Delaware's Greenhouse Gas Inventory 2022

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and Environmental Control
Air Quality

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Executive Summary

Economic Sector	2022 GHG Emissions	Projection to 2030 (future)[d]	Projection to 2050 (future)[d]
Overall GHG Emissions[a]	**• Decrease by 0.4 $MMTCO_2e$ (2.1%) from 2021 GHG emissions**	**• Increase of 3.1 $MMTCO_2e$ (17.7%) from 2022 GHG emissions**	**• Increase of 4.9 $MMTCO_2e$ (28.2%) from 2022 GHG emissions**
Transportation[b]	• Decrease by 0.2 $MMTCO_2e$ (3.1%) from 2021 GHG emissions • Largest sector of GHG emissions	• Increase of 0.6 $MMTCO_2e$ (12.6%) from 2022 GHG emissions • Second largest sector of GHG emissions	• Increase of 0.6 $MMTCO_2e$ (11.7%) from 2022 GHG emissions • Largest sector of GHG emissions
Electric Power[c]	• Decrease by 0.1 $MMTCO_2e$ (1.1%) from 2021 GHG emissions • Second largest sector of GHG emissions	• Increase of 1.33 $MMTCO_2e$ (28.2%) from 2022 GHG emissions • Largest sector of GHG emissions	• Increase of 2.3 $MMTCO_2e$ (48.0%) from 2022 GHG emissions • Second largest sector of GHG emissions
Industrial	• Decrease by 0.13 $MMTCO_2e$ (3.3%) from 2021 GHG emissions • Third largest sector of GHG emissions	• Increase of 0.6 $MMTCO_2e$ (15.6%) from 2022 GHG emissions • Third largest sector of GHG emissions	• Increase of 1.2 $MMTCO_2e$ (30.1%) from 2022 GHG emissions • Third largest sector of GHG emissions
Commercial Buildings	• Decrease by 0.2 $MMTCO_2e$ (16.8%) from 2021 GHG emissions	• Increase of 0.3 $MMTCO_2e$ (31.7%) from 2022 GHG emissions	• Increase of 0.6 $MMTCO_2e$ (53.7%) from 2022 GHG emissions

Economic Sector	2022 GHG Emissions	Projection to 2030 (future)[d]	Projection to 2050 (future)[d]
Residential Buildings	↑ • Increase of 0.1 $MMTCO_2e$ (5.8%) from 2021 GHG emissions	↓ • Decrease by <0.1 $MMTCO_2e$ (0.1%) from 2022 GHG emissions	↓ • Decrease by <0.1 $MMTCO_2e$ (2.1%) from 2022 GHG emissions
Agricultural	↑ • Increase of 0.08 $MMTCO_2e$ (13.0%) from 2021 GHG emissions	↓ • Decrease by <0.1 $MMTCO_2e$ (3.1%) from 2022 GHG emissions	↓ • Decrease by <0.1 $MMTCO_2e$ (12.8%) from 2022 GHG emissions
Waste Management	↑ • Increase of 0.06 $MMTCO_2e$ (11.3%) from 2021 GHG emissions	↑ • Increase of 0.2 $MMTCO_2e$ (26.0%) from 2022 GHG emissions	↑ • Increase of 0.4 $MMTCO_2e$ (59.4%) from 2022 GHG emissions

Note: $MMTCO_2e$ stands for million metric tons of carbon dioxide equivalents.

[a] Gross GHG emissions; land-use, land-use change, forestry not included.

[b] Change in jet-fuel consumption estimation methodology contributed to the increase.

[c] Emissions associated with combined in-state electricity generation and electricity consumption (imported electricity).

[d] Projections do not include programs and policy interventions recommended in Delaware's Climate Action plan or federal policy interventions. Available online at: https://dnrec.delaware.gov/climate-plan/.

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List of Acronyms

AQ	Division of Air Quality
AR4	Fourth Assessment Report
AR5	Fifth Assessment Report
BAU	Business as usual
CARB	California Air Resources Board
CBECS	EIA Commercial Buildings Energy Consumption Survey
CH_4	Methane
CO_2	Carbon dioxide
CO_2FFC	Carbon dioxide from fossil fuel combustion
COVID-19	Coronavirus
DNREC	Delaware Department of Natural Resources and Environmental Control
eGRID	Emissions and Generation Resource Integrated Database
EIA	United States Energy Information Agency
EPA	United States Environmental Protection Agency
FFC	Fossil fuel combustion
GHG	Greenhouse gas
GHGRP	EPA's GHG Reporting Program
GWP	Global warming potential
HFC's	Global warming potential
IP	Industrial processes
IPCC	Intergovernmental Panel on Climate Change
kWH	Kilowatt-hour
LULUCF	Land use, land-use change, and forestry
$MMTCO_2e$	Million metric tons of carbon dioxide equivalents
MSW	Municipal Solid Waste
$MTCO_2e$	Metric tons of carbon dioxide equivalents
N_2O	Nitrous oxide
NF_3	Nitrogen trifluoride
PFC_S	Perfluorocarbons
PT	Projection Tool
RECS	EIA Residential Energy Consumption Survey
RPS	Renewable Portfolio Standards
SEDS	EIA State Energy Data Source
SF_6	Sulfur hexafluoride
SH	Space-heating
SIT	State Inventory Tool
T&D	Transmission and distribution
USCA	United States Climate Alliance
VMT	Vehicle miles traveled
WH	Water-heating
WWT	Wastewater treatment
ZEV	Zero Emission Vehicle

1.0 2022 Greenhouse Gas Inventory

1.1 Introduction and Background

This inventory is prepared by Delaware's Division of Air Quality (AQ) to provide data on greenhouse gas (GHG) emissions in the state from 1990 through 2022. This inventory is the primary tool from which state policy makers can track progress of emissions over time and determine whether Delaware is meeting long-term emission reduction goals. The Delaware Climate Change Solutions Act of 2023[1] sets ambitious but attainable GHG emission reduction targets of 50.0% by 2030 and net-zero by 2050 from a 2005 baseline. The statute stipulates that Delaware Department of Natural Resources and Environmental Control (DNREC) update its inventory on an annual basis to track progress towards these targets.

This inventory report estimates GHG emissions from various sources across economic sectors in Delaware. The data provided in this report were estimated using the United States Environmental Protection Agency (EPA) State Inventory Tool (SIT) and Projection Tool (PT).[2]

The emissions estimates in this inventory are represented in million metric tons of carbon dioxide equivalents (MMTCO_2e). In comparison to Delaware's 2005 baseline year emissions levels (23.1 MMTCO_2e), Delaware's gross total GHG emissions in 2022 were estimated at 17.3 MMTCO_2e, which represents a 25.4% decrease in emissions from the

IPCC's Fifth Assessment Report Update[a]

Delaware's previous inventories used global warming potential (GWP)[b] values from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4).[c] For the 2020 inventory, Delaware updated its inventory using GWP values from the Fifth Assessment Report (AR5) to provide the most updated science and ensure that Delaware's inventory is comparable to the nationwide U.S. Greenhouse Gas Inventory. Updating GWP values result in slight differences in emissions values. This is why total gross emissions in 2005, the baseline year from which Delaware's GHG reduction goals are set, has changed from 23.3 MMTCO_2e under the previous methodology to 23.1 MMTCO_2e in the current inventory. This update reflects Delaware's effort to use the most scientifically accurate data when evaluating emissions in Delaware sectors.

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[1] Legislature, D. (n.d.). *Delaware Code Online*. https://delcode.delaware.gov/title7/c100/index.html
[2] Environmental Protection Agency. (n.d.). EPA. https://www.epa.gov/statelocalenergy/state-inventory-and-projection-tool
[a] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. AR5 Synthesis Report - Climate Change 2014
[b] Environmental Protection Agency. (n.d.-a). EPA. https://www.epa.gov/ghgemissions/understanding-global-warming-potentials
[c] IPCC, 2007: *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp. ar4_syr_full_report.pdf

baseline year. This indicates that Delaware is making steady progress towards its emission goals.

This inventory report also includes a "business-as-usual" (BAU) scenario with projections to 2050. This scenario is generated using the EPA PT and is intended to represent a future in which the state takes no further actions on climate change, current energy consumption trends continue, and Delaware's population and economy continue to grow. Under the BAU scenario, in the absence of state policy and program interventions called for in Delaware's Climate Action Plan, total gross emissions are projected to increase to 20.3 $MMTCO_2e$ in 2030 and 22.1 $MMTCO_2e$ in 2050. This BAU scenario provides a useful baseline for comparison when assessing estimated emissions reductions for various energy policies and programs but should not be considered the "expected" future outcome for Delaware.

In 2022, emissions in many sectors decreased compared to 2005 levels, except for the commercial buildings, agriculture, and waste management sectors. Overall, the emissions decreased slightly in 2022 compared to 2021 as the effects of the coronavirus (COVID-19) pandemic diminished. The 2023 inventory is anticipated to offer a more precise assessment of Delaware's GHG emission reductions post-pandemic, enabling a clearer evaluation of progress towards emission reduction targets outlined in the Delaware Climate Solutions Act of 2023.

DNREC conducted a comprehensive analysis of emission reduction pathways as part of the 2025 update to Delaware's Climate Action Plan. This analysis integrated the latest state, local, and federal policies to model the impact of proposed policies and programs on GHG emissions. The study focused on achieving emission reduction targets by addressing Delaware's highest-emitting sectors and enhancing carbon storage and sequestration within the state's natural and working lands.

Key Findings

- In 2022, gross GHG emissions in Delaware were **17.3 $MMTCO_2e$,** a **25.4% decrease** from Delaware's 2005 baseline year.
- The emissions decreased slightly in 2022 compared to 2021 as **the effects of the coronavirus (COVID-19) pandemic diminished**.
- The sectors with the largest contribution to Delaware's GHG emissions remain the **transportation, electric power, and industrial sectors** accounting for almost 79.6% of all gross GHG emissions in 2022.

Baseline Year: 2005	Last Inventory: 2021	Current Inventory: 2022
23.1 $MMTCO_2e$	17.6 $MMTCO_2e$ 23.8% reduction from 2005 levels	17.3 $MMTCO_2e$ 25.4% reduction from 2005 levels

1.2 Sources of Greenhouse Gas Emissions and Trends

The 2022 GHG inventory estimates GHG emissions from various sources across economic sectors in Delaware. The economic sectors that were assessed are transportation, electric power,[3] industrial, residential, and commercial buildings, agriculture, waste management, and land-use, land-use change, and forestry (LULUCF). Sector specific methodologies and activity data, such as fossil fuel combustion, were used to estimate GHG emissions from each of the sectors.

Figure 1 shows the breakdown of Delaware's GHG emissions (in $MMTCO_2e$) in 2022 by economic sector and end-use (where available) to provide a high-level overview of sources of GHG emissions. Methodologies and data sources for each end-use estimate displayed in Figure 1. are provided in the relevant sector section. Key takeaways from this figure include:

- The largest source of GHG emissions in Delaware was the transportation sector, which represented 29.6% of the gross GHG emissions in 2022.
- When including electricity consumption-based (imported electricity) emissions, the electric power sector was the second largest contributor of GHG emissions, accounting for 27.2% of gross emissions. More than half of emissions from the electric sector were from imported electricity (15.5% of total emissions), with the rest generated in-state (11.7% of total emissions).
- The industrial sector was the third largest contributor of GHG emissions, accounting for 22.8% of gross emissions.
- The buildings sector accounted for a total of 13.0% of statewide GHG emissions, with 6.7% and 7.2% of total emissions from the residential and commercial sectors, respectively.
- Finally, in 2022 the agriculture sector contributed 3.8% and the waste sector 3.6% of gross GHG emissions.

[3] Including electricity consumption-based GHG emissions.

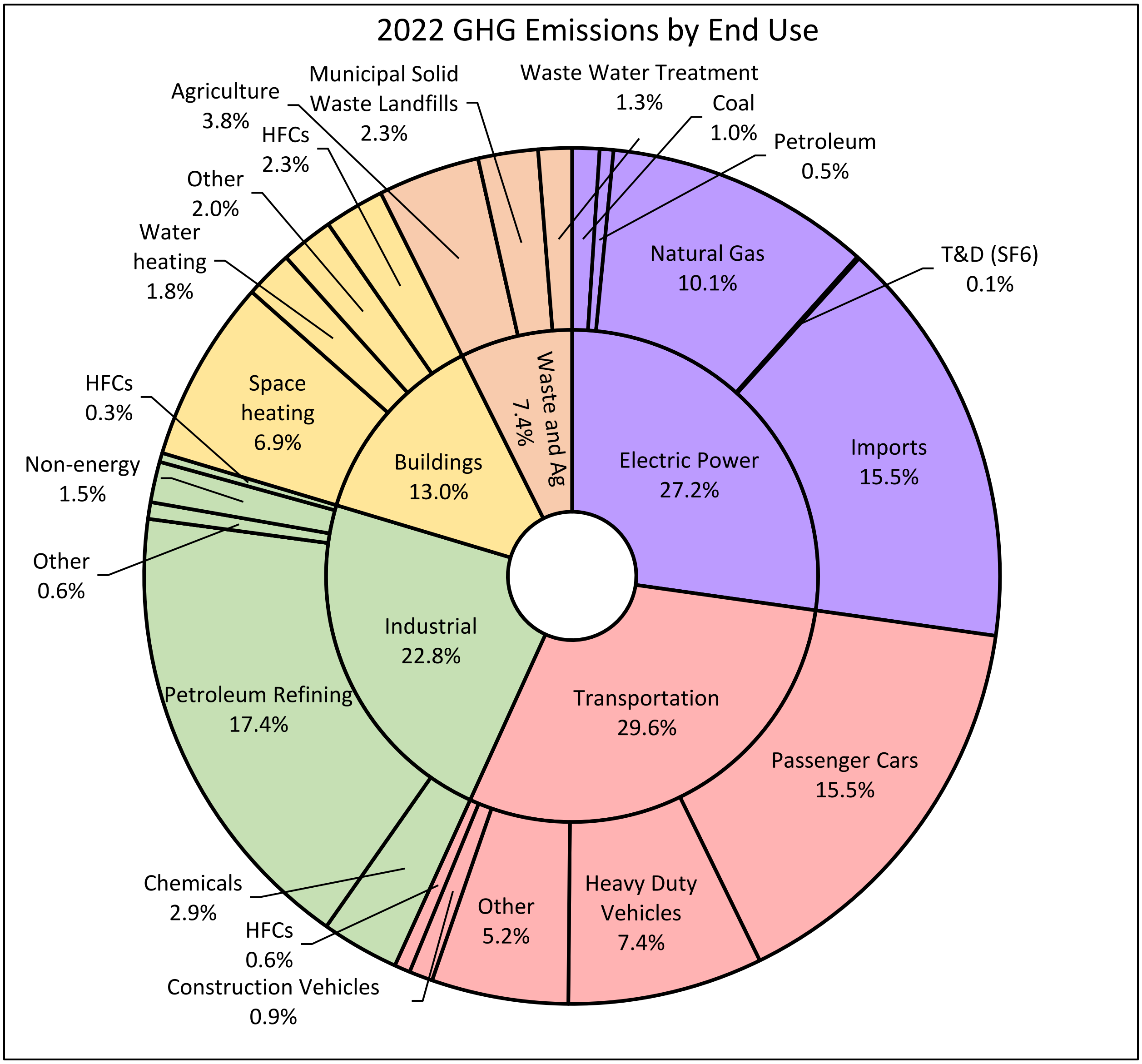

Figure 1: Gross GHG emissions in 2022 broken out by sector and end-use (% of MMTCO₂e)

In 2022, Delaware's gross total GHG emissions were estimated at 17.3 $MMTCO_2e$, accounting for approximately 0.3% of national gross GHG emissions. For comparison, the United States's total gross emissions was 6,343.2 $MMTCO_2e$ in 2022.[4] In the previous year, 2021, Delaware's gross emissions were slightly higher at 17.6 $MMTCO_2e$. Figure 2 shows the historical gross GHG emissions in Delaware from 1990 to 2022.

[4] EPA: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022; available: [Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022 – Executive Summary]

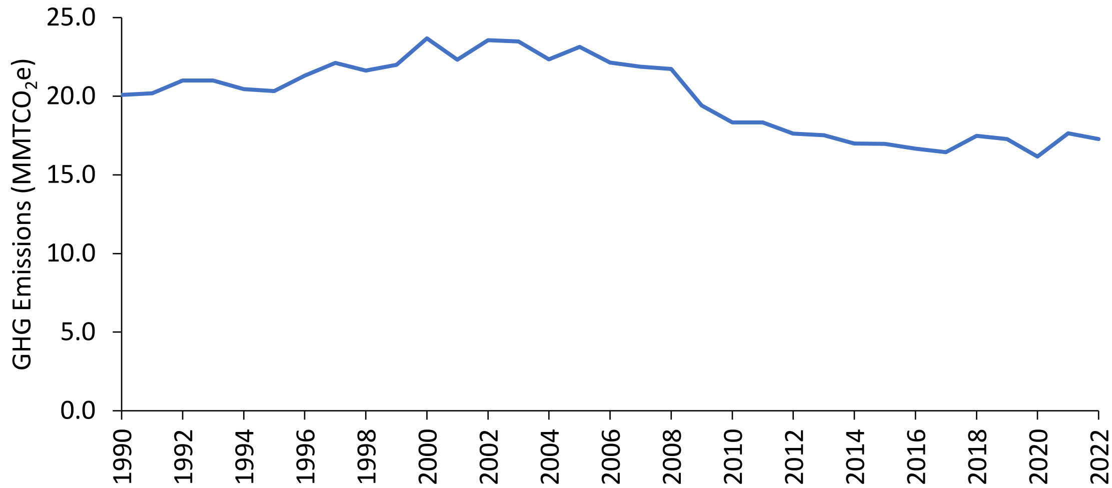

Figure 2: Gross GHG emissions from 1990 to 2022

Sector specific trends in GHG emissions are shown in Figure 3. This figure reports emissions from in-state electricity generation and electricity consumption (imported electricity) separately. Emissions from both sources of electricity combined decreased between 2005 and 2022 by 54.2%, influenced by factors such as decreased demand for electricity from the industrial sector since 2003, shifting fuel from coal to natural gas for power generation, and emission reductions associated with Delaware's renewable portfolio standards (RPS).[5] The RPS mandates that Delaware's utilities derive 40 percent of their energy from renewable sources such as wind and solar by 2035.

