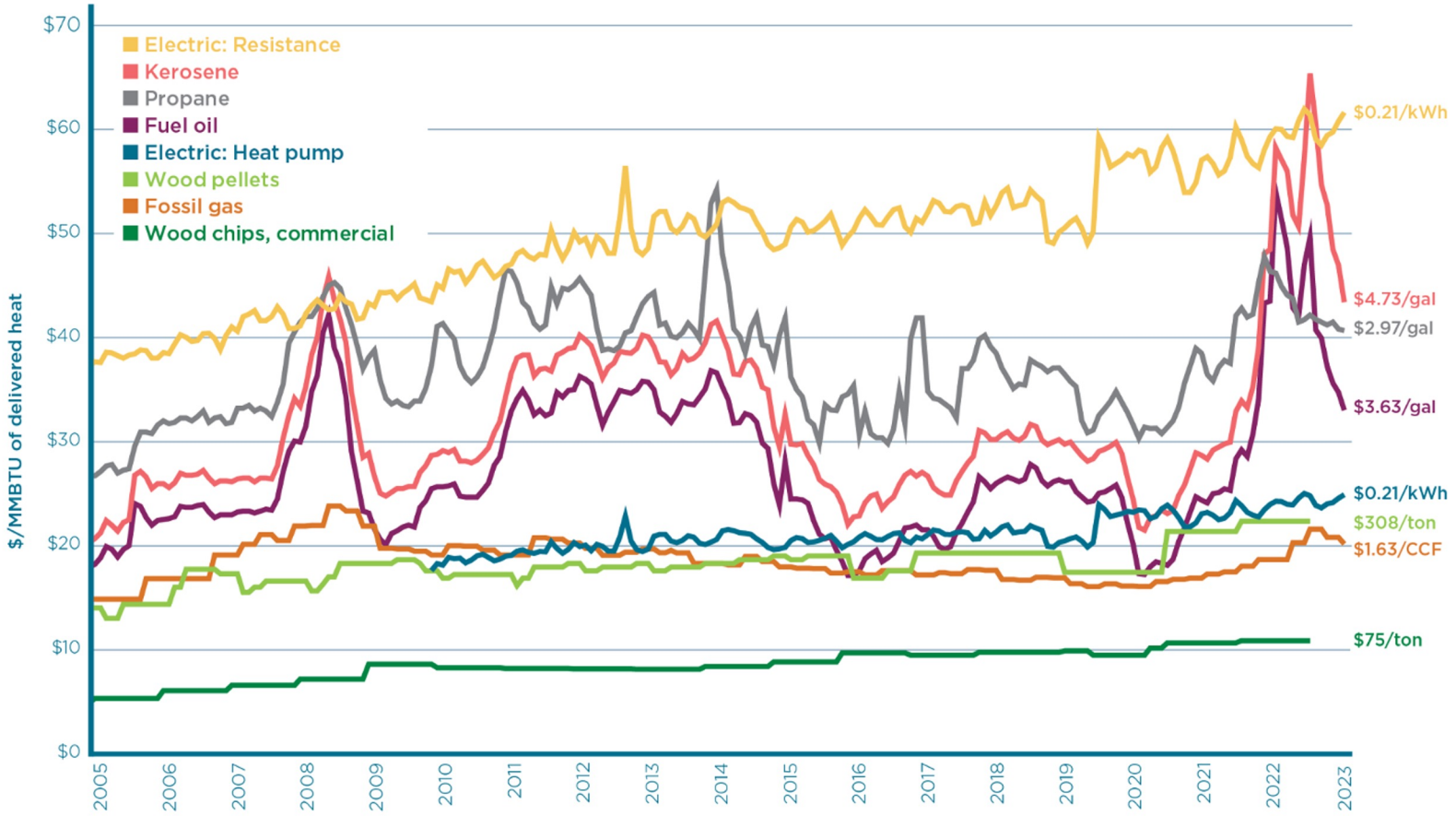
Cost comparison of different heating fuel options over time



