
Estimating Vermont's 2024 Greenhouse Gas Emissions

Prepared for the Conservation Law Foundation

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EXECUTIVE SUMMARY

In the spring of 2025, the Conservation Law Foundation asked Synapse to develop an estimate of Vermont's calendar year 2024 greenhouse gas (GHG) emissions, given the best available data at this time. Under the Vermont Global Warming Solutions Act (GWSA) of 2020, Vermont is required to reduce its GHG emissions to 26 percent below 2005 levels by January 1, 2025.¹ As of July 2024, this is estimated to be equal to a goal of 7.30 million metric tons carbon dioxide (CO₂) equivalent (MMTCO₂e).² While Vermont is required to publish an official inventory estimating statewide GHG emissions on an annual basis, this report is published on a three-year delay given lag times between the close of each calendar year and the availability of the required data for the estimate. This report aims to estimate 2024 emissions ahead of the official 2024 Inventory, which is not expected to be published until 2027, in order to more immediately assess whether Vermont has met its January 1, 2025, requirement. During the preparation of this report, Vermont published its 2022 Inventory, which estimates annual emissions from 1990 through 2022 and includes minor changes in methods and parameters.³ Because our analysis follows the methods and assumptions of Vermont's 2021 Inventory, in this report we present our results alongside estimates and target levels as established in the 2021 Inventory.

Figure 1 shows the results of Synapse's estimate of GHG emissions in Vermont in 2022, 2023, and 2024, alongside the results of the 2021 Vermont state inventory.⁴ We estimate total 2024 GHG emissions in Vermont to be 7.61 MMTCO₂e. This is about 0.31 MMTCO₂e, or about 4.3 percent, above the state's January 1, 2025, requirement of 7.30 MMTCO₂e.

¹ Vermont Legislature - Global Warming Solutions Act (Act 153):
<https://legislature.vermont.gov/Documents/2020/Docs/ACTS/ACT153/ACT153%20As%20Enacted.pdf>.

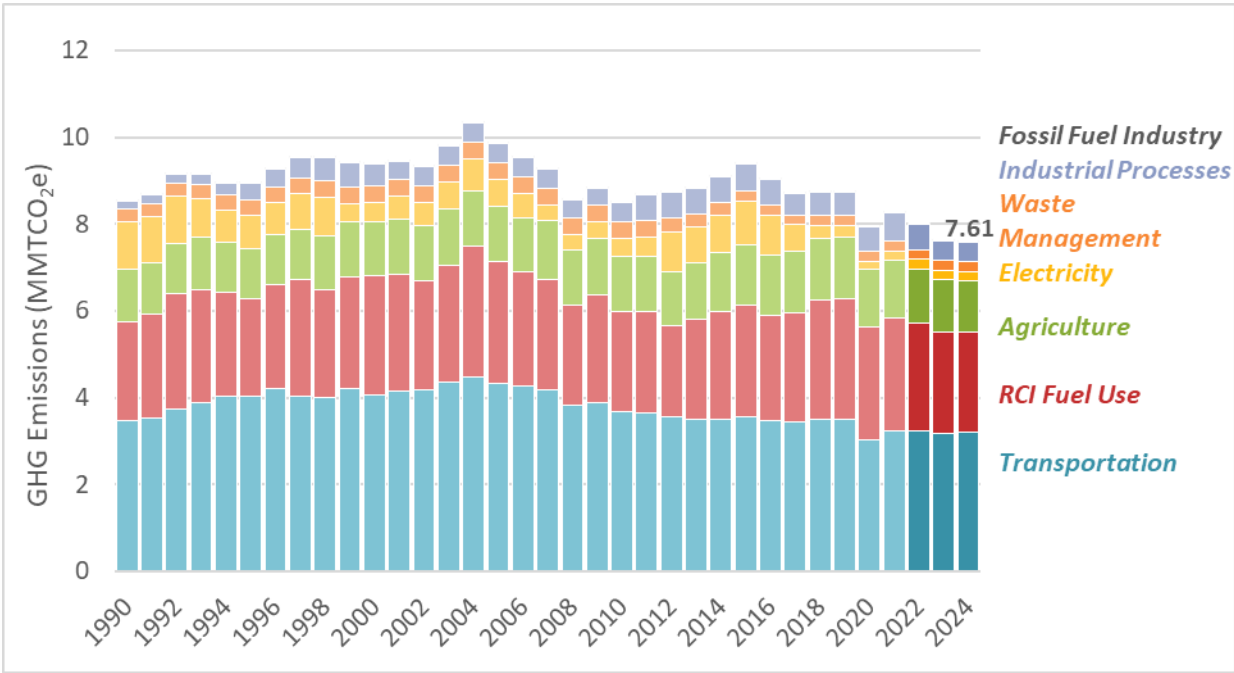
² Vermont Agency of Natural Resources. 2024. *Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990-2021*. Available at: <https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory>.

³ Vermont Agency of Natural Resources. 2025. *Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990-2022*. Available at: <https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory>.

⁴ Vermont Agency of Natural Resources. 2024. *Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990-2021*. Available at: <https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory>.



Figure 1. Vermont GHG Inventory (1990–2021) and Synapse Estimates (2022–2024)



1. INTRODUCTION

1.1. Background

Through the Vermont Global Warming Solutions Act (GWSA) of 2020, Vermont is required to reduce its greenhouse gas (GHG) emissions to 26 percent below 2005 levels by January 1, 2025, 40 percent below 1990 levels by January 1, 2030, and 80 percent below 1990 levels by January 1, 2050.⁵ To track progress towards these goals, Vermont is required to publish *Vermont Greenhouse Gas Emissions Inventory and Forecast* reports on an annual basis.⁶ In July 2024, the Vermont Agency of Natural Resources published its methodologies and results for estimating GHG emissions from 1990–2021.

1.2. Objectives

While Vermont is already required to publish an estimate of the state’s GHG emissions each year, these estimates are released with a three-year lag time (e.g. estimates for 2021 were released in 2024). In the spring of 2025, the Conservation Law Foundation (CLF) contracted Synapse Energy Economics (Synapse) to develop an estimate of calendar year 2024 Vermont GHG emissions given the best available data at the time, with the goal of assessing in the near term whether Vermont has likely met its January 1, 2025, emissions reduction requirement. This report documents, by sector, the methodologies employed by Synapse, and Synapse’s ultimate estimate of Vermont GHG emissions for 2024.

1.3. Summary of 1990–2021 Inventory

In July 2024, Vermont published the *Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990–2021* (2021 Vermont Inventory).⁷ This inventory contains official statewide emissions estimates of carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) for the years 1990 through 2021, with results detailed by sector. Alongside the 2021 Vermont Inventory, the Vermont Agency of Natural Resources published the *Vermont Greenhouse Gas Emissions Inventory and Forecast: Methodologies* report, which details the methods and sources used to estimate the 2021 Vermont Inventory.⁸ During the preparation of this report, the State published the 2022 Vermont Inventory, which includes minor

⁵ Vermont Legislature - Global Warming Solutions Act (Act 153):
<https://legislature.vermont.gov/Documents/2020/Docs/ACTS/ACT153/ACT153%20As%20Enacted.pdf>.

⁶ Vermont Statute 10 V.S.A. § 582: <https://legislature.vermont.gov/statutes/section/10/023/00582>.