Transportation sector GHG emissions decreased by 7.3% between 2005 and 2018, followed by a peak in 2019 due to a change in jet fuel consumption estimates (discussed in more detail in "1.3.1 Updates from the 2018 Delaware GHG Inventory"). There was a sharp decline in GHG emissions from the transportation sector between 2019 and 2020, due to reduced travel during the COVID-19 pandemic. The emissions in the transportation sector increased in 2021 as travel activities rebounded following the COVID-19 pandemic. In 2022, emissions decreased as the lingering effects of the pandemic subsided and travel patterns began to stabilize.

The industrial sector emissions dropped significantly in 2009, caused by the economic recession and the Delaware City refinery shutting down operations. Emissions from the industrial sector returned to their pre-2009 levels shortly after refinery operations resumed in 2011. The agriculture sector emissions increased by 33.6% from 2005 to 2022. This increase is attributed to a combination of factors, including higher demand for agricultural products, the impacts of climate change, changes in soil and manure management practices, and various economic drivers.

[5] Delaware Legislature. (2018). Delaware Code Online. Delaware.gov. https://delcode.delaware.gov/title26/c001/sc03a/index.html

Emissions from the waste management sector increased by 13.1% from 2005 to 2022. This increase is largely explained by population growth during that period. The use of hydrofluorocarbons (HFCs) increased significantly between 2005 and 2022 in the residential and commercial sectors, a total change in the combined building sector of 0.3 $MMTCO_2e$.

The driving force for GHG emissions across all economic sectors was energy consumption. Energy-related activities – specifically, fossil fuel combustion – were the largest source of GHG emissions in 2022.

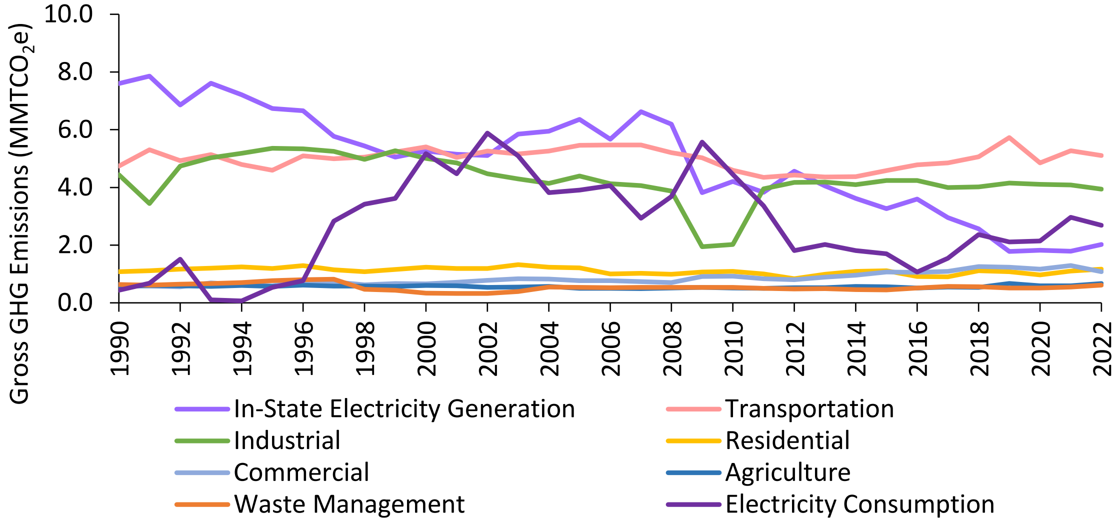

Figure 3: Gross GHG emission trends by economic sector from 1990 to 2022

Net GHG emissions are calculated by including the LULUCF sector in total. The LULUCF sector can act as a sink for carbon dioxide (CO_2) emissions (i.e., remove CO_2 emissions from the atmosphere through capture by the land sector). In this analysis, the LULUCF sector was a source of emissions between 1990 and 1998 (excluding 1997), as shown in Figure 4. In 2022, the total net GHG emissions were 16.4 $MMTCO_2e$, with a reduction in emissions by the LULUCF sector of 0.9 $MMTCO_2e$, or 5.2% of the total gross GHG emissions. Further discussion of the LULUCF sector is provided in the sector specific section of this inventory.

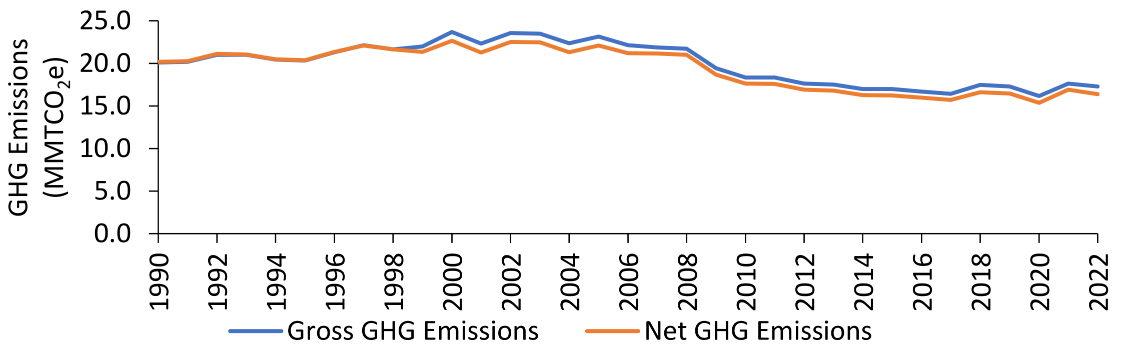

Figure 4: Comparison of gross and net GHG emissions from 1990 to 2022

1.2.1 Greenhouse Gas Emission Trends by Economic Sectors

The 2022 GHG emissions inventory reports Delaware GHG emissions across eight economic sectors. A summary table of the GHG emission inventory estimates and BAU projections is provided in Table 1. Sector specific findings are summarized in the following sections. FFC stands for "fossil fuel combustion" and T&D stands for "transmission and distribution".

Table 1: Summary table of Delaware GHG emissions estimates and BAU projections ($MMTCO_2e$)

	1990	2005	2020	2021	2022	2030	2050
In-State Electricity Generation	**7.60**	**6.35**	**1.82**	**1.79**	**2.02**	**1.20**	**1.33**
CO_2^+ from FFC	7.49	6.29	1.80	1.77	2.00	1.19	1.32
N_2O^+ from FFC	0.03	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
CH_4^+ from FFC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SF_6^+ from T&D	0.08	0.04	0.01	0.02	0.01	<0.01	<0.01
Electricity Consumption	**0.43**	**3.91**	**2.14**	**2.97**	**2.68**	**4.83**	**5.63**
CO_2 from FFC	0.43	3.90	2.14	2.96	2.68	4.82	5.62
N_2O from FFC	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
CH_4 from FFC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Transportation	**4.74**	**5.46**	**4.85**	**5.27**	**5.10**	**5.75**	**5.70**
CO_2 from FFC	4.53	5.15	4.72	5.11	4.94	5.56	5.57
N_2O from FFC	0.18	0.15	0.04	0.05	0.05	0.07	0.07
CH_4 from FFC	0.03	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
HFCs	<0.01	0.15	0.08	0.10	0.10	0.11	0.06
Industrial	**4.44**	**4.40**	**4.11**	**4.08**	**3.94**	**4.56**	**5.13**
CO_2 from FFC	4.04	3.93	3.80	3.75	3.61	4.13	4.71
N_2O from FFC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
CH_4 from FFC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
CO_2 from IP	0.20	0.17	<0.01	<0.01	<0.01	<0.01	<0.01
CH_4 from IP	0.19	0.24	0.25	0.26	0.26	0.34	0.34
$HFC/PFC/NF_3^+$	<0.01	0.03	0.04	0.06	0.06	0.08	0.06
Residential	**1.08**	**1.21**	**0.97**	**1.10**	**1.17**	**1.17**	**1.14**
CO_2 from FFC	1.07	1.19	0.87	0.97	1.02	0.91	0.84
N_2O from FFC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
CH_4 from FFC	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
HFCs	<0.01	<0.01	0.09	0.13	0.14	0.25	0.30
Commercial	**0.58**	**0.77**	**1.17**	**1.29**	**1.07**	**1.42**	**1.65**
CO_2 from FFC	0.58	0.73	1.00	1.06	0.82	1.03	1.26
N_2O from FFC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

	1990	2005	2020	2021	2022	2030	2050
CH_4 from FFC	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
HFCs	<0.01	0.04	0.16	0.23	0.25	0.38	0.39
Agricultural	**0.57**	**0.50**	**0.59**	**0.59**	**0.66**	**0.64**	**0.58**
Enteric Fermentation	0.07	0.06	0.03	0.03	0.03	0.03	0.03
Manure Management	0.17	0.17	0.17	0.19	0.21	0.23	0.22
Agricultural Soil Management	0.32	0.27	0.38	0.36	0.42	0.37	0.31
Agricultural Residue Burning	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Liming and Urea	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Waste Management	**0.64**	**0.54**	**0.52**	**0.55**	**0.61**	**0.77**	**0.97**
Wastewater Treatment	0.12	0.16	0.19	0.22	0.22	0.23	0.29
Landfill Activities	0.37	0.38	0.33	0.33	0.39	0.54	0.68
Waste Incineration	0.15	NO	NO	NO	NO	NO	NO
LULUCF	**0.09**	**-1.05**	**-0.80**	**-0.72**	**-0.90**	**-0.90**	**-0.90**
Gross GHG Emissions	**20.08**	**23.14**	**16.16**	**17.63**	**17.27**	**20.33**	**22.14**
Net GHG Emissions	**20.17***	**22.09**	**15.36**	**16.91**	**16.37**	**19.43**	**21.24**

Notes: Totals may not add up exactly due to independent rounding of individual items. NO = Not Occurring. +CO_2 = Carbon Dioxide, N_2O = Nitrous Oxide, CH_4 = Methane, SF_6 = Sulfur Hexafluoride, PFC = Perfluorocarbon, NF3 = Nitrogen trifluoride. *Net GHG emissions are greater than gross because the LULUCF sector was estimated to be a source of emissions in 1990.

1.2.1 Greenhouse Gas Emissions by Gas Type

The 2022 GHG inventory estimated emissions for the following GHGs, per the Greenhouse Gas Protocol: carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), HFCs, perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).[6]

Figure 5 presents the gross GHG emissions by gas in 2022. GHGs trap heat in the atmosphere at varying rates over a specific time period (usually 100 years) compared with CO_2. The IPCC assigns a GWP to each GHG that measures its potency compared with CO_2 (which has a GWP of 1). For example, CH_4 has twenty-eight times the GWP of CO_2. In Delaware, CO_2 emissions accounted for the greatest fraction of emissions, 87.4% of the total, followed by methane, 5.6%, and nitrous oxide, 3.7%. The combined contribution of the fluorinated gases (HFCs, PFCs, and NF_3) was 3.2% of the total 2022 GHG emissions in Delaware. Sulfur hexafluoride emissions associated with the T&D of electricity were less than 1.0% of total emissions.

[6] Greenhouse Gas Protocol, February 2013, Required Greenhouse Gases in Inventories, https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

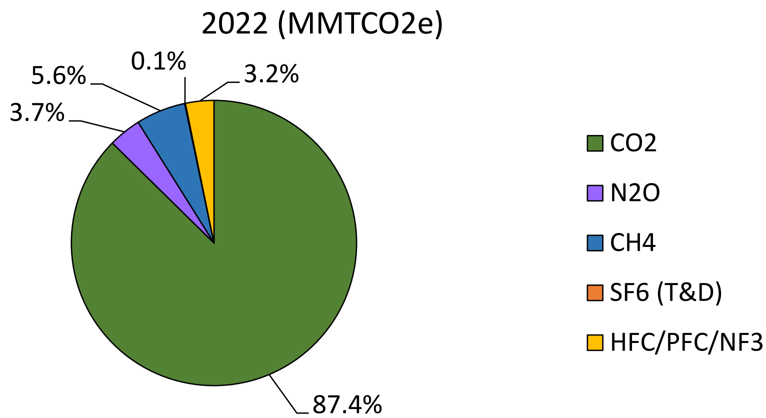

Figure 5: Gross GHG emissions by gas type in 2022 (% of CO_2e)

1.3 Methodology

EPA's SIT was utilized to estimate GHG emissions for various economic sectors in Delaware. SIT is a Microsoft Excel®-based tool designed to help states develop GHG emissions inventories. The SIT consists of sector specific estimation modules to calculate GHG emissions. The default data within the SIT are gathered by federal agencies and other sources covering fossil fuels, electricity consumption, agriculture, forestry, waste management, and industry. The SIT is designed to use methods and sectors consistent with those used in the U.S. GHG Inventory. The EPA disaggregates the National GHG inventory across the 50 states for all sectors.

Where data were unavailable within the SIT, additional state-specific data sources were used and are highlighted within the sector specific methodology sections, including the following adjustments:

- To prevent double-counting within the electric power sector, electricity generation data from Delaware's Energy Information Administration (EIA) were utilized to subtract the amount of electricity generated in-state from the total electricity consumption data provided by the SIT module.
- The SIT does not include default data for industrial wastewater estimates. For 2019 through 2022, industrial wastewater estimates were used from the EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks by State.[7]
- For reporting years 2019 through 2022, lime tonnage data were provided by the Delaware Department of Agriculture. To calculate the total amount of agricultural limestone applied to the soil for each year, data from the U.S. Geological Survey was used to determine the ratio of total agricultural limestone to total agriculture-specific limestone.[8] These ratios were multiplied by the lime tonnage data provided by the

[7] EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks by State for 1990-2022. Available online at: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2022 | US EPA

[8] US Geological Survey Mineral Yearbook for Crushed Stone. Table 10 ("Limestone and Dolomite Sold or Used by Producers in the United States in 2019/2020, by use"). Available online at: https://www.usgs.gov/centers/national-minerals-information-center/crushed-stone-statistics-and-information#myb

Delaware Department of Agriculture and entered as activity data in the SIT Agricultural module.

- The SIT evenly distributes regional iron and steel production among states within the region, so estimates were reviewed against facility level reporting to the EPA's GHG Reporting Program (GHGRP) to determine whether there is actual production in Delaware. Based on this reporting, the Evraz Claymont Steel facility ceased operations in 2013, and there are no other facilities reporting to the GHGRP, there are no emissions occurring from iron and steel production in Delaware.[9]

Projections were developed using the EPA's PT, which allows users to create a simple forecast of emissions through 2050 based on historical emissions imported from the SIT modules. These projections do not include state-specific policies (e.g., RPS or zero emission vehicle [ZEV] regulations) and are meant to provide additional context when reviewing emissions inventory results. State-specific assumptions were made where PT estimates were unavailable, including the following adjustments:

- HFC emissions were disaggregated using United States Climate Alliance (USCA)/California Air Resources Board (CARB) projected HFC estimates following the same methodology described in the inventory to separate emissions between the residential, commercial, transportation, and industrial sectors. This is described further in "1.3.1 Updates from the 2018 Delaware GHG Inventory."
- Default oil refinery emissions for Delaware in the PT included incorrect activity data that overestimate the state's oil refining operations in 2020 and subsequent projected years. As a result, 2020 emissions were held constant.
- The PT does not include projections for the LULUCF sector. To develop projections, 2022 emissions were held constant.

1.3.1 Updates from the 2018 Delaware GHG Inventory

This section details some of the most significant methodology and data source changes from the 2018 Inventory.

1.3.1.1 Update from AR4 to AR5 Global Warming Potentials

The United Nations Framework Convention on Climate Change requires countries that have ratified the Convention to use 100-year GWP values from the AR5. This reflects updated science and ensures that GHG inventories are comparable. The 2022 Delaware Inventory reflects CO2-equivalent GHG emission totals using 100-year AR5 GWP values. A comparison of 100-year GWP values from the IPCC AR4 used in the previous inventories and the AR5 values used for 2020 through 2022 inventories can be found below in Table 2.

[9] EPA, Greenhouse Gas Reporting Program; available: https://www.epa.gov/ghgreporting
Delaware Online. Evraz Claymont Steel Shutting Down. 2013.
https://www.delawareonline.com/story/money/economy/1/01/01/evraz-claymont-steel-shutting-down/2978917/

Table 2: GWPs Used in Previous and Current Inventories

Gas	AR4 GWPs used in *previous* inventories	AR5 GWPs used in current inventory
CO_2	1	1
CH_4	25	28
N_2O	298	265
HFC-23	14,800	12,400
HFC-32	675	677
HFC-125	3,500	3,170
HFC-134a	1,430	1,300
HFC-143a	4,470	4,800
NF_3	17,200	16,100
SF_6	22,800	23,500

To ensure consistency when comparing GHG estimates from 2020 through 2022 with previous years, the GWPs for all historical inventory years were updated to use the values from the AR5. This change allows for direct comparison across years using a uniform basis. The adoption of AR5 GWPs led to a 12.0% increase in reported CH_4 emissions, an 11.1% decrease in N_2O emissions, a 3.1% increase in SF_6 emissions, and variable impacts on HFCs and perfluorocarbons (PFCs).