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

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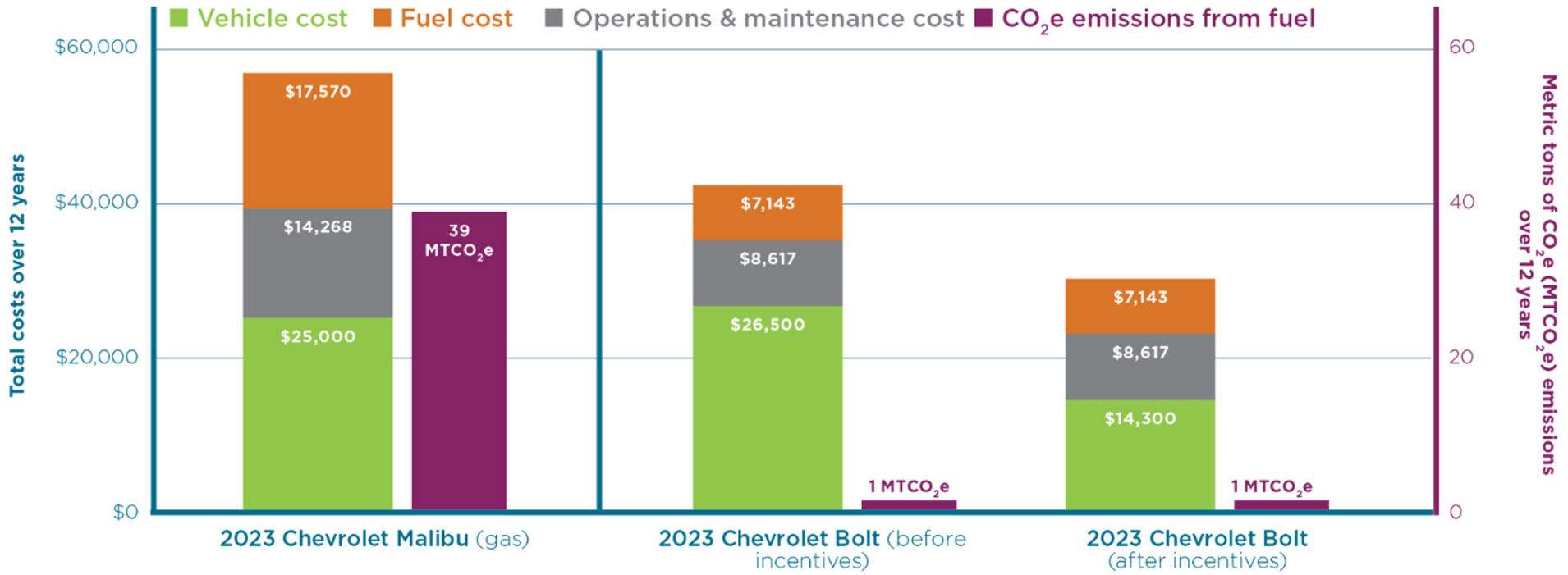
Cost Comparison of Comparable Gas vs. Electric Vehicles

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



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

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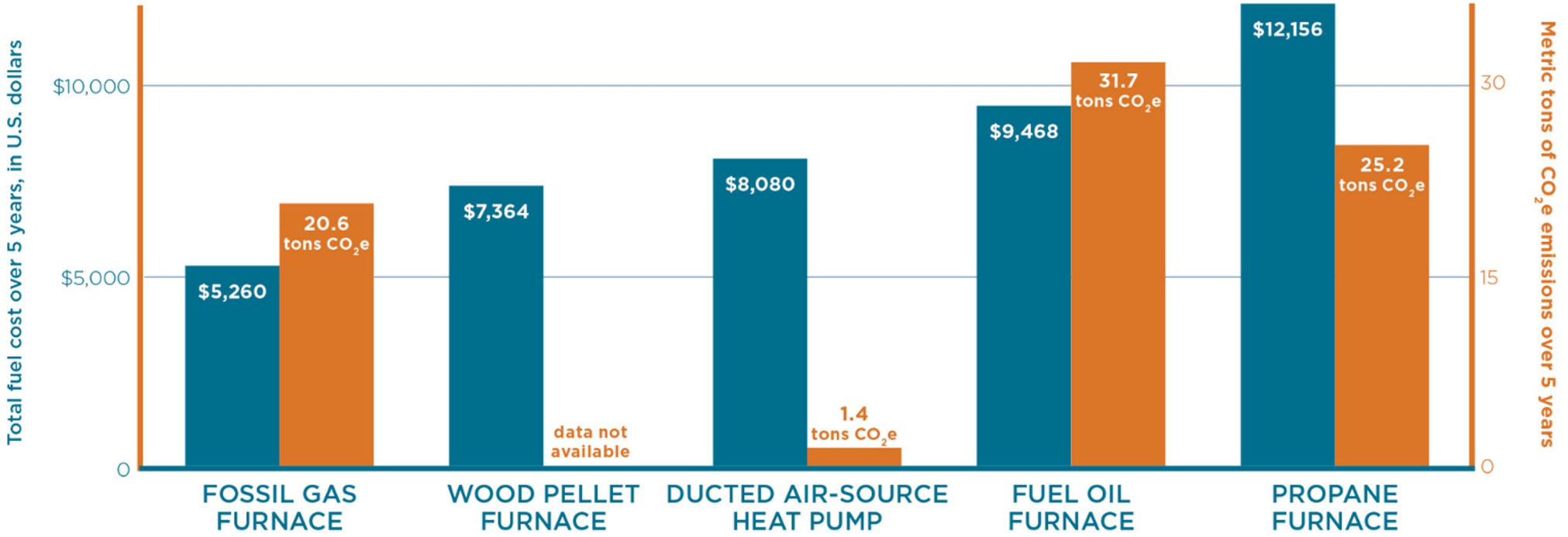
Cost Comparison of Heating Fuel Options in Vermont, 2018-2022