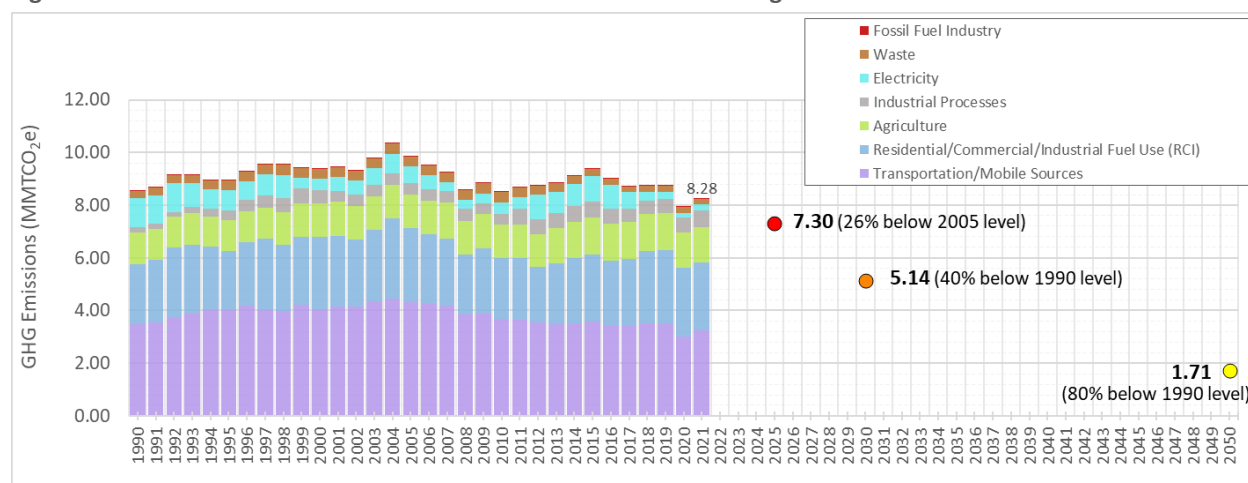
⁷ Vermont Agency of Natural Resources. 2024. *Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990–2021*. Available at: <https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory>.

⁸ Vermont Agency of Natural Resources. 2024. *Vermont Greenhouse Gas Emissions Inventory and Forecast: Methodologies*. Available at: <https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory>.

changes in methodological assumptions and default parameter values.⁹ These changes affect historical results from 1990 to 2021, and in turn impact the mandated reduction targets. Because our analysis follows the methods and assumptions of the 2021 Vermont Inventory, in this report we will continue to compare our analysis against the targets set out by the 2021 Vermont Inventory. We will identify and discuss briefly how the State’s newly published 2022 results compare with our estimates.

Figure 2 shows the results of the 2021 Vermont Inventory, by year, as well as the three emissions reduction goals set out by the GSWA, as calculated by the inventory. This inventory estimates that total GHG emissions in Vermont in 2021 were 8.20 million metric tons CO₂ equivalent (MMTCO₂e). It states that, using the methods for the 2021 inventory, GHG emissions must be below or equal to 7.30 MMTCO₂e by January 1, 2025, 5.14 MMTCO₂e by January 1, 2030, and 1.71 MMTCO₂e by January 1, 2050.

Figure 2. Vermont GHG emissions levels and mandated reduction targets



Source: Vermont Agency of Natural Resources. 2024. *Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990-2021*. Available at: <https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory>. [typo in key corrected]

In addition to the estimates shown here, for each sector (where applicable), the official Vermont inventory estimates emissions of biogenic CO₂. These are emissions associated with the breakdown of biologically-based materials. The 2021 Vermont Inventory provides these estimates as supplemental information and does not include them in emissions inventory totals, in accordance with

⁹ Vermont Agency of Natural Resources. 2025. *Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990-2022*. Available at: <https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory>.

Intergovernmental Panel on Climate Change (IPCC) guidelines.^{10,11} For this reason, we do not estimate biogenic CO₂ emissions in our analysis.

¹⁰ Intergovernmental Panel on Climate Change (IPCC). 2006. *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at: <https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/>.

¹¹ IPCC. 2019. *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Available at: <https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html>.



2. INVENTORY METHODOLOGY AND RESULTS BY SECTOR

The following subsections document the methodologies used to estimate 2022, 2023, and 2024 GHG emissions, and the resulting estimates by sector. For each sector, we aim to replicate the official methodology used by the 2021 Vermont Inventory, as described in the State's 2021 methodology companion report. These subsections aim to highlight the data sources Synapse used and any key differences from the 2021 Vermont Inventory's methodology. For more details on the specific steps used, please refer to the 2021 Vermont Inventory methodology report.

For Synapse's estimate of GHG emissions in 2024, we make every attempt to apply 2024-specific data whenever available. While 2024-specific data is available for many of the major inputs into the emissions analysis (e.g., gallons of fuel sold, cattle population estimates, electric utility sales), where gaps exist we apply 2022- or 2023-specific values, or recent-year averages. We document these assumptions in the subsections that follow.

2.1. Transportation and Mobile Sources

Methodology

Emissions from the transportation and mobile sources sector are broken into six source categories:

- CO₂ emissions from onroad and nonroad motor gasoline
- CO₂ emissions from onroad and nonroad diesel
- CO₂ emissions from hydrocarbon gas liquids, residual fuel, and natural gas
- CO₂ emissions from jet fuel and aviation gasoline
- CO₂ emissions from non-energy consumption of lubricants
- CH₄ and N₂O emissions (all mobile)

For all five source categories of CO₂ emissions, we follow the 2021 Vermont Inventory methodology and apply the U.S. Environmental Protection Agency's (EPA) State Inventory Tool (SIT): Carbon Dioxide Emissions from Combustion of Fossil Fuels Module, version 2024.1.¹² We obtain data on annual gallons

¹² All of U.S. EPA's most recent State Inventory and Projection Tool modules can be downloaded at <https://www.epa.gov/statelocalenergy/download-state-inventory-and-projection-tool>. Note that we relied on version 2024.1 for all of the modules applied throughout this analysis, to be consistent with the assumptions used by the 2021 Vermont Inventory. Applying a newer version of the State Inventory and Projection Tool could yield different historical emissions estimates, and thus a different January 1, 2025, target, than those in the 2021 Vermont Inventory we are interested in comparing 2024 emissions against.

of motor gasoline and diesel sold from the Vermont Joint Fiscal Office.¹³ We apply year-specific heat rates from the U.S. Energy Information Administration (EIA), and Vermont-specific annual consumption data from U.S. EIA's State Energy Data System (SEDS), version 2023P.^{14,15} Where SEDS consumption data is used, we adopt the 2023 consumption value for 2024 because 2024 data is not yet available. Where a combination of actual and SEDS data is used, we extrapolate trends from SEDS data from 2022 to 2023 into 2024. For all other parameters, we rely on the assumptions provided by the SIT module.

To calculate CH₄ and N₂O emissions (all mobile), we rely on the U.S. EPA's SIT: CH₄ and N₂O Emissions from Mobile Combustion Module, version 2024.1. Following the 2021 Vermont Inventory methodology, we primarily rely on default data provided by the SIT module, along with SEDS 2023P data. We pull 2022 data from the most recent SIT module version into version 2024.1 for the year 2022. Following the sources used by the methodology, we also apply Vermont-specific vehicle-miles traveled (VMT) data from the State of Vermont Agency of Transportation, and gasoline consumption from boats from the Federal Highway Administration.^{16,17}

Results

Table 1 presents the results of the 2022–2024 emissions estimates for the transportation and mobile sources sector, alongside select historical years and the most recent years of the 1990–2021 official inventory. Figure 3 presents estimates for all years from 1990 through 2024, with results prior to 2022 coming from the 2021 Vermont Inventory. We estimate total GHG emissions from the transportation sector to be 3.21 MMTCO₂e in 2024, a 0.9 percent decrease from 2021. Transportation emissions make up the largest share of total statewide GHG emissions in 2024 (42 percent), consistent with historical trends.