Emissions estimates for 2019 and 2020 were developed using the 2023 SIT version, while the 2021 estimate utilized the 2024 SIT version, and the 2022 estimate relied on the 2025 SIT version. These updates reflect Delaware's effort to use the most scientifically accurate data to develop GHG inventories for Delaware.

1.3.1.2 SIT Methodological Updates

Apart from the update to use AR5 GWPs, various other updates have been made to SIT methodologies recently. These updates were made to align with the U.S. National GHG Inventory and to incorporate newly available data sources. The January 2025 version of the SIT was used to develop the 2022 estimate, and all results in this report reflect these changes. The most significant updates include:

- In 2020, the EIA's State Energy Data Source (SEDS)[10] updated the methodology used to estimate state-level jet fuel consumption. Updated fuel consumption estimates used for the 2019 through 2022 inventories are significantly higher and not directly comparable with estimates for the historic time series 1990-2018. EIA SEDS is the data source used by the CO_2 from Fossil Fuel Combustion (CO_2FFC) module of SIT to estimate emissions

[10] U.S. Energy Information Administration - EIA - Independent Statistics and Analysis. (n.d.). https://www.eia.gov/ https://www.eia.gov/state/seds/

associated with jet fuel. The increase in recent jet-fuel emissions compared with 2018 can be almost entirely attributed to this update.

- The Industrial Processes (IP) module now incorporates an updated methodology for disaggregating national emissions from ozone-depleting substances substitutes (most commonly HFCs) to the state level.
- The state-level allocation of fuel consumption data in the CO_2FFC and Stationary modules was updated to exclude use of fuels for industrial processes, which are accounted for in the IP module of the SIT.
- The CO_2FFC module now incorporates updated international bunker fuel data. International bunker fuel emissions (e.g., emissions associated with an international flight landing in Delaware) are not included in inventory totals, following IPCC guidelines.
- In the 2025 SIT tool, the emissions factors for the Wastewater module were updated to align with the most recent U.S. GHG Inventory methodology.[11]
- The Coal, IP, LULUCF, Municipal Solid Waste, and Natural Gas and Oil modules have been updated to include Additional Emissions tabs for users to input any emissions data from sources that are not included in the modules.

1.3.1.3 Additional Methodological Updates

Delaware's GHG inventory uses a combination of methods. For the years 1990–2018, historical activity data and SIT methodologies remained consistent with those used in the 2018 Delaware GHG Inventory, except for updating global warming potentials (GWPs) to the AR5 values. Emissions estimates for 2019 and 2020 were developed using the 2023 SIT version, while the 2021 estimate utilized the 2024 SIT version, and the 2022 estimate relied on the 2025 SIT version. For hydrofluorocarbons (HFCs), emissions estimates for all years were calculated using the most up-to-date SIT version to ensure consistent application of AR5 GWPs. On average, total gross emissions from 1990 to 2018 decreased by 0.3% due to the change from AR4 to AR5 GWPs. HFCs were disaggregated to economic sectors based on estimates from the USCA/CARB HFC inventory tool described in the 2018 Delaware GHG Inventory.[12] Projected HFC emissions were estimated using EPA's PT and disaggregated similarly.

Where possible, the 2019 through 2022 inventories were developed using the latest version of SIT. This allows for simplified updates and consistency for future inventory development. As described above, additional data were used to supplement inaccuracies or missing data for the

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[11] EPA. (2024). Crosswalk between the Inventory U.S. Greenhouse Gas Emissions and Sinks by U.S. State: 1990-2022 and the State Inventory Tool (SIT, January 2024 edition). In EPA (pp. 1–13). https://www.epa.gov/system/files/documents/2024-09/factsheet_crosswalk-between-ghgibystate-and-sit_august_2024.pdf

[12] The USCA/CARB inventory tool was developed to determine HFC emissions per person, per household, or per vehicle. For more information on how this tool is integrated into the inventory analysis, please see page 3 of the 2018 Delaware Greenhouse Gas Inventory: https://documents.dnrec.delaware.gov/Air/Documents/2018-DE-GHG-Inventory.pdf.

electric power, wastewater, and agriculture sectors. These sector specific methodology sections of this inventory highlight any deviations from the SIT in detail.

1.4 Greenhouse Gas Emissions by Sector

1.4.1 Electric Power Sector

The emissions of GHGs in the electric power sector are driven by fossil fuel combustion for electricity generation. As outlined in the 2021 Delaware GHG Inventory, GHG emissions were estimated for both electricity generated within the state and electricity consumed in Delaware. To meet the state's energy demand, electricity was produced both in-state and imported from out-of-state sources, with fossil fuels such as coal, natural gas, and petroleum products serving as primary fuels. Table 3 presents the GHG emissions in $MMTCO_2e$ from both electricity generation and imports, broken down by year and source for Delaware.

Table 3: GHG Emissions from the Electric Power Sector by Source and Year ($MMTCO_2e$)

Source	1990	2005	2020	2021	2022
Fuel Total	**7.52**	**6.32**	**1.81**	**1.77**	**2.01**
Coal	5.05	5.00	0.19	0.44	0.18
Petroleum	1.86	0.61	0.01	0.02	0.09
Natural Gas	0.61	0.71	1.61	1.31	1.74
T&D Total	**0.08**	**0.04**	**0.01**	**0.02**	**0.01**
T&D	0.08	0.04	0.01	0.02	0.01
Imports Total	**0.43**	**3.91**	**2.14**	**2.97**	**2.68**
Imports	0.43	3.91	2.14	2.97	2.68
Electric Power Total	**8.03**	**10.27**	**3.96**	**4.76**	**4.70**

Note: Totals may not add up exactly due to independent rounding of individual items.

Total electric power sector emissions were the sum of the GHG emissions associated with in-state electricity generation and imported electric power. Total electric power sector emissions accounted for 27.2% of Delaware's gross GHG emissions in 2022, which made this sector the second largest source of GHG emissions in Delaware. Figure 6 shows the electric power sector GHG emissions from 1990 to 2022. Emissions from in-state electricity generation are shown by source type, while electricity imported from outside of Delaware is shown as a total. Combining in-state electricity generation and imports gives total emissions from electricity consumption. Figure 6 presents SF_6 emissions, a chemical commonly used for insulation in electricity T&D equipment.

Total electricity demand in Delaware reached a maximum in 2003, driven by high industrial electricity consumption that year, and has decreased since. Between 2005 and 2022, GHG emissions from in-state electricity generation decreased by 68.2%.[13] Despite this overall trend, GHG emissions from in-state electricity generation have increased slightly in recent years. This rise can largely be attributed to population growth, which drives greater energy demand, and to the impacts of climate change. Warm summer conditions, with a higher number of cooling

[13] EPA, Emissions & Generation Resource Integrated Database; available: https://www.epa.gov/egrid

degree days,[14] require additional energy for cooling and can drive an overall increase in energy sector emissions. Emissions also increased slightly between 2021 and 2022, although they remain significantly lower than overall peaks in the time series (2000-2008). The significant decrease in GHG emissions in recent years can be attributed to multiple factors, including energy efficiency and fuel switching from coal to natural gas.

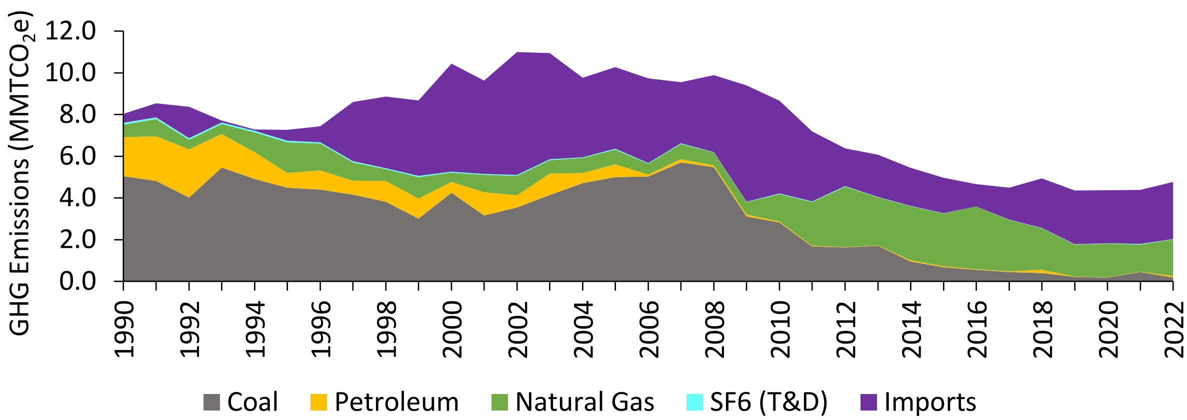

Figure 6: GHG emissions estimates in the electric power sector from 1990 to 2022 by source

Figure 6 illustrates the annual variability in GHG emissions associated with both electricity generation and imports in Delaware. From 2005 to 2022, the share of electric power sector emissions attributable to imported electricity ranged from 22.9% to 62.4%, with an average of 42.6%. During this period, total energy emissions declined 54.2% as the electric power grid added more renewable energy sources and increased generation from lower-emitting technologies. The carbon intensity of grid-supplied electricity has also decreased over this time period.[15] In 2022, emissions from electricity imports accounted for 57.0% of electric power sector emissions. Despite a rise in total electricity demand in 2022, in-state generation decreased, leading to an increased reliance on imported electricity.

1.4.1.1 Sector Specific Methodology

EPA's CO_2 from CO_2FFC SIT module was used to estimate the GHG emissions associated with power generation within the state. The SIT module uses EIA SEDS fossil fuel consumption data for electricity generation in Delaware. Each fossil fuel type has an associated carbon content, which was multiplied by the amount of fuel consumed for electric power generation to estimate GHG emissions from in-state generation. To estimate the emissions from imported (out-of-state) electricity, the SIT Electricity Consumption module was used. This module estimates emissions based on the amount of electricity consumed in kWhs multiplied by an emission factor from EPA's Emissions and Generation Resource Integrated Database (eGRID),

[14] Cooling degree days are a measure of how hot the temperature was on a given day. This is determined by comparing the mean outdoor temperature recorded for a day to a standard temperature (typically 65°F). For example, a day that is 70°F has 5 cooling degree days. Definition and data are available at: https://www.eia.gov/energyexplained/units-and-calculators/degree-days.php

[15] EPA, Emissions & Generation Resource Integrated Database; available: https://www.epa.gov/egrid

accounting for losses due to transmission.[16] The electricity consumption is reported separately for the residential, commercial, industrial, and transportation sectors.[17]

Because the emissions estimated by the Electricity Consumption module include both emissions from in-state generated and imported electricity, additional steps need to be taken to avoid double-counting emissions. It was assumed that electricity consumption needs in Delaware were first met by electricity generated within the state. Thus, imported electricity can be calculated by subtracting in-state generated electricity (in kWh) from the total electricity consumed (in kWh) in the state. Delaware in-state generation, from EIA's Annual State Generation data,[18] was subtracted from SEDS Delaware total electricity consumption data. This difference is the imported electricity consumed.

The imported electricity was assumed to be split between the residential, commercial, and industrial sectors, the same as total electricity consumption. To estimate emissions from imported electricity, imported consumption (in kWh) by sector was used as an input parameter in the SIT Electricity Consumption module. This calculation was developed to better understand Delaware's uniquely high proportion of imported power. Figure 7 presents further details on Delaware's imported electricity from 1990 to 2022. This figure offers insights into the trends and fluctuations in imported power over this time period, complementing the discussion on the electric power sector's emissions and reliance on imports.

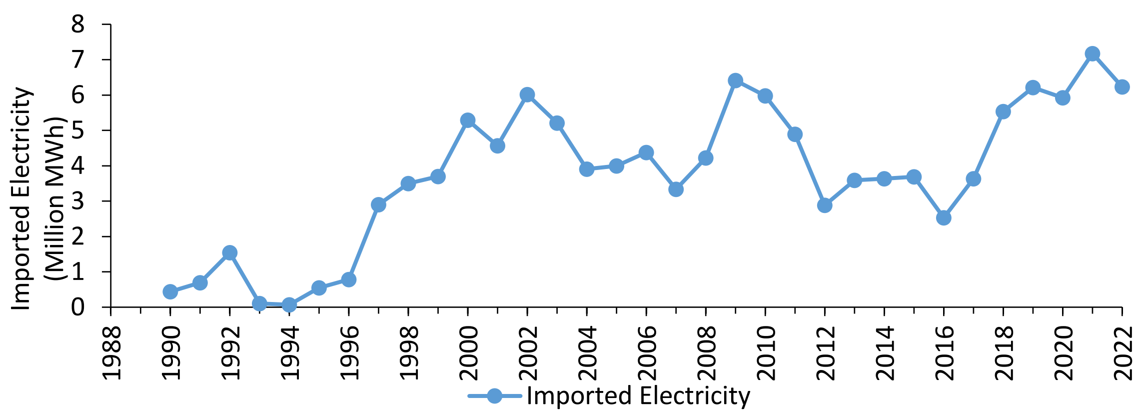

Figure 7: Delaware Imported Electricity from 1990 to 2022

As a supporting, informational calculation to provide more context for this report, data from EIA SEDS was used to estimate electricity demand for each relevant economic sector (Industrial, Residential, and Commercial) in 2022. The breakdown of total electricity demand (from all sources) per sector in 2022 can be seen in Figure 8.

[16] EPA, Emissions & Generation Resource Integrated Database; available: https://www.epa.gov/egrid
[17] Currently, the electricity consumed by the transportation sector in EIA SEDS is 0 kWh for Delaware in all inventory years.
[18] Total Electric Power Industry: https://www.eia.gov/electricity/data.php

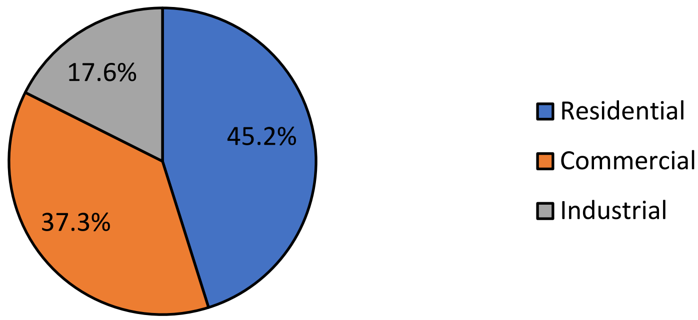

Figure 8: Electricity consumption per sector in 2022 (% of kWh)

1.4.2 Transportation Sector

The transportation sector was the largest source of GHG emissions in Delaware in 2022, at 29.6% of the total gross GHG emissions. Transportation has been the largest emitting sector since 2016. Transportation emissions decreased in 2020 to 4.8 $MMTCO_2e$, as seen in Table 4. The sharp decline in gasoline, diesel, and jet fuel kerosene emissions from 2019 to 2020 was largely due to the impacts of the COVID-19 pandemic on travel and economic activity. Emissions in this sector increased in 2021 due to post-COVID travel activity and began leveling off in 2022.

Table 4: GHG Emissions from the Transportation Sector by Source and Year ($MMTCO_2e$)

Source	1990	2005	2020‡	2021‡	2022‡
Fuel Total	**4.74**	**5.31**	**4.77**	**5.16**	**5.00**
Gasoline	3.22	4.00	3.51	3.78	3.72
Jet Fuel, Kerosene*	0.51	0.07	0.45	0.62	0.51
Diesel	1.01	1.23	0.77	0.73	0.73
Natural Gas	<0.01	<0.01	0.03	0.04	0.05
HFC Total	**<0.01**	**0.15**	**0.08**	**0.10**	**0.10**
HFCs	<0.01	0.15	0.08	0.10	0.10
Transportation Total	**4.74**	**5.46**	**4.85**	**5.27**	**5.10**

*Naphtha-based jet fuel consumption was included in totals for 1990-1994.
‡Jet fuel kerosene consumption for these years was estimated using the new SEDS methodology, described earlier in this report. Jet fuel kerosene cannot be directly compared with earlier years.
Note: Totals may not add up exactly due to independent rounding of individual items.

GHG emissions in the transportation sector were primarily due to the combustion of fossil fuels, and particularly the combustion of petroleum products. Fossil fuel combustion in on-road and non-road vehicles was the source of at least 98.0% of all GHG emissions in the transportation sector in 2022. The remainder of transportation sector emissions were HFC emissions, which are associated with motor vehicle air conditioning. A small amount of GHG emissions were from alternate fuel vehicles, which use natural gas as a fuel. Figure 9 displays the annual GHG emissions in the transportation sector from 1990 to 2022 by fuel type and HFCs.

As Figure 9 shows, total transportation sector emissions peaked in 1991, 2000, and 2007 before emissions dipped following the recession in 2008. Emissions reached their highest point in 2019, driven by an increase in gasoline usage and a change in EIA SEDS methodology that increased the estimated consumption of jet fuel, as discussed in the "1.3.1 Updates from the 2018 Delaware GHG Inventory" section. Jet fuel consumption estimates for years before 2019 were not impacted by the SEDS methodology change, as the data and methodologies used for historical inventory years were not updated, apart from the conversion from AR4 to AR5.