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



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

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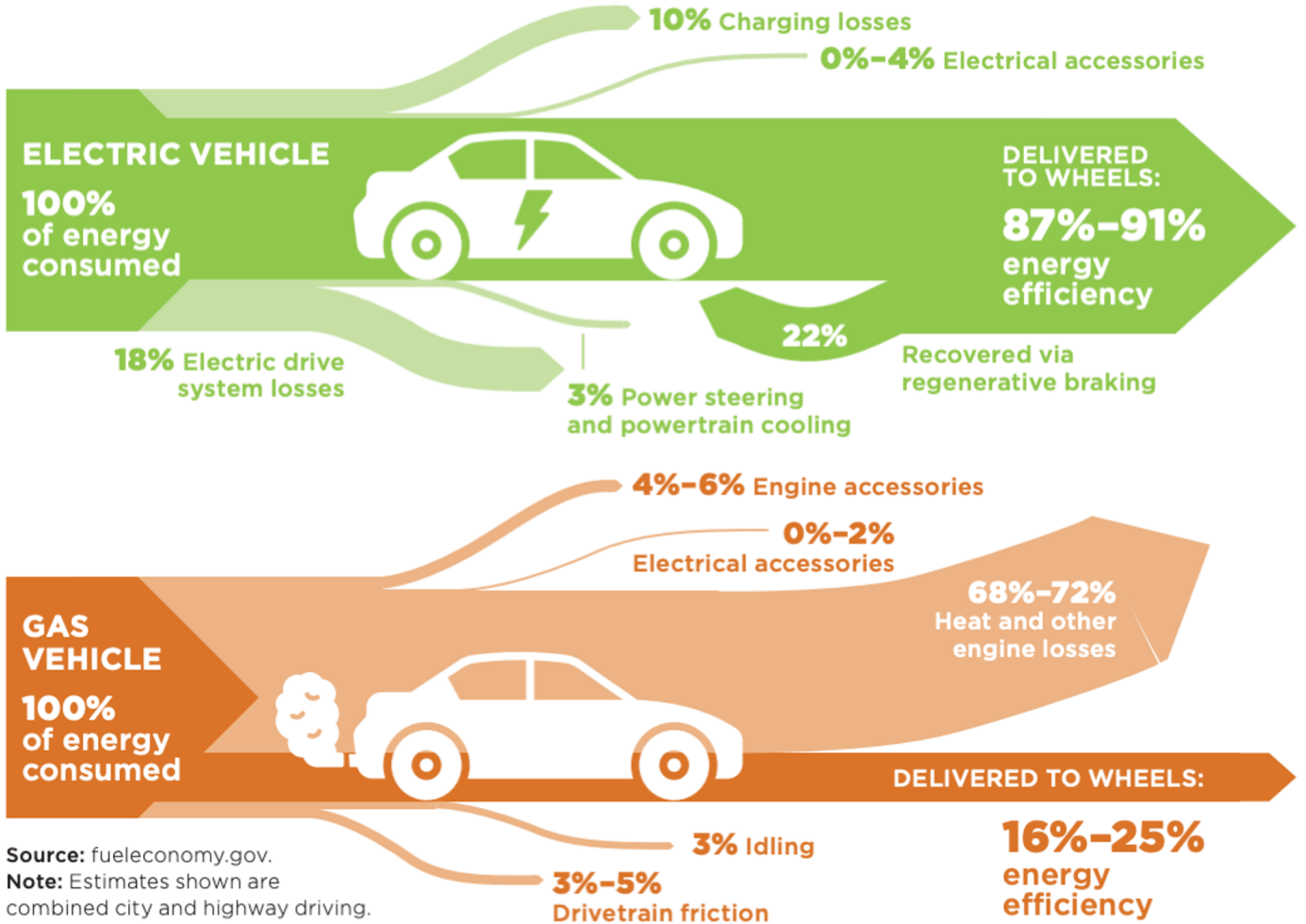
Electrification lets us use less polluting energy – and less energy overall