¹³ Vermont Joint Fiscal Office. April 7, 2025. "Feb 2025 Gasoline and Diesel Gallons Taxed." Available at: <https://ljfo.vermont.gov/subjects/transportation/monthly-data>.

¹⁴ U.S. Energy Information Administration. "Table A3 Approximate Heat Content of Petroleum Consumption and Fuel Ethanol." Available at: <https://www.eia.gov/totalenergy/data/monthly/index.php#appendices>.

¹⁵ U.S. Energy Information Administration. "State Energy Data System (SEDS): 2023 Updates by Energy Source." Available at: <https://www.eia.gov/state/seds/>.

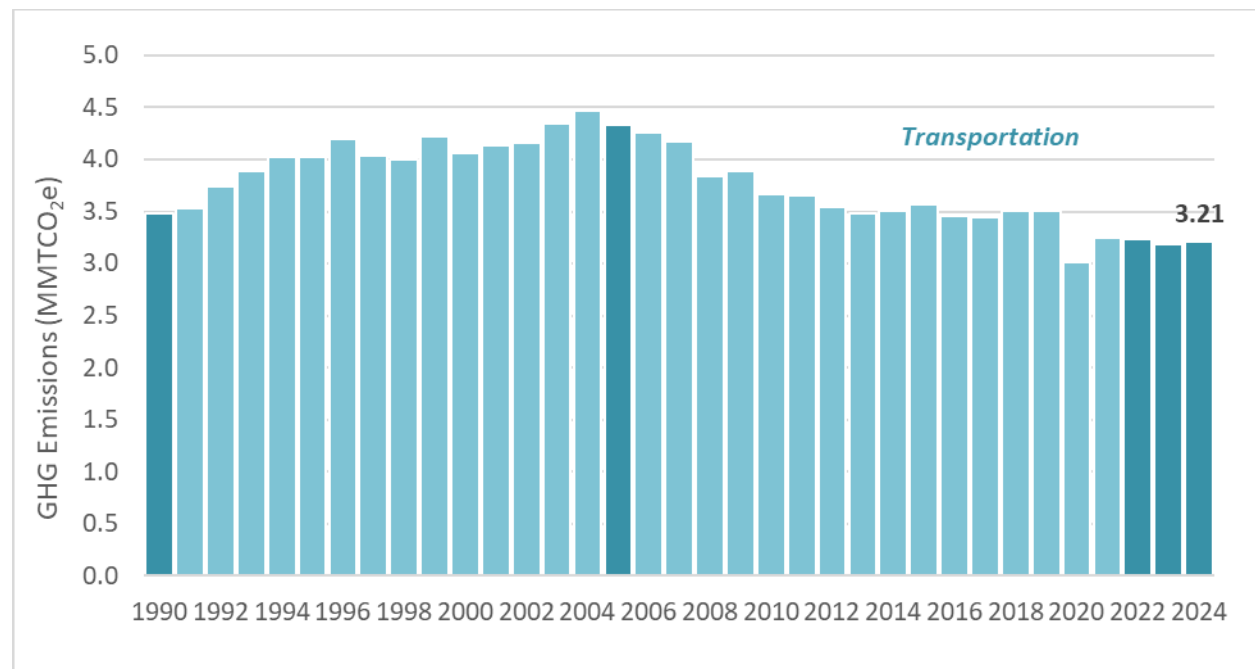
¹⁶ State of Vermont Agency of Transportation. "Traffic Data: Statewide VMT by Functional Class." Available at: <https://vtrans.vermont.gov/operations/OSB/data/traffic>.

¹⁷ Federal Highway Administration. "Statistics Series for 2022 and 2023, Table MF-24". Available at: <https://www.fhwa.dot.gov/policyinformation/statistics.cfm>.

Table 1. Transportation sector emissions from select years, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse

Transportation and Mobile Sources Sector	GHG Emissions (MMTCO ₂ e)								
	1990	2005	2010	2019	2020	2021	2022	2023	2024
Motor Gasoline (Onroad and Nonroad) (CO ₂)	2.54	3.05	2.63	2.42	2.01	2.19	2.18	2.19	2.21
Diesel (Onroad and Nonroad) (CO ₂)	0.72	1.02	0.88	0.95	0.89	0.92	0.90	0.85	0.85
Jet Fuel & Aviation Gasoline (CO ₂)	0.08	0.13	0.07	0.07	0.06	0.09	0.10	0.10	0.10
All Mobile (CH ₄ , N ₂ O)	0.12	0.10	0.07	0.04	0.04	0.04	0.04	0.04	0.04
Non-Energy Consumption - Lubricants (CO ₂)	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Hydrocarbon Gas Liquids, Residual Fuel, Natural Gas (CO ₂)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	3.48	4.33	3.67	3.50	3.02	3.24	3.23	3.18	3.21

Figure 3. Vermont GHG emissions from the transportation/mobile sources sector, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse



The 2022 Vermont Inventory’s published GHG emissions value for the transportation and mobile sources sector is 3.21 MMTCO₂e in 2022, about 0.7 percent less than our 2022 estimate of 3.23 MMTCO₂e. This difference is likely driven by updated assumptions in version 2025.1 of the SIT module, used by the 2022 Vermont Inventory.

2.2. Residential/Commercial/Industrial Fuel Use

Methodology

Potential sources of GHG emissions from residential, commercial, and industrial (RCI) fuel use include the use of coal; natural gas; oil, propane, and other petroleum; and wood. The 2021 Vermont Inventory calculations workbook estimates emissions for this sector through 2023, so for this sector we focus on updating the existing workbook with more up-to-date data where possible, and on adding 2024 estimates to the existing infrastructure. There is no recent historical coal use in Vermont, so we assume no emissions from coal in 2022, 2023, or 2024. Emissions of CH₄ and N₂O across fuel types are small and stable over time in recent historical years, making up about 1 percent of total Vermont emissions in each of the last 10 years. For these reasons, we adopt the Vermont Agency of Natural Resource's 2022 and 2023 CH₄ and N₂O emissions estimates for this sector, and we carry forward the 2023 estimate into 2024.

We focus the rest of our analysis on calculating CO₂ emissions from natural gas and oil, propane, and other petroleum. Following along the 2021 methodology, we obtain 2024 total petroleum, heating oil, other dyed diesel, and kerosene sales data, in gallons, from data collected by the Vermont Department of Taxes form FGR-617. We disaggregated the consumption of each fuel type into the RCI sectors using sector-specific consumption data from SEDS 2023P. For other fuel categories not available through form FGR-617, we apply consumption data from SEDS 2023P, also replacing placeholder data used by the 2021 Vermont Inventory from SEDS 2021F. We also adopt 2023 data from SEDS for the year 2024 where 2024-specific data is not available. We carry forward the steps outlined in the 2021 methodology for avoiding double-counting, by removing "off highway" consumption from distillate fuel totals, and subtracting ethanol used in motor gasoline for the commercial and industrial sectors. Finally, we apply the resulting annual consumption estimates for all sectors and fuel types to the U.S. EPA's SIT: Carbon Dioxide Emissions from Combustion of Fossil Fuels Module, version 2024.1.