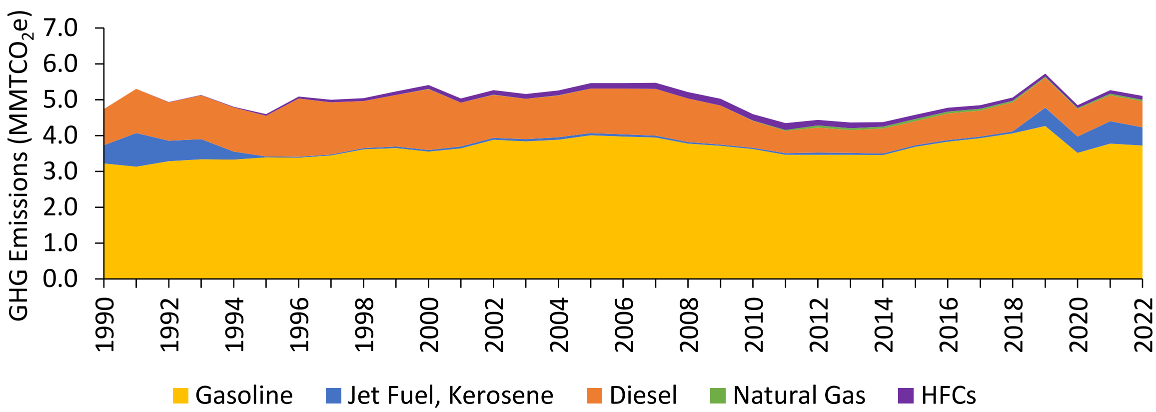

Figure 9: GHG emissions in the transportation sector from 1990 to 2022 by source

1.4.2.1 Sector Specific Methodology

Emission estimates for CH_4 and N_2O in the transportation sector were calculated within the SIT Mobile Combustion module by vehicle type. These emissions are calculated based on the vehicle miles traveled (VMT) by each type. VMT is further disaggregated for each vehicle type by model year and the emission control systems used. Each different category of vehicle, year, and control system has different associated emissions. CH_4 and N_2O emissions are grouped by fuel type based on the fuel used for different types of vehicles, to be consistent with CO_2 estimates. CO_2 emissions from vehicle travel were estimated in the CO_2FFC module of the SIT and were based on EIA SEDS fuel consumption data. Estimates were developed at the fuel type, not vehicle type, for CO_2.

To provide additional information, outside of inventory totals, the Mobile Combustion module for the transportation sector calculated CO_2 emissions based on vehicle type and VMT in Delaware. These calculations were not part of the standard inventory methodology and were not used to estimate emissions totals in the overall inventory. However, presenting GHG emission estimates by vehicle type (passenger cars, heavy-duty vehicles, etc.) can provide useful context for understanding the sources of emissions in Delaware. These estimates by vehicle type and HFCs for the transportation sector are shown in Figure 10.

Passenger cars were the largest source of transportation GHG emissions from 1990 to 2022, including a 52.6% share in 2022. Light-duty trucks and motorcycles were also included in this category. Heavy-duty vehicles were the second-highest source of emissions with a 24.9% share of overall transportation emissions in 2022.

The “Other” category with the remaining 17.5% of transportation emissions included non-road sources of GHG emissions such as locomotives, aircraft, marine vessels, farm equipment, utility vehicles, and snowmobiles. This category showed a significant decrease in emissions in 2009, potentially related to the economic recession. Emissions from this sector appear greater 2019 onwards due to the change in EIA SEDS methodology discussed in “1.3.1 Updates from the 2018 Delaware GHG Inventory.” Construction vehicles contributed to 2.9% of total transportation GHG emissions in 2022. HFC emissions are a total for all vehicle types. As previously mentioned, the COVID-19 pandemic caused a decrease in 2020 emissions, with CO_2 emissions from transportation dropping by 15.5% between 2019 and 2020. However, CO_2 emissions in this sector went up 8.3% in 2021 due to post-COVID travel activity and began leveling off in 2022.

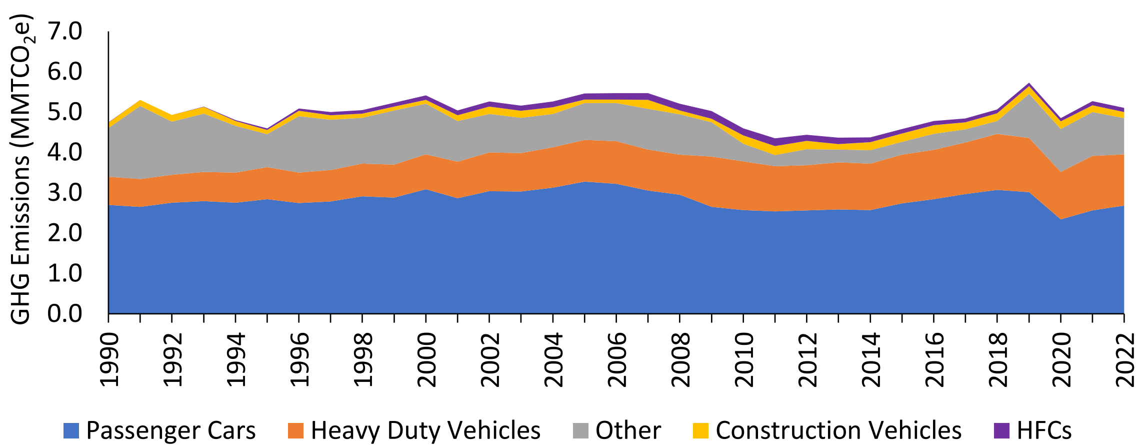

Figure 10: GHG emissions from fossil fuel combustion disaggregated by vehicle type and HFCs from 1990 to 2022

1.4.3 Industrial Sector

Industrial sector GHG emissions in Delaware were from energy and non-energy related activities. The total industrial sector was the source of 22.8% of GHG emissions in the state of Delaware in 2022. This represented a slight decrease relative to the fraction of state emissions from the industrial sector in 2021. Industrial sector emissions in 2022 decreased 10.3% from 2005, dropping from 4.4 $MMTCO_2e$ to 3.9 $MMTCO_2e$, as seen in Table 5.

Table 5: GHG Emissions from the Industrial Sector by Source and Year ($MMTCO_2e$)

Source	1990	2005	2020	2021	2022
Energy Total	**4.05**	**3.95**	**3.81**	**3.76**	**3.62**
Coal	0.08	0.29	NO	NO	NO
Petroleum	3.08	2.83	2.04	2.08	2.04
Natural Gas	0.89	0.82	1.77	1.67	1.58
Wood	<0.01	<0.01	<0.01	0.00	<0.01
Non-Energy Total	**0.40**	**0.45**	**0.30**	**0.32**	**0.32**
Soda Ash	0.01	0.01	0.01	0.01	0.01
Ammonia & Urea	<0.01	<0.01	<0.01	0.00	<0.01
Semiconductor Manufacturing	NO	NO	NO	NO	NO
TiO_2 Production	0.19	0.14	NO	NO	NO
Iron & Steel Production	NO	0.03	NO	NO	NO
HFC/PFC	<0.01	0.03	0.04	0.06	0.06
Natural Gas Systems	0.18	0.23	0.25	0.25	0.25
Oil (Refinery)	0.01	0.01	0.01	0.01	0.01
Industrial Total	**4.44**	**4.40**	**4.11**	**4.08**	**3.94**

Note: Totals may not add up exactly due to independent rounding of individual items. NO = Not Occurring.

Emissions from energy-related activities were those from the direct combustion of fossil fuels, which are the majority of total industrial sector emissions. Emissions from non-energy related activities are associated with specific industrial processes. Non-energy related activities included natural gas T&D pipelines, HFC emissions, fugitive emissions associated with refinery operations, and soda ash consumption.

Figure 11 shows GHG emissions in the industrial sector broken out by fuel type for energy-related activities, and total non-energy emissions. Energy-related emissions made up 91.8% of total GHG emissions in the industrial sector in 2022. On average, energy-related emissions accounted for around 90.5% of industrial sector emissions from 1990 to 2022, with the notable exceptions in 2009 and 2010. Industrial sector GHG emissions had a steep decline, potentially associated with the economic recession, loss of heavy industry, and shutdown of Delaware City refinery operations from late 2009 to late 2011.[19] Wood burning for energy related activities contributed to less than 1.0% of annual industrial GHG emissions. The combustion of petroleum products and natural gas were the major sources of GHG emissions in the industrial sector in Delaware.

[19] "PBF Celebrates Successful Restart of its Delaware City Refinery", Delaware News, Office of the Governor, October 2011

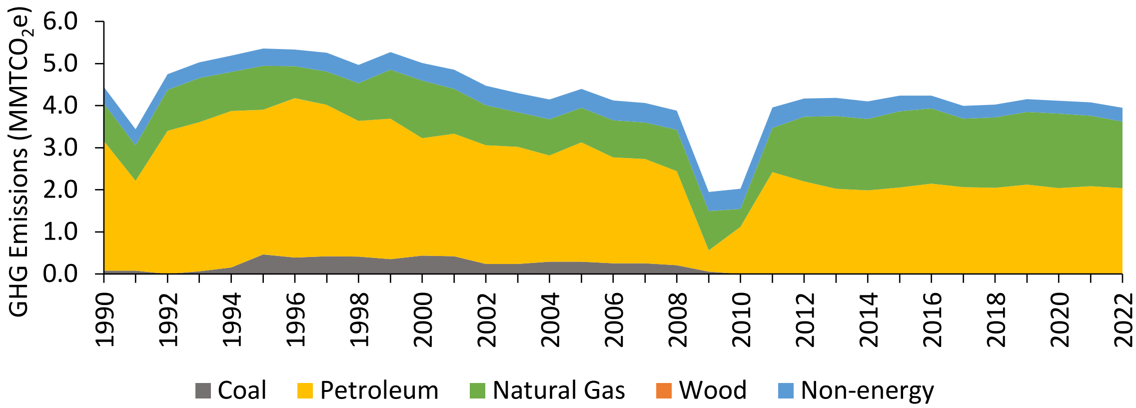

Figure 11: GHG emissions in the industrial sector from 1990 to 2022 by source

1.4.3.1 Sector Specific Methodology

Industrial sector emissions were estimated using the CO_2FFC module from the SIT for energy-related emissions, the IP module for non-energy uses, and the Natural Gas and Oil module. The SIT evenly distributes regional iron and steel production among states within the region, so estimates were reviewed against facility-level reporting to the GHGRP to determine whether there is actual production in Delaware. Based on this reporting, because the Evraz Claymont Steel facility ceased operations in 2013, there are no emissions occurring from iron and steel production in Delaware.[20]

To better understand industrial sector emissions in Delaware, separately from the inventory estimates, data from the GHGRP was further reviewed. The industrial sector in Delaware includes a variety of chemical manufacturers, one petroleum refinery, poultry processing facilities, and other industries. Petroleum refining and fuel combustion for process heat contributed to the majority of GHG emissions at the refinery. Since 2010, sources that meet applicable criteria are required to report GHG emissions to the GHGRP.[21] Not all of Delaware's industrial sources meet these requirements and thus, do not report to the national program.

The GHGRP mandates reporting from facilities that emit 25,000 $MTCO_2e$ or more GHG emissions per year. This means that data reported to the GHGRP does not provide a complete inventory of Delaware's industrial sector GHG emissions.

To provide additional context to emissions estimates, GHGRP data was used to apportion 2022 emissions by industry. The major categories[22] among industrial sources identified in the data were refinery, chemicals, and other. The Other category included fossil fuel combustion-based

[20] EPA, Greenhouse Gas Reporting Program; available: https://www.epa.gov/ghgreporting
Delaware Online. Evraz Claymont Steel Shutting Down. 2013.
https://www.delawareonline.com/story/money/economy/1/01/01/evraz-claymont-steel-shutting-down/2978917/
[21] EPA, Greenhouse Gas Reporting Program; available: https://www.epa.gov/ghgreporting
[22] The chemicals category also included emissions associated with titanium dioxide manufacturing which took place through 2015.

emissions from operating equipment at poultry processing plants as well as emissions from institutional sources.[23]

The disaggregated GHG emission estimates from the industrial sector for 2022 can be seen in Figure 12. The majority of GHG emissions in the industrial sector were from petroleum refining operations, which is the most carbon-intensive industrial source. This disaggregation of GHG emissions from the industrial sector in Delaware was an approximation because not all industrial sources within Delaware are required to report to the GHGRP. This characterization of major emission sources in the industrial sector can be helpful, but carries a degree of uncertainty.

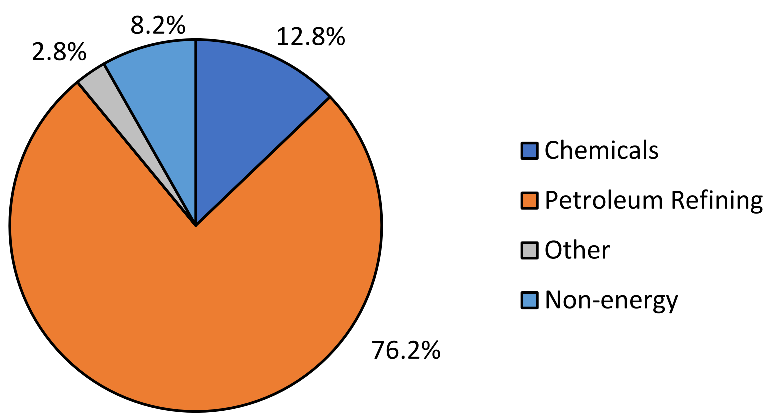

Figure 12: GHG emissions in the industrial sector in 2022 disaggregated by subsector

1.4.4 Buildings Sector (Residential and Commercial)

This section describes the GHG emissions associated with both the residential and commercial sectors. The GHG emissions presented cover those associated with fossil fuel combustion as well as HFCs. GHG emissions associated with electricity consumption in these sectors were not included but were accounted for in the Electric Power Sector section of this inventory. Table 6 shows residential and commercial subsector emissions by source and year.

Table 6: GHG Emissions from the Building Sector by Source and Year ($MMTCO_2e$)

Source	1990	2005	2020	2021	2022
Residential Fuel Total	**1.08**	**1.20**	**0.88**	**0.98**	**1.03**
Coal	0.01	NO	NO	NO	NO
Petroleum	0.67	0.63	0.28	0.33	0.37
Natural Gas	0.39	0.57	0.60	0.64	0.65
Wood	0.01	<0.01	<0.01	<0.01	<0.01
Commercial Fuel Total	**0.58**	**0.73**	**1.00**	**1.06**	**0.82**
Coal	0.04	NO	NO	NO	NO

[23] The only institutional source that reported to the GHGRP in the time period was the University of Delaware.

Source	1990	2005	2020	2021	2022
Petroleum	0.32	0.27	0.19	0.21	0.23
Natural Gas	0.22	0.46	0.82	0.85	0.60
Wood	<0.01	<0.01	<0.01	<0.01	<0.01
HFCs	**<0.01**	**0.05**	**0.25**	**0.36**	**0.39**
Residential Building HFCs	<0.01	0.01	0.09	0.13	0.14
Commercial Building HFCs	<0.01	0.04	0.16	0.23	0.25
Residential Total*	**1.08**	**1.21**	**0.97**	**1.10**	**1.17**
Commercial Total*	**0.58**	**0.77**	**1.17**	**1.29**	**1.07**
Buildings Total	**1.66**	**1.98**	**2.13**	**2.40**	**2.24**

Note: Totals may not add up exactly due to independent rounding of individual items. NO = Not Occurring.
*including HFCs

Overall, the buildings sector was the source of 13.0% of total gross GHG emissions in Delaware in 2022. The residential sector was 6.7% of the total gross GHG emissions, while the commercial sector was 6.2% of the total gross GHG emissions. Figure 13 shows the overall GHG emissions in the combined buildings sector. Building sector emissions in 2022 decreased 6.4% from 2021, from 2.4 $MMTCO_2e$ to 2.2 $MMTCO_2e$, as seen in Table 6. Some contributing factors to emission changes in this sector include changes in EPA's SIT tool methodology. Buildings sector emissions are estimated using the CO_2FFC module from the SIT for all emissions except those from HFC emissions resulting from refrigeration and air-conditioning. Emissions from residential buildings in 2022 increased 5.8% from 2021, from 1.1 $MMTCO_2e$ to 1.2 $MMTCO_2e$. While emissions from commercial buildings decreased 16.8% from 2021, from 1.3 $MMTCO_2e$ to 1.1 $MMTCO_2e$, as seen in Table 6. More details on each subsector is provided in the following sections.

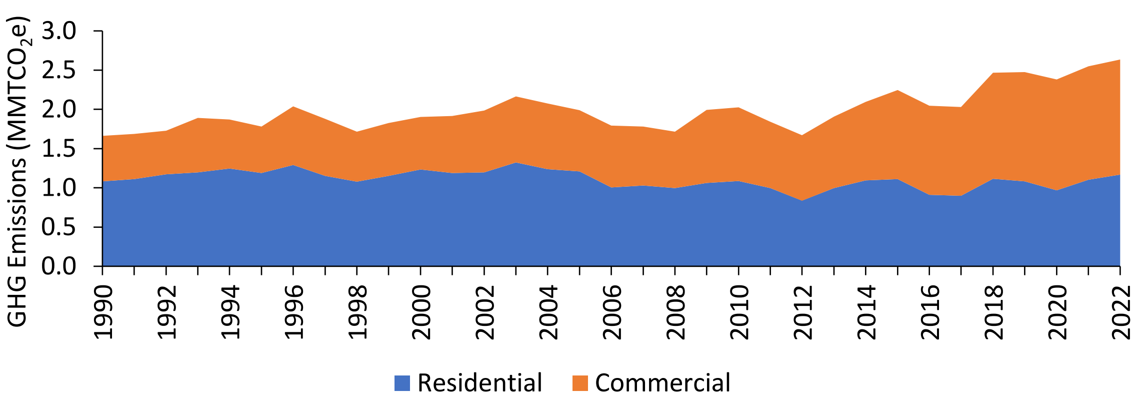

Figure 13: GHG from residential and commercial buildings from 1990 to 2022

1.4.5 Residential Sector

The primary fuel used in the residential sector in 2022 was natural gas. Figure 14 shows emissions by fuel type, while HFCs are provided overall. Historical emissions from 1990 to 2022 show fluctuations that can be attributed in part to weather. For example, a local peak in the data in 1996 can be linked to temperature data at the Dover Meteorological station. The year

1995 had the most days with a maximum temperature below 32.0°F between 1990 and 2022.[24] The most recent peak in emissions may also be linked to impacts from temperature. The number of heating degree days[25] have also increased in recent years for the same reasons. Overall, petroleum consumption in the residential sector has decreased while natural gas consumption has grown.