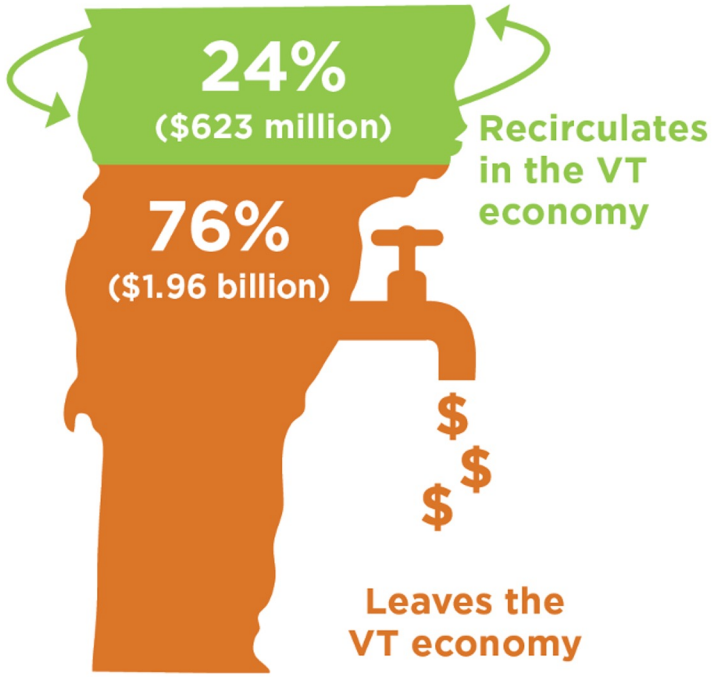
Where the energy goes: Electric vehicles vs gas vehicles



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

Local $ Recirculation of Different Energy Sources

Vermont fossil fuel spending, 2022



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

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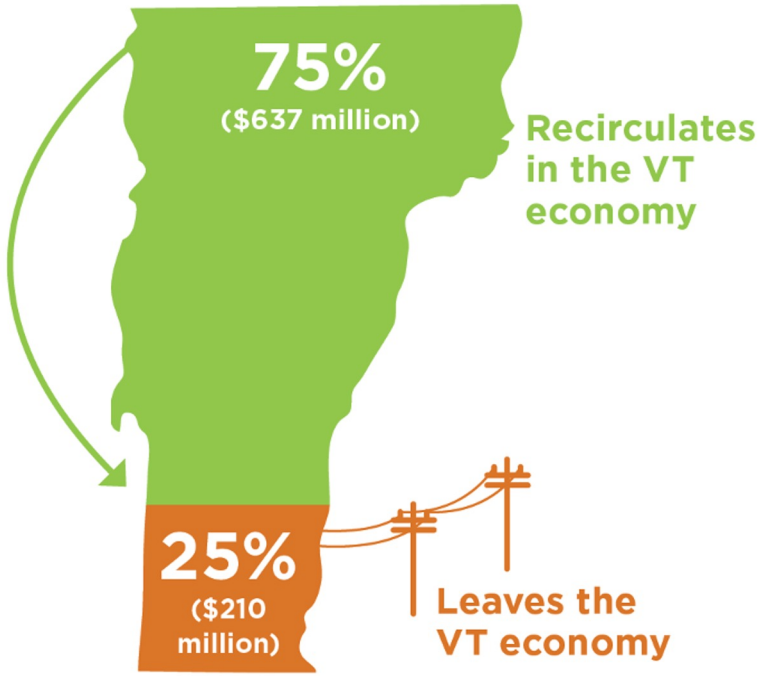
Vermont electricity spending, 2021



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

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