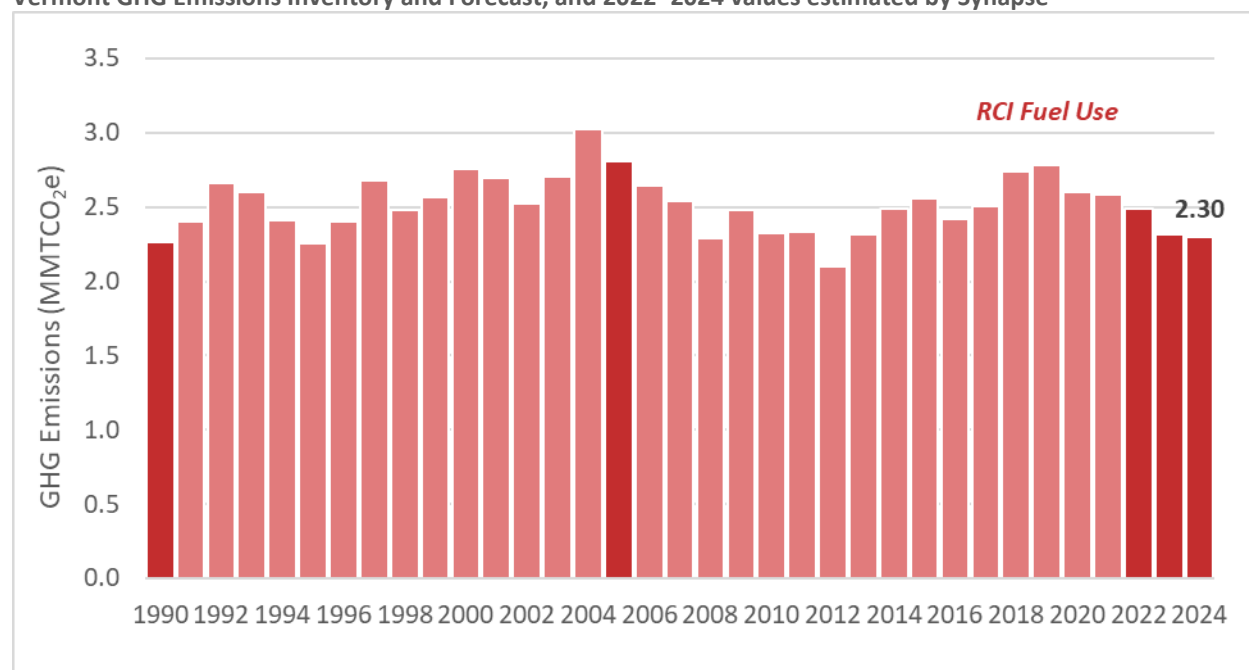
Results

Table 2 presents the resulting estimates of GHG emissions for the RCI fuel use sector in 2022, 2023, and 2024, along select historical years of results from the 2021 Vermont Inventory. We estimate a decline of emissions in this sector of 11 percent from 2021 to 2024, with emissions totaling 2.30 MMTCO₂e in 2024. We estimate this sector to contribute 30 percent of total 2024 statewide emissions. Figure 4 shows the Synapse estimate along with all historical years of the 2021 Vermont Inventory.

Table 2. RCI fuel use sector emissions from select years, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse

RCI Fuel Use Sector	GHG Emissions (MMTCO ₂ e)								
	1990	2005	2010	2019	2020	2021	2022	2023	2024
Oil, Propane & Other Petroleum	1.85	2.28	1.79	1.92	1.78	1.77	1.64	1.52	1.50
Natural Gas	0.32	0.44	0.44	0.75	0.71	0.72	0.75	0.69	0.69
Wood (CH ₄ & N ₂ O)	0.07	0.08	0.09	0.11	0.11	0.10	0.10	0.10	0.10
Coal	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2.26	2.80	2.32	2.79	2.60	2.59	2.49	2.32	2.30

Figure 4. Vermont GHG emissions from the RCI fuel use sector, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse



The 2022 Vermont Inventory’s published GHG emissions value for the RCI fuel use sector is 2.71 MMTCO₂e in 2022, 9.0 percent higher than our 2022 estimate of 2.49 MMTCO₂e. This is the sector with the largest such difference. The 2022 Vermont Inventory also raised higher historical emissions in recent years as compared to the 2021 Vermont Inventory, raising emissions in 2019, 2020, and 2021 each by about 5 percent. This difference is likely driven by updated assumptions in version 2025.1 of the SIT module, used by the 2022 Vermont Inventory.

2.3. Agriculture

Methodology

Synapse estimates GHG emissions from the agricultural sector using the U.S. EPA’s SIT: Carbon Dioxide, Methane, and Nitrous Oxide Emissions from Agriculture module, version 2024.1. Emissions included

from this sector are GHG emissions from enteric fermentation, manure management, agricultural soils, and liming and urea fertilization. Following along the 2021 methodology, we apply year-specific livestock inventory data for Vermont from the U.S. Department of Agriculture’s (USDA) National Agriculture Statistics Service.¹⁸ For animals where 2023- or 2024-specific population data are not yet available, we apply data from 2022. We then apply the most recent estimates of dairy cows paired with anaerobic digesters (data from 2018 and 2019 available) and extrapolate values through 2024 assuming linear growth, as is done by the 2021 Vermont Inventory. We subtract these populations from total dairy cow estimates only for the purposes of calculating CH₄ emissions from manure management. We apply all of the collected population data to the SIT module, and we rely on default assumptions for Vermont from the SIT module for non-animal related emissions. We carry forward the most recently available assumptions through 2024.

Results

Table 3 presents Synapse’s estimates of 2022, 2023, and 2024 GHG emissions from the agriculture sector, alongside select years of historical results from the 2021 Vermont Inventory. We estimate GHG emissions from this sector in 2024 to be 1.17 MMTCO₂e. This comprises 16 percent of total estimated GHG emissions for 2024. Declining emissions from 2022 to 2024 are driven in part by declining livestock populations, as reported by the USDA, as well as the assumed continued growth in anaerobic digesters.

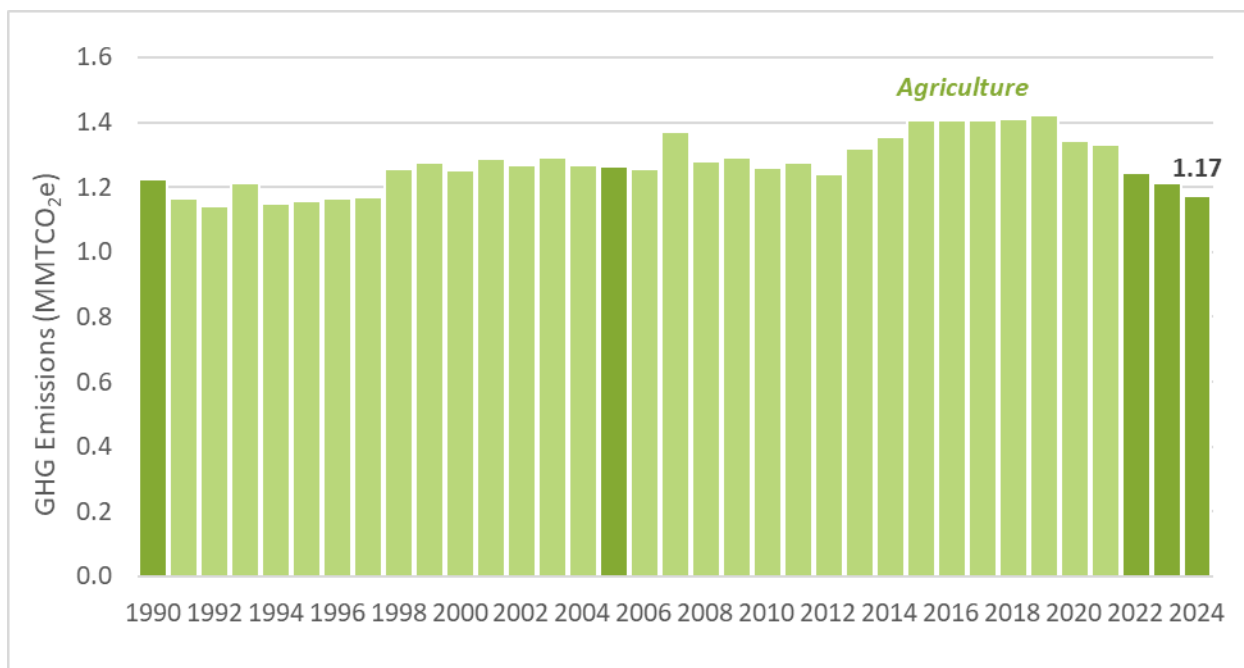
Table 3. Agriculture sector emissions from select years, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse