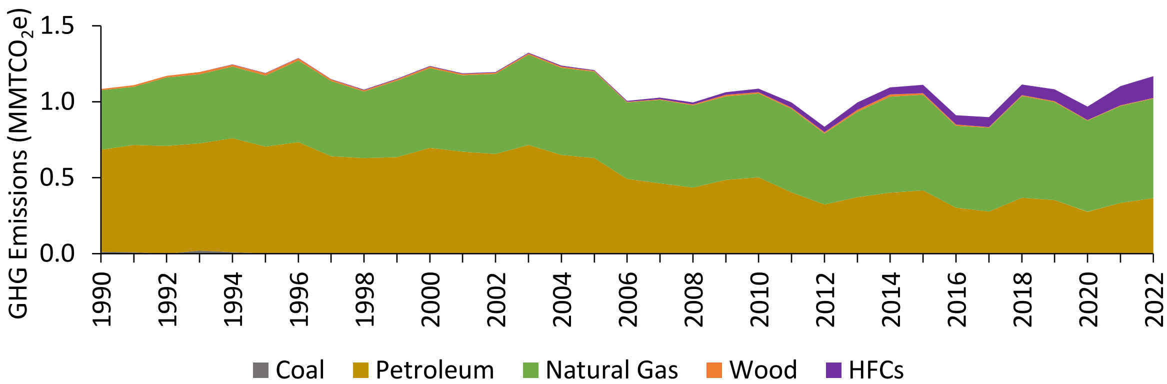

Figure 14: GHG emissions in the residential sector from fuels and HFCs in Delaware from 1990 to 2022

1.4.5.1 Sector Specific Methodology

Residential sector GHG emissions were estimated using the SIT CO_2FFC module, which includes energy consumption data and the carbon content of each fuel type used. HFC emissions from residential refrigeration and air-conditioning were estimated using the SIT IP module.

Separate calculations outside of the EPA SIT tool were done to provide additional context. Two primary uses of fossil fuels were identified for the residential sector to further categorize GHG emissions: space-heating (SH) and water-heating (WH). To estimate the associated emissions, data from the EIA Residential Energy Consumption Survey (RECS)[26] were used to characterize fossil fuel use in each of these end-uses. The most recent RECS data were published for 2020 and 2015. Values were then linearly interpolated from 2016 through 2019 to ensure a consistent time series. Using these and previous RECS data, GHG emissions could be estimated for the base year and past years but could not be used to project future emissions by end-use. Data were not available at the state level, but were presented at the census division level. Thus, GHG emissions per end-use in the residential sector contain a degree of uncertainty.

While population in the state of Delaware increased annually from 2015 to 2022, the overall emissions impact was mitigated in part by switching from petroleum (e.g., fuel oil, kerosene, and propane) to natural gas as a fuel for heating. This general trend can be observed in Figure 14 and a more in-depth assessment of particular end-uses in residential buildings can be

[24] National Oceanic and Atmospheric Administration, National Centers for Environmental Information – Climate Data Online.
[25] Heating degree days are a measure of how cold the temperature was on a given day by comparing the mean outdoor temperature recorded for a given day to a standard temperature (typically 65°F).
[26] EIA, Residential Energy Consumption Survey; available: https://www.eia.gov/consumption/residential/

observed in Figure 15. GHG emissions in the residential sector were primarily from SH needs, which have undergone a transition from petroleum product use to natural gas since 1990. GHG emissions associated with WH were primarily from natural gas use for the whole period of 1990 through 2022. The "Other" category in Figure 15 includes emissions associated with the use of natural gas and petroleum products in other applications, such as clothes dryers, cooking, and more. The "Other" category also included small amounts of wood and coal.

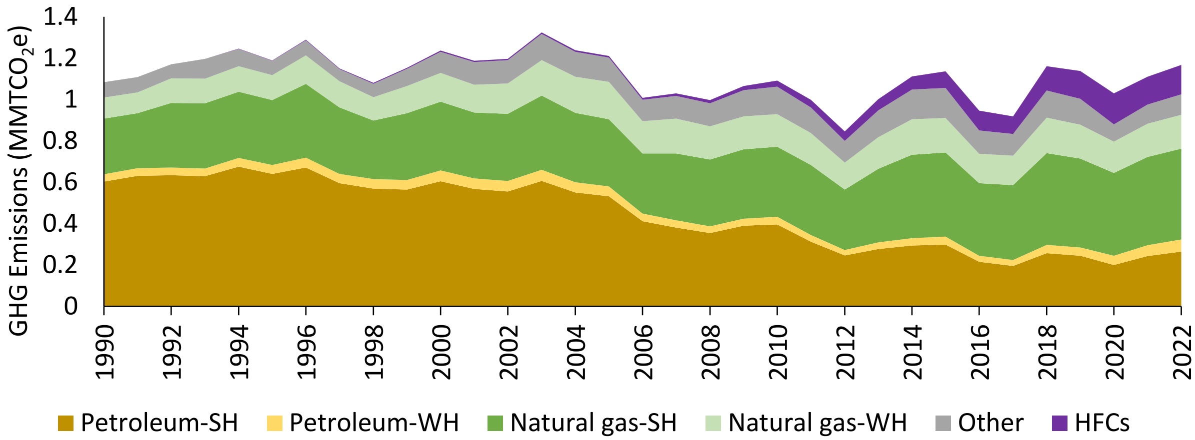

Figure 15: GHG emissions in the residential sector in Delaware from 1990 to 2022 by end-uses; SH refers to space-heating, WH refers to water-heating.

1.4.6 Commercial Sector

Natural gas was the most prominent fuel used in the commercial sector. GHG emissions in the commercial sector by fuel type and HFCs can be seen in Figure 16 for the years 1990 to 2022. Some fluctuations occurred in the emissions estimates that were likely attributed to the changes in weather. Emissions from the combustion of natural gas became the majority of total commercial sector emissions by 2002. The decline in commercial sector emissions is likely attributable to changes in EPA's SIT tool methodology, as well as a leveling off of economic activity following post-COVID effects. Commercial sector GHG emissions showed an overall increase from 1990 through 2022.

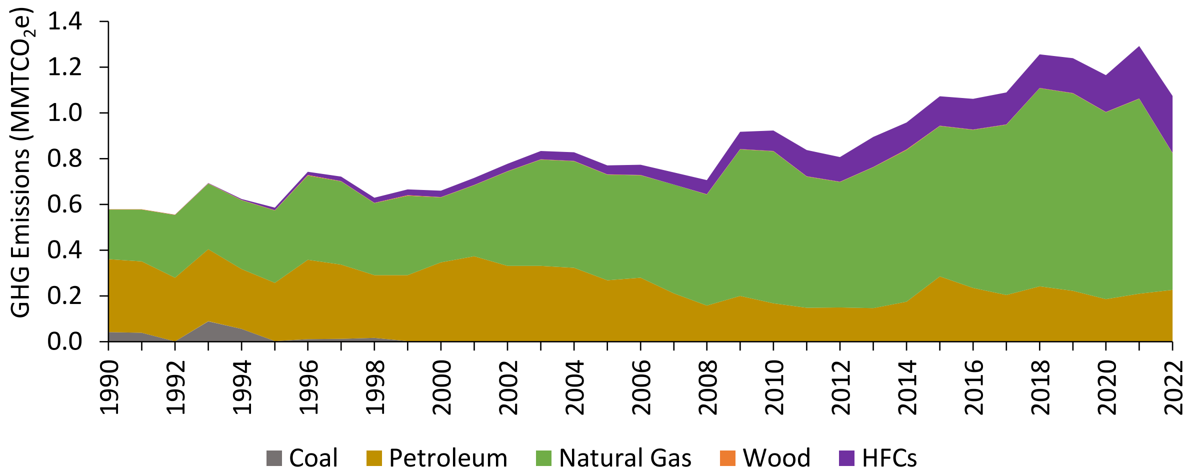

Figure 16: GHG emissions in the commercial sector from fuels and HFCs in Delaware from 1990 to 2022

1.4.6.1 Sector Specific Methodology

Commercial sector GHG emissions were estimated using the SIT CO_2FFC module, which includes energy consumption data and the carbon content of each fuel type used. HFC emissions from commercial refrigeration and air-conditioning were estimated using the SIT IP module.

Separate calculations outside of the EPA SIT tool were done to provide additional context. GHG emissions associated with SH and WH needs in the commercial sector were estimated. Data from the EIA Commercial Buildings Energy Consumption Survey (CBECS) were used to assess the relative fuel uses for each end-use.[27] The most recent edition of the CBECS was published for 2018 data. Therefore, the 2018 data have been held constant through 2022. CBECS data for 2012 and earlier editions were used to estimate GHG emissions by key end-uses in the commercial sector by linearly interpolating years in between survey results. As with the RECS data, the CBECS data were only available at the census division level,[28] not the state level, introducing a degree of uncertainty.

Space-heating applications were the highest contributor to GHG emissions in the commercial sector, as Figure 17 shows. Relative to the residential sector, a larger percentage of the overall GHG emissions in the commercial sector can be observed in the “Other” category, which was the second highest source of emissions in the commercial sector. Emissions from the “Other” category include emissions from energy use for cooking, lighting, computing, and more. Natural gas and petroleum product use in other applications, especially in food service, contributed to a significant portion of commercial sector GHG emissions.

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[27] EIA, Commercial Buildings Energy Consumption Survey; available: https://www.eia.gov/consumption/ commercial/

[28] Prior to the 2003 edition of the CBECS, data were only available at the census region level; therefore, the 2003 CBECS data were held constant retrospectively through 1990.

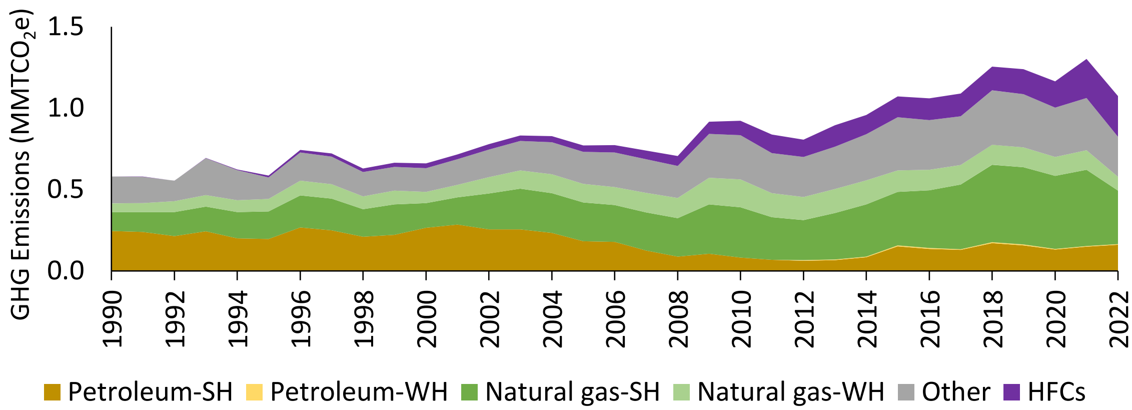

Figure 17: GHG emissions in the commercial sector from 1990 to 2022 by end-use; SH refers to space-heating, WH refers to water-heating

1.4.7 Waste Management Sector

Waste Management sector GHG emissions represented 3.5% of the total gross GHG emissions in Delaware in 2022. GHG emissions from the waste management sector included wastewater treatment (WWT) CH_4 and N_2O emissions, and municipal solid waste (MSW) (landfill) CH_4 emissions. GHG emissions from municipal and industrial WWT decreased between 1990 and 2004 and remained fairly constant from 2004 to 2022. The majority of emissions for all years in the waste management sector were fugitive methane emissions from MSW landfills. For completeness, historical GHG emissions associated with the incineration of MSW were included, but the practice was banned in Delaware in 2000. A full summary of emissions from the waste management sector by source is shown below in Table 7.

Table 7: GHG Emissions from the Waste Management Sector by Source and Year (MMTCO₂e)

Source	1990	2005	2020	2021	2022
Wastewater Treatment	0.12	0.16	0.19	0.22	0.22
Landfill Activities	0.37	0.38	0.33	0.33	0.39
Waste Incineration	0.15	NO	NO	NO	NO
Waste Management Total	**0.64**	**0.54**	**0.52**	**0.55**	**0.61**

Note: Totals may not add up exactly due to independent rounding of individual items. NO = Not Occurring.

As shown in Figure 18, GHG emissions in the waste management sector fluctuated significantly from 1990 to 2022. These fluctuations in the waste management sector were largely driven by changes in operations within the MSW sector. The first shift in emissions occurred between 1997 and 1998, when flaring began at each of the three major landfills. In addition, landfill gas recovery for energy generation started in 1997 at the Cherry Island Landfill site. Energy generation from landfill gas began in 2007 at the Central and Southern Solid Waste Management Centers; however, additional decreases in emissions were not observed because processes simply shifted from solely flaring. A short-term moderate increase in emissions was observed in 2017 and 2018 due to a lower collection efficiency at Cherry Island Landfill site. The increase in emissions from 2020 to 2022 can be largely attributed to increased waste generation during that period.

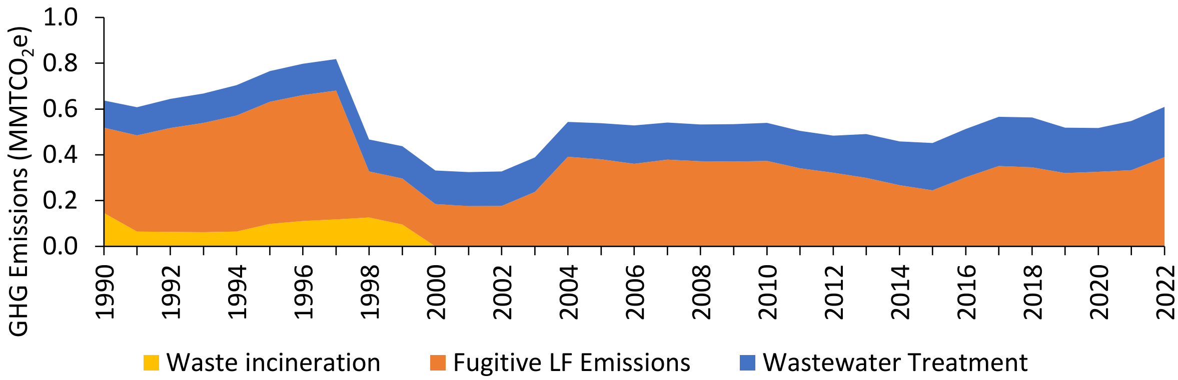

Figure 18: GHG emissions from the waste management sector from 1990 to 2022 by source

1.4.7.1 Sector Specific Methodology

Both the solid waste and wastewater subsectors used state-specific data for portions of the historic time series. For reporting years 2018 and earlier, GHG emissions for solid waste were calculated using data reported by individual landfill sites, some of which are no longer in use. As a result, estimates were developed outside the SIT using comparable methods. For reporting years 2019 through 2022, GHG emissions were calculated using the SIT and default data sources within the tool.

The SIT does not include default data for industrial wastewater estimates. For the years 1990-2018, activity data related to state-level processing of fruit, poultry, and red meat were sourced and used in the SIT module. For 2019 through 2022, industrial wastewater estimates were used from the EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks by State.[29] Emissions provided in the state-level inventory for industrial wastewater cover a similar scope as the SIT.[30]

1.4.8 Agricultural Sector

Agricultural sector GHG emissions represented 3.8% of the total gross GHG emissions in Delaware in 2022. GHG emissions from the agricultural sector have been fluctuating since 1990, as shown in Figure 19. The major GHG emissions in the agricultural sector were N_2O and CH_4. The major sources of GHG emissions in the agriculture sector were associated with agricultural soil management and manure management. Agricultural soil management emissions were entirely N_2O and contributed 63.7% of the GHG emissions from the agricultural sector in 2022. Manure management GHG emissions included both N_2O (75.0%) and CH_4 (25.0%) and contributed 31.4% of total agricultural GHG emissions in 2022. The remaining source categories

[29] EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks by State for 1990-2022. Available online at: https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals

[30] EPA's crosswalk of SIT estimates and the U.S. Inventory by state disaggregation is available online at: https://www.epa.gov/system/files/documents/2022-03/factsheet-crosswalk-between-ghg-by-state-and-sit.pdf

made up less than 4.9% of the total 2022 agricultural emissions.[31] A full summary of emissions from the agriculture sector by source is shown below in Table 8.