Agriculture Sector	GHG Emissions (MMTCO ₂ e)								
	1990	2005	2010	2019	2020	2021	2022	2023	2024
Enteric Fermentation	0.76	0.69	0.67	0.70	0.67	0.67	0.67	0.65	0.62
Agricultural Soils	0.29	0.23	0.24	0.29	0.25	0.25	0.25	0.25	0.24
Manure Management	0.18	0.34	0.35	0.39	0.37	0.36	0.23	0.22	0.21
Liming and Urea Fertilization	0.00	0.00	0.01	0.04	0.05	0.06	0.10	0.10	0.10
Total	1.22	1.26	1.26	1.42	1.34	1.33	1.24	1.21	1.17

Figure 5 presents agriculture sector emissions in every year from 1990 to 2021. 1990, 2005, and the Synapse-estimated years (2022–2024) are highlighted. Synapse’s estimates follow an annual trend of steadily declining emissions in each year from 2019 through 2024.

¹⁸ U.S. Department of Agriculture (USDA). National Agriculture Statistics Service. Available at: <https://quickstats.nass.usda.gov>.

Figure 5. Vermont GHG emissions from the agriculture sector, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse



The 2022 Vermont Inventory’s published GHG emissions value for the agriculture sector is 1.26 MMTCO₂e in 2022, about 1.2 percent higher than our 2022 estimate of 1.24 MMTCO₂e. This difference is likely driven by updated assumptions in version 2025.1 of the SIT module, used by the 2022 Vermont Inventory. According to the 2022 Vermont Inventory methodology report, the State also modified default manure management storage values, based on discussions with the Agency of Agriculture Food and Markets (AAFM).¹⁹

2.4. Industrial Processes

Methodology

Emissions from industrial processes include GHG emissions from ozone depleting substances (ODS) substitutes, electric utilities (sulfur hexafluoride, or SF₆, emissions from electric power transmission and distribution systems), semiconductor manufacturing, limestone and dolomite use, soda ash use, and urea consumption. In line with the 2021 Vermont Inventory methodology, for all emissions sources except for semiconductor manufacturing, Synapse relies on the U.S. EPA’s SIT: Industrial Processes module, version 2024.2. For ODS substitution estimates, we apply the 2022 Vermont-specific estimate

¹⁹ Vermont Agency of Natural Resources. 2025. *Vermont Greenhouse Gas Emissions Inventory and Forecast: Methodologies Expanded*. Available at: <https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory>.

from the U.S. EPA's most recent U.S. EPA national GHG inventory.²⁰ Due to a lack of more readily available information, for 2023 and 2024 for this estimate we apply the most recently available five-year average (2018–2022). To estimate emissions from electric utilities, limestone and dolomite use, soda ash use, and urea consumption, we apply 2022 default Vermont consumption values from the latest version of the SIT module (version 2025.1) to the SIT version 2024.2 infrastructure. We otherwise rely on emissions factor defaults and other assumptions from version 2024.2.

To estimate emissions from semiconductor manufacturing, we apply the same methodology and global warming potential (GWP) values as detailed in the 2021 Vermont Inventory, using 2022 and 2023 facility-level data for semiconductor manufacturing facilities reported to U.S. EPA's Greenhouse Gas Reporting Program (GHGRP).²¹ Due to a lack of available 2024-specific information for semiconductor manufacturing at the time of the analysis, we adopt 2023 values for 2024.

Results

Table 4 shows the Synapse estimates of 2022, 2023, and 2024 GHG emissions from the fossil fuel industry, alongside select years of historical results from the 2021 Vermont Inventory. We estimate GHG emissions from this sector in 2024 to be 0.45 MMTCO₂e, making up 6 percent of total estimated GHG emissions for 2024. Declining emissions from this sector between 2022 and 2023 are driven by declining emissions from semiconductor manufacturing, as reported to U.S. EPA GHGRP.

Table 4. Industrial processes sector emissions from select years, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse

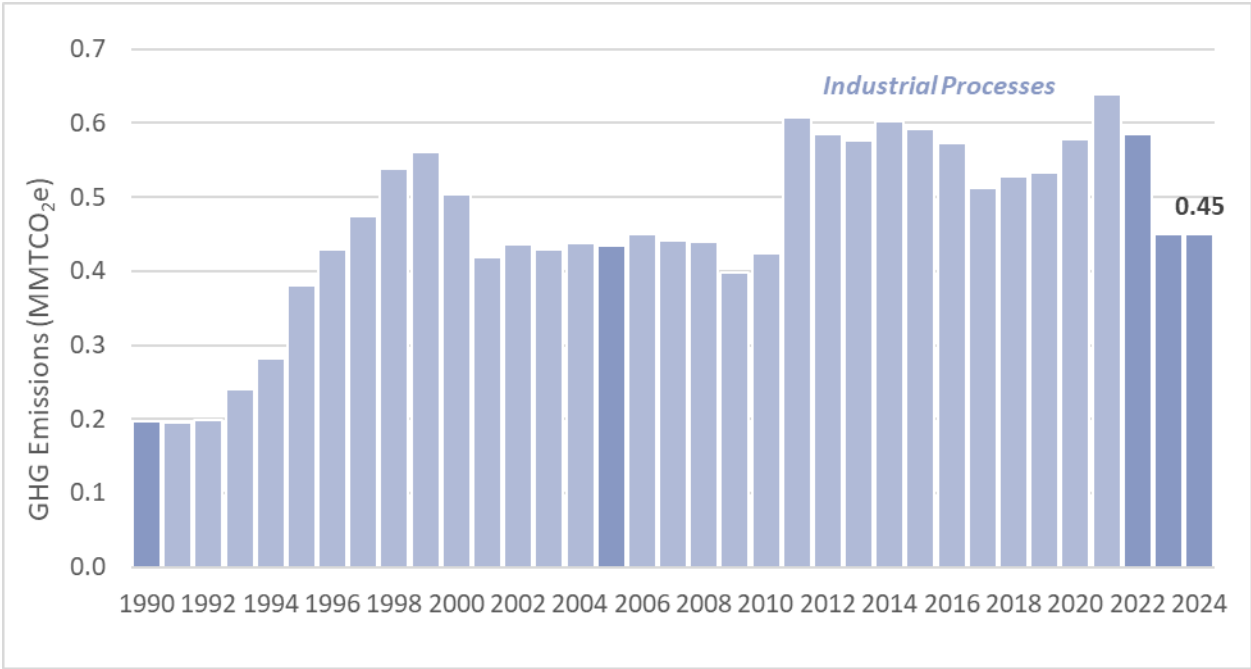
Industrial Processes Sector	GHG Emissions (MMTCO ₂ e)								
	1990	2005	2010	2019	2020	2021	2022	2023	2024
ODS Substitutes	0.00	0.19	0.21	0.29	0.32	0.33	0.35	0.32	0.32
Semiconductor Manufacturing (HFCs, PFCs & SF6)	0.15	0.20	0.17	0.21	0.23	0.24	0.20	0.10	0.10
Limestone & Dolomite Use	0.00	0.03	0.02	0.02	0.02	0.05	0.02	0.02	0.02
Electric Utilities (SF6)	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Soda Ash Use	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Urea Consumption	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.20	0.43	0.42	0.53	0.58	0.64	0.59	0.45	0.45

Figure 6 shows the total annual estimated GHG emissions in each year from 1990 through 2024 for the industrial processes sector. 1990, 2005, and the Synapse-estimated years (2022–2024) are highlighted.

²⁰ U.S. Environmental Protection Agency. 2024. *Inventory of U.S. Greenhouse Gas Emissions and Sinks By State: 1990 – 2022*. Available at: <https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals>.

²¹ U.S. Environmental Protection Agency. "Greenhouse Gas Reporting Program (GHGRP): Data Sets". See "i_freq_request_data.xlsx". Available at: <https://www.epa.gov/ghgreporting/data-sets>.

Figure 6. Vermont GHG emissions from the industrial processes sector, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse



The 2022 Vermont Inventory’s published GHG emissions value for the industrial processes sector is 0.57 MMTCO₂e in 2022, 2.7 percent less than our 2022 estimate of 0.59 MMTCO₂e. This difference is likely driven by updated assumptions in version 2025.1 of the SIT module, used by the 2022 Vermont Inventory.

2.5. Waste Management

Methodology

The GHG emissions estimates from the waste management sector are steady over the five most recent years included in the 2021 Vermont Inventory (2017 to 2021), experiencing minor changes year-over-year ranging -3 to +3 percent. Additionally, this sector has historically contributed a small amount to the total Vermont GHG emissions estimate (less than 3 percent in 2021). For these reasons, for this sector we take a simplified approach: we calculate the average annual emissions estimates from this five-year period and apply this average to the years 2022, 2023, and 2024.

Results

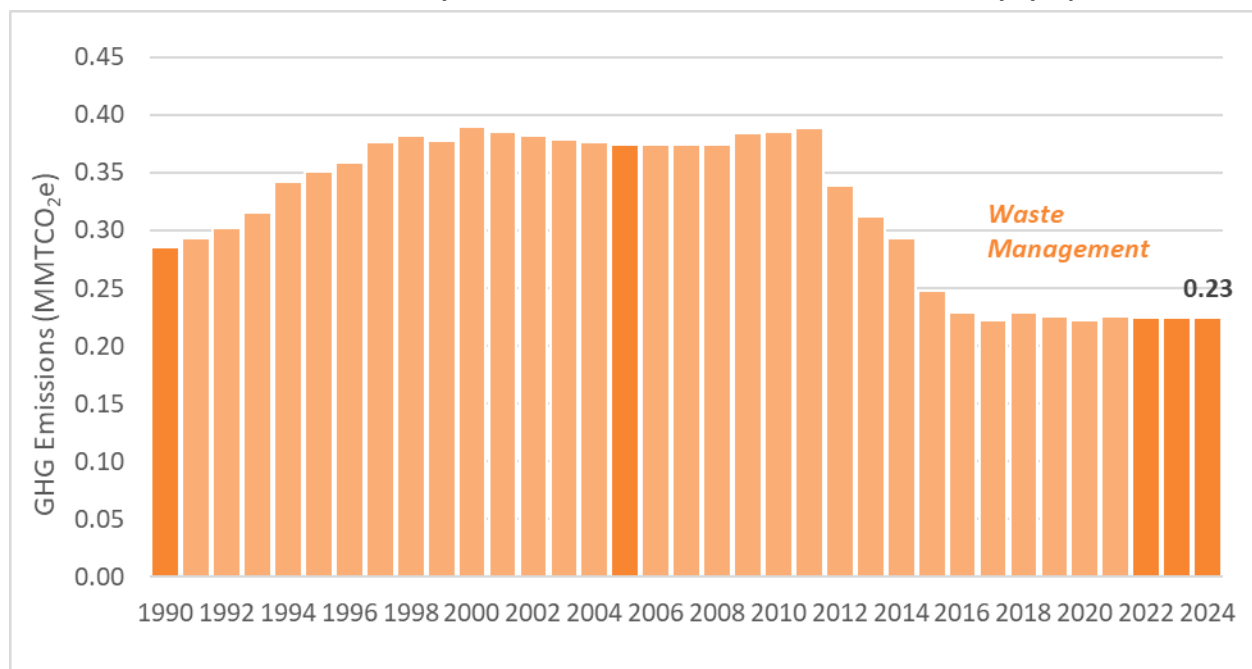
Table 5 presents our estimates of 2022, 2023, and 2024 GHG emissions from the waste management sector, alongside select years of historical results from the 2021 Vermont Inventory. We estimate GHG emissions from this sector in 2024 to be 0.23 MMTCO₂e. This comprises 3 percent of total estimated GHG emissions for 2024.

Table 5. Waste management sector emissions from select years, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse

Waste Management Sector	GHG Emissions (MMTCO ₂ e)								
	1990	2005	2010	2019	2020	2021	2022	2023	2024
Solid Waste	0.24	0.31	0.32	0.16	0.15	0.15	0.15	0.15	0.15
Wastewater	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Composting	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total	0.29	0.37	0.39	0.23	0.22	0.23	0.23	0.23	0.23

Figure 7 shows the total annual estimated GHG emissions in each year from 1990 through 2024 for the waste management sector. The highlighted bars are 1990, 2005, and the Synapse-estimated years (2022–2024).

Figure 7. Vermont GHG emissions from the waste management sector, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse



The 2022 Vermont Inventory’s published GHG emissions value for the industrial processes sector is 0.22 MMTCO₂e in 2022, 2.2 percent or 0.01 MMTCO₂e less than our 2022 estimate of 0.23 MMTCO₂e. This difference is driven by differences in methodology; while Synapse applied a simplified approach to estimating emissions for this sector, both estimates show that emissions are stable over time in recent years.

2.6. Electricity Consumption

Methodology

The electricity consumption sector includes emissions from electricity used in Vermont. This includes both emissions from electricity generated in the state of Vermont, and point-of-generation emissions from electricity generated outside of Vermont's boundaries but consumed in the state. Potential fuel sources of emissions from this sector include coal, natural gas, oil, wood, and emissions associated with the residual system mix. According to the 2021 Vermont Inventory, there has been no electricity consumption from electricity generated specifically from coal, natural gas, or oil since 2017 in the state. Synapse therefore assumes emissions from these fuels are zero through 2024. Emissions of CH₄ and N₂O from wood are unchanged from 2019 through 2021; they make up 0.1 percent of total statewide emissions in 2021. We therefore assume wood emissions remain unchanged through 2024.

The remaining source of emissions for this sector is emissions associated with the residual system mix, which reflects regional generation and includes oil, natural gas, and coal generation. Due to differences in available data used in the 2021 Vermont Inventory and data available to Synapse, our methodology for estimating these emissions differs where necessary. We start by obtaining total electricity sales and load, in megawatt hours (MWh), for each utility in the state, from annual legislative reports.²² This data is available for 2022 and 2023. We also obtain 2024-specific sales for Green Mountain Power (GMP) from its filing of FERC Form 1, and we assume the same percent growth in sales from 2023 to 2024 for all other utilities that GMP experiences. From the same legislative reports, we also obtain each utility's annual renewable energy credit (REC) retirements and savings claims as a percent of sales. We make refinements to these assumptions based on 2020 Ownload Summary data provided by the State and energy mix data found on utility websites (including archived versions from the WayBack Machine²³). We subtract these adjustments from total annual sales to determine the residual system mix for each utility.