Table 8: GHG Emissions from the Agricultural Sector by Source and Year (MMTCO₂e)

Source	1990	2005	2020	2021	2022
Enteric Fermentation	0.07	0.06	0.03	0.03	0.03
Manure Management	0.17	0.17	0.17	0.19	0.21
Agricultural Soil Management	0.32	0.27	0.38	0.36	0.42
Agricultural Residue Burning	<0.01	<0.01	<0.01	<0.01	<0.01
Liming and Urea	<0.01	<0.01	<0.01	<0.01	<0.01
Agriculture Total	**0.57**	**0.50**	**0.59**	**0.59**	**0.66**

Note: Totals may not add up exactly due to independent rounding of individual items.

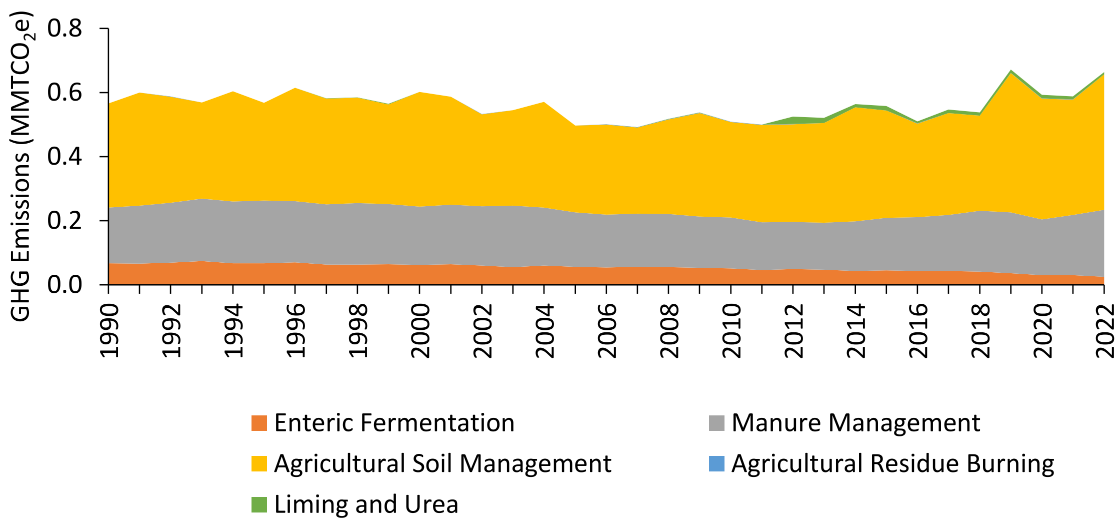

Figure 19: GHG emissions in the agricultural sector from 1990 to 2022 by source

1.4.8.1 Sector Specific Methodology

State-specific agricultural data was used to supplement SIT default data in the agriculture module. For reporting years 2019 through 2022, lime tonnage data was provided by the Delaware Department of Agriculture. To calculate the total amount of agricultural limestone applied to the soil for each year, data from the U.S. Geological Survey was used to determine the ratio of total agricultural limestone to total agriculture-specific limestone.[32] These ratios were multiplied by the lime tonnage data provided by the Delaware Department of Agriculture and entered as activity data in the SIT Agricultural module.

[31] Enteric fermentation is a part of the digestive process in domestic livestock that results in methane emissions. Liming and urea include CO_2 emissions from the application of crushed limestone and dolomite and urea fertilization.
[32] US Geological Survey Mineral Yearbook for Crushed Stone. Table 10 ("Limestone and Dolomite Sold or Used by Producers in the United States in 2019/2020, by use"). Available online at: https://www.usgs.gov/centers/national-minerals-information-center/crushed-stone-statistics-and-information#mayb

1.4.9 Land-use, Land Use Change and Forestry

Delaware's land use sector includes the management of cropland, grassland, wetlands, and forests. Specifically, this sector measures the emissions or sequestration (i.e., removal of carbon from the atmosphere) that results from land use changes, like deforestation. Source categories within the LULUCF sector include forest carbon flux, urban trees, landfilled yard trimmings and food scraps, N_2O from settlement soils, and agricultural soil carbon flux.[33, 34] Unlike other sectors, emissions from the land use sector can be positive (carbon released into the atmosphere) or negative (carbon removed, or sequestered, from the atmosphere).

The 2021 Delaware GHG Inventory previously identified the land-use sector as a sink[35] for GHG emissions in Delaware, and that remains true for 2022 estimates. Carbon emissions and/or sequestration in the land-use sector were calculated as the annual change in carbon storage among different carbon pools (systems with the capacity to store or release carbon) of Delaware's forest and croplands, as well as harvested wood products.

Between 1990 and 1998, estimated emissions from the land-use sector were positive (except for 1997, when emissions were negative). Increasing urbanization has caused a decline in forest acreage. In 2022, Delaware had 382,000 total acres of forestland, with approximately 1,192 acres converting from forest to non-forest annually.[36] However, despite some losses in forest acreage, increased forest management practices and trees reaching maturity have enhanced carbon sequestration from 1999 to the present.[37] In 2022, total GHG emissions for the LULUCF sector were -0.9 $MMTCO_2e$; meaning 0.9 $MMTCO_2e$ in GHG emissions were sequestered from the atmosphere by Delaware's land sector. This would be equivalent to offsetting 5.2% of Delaware's gross GHG emissions in 2022.

This is a decrease in removal compared with 1.1 $MMTCO_2e$ in 2005. The removal of GHGs in this sector peaked in 2002 with a net GHG removal of 1.1 $MMTCO_2e$, as indicated in Figure 20.

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[33] Carbon flux is the net change in stored carbon, capturing both emissions and sequestration. Forest carbon flux is the net change in carbon stored in forestland and agricultural carbon flux is the net change in carbon stored in agricultural land.
[34] Settlement soils include all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories.
[35] A sink is the removal of GHG from the atmosphere.
[36] Delaware -2022 Forest Health Highlights. (n.d.). Retrieved November 9, 2025, from https://www.fs.usda.gov/foresthealth/docs/fhh/DE_FHH_2022.pdf
[37] Delaware Forests 2018: Summary Report, USDA Forest Service, 2022. https://www.fs.usda.gov/nrs/pubs/rb/rb_nrs129.pdf

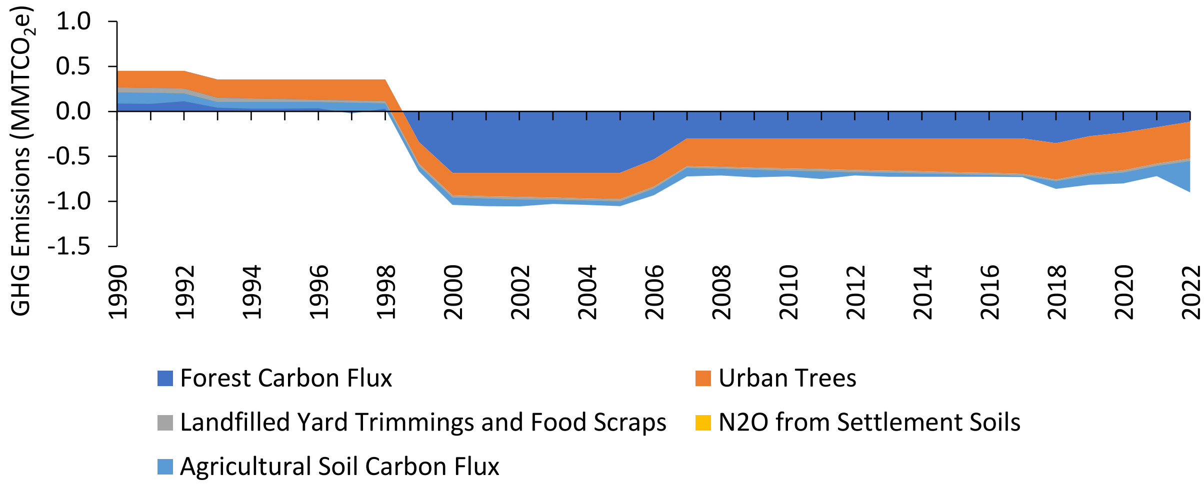

Figure 20: GHG emissions and sequestration (represented as negative emissions) (in MMTCO₂e) in the LULUCF sector from 1990 to 2022 by source

1.4.9.1 Sector Specific Methodology

The SIT LULUCF module was used to calculate emissions from the sector. As mentioned in the previous GHG Inventory, the SIT updated the LULUCF module methodology. The prior SIT method was still used for years before 2018, while 2018 onward uses the newer SIT method.

Where possible, the 2019 through 2022 inventories were developed using the latest version of SIT and the tool's default data. In January 2025, the EPA released an updated version of SIT, and that version is used to develop 2022 emission estimates.

1.4.10 HFCs by Sector

Emissions from HFCs were included in the Transportation, Industrial, Residential, and Commercial sectors and presented in the respective sector sections of this report. HFC emissions by sector are presented for select years in Table 9 and for the 1990 to 2022 time series in Figure 21. The In-State Electricity Generation, Electricity Consumption, Agriculture, Waste Management, and LULUCF sectors did not generate HFCs. Emissions from HFCs have grown significantly between 1990 – 2022. They are used as a replacement for ozone-depleting substances previously used for refrigeration that have been phased out under international agreements.[38]

HFC emissions were estimated using AR5 GWPs in the SIT IP module for all years. HFC emission estimates per sector from the USCA/CARB were used to disaggregate SIT HFC emission estimates to individual sectors. The fraction of HFC emissions per sector from the USCA/CARB data was applied to the SIT estimates. Delaware adopted 7 Del. Admin Code 1151[39] which

[38] The Montreal Protocol on Substances that Deplete the Ozone Layer. 1987. https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol

[39] 1151 Prohibitions on Use of Certain Hydrofluorocarbons in Specific End-Uses. (2021). Delaware.gov. 1151 Prohibitions on Use of Certain Hydrofluorocarbons in Specific End-Uses

established a phase-down of certain HFCs in specific end-uses by 2024. The significant increase in HFC emissions in 2021 and 2022 is associated with the SIT updates that occurred in 2024.

Table 9: HFC Emission by Sector and Year ($MMTCO_2e$)

Sector	1990	2005	2020	2021	2022
Transportation	<0.01	0.15	0.08	0.10	0.10
Industrial	<0.01	0.03	0.04	0.06	0.06
Residential	<0.01	0.01	0.09	0.13	0.14
Commercial	<0.01	0.04	0.16	0.23	0.25
Total HFCs	**<0.01**	**0.23**	**0.37**	**0.52**	**0.55**

Note: The Industrial sector includes HFCs and PFCs, which could not be disaggregated.

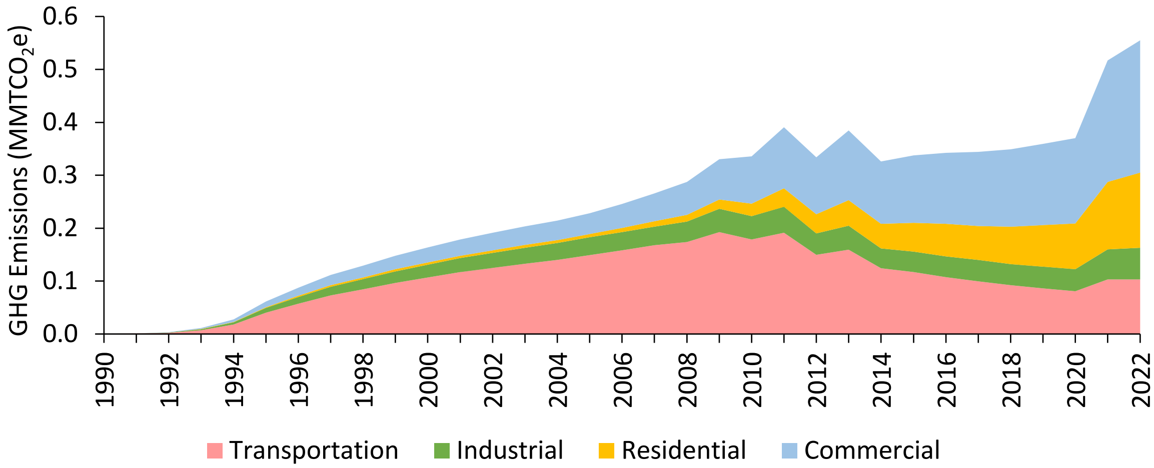

Figure 21: HFC Emissions by Sector from 1990 to 2022

2.0 Projections Through 2050

2.1 Business as Usual Greenhouse Gas Emission Projections

GHG emissions in Delaware are projected to increase from 2022 to 2050 under a BAU scenario. In this scenario, projections are calculated assuming that no state or local policy interventions are made to impact future emissions. Figure 22 shows that GHG emissions steadily increase after 2022. These projections were developed using EPA's PT and project future emissions from historic data, either based on linear interpolation or the projected growth in population. The PT does not consider any federal or state emissions policies or plans. Updated projections will be included in the state Climate Action Plan. These projections are provided for comparison with the 2022 inventory estimates. Total gross GHG emissions are projected to increase from 20.2 MMTCO_2e in 2023 to 20.3 MMTCO_2e in 2030 and 22.1 MMTCO_2e in 2050. It is important to note that this projection is just one prediction to review when considering the future of GHG emissions in Delaware. The uncertainty associated with these projections increases as the projection period is extended.

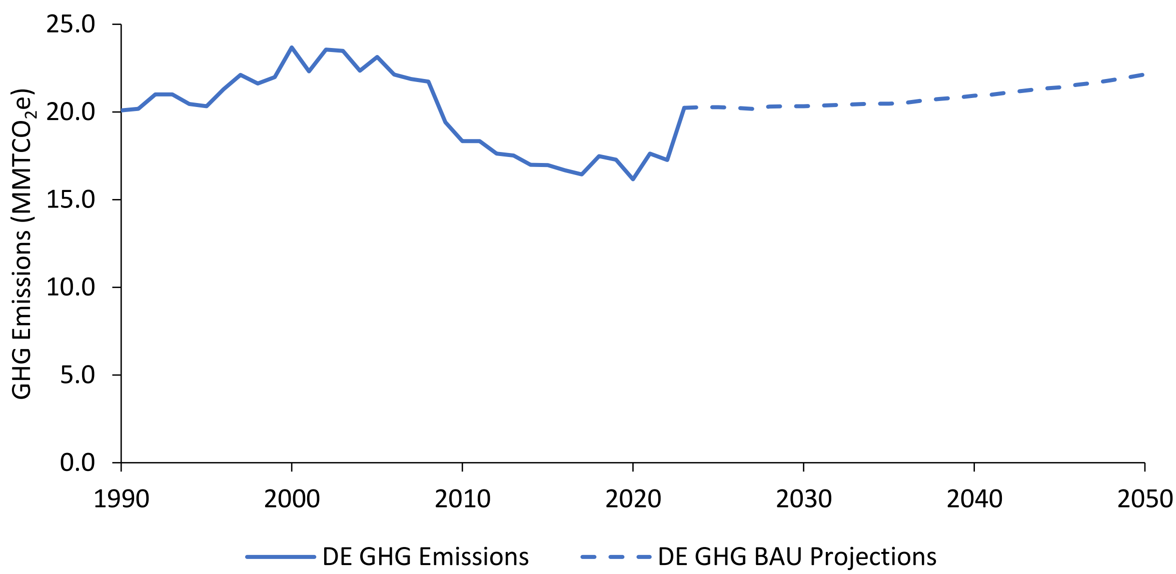

Figure 22: Gross GHG emissions and BAU projections from 1990 to 2050

The sector level breakdown of gross Delaware GHG emissions projected for 2030 and 2050 is shown in Figure 23. The electric power sector (combining in-state electricity generation and consumption-based emissions) is projected to be the largest source of GHG emissions in 2030. However, as the grid incorporates more renewables, the transportation sector is projected to become the largest source of GHG emissions by 2050. The industrial sector is expected to be the third-largest source of GHG emissions in both 2030 and 2050. The relative contributions from the remaining sectors will also remain unchanged from 2022.

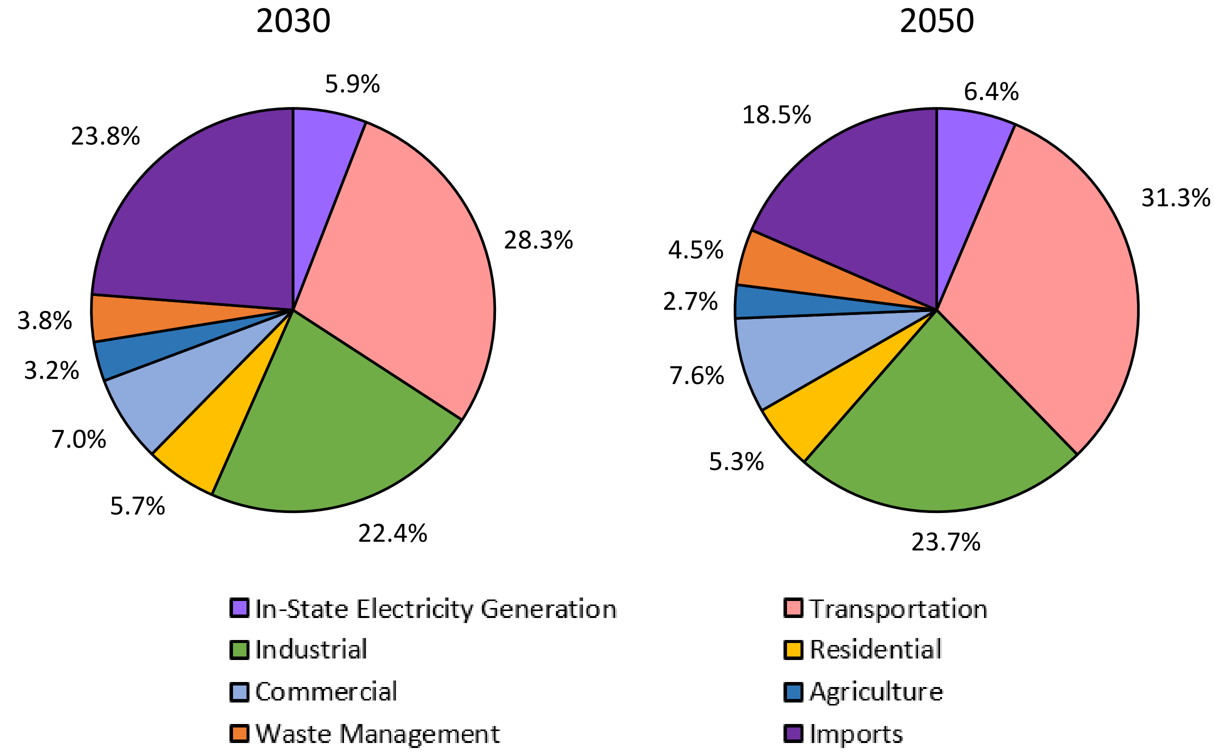

Figure 23: Gross GHG projections by sector

GHG emission estimates and projections by sector from 1990 through 2050 are shown in Figure 24. Projections exclude any federal and state policy interventions. Based on 2025 SIT version, the greatest percent increase in GHG emissions from 2005 to 2050 is a 114.5% increase in the commercial sector, driven in large part by the increase in HFC projections. As mentioned earlier, Delaware adopted 7 Del. Admin Code 1151[40] which established a phase-down of certain HFCs in specific end-uses. The significant increase in HFC emissions in 2021 and 2022 is associated with the most recent SIT updates that occurred in 2024.