Finally, we apply annual residual mix CO₂ emission rates from the New England Power Pool Generation Information System (NEPOOL GIS).²⁴ In line with the 2021 Vermont Inventory, we exclude from the NEPOOL emission rates the emissions associated with biogenic fuel sources. Therefore, we only include emissions from the following fuel sources in the residual mix: coal, diesel, import system mix, jet, municipal solid waste, natural gas, and oil.

²² State of Vermont Department of Public Service. "Legislative Reports: 2025 Annual Energy Report." See slide 35, available at: [https://publicservice.vermont.gov/sites/dps/files/documents/2025 Annual Energy Report 1-15-2025.pdf](https://publicservice.vermont.gov/sites/dps/files/documents/2025%20Annual%20Energy%20Report%201-15-2025.pdf).

²³ Internet Archive. "WayBack Machine". Available at: <https://web.archive.org/>.

²⁴ New England Power Pool Generation Information System (NEPOOL GIS). "NEPOOL Generation Information System: NEPOOL Residual Mix Public Report." Available at: <https://nepoolgis.com/public-reports/>.

Results

Table 6 shows Synapse’s estimates of 2022, 2023, and 2024 GHG emissions from the electricity consumption sector, alongside select years of historical results from the 2021 Vermont Inventory. We estimate GHG emissions from this sector in 2024 to be 0.22 MMTCO₂e, or 3 percent of total estimated emissions in 2024. Because data limitations required us to follow an adjusted methodology for this sector, in creating our estimates we also developed emissions estimates for 2019, 2020, and 2021 as well. This allowed us to compare results to those in the 2021 Vermont Inventory. In these three years, we find that our estimates range 1 to 22 percent higher than the reported values in the 2021 Vermont Inventory. This discrepancy may be driven by utilities over-complying beyond minimum REC requirements; our analysis relies on default REC requirement assumptions where more accurate data is not available. Our estimate is therefore likely overstated. A more likely estimate of total emissions in 2024 for this sector may be between 0.18 and 0.20 MMTCO₂e, but we present our results as-is, without the availability of actual data. Given that the electricity consumption sector makes up only 3 percent of total state emissions, a reduction in 2024 electric portfolio emissions by 20 percent would reduce total statewide emissions by less than 0.6 percent.

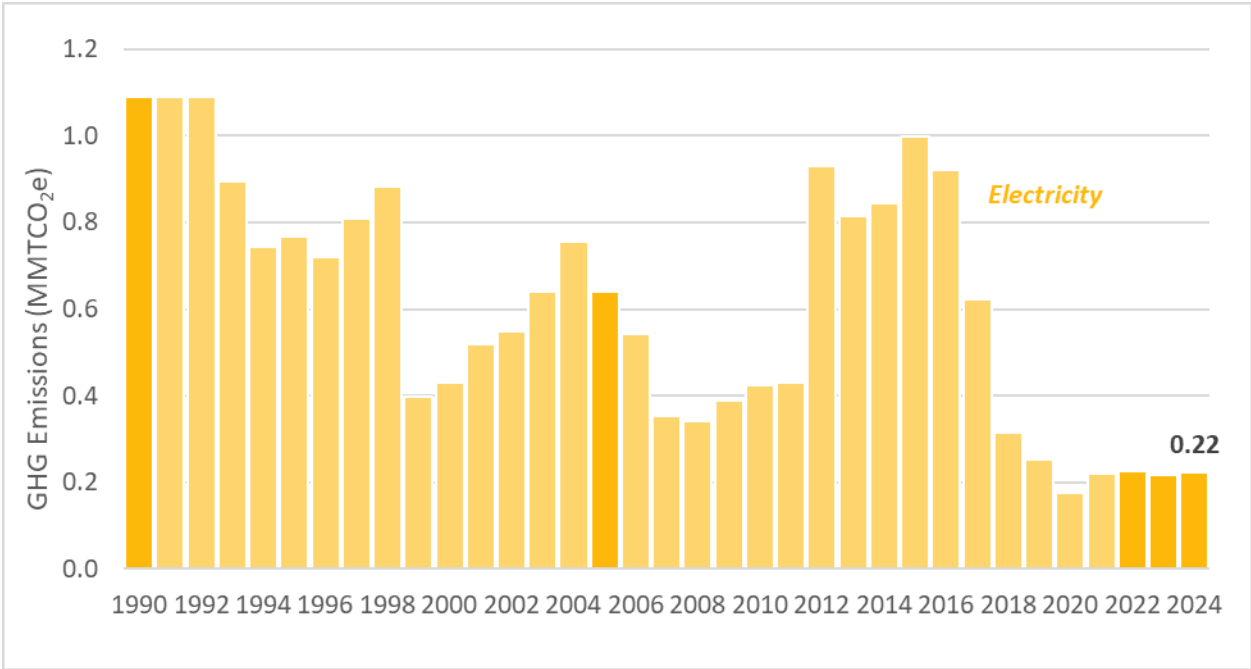
Table 6. Electricity consumption sector emissions from select years, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse

Electricity Consumption Sector	GHG Emissions (MMTCO ₂ e)								
	1990	2005	2010	2019	2020	2021	2022	2023	2024 ^A
Residual System Mix	1.03	0.62	0.36	0.24	0.16	0.21	0.21	0.20	0.21
Wood (CH ₄ & N ₂ O)	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Natural Gas	0.05	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Oil	0.01	0.01	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Coal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.09	0.64	0.43	0.25	0.18	0.22	0.23	0.22	0.22

^A Estimates in 2022, 2023, and 2024 are likely overstated by 10 to 20 percent. However, without the availability of actual data on the residual system mix claimed in these years, we present our estimates as-is.

Figure 8 shows the total annual estimated GHG emissions in each year from 1990 through 2024 for the electricity consumption sector. The highlighted bars are 1990, 2005, and the Synapse-estimated years (2022-2024).

Figure 8. Vermont GHG emissions from the electricity consumption sector, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse



The 2022 Vermont Inventory’s published GHG emissions value for the electricity sector is 0.24 MMTCO₂e in 2022, slightly higher (0.01 MMTCO₂e) than the 2022 Synapse estimate of 0.23 MMTCO₂e. This difference is likely driven by the differences in methodology used by Synapse and the official inventory. Synapse does not have access to 2022 Ownload data used by the official state inventories, which provides actual annual residual electric load after REC retirements. Synapse instead relied on legislative reports and other publicly available information to estimate the residual system mix, by utility, which may result in discrepancies in the residual system mix used in the two analyses.

2.7. Fossil Fuel Industry

Methodology

The GHG emissions estimates from the fossil fuel industry in all historical years make up the smallest share of statewide GHG emissions in Vermont (0.4 percent in 2021). Much like the waste management sector, the fossil fuel industry annual GHG emissions estimates have remained steady in recent years, with an approximately zero percent annual change each year from 2017 to 2021. For these reasons, for this sector we take a simplified approach, setting GHG emissions results for the years 2022, 2023, and 2024 to equal the average results for the sector from 2017 to 2021.

Results

Table 7 presents our estimates of 2022, 2023, and 2024 GHG emissions from the fossil fuel industry, alongside select years of historical results from the 2021 Vermont Inventory. We estimate GHG

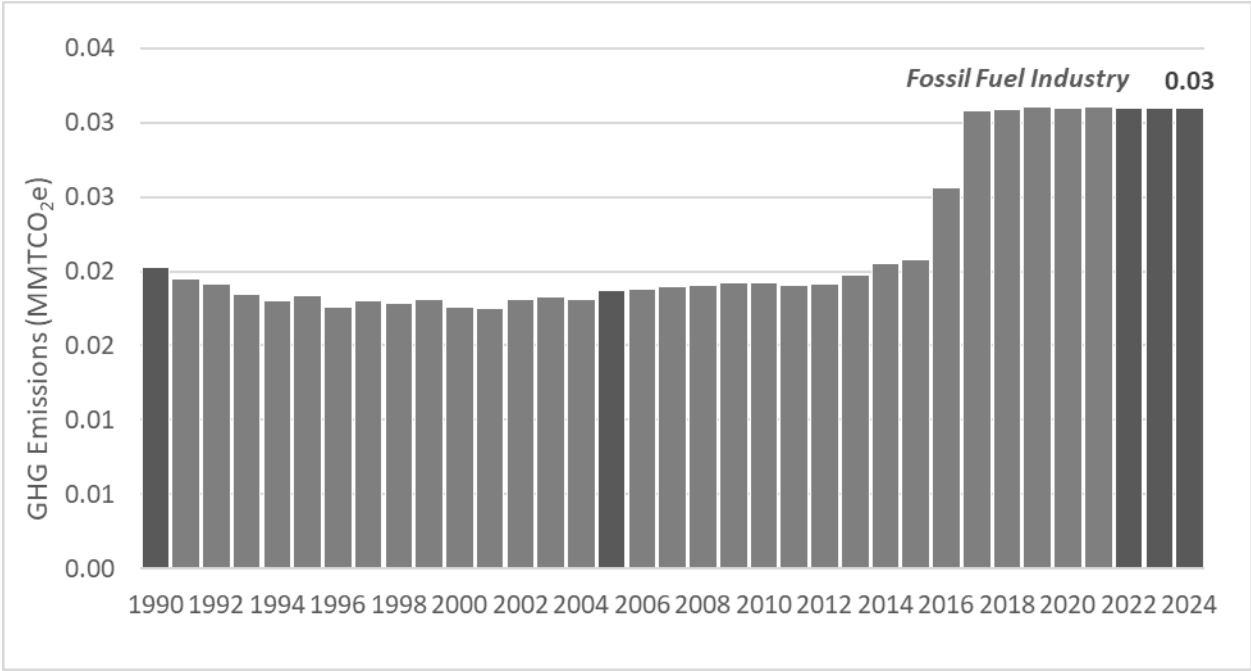
emissions from this sector in 2024 to be 0.03 MMTCO₂e. This comprises 0.4 percent of total estimated GHG emissions for 2024.

Table 7. Fossil fuel industry sector emissions from select years, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse

Fossil Fuel Industry Sector	GHG Emissions (MMTCO ₂ e)								
	1990	2005	2010	2019	2020	2021	2022	2023	2024
Natural Gas Transmission	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03
Natural Gas Distribution	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03

Figure 9 shows the total annual estimated GHG emissions in each year from 1990 through 2024 for the fossil fuel industry sector. The highlighted bars are 1990, 2005, and the Synapse-estimated years (2022–2024).

Figure 9. Vermont GHG emissions from the fossil fuel industry sector, including 1990–2021 values from the 2021 Vermont GHG Emissions Inventory and Forecast, and 2022–2024 values estimated by Synapse



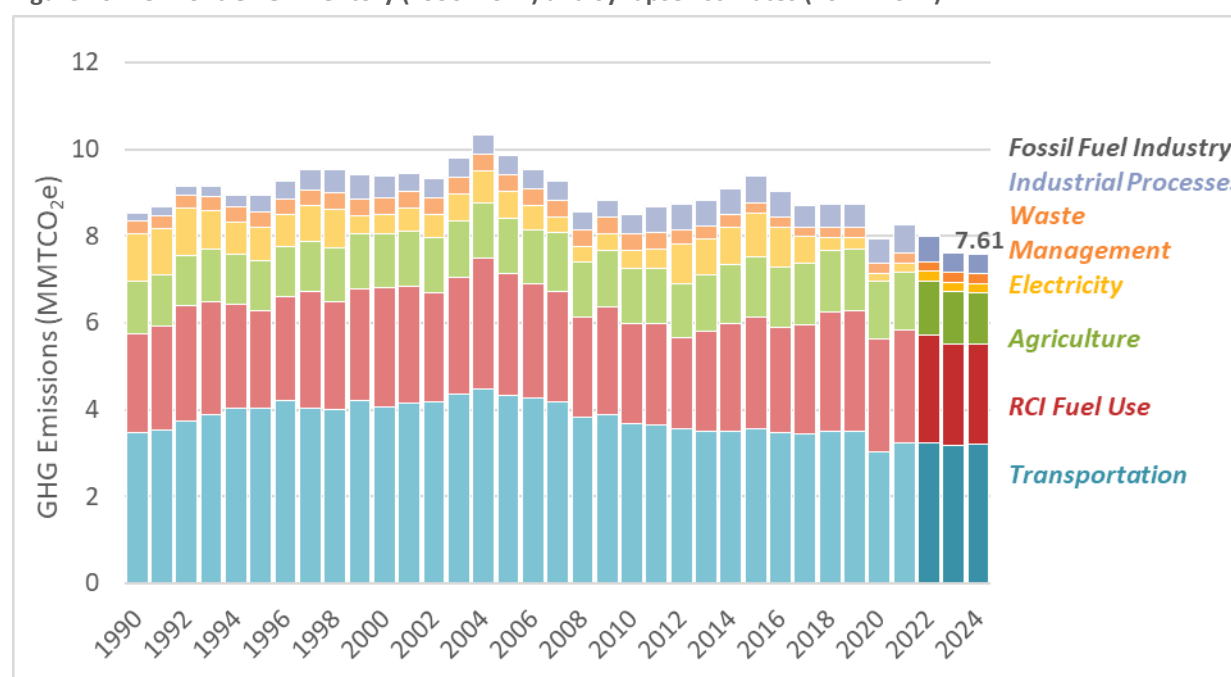
The 2022 Vermont Inventory and Synapse both estimate GHG emissions for the fossil fuel industry to be 0.03 MMTCO₂e in 2022, consistent with estimates in recent years.



3. CONCLUSIONS

Figure 10 shows the results of Synapse’s estimate of GHG emissions in Vermont in 2022, 2023, and 2024, using the most up-to-date data available to us. We present results alongside historical annual emissions from the 2021 Vermont Inventory.²⁵ We estimate total GHG emissions in 2024 in Vermont to be 7.61 MMTCO₂e. This is about 0.31 MMTCO₂e above the state’s January 1, 2025, requirement of 7.30 MMTCO₂e. This estimate suggests that Vermont has not succeeded in meeting the required January 1, 2025, level; emissions are about 4.3 percent higher than the established requirement as defined by the 2021 Vermont Inventory.

Figure 10. Vermont GHG Inventory (1990–2021) and Synapse Estimates (2022–2024)



Overall, we expect that our 2024 estimates would not change significantly under the 2022 Inventory’s methods. The 2022 Vermont Inventory estimated total statewide emissions to be 8.25 MMTCO₂e in 2022. This is 2.7 percent higher than Synapse’s total 2022 estimate of 8.03 MMTCO₂e. The 2022 Vermont Inventory also retroactively updated historical emissions, resulting in an updated January 1, 2025, goal of 7.28 MMTCO₂e, slightly lower than the 2021 estimated goal of 7.30 MMTCO₂e. These two things suggest that both Synapse’s 2024 total emissions estimate, and the target which it is evaluated against, may be conservative, and that performing this analysis against the 2022 Vermont Inventory

²⁵ Vermont Agency of Natural Resources. 2024. *Vermont Greenhouse Gas Emissions Inventory and Forecast: 1990-2021*. Available at: <https://climatechange.vermont.gov/climateactionoffice/greenhouse-gas-inventory>.

results and methodologies would not change our overall finding that Vermont is very unlikely to have met its January 1, 2025, target.