The greatest total increase in GHG emissions from 2005 to 2050 is a 1.7 $MMTCO_2e$ increase in the electricity consumption sector as population and economic activities continue to grow. However, combined electric power sector emissions are projected to decrease by 32.2% between 2005 and 2050, or 3.3 $MMTCO_2e$. GHG emissions from in-state electricity generation show a declining trend from 2005 through 2030 and then generally remain flat through 2050. Projected emissions from in-state electricity generation fall below those in the commercial sector.

Emissions from the transportation sector are also projected to increase from 2005 through 2050, reaching 5.7 $MMTCO_2e$ in 2050 as population and economic activities continue to grow. From 2005 through 2050, agricultural sector and waste management emissions increase 16.5%

[40] 1151 Prohibitions on Use of Certain Hydrofluorocarbons in Specific End-Uses. (2021). Delaware.gov. [1151 Prohibitions on Use of Certain Hydrofluorocarbons in Specific End-Uses]

and 80.3% respectively, although these are smaller contributing sectors to overall emissions. Industrial emissions increase 16.7% between 2005 and 2050 to a total of 5.1 $MMTCO_2e$ in 2050.

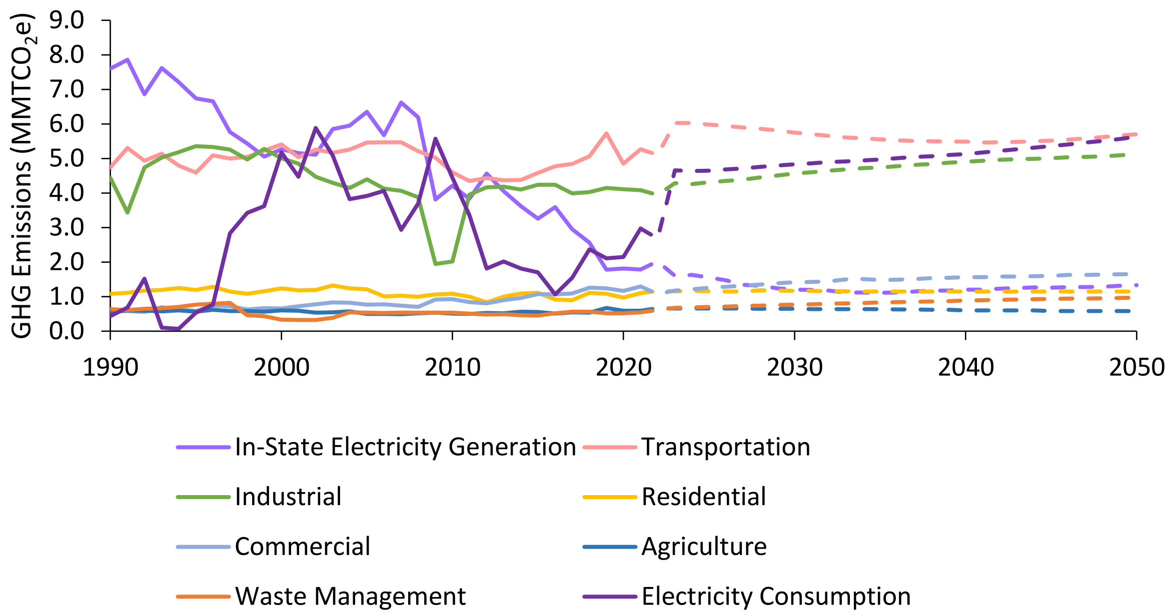

Figure 24: Gross GHG emission and projection trends by economic sector from 1990 to 2050

The relative contributions projected per gas in 2030 and 2050 are shown in Figure 25. CO_2 is projected to remain around 87.3% of total GHG emissions in Delaware through 2050. Relative contributions of N_2O slightly decreases, while CH_4 increases.

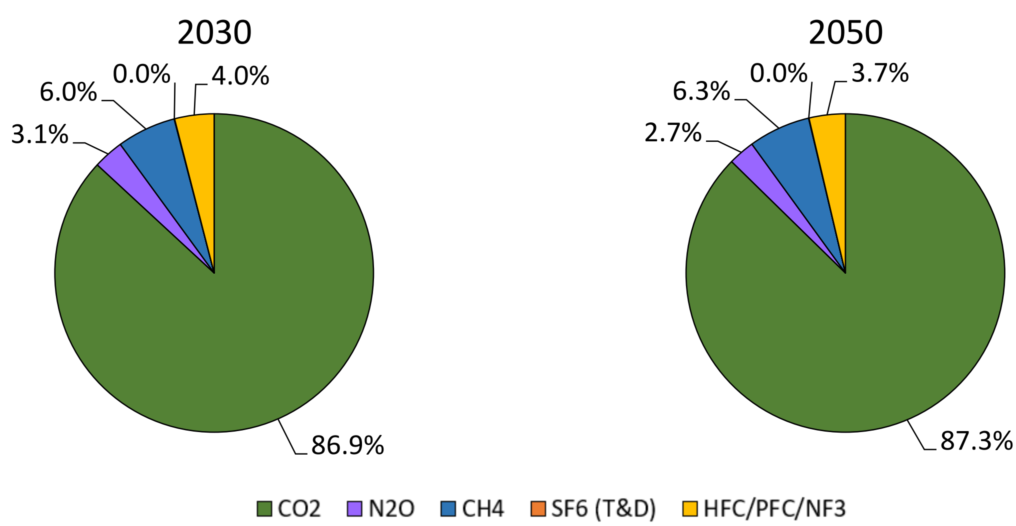

Figure 25: Gross GHG emissions projected by gas type in Delaware

The state of Delaware has a GHG emissions reduction target of 50.0% reduction below its 2005 baseline emission levels by 2030 and net-zero emissions by 2050 in alignment with the

Delaware Climate Change Solutions Act of 2023.[41] Net-zero emissions means that any emissions produced by 2050 will be appropriately offset through carbon sinks or sequestration methods. Gross GHG emissions in Delaware were estimated at 23.1 MMTCO$_2$e in 2005. Figure 26 shows the gross GHG emission estimates and projections in Delaware from 1990 to 2050. In the absence of any policies, the total gross emissions in 2050 are predicted to be 22.1 MMTCO$_2$e.

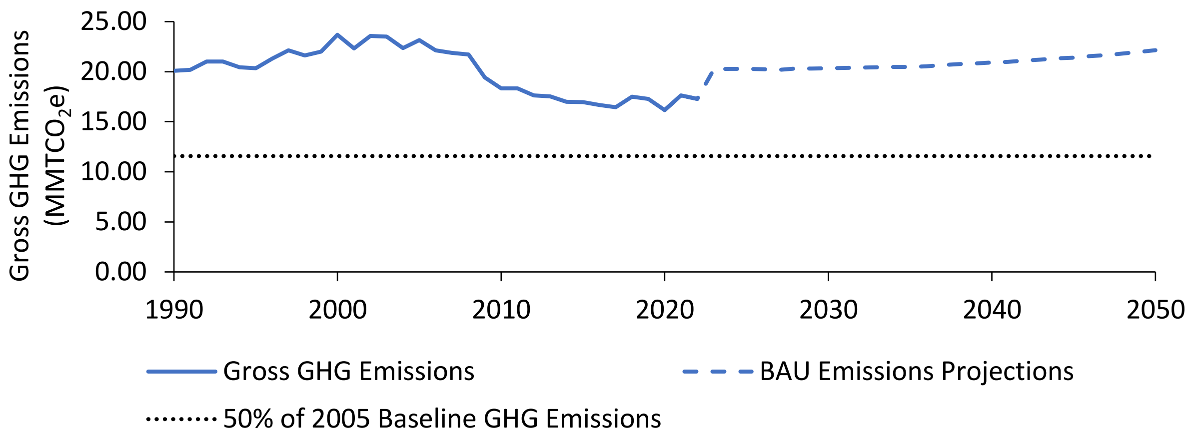

Figure 26: Baseline GHG emission estimates and projections from 1990 to 2050

2.2 Greenhouse Gas Emissions per Person

Delaware's GHG emissions can also be presented on a per capita basis, calculated using the state's current and projected population. This is useful when comparing emissions between states. Many factors contribute to GHG emissions per capita. According to the EIA, factors such as climate, the structure of the economy, population density, energy sources, building standards, and state policies can impact GHG emissions. In the EIA analysis, only CO$_2$ emissions associated with in-state energy-related activities (i.e., fossil fuel combustion) were included. In 2022, Delaware ranked 22nd in energy-related CO$_2$ emissions per capita at 12.7 metric tons CO$_2$e (MTCO$_2$e) per person according to the EIA.[42] The U.S. average energy-related emissions per capita in 2022 were 14.2 MTCO$_2$e/person, which is 10.6% higher than Delaware.

Figure 27 shows the trend of per capita GHG emissions in Delaware, including all GHG emissions and projections (not only energy-related), based on estimates from this report. Projected population data are from The Delaware Population Consortium.[43] Annual per capita GHG emissions decreased by 37.3% from 2005 to 2022 (27.6 MTCO$_2$e/person in 2005 to 17.3 MTCO$_2$e/person in 2022).[44] The significant decrease in per capita GHG emissions from 1990 to

[41] Delaware Climate Change Solutions Act of 2023, 99 (2023). https://legis.delaware.gov/BillDetail/130272
[42] EIA, Energy-Related CO$_2$ Emission Data Tables; available: https://www.eia.gov/environment/emissions/state/
[43] The Delaware Population Consortium. Projections developed in October 2023. https://stateplanning.delaware.gov/demography/dpc.shtml
[44] EIA reports energy-related emissions per capita by state. Delaware's estimate is based on total gross emissions from the SIT, which includes, but is not limited to, energy-related emissions. The difference between the two estimates is due to this difference in scope.

2022 can be attributed to multiple factors, including energy efficiency and fuel switching from coal to natural gas.

According to the SIT estimates, projected GHG emissions per capita are expected to increase from 17.0 $MTCO_2e$/person in 2022 to 18.9 $MTCO_2e$/person in 2050 in the absence of any policy intervention.

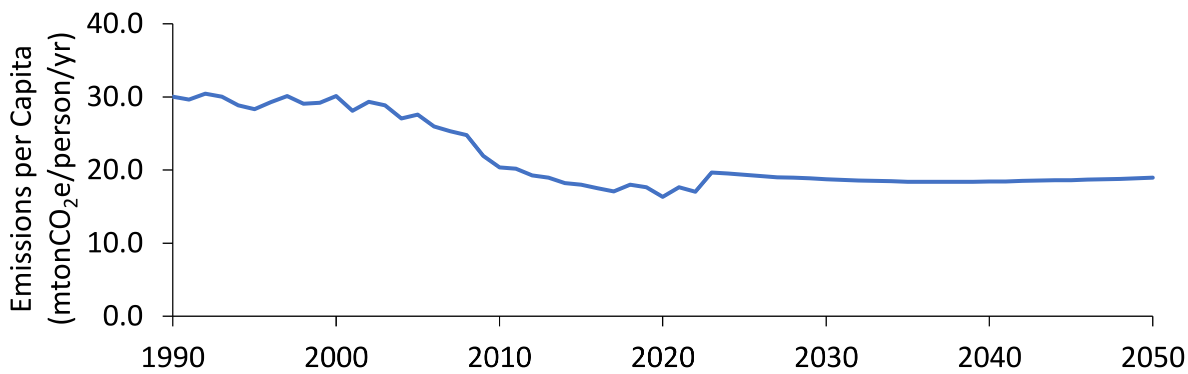

Figure 27: Annual gross GHG emissions per capita from 1990 to 2050

2.3 Electric Power Sector

Projected imported power was estimated using the PT. The PT held the emission factor for electricity consumption and the transmission loss factor constant through the projection period. It should be expected that the emission estimates for earlier years of the projection period are more accurate, while later years have more uncertainty as the regional grid continues to add more renewable energy and lower-emitting resources.

Projected emissions in the electric power sector can be seen in Figure 28. Data shown by fuel type represents in-state electricity generation, which, combined with imports, equals total electricity consumption. Emissions associated with SF_6, from T&D are also shown. Although in-state electricity generation is expected to decrease between 2022 and 2050, total emissions from the electric power sector are projected to significantly increase. This rise in emissions is primarily attributed to population growth and the resulting increased demand for electricity. It is important to note that these projections do not account for Delaware specific or federal policies aimed at reducing emissions. Delaware has two significant policies - the RPS and the Regional Greenhouse Gas Initiative - that will drive the decrease in emissions associated with increasing demand.

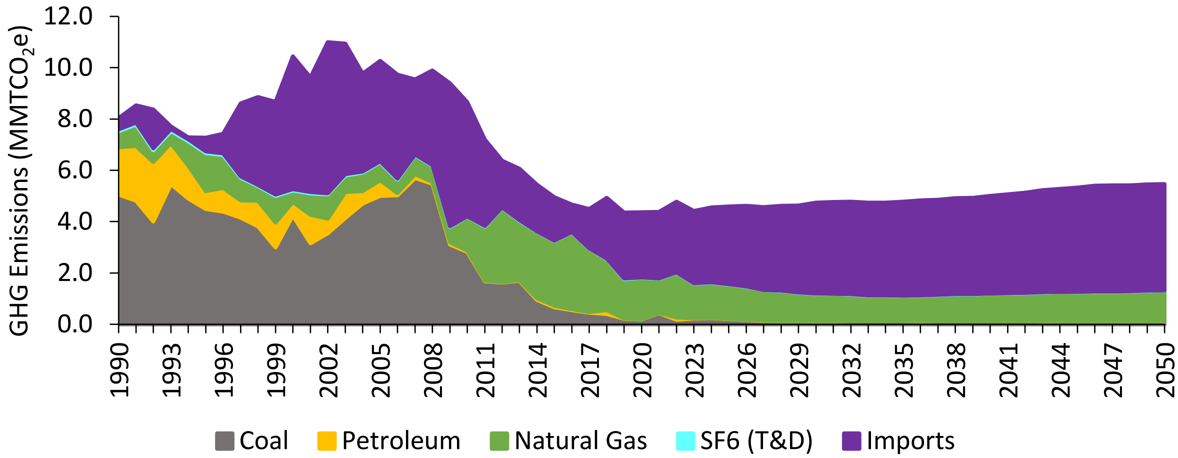

Figure 28: GHG emissions and projections in the electric power sector from 1990 to 2050 by source

2.4 Transportation Sector

Projections of GHG emissions are not estimated for individual vehicle type categories, as that analysis would require in-depth modeling of the projected vehicle fleet. Figure 29 shows GHG emission projections in the transportation sector by fuel type and HFCs. Gasoline is the dominant fuel type in the transportation sector, followed by diesel. Overall, GHG emissions from transportation are expected to remain relatively steady through 2050, as the vehicle fleet transitions to cleaner fuels. The overall change in GHG emissions projected from 2022 to 2050 is an increase of 0.2 $MMTCO_2e$, or 4.4%. Projected emissions do not include Delaware specific or federal policies for emissions reductions, or any assumptions related to ZEV adoption.

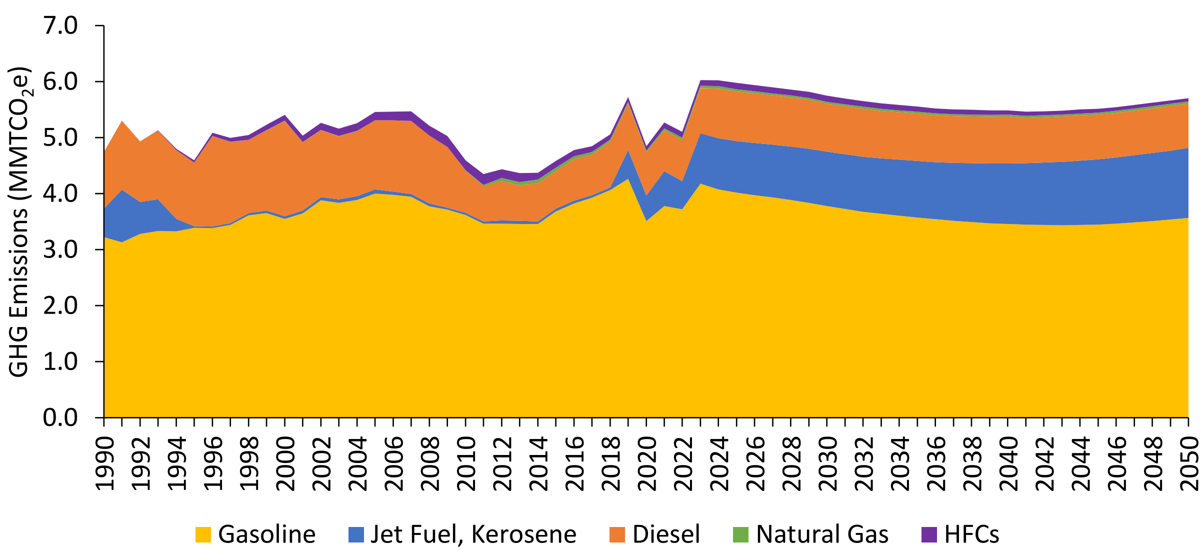

Figure 29: GHG emissions and projections in the transportation sector from 1990 to 2050 by source

2.5 Industrial Sector

As seen in Figure 30, GHG emission projections in the industrial sector show a steady increase after 2022. Industry-related GHG emissions are projected to increase by 1.2 $MMTCO_2e$, or 30.1%, from 2022 levels. Non-energy emissions are projected to be essentially constant through 2050.

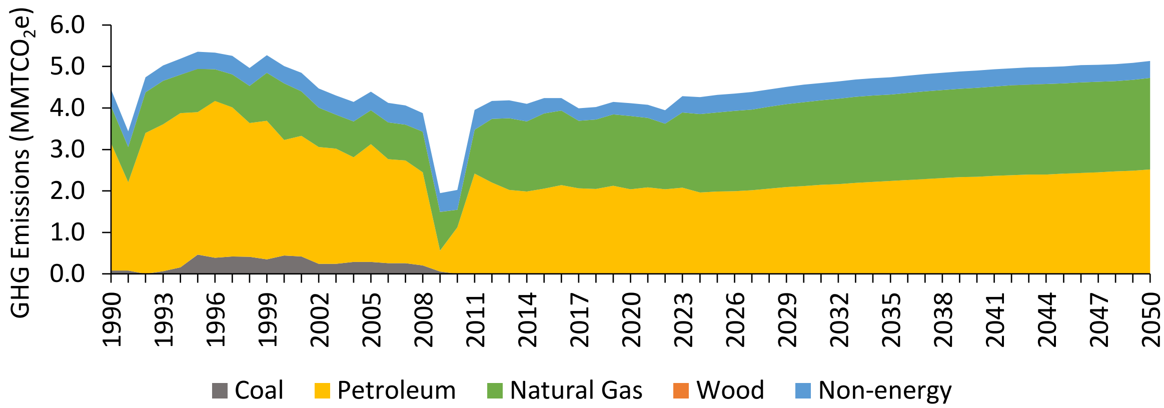

Figure 30: GHG emissions and projections in the industrial sector from 1990 to 2050 by source

2.6 Buildings Sector (Residential and Commercial)

GHG emissions in the residential sector are projected to remain steady from 2022 to 2050, as shown in Figure 31. By 2050, GHG emissions in the residential sector are projected to decrease less than 0.1 $MMTCO_2e$, or about 2.1%, compared to 2022 emissions. The major source of GHG emissions projected in the residential sector continues to be the combustion of natural gas. Petroleum-based emissions decrease through 2050. Figure 31 shows energy-related emissions by fuel type, while HFC emissions are provided overall.

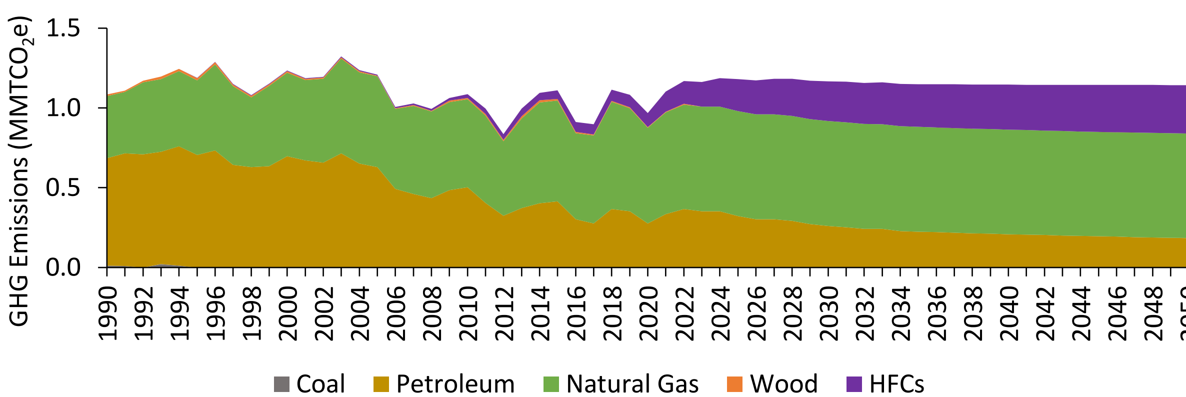

Figure 31: GHG emissions and projections in the residential sector from 1990 to 2050 by source

GHG emission projections in the commercial sector show an increasing trend. Figure 32 shows the projected GHG emissions in the commercial sector from 2022 to 2050, which is projected to increase by 53.7%, or 0.6 $MMTCO_2e$. Emissions associated with petroleum product combustion remain constant over the period. In contrast, emissions associated with natural gas combustion show a significant increase, contributing substantially to the overall rise in commercial sector emissions. Key factors that may drive this growth include population expansion and the increasing demand for commercial applications such as comfort cooling and refrigeration.

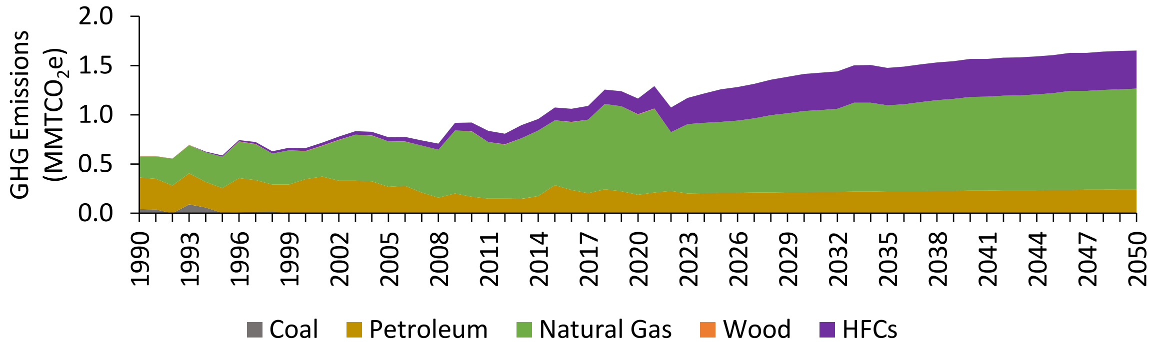

Figure 32: GHG emissions and projections in the commercial sector from 1990 to 2050 by source

2.7 Waste Management Sector

GHG emission projections in the waste management sector show an increase of 59.4%, or 0.4 $MMTCO_2e$, between 2022 and 2050 as shown in Figure 33. The PT models emissions based on assumed linear growth.

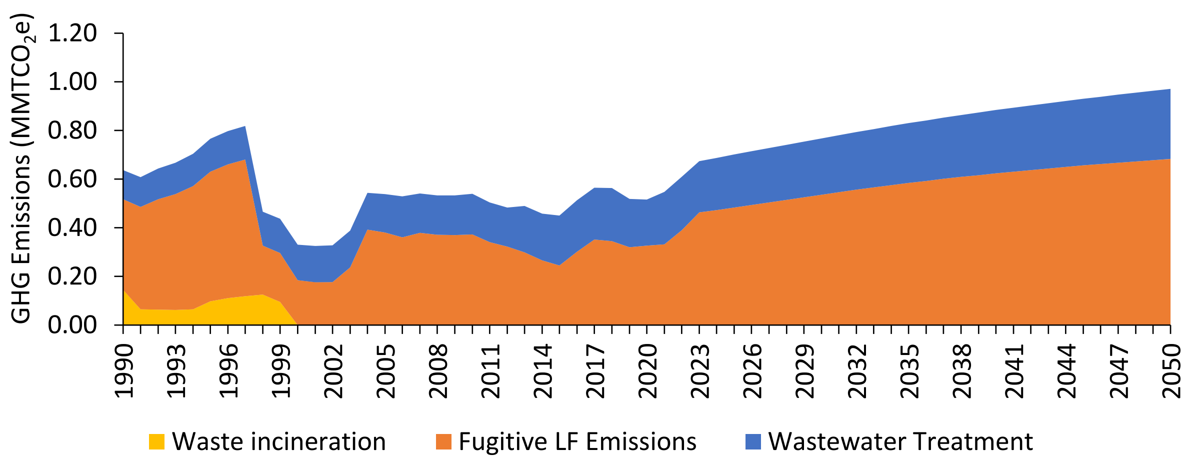

Figure 33: GHG emissions and projections in the waste management sector from 1990 to 2050 by source

2.8 Agriculture Sector

GHG emission projections in the agriculture sector indicate a stable trend with a change of less than 0.1 $MMTCO_2e$ from 2022 to 2050, as shown in Figure 34. The PT model assumes a linear decrease in emissions over this period, resulting in relatively steady overall GHG emissions for the agriculture sector.

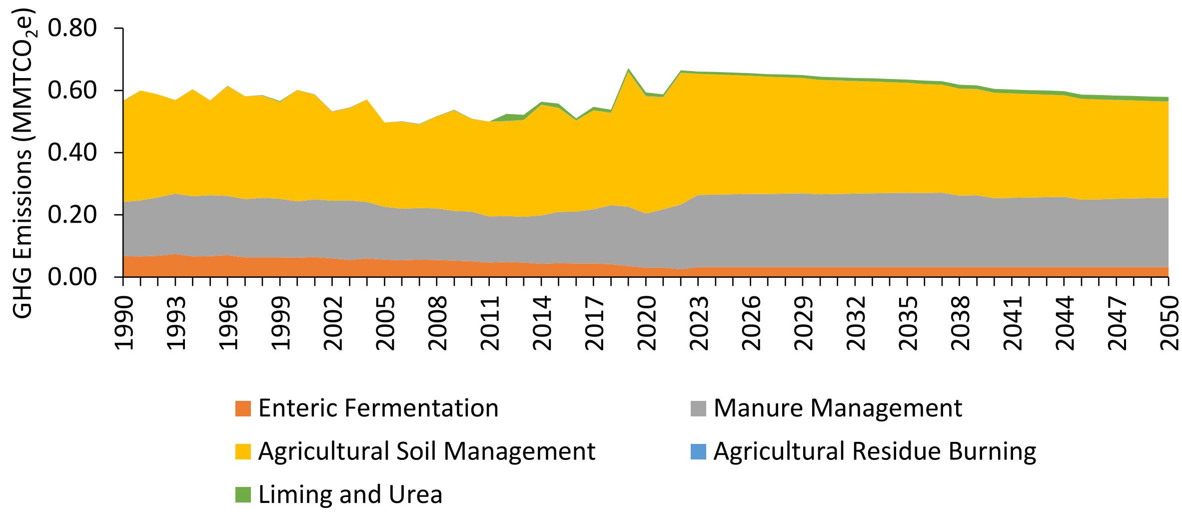

Figure 34: GHG emissions and projections in the agricultural sector from 1990 to 2050 by source

2.9 Land Use, Land Change, and Forestry Sector

The LULUCF sector is not included in the PT. To develop projected estimates, it was assumed that emissions and sequestration remain constant after 2022, as shown in Figure 35.

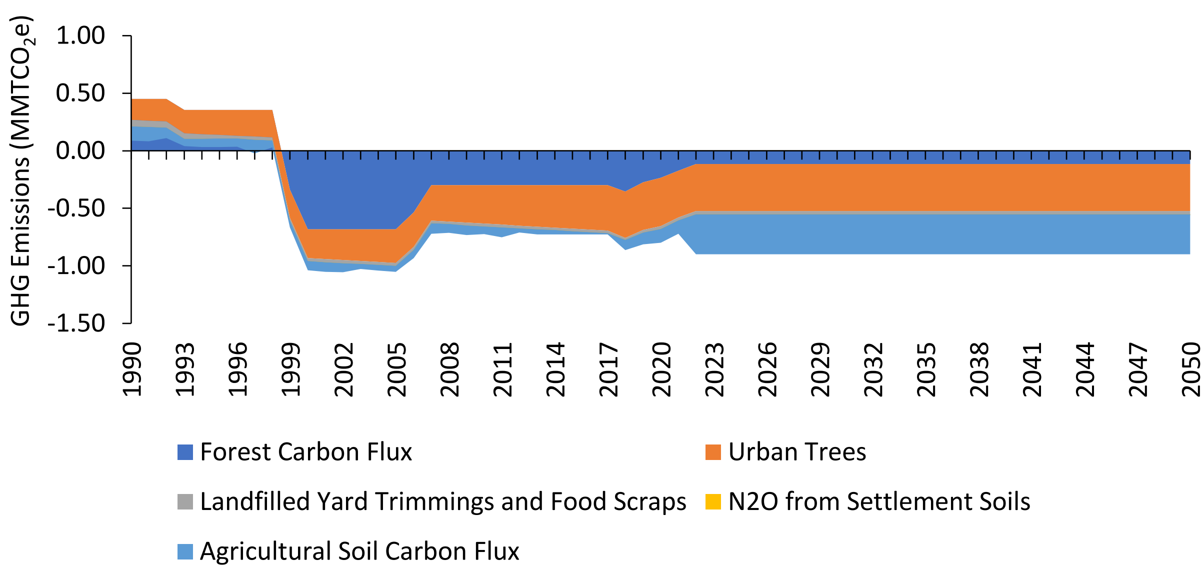

Figure 35: Projections of GHG emissions and sequestration (represented as negative emissions), of carbon (in MMTCO₂e) in the LULUCF sector from 1990 to 2050 by source

3.0 Key Takeaways

Delaware's gross total GHG emissions in 2022 were estimated at 17.3 $MMTCO_2e$, which represents a 25.4% decrease in emissions from the baseline year. This indicates that Delaware is making steady progress towards its emission goals. Although Delaware has made progress towards its emissions reduction goals, it is important to note that much of the emissions reduction in 2022 resulted from the stabilization of economic activity following the post-COVID period.

The 2022 GHG Inventory includes the same sources and sinks as in the 2021 Inventory, with updates to the SIT modules used and additional sector specific updates mentioned in this report.

The three largest emitting sectors in Delaware in 2022 were transportation, electric power (including consumption-based emissions), and industrial sectors. After experiencing a gradual increase in recent years, the transportation sector saw a sharp decrease in emissions in 2020 due to the effects of the COVID-19 pandemic. However, this decrease was only temporary as emissions from the transportation sector went up again in 2021 and began leveling off in 2022. The electric power sector has shown significant declines from shifts to lower-emitting combustion fuels and zero-emitting sources of power. Emissions from electric power generated in-state are projected to decrease, while emissions from electric power imported into Delaware are expected to increase in the future. The industrial sector had a sharp decline in 2009, which was primarily caused by the economic recession and the Delaware City refinery temporarily shutting down operations. However, emissions from the industrial sector returned to their pre-2009 levels shortly after and are expected to continue increasing in the future.

The 2021 Delaware Climate Action Plan[45] identified three important takeaways for reducing GHG emissions from these high-emitting sectors in Delaware:

1) Decarbonizing the electrical grid has the greatest emissions reduction potential in the mid- and long terms and accelerates the emissions reduction potential of other actions.
2) Energy efficiency actions provide effective and low-cost strategies to meet Delaware's short-term goal and remain important for emissions reduction in the long term.
3) Electrification of the transportation and building sectors is an important transition that can lead to significant GHG emissions reductions over time. Achieving the greatest potential emissions reductions from these actions depends on decarbonizing the electrical grid.

Delaware is already experiencing harmful impacts from the effects of climate change such as increased temperatures, hotter and longer summers, rising sea levels, and increased precipitation. The State has already experienced over 1 foot of sea level rise at the Lewes tide gauge since 1900. By midcentury, sea levels are projected to rise another 9 to 23 inches and, by

[45] Delaware's Climate Action Plan (2021). https://documents.dnrec.delaware.gov/energy/Documents/Climate/Plan/Delaware-Climate-Action-Plan-2021.pdf

2100, up to an additional 5 feet. Average temperatures in Delaware have increased approximately 2°F since 1895, and temperatures are projected to continue increasing. Annual average precipitation in the state is projected to increase by 10% by 2100. The number of very wet days (2" or more of rainfall) will also increase. This can result in more flooding events, which are further amplified by sea level rise.[46]

It is important to continue to reduce GHG emissions by implementing the policies and programs outlined in Delaware's Climate Action Plan to protect Delaware from potential harmful impacts of climate change. A detailed analysis of emission reduction strategies is presented in the 2025 update to Delaware's Climate Action Plan. This analysis models emissions and provides further detail on the policies and programs necessary to reduce GHG emissions projected in the BAU scenarios described in this report. Reducing emissions in the transportation, electric power, and industrial sectors will have a meaningful impact on emissions in Delaware and will help meet state goals to reduce emissions by 50.0% from the 2005 baseline by 2030 and to reach net-zero emissions by 2050.

[46] Delaware's Climate Action plan. Available online at: https://dnrec.delaware.gov/climate-plan/